Graduate Education
and
Research
in the
School of Engineering

by

by

CIRCULAR NO. 39
JANUARY 1970

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ENGINEERING EXPERIMENT STATION
OREGON STATE UNIVERSITY
CORVALLIS, OREGON 97331

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OREGON STATE UNIVERSITY
CORVALLIS, OREGON 97331
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<tr>
<td>Specialty Areas of Engineering Faculty</td>
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</tbody>
</table>
FORWARD

This report briefly summarizes the graduate education and research activity in the School of Engineering at Oregon State University. The undergraduate and graduate programs of the School provide a basis for sound modern training of personnel for the technical community.

Programs leading to B.S., M.S., and Ph.D. are offered in the following majors:

Agricultural Engineering (Cooperative with School of Agriculture)
Chemical Engineering
Civil Engineering
Electrical and Electronic Engineering
Industrial Engineering
Mechanical Engineering
Metallurgical Engineering
Nuclear Engineering
Ocean Engineering (Master of Ocean Engineering also offered, no B.S. offered)

The research activity in the School is fully integrated into the graduate program. All research projects are initiated by faculty and are conducted in the laboratories of the several departments of the School. Research supported by outside sponsors must be (a) of such a nature that it utilizes the special facilities of the School and the special professional competence of one or more members of the engineering faculty; (b) closely allied to the on-going research program of the School and the faculty conducting the work; (c) of a nature so that it may serve the educational objectives of the School through participation of graduate students studying in fields closely related to work; and (d) it may qualify for M.S. or Ph.D. theses. All Faculty carrying on research activities also participate fully in both undergraduate and graduate instructional activities in the School.

Graduate programs in the School of Engineering are flexible so that the individual needs and desires of each student may be accommodated. There is ample opportunity for interdisciplinary work among the various engineering departments as well as with other Schools on the campus.

Present research activity in the School amounts to slightly more than $900,000 per year. One-third of this amount goes toward the support of graduate students through research assistantships, traineeships, and fellowships. The remainder provides summer support for Faculty and experimental equipment. Equipment purchased by research funds greatly enhances both the undergraduate and graduate instructional programs.
## Ten Year Statistics - Enrollment and Degrees

<table>
<thead>
<tr>
<th>Year</th>
<th>Undergraduate</th>
<th>Graduate</th>
<th>B.S.</th>
<th>M.S.</th>
<th>Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968-69</td>
<td>1800</td>
<td>166</td>
<td>347</td>
<td>47</td>
<td>14</td>
</tr>
<tr>
<td>1967-68</td>
<td>1717</td>
<td>172</td>
<td>266</td>
<td>43</td>
<td>15</td>
</tr>
<tr>
<td>1966-67</td>
<td>1566</td>
<td>149</td>
<td>248</td>
<td>39</td>
<td>11</td>
</tr>
<tr>
<td>1965-66</td>
<td>1493</td>
<td>137</td>
<td>222</td>
<td>41</td>
<td>8</td>
</tr>
<tr>
<td>1964-65</td>
<td>1388</td>
<td>122</td>
<td>269</td>
<td>42</td>
<td>9</td>
</tr>
<tr>
<td>1963-64</td>
<td>1408</td>
<td>117</td>
<td>223</td>
<td>37</td>
<td>4</td>
</tr>
<tr>
<td>1962-63</td>
<td>1418</td>
<td>101</td>
<td>209</td>
<td>47</td>
<td>1</td>
</tr>
<tr>
<td>1961-62</td>
<td>1278</td>
<td>83</td>
<td>252</td>
<td>38</td>
<td>5</td>
</tr>
<tr>
<td>1960-61</td>
<td>1275</td>
<td>83</td>
<td>257</td>
<td>26</td>
<td>--</td>
</tr>
<tr>
<td>1959-60</td>
<td>1334</td>
<td>59</td>
<td>311</td>
<td>29</td>
<td>1</td>
</tr>
</tbody>
</table>
GRADUATE EDUCATION IN ENGINEERING
OREGON STATE UNIVERSITY
1960-1969

- Total Advanced Degrees in Engineering
- Graduate Enrollment in Engineering
- PhD's Granted in Engineering
### FACULTY, ENROLLMENT, AND GRADUATE DEGREES GRANTED

#### Enrollment, Fall 1968

<table>
<thead>
<tr>
<th>Degree Program</th>
<th>Faculty</th>
<th>M.S.</th>
<th>Ph.D.</th>
<th>M.S.</th>
<th>Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Engrg.</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chemical Engrg.</td>
<td>6</td>
<td>4</td>
<td>17</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Civil Engrg.</td>
<td>22</td>
<td>33</td>
<td>13</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Electrical Engrg.</td>
<td>18</td>
<td>36</td>
<td>13</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Mechanical Engrg.</td>
<td>21</td>
<td>20</td>
<td>15</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Industrial Engrg.</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Nuclear Engrg.</td>
<td>3</td>
<td>7</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>84</strong></td>
<td><strong>109</strong></td>
<td><strong>65</strong></td>
<td><strong>52</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

Only three professorial ranks.

#### Degrees Granted, 1967-68

<table>
<thead>
<tr>
<th>Degree Program</th>
<th>Faculty</th>
<th>M.S.</th>
<th>Ph.D.</th>
<th>M.S.</th>
<th>Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Engrg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Engrg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil Engrg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Engrg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Engrg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Engrg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear Engrg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71</strong></td>
<td><strong>47</strong></td>
<td><strong>14</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Only three professorial ranks.

#### Enrollment, Fall 1969

<table>
<thead>
<tr>
<th>Degree Program</th>
<th>Faculty</th>
<th>M.S.</th>
<th>Ph.D.</th>
<th>M.S.</th>
<th>Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Engrg.</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chemical Engrg.</td>
<td>6</td>
<td>8</td>
<td>13</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Civil Engrg.</td>
<td>22</td>
<td>36</td>
<td>15</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Electrical Engrg.</td>
<td>18</td>
<td>43</td>
<td>13</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Mechanical Engrg.</td>
<td>16</td>
<td>20</td>
<td>17</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Industrial Engrg.</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>0</td>
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<tr>
<td>Nuclear Engrg.</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Metallurgical Engrg.</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>1</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>87</strong></td>
<td><strong>125</strong></td>
<td><strong>71</strong></td>
<td><strong>47</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>

Only three professorial ranks.
APPOINTMENT AVAILABLE TO GRADUATE STUDENTS

<table>
<thead>
<tr>
<th>Title of Appointee</th>
<th>Appointments Available</th>
<th>Appointments Available</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1968-69</td>
<td>1967-68</td>
</tr>
<tr>
<td>Research Assistant</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Research Assistant</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>FWPCA Trainee</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>NSF Trainee</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>NASA Fellow</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>NDEA Fellow</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>NIH Trainee</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Ind. Fellow</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Teaching Assistant</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>OCD Trainee</td>
<td>--</td>
<td>2</td>
</tr>
<tr>
<td>USBM Fellow</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

1 Appointments on sponsored research projects.
2 State-supported research assistantships.

SOURCE OF RESEARCH INCOME

<table>
<thead>
<tr>
<th></th>
<th>1967-68</th>
<th>1968-69</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Government</td>
<td>$550,000</td>
<td>$762,000</td>
</tr>
<tr>
<td>State and Local Government</td>
<td>50,000</td>
<td>76,000</td>
</tr>
<tr>
<td>Private, Nonprofit organization</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Business and Industry</td>
<td>40,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Other</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$710,000</td>
<td>$933,000</td>
</tr>
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</table>
RESEARCH ACTIVITY IN THE SCHOOL OF ENGINEERING
OREGON STATE UNIVERSITY
1960 - 1969

ANNUAL EXPENDITURE - MILLIONS OF DOLLARS

YEAR

1960  '61  '62  '63  '64  '65  '66  '67  '68  '69  1970
CURRENT RESEARCH AREAS

Agricultural Engineering

Mechanical Stemming of Strawberries
Housing the Aged
Irrigation and Drainage
Sprinkler Irrigation
Computer Analysis of Drainage
Small Fruit Harvesting and Handling
Douglas Fir Bark as a Filter Media for the Disposal of Animal Wastes
Labor Efficiency Studies in the Lily Bulb Industry
Pesticide Application Equipment
Field Burning Abatement Investigation
Air-Supported Plastic Greenhouses
Farm Structures and Environment

Chemical Engineering

Minimizing Axial Dispersion of Fluid in Process Equipment
Design of Continuous Chromatographic Columns
How to Treat Reactive Distillation
Control of Residence Time Distribution of Flowing Solids in Gas-Solid Equipment
Reaction Products in A.C. Electrolysis
High Temperature Batteries with Solid Electrolyte
Pore Size Distributions in Battery Separators
Mechanism of Purification of Kroll-Process Sponge
Mixed Mechanism Kinetics of the Decomposition of N₂O
Composition Dependence of Diffusivity in Binary Gaseous Systems
Demineralization of Water by Continuous, Countercurrent Ion Exchange
Diffusion Coefficients of Hydrocarbons in Air
Gas Absorption by Entrainment from a Plunging Liquid Jet
Kinetics of Microbial Growth
Thermal Distillation within a Wetted-Wall Column
Absorption of Methyl Iodide by Aqueous Hydrazine Solutions within Spray Chambers
Absorption of Methyl Mercaptans with and without Chemical Reactors
Characteristics of Climbing Film Flow in Annular Ducts
Flow Characteristics of Dispersions
Scaling and Fouling in Boiling Liquids
Mixing in Rod Bundles

Civil Engineering

Airphoto Analysis of Ocean Outfall Dispersions
Pulp Mill Waste Disposal in Marine Waters
Civil Engineering - continued

Statistical Quality Control Applied to Asphalt Concrete
Economic Analysis for Highway Planning
Nuclear Moisture Measurement of Ocean Sediments
Compaction Pore Pressure Prediction in Dams
Construction Scheduling
Friction Pile Capacity in Silts
Settlement Estimates for Fills on Silts
Strength of Wood in Radial Tension
Virus Adsorption
Buoy Dynamics
Low Ocean Current Measurement
Construction Research
Finite Element and Matrix Analysis of Structures
Computer Applications in Predicting Water Quality
Influence of Log Handling Practices on Water Quality
Structural Dynamics of Elastic Plates and Shells
Electronic Surveying
Error Analysis of Complex Control Networks
Watershed Hydrology
Effects of Watershed Practices on Stream Sediment
Quantitative Behavior of Estuaries
Water Quality of Netarts Bay
Thermal Pollution
Environmental Engineering and Management factors for Urban and Regional Planning of the Willamette Valley

Electrical and Electronics Engineering

High Voltage Transmission Lines
Computers
Scattering from Moving Objects
Diffraction of Dipole Radiation by a Moving, Dispersive Half Space
Surface Waves Along a Moving, Plasma Half-Space
Digital Wave Height Sensor
Independent Spacial Mode Control in Lasers
Thin and Thick Film Wave Guiding Structures
Scattering from a Rough Sea Surface
Remote Sensing
Optimization of Distributed Parameter Networks
Solid-State Devices
Wave Propagation on Lossy Transmission Lines, Taking Account of Ground Impedance
Man-Machine Interactive Algorithms
Digital Systems
Magnetic Materials
Electrical and Electronics Engineering - continued

Switching Theory
Hydroacoustics
Integrated Circuits

Industrial Engineering

The Saury Fishery Resource
GASP Simulation Language
Fisheries System Design
Capital Budgeting
Quantitative Decision Making

Mechanical Engineering

Secondary Laminary Flow in Bends
Computer Programs for External Flows
Air Pollution from Agriculture and Forest Burning
Air Pollution Studies
Flow Coupled Diffusion
Thermodynamics
Thermal Plume Dispersion
Natural Conversion in Liquid Metals
Thermal Starting Length Studies in Non-Newtonian Fluids
Unsteady Flow

Metallurgical Engineering

Fracture Mechanics
Structural Aspects of the Properties of Materials
Deformation Characteristics of Metals
Diffusion

Nuclear Engineering

Neutron Radiography
Fast Reactor Computation
Nuclear Moisture Meter for Ocean Sediments
Nuclear Processing
MAJOR FACILITIES OF THE SCHOOL OF ENGINEERING

CHEMICAL ENGINEERING - 18,600 sq. ft. of laboratory area including:

- Unit Operations Laboratory
- Electrochemical Laboratory
- Control Laboratory
- Computer Laboratory
- Various Specialty Laboratories

Major Equipment includes: EAI TR 20 Analog Computer, Instrumentation equipment, Minneapolis Honeywell visicorder, equipment to study transport phenomena, various analytical equipment including chromatographs and spectrophotometers.

CIVIL ENGINEERING - 35,400 sq. ft. of laboratory area including:

- Sanitary Engineering Laboratory
- Highway Materials Laboratory
- Transportation Laboratory
- Concrete Materials Laboratory
- Hydraulic and Fluid Mechanics Laboratory
- Soil Mechanics Laboratory
- Water Demonstration Laboratory
- Structural Laboratory
- Surveying and Photogrammetry Laboratory

Equipment includes: Materials testing machines, chromatographs, spectrophotometers, carbon analyzer and other Sanitary Engineering laboratory instruments, open channel, wave basin, wave generation and fluid measuring equipment, soil mechanics instrumentation, sediment transport channel, various boats for field studies.

ELECTRICAL AND ELECTRONICS ENGINEERING - 24,000 sq. ft. of laboratory area including:

- Analog Computer Laboratory
- Circuits Laboratory
- Communications Laboratory
- Control Laboratory
- Design Laboratory
- Digital Laboratory
- Electronics Laboratory
- Energy Conversion Laboratory
- High-Voltage Laboratory
ELECTRICAL AND ELECTRONICS ENGINEERING - continued

Pulse Circuits Laboratory
Radiation Laboratory
Simulation Laboratory
Solid-State Laboratory
Systems Instrumentation Laboratory
Transmission Lines Laboratory

Equipment includes: EAI 690 Hybrid Computer with FR 1300 Ampex portable tape recorder, 3 analog computers (2 PACE and 1 Comcor), Varian Unit, furnaces, high voltage equipment (350,000 AC, 400,000 DC), Miscellaneous Instrumentation, Oscillascopes, Tape Transports, and Plotters.

INDUSTRIAL ENGINEERING - 2,000 sq. ft. systems design laboratory including:

21 Individual Carrels
Control Area
Main Laboratory

Equipment includes: Time lapse devices, 16 mm projectors, portable tape recorders, Vidicon camera, monitors.

MECHANICAL ENGINEERING - 40,000 sq. ft of laboratory area including:

Mechanical Laboratory
Stress Analysis
Vibrations
Heating and Air Conditioning
Refrigeration
Fuels and Lubricants
Principles of Nuclear Engineering
Power Plant Engineering
Gas Turbines and Jet Engines
Analogue Computers
Industrial Instrumentation
Acoustical Measurement and Control
Automotive Engineering
Heat Transfer

METALLURGICAL ENGINEERING - 7,000 sq. ft. of laboratory area including:

- Metal melting, heat treating and forming laboratory
- Metallography laboratory
- Physical properties laboratory
- X-ray analysis laboratory
- Electron microscopy laboratory
- Nature and Behavior of Materials laboratory

Equipment includes small rolling mill, ten furnaces, extensive metallography equipment, electron beam single crystal growing equipment, crystal slicer, Instron testing machine, electrical conductor creep testing equipment, Norelco x-ray diffraction unit with extensive accessories, 200 kv Baltograph radiography unit, Hitachi 125 kv electron microscope.

NUCLEAR ENGINEERING - 1,840 sq. ft. of office and laboratory space with an additional part-time use of about 15,000 sq. ft. of laboratory area in OSU Radiation, shared by research and instructional activities of other departments including:

- Instrument Laboratory
- Counting Laboratories
- X-ray Laboratory; 300 Kva, 250 Kva x-ray generators
- Gamma Radiation laboratory with 3,000 Curie Co-60 source
- Hot cell facilities
- Nuclear Reactor Analysis laboratory

Equipment includes: TRIGA Mark II reactor, AGN-201 reactor, 14 Mev Neutron Generators, Subcritical Assembly.
GRADUATE PROGRAM IN OCEAN ENGINEERING

The School of Engineering participates in the University's Sea Grant program which is funded by the National Science Foundation with a portion to be matched by State contributions.

The initial grant by NSF for one year beginning February 1, 1968 amounted to $530,000. The second year's grant from NSF amounted to $800,000.

The total extent of research and training carried on by the School of Engineering presently amounts to about $250,000 per year.

Graduate study in ocean engineering is offered at Oregon State University through the School of Engineering. This program of study leads to the degree of Master of Ocean Engineering or Master of Science and Doctor of Philosophy degrees in Engineering with an emphasis on ocean engineering. These interdisciplinary programs are offered in cooperation with the Oceanography Department and other academic faculties with special interests in ocean science.

The Master of Ocean Engineering program is administered on an interdepartmental basis by a School of Engineering committee. The Master of Ocean Engineering and the Master of Science in Engineering require 45 quarter credit hours, including research. A major field of study in one of the engineering disciplines and a minor in oceanography are normally required. The Doctor of Philosophy program requires at least three years of study beyond the baccalaureate degree and includes about 135 quarter credit hours of course and thesis work.

A student in ocean engineering, depending on his specific interests, is admitted to the Department of Chemical, Civil, Electrical, Industrial, or Mechanical Engineering. A program of study is then designed to fit the individual's professional objectives and to achieve a high degree of engineering competence applied to the ocean environment.

Research

Students in this program are expected to prepare a thesis on a problem related to ocean engineering. Joint projects are frequently carried out with the Oceanography Department and other academic units.
Some of the study and research areas emphasized for development under the "Sea Grant" program are:

- Coastal and estuarine hydrodynamics and hydraulics
- Marine water pollution control
- Marine geotechnique
- Coastal structures
- Engineering materials and electrochemical processes
- Marine systems design
- Instrumentation
- Simulation
- Fluid measurements
- Underwater acoustics
- Biochemical engineering
- Marine bioacoustics

Facilities

In addition to on-campus facilities, Oregon State University maintains field laboratories and has access to the facilities of several federal laboratories. These include the following:

OSU Marine Science Center at Newport, Oregon
    Yaquina Marine Biology Laboratory
    Pacific Fisheries Laboratory

OSU oceanographic research vessels
    Yaquina (180 feet, 900 tons)
    Cayuse (80 feet)
    Paiute (33 feet)

OSU Netarts Bay Research area
OSU Port Orford Marine Station
OSU Seafoods Laboratory, Astoria
Pacific Northwest Water Laboratory, USDI, FWPCA, Corvallis
Vaughn William Abbott  
Mechanical Engineering  
"The Effect of Small Amounts of Magnesium on the Superplastic Behavior of an Aluminum-Zinc Alloy"

Tsunehiro Aibara  
Electrical Engineering  
"A New Method for the Synthesis of Networks by Using Cut-set Matrices"

Yoon-Goon Bae  
Electrical Engineering  
"Limit Cycle Detection of the Van der Pol Equation"

Robert James Bertorello  
Electrical Engineering  
"A Zero-Crossing Analyzer for Distribution-Free Detection of a Signal in Noise"

John Roger Bladholm  
Industrial Engineering  
"The Development and Application of a 'Self-Help' Industrial Training Concept for the Fashion Apparel Industry"

Richard William Bradley  
Electrical Engineering  
"Real-Time Band with Compression Using Hilbert Transforms"

David Kin-Poon Cheung  
Electrical Engineering  
"Compatible Field-Effect and Bipolar Transistors"

Ching Hwa Chiang  
Electrical Engineering  
"Active Network Synthesis Using Operational Amplifiers"

James Dennis Clarke  
Civil Engineering  
"The Evaluation of the Field Vane Shear Strength Analysis of the Glen Aiken Creek Embankment Failure"

Paul Nelson Cowgeill  
Electrical Engineering  
"Design-Approach Evaluation of Multiple-Input, Model-Reference, Adaptive Control Systems"

Gerald Robert Cunningham  
Civil Engineering  
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