CLEMSON UNIVERSITY

ANNUAL REPORT

1986-1987

Printed Under the Direction of The State Budget And Control Board
As we begin a year of Centennial celebration and renewed commitment to excellence in Clemson University's Second Century, it is a good time to look back at the many accomplishments of the 1986-87 academic year.

**In Research and Academic Affairs:**
- The number of proposals sent to funding sources increased 20 percent.
- The total value of grants and contracts awarded increased 58 percent ($6.5 million more than the previous year).
- Five new centers and institutes were approved: Center for Computer Communication Systems, National Dropout Prevention Center, Emerging Technology Development and Marketing System, Institute for Recreation, Travel and Tourism, and Center of Excellence in Math and Science Education.
- An agreement with Monsanto to seek federal approval to field test a genetically engineered microorganism launched Clemson's Agri-Biotech Initiative.
- Clemson took the lead in a statewide effort to eradicate rural illiteracy in a joint program of the College of Liberal Arts and the College of Agricultural Sciences.
- Internationally known scholar Dr. Art Young was chosen to fill the nation's only endowed chair in technical communications — the Campbell Chair.
- Construction began on a new 40,000-square-foot computer center in the Clemson Research Park.
- A new $11.6 million chemistry building was built and dedicated.
- New programs were instituted in: ceramic engineering (doctorate), language and international trade, fine arts, philosophy, and landscape architecture.
- A week-long program celebrating the Bicentennial of the Constitution brought nationally recognized speakers to campus.
- Calhoun College celebrated its 25th birthday, making it the oldest as well as the largest honors program in South Carolina.
- The College of Engineering produced the third Presidential Young Investigator Award winner from Clemson in the National Science Foundation program's four-year history.
- The Strom Thurmond Institute was awarded $125,000 for the fourth consecutive year to assist the S.C. Water Resources Commission in developing a statewide water policy.

**In Private Support:**
- The year ended June 30 with a record level of $7.3 million in private giving to support Clemson's academic mission.
- Unrestricted annual giving to the Loyalty Fund also reached a record high of $1.08 million.
- The total also includes $3.4 million from corporations, foundations and associations, the largest sum raised from those groups in Clemson history.
- 268 freshmen entered Clemson on academic scholarships, the largest group ever.
In Student Affairs:

- The 1986-87 year marked the highest on-campus enrollment with 12,152 students registered for classes. A net increase in undergraduate enrollment of 350-400 is expected for this semester.
- Entering freshmen averaged a Scholastic Achievement Test score of 1,025 compared with a national average of 906, giving Clemson the highest average among state-supported institutions in South Carolina.
- Five out of five students nominated received Fulbrights.
- A new employer database in Career Services allowed students to view from any campus terminal a list of employers on campus conducting interviews.
- University Housing developed a one-stop conference shop servicing 11,600 conference/camp attendees this summer.
- The University enjoyed one of its most successful athletic years ever, winning seven ACC championships, “Coach of the Year” honors for three coaches, and All-America and Academic All-America honors for several students.

These are just a few of the highlights of a busy, productive year at Clemson University. Details are presented in the body of this report.

Max Lennon
President
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Board of Trustees</td>
<td>5</td>
</tr>
<tr>
<td>Administrative Officers</td>
<td>5</td>
</tr>
<tr>
<td>College of Agricultural Sciences</td>
<td>7</td>
</tr>
<tr>
<td>College of Architecture</td>
<td>7</td>
</tr>
<tr>
<td>College of Commerce and Industry</td>
<td>11</td>
</tr>
<tr>
<td>College of Education</td>
<td>16</td>
</tr>
<tr>
<td>College of Engineering</td>
<td>18</td>
</tr>
<tr>
<td>College of Forest and Recreation Resources</td>
<td>27</td>
</tr>
<tr>
<td>College of Liberal Arts</td>
<td>27</td>
</tr>
<tr>
<td>College of Nursing</td>
<td>30</td>
</tr>
<tr>
<td>College of Sciences</td>
<td>32</td>
</tr>
<tr>
<td>Division of Agriculture and Natural Resources</td>
<td>39</td>
</tr>
<tr>
<td>College of Agricultural Sciences</td>
<td>40</td>
</tr>
<tr>
<td>S.C. Agricultural Experiment Station</td>
<td>41</td>
</tr>
<tr>
<td>Cooperative Extension Service</td>
<td>64</td>
</tr>
<tr>
<td>Division of Regulatory and Public Service Programs</td>
<td>78</td>
</tr>
<tr>
<td>Livestock-Poultry Health Division</td>
<td>82</td>
</tr>
<tr>
<td>College of Forest and Recreation Resources</td>
<td>83</td>
</tr>
<tr>
<td>Academic Affairs</td>
<td>88</td>
</tr>
<tr>
<td>Clemson University Libraries</td>
<td>88</td>
</tr>
<tr>
<td>Computing and Information Technology</td>
<td>92</td>
</tr>
<tr>
<td>Graduate School</td>
<td>94</td>
</tr>
<tr>
<td>Strom Thurmond Institute</td>
<td>94</td>
</tr>
<tr>
<td>Undergraduate Studies</td>
<td>95</td>
</tr>
<tr>
<td>University Research</td>
<td>95</td>
</tr>
<tr>
<td>Vice President for Administration and Secretary of the Board of Trustees</td>
<td>96</td>
</tr>
<tr>
<td>Fire Department</td>
<td>96</td>
</tr>
<tr>
<td>Human Resources</td>
<td>96</td>
</tr>
<tr>
<td>Internal Auditing</td>
<td>97</td>
</tr>
<tr>
<td>Municipal Judge</td>
<td>97</td>
</tr>
<tr>
<td>Parking and Vehicle Registration</td>
<td>97</td>
</tr>
<tr>
<td>Police Department</td>
<td>97</td>
</tr>
<tr>
<td>Business and Finance</td>
<td>99</td>
</tr>
<tr>
<td>Institutional Advancement</td>
<td>100</td>
</tr>
<tr>
<td>Alumni Relations</td>
<td>100</td>
</tr>
<tr>
<td>Development Office</td>
<td>100</td>
</tr>
<tr>
<td>University Relations</td>
<td>101</td>
</tr>
<tr>
<td>Student Affairs</td>
<td>104</td>
</tr>
</tbody>
</table>
UNIVERSITY BOARD OF TRUSTEES

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COLLEGE OF AGRICULTURAL SCIENCES

The report of 1986-87 activities for the College of Agricultural Sciences' resident instruction and public service programs is included under the Division of Agriculture and Natural Resources on page 40.

COLLEGE OF ARCHITECTURE

The 1986-87 academic year marked the 28th anniversary for the College of Architecture. It has been a significant year with the arrival of Dean James F. Barker, AIA, in July, the approval of three new programs, the selection of two new department heads, the completion of the initial groundwork for the Clemson University College of Architecture Center at the College of Charleston, and the planning for an outstanding visiting critic for 1987-88.

The College of Architecture offers the state of South Carolina's only programs in architecture (undergraduate and graduate), building science and management (undergraduate and now a newly approved master's program), visual arts and history (graduate and newly approved undergraduate program), city and regional planning (graduate) and another new undergraduate professional program in landscape architecture. Architecture, city and regional planning, and the undergraduate program in building science and management are fully accredited by the appropriate accreditation agencies.

The goal of the College of Architecture is to prepare professionals in all facets of our built environment. The importance of sensitive design, careful planning and efficient construction cannot be over-emphasized in protecting our social values and our quality of life.

The addition of the undergraduate program in landscape architecture adds a new dimension to the design and planning aspects of the college just as the undergraduate program in fine arts will strengthen the graduate program in that area. The Master of Building Science and Management program will be a source of top-level managers in the construction industry as this industry moves toward a professional licensing system. The success of these new programs will depend upon additional physical facilities since the current programs already strain the space available to the college. (The College of Architecture is the only one of the nine colleges at Clemson University to restrict enrollment of new students each year.) These three new programs will also demand additional faculty and clerical support as well as equipment to ensure that they will be of a high quality.

An additional goal of the college is to add to the computer capabilities now in place in both graphics and alpha-numeric areas. The present graphic computer facilities are inadequate for the needs of our students. A faculty member is scheduling one color graphics terminal on a 24-hour basis each day. This terminal is in constant demand for both color theory and design graphics.

College Programs

The Clemson University College of Architecture Center at the College of Charleston is a remarkable example of cooperation between two state institutions. The basic plan, starting in the spring of 1988, is to send third- and fourth-year students to Charleston for a semester of study. Physical facilities will be furnished by the College of Charleston, and our students will take studio courses taught by Clemson University design faculty members as well as other courses offered by the College of Charleston. This off-campus program in historic Charleston, along with the on-going graduate program in Genoa, Italy, moves this college to a top position in the nation in off-campus study centers. The Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy, is an intensive research and graduate study center for 20-24 students each fall and spring semester. The center is owned by the Clemson Architectural Foundation, and the program was first implemented in 1973. The center is available to all graduate disciplines in the college.
Each year the college undertakes public service projects that may involve long-range planning and revitalization of communities throughout South Carolina. These types of real-life projects not only assist the communities of the state, but are also a valuable educational experience for our students. Public service projects undertaken during the year include: Riverbanks Zoo Medical and Research Complex, Columbia; Urban Design Study for Florence; Chamber of Commerce Renovations for Gaffney; St. Eugene’s Hospital, Dillon; Wampee Conference Center, Moncks Corner; planning and design proposals for the Isle of Palms; and a study for the Green Avenue area of Greenville.

The Clemson Architectural Foundation Lecture Series, supported entirely by donations to the Clemson Architectural Foundation, continued to bring prominent architects, artists, constructors and planners for evening lectures. Speakers for this series included: Dean James F. Barker, David Seamon, Kent Kubbell, Sho zo Uchii, Richard Hayden, Brian Yale, Paul Maxwell, Orrin Pilkey, Richard Haag, Terrance La Noue, Frank McCall, Roger Rollin, Richard Hails.

Another continuing program supported by the Clemson Architectural Foundation in the College of Architecture is the exhibition series in the Rudolph E. Lee Gallery where student and faculty work is shown as well as traveling shows. The exhibitions shown this past academic year included:

- August 4 - 25: Yugoslav Urban Design Youth Competition
- September 1 - 22: Byron McKeeby Retrospective Print Exhibition
- Sept. 29 - Oct. 13: Visual Arts Faculty Exhibition
- October 20 - 27: Miss Liberty Rededication
- November 3 - 24: North/South Fiber Competition
- November 25 - 26: Architectural Terminal Project Reviews
- December 2 - 19: MFA Thesis Exhibition
- January 7 - 26: The Contemporary Terra Cotta Tile Competition
- Jan. 12 - Feb. 2: Paul Maxwell Paintings and Prints
- Feb. 9 - March 9: Clemson National Print and Drawing Exhibition
- March 23 - April 8: MFA Thesis Exhibition
- April 13 - 14: Architecture Terminal Project Reviews
- May 4 - June 1: Student Honors Exhibition
- June 15 - July 27: Summer Show of Student Work

Department of Architectural Studies

A milestone for the department was the renewal of accreditation by the National Architectural Accrediting Board for the maximum term of five years. This makes the sixth consecutive five-year term of accreditation of the department’s professional degree.

Professor and Dean Emeritus Harlan E. McClure, FAIA, was awarded the Honorary Doctorate of Humanities at Clemson commencement in May 1987. In his final year before retirement, he was part-time professor-in-residence at the Charles E. Daniel Center in Genoa, Italy.

Professor George C. Means Jr., FAIA, presented a workshop on “Health Care Facilities Design Concepts” in Berkeley, CA, and presented “The History and Future of Health Facilities Design” to the Bay Area Chapter of AIA in Oakland, CA.

Professor Martin Davis, editor of the college newsletter, has completed the first two issues of the newsletter and is working on the third. Professor Davis also presented a paper, “The Eclectic Reuben Harrison Hunt,” to the Southeast Chapter of the Society of Architectural Historians at the annual conference in Alabama.

Professor Robert Hogan presented “The Academic Bridges: Convention, Computers and Creativity in the Design Process” at the Southeast Regional ACSA Meeting in Knoxville, TN.

Dr. Jane Hurt successfully completed the requirements for the Ph.D. degree and presented her dissertation, “A Critical Analysis of the Relationships Between User Need and Architectural Form in Eleven Nottinghamshire Primary School Class Groups,” this year at the University of Nottingham in England.
Professor Yuji Kishimoto presented a paper, "The Cross Cultural Research, Rhythm of Space," at the International Conference on Built Form and Cultural Research at the University of Kansas. He also presented "Case Study on Structural Theory for Student Architects" at the ACSA Technology Conference in Washington, DC. Professor Kishimoto traveled to Tokyo to develop the groundwork for an exchange program with Japan. In June 1987 Professor Kishimoto was promoted to the rank of professor.


Professor Richard Norman presented "Intuitive Design of Computation" at a symposium held at the State University of New York. He also presented "Introducing Textile Electronic Color to the Design Studio" at the 1987 World Conference of the Textile Institute in Como, Italy.

Professor Kenneth Russo participated in the Genoa program as the 1985-86 professor-in-residence in Genoa, Italy. He resumed his duties as department head immediately upon his return; Professor John Jacques served as acting department head during that time.


Professor Gayland Witherspoon was elected 1987 president of the South Carolina Chapter of the American Institute of Architects. Professor Witherspoon also organized the 1987 Air Force Symposium held in our college in July.

Professor Joe Young was the 1986-87 professor-in-residence at the Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy.

Department of Building Science and Management

The academic year 1986-87 has been one full of significant events for this department. Professor Ralph Knowland retired as department head, and after a national search, Associate Professor Roger Liska was named to that position.

In November a master's program in building science and management was approved by the Commission on Higher Education. The department celebrated the 25th anniversary of the establishment of the building construction program.

Professor Liska serves as chairman of the Accreditation Committee of the American Council for Construction Education and as a member of the Board of Directors of the American Institute of Constructors.

Professor Steve Schuette is a member of the Board of Directors of the Associated Schools of Construction and also regional director of the ASC. In October, he presented "The Use of Computers in Construction Education" at the regional ASC meeting in Atlanta. Professors Schuette and Liska co-authored "The Electronic Spreadsheet: An Alternative for Computerized Construction," which was published in Builder and Contractor in November 1986.

Department of Planning Studies

The department has completed its 19th year and has produced 133 graduates. It has a current all-time high enrollment of 34 students. The appointment of Professor Jose Caban as department head is another significant event in this department.

Professor Caban continues to serve as editor of the "Palmetto Planner." He was elected to the national office as secretary-treasurer of the American Planning Association's Urban Design and Preservation Division and is a member of the Editorial Board of Urban Design Review.

Professor Barry Nocks presented a paper to the Gerontological Society of America in Chicago entitled "Planning Methodology for Institutional and Community Based Long-Term Care Services."
He also made a presentation to the Carolina Associates Conference on “Divergence in Community Values: Examples in Local Planning Practice.”

A field trip to Baltimore and Washington, DC, for a group of planning students was led by Professor James London and included sessions with planning officials, federal agencies and Senator Strom Thurmond.

The department was involved with several public service projects during the past academic year. Professors Faoro and Caban participated in a joint architectural/planning project for the Isle of Palms with Professor Peter Lee. Visiting Assistant Professor Margaret Foster was responsible for survey of physical and social problems in one of Greenville’s oldest neighborhoods in the Green Avenue area.

Professor London and Professor J. C. Hite presented “Spatial Dimensions of Water Resources Policy” at the Southern Regional Science Association Meeting in Atlanta.

Department of Visual Arts and History

Approval of the Bachelor of Fine Arts program adds a new dimension to the department’s offerings and will strengthen the existing master’s program. Presently, all fine arts graduate students are from other undergraduate programs, and most are out-of-state students.

The department welcomed the return of the department head, Professor John Acorn, from his one-semester sabbatical leave. Professor Mark Hudson was acting head during this period.

Professor Janet Mulholland’s Christo essay on *Surrounded Island* was published in October by Abrams.

Professor Sam Wang had exhibitions in the Rudolph E. Lee Gallery, the University of Oregon Museum of Art and the L. B. Barratt Gallery. Professor Wang received the National Endowment for the Arts/Southern Arts Federation 1987 Fellowship.

Dr. Cecilia Voelker has been conducting research on the quarantine structures on the coast of South Carolina and is the founder of the Southeast Architects and Artists Database (SEAAD). This research is scheduled for publication by *National Geographic*.

Office of the Dean

Dean James Barker gave presentations to the Greenville/Spartanburg, Columbia, Charleston and Hilton Head AIA Sections during the fall and spring semesters. He attended the AIA Urban Design Planning Committee meeting in Starkville, MS. Dean Barker represented Clemson University at the Inter-Community Conference in Jacksonville, FL.

The Clemson Architectural Foundation members elected Dean Barker as secretary-treasurer of the CAF at their annual meeting in February, which was held in Hilton Head. Dean Barker was also elected the Southeastern design arts coordinator for the National Endowment for the Arts.

In March Dean Barker served as a member of the accreditation team that visited the University of Arkansas. Governor Riley appointed Dean Barker to the South Carolina State Board of Architectural Examiners in September. At the national ACSA annual meeting, Dean Barker served as the moderator for the Smalltown Urbanism session.

Dean Barker participated in the July grading session for the National Council of Architectural Registration Board in St Louis. James Barker was also elected the director-elect of ACSA’s Southeast Region and will serve on the National Board of ACSA.
COLLEGE OF COMMERCE AND INDUSTRY

The College of Commerce and Industry comprises Clemson University’s business and textile educational, research and service programs. The main service functions are found in the Small Business Development Center, the Office of Professional Development and the public service component of the School of Textiles. Funded research is monitored by the associate dean and director of research. The Center for Policy Studies has successfully attracted funds to support research in the Department of Economics. The college grants degrees in all the functional business areas and grants three textile degrees at the undergraduate level.

The college is looking forward to the future with an aggressive posture. Faculty and administrators believe the economic development of South Carolina and our region will depend on expanded activities in teaching, research and service by Clemson University. The College of Commerce and Industry will play a critical role in its success.

Over the past several years, more emphasis has been placed on the research accomplishments of the faculty in the College of Commerce and Industry. This emphasis has been particularly evident in hiring of new faculty. We have taken care to ensure that quality teaching is maintained in the context of this new emphasis.

The following (abridged) examples illustrate the accomplishments of the various units of the college.

School of Textiles

As an expansion in innovative teaching programs, a third European Textile Machinery Study has been organized to coincide with the 1987 International Textile Machinery Association Exhibition in Paris. Funding to underwrite travel expenses for 14 students and five faculty members has been obtained from textile industry sources. Following the trip, students and faculty will conduct a seminar to discuss recent technical developments displayed at the show.

During the spring semester our 10th New York Textile Workshop was carried out. Twenty-one students and eight faculty and staff members participated in this three-day program at the New York offices of five major textile corporations.

Enrollment in the textile curricula has increased modestly with more than 100 students majoring in textile programs. There has been expanded interest in textile management, and the response to new course offerings has been positive. During the past year, five new courses were implemented and a thesis-exempt master’s option program was organized and approved.

Research activity in textiles continues to be strong. Textile faculty members have 24 sponsored programs under way, have submitted 32 proposals for additional research, and reported 19 proposals in preparation. Major funding to support the construction of an apparel manufacturing demonstration facility for the Defense Logistics Agency is pending. Should this project materialize, Clemson textiles would be well positioned to expand services to the apparel sector.

Publication efforts also have been rewarding. During the past academic year, textile faculty members published 27 articles and have an additional 17 manuscripts in preparation.

The School of Textiles works closely with textile manufacturers and suppliers. Over the past 12 months, faculty completed nearly 200 public service requests and organized 45 continuing education courses.

School of Business

Department of Economics

The Department of Economics stresses scholarly research, effective teaching and informative public service. The 23 full-time faculty members obtained their Ph.D. degrees from many of the best universities in the nation, bringing to Clemson a variety of teaching and research perspectives.
This year faculty members published in 19 economics journals. Four of these: *The Journal of Political Economy*, *Journal of Law and Economics*, *Review of Economics and Statistics* and *Journal of Human Resources* are among the best journals in the profession.

Published research is directed at important national policy issues: the acid rain debate, academics versus athletics, military wages, regional development, unemployment insurance and survivorship in the banking industry.

Ongoing research is directed at topics such as sexual discrimination in the workplace, academic governance, market approaches to environmental regulation, the impact of regulation on energy supplies and air traffic safety, as well as the more arcane areas of pure economic theory. Both the recently published and ongoing research have received attention in the popular press. This year faculty were recognized in *The Wall Street Journal*, *New York Times*, *Fortune*, *Forbes*, *Washington Post*, *American Banker* and *Aviation Week*.

The department received grants of more than $100,000 this year to support research, including a continuing grant of $10,000 from the DuPont Company for environmental economics research. The department works closely with the Center for Policy Studies to disseminate this research to the widest possible audience.

A grant from the DuPont Company allowed the department to sponsor, in conjunction with the Center for Policy Studies, a seminar series for distinguished scholars. Scholars from the University of Chicago, Texas A & M University, the Federal Reserve Board and other noted institutions participated.

Five master’s students and one Ph.D. student completed requirements for their degrees this year. All accepted positions in government and business. Our first economics Ph.D. student has accepted a position with the Securities and Trade Commission in the Office of Chief Economist.

The department completed a proposal to begin a new economics journal tentatively entitled the *Journal of Industrial Economics*. Several publishers have expressed strong interest. We think this journal will provide an exciting new outlet for economic research and will fully exploit the expertise of our faculty.

**Department of Finance**

The Department of Finance’s teaching load soared to one of the highest in the University during the past year as the growth in finance majors began to “come on line.” This load increase occurred in spite of adding a net of one faculty member for the year. Growth in finance majors will continue, with 183 new majors expected this fall. This represents a 66 percent increase over last year. The department will need additional resources and faculty in the near future.

Finance faculty members emphasized their research this past year to help the department exceed AACSB accreditation standards for research. Professor Sirmans continues to lead the department’s research effort with five refereed publications. The variety of research subjects investigated by the faculty included creative debt financing and municipal bonds, valuation of VA assumable loans, income property valuation, an analysis of IRAs, how expenditure taxes affect saving incentives, how insider “nontrading” can be inefficient, leveraged buyouts in the textile industry, how specialized assets and government regulation interact to affect organizational structure in the natural gas industry, and an analysis of how effectively the diverse kinds of price and interest rate indices in mortgage contracts cope with volatile interest rates.

Several financial institutions, including NCNB and First Union of South Carolina, and other companies supported student scholarships during the year. Thomas C. “Buck” Breazeale contributed $5,000 as seed money for a financial planning program. David Strain, vice chairman of First Union, personally contributed to a Finance Excellence Fund, which will support faculty travel and research.

**Department of Management**

Two members of the Department of Management faculty, Professors LaForge and McNichols, won the 1986 Instructional Innovation Award from the National Decision Sciences Institute (DSI). Their paper, “An Integrative, Experiential Approach to Teaching Production Management,” explained the development of a course allowing students to gain managerial experience in a computer-simulated manufacturing plant. The award was presented in Hawaii Nov. 23.
Jobscope Corporation gave the department software, valued at $65,000, for teaching and research in manufacturing management. Also, IBM gave the department almost $100,000 worth of software for use in artificial intelligence.

Consistent with the department’s policy to keep curricula responsive to the needs of the business community, the curricula for the Bachelor of Science in Management and the Bachelor of Science in Industrial Management were updated for the 1986 fall term.

The teaching load on the department’s faculty, in terms of number of students taught, increased almost 10 percent over the previous academic year.

Starting with the 1986 fall term, the department began publication of the “Alumni Newsletter.” The need for the publication was identified in a survey of the department’s alumni.

**Department of Marketing**

Marketing has the newest undergraduate curriculum in the College of Commerce and Industry. It received final approval at the state level in May 1986 and was initiated in August 1986. This program was received with great enthusiasm, evidenced by the more than 300 students who enrolled during the first year. Students have transferred into marketing from majors across the campus, and many incoming freshmen have chosen marketing as their major.

A new tenure-track faculty member with an engineering and industry background has been added to teach the industrial marketing course. Another faculty member successfully completed the research requirement for his Ph.D. degree at the University of Tennessee.

One faculty member is funded for a research project to gain insight into improving retention rates for minority students at Clemson University. Another taught a spring semester seminar in “Services Marketing.”

Some marketing classes received significant publicity this year for research projects performed for the business community. Several business owners came to campus to hear student presentations on improving marketing practices in their companies.

**School of Accountancy**

The School of Accountancy graduated 94 students during the 1986-87 academic year, 86 B.S. and 8 MPAcc degrees. Of these graduates, 36 percent accepted positions with certified public accounting firms, 27 percent with national public accounting firms. These percentages are below the 1985-86 experience but compare favorably with regional and national statistics. The number of firms recruiting accounting students continues to increase. The School of Accountancy is being recognized by accounting firms and industry in South Carolina, Georgia and North Carolina as a major accounting program in the region. Enrollments in the B.S. and the MPAcc programs continue to increase with record numbers anticipated for the fall semester 1987. Performance by Clemson students on the CPA exam has improved. Curriculum changes should produce continued improvement over the next several years.

Faculty research productivity continues to increase. During the 1986-87 academic year, the faculty authored or co-authored 35 articles published or accepted for publication in accounting and business journals. Additionally, the faculty presented 11 papers at professional meetings and presented numerous speeches and professional development courses. Three faculty members received national recognition for a manuscript submitted to *Management Accounting*, which was selected as one of the top 25 submitted to the journal.

A member of the school’s faculty received the first College of Commerce and Industry J. E. Sirrine Foundation Award for Excellence in Teaching. The faculty has been active professionally, with five faculty members serving on committees of national professional accounting organizations. Several faculty members hold positions on the board of directors of local or regional professional accounting organizations. Several serve on committees at the state level as well.
Small Business Development Center

The Clemson University Small Business Development Center, with satellite offices at Spar-
tanburg Technical College, Greenville Technical College and Lander College, continued to deliver quality business and technical assistance to the 11 northwestern counties of South Carolina. The goal, assigned by the Small Business Administration and the Control Center, of assistance to 390 small businesses was exceeded by 176 percent for a total of 688 clients served. The goal of 18 management training programs assigned to our center was exceeded by 122 percent, and the assigned number of attendees of 306 was exceeded by 155 percent for a total of 474 attendees. Loan packages have been developed and funds dispensed for more than $1,000,000 this calendar year.

The Clemson Basic Service Center has continued efforts in the research area. A Research Findings of Small Business Needs Assessment has been completed and printed. This report includes business management information, educational needs assessment and respondent information. This management tool is valuable as we plan and deliver business management and educational needs to our clients.

The center has been assigned additional responsibility for administering a Defense Logistics Agency grant for the establishment of a federal procurement program for small businesses.

Beyond establishing and maintaining this foundation of deliverables, the Small Business Development Center has voluntarily expanded its role on the campus of Clemson University. It promotes funding from sources other than the federal and state governments to initiate economic development programs that support Clemson University's Second Century Plan for rural economic development and an Emerging Technology Development and Marketing Center.

Center for Policy Studies

The Center for Policy Studies completed its second full year of operation. More than $200,000 in private funding from foundations supported programs this year. The primary source of funding has been the Sarah Scaife Foundation of Pittsburgh.

Twelve working papers by Clemson economics faculty were produced and distributed to a national audience of academicians and selected government officials concerned with economic analysis.

The center hosted two programs for the Liberty Fund, Inc., attracting 50 professors from various social science and liberal arts disciplines at colleges in the Southeast. The programs featured lectures by nationally recognized scholars in economics and the American Constitution. These programs brought Southern faculty into contact with members of the Clemson economics faculty and helped identify Clemson as a center of scholarly activity.

The center provided travel and summer salary research support for members of the Clemson economics faculty. This is one of the most important aspects of the center since Clemson is not competitive with major research universities in the availability of internal summer money. Some new faculty became more interested in Clemson because of the possibility of summer research support.

The center hosted several academic programs during the past year. In December five Clemson economists joined 20 other participants for a program at Boston University to discuss the impact of culture on economic development. Co-hosted with the Institute for Economic Culture of Boston University, participants considered the degree of economic success in Asia and the failure elsewhere that could be attributed to social forces.

In February the center organized a program in Bermuda to study the impact of governmental funding on academic freedom. Four Clemson economists joined a dozen others from colleges around the country to consider whether academics have incentives to support large governments since funding for state and private colleges mostly comes from governmental sources. The results will be published next year in a book titled The Academy and the State.

In June 20 participants gathered at the Lutheran Seminary in Columbia to hear lectures on the role of economics in Christian ethics. Economists from Clemson joined with clergy from various denominations for three days to discuss the morality of the market.
Clemson economists working with the center continued to publish textbooks, scholarly books, articles in scholarly journals, as well as popular pieces in publications such as Fortune, Forbes and the Greenville News. To help spread the lessons of market economics, faculty members affiliated with the center served on state and federal commissions and projects examining government policy in various areas.

The center continued to work with the South Carolina Council on Education by sponsoring a three-credit college course for teachers in Greenville each semester and summer session. The center also hosted Economics Day, attracting more than 60 high school students who came to hear Clemson faculty talk about economics as a career and about current economic issues.

**Office of Professional Development**

The College of Commerce and Industry made great strides in continuing professional education in 1986-87 with a streamlined product line in an extremely competitive seminar economy.

As more low-cost seminar providers began flooding the marketplace and big-name competitors declared bankruptcy, Professional Development adjusted its strategy to conform to the competitive environment and ensure survival. In the process, PD had its best financial year.

As always, the backbone of Professional Development, known widely as the nation's largest college-based continuing education unit, is textiles. With the somewhat more normal economic complexion of the textile industry, textile enrollments exceeded projections, garnering almost 3,000 participants in 46 two-day and three-day technical conferences.

Just-in-time (JIT) and quick response technology were the major drawing cards in the textile arena as two conferences attracted 135 public attendees and generated seven or more specially tailored on-site programs. More JIT conferences are being planned.

With the help of multiple mailing techniques, Textile School Director Ed Vaughn's Nonwoven Fabrics Forum also enjoyed significant success — its highest enrollment ever at 170 participants. Fast on the heels of the textile successes came computer competency, which generated 40 percent of total enrollment with basic, advanced and specialized software courses in seven states (South Carolina, Alabama, Florida, Georgia, North Carolina, Virginia and Maryland) and Washington, DC.

So successful are these hands-on computer seminars that two new states, Ohio and Kentucky, already are in the fall 1987 catalogs, and new seminars on finance, sales and marketing, R-Base 5000 and Powerbase are being phased into a 650-seminar-a-year schedule.

PD's "Computers on Wheels" strategy is paying off especially well in the specialty markets for "The PC and Your Personnel Department," "Statistical Quality Control" and "Project Management." Each of these seminars has exceeded the 24-person limit and forced the scheduling of a second session in major markets like Washington, DC, Tampa and Atlanta.

On-site training, as well, continued to boom. Ongoing relationships with major corporate entities, such as Westinghouse, Santee Cooper, Sonoco and Milliken, flourished while new relationships were struck with Georgia Power, the National Wildlife Federation and the CIA.

The CIA and Georgia Power both sent groups of 20 or more employees to Clemson for training, as did the British textile company Courtaulds, the second largest textile company in the world. Again this year, Courtaulds put 24 of its top managers through two rigorous weeks of executive training.

International outreach, however, did not stop with Courtaulds. In fact, PD efforts reached all the way to China, where U.S. hosiery executives were treated to mill inspections; to Colombia, where the government sponsored six weeks of executive training for 120 textile managers; and to Taiwan, from which the Ministry of Education extended an invitation to Associate Dean and PD Director Ralph Elliott to conduct a two-city speaking tour on direct marketing.

In the management arena, "Professional Development for Women" embarked on a tour of its own. Following successes in Raleigh and Greenville last year, PD Assistant Director Helena Douglas launched the conference in Richmond where it established a recent attendance record of 230. More sessions are planned for Charleston, Orlando and Wilmington, DE.
During a year of intensive internal review and program modification, Clemson has reaffirmed its commitment to excellence in the teacher education field. Faculty and administrators of the College of Education have been hard at work upgrading programs to meet the new accreditation standards of the State Board of Education and the National Council for Accreditation of Teacher Education.

An assessment of future needs led to the development of a one-year plan and a five-year plan, setting teacher education priorities that are tied to the goals of Clemson University’s Second Century program.

These evaluation, planning and accreditation activities reflect the increased level of accountability demanded by the education reform movement. In South Carolina, the Education Improvement Act has focused attention on teaching as a profession, efforts to attract the state’s brightest students to teaching careers, upgrading programs to improve the quality of graduates entering the profession, and providing in-service programs to expand the opportunities and enhance the competencies of those already in the profession.

**Instruction**

The College of Education offers a variety of programs designed to prepare students to meet the growing demand for competent teachers and professional service personnel for schools from kindergarten through university levels. The college is the state’s major producer of math, science and vocational teachers and offers an excellent graphic communications program that prepares students for professional careers in the printing/publishing/packaging industries.

Clemson is a leader among South Carolina institutions in providing support services for local school districts, teacher organizations, teachers, administrators and industries. Graduate classes are offered in the evening to accommodate the needs of teachers and administrators from nearby schools. In addition, a number of special institute courses for graduate credit are designed and taught off-campus to meet unique needs of school districts.

Funding for the South Carolina Center of Excellence in Math and Science Education, a joint project of the College of Education and the College of Sciences, was renewed by the State Commission on Higher Education. The project is designed to increase the number of public school teachers certified to teach math and science and to upgrade the skills of in-service teachers in these disciplines.

The United States Department of Education renewed its grant to prepare special education teachers to work with handicapped students in public schools at the secondary level.

The contractors completed the major renovations of Godfrey Hall in January 1987. The building, completely stripped of all asbestos, was redesigned to accommodate most of the industrial education laboratories. There are new laboratories for drafting, electricity/electronics, graphic communications (basic and advanced), printing (offset, gravure, flexography, screen, etc.), photography, micro-teaching, industrial training, instructional resources and computer applications. Laboratories for arts and crafts, plastics and power technology are located on the lower level of Godfrey Hall. All education programs are housed in asbestos-free Tillman and Godfrey halls, except the woodworking, machining and metals labs.

The Learning Resource Microcomputer Lab in Tillman Hall operated on a 12-hour daily schedule to help students upgrade basic skills. This program served approximately 200 students per week. Another computer lab in Tillman Hall was used to teach classes in educational applications of microcomputers. More than 200 students completed this three-credit class.

**In-Service**

During 1986-87 the College of Education offered 116 off-campus courses at 35 locations throughout the state for 1,903 students. Sixty-one regular Clemson University courses were offered
at 15 different locations for 824 students, and five contract courses were held at 20 additional sites and provided another 1,069 student enrollments. The 55 contract courses included 40 courses funded by the State Department of Education as Critical Teacher Needs courses in the teaching areas of mathematics, reading, sciences and computer education for 771 students.

The College of Education also offered four non-credit two-day seminars on computer usage for school staff. These seminars presented instruction necessary to implement the OSIRIS school administration network within the public school system and provided for a total enrollment of 45 students.

**Research and Grants**

Three grants totaling more than $60,000 from the State Department of Education were awarded to the Department of Industrial Education to provide teacher education activities and courses to vocational and industrial technology teachers in South Carolina. Two institutes were provided for the retraining of industrial arts and pre-vocational education teachers.

The State Department of Education also provided a $60,574 grant to continue the Trade and Industrial Teacher Education program.

The Council on Technology Teacher Education awarded a small grant to the Industrial Education Department to make a national study of successful recruiting techniques.

In addition to the Center of Excellence in Math Education and the Secondary Special Education grants mentioned under "Instruction," the Elementary and Secondary Education Department received a grant from the South Carolina Department of Education in conjunction with The Citadel, Francis Marion College, Furman University, South Carolina State College, The University of South Carolina and Winthrop College to support training and technical assistance centers to improve the leadership skills of prospective and practicing school administrators. It has become known as the L.E.A.D. (Leadership in Educational Administration Development) project. Specifically, Clemson will conduct research with practicing school administrators to determine leadership styles and their use. This summer an Administrators Leadership Conference was held, and additional seminars focusing on effective school research practices will be offered during the year to school personnel.

**Special Activities and Services**

The College of Education provided a variety of services to the South Carolina Department of Education, school districts and teachers continuing their education. For example:

- Special institute graduate courses on the educational applications of computers were taught in several school districts.
- The Clemson Writing Project, a joint venture of the College of Education, the College of Liberal Arts and several nearby school districts, worked with classroom teachers to help teach writing in the public schools.
- An Industrial Education institute was conducted during the summer of 1987 to bring industrial arts teachers to Clemson to help them expand their skills as industrial technology teachers. They were asked to update the curriculum and prepare a teaching plan to implement industrial teaching technology education into their schools during fall 1987.
- The annual Clemson Reading Conference provided an opportunity for reading and elementary teachers to hear national leaders discuss ways to improve reading instruction in the schools.
- The Office of Educational Services and Placement welcomed 72 school districts to campus. The district recruiters conducted approximately 1,100 interviews with Clemson teacher candidates.

Through these programs, Clemson has attempted to expand the opportunities for public school teachers and students throughout the state. In addition, the Department of Industrial Education, in
cooperation with the South Carolina Vocational Association, provided special training for more than 50 individuals from industry during 1986-87.

The industrial training program has expanded to serve more individuals from the printing and related industries. An instructor was employed to devote full time to the program, which is financed by fees collected from participating companies or agencies. The demand for industrial training is continuing to increase.

The National Dropout Prevention Center was conceived in the spring of 1986 and formally established on October 28, 1986, as a joint enterprise of the New York-based National Dropout Prevention Fund and Clemson University. This move was a response to the serious national crisis wherein about 25 percent of public school students drop out each year. The center concept was approved by the South Carolina Commission on Higher Education on November 6, 1986. A unit of the Department of Elementary and Secondary Education, the center will serve as an ever-growing resource base for dropout prevention efforts throughout America. Its goal is to support and assist individuals and organizations involved in dropout prevention by consolidating, evaluating and disseminating knowledge as well as coordinating future research and development efforts. To this end, the NDP Center is developing programs on the national and state level within three broad areas: information collection and dissemination, networking and research evaluation. On May 6, 1987, the center hosted a conference for the National Dropout Prevention Network, whose members met here to formally organize a national network. Thirty practitioners and researchers approved organizational documents and elected an executive committee (which includes the acting director of the center) and an executive director. During the year, much progress was made on development of a national directory of contacts in dropout prevention and in working with Clemson computer specialists in planning the database for dropout prevention programs.

Army and Air Force ROTC programs provided $538,921 in academic aid for Clemson University students during 1986-87. There were 130 students attending Clemson on ROTC scholarships. The AFROTC student organization, the Arnold Air Society, won national recognition for the second year in a row as “Best in the Nation.” This year saw the establishment of the Army ROTC Endowment Fund. When the fund becomes operational, it will provide room and board for four-year Army ROTC scholarship winners.

The Bob and Betsy Campbell Lecture Series began this past year. The series, part of the college’s initiative to improve technical communications, is made possible by gifts from the Campbells.

The college formed an Advancement Committee for Fund Raising. Professor T. H. Oswald, formerly director of Continuing Engineering Education and now the college’s new director of development, is coordinating the activities of the committee. Dr. F. C. Alley, professor of chemical engineering, is now interim director of Continuing Engineering Education.

**COLLEGE OF ENGINEERING**

The challenge for the College of Engineering is to provide the marketplace with increasing numbers of qualified engineering students while aggressively seeking new knowledge in research and serving our constituents through public service activities. With innovative programs and with a dedicated faculty and staff, the college is meeting the challenge. Progress toward meeting our goals is well demonstrated in many of the accomplishments of the 1986-87 year.

Our students are some of the best in the state and nation. SAT scores continue to be high, the highest ever this past fall. In addition, graduating seniors last year performed well above the national average on the Engineering in Training exam.

The college received a record amount of gifts and contributions this past fiscal year. Research in the college, in terms of contracts and grants awarded and in force, was also at a record high.

The state Commission on Higher Education approved two new research centers housed in the College of Engineering, a new Ph.D. program in ceramic engineering and a new master’s degree specialization in automated manufacturing.

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Other administrative changes in the college this year include the hiring of a new department head in Chemical Engineering, Dr. C. H. Barron, formerly a principal consultant with E. I. DuPont de Nemours and Company. Dr. R. H. Brown, department head of Civil Engineering, is moving to the dean's office to serve as interim associate dean for research and graduate affairs. Dr. Brown follows Dr. D. D. Edie, professor of chemical engineering, who served as interim associate dean this past year. Dr. P. B. Zielinski, director of the Water Resource Research Institute and professor of civil engineering, will serve as acting department head in Civil Engineering while Dr. Brown is in the dean's office.

The college continues to initiate and participate in many public service activities. A report on Continuing Engineering Education activities is in the "Public Service" section of this report.

Faculty and Student Honors and Awards

Students

We are proud of those students in the college who have received regional and national honors. A few examples of such honors include an NSF graduate fellowship earned by J. Vernon Cole, a graduate student in chemical engineering. Mr. Cole is one of only 20 recipients of the fellowship nationwide this year.

Beth Gainey, a senior chemical engineering student, was the recipient of an NSF "Creativity Award in Engineering" for 1987. There were 65 finalists nationwide, including three from Clemson. Ms. Gainey also was awarded the Air Force Office of Scientific Research Graduate Fellowship. She will be doing her graduate work at Clemson.

Larry Smith, a civil engineering undergraduate, received a 1987 Washington Internship for Students of Engineering. He is one of 15 national participants to be selected to attend the 10-week academic program in engineering and public policy.

Douglas J. Bone and Patrick S. Freeman, electrical and computer engineering students, received Tau Beta Pi graduate fellowships. Bone and Freeman were two of only 31 recipients of these fellowships nationwide.

One of the 18 senior design teams composed of electrical and computer engineering students won first place in the Southeastern Senior Design Contest during the IEEE regional conference in Tampa, Florida, in April 1987.

Jay A. Blessing, a graduate student in industrial engineering, was selected by the Institute of Industrial Engineers (IIE) to receive the 1987 IIE Graduate Research Award for the best master's thesis in industrial engineering in the country.

Faculty

The College of Engineering faculty's dedication to quality education and an enriched student environment can be seen in the number of awards presented to the engineering faculty for exceptional teaching and other student-related activities.

G. C. Robinson, professor of ceramic engineering, was appointed to the position of Lucius Harvin Alumni Professor at Clemson. Alumni professors are selected primarily for their excellence in teaching. Robinson's dedication to teaching and to the welfare of his students made him the perfect candidate for the professorship.

E. J. Hayter, assistant professor of civil engineering, received the 1987 Byars Prize. This award was established to recognize outstanding undergraduate teaching in engineering mechanics.

J. C. McCormac, Alumni Professor of civil engineering, was awarded the AT&T Foundation Award, given by ASEE to commend excellence in the instruction of engineering students. Prof. McCormac is one of only 15 award recipients in the nation.

D. J. Dumin, S. R. Rhodes Professor of electrical and computer engineering, received the IEEE Student Branch Counselor Award. This award is given to only 10 IEEE branches worldwide.

The IIE student chapter at Clemson won an Award of Excellence for the quantity and quality of activities during the past year. Dr. Bevlee A. Watford, assistant professor of industrial engineering, is chapter adviser.
E. H. Bishop, professor of mechanical engineering, was selected 1987 Engineering Educator of the Year by the S. C. Society of Professional Engineers, Piedmont Chapter.

Several members of the college faculty received special recognition in 1986-87 for their accomplishments in research and public service and their contributions to the engineering profession.

For his contributions to his profession, J. C. Jennett, dean of engineering and professor of environmental systems engineering, was selected as the University of New Mexico’s outstanding alumnus for 1987. Dean Jennett was also elected president of the South Carolina Society of Professional Engineers, Piedmont Chapter for 1987-88, and he was elected to the board of the Hazardous Waste Research Center in the College of Engineering at Louisiana State University.

C. M. Butler, professor of electrical and computer engineering, received the Oliver Lodge Premium Award from the Institution of Electrical Engineers of London for the best paper of the year in the electronics category published in the IEE Proceedings. Dr. Butler was also elected vice chairman of the U.S. National Committee of the International Union of Radio Science and chairman of the National Research Council Panel for the Electromagnetic Sensing of Buried Objects.

Y. F. Zheng, assistant professor of electrical and computer engineering, received the state’s only Presidential Young Investigator Award for 1987. He earned the award for his research in robotics, specifically the development of coordinated robotic arms and legs. Dr. Zheng is the third PYI award winner in the College of Engineering in the past four years.

C. P. L. Grady, R. A. Bowen Professor of environmental systems engineering, was awarded the Alumni Award for Outstanding Research by the Clemson University faculty.

J. A. Chisman, professor of industrial engineering, was in Ireland during the spring and summer of 1987. He was the recipient of a Fulbright Scholarship to teach and perform research at the University of Cork.

C. O. Huey, Jr., associate professor of mechanical engineering, was the 1987 recipient of the McQueen Quattlebaum Faculty Achievement Award. The intent of this award is to encourage faculty members to contribute to the advancement of engineering.

C. E. G. Przirembel, department head and professor of mechanical engineering, was elected a fellow member of the American Society for Engineering Education in recognition of his outstanding contributions to ASEE as well as his qualifications and experience in and contributions to engineering education. Dr. Przirembel also was recently appointed to the Board of Directors of the Accreditation Board for Engineering and Technology as a representative for the ASME.

In addition to above honors, several other faculty were elected to leadership positions in professional societies and committees during the past year. P. B. Zielinski, professor of civil engineering and director of the Water Resources Research Institute, was elected secretary-treasurer of the National Association of Water Institute Directors for 1987-88. A. W. Bennett, department head and professor of electrical and computer engineering, was elected to serve as vice-president of the Electrical Engineering National Department Heads Association. V. B. Anand, associate professor of engineering graphics, was elected director of the Professional and Technical Committees, Engineering Design Graphics Division, American Society for Engineering Education. Last year Prof. Anand also became a member of the Board of Review for the Engineering Design Graphics Journal. J. Y. S. Luh, Quattlebaum Professor of electrical and computer engineering, was elected chairman of the program committee for the International Symposium on Robot Manipulators.

**Instruction**

The College of Engineering is the largest academic unit on campus in terms of enrollment and degrees granted. Fall 1986 enrollment was 3,369; 2,943 of these students were undergraduates and 426 were graduate students. For 1986-87, 570 baccalaureate degrees were awarded, in addition to 127 master’s and 13 doctorate degrees.

In February 1987 the S. C. Commission on Higher Education approved the implementation of a Ph.D. program in ceramic engineering at Clemson. Clemson is nationally known as a leader in ceramic engineering and is one of only 11 colleges in the country with an accredited ceramic engineering department.
The Freshman Engineering Program is now well established. With just three staff advising students, we are able to advise all freshman and transfer engineering students more efficiently and effectively. The program improves advising during the critical freshman year and is so constructed that should a freshman choose, he/she could transfer to any program at Clemson University without losing credits. Enrollment in the freshman engineering program (including freshmen and transfer students) in fall 1985 was 748. Enrollment for fall 1986 was 1,152. Enrollment in the freshman program for fall 1987 is projected to be between 1,300 and 1,400. (The program began in fall 1985; therefore, all 748 students that year were new freshmen or transfers. In fall 1986, 875 of the students were new. In fall 1987 we predict to have between 1,000 - 1,100 new freshmen or transfer students.)

Many Clemson engineering students found the Cooperative Education Program to be an important component of the undergraduate program. During 1986-87, more than 82 percent of all participants in the Cooperative Education Program were engineering students. The program provides students with challenging industrial work experience related to their college curricula and is sponsored by approximately 200 Southeastern companies.

There is an increasing demand for engineers in the marketplace. Starting salary offers for B.S. graduates in engineering are high compared to those in most disciplines. The average starting salary (non-government) offered to December '86 and May '87 Clemson engineering graduates with B.S. degrees was a record $28,737 per year. The College of Engineering is being challenged to meet the demands of industry; however, a goal of excellence in education, not quantity of engineers graduated, remains the primary objective.

The demand for women and minority engineers continues to increase. A promising indication of our ability to satisfy this increased demand is the strong enrollment of minority and female students in the College of Engineering. Minority enrollment in the college increased from 239 in fall 1985 to a record 255 in fall 1986. Fall 1986 figures show that women comprise more than 17.5 percent of the total enrollment in the College of Engineering and more than 20 percent of the freshman class.

The Summer Engineering Minority Program for high school students marked its tenth year in 1986-87 and continues to be a success. This program is directed by R. W. Snelsire, associate professor of electrical and computer engineering. More than 900 students have participated in this program. Both this program and a minority scholarship program are sponsored by industry and foundations.

Clemson University was officially accepted into membership in the National Consortium for Graduate Degrees for Minorities (GEM) in October 1982. Since that time, five Clemson students have been awarded the $5,000/year plus full tuition scholarships. Two GEM fellows have graduated from Clemson with M.S. degrees. Two new GEM fellows are expected to enroll in fall 1987. The primary purpose of GEM is to increase minority enrollment in engineering graduate schools.

Within the Department of Electrical and Computer Engineering, the summer master of engineering program, begun in 1980 and totally funded by AT&T Technologies, continues to be strongly supported. Sixty-two students were enrolled for the first session of summer '87. This year's graduating class contains one student who will receive an M.Engr. degree. This will bring the total number graduated from this program to 41.

Another program that has been successful for the Electrical and Computer Engineering Department is the industrial graduate fellowship program, which was established to encourage outstanding U.S. citizens to attend graduate school. To date, 30 M.S. students and six Ph.D. students have participated. Each student receives a fellowship of $3,000 - $5,000 and a graduate assistantship, providing total support ranging from $9,000 to $12,800 for the academic year. In addition, each fellow is provided a summer job opportunity.

The Department of Chemical Engineering continues to strengthen its graduate/research program. The Master of Science Industrial Residency Program is vital to this effort. In 1986-87, five new students entered the Industrial Residency Program and began their initial work periods at Dow, DuPont, Gist-Brocades, Milliken and Rexham. This represents new industrial commitments in excess of $130,000.
Research

Clemson University continues to be a leader in engineering research among institutions of higher education in South Carolina and the nation. Engineering research at Clemson has three essential objectives: to seek new knowledge, to seek answers to both the short- and long-term problems of the state and nation, and to support advanced-level educational programs by providing research experience for students.

The College of Engineering at Clemson traditionally receives a greater percentage of research funds (30-40 percent) from industry than do engineering departments at most other universities. The dollar amount of contracts and grants has increased each year for the past four years, with a record-breaking $8.3 million of funded grants and contracts in force in 1986-87. Contracts and grants awarded also increased this past year, from $3.5 million in 1985-86 to $5.2 million for the 1986-87 fiscal year, a 47.5 percent increase. During the past year, 105 faculty were engaged in research. Their efforts were supported by 265 graduate students, 107 undergraduate students and 23 staff (temporary and permanent) and visiting scholars.

Major Gifts to the College
The College of Engineering received several major equipment gifts from industry this past year. This type of industrial support is vital to enhancing educational opportunities for students and research facilities for faculty.

Texas Instruments donated more than $120,000 worth of new computer equipment and software to the Bioengineering Alliance. The Department of Bioengineering received more than $111,000 worth of arthroscopic equipment and instruments from Dr. Lorin Mason and a blood gas analyzer, printer, electrodes and supplies from St. Francis Hospital worth $15,000.

Exxon Corporation donated a gas chromatograph, a metering pump, a vacuum dehydrator, a pellet press, two flow meters and miscellaneous other laboratory equipment valued at $10,750 to the Chemical Engineering Department. The ChE Department also received two gas chromatographs, two precision balances and other laboratory equipment from Dow Chemical Company valued at $24,200.

The Department of Electrical and Computer Engineering received several major equipment gifts including a gift from IBM of equipment valued at $61,000 to construct a microelectronics clean room; computer equipment and software valued at $187,200 from Mentor Graphics Corporation; and six complete computer systems plus eight NCR PC8s valued at almost $73,000 from NCR.

The Industrial Engineering Department received a microcomputer local area network, including four Tandy 3000HD microcomputers and peripherals valued at more than $20,000 from Tandy Corporation.

Exxon Engineering Laboratory donated $15,000 worth of creep frames and about $54,000 worth of specialized laboratory equipment to the Mechanical Engineering Department. (The $54,000 worth of laboratory equipment is a portion of the total gift from Exxon which was split between the departments of Chemical Engineering and ME.) Exxon Research Laboratory donated a viscometer to the ME department valued at $21,000, and DuPont donated a sedigraph and data acquisition system to ME valued at $20,000.

Research Centers
The college is aggressively expanding its role as a major research institution through its research centers of excellence. Two centers have been operational in the college for several years, the Center for Automated Manufacturing Technology and the Semiconductor Device Reliability Research Center. Two new centers were approved by the S. C. Commission on Higher Education this year, the Center for Computer Communications Systems and the Center for Engineered Ceramic Manufacturing. Each of these four centers concentrates on a particular area of research and is supported by faculty with recognized expertise in that area.

The Center for Semiconductor Device Reliability Research, which was formed in 1984 to provide an academic focal point for the study of semiconductor component degradation after manufacture, completed its third year of operation last year. Seven faculty and eight graduate students are
Currently studying factors affecting the reliability of very large scale integrated (VLSI) circuits. Support for the center was divided between industrial firms (75 percent) and government (25 percent). Billings last year were $528,000, only slightly greater than the previous year's $525,000, reflecting the loss of a solar cell contract. We hope to initiate a new program on microwave device reliability in the coming year. The availability of the new ECE clean room and VLSI design facility will expand the center's research capability. A new reliability option leading to the M.S. degree was introduced within the Electrical and Computer Engineering Department last year. The cornerstone of the program is a new course, ECE 407/607, VLSI Reliability, which was taught for the first time during the spring 1987 semester.

Approved by the S. C. Commission on Higher Education in 1981, the Engineering Center for Automated Manufacturing Technology (CAM) continued to grow last year under the direction of F. W. Paul, McQueen Quattlebaum Professor of mechanical engineering. The center's research thrusts are focused in the areas of robotics and machine automation, computer-aided engineering and expert systems, materials and manufacturing processes, and manufacturing systems. The research center has two industrial sponsors, Reliance Electric Company and the Torrington Company, and one industrial affiliate, Kellogg-Rust. Since 1983, the center has processed approximately $760,000 in total grants and contract research support. Additionally, the center, through the Clemson University Foundation, has established an endowment principal of $17,500 from our industrial members. Goals for 1987-88 include increasing industrial CAM Center membership and participation, working toward the establishment of one research-focused industrial consortium, doubling the number of research contracts in force, and encouraging all CAM faculty participants to submit one external research proposal.

CUEPRA

The Clemson University Electric Power Research Association (CUEPRA) was formed in 1982 to give visibility to electric power engineering. In 1986, the CUEPRA budget was $33,750, contributed by five members. In 1987, CUEPRA has moved to the second phase of establishing a comprehensive research program for both the graduate and undergraduate programs in power systems. Presently, six members jointly fund basic and applied research programs. The basic research program has a budget of $90,000 and consists of five research areas. The applied research program consists of three research projects externally funded by CUEPRA members. The annual budget of these research projects is approximately $160,000. The results of CUEPRA projects are published in reports, technical papers and theses. Four M.S. theses, five international journal papers and 12 conference publications resulted from the 1986-87 research. Presently, there are 15 M.S. and Ph.D. candidates in the power systems area. It is anticipated that CUEPRA represents the basis for establishing a national center of electric power systems research.

Specific Research Projects

A partial list of projects in the College of Engineering gives an indication of the scope and breadth of engineering research at Clemson:

- Research in the Department of Bioengineering has traditionally focused on man-made prosthetic materials for their suitability and safety as implant material. More recently, cadaver tissues have shown their superiority in many applications of tissue replacement surgery. A joint research project between Clemson University, University of Southern California and industry is currently under way to evaluate the use of cow tendons for replacement of ligaments in man, using sheep as models.
- Research in ceramic fibers is ongoing in the Department of Ceramic Engineering. In the past, it has been impossible using conventional processes to produce fibers from some ceramic materials that have highly desirable and interesting properties. A novel piggyback process developed at Clemson for producing a fibrous form from nearly any ceramic material is showing great promise. The patent pending process is being applied to producing fibers from ceramic superconductor compositions.
- In the Department of Chemical Engineering, research projects continue to focus on
three major areas: thermodynamics, polymer processing and process automation. In the polymer area, work on carbon fibers for composite materials provided the impetus for the formation of a research group in advanced engineering fibers. The collaborative effort includes input from the departments of Ceramic Engineering, Chemical Engineering, Mechanical Engineering and Textiles.

- Also in Chemical Engineering, in the area of thermodynamics, internationally recognized research in molecular simulation continues. And research is under way in high pressure phase equilibrium measurement and analysis.

- Very flexible beams subjected to concentrated or distributed loads may deform in unexpected ways. A research project in the Department of Civil Engineering aims to gain a better understanding of alternate equilibrium states that a very flexible beam can assume.

- In the structures area of the Department of Civil Engineering, two NSF projects are under way on masonry construction. One is an evaluation of composite masonry walls subjected to gravity and earthquake loads. The other project, which is nearing completion, deals with the flexural strength of reinforced masonry constructed with hollow clay units. A third project, sponsored by the Construction Industry Institute, studies a system (developed in an earlier project) designed to capture and track the costs of quality during design and construction of projects. The object of this study is to optimize the tracking system for use throughout the construction industry.

- The object of another project in the Department of Civil Engineering is to analyze traffic accident records in South Carolina using SAS to identify local and statewide traffic accident problems and to provide recommendations for solutions to the problems.

- In the Department of Electrical and Computer Engineering, the electromagnetics laboratory is involved in a project to develop a new technique for analyzing a general class of antennas. The technique is called the modified dielectric theory. When the theory has been refined and further developed, it will enable engineers to analyze more complex and larger (electrically) antenna structures than can be analyzed with present methods. The basic nature of the theory renders it highly amenable to antenna synthesis, and it is far more readily understandable to the typical antenna engineer than present analysis techniques.

- Five Electrical and Computer Engineering faculty are involved in a cooperative research effort to determine the reliability of VLSI circuits. The project is divided into four subtasks: thin oxide reliability, electromigration reliability, electrostatic discharge and design for reliability. This project is in its fourth year and is funded by the Semiconductor Research Corporation and grants from General Electric, NCR and Texas Instruments.


- Research on biped robots began at Clemson University in 1984 to study the locomotion mechanism of the biped robot and to develop sophisticated biped robots that can replace human beings in hostile environments, such as a contaminated area of a nuclear power plant. Advanced computer systems, sensory devices, artificial intelligence and other areas of high technology are key to the successful design and construction of a complicated biped robot. Current research is being sponsored in the Electrical and Computer Engineering Department by the Savannah River Laboratory and NSF.
• In automated manufacturing, some tasks, such as assembling two parts into a single unit or lifting a very large object, are beyond the capability of a single robot and need to be completed by two coordinated robots. As the extent of factory automation is further enlarged, the development of coordinated robots becomes more and more important. Clemson University leads the nation in research in this area. Coordination algorithms, sensor-interactive control and computer systems are a few topics being pursued in the Electrical and Computer Engineering Department.

• In the area of image/signal processing in the Electrical and Computer Engineering Department, work is being done on the design, analysis, verification and implementation of image motion analysis algorithms and systems. Applications of such algorithms include motion-based guidance and bandwidth compression of high-resolution time-varying imagery. Current research involves the development of a structural or syntactic approach to motion analysis as a basis for multiple motion-related feature extraction and a link between motion and scene-static structural information.

• Several faculty in the Engineering Graphics Department are working on mathematical modeling of geometric surfaces. This is an important area in both CAD and CAM since a mathematic relationship that defines a particular surface is preferable (for a computer environment) to a discrete set of points. Funding from NSF and NAS is expected for 1987-88.

• A project under the sponsorship of the EPA is being conducted in the Environmental Systems Engineering Department to develop a simple and rapid procedure for evaluating the biodegradation kinetics of individual synthetic organic compounds. The procedure, based on measurement of oxygen consumption, will allow development of a large database concerning the biodegradability of such compounds. The database can be used by both industry and government agencies evaluating the fate of such compounds in the environment.

• Other research in the Environmental Systems Engineering Department includes fundamental theoretical, laboratory and field investigations concerning the physical/chemical characteristics and fate and distribution of PCBs. Efforts focus on requirements to understand the nature and potential effects of PCB contamination of Lake Hartwell, but are applicable to other locations and compounds. Process elucidation, such as rate and extent of adsorption/desorption, aims to improve predictive modeling capabilities.

• Duke Power supports two research projects in the Environmental Systems Engineering Department. One deals with evaluating and improving the performance of environmental protection systems, as well as assessing the residual impact on off-site streams, at the billion-dollar Bad Creek hydroelectric station under construction. The other project focuses on assessing the quality of several important cold-water aquatic ecosystems in the vicinity of Duke’s proposed 3.8 billion-dollar pumped storage hydroelectric station on Coley Creek above Lake Jocassee. Both projects are contributing substantially to better methods for siting, designing, building and operating major energy production facilities in an environmentally acceptable manner.

• A study was performed in the Department of Environmental Systems Engineering to verify the calculational methods used in assessing the risk associated with subsurface transport of radioactive, hazardous and mixed wastes from disposal sites at the Savannah River Plant. The study was part of a larger effort designed to assess the impact of various closure options for the waste sites. The transport models used in the risk assessment were verified by independent calculations and by comparison with alternate two-dimensional and three-dimensional transport approximations. In addition, a methodology was developed for performing screening calculations of the sensitivity and uncertainty of models’ predictions due to uncertainty in the input parameters.
• A contract, titled "Hardware and Software Techniques for Tactical Information Search, Retrieval, Control and Display," and sponsored by the Naval Ocean Systems Center, is under way in the Department of Industrial Engineering. The goal is to develop design guidelines for human-computer interfaces that enable efficient display and control of navy tactical data. Research is being pursued to develop guidelines for (1) the coding of geo-positional data on monochromatic visual displays, (2) the management of windows for simultaneous access to various information sources and (3) the occasional input of numeric data within a predominantly menu-oriented human-computer dialogue.

• A project titled "Deformation Processing of High Temperature Metal Matrix Composites" is being pursued in the Mechanical Engineering Department. The project examines experimentally the deformation behavior of short fiber and particulate reinforced metal matrix composites during thermomechanical processing. A generalized plasticity model will be developed that will take into consideration material, thermal and boundary effects and will be used to predict composite metal flow during elevated temperature processing. High temperature metal matrix composites have major applications in the National Aerospace Plane Program.

• Research is being done in the Department of Mechanical Engineering for DuPont and the Savannah River Laboratory on performance characteristics of a hydraulic sampler system for a nuclear processing plant. A prototype air-lift pump and degasser system is being designed, fabricated and tested for a range of operating conditions and working fluids. Optimization studies are being conducted. The new system will significantly improve the safe processing of nuclear materials.

• A preliminary study into the feasibility of using piezoelectric materials embedded in a compliant matrix as a means of detecting incipient slip at the gripping surface of robot end effectors (hands) is being conducted by faculty members in the Mechanical Engineering and Ceramic Engineering departments. The ability to detect and respond to incipient slip will yield a significant advance in the tactile sensing capability of robots, which often use compliant substances on gripping surfaces in handling delicate objects.

**Books Published**


**Public Service**

The Continuing Engineering Education (CEE) program continued its role as the primary public service arm of the College of Engineering. A highly responsive program of seminars, workshops,
short courses, conferences and professional engineering reviews was presented to enhance the
opportunities for professional development of the engineers of the region and nation.

The 1986-87 program is shown below.

<table>
<thead>
<tr>
<th>Type of Offering</th>
<th>Number</th>
<th>Program Days of Effort</th>
<th>Total People Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminars, workshops, short courses</td>
<td>25</td>
<td>43</td>
<td>1,043</td>
</tr>
<tr>
<td>Major conferences</td>
<td>5</td>
<td>13</td>
<td>608</td>
</tr>
<tr>
<td>EIT/PE reviews</td>
<td>119</td>
<td>119</td>
<td>2,824</td>
</tr>
<tr>
<td>In-house seminars (for industry)</td>
<td>11</td>
<td>21</td>
<td>282</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>160</strong></td>
<td><strong>196</strong></td>
<td><strong>4,757</strong></td>
</tr>
</tbody>
</table>

Fields served in the above totals were:

- Advanced manufacturing
- Biotechnical processing
- Ceramic engineering
- Electrical power systems
- Hazardous waste management
- Plant engineering
- Advanced materials
- Bioengineering
- Construction
- Manmade fibers
- Industrial engineering
- Transportation systems

During the first ten months of 1986-87, the Continuing Engineering Education program was
administratively merged with the Office of Professional Development in the College of Commerce
and Industry. In April 1987 it was decided that the CEE program would better be returned to the
College of Engineering, and the combined CEE/PD program arrangement was terminated.

COLLEGE OF FOREST AND RECREATION RESOURCES

The report of 1986-87 activities for the College of Forest and Recreation Resources’ resident
instruction, research and Extension programs is included under the Division of Agriculture and
Natural Resources on page 83.

COLLEGE OF LIBERAL ARTS

It has been said that no university will ever become a great institution of higher learning without
a strong program in the humanities and social sciences. The College of Liberal Arts recognizes the
validity of this observation. It subscribes to the notion that a self-governing society requires of its
citizens a basic and general education that will enable them, regardless of their occupations or
professions, to lead full and useful lives, and to contribute to the general welfare of society.

Nine percent of the undergraduate student body at Clemson University major in the liberal arts.
The faculty of the college teach nearly one-third of the credit hours taken by students, and the college
offers a number of the courses that fulfill the general education requirements of the University.

The college is composed of the departments of English, History, Languages, Music (reorgan­
ized as Performing Arts effective July 1, 1987), Political Science, Psychology and Sociology. With
the exception of Music, all departments offer majors leading to the Bachelor of Arts degree, and
English and History offer programs leading to the Master of Arts degree.
Eighty-eight percent of the tenured or tenure-track Liberal Arts faculty hold the doctoral or other terminal degree. Graduates of the college enter some of the outstanding graduate and professional schools in the country, and many pursue careers in business or government.

Faculty Highlights

Three highly respected journals emanate from the College of Liberal Arts. "The South Carolina Review" is edited and published by faculty members in the Department of English. This distinguished magazine provides a forum for literary scholarship and criticism as well as for outstanding poetry and short stories. The "Journal of Political Science," with an international editorial board under the leadership of a faculty member in the Department of Political Science, boasts a list of authors from leading universities and colleges from this country and from overseas. This journal emphasizes the scholarly contributions of younger researchers and addresses contemporary themes such as terrorism and the Bicentennial of the U.S. Constitution. The Department of Languages edits and publishes "The Comparatist," which is devoted to the literary and language interests of scholars in the Southeast and which is the official publication of the Southern Comparative Literature Association.

In addition to editing and publishing these journals, Liberal Arts faculty continue to be active in scholarly and creative work. They deliver papers at numerous regional, national and international meetings and conferences; they contribute articles, as well as poetry and fiction, to a variety of established and influential journals; they edit book-length collections and prepare textbooks; and they write books in their areas of expertise that are brought out by respected publishers and that meet with favorable reviews.

Other departmental activities include, but are not limited to, the following: a syndicated book review column originating in the Department of History and published in newspapers across the country; a book review service originating in the Department of English that specializes in children's books; research conducted by faculty members in the Department of Psychology on a variety of topics such as aging, laterality of brain function, stress management, computer-assisted instruction and artificial intelligence; and research conducted by faculty in the Department of Sociology encompassing several areas, including the prison system, parental grief, children's responses to crises, parental abuse, alcohol consumption and abortion.

Regular features of the College of Liberal Arts include gatherings of scholars and creative writers. The college often conducts programs in cooperation with the Strom Thurmond Institute of Government and Public Affairs. Other annual affairs include events in observance of Black History Month and Women's History Week. This year the college continued the Women's Studies Colloquia, which included monthly lectures and/or discussions on timely topics. One especially successful lecture was entitled "A Social History of the Cotton Harvester." Another noteworthy event was a week-long symposium celebrating the Bicentennial of the U.S. Constitution.

A highlight of the year was the college's success in carrying out the Challenge Grant from the National Endowment for the Humanities (NEH), the only such grant funded in South Carolina. The Challenge Grant has resulted in the establishment of an endowment entitled "The Humanities and Cultural Literacy." Private gifts totaling $700,000 to the humanities have been matched by $300,000 from NEH. To complete the Challenge Grant goal, an additional $200,000 in private donations must be raised. The interest income from this endowment will support three essential projects: acquisition of library resources, faculty development and enrichment of the cultural life on campus.

Public Service

The college's public service role throughout the state and region continues to grow. Political Science faculty are frequently called upon by units of local and state government or business and industry for advice on such problems as poll-taking, tax matters and governmental organization. In addition, political scientists are frequent panelists for civic organizations and consultants to both the print and electronic media on national and international affairs.
Sociologists contribute their expertise on such topics as design and analysis of social surveys, the impact of industrial development on society, organizational functioning and leadership training, and program development and evaluation in the fields of prison reform, spouse abuse, mental health, and alcohol and drug problems. Psychologists provide clinical service to Clemson's Redfern Health Center, management training for area industries and hospitals, consultation on jury selection, eyewitness validation and expert witnesses on criminal sanity, survey studies for local and state agencies, and a weekly newspaper column on labor-management relations. English faculty work with industry by conducting seminars and workshops in business and technical writing.

The Department of Languages continues to emphasize a practical, business orientation by encouraging Clemson undergraduates to major or minor in a modern language while preparing for careers in business, engineering, computer science or textile science. Given the large foreign investment in South Carolina industry and the need to develop overseas trade markets, this is an important career option for Clemson students. This need is being met with a new undergraduate degree program, language and international trade, which was recently approved by the Commission on Higher Education. The Department of Languages also sponsors an annual Language Declamation Contest, which draws hundreds of participants from South Carolina and nearby states. In addition, the department conducted 1987 summer foreign-study programs in France, Germany and Spain.

Recognition of Clemson's language students came this spring when the national Fulbright Award Committee selected five students for a year's scholarship to study abroad in France and Germany.

Among the recipients of the college's public service endeavors are the state's schoolteachers. Improved civic education in the state’s public schools is the goal of the Thurmond Seminar, which is conducted by the Department of Political Science with funds from the Strom Thurmond Institute for Government and Public Affairs. Nineteen social science teachers from South Carolina’s secondary schools participated in this summer’s seminar, with classes held both in Clemson and in Washington. As part of the Educational Improvement Act, summer institutes were conducted on campus for Advanced Placement teachers in American history, English, European history and Spanish.

Eighteen Piedmont-area teachers interested in the teaching of writing attended the fifth six-week summer institute of the Clemson Writing Project sponsored by the Department of English and the College of Education. In addition, each fall the Department of English hosts the well-known and widely attended Children's Literature Symposium for the state’s librarians and teachers. This year the department received funding from the Bread Loaf School and the Rockefeller Foundation to support a writing program for the rural areas of the state.

Members of the faculty serve regularly as program leaders for the South Carolina Committee for the Humanities. Again this spring they helped organize, conduct and contribute to the Piedmont Humanities Scholars Forum. Department of Music faculty regularly act as performers and judges in the state and region.

The College of Liberal Arts serves the entire student body in a variety of ways. For example, the Model United Nations Program, which is sponsored by the Department of Political Science, annually competes in and has won awards at national conferences in Boston, New York and Washington. Also sponsored by the Department of Political Science are the State Student Legislature, which holds its annual competition in Columbia, and the government internship program, which involves students participating in local, state and national government. The Department of English has designed a developmental course for freshmen with poor communication skills and operates a writing laboratory open to all students with writing deficiencies. As an aid to foreign students, the department offers a course in English as a second language.

The college also contributes to university life by sponsoring a number of student organizations and extracurricular activities. The Department of English sponsors the Clemson Players, the student drama group that presents four plays during the academic year and two during summer school. In recent years these productions have received regional and national attention. This year included the production of "Madonna and Child," an original play authored by a Clemson graduate student who also received her undergraduate degree here.

The Department of English provides faculty advisers for debate activities and for student publications, including The Tiger, The Chronicle and The Calhoun Literary Review. The Depart-
ment of Music sponsors and manages the University Concert Series, The Lillian and Bob Utsey Chamber Music Series, and student musical organizations, including Tiger Band, the Symphonic Band, the University Chorus, the CU After Six Singers and the Jazz Ensemble. The Gospel Choir is sponsored by the Department of History.

The state’s elementary and secondary school students make up another constituency served by the college. In conjunction with the College of Engineering and the College of Sciences, the Department of Psychology runs a series of summer science camps for gifted junior high and high school youth. The Department of Languages offers instruction in French, German and Spanish to area elementary school students and again this year conducted a two-week summer camp for high school students interested in enhancing their competency in French, German, Russian and Spanish. The Department of History annually presents History Day for pre-college students in the Third Congressional District.

Program Development

Despite the budget cuts that have been absorbed in 1986-87, the educational environment of the college has improved considerably in the past year. The Department of Psychology is now more comfortably housed in Brackett Hall, having moved from Hardin Hall at the beginning of the 1987 summer. The Commission on Higher Education has approved new majors in language and international trade and in philosophy. The faculty have initiated and University approval has been granted for a new minor in geography, and courses in Russian are once again being taught.

A new Language Learning Laboratory and Audio-Visual Center has been equipped, thus enriching instructional and research facilities for both students and faculty.

In sum, the College of Liberal Arts is making progress on all fronts and looks forward with enthusiasm to the coming year.

COLLEGE OF NURSING

The College of Nursing offers academic programs leading to a Bachelor of Science degree and a Master of Science degree. Professional development programs for nurses, other health-care workers and lay persons are offered by the Department of Continuing Education. The Nursing Center under the direction of Dr. Sara Barger provides health-care services to the public and serves as a site for student and faculty practice in clinical nursing.

Administration

With the resignation of Dean Mary Lohr, a national search for a new dean was initiated during the spring semester. This search was brought to a successful completion with the appointment of Dr. Opal Hipps as dean of the college effective August 3, 1987. The faculty look forward to working with Dr. Hipps in continuing the development of all programs and services offered by the college.

A major project for the college during the 1986-87 academic year has been the implementation of the new organizational structure. This change in administrative management was developed during the 1985-86 academic year. Discussion and review by faculty in the fall and spring resulted in a structure that includes four departments: family nursing, adult nursing, professional role development and continuing education. Additionally, two staff positions, associate dean for academic programs and associate dean for professional services, were created. Course responsibilities and faculty assignments to each department have been completed. Department heads will be appointed during the coming academic year.
Teaching

A total of 91 students were graduated from graduate and undergraduate degree programs during the 1986-87 academic year. Ninety-five percent of May undergraduates and 100 percent of December undergraduates were successful with NCLEX exams and qualified for licensure as professional nurses.

As a result of budget cuts during the academic year, the college lost one and a half teaching positions. However, the percentage of doctorally prepared faculty continued to increase. The fall of 1986 saw a 4 percent increase over the fall of 1985. Sixteen additional faculty are enrolled in doctoral study.

Student recruitment has received emphasis during the past academic year. An extensive program of high school and middle school visitation was planned and implemented. Results of a survey conducted during the 1985-86 academic year furnished approximately 150 names of prospective graduate students. Information was sent to all, and telephone contacts made with the majority. These efforts should result in increased enrollments for both the undergraduate and graduate programs in the fall of 1987.

A videotape, "Why Nursing," was produced for distribution to South Carolina high schools to inform counselors and students about the changing nature of nursing and the increased opportunities available to professional nurses in all areas of health care. Recruitment of minority students was emphasized by continuing the summer program for students interested in health careers. Sixteen students attended. Of that number, 10 were new to the program, and six were returning for the second summer.

Mr. Max Bonek assumed the duties of student enrollment/services manager in July 1987. Programs developed through this office are expected to bring increased emphasis and professional skill in the recruitment area, as well as redesign for all brochures describing academic programs of the college.

Research

In addition to increasing enrollments, another major goal of the faculty during the 1986-87 academic year was increased productivity in research. Six faculty received internal research funding. Three external research grants were received, including a grant of $201,002 to Dr. Betty Baines from the National Center for Nursing Research, National Institute of Health, for the study of nursing assistance to families and victims of Alzheimer's disease. Twenty-five faculty received support for presenting research or scholarly papers at 32 different meetings and conferences during the year.

Service

Fifty-five continuing education programs were offered during the 1986-87 academic year. A wide variety of programs was presented, including two study tours (Hawaii and Australia), certification review courses and programs cosponsored with various professional organizations. Three programs were offered on the West Coast to test the market for Clemson University College of Nursing programs. Outcomes met minimal expectations. Serious efforts were begun to study means of improving the ratio of brochures mailed and resulting program registrations. Some improvement was noted, but further study is needed. Income generated during the 1986-87 academic year was $369,963. This represents a 16 percent increase over 1985-86.

The School Nurse Practitioner Program begun at the end of the 1985-86 academic year has continued. Six additional students were enrolled bringing the total to 12. Attempts to obtain scholarship funding were unsuccessful. Efforts will continue in this area. Notification has been received that funding for the third year of the project, extending from October 1987 through September 1988, has been granted. In addition, a proposal was submitted for a grant to extend federal funding for the fourth and fifth years of the program.
The Nursing Center is completing its fourth year of offering health promotion/disease prevention services on a regular basis. A special program to encourage aerobic exercise was provided for University students, faculty and staff in cooperation with the Department of Physical Training and Intramural Sports. A total of 759 people participated in the program.

Approximately 99 percent of all junior and senior undergraduate students and 25 percent of all graduate students have participated in center activities as a part of their clinical laboratory experience. Approximately 63 percent of all faculty participated. More than 600 new clients received services during the academic year; 31 clients were referred by other providers to the Nursing Center; and an average of 349 clients were seen each month. Monitoring of center costs continues, and efforts to make the center self-supporting continue to be a high priority. This year three agencies/companies contracted with the center for nursing services. The rate of uncollectable fees for the year was 3.5 percent with a total increase in revenue generated of 39 percent.

COLLEGE OF SCIENCES

The College of Sciences had a banner year in 1986-87 on all fronts. It continues to carry the heaviest responsibility in terms of undergraduate and graduate education, with the 1986-87 total teaching load representing 30 percent of the effort of the entire University. All programs and curricula in the University are affected by the quality of instruction provided in the College of Sciences since every major requires courses taught within this unit.

The college continues to be a leader of innovative teaching and service to the community. It is playing an increasingly large role in the nationwide attempt to improve the quality of science and mathematics teaching in the public schools. Numerous federal and state grants supported programs to strengthen the background of first grade through high school teachers of science and mathematics. A joint proposal from the College of Sciences and the College of Education was approved for funding by the Commission on Higher Education at the end of the year. This proposal will create a Center of Excellence in Science and Mathematics at Clemson University that will be funded over the next two-year period and has a strong possibility of continued funding. This grant will make it possible to bring public school teachers to the campus and assist them in all areas of science and mathematics instruction.

Despite the activity in the undergraduate, graduate and public service instruction, the college maintains a high level of research activity. The total value of all externally funded support for research at the end of this year was approximately $12 million. This represents an increase of 60 percent from the previous year despite a general decrease in the availability of external research funding. This gives the College of Sciences the largest external funding for research in the University from non-state sources.

The Department of Chemistry moved into its new building in January of 1987. The building was dedicated April 30, 1987, and officially named The Howard L. Hunter Chemistry Laboratory after the chemist who had been dean of the College of Arts and Sciences for many years before his retirement in 1969. The new building provides modern research facilities for the activities of the faculty and sophisticated laboratories and instructional areas for undergraduate students.

During the year Dean Henry E. Vogel announced that he was stepping down from that position after having served in it for 16 years to return to the faculty. Upon his return to the faculty, Dean Vogel plans to work with a group trying to improve the science and mathematics competency of public school teachers.

Effective with the beginning of the Fall Semester of 1987, the new dean is Dr. Bobby Wixson, an aquatic biologist and environmentalist who comes to Clemson from the University of Missouri at Rolla.
In the fall of 1986 the Department of Biological Sciences had 194 students enrolled in undergraduate degree programs (70 in biochemistry, 45 in biological sciences and 79 in zoology). There were 32 M.S. students (five in biochemistry, nine in botany and 18 in zoology) and 34 Ph.D. students (five in biochemistry, one in botany enrolled under the program in plant physiology in the College of Agricultural Sciences, and 28 in zoology). The doctoral program in zoology continues to serve the largest group of Ph.D. students in the College of Sciences. During the 1986-87 academic year, the department awarded 30 B.S. degrees (seven in biochemistry and 23 in zoology), two M.S. degrees (one each in biochemistry and zoology) and one Ph.D. degree (in zoology).

Research and training activities were supported by 25 grants and contracts: seven from the National Science Foundation, four from the National Institutes of Health, three each from the U.S. Army Corps of Engineers and Water Resources Research Institute, two each from the South Carolina Sea Grant Consortium (NOAA) and the U. S. Department of Agriculture, and one each from the E. I. DuPont de Nemours & Co. (DOE), the U. S. Air Force Office of Scientific Research, American Heart Association, and Pioneer Hi-Bred International. Three faculty members received University Research Grants and one received a Provost’s Award. Students received funds from the American Museum of Natural History, Sigma Xi, and Slocum Lunz and Lerner Gray Awards. The faculty includes one Rhodes Scholar, one Danforth Fellow and two Fellows in the Explorers Club.

Scholarly activities by faculty and students during the year included papers presented at 11 international meetings and 52 national and regional meetings of scientific or professional societies. Forty-three scientific papers, 11 chapters or monographs, one book and at least 31 abstracts, notes or reviews were published or are in press. Doctoral students received the National Sea Grant Award for excellence in applied marine research and the Best Student Paper Award at the annual SEEM Conference.

Professional and service contributions by members of the faculty included the following activities: chairman, South Carolina Heritage Trust Advisory Board; president, Animal Behavior Society; president and member of the Board of Scientific Advisors, Highlands Biological Association; Board of Governors of the South Carolina Aquatic Plant Management Society; member of the University, State and District Selection Committees for the Rhodes Scholarship Trust; associate editors for the Transactions of the American Microscopical Society, the Journal of Experimental Zoology and the Journal of Environmental Biology of Fishes; and technical editor of the Journal of the American Killifish Association. Lawrence A. Dyck completed his term as president of the Faculty Senate, and a number of faculty members served on commissions and other University, college and departmental committees.

Faculty members gave at least seven seminars at other institutions. A number of seminars were presented in the department by students and faculty from other departments and institutions. Cooperation with the Animal Physiology Program led to the development of a series of seminars giving our faculty, staff and students coverage of new topics in rapidly developing areas of the life sciences and promoted the exchange of information and ideas.

A number of projects in the area of modern molecular biology known as “biotechnology” were developed and integrated with others as part of the Second Century Plan. Programs in biomathematics and environmental science are also being developed. Plans for development of the various systematic collections at Clemson have been discussed. We have particularly strong collections of plant materials in our herbarium and vertebrates in our vertebrate collections and now have representatives of 80 percent of the families of birds of the world in our teaching collection. One faculty member chairs the Animal Research Committee. Plans for a new centralized animal facility are being developed to support agricultural and biomedical research throughout the University. Training and research in tropical ecology will receive a major emphasis as we seek to join the Organization of Tropical Studies and develop facilities and programs on Dominica in the West Indies.

The year has been one of opening new opportunities and developing initiatives to support our research and teaching roles in the state, region, country and world at large.
Biology Program

During the 1986-87 academic year, approximately 4,800 students were enrolled in courses offered by the Biology Program. Eight lecture sections and 61 laboratory sections per week were taught each semester by faculty and graduate students from the Biology Program and departments of Microbiology and Biological Sciences. Summer programs included an NSF teacher workshop in Life Science and Biology and an Advanced Placement Institute in Biology.

The Personalized Assistance Laboratory continued to be used by students with the addition of computers and video-disc software. The Biology Program cut its own video-disc with contributions from both Agriculture and Biological Sciences and assistance from the Communications Center. This is the first video-disc developed on the Clemson campus. The project was supported by a grant to the Biology Program.

The Biology Program has been asked to serve as the regional center for the National Association of Biology Teachers Update with the first meeting in August 1987.

The Eighth Clemson University Biology Merit Exam was conducted for more than 1,600 high school and junior high school students. Top winners were awarded scholarships to Summer Science Camp through a grant from the Alumni Foundation Fund.

Notable faculty activities included renewal of a $2.2 million National Science Foundation grant in conjunction with the University of South Carolina and the Charleston Consortium. The grant is a three-year program in teacher education in science and mathematics. The Biology Program is also part of a Math and Science Excellence Center proposal recently approved by the Commission. This center will support courses and development of materials for K-12 science teachers. A second faculty member continued work on a $184,000 grant from the National Science Foundation to develop computer software in biology. A second grant from IBM for the evaluation of biology software was funded. One faculty member served as director of the Junior Academy of Sciences for South Carolina, and another was appointed chief reader for Advanced Placement Biology with the Educational Testing Service. The premedical advisor, also a faculty member in the Biology Program, served as director of the Southern Association of Advisors to the Health Professions and was elected to the president's advisory board for the Medical University of South Carolina.

Additional activities included presentation of seven papers at annual meetings of the National Science Teachers Association and National Association of Biology Teachers; review of NSF CSIP proposals and computer development proposals for the state of New Jersey; presentation of a workshop of video and computer technology and its application to the teaching of biology for the State Department of Education in New Jersey; and judging of the South Carolina Junior Academy paper presentations.

Two manuscripts were published, and four laboratory manuals were revised and published. One laboratory manual was published through a national firm and is now one of the top selling manuals nationally. Two grants were renewed for the 1986-87 year, and three new proposals were submitted.

Department of Chemistry

A most important event for the department occurred in December 1986 when the Howard L. Hunter Chemistry Laboratory was occupied. This 100,000-square-foot building and lecture hall houses the entire department and provides a first-rate facility for the future development of graduate and undergraduate chemistry programs. Moving from Brackett Hall to the Hunter Laboratory was accomplished by students, faculty and staff working long hours through the Christmas holidays to complete the task before the beginning of the spring semester. On April 30, 1987, the new facilities were dedicated to the memory of Dr. Howard L. Hunter, respected dean and professor of chemistry, who served Clemson University for more than 40 years. As part of the dedication, a symposium was held featuring three outstanding chemists: Dr. Alexander MacLachlan, senior vice-president of the DuPont Company; Sir Derek Barton, Nobel Laureate and Distinguished Professor of Chemistry at Texas A&M University; and Dr. Fred Basolo, Morrison Professor of Chemistry at Northwestern University.
The 230-seat lecture hall is to be primarily used for the large freshman chemistry sections and has been equipped with a video projection system purchased by funds from the PPG Foundation. A microcomputer lab is available in Hunter Laboratory to provide computer-assisted instruction to freshman chemistry students.

A crystallographic and molecular structure center has been established, and Dr. William Pennington has been employed to manage the center and assist the faculty and graduate students in determining the structure of new compounds. Dr. Pennington comes from industry with considerable experience in structural determination techniques. His addition to the faculty will provide much needed expertise to the chemical synthesis focus in the department. This focus has been selected to be a part of the University’s Second Century program.

The position of director of undergraduate laboratories has been created and is to be filled by Dr. Melanie Cooper. One of her primary tasks is to examine the present undergraduate laboratory program, especially that of freshman chemistry, and ensure that the experiments are up-to-date and safe. Dr. Clark Bricker, retired professor of chemistry from the University of Kansas and well-known chemical educator, has been appointed visiting professor for next year and will be teaching in the freshman program. Dr. A. Reginald Pinder, Calhoun Professor of Chemistry at Clemson for 21 years, retired.

The number of bachelor’s degrees given is about the same as in previous years (six B.S. and two B.A.). Unlike many institutions in the nation, Clemson has not seen a decrease in undergraduate majors. In fact, freshman chemistry major enrollment for next year appears to have significantly increased. The number of graduate degrees has increased (nine M.S. and five Ph.D.) from last year. None of the graduates have experienced any difficulty obtaining employment. For the second year in a row, a chemistry graduate has received Clemson’s top undergraduate award, the Norris Medal. This year the award went to Tallulah L. Fellers, who also won a Fulbright Scholarship to study in Germany next year.

Funding for grants and contracts was budgeted at about $1.6 million, which places the department among the best funded in the University. This amount is spread over 25 active grants and contracts with 13 being from industry and the remainder from government.

Department of Earth Sciences

The Department of Earth Sciences completed its first academic year in 1986-87. The department offers undergraduate curricula leading to the degrees of Bachelor of Arts and Bachelor of Science in geology. During 1986-87, five students received B.S. degrees in geology, and three geology B.A. degrees were awarded.

Results of a fall 1985 evaluation of undergraduate geology programs by the American Institute of Professional Geologists were made available in January 1987. It was found that “your school’s undergraduate program leading to a bachelor’s degree with a major in geology fully meets or exceeds this Institute’s minimum guidelines for such programs.” The Earth Sciences faculty moved to enrich its undergraduate program by approving two new courses that will be offered for the first time in the 1987-88 academic year. These are Geology 210, Geology of the National Parks, and Geology 220, Planetary Science.

The department has seven full-time faculty members, all of whom devote primary responsibility to teaching. Despite the teaching emphasis necessary in an undergraduate program, research by the Earth Sciences faculty is active and varied. Major projects involve groundwater quality and quantity in the Piedmont area and the influence of lineaments on groundwater supply; structure and mineralogy of igneous and metamorphic Piedmont rock formations; relict periglacial landforms in the western North Carolina mountains; and paleoenvironments and fossil correlations in northeast Tennessee and elsewhere in the Southern Appalachian region.

Faculty members have obtained outside research funding during 1986-87 from the following sources: Water Resources Research Institute/South Carolina Water Resources Commission, South Carolina Geological Survey, Petroleum Research Fund (American Chemical Society) and the Kellogg Foundation. The research contribution of the department has been recognized nationally.
in that two faculty members were invited to participate in symposia held during the 36th Annual Meeting of the Southeastern Section of the Geological Society of America in Norfolk, Virginia, in March 1987. Faculty also were active in service, principally through involvement with science teachers' education in South Carolina and through offering tours and special lectures to elementary and secondary school classes.

During 1986-87 Richard Warner served as acting department head. A search for a permanent administrator was opened, but final selection was postponed because of Clemson University's severe budgetary constraints. The move of the Department of Chemistry out of Brackett Hall was completed by early January 1987. A plan for Brackett Hall that temporarily (until renovation is possible) locates the Department of Earth Sciences on the ground, first and second floors of the Brackett Annex (new Wing) was submitted to and approved by the University administration in early February 1987. The minor modifications necessary for the department to use the vacated facilities have mostly been completed, and the faculty have moved out of the old wing into the new space. A museum that will showcase the mineral, rock and fossil collections of the department is being set up in part of the allocated space.

**Department of Mathematical Sciences**

During 1986-87, 60 mathematical science majors received baccalaureate degrees, 26 received master's degrees and five received doctoral degrees.

One member of the faculty, Mrs. Eugenie Sturgis, retired. Promoted to rank of professor was Dr. James P. Jarvis. Dr. Jerry Nedelman was promoted to associate professor with tenure. Dr. Richard D. Ringelstein succeeded Dr. Clayton V. Aucoin as department director of graduate studies, and Dr. Donald R. LaTorre succeeded Dr. S.M. Lukawecki as departmental director of undergraduate studies. Four members of the faculty spent 1986-87 on sabbatical leave.

A member of the faculty was a principal speaker at five international conferences and organized a sixth conference. Two of our faculty are managing editors of prominent research journals while several others serve on editorial boards of research journals. Another member of our faculty shared the first Bellman Prize for the best research article in a particular research journal. One member of our faculty chairs the Academic Council of the College Board, is director of the Advanced Placement Reading for the Educational Testing Service, and is a member of the Board of Governors of the Mathematical Association of America.

The department currently has more than $4.0 million in contracts and grants in force. In September 1987 faculty of the department initiated activity relative to a five-year, $3.2 million research contract with the Office of Naval Research (ONR) in the University Research Initiative Program of the Department of Defense. The contract, the largest single grant or contract in the history of the University, funds basic research in computational analysis and discrete mathematics as well as graduate students, fellows, postdoctoral and other visitors, and computational equipment to support the research. In particular, the contract allowed the purchase of a 16-node computational hypercube parallel processor, which has the computational power of machines that cost several million dollars. The ONR contract and the departments of Mathematical Sciences and Computer Science jointly funded an ONR Conference in Discrete Mathematics during fall 1986. The department also hosted the Southeast Atlantic Conference on Differential Equations.

With the Department of Elementary and Secondary Education, the Mathematical Sciences Department participated in a Center of Excellence Grant in Mathematics Education funded by the South Carolina Commission on Higher Education. This marks the second straight year the grant has been awarded, and the level of funding was significantly increased over 1985-86. Faculty of the department also participated in the National Science Foundation Grant to South Carolina, "The South Carolina Cooperative Plan for the Professional Development of Science and Mathematics Teachers in Grades 7-12."
Medical Technology Program

The Medical Technology Program completed another productive year of advising, teaching, administrative activity and club sponsorship.

Seven entering freshmen and 12 transfer or change-of-major students joined the medical technology curriculum. This was partially offset by nine students transferring out of the program. In addition, five students completed the baccalaureate degree requirements for graduation. Approximately 30 students are enrolled in the program. Our senior clinical-year students continue to excel on the national certification exam, and all have been successful in finding employment in the field.

The senior-year clinical courses continue to be offered by hospital program affiliates and other nonaffiliated schools. Active affiliation programs are at the schools of Medical Technology at Anderson Memorial Hospital in Anderson, S.C., and at McLeod Regional Medical Center in Florence, S.C. This year all successful senior students remained within our affiliate network and were accepted by and chose to attend the nearby Anderson Hospital program. The Anderson program also continues to help teach the introductory medical technology course taken by new majors.

With the recent advent of government restrictions limiting health-care reimbursements, many hospital-based programs in health education need to develop additional sources of funding to survive. Through the Medical Technology Committee, the University developed a plan beginning in the 1987-88 year whereby Clemson University provides a significant amount of support to the Anderson Hospital School of Medical Technology for each Clemson clinical student in attendance there in return for a guarantee of eight places in the class.

The current program coordinator continued to promote medical technology by group and individual presentations to students from around the state and by participation in the fall and spring annual meetings of the S.C. Society for Medical Technology.

The Medical Technology Club completed another successful year of activities including trips to an area hospital lab and to the Atlanta Red Cross Blood Center, presentations by speakers, service projects and attendance by several students at the SCSMT meetings.

Department of Microbiology

This has been a productive year for both teaching and research activities in the department. There were 99 students enrolled in the B.S. program, 31 in the M.S. and 16 in the doctoral program. A total of 23 B.S., three M.S. and two Ph.D. degrees were awarded. Throughout the year, 12 undergraduates achieved the President’s List, and 35 students were recognized on the Dean’s List. The two Ph.D. graduates accepted postdoctoral positions at Brookhaven National Labs and at the University of Miami Medical School; the M.S. graduates accepted research and development positions with industries; while the B.S. graduates either entered medical or dental schools, continued with graduate studies or accepted positions with industrial companies.

All faculty have operated active research programs in a variety of areas. They submitted some 20 proposals to external sources for funding and received awards from U.S.D.A., Hatch, Food Science Corp., Cancer Health Research Fund, Milkhous Labs, Monsanto Co., U.S. Geological Survey, N.I.H., N.I.D.R., E.R.D.C. and Dow Corning.

Some of the projects undertaken were: the effects of pesticides on microbial activities in aquatic sediments; the microbial degradation of herbicides by anaerobic aquatic sediments; biological nitrogen fixation by a halotolerant bacterium that associates with sea grass plants; diseases of catfish and their immunological response; decontamination of microbially polluted shell fish; the role of certain bacteria in one form of arthritis; chemical stimulation of the immune response; development of monoclonal antibodies and DNA-probes for pathogenic mycoplasma; the genetics and control of cellulase enzyme production; effective conversion of residual cellulose in extracted alfalfa to sugars; genetic engineering of rhizobia for improved biological nitrogen fixation; genetic engineering of lactic acid bacteria for improved food processing and production; enhancement of amino acids and vitamins production by a strain of Escherichia coli; hormonal control of DNA expression...
in mouse melanoma cells; regulation of procaryotic and eucaryotic DNA expression by low molecular weight metabolites; isolation and characterization of oncogenes; interactions of chemical carcinogens with DNA; repair of UV-damaged DNA; interactions between methanogenic and sulfidogenic bacteria; characteristics of the cellulase complex produced by a salt marsh bacterium; and microbial aspects of cotton dust as related to brown lung disease.

Faculty published 13 research articles in international professional journals, presented papers to regional and national meetings of professional societies, served as consultants, reviewed research proposals for granting agencies, and served as reviewers of papers for scientific journals.

One faculty member wrote a chapter on “Microbial Cellulases” for a definitive treatise on cellulose and its degradation. Another published a book chapter dealing with the fundamental biology of L-forms.

Last November a faculty member received the Outstanding Microbiologist award from the South Carolina Branch of the American Society for Microbiology. This award is given sporadically for outstanding service to the society, the state, and for contributions to the science of microbiology. This is the third member of the department to receive this award in the past 16 years.

The department developed a biotechnology conference entitled “Key Issues in Scale-Up: Mammalian Cell Culture.” This was presented December 9-10 in Atlanta in coordination with The Association of Biotechnology Companies. Presentations were made by representatives of some of the major biotechnology companies in the country, e.g. Genentech, Inc., Damon Biotech, Inc., BioResponse, Inc. There were about 100 attendees representing industries, universities and biotechnology programs throughout the nation. A second biotechnology conference is being planned.

The most exciting and potentially important research initiated in the department was to investigate the survival and transmission of a genetically engineered bacterium after its release into soil, together with an agricultural crop plant. This is a multi-departmental effort funded by the Monsanto Co. The test is expected to begin later this year after E.P.A. approval. This study will be a benchmark for the use of genetically engineered bacteria in the environment.

Department of Physics and Astronomy

Activities in the department this year have a decidedly international aspect. One of last year’s graduates spent the year in Germany on a Fulbright Fellowship, our third in the past four years. Dr. Ray Turner was invited to present Toys in Physics at the International Conference on Physics Education held in Mexico. He has reached 500 instructors and 1,200 school children with his presentation this year.

In research, Dr. J.R. Manson divided his summer collaborations between CEN at Saclay and the Max-Planck-Institute at Göttingen. Dr. Miguel Larsen, along with Dr. Phil Burt and several graduate students, traveled to Greenland to study winds in the upper atmosphere by rocket-borne chemical releases. Dr. Larsen also spent time at Arecibo, Denmark, and in Tel Aviv. Dr. Burt presented invited papers at Hamburg and Joensu. Dr. A.L. Laskar and a graduate student participated in the NATO Advanced Study Institute in Italy, and Dr. Laskar continues his conference-organizing and book-editing endeavors with colleagues in India. Dr. D. P. Miller gave an invited paper at the IDSP conference in Geneva and collaborated with a colleague in Grenoble.

External grants in effect during the year, listed with the principal investigator, include Martin-Marietta, Dr. Robert Chaplin; NASA and AFOSR, Dr. Larsen; NRL and Kodak, Dr. Laskar; NASA, Dr. John Ray; NSF, Dr. Carl Ulbrich; and notification of an award from NIH, Dr. Lyndon Larcom. Additionally, Dr. Larcom and Dr. Henry Graben were awarded Provost Research Awards, and Dr. Burt received an Energy Institute travel award. The Advanced Placement Physics Summer Institute, proposed by Dr. Ed Gettys, was funded by the State Department of Education.

Dr. John McKelvey chaired several committees of Southeastern Universities Research Association, including the New Projects Committee. Dr. E.P. Stillwell has been named as the Clemson representative to the SURA board, replacing Dr. McKelvey who has retired. Dr. Malcolm Skove continues her active research program with present and former students and colleagues. Dr. Phil
Flower served on the Roper Mountain Telescope Committee and helped develop a proposal for an astronomical observatory near the campus. Dr. Max Sherrill served on the Dean Selection Committee, which successfully completed the search for a new dean of the college.

Physics Day, organized by Professor Collins, was the most successful yet with about 800 students and 45 teachers in attendance. Dr. Graben organized the meeting here of the South Atlantic coast section of the AAPT. Dr. P.A. Steiner handled class scheduling and attended to curricular matters. Professor John Gilreath returned from sabbatical at Montana State where he developed the use of microcomputers in physics instruction. Dr. M.G. Miller continued developing experiments for the junior lab. Drs. Fred Keller, Gettys and Skove continued the preparation of their book. Dr. Ulbrich completed his term as acting department head and turned over the duties to Dr. Gettys as a search for a permanent head continues.

DIVISION OF AGRICULTURE AND NATURAL RESOURCES

The Division of Agriculture and Natural Resources is responsible for instructional, research and public service programs in the College of Agricultural Sciences and the College of Forest and Recreation Resources.

In addition to its programs for resident instruction, the College of Agricultural Sciences administers statewide public service programs that serve businesses, industry and virtually every citizen of the state. These public service functions include administration and coordination of the South Carolina Agricultural Experiment Station, the Clemson Cooperative Extension Service, the Division of Regulatory and Public Service Programs and the Livestock-Poultry Health Department.

The scope of the College of Forest and Recreation Resources also spans the entire state and touches the lives of all South Carolinians through teaching, research and Extension activities in forest management, wood utilization, recreation resources and services, and tourism management.

During their past century of service to the state, the agriculture divisions and their leaders have emphasized agricultural production and improved family life, thus laying a strong foundation for the next century. As we enter the University’s second century, our objectives will also include increased productivity, increased employment opportunities, and conserving and protecting our natural resources.

In the past year, our public service divisions have made strong inroads toward meeting the challenges that await us. The three Extension districts were reorganized into four to more closely reflect the agricultural production of each area. This allowed more efficient operation with reduced manpower. A grass roots effort involving more than 5,000 South Carolinians aided administrators in developing an aggressive plan of action for the next four years. The 20 program areas include deteriorating state water quality, need for alternative crops and teen pregnancy.

Research efforts in the area of biotechnology took a great step forward with the establishment of the Clemson University AgriBiotech Initiative, an interdisciplinary effort that focuses on research in the College of Agricultural Sciences but which will draw on areas of expertise from all areas of the University. The first major cooperative effort was begun, and we anticipate that it will establish Clemson as a major force in applied biotechnology. As this program continues and expands, all facets of our public service area will be called on to research applications, assess their safety, and disseminate information to the public.

During the past fiscal year, the College of Forest and Recreation Resources was awarded a major research contract from the U.S. Environmental Protection Agency to study the effects of acid rain and other atmospheric pollutants on tree growth. A unique program in wood chemistry continued to move toward the goal of using wood waste to create materials with the durability and non-flammability of plastic from this renewable resource. A contract to do recreational planning for the U.S. Navy was awarded in the fall of 1986.

A new doctoral program in parks, recreation and tourism management was begun, and ground was broken for a new aquatic facility at the Outdoor Lab on Lake Hartwell, which provides summer
camps for special populations. The Travel and Tourism Institute continued to provide specialized training for the U.S. Forest Service park rangers and research and educational support for the tourism industry.

More detailed reports of each of our divisions follow.

COLLEGE OF AGRICULTURAL SCIENCES

Agricultural Instruction

The mandate of the Will of Thomas Green Clemson, "to afford thorough instruction in agriculture and the natural sciences connected therewith...", is satisfied by the College of Agricultural Sciences through the 17 undergraduate curricula and a full spectrum of master's and doctoral programs administered by the college.

Agriculture remains a dynamic and increasingly complex professional field of significant economic importance. Worldwide, agriculture is the leading force in alleviating human suffering arising from widespread undernourishment and malnutrition. As an industry, in the United States agriculture is a major, positive factor in the balance of trade and accounts for nearly 20 percent of the nation's employment, with less than 3 percent of the population directly involved in the production of crops and livestock. In South Carolina, the agricultural industry contributes up to $3 billion annually: crop and livestock production (about $1 billion) and all aspects of value added industries, such as packaging and processing.

The agriculture of South Carolina is changing. In addition to an expanding food manufacturing industry, ornamental and landscape horticulture, including turf production, are expanding rapidly. Agricultural graduates are prepared to serve this complex industry in the state, the nation or worldwide.

Undergraduate education in agriculture must stress the application of principles to the recognition and solution of practical problems. Caution must be exercised to avoid overemphasis on teaching solutions, rather than developing problem-solving abilities, and curricula must be evaluated to ensure that the most current, factual information is presented to students. Curricula stress developing capabilities in five general areas: communications, business, people management, basic sciences and a field of technical agriculture.

The association of teaching, research and extension in the College of Agricultural Sciences reflects the basic structure and philosophy of the land-grant institution and helps ensure that students are exposed to the most current ideas, concepts and controversies. The classroom instructor is also a research scientist or Extension specialist. In addition, students benefit from the availability of equipment and facilities associated with research responsibilities that might not be available exclusively for teaching.

Graduate education is a recognized responsibility of the college. Graduate students contribute significantly to the research efforts of the college. Growth of graduate programs reflects maturity of the college and University. Reduced support for students and a decline in the pool of potential graduate students have added emphasis to efforts to attract the most highly qualified prospects. National studies indicate a serious deficiency of master's and doctoral graduates in many agricultural disciplines.

During 1986-87 several faculty participated in a national curriculum development program funded in part by the USDA. This has led to changes and redirection of several curricula and increased interest in curriculum. In addition, the faculty voted to restructure the undergraduate major in economic biology to give better identity to the three curricula (economic zoology, entomology and plant pathology) and approved a proposal for a Master of Science in Animal Physiology. Curricula will be further reviewed in light of continued low enrollments to ensure that student/employer demands are fully considered, but educational efforts will not become merely vocational training for a specific job.

Enrollment remains a serious problem in all undergraduate curricula. Low enrollment in agriculture is not unique to Clemson, and the reasons are many: a generally poor perception of agriculture as a
career field caused by the economic plight of farmers; competition from other disciplines; and a smaller, traditional college-age pool. The college has stressed recruiting. Major emphasis is on direct high school visits; more than 65 schools were visited in 1986-87. In addition, off-campus district-wide recruiting programs were presented three times during the 1986-87 academic year at the invitation of public school administrators, and a student speakers' bureau has been established. Follow up of applicants has been improved, and a series of special on-campus programs is scheduled, including the annual fall Open House/Parents Day. An Ag Alumni organization has been formed, which should also help recruiting.

The success of instructional programs can be measured in several ways. Demand for graduates is good for all degree levels. If graduates are willing to relocate, demand exceeds supply. This is markedly the case for graduates in the food manufacturing area and for some agricultural business students. Scholarship support is stable, to increasing, and enrollments are slowly increasing.

International Agriculture

The College of Agricultural Sciences continues to serve international students. During 1986-87 six undergraduate and 45 international graduate students were formally enrolled in college curricula. In addition, the college hosted more than 30 foreign visitors whose lengths of visits varied from a few hours to several months. Faculty have participated in a variety of short-term foreign assignments, and preliminary steps have been taken to establish formal training agreements with several foreign institutions. The majority of the efforts in international agriculture are associated with research projects or involve training graduate students and visiting faculty. The Office of the Director of International Programs in the college needs to be further strengthened. The director has initiated many positive activities deserving broader recognition and support. Participation in international programs is clearly within the mission of the college.

Continuing Education

Short courses, workshops, seminars and in-service training activities are presented throughout the state to serve professionals and to help improve technical competency. Agriculture continues to face negative economic conditions of near crisis proportion. Technical help for all areas of agriculture is essential, and the agricultural industry will depend on college programs and graduates to provide it.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION

Agricultural Economics and Rural Sociology

Research goals in the Department of Agricultural Economics and Rural Sociology include enhancing the quality of life, giving policy makers scientifically based information, and improving economic well-being in local, regional, national and international economic sectors, particularly agriculture and rural areas. Research projects focus on contemporary issues and problems.

A study of public water systems in South Carolina revealed many institutional problems. The state has many small systems that cannot take advantage of economies of size. In many cases, operating cost and rate structure are unrelated, and pricing systems are not designed to encourage economizing. The most significant problem is the lack of information on water quality, quantity, pricing, cost of production, costs of maintenance and expansion, and long-run supply and demand.
Research on social and economic development suggests that rural areas and areas with large proportions of black residents lag behind in efforts to reach the level of economic well-being of urban, suburban, resort and retirement areas of South Carolina.

Predicted development trends will likely widen the economic gap between rural and other geographic areas. Rural counties made good progress until the mid-'70s, but since have been declining or merely holding their own. Non-metro counties have managed to keep pace with national indices, but those based on farming and forestry have made no progress toward closing the income gap since the late '60s to early '70s. From 1985 to 2000, a population increase of 31 percent is expected in the non-coastal metro counties, and another 36 percent increase is expected in the six coastal counties. The important implications are a shift from manufacturing to service employment and impacts on the natural resource base.

Over the past 25 years, the structure of agriculture in the United States and South Carolina has undergone a tremendous transformation. Farm numbers in the state have declined to less than 30,000, with larger units producing more of the total farm receipts. Research indicates there is still significant support for maintaining a family-farm based system of agriculture in the nation; however, this support is dwindling.

A survey of 1,200 South Carolina farmers was conducted to determine the industry's financial condition in the fall of 1986. Results indicated that, though the financial crisis of the state's agricultural economy was by no means over, the condition for most farmers was not dramatically worse in 1986 than in 1985. The 1986 drought affected most farms in the state, but only a small percentage was or will be out of farming as a result.

A model was constructed to study the effect of a European Community oils tax on U.S. soybean exports. Empirical results indicate the impact of a tax as high as 90 percent would have only a small impact on U.S. soybean exports.

Peach quality researchers studied the incentives for producers and packinghouse operators to pack peaches in size classifications different from those customarily used in the Southeast. Results indicate that careful management of the sizes marketed can improve revenues. User-friendly computer programs have been developed to assist in these marketing decisions.

The No Net Cost Tobacco Program Act of 1982 provided for the sale of tobacco quota, and in some cases required the sale or loss of quota by non-producers. A survey of buyers and sellers of quota in South Carolina found that most buyers were relatively large tobacco producers, and indicated a great deal of discounting for program uncertainty. Model results confirmed that program uncertainty decreased the demand for quota and increased the supply of quota for sale. Both had a negative effect on quota prices.

Three financial strategies and three credit policy options that farmers might follow over a four-year period were evaluated. The study took into consideration different economic scenarios as well as levels of farm debts and assets. Under pessimistic economic conditions, a farm with initial debt-to-asset (IDTA) ratio of 20 percent was able to survive the next four years by using asset sales strategies. No policy options or financial strategies allowed farms with IDTA ratios of 40 percent and 70 percent to survive past 1990. Under current economic conditions, the farm with IDTA ratio of 20 percent survived without any options or strategies; the farm with IDTA ratio of 40 percent survived using the asset sales strategies; but the farm with IDTA ratio of 70 percent was technically insolvent to 1990 under all policy options and financial strategies. Under optimistic economic conditions, no policy options or financial strategies were necessary for the farms to survive.

Agricultural Education

The Department of Agricultural Education is participating in a regional project to analyze the labor force experience and continuing education of college graduates in agriculture.

During 1986-87, 86 percent (186 of 216) of a sample of Clemson's former undergraduate agricultural students were located for the study. After editing and pretesting, questionnaires were sent to those students. Data on educational attainment, career mobility, college curriculum competencies and skills, opinions about agricultural careers and personal characteristics were compiled from the 155 questionnaires returned. The data will be analyzed during the coming year.
Agricultural Engineering

Agricultural engineers have been involved in a wide range of research projects to improve the food and fiber production in American agriculture with a concern for the environment and farm profitability. The primary research areas are power and machinery, farm structures and environment, waste management, fruit and vegetable mechanization, soil and water, electrical power processing and aquaculture. Three of 45 projects are highlighted here.

To better understand the role of moisture stress in peach tree short life, a detailed study was conducted in an orchard in Edgefield County. The root zones of a number of trees, both irrigated and non-irrigated, were intensively instrumented for soil moisture measurement. Rainfall, solar radiation, temperature, humidity and other meteorological factors were measured at the site so the demand for water could be calculated. When soil moisture was readily available, the trees extracted 75 percent of their total water needs from the top 30 cm of soil. However, as the surface layers became drier, progressively more water was drawn from deeper in the soil. Trickle irrigated trees were able to draw up to 25 percent of their water needs from the moist zone around each emitter.

Based on the field data, a computer model has been developed to reproduce the water balance of irrigated and non-irrigated trees. With further refinement and testing, this model could become a useful tool for scheduling orchard irrigation to reduce moisture stress on trees.

An air blast orchard sprayer has been modified to more efficiently apply pesticides to fruit trees. The modification includes an ultrasonic ranging system that measures the dimensions of the tree, a ground position indicator that measures linear travel along the row, and a computer-controlled system that can modulate the quantity and direction of the spray by opening and closing solenoid valves. The system has the ability to record the dimensions of the trees for later use in determining yield prediction and fertilizer needs. The sprayer has been initially tested on a mature peach orchard and a young apple orchard. The average savings of chemicals, 15 percent, was significant. Actual savings will depend on individual orchards.

Major success in the development of a mathematical understanding of the engineering requirements for curing tobacco was accomplished by installing laboratory facilities for curing tobacco in bulk boxes. To determine the requirements for minimizing curing costs with non-uniformly loaded boxes, one-fifth scale, box-type bulk barns were set up in the enclosed Agricultural Engineering Tobacco Curing Building at the Pee Dee Research Center. Research showed that relatively high airflow was needed to properly cure non-uniformly loaded boxes. It also showed that with low airflow barns, loading boxes lightly may be more important than loading them uniformly.

Agronomy and Soils

The Agronomy and Soils Department conducts research directed toward the most efficient use of soil resources for agricultural production and preservation of environmental quality. It also conducts research in management of agronomic cropping systems and in development of new crop varieties.

A long-range study of the effects of soil and crop management on contamination of ground water by agricultural chemicals has begun. Earlier work showed that a major portion of the water and chemicals can bypass large portions of the soil and can be transported by a small fraction of the available pore space. Current research is expected to define the circumstances under which this can occur, leading to more efficient production of agricultural crops and more effective ground water protection strategies.

A new agri-biotechnology research initiative was implemented in conjunction with industry and two other departments (microbiology and plant pathology and physiology) at Clemson. The project involves field testing a genetically engineered soil microorganism to assess its fate and some of its microbial ecological effects. The test microorganism is a common, naturally occurring soil microbe that has been designed so it can be easily tracked. The microorganism was developed by the Monsanto Co., which is providing partial support for the research. The research design deals with
fundamental questions associated with the release of any engineered organism, such as its survival and competitive nature compared to naturally occurring soil microorganisms, its ability to over-winter, and the potential for exchange of "transplanted" genetic material.

Closely related work has resulted in the isolation of genetic material from another natural soil microorganism responsible for the accelerated decomposition of a commonly used group of herbicides. This work could lead to the development of soil microorganisms that can degrade toxic wastes.

PERRIN, a new soybean variety, has been proposed for release to the S.C. Foundation Seed Association. PERRIN is a Maturity Group VIII strain that offers an improved level of tolerance to peanut rootknot nematode and excellent tolerance to stem canker disease. Generally its yield has been equal to or better than other cultivars of similar maturity. Breeder seed will be released to the S.C. Foundation Seed Association and seed organizations in other states that choose to participate in its release.

A geneomic library for soybeans has been developed that will be used in germplasm development and biotechnology research related to soybean breeding. Scientists in the Department of Biological Sciences are collaborating in the research.

Forage evaluations of a number of warm season perennials were initiated at Clemson and at the Pee Dee and Edisto Research and Education Centers. Ecological studies of alfalfa interseeded in coastal bermuda sod show considerable promise as a grass-legume forage mixture, and grazing trials will be initiated if advanced evaluations go well. A selection of Kentucky 31 fescue has been isolated from an established pasture in the Piedmont that is low in endophyte infection. It shows promise of being fungus-free and particularly adaptable to the upstate of South Carolina.

A joint activity with the Agricultural Engineering Department has resulted in the development of a device and method for interseeding soybeans directly into standing wheat and other small grains. When perfected, this could make substantial improvement in efficiency and cost of production for small grain and soybean producers.

Animal Science

Beef cattle research centered on methods and techniques to enable South Carolina producers to be more competitive in the beef cattle industry. Bull test station records showed 365-day weights increased, with 105 state producers participating in the testing programs. Graded feeder calf sales showed that large- and medium-framed steer calves netted at least $80 more than small-framed calves. Heifer calves showed an average difference of $39.

Crossbreeding research demonstrated significant differences in the performance of crossbred dams. Breeds with higher milk-producing and growth ability (Simmental-Angus crosses) outproduced the popular Polled Hereford-Angus dams at both the Simpson and Edisto Experiment Stations. Likewise, sire breeds with the highest growth rates often have the highest birth weights, which can cause dystocia (calving difficulty).

Evaluation of "heat adapted" sire breeds, including Senepol, Brahman, Brangus and Santa Gertrudis, was begun. Clemson University also was involved in evaluating young sires from the Charolais Herd Improvement Program (Sire Evaluation Program) in cooperation with the American International Charolais Association. Of six sires tested, only one exceeded the 205-day weaning weight average of the reference sires. Carcass and yearling data are still to be analyzed.

A five-year summary of five breed groups — Angus, Polled Hereford-Angus, Charolais-Angus, Holstein-Angus and Simmental-Angus crosses — on two levels of nutrition revealed the higher lactating dams (Holstein-Angus and Simmental-Angus) had the highest weaning weight for both nutritional levels.

Studies involving the effects of prostaglandins on secretion of progesterone, a pregnancy-maintaining hormone, were completed. The results indicate that progesterone is secreted in a periodic manner and peaks within five hours after prostaglandin is administered.

Surveys of the current health and/or carcass quality status of South Carolina hogs indicated that fewer than 50 percent of the hogs are lean enough to grade USDA No. 1. Internal parasite loads
were quite low, and atrophic rhinitis levels were found in fewer than 30 percent of the population, but respiratory lesions were more widespread.

Research continued into edible tissue growth and skeletal changes in boars, barrows and gilts slaughtered at different ages. Several reproductive hormonal interactions were studied in an effort to better understand and control reproductive processes. Low feed intakes were identified as the main culprit in high sow post-farrowing weight losses.

Management and nutritional studies with 21-day-old pigs received primary attention. Triticale grain, high nutrient-density early wean diets and various copper levels were compared to standard control diets. All were found to add a favorable dimension to production. The importance of dietary lysine levels was shown, and a demonstration project confirmed the highly significant benefit of managing nurseries by starting and finishing all young pigs at the same time.

Many reproductive problems have been associated with mares grazing tall fescue. Recent studies indicate that these problems — prolonged gestation, thickened placentas, weak or dead foals and lack of milk production — are directly related to the ingestion of Epichloe typhina-infested fescue. Sixteen pregnant mares were grazed on fungus-free and fungus-infected Kentucky 31 fescue pastures. Normal reproduction occurred in mares grazed on the fungus-free fescue, but only one foal was raised from those grazing fungus-infected pastures.

The efficacy of organic acids as hay preservatives is well documented but their effect on animal intake is not. Four mature geldings were used in a switchback trial to measure the intake and digestibility of alfalfa hay treated with propionic acid. From an animal standpoint, adding propionic acid had no effects on utilization of hay.

**Aquaculture, Fisheries and Wildlife**

Increased consumption of seafood products, coupled with a static or reduced number of wild fishery resources, has prompted an international interest in aquaculture. Clemson University has responded with a multidisciplinary research team that is addressing intensive aquaculture production systems management. The nutritional requirements of aquatic life are influenced by the availability of food and the stress factors encountered. A major effort at Clemson involves developing cost-effective feed formulations for fish raised in cages and raceways. Research to date has demonstrated catfish raised in cages can convert 1.2 pounds of feed to one pound of fish.

Cooperative efforts with the S.C. Wildlife and Marine Resources Department have made advancements in the techniques of culturing hard clams. Research findings indicate that considerable benefit can be gained from genetic manipulation of hard clams and that small improvements in handling brood stock could provide a major stimulus to the growth of clam culture in the state and nation.

Crawfish farming is one of the fastest growing agricultural industries in South Carolina. Different management strategies are being evaluated to determine ways to improve production and extend the growing season. Future projects will involve testing new varieties of crawfish, evaluating harvesting techniques and screening forage species for maximum production and yield.

Fisheries research includes both applied and basic topics. A study conducted with the S.C. Wildlife and Marine Resources Department documented the ability of silver carp, which feed on microscopic plants, to control algae in dairy farm ponds. In a 180-day period, net fish production was 2,507 kilograms/hectare.

The thermal tolerance of largemouth bass embryos and larvae in a nuclear plant cooling reservoir was studied in a project supported by DuPont Department of Energy/Savannah River Laboratory. This study demonstrated that temperature changes could increase the survival rate of larval bass exposed to fluctuating temperatures. Another study conducted in cooperation with the S.C. Wildlife and Marine Resources Department examined the movements of striped bass in the Santee-Cooper reservoir system. This study found that the striped bass confined their movements to the former river channels in the impoundments and sought thermal refuges during June, July and August.

Preliminary studies by wildlife researchers showed that during their first breeding season, male white-tailed deer establish new home ranges up to five miles from their place of birth. These findings
strongly suggest that areas to be intensively managed for production of trophy bucks should be in excess of 50,000 acres.

The use of advanced radio-telemetry technology to study eastern bluebirds revealed that these birds use much larger areas and a greater variety of habitats to sustain their needs than previously recorded. The study revealed that breeding pairs use areas averaging 40 acres in size, while individual birds use much larger areas, about 280 acres, during the winter. In addition to using habitats such as clearcuts and roadsides, bluebirds regularly use pine stands. More accurate information about the bluebird’s needs will enable conservationists to provide better living conditions for this bird.

**Dairy Science**

Thrusts in nutrition, physiology and dairy manufacturing encompass numerous research activities by dairy scientists in both production and processing.

Research is being conducted to determine the effects of a sustained-release bovine somatotropin (BST) on the lactation, reproduction and health of dairy cows. The study involves administering the BST at 14-day intervals over a period of 210 days. Treatments begin approximately 100 days after the cow has given birth. The study involves the same cows for at least two lactations to get a long-term picture of BST effects. To date, no health problems have been encountered, and no evidence of potential pathogens in milk cells has been found. Increased milk production and improved feed efficiency are evident. No metabolic disorders from higher energy intake have been encountered.

Scientists are studying the possible link between aflatoxin and outbreaks of specific diseases to determine if aflatoxin may repress or damage the bovine cellular immune system. If such a connection is made, further studies will examine how such damage occurs. Comparative studies concerning the interactions of nutrition and cancer have continued, using diverse animal models such as the shark, skate, calf and turkey. Methods for extracting and purifying animal enzymes have been developed, using the turkey as a model. These methods are being adapted for possible use in efficiently purifying and characterizing bovine enzymes.

Preliminary research investigating light-induced degradation of the low-calorie sweetener aspartame has proven unsuccessful in detecting any breakdown, suggesting that aspartame is not susceptible to light-mediated changes. That fact may be significant because aspartame utilization continues to increase with new products being introduced and the Food and Drug Administration allowing new categories of aspartame-sweetened products to be produced.

Initial work with frozen dairy-based desserts using carbon dioxide to replace air appears to improve sherbet color, flavor and texture. This process could easily be adapted to current production processes. Work continues with this process, which might easily become commercially important.

**Entomology**

Concerns about pollution of South Carolina lakes and streams and the quality of surface and ground water have prompted intensive research by Clemson entomologists. Because many insects that live in freshwater habitats are unable to survive even moderate amounts of pollution, their presence or absence may be indicative of water quality. Monitoring insect populations has advantages — including continuous monitoring, indications of cumulative effects of low-level pollutants over time, and effects of several pollutants in combination — over periodic water sampling to test water chemistry.

Research at the Upper Three Runs Creek at the Savannah River Plant near Aiken has found more than 650 species of aquatic insects, more than have been documented for any other stream in North America. Studies of the responses of these insect populations are establishing fundamental guidelines for sampling and evaluating stream insect communities throughout the state. A study of the insect community of the Chattooga River found that, while water quality is generally good in the
Chattooga, there are at least two problem sites at which organic pollutants are being introduced into parts of the watershed. Future research should help distinguish natural population changes from those induced by activities of man.

The corn earworm is one of the major agricultural pests of the Southeast. Recent estimates indicate this insect is responsible for losses of approximately $100 million per year. Management strategies, particularly those involving biological control, are critically dependent on knowledge of the species' basic biology. Yet, surprisingly little is known of the corn earworm's behavior. As a result, Clemson entomologists have developed a major program to study the behavior of the corn earworm. A complete behavioral time budget developed at Clemson for the corn earworm was the first time study for any pest species.

Corn earworm behavior was studied from the time the larvae hatched through the final feeding 10 days later. Repeatable behavior patterns and the most vulnerable periods in the larval life were identified to help determine the times and methods of control.

Behavior of the adult corn earworm is being studied to identify patterns of feeding. The reproductive potential depends largely on the quantity and quality of food, primarily floral nectar. Research results strongly indicate that population densities can be controlled through manipulation of nectar sources. Additional studies of corn earworm behavior center on the species' cannibalistic larval habits. Current research is examining ways to more efficiently use cannibalism as a means of self-regulating populations.

The Formosan subterranean termite is a highly destructive species of termite that came to the United States from China. The first record of this insect in the continental United States was in Charleston in 1957. It has since been recorded in other locations in the Southeast.

Studies were conducted to determine the distribution and swarming activity of this termite in South Carolina. To date, the distribution in South Carolina has been restricted to the Charleston area. Most infestation can be attributed to natural dispersal, which is very slow and limited. Dispersal by man is a cause for serious concern and warrants consideration of quarantine procedures. Studies of swarming patterns indicate the termite is attracted to light and that it has specific swarming patterns that can be used in observing and predicting movement.

**Food Science**

Studies investigating the use of metallic filtration membranes and biotechnology to enhance food product and process development continue.

Of special interest is the study of metallic ultrafiltration membranes for determining the amount of calcium retained in a diet. Membranes were used to simulate the human intestinal tract. Calcium-containing compounds and amino acid solutions were evaluated to determine how the pH level of the membrane, charge of the amino acid and the type membrane used affect passage through the membrane. Calcium passage varied from 20 to 81 percent depending upon the membrane and pH. When membranes at neutral pH were used and no other compounds were present, 80 to 90 percent of the free calcium was passed. The passage of selected amino acids varied from about 30 percent to almost 100 percent depending on the membrane and pH used.

It is evident that reactions occurring at the membrane surface may quickly alter the characteristics of the membrane. For example, steam sterilization is necessary for aseptic processes, so all metallic membranes were sterilized by steam prior to microbial challenges. Steam changed the permeability of metallic membrane filtration systems, hyperfiltration and ultrafiltration to dyes and salts.

The ultrafiltration membrane systems were tested for their ability to retain yeast, bacilli or pseudomonas cells in apple puree. All membranes rejected yeasts better than bacilli or pseudomonads. The food grade metallic ultrafilter excluded all yeasts at pressure employed for juice processing. With the exception of a single unit, ultrafiltered juice was microbiologically stable. The use of metallic ultrafiltration membrane systems is an alternative means for the production of commercially sterile apple juice.

Preliminary research was begun on lactobacilli, the bacteria used in producing pickles, summer sausage and other fermented dairy products. Efforts focused on identifying viruses that attack
bacteria and determining if these viruses can be used to transfer genes into the lactobacilli to improve their efficiency and stability. Five such viruses were identified, and work continues to determine possible roles they can play in genetic transfer.

Modifications of an existing method resulted in a less expensive way to isolate plasmids (rings of DNA). Research on isolating the plasmids and identifying what traits they are responsible for has begun. Results could provide an opportunity to design lactobacilli for specific applications for the food industry.

**Home Economics**

Research on the nutritional status and body composition of middle-aged, normal-weight women was begun by researchers at the Center for Home Economics Research at Winthrop College. One hundred women were measured for height, weight and body fat, as well as the level of physical fitness, blood cholesterol and triglyceride. The subjects were questioned about their eating habits, exercise patterns, health status, vitamin and mineral supplement intake, and general lifestyle.

Most of the women were in the good to superior physical fitness categories. Regardless of age (35-59 years), body fat was lower for women in the excellent and superior categories. According to blood cholesterol and triglyceride test results, more than two-thirds of the subjects were below the average level of risk for heart disease.

Preliminary information shows the majority of the subjects ate three meals and at least one snack per day. More than two-thirds drank alcoholic beverages in moderation, but only 12 percent smoked cigarettes. More than half took vitamin or mineral supplements. Only 10 percent of the women had ever enrolled in a weight loss center, but more than a third have followed some self-imposed program of weight loss, including the routine use of artificial sweeteners.

**Horticulture**

Research projects in the Department of Horticulture include peach tree short life, alternative crops, plant breeding and packaging. Additional research on consumer preferences, ornamentals and pesticides is being conducted.

Researchers are studying chemical treatments to delay blooming of peach trees as a means of reducing damage from spring frosts. Efforts in the peach breeding program have identified several lines of Prunus that survive in areas characterized by the peach tree short life syndrome. These varieties may be useful as rootstocks in these affected sites.

Other fruit-related research projects include exploration of kiwifruit as an alternative crop and traditional cultural studies of brambles and strawberries.

Members of the department are contributing to the Tri-State Agricultural Adjustment in the Southeast through Alternative Cropping Systems project. This research will be critical in guiding potential investors who choose vegetable crop production as an agricultural alternative system.

An international program is being developed in the area of fruit crops postharvest physiology in collaboration with the Southeast Consortium for International Development (SECID) and the Caribbean Agricultural Research and Development Institute (CARDI).

Plant breeders are developing improved selections of tomatoes, cowpeas, watermelons and sweet potatoes. Research also is being conducted in the area of long-term germplasm storage of sweet potato lines, the evaluation of sweet potatoes for use in potato chip production, and acceleration of plant growth by modification of the gaseous environment.

Postharvest research involving physiological and pathological changes associated with stored and packaged vegetable crops has been initiated. Experiments directed toward use of modified atmospheres in packaging leafy green vegetables has indicated significant increase in shelf life. In conjunction with the packaging research, work is being conducted to develop enhanced cultural techniques to increase the market quality of cantaloupe, spinach and onions.
Research on ornamental plants and consumer horticulture has been designated as an area of significant emphasis for the next few years. Plans are under way for the implementation of a statewide botanic garden/arboretum concept that will use the Clemson University Botanical Garden as a basis for further expansion. Associated with this program will be a significant redirection of the pecan nutrition and cultural management program at the Sandhill Research and Education Center.

Active research on ornamental crops includes evaluating the chilling tolerance of tropical foliage plants and optimizing the fertility, support medium and cultural practices involved in producing nursery stock in containers. The adaptation of pesticides to horticultural production practices is being actively studied. Research in controlling turfgrass weeds as well as diseases and weeds in containerized nursery stock is being conducted. Monoclonal antibody diagnostic test kits are being evaluated for potential use as pathogen identification systems. These tests are highly reliable and very rapid.

Methods are being developed to study root growth in situ in a nondestructive fashion. These techniques will allow the effects of various control practices on root growth of turf to be monitored.

**Plant Pathology and Physiology**

Several South Carolina Agricultural Experiment Station projects funded by both state and extramural monies have been directed toward improving disease control of fruit crops. Most of the objectives are concerned with peach diseases and cover areas such as finding alternatives to pesticides for controlling ring nematodes, evaluating peach rootstocks for resistance to ring nematode, producing virus-free nursery stock and resistance to fungicides.

Studies found that buckhorn plantain, “Janie Flame” marigold, sicklepod and goosegrass tended to lower ring nematode populations when grown with young peach trees. However, these same plants reduced peach root and shoot growth. Just as importantly, centipedegrass, showy crotalaria and perennial ryegrass planted among the trees resulted in larger populations of ring nematodes than when peaches were grown alone.

Continued observation of 143 *Prunus* lines planted in a peach tree short life site indicates there is differential susceptibility among lines to ring nematodes. Some Tennessee Natural Selections appear to be among the best, and some of those lines also exhibit resistance to some rootknot nematode species.

Virus-free peach rootstock seed and virus-free and true-to-name scion wood of *Prunus* varieties are being produced. The variety collection is being revamped to contain more low chill requirement varieties. A survey of peach orchards throughout South Carolina indicates that Prunus necrotic ringspot virus is more of a production problem than formerly thought. Some varieties are infected with this virus at a very high rate. With further refinement of procedural techniques, the scion wood and seed production for peach tree certification will be able to supply many of the base materials for a more progressive fruit tree nursery production.

In fungicide tests, the experimental materials HWG1608 and Baycor continue to excel in controlling brown rot in peaches. Studies continue to show that benomyl-resistant strains of *Monilinia fructicola* peach pathogens are less competitive in the field than benomyl-sensitive strains. Therefore, limited use of benomyl is suggested in orchards where resistance to brown rot has been a problem.

**Poultry Science**

Research efforts in the Poultry Science Department encompass housing, immunology, nutrition, physiology, products, management and pathology. Nutrition work concerns regulation of food intake and fat deposition in chickens, evaluation of new feed ingredients, dietary contaminants, metabolism of vitamin D, egg shell strength and nutrient requirements.
Avian reproduction research projects include studies of semen preservation, effects of removing the pineal gland in male turkeys, and investigations of the avian adrenal gland. The effects of heat stress on reproduction also are being studied.

Products research stresses the function, nutritive composition, quality, stability and efficient production of poultry products. Poultry products research continues to emphasize the prevention of microbial contamination in poultry foods. Procedures for reducing the incidence and numbers of Salmonella in commercial broiler processing plants are being evaluated.

Pathology research includes factors affecting the immune process of poultry, fowl cholera infections and immunity in turkeys and chickens, and quail and rabbit coccidiosis. The eradication of chlamydiiosis, paratyphoid and avian tuberculosis in pigeons also is being studied. Immunology research focuses on the maturation of the fowl immune system.

A cooperative project with the Agricultural Engineering Department involves renewable energy and passive solar housing design for broiler production, and attempts to increase efficiency of energy utilization in poultry housing systems by technological and management alternatives.

The department has begun developing long-range plans and research goals. Such goals could focus on avian immunobiology. This approach would accommodate the department’s expertise in disease, immunology, food science, management, microbiology, nutrition and reproductive physiology. Identifying the area of avian immunobiology as the long-term goal for the research of the Poultry Science Department would be a realistic attempt to harness the expertise of the faculty to promote the goals of the S.C. Agricultural Experiment Station, Clemson University, and the future needs of the poultry industry.

Research and Education Centers

The S.C. Agricultural Experiment Station’s four research and education centers continue to stress the specialties of the areas in which they are located.

The Sandhill Center at Pontiac focuses on fruit, nut tree and vegetable research. The S.C. Swine Evaluation Center and Livestock-Poultry Health Division are located at Sandhill.

The Pee Dee Center near Florence continues to expand crop research on tobacco, soybeans, corn, cotton, peanuts, small grains and vegetables. Studies of aquaculture are planned at the 2,300-acre experiment center. Center personnel breed plant varieties for resistance to diseases, insects, frost and drought, and develop better cultivation methods and machinery for harvesting. Pee Dee Center scientists have been responsible for several research developments that brought international acclaim to the center.

The Coastal Center at Charleston furnishes data to the Extension Service for work with vegetable growers in the Coastal Plains. Ornamental research is conducted at the facility, and a large urban research and demonstration area on Highway 76 South provides information to school classes, garden clubs and homeowners concerning flowers, herbs, shade trees, lawn grasses, vegetables and other plants.

The Edisto Center at Blackville designs research for growers and cattle producers in the Upper Coastal Plains. Field crops such as corn, soybeans, small grains, melons and sweet potatoes are studied, along with forage/beef cattle systems.

Active Research Projects 1986-87

Agricultural Economics and Rural Sociology
Impact of changing costs, institutions and technology on the Southern dairy industries.
U.S. food demand and consumption behavior.
Structural and operational efficiency of the fruit and vegetable production-marketing system.
An economic analysis of risk management strategies for agricultural production firms.
Economics of improving productivity in the livestock-meat systems in the South.
Labor markets and labor force differentiation in non-metropolitan areas.
Disturbances to price discovery-risk management by marketing firms in Southern agriculture.
Economic analysis of the impact of alternative flue-cured tobacco programs.
Monetary, fiscal and trade policy impacts on farm organization.
Socioeconomic dimensions of technological changes, natural resource use and agriculture structure.
Organization and operation of S.C. water utility systems.
Growth of the S.C. broiler industry relative to other Southeastern states and the United States.
Agricultural adjustment in the Southeast through alternative cropping systems.
Marketing strategies for agronomic crops with uncertain prices and yields.
Agricultural water use and irrigation profitability in South Carolina.
Economic analysis for coastal resources management and policy.
Consumption of and market potential for catfish and crawfish in South Carolina.
Consumer acceptance of direct marketing of fruits and vegetables.
Demographic data analysis and policy implications.
Analysis of the farmland market in South Carolina.
Rural entrepreneurship: assessment of its potential as a rural development strategy.
Analysis of structural and organizational changes in rural counties in the South.

Agricultural Education
Labor force experiences of persons trained in colleges of agriculture.

Agricultural Engineering
Soybean production simulation models.
Effects, mechanisms and control of erosion and sediment from agricultural and forested lands.
Agricultural meteorology and climatology for production in the Southern region.
Effect of swine lagoon effluent on hardwood seedling growth.
Methane production potential from farm crops.
Factors contributing to and control of peach tree short life in South Carolina.
Processing and storage of Southern agricultural commodities.
Engineering and management systems for cotton production, harvesting and processing.
Engineering analysis and design for aquaculture of catfish, crawfish and clams.
Animal waste as nutrient and energy resources in warm, humid climates.
Automatic monitoring and controlling grain storage.
Remote sensing and sensor development for tree fruit production and harvesting.
Optimizing production efficiency of animal housing systems in the Southern region.
Electronic sorting and grading of fruit for quality and maturity.
Engineering systems for plant tissue culture.
Automatic control of field machine functions for increased efficiency and energy conservation.
Compost for control of apple collar rot.
Hydrologic/water quality modeling of sediment and chemical movement.
Agronomy and Soils
Grain yields and field performance of barley, oats, rye and wheat.
Advanced strains and cultivars of cotton, soybeans and peanuts.
Soil fertility management for irrigated corn and soybeans.
Development of improved soybean varieties.
Weed control in corn, cotton and soybeans.
Overcoming factors limiting biological dinitrogen fixation by leguminous plants.
Cellular and molecular genetics for crop improvement.
Chemistry of atmospheric deposition: effects on agriculture, forestry, surface waters and materials.
Heat-drought tolerance of white clover stolon meristems.
Life history, population dynamics and interference: a basis for understanding weed biology.
Small grain breeding and genetics.
Spatial and temporal variability of soil characteristics and material fluxes in field soils.
Influence of various tillage and cropping systems on integrated pest management in soybeans.
Rhizobia and mycorrhizae to enhance BNF in cowpeas.
Growth and nutrient uptake by soybean roots as affected by cultivars and soil properties.
Bacterial extrachromosomal factors controlling *Rhizobium japonicum* soybean symbiosis.
Breeding cool season forage grasses.
Modifying aluminum toxicity for plants in acid soils.
Field corn and grain sorghum cultivars for grain production.
Establishment and management of forage crops under stresses of environment and biotic origin.
Characterizing plant traits for improved crop performance.
Mineralogy of selected soils in the Southern region.
Cytological and developmental studies of soybean and clover hybrids.
Nitrogen source for production of forages.

Animal Science
Breeding methods for beef cattle in the Southern region.
Marketability and acceptability of beef produced under forage-grain management systems.
Nutrition and management of swine for increased reproductive efficiency.
Utilization of forages for production of slaughter cattle throughout the year.
Estimation of pork muscle growth and evaluation of hot processing and chlorine washing for hams.
Effect of gender and feed intake on growth and serum hormones and metabolites of the bovine.
Improving reproductive efficiency of cattle and swine.
Efficacy of starter diets for early weaned pigs.
Endocrine mechanisms during pregnancy in the cow.
Physiology of pregnancy and embryo survival.
Forage components that influence nutrient digestion and metabolism in ruminants.

Aquaculture, Fisheries and Wildlife
Warm water aquaculture.
Dynamics of harvesting a S.C. Coastal Plain deer herd.
Home range size, movement behavior and territoriality in the beaver.
Movement behavior of gray fox and scent station transects validation.
Thermal habitat selection by striped bass in Santee-Cooper.
Biology of clams, whelks and other important shellfish.
Juvenile white-tailed deer dispersal and movement behavior.
Eastern bluebird home range and habitat use.
Effect of a statewide cooperative nest box program on wood duck production.
Home range and habitat use of fox squirrels in Coastal Plain South Carolina.
Nesting biology and gosling survival of Canada geese at Monticello Reservoir, S.C.

**Dairy Science**
Effects of environmental and management stressors on production and reproduction in dairy cattle.
Metabolism, toxicokinetics and physiological effects of aflatoxinB-1 in the bovine.
Protein nutrients for ruminants.
Preventing light-induced off-flavor in dairy products.
Development of cold pack and process blue cheese.
Metabolic and production response of dairy cattle fed forage-based diets.
Dietary factors affecting the toxic and immune response of ruminants to mycotoxins.
Optimizing nutritional management of dairy cows.
Factors affecting composition, quality and shelf life of cultured dairy products.

**Entomology**
Entomopathogens for use in pest management systems.
Identification and distribution of insects of potential importance in S.C.
Biology and control of arthropod pests on apples.
*Heliothis* spp: management systems for field crops.
Improved systems of management for pecan arthropod pests.
Insecticide resistance in insect pests and their predators in cotton, corn, soybeans and tobacco.
Physiological relationships between insects and biological control agents.
Biology and control of imported fire ant.
Biotypes of *Heliothis* *zea* in South Carolina.
Synanthropic diptera, exoparasites and other associated pests of poultry.
Population dynamics and management of peach arthropods.
Area-wide population dynamics and ecology of the corn earworm.
Management and biology of arthropod pests of livestock.
Biology, ecology and control of selected cockroach and termite pest species.

**Food Science**
Functional properties of proteins.
Maximizing the use, nutritive quality and consumer acceptance of sweet potatoes and their products.
An energy audit of laboratory animals using a modified whole body calorimeter.
Optimization of thermal processes for conduction-heated foods in retortable pouches.
Protein quality and dietary fiber interactions.
Interrelationships of diet and physical activity in hypertension.
Processing foods by metallic membrane ultrafiltration and hyperfiltration.
Shelf-life and quality of individually shrink-wrapped fruits and vegetables.
Dietary carbohydrates and aberrations in lipid metabolism.
Plasmid and genetic transfer systems in lactobacilli.
Protein and mineral bioavailability from food products.
Dietary zinc and changes in bone composition.
Trace mineral bioavailability studies in plant proteins utilizing protozoa.

Home Economics Research (cooperative with Winthrop College)
Nutritional status and body composition of normal-weight, middle-age females.
Textile fiber systems for performance, protection and comfort.

Horticulture
Environmental and biological stresses of rootstocks in peach tree longevity.
Plant germplasm — its introduction, maintenance and evaluation.
Trickle irrigation in humid regions.
Turfgrass culture and improvement.
Breeding improved stone fruit scion and rootstock cultivars.
Cultural and environmental effects on strawberries.
Evaluation of herbicides to support registration on vegetable crops.
Chilling injury of selected greenhouse plants.
Photosynthesis, carbohydrate distribution and growth in peach trees.
Alteration of stone fruit metabolism.
Nitrogen and water application practices for ornamentals and turfgrasses.
Quality maintenance and improvement of fresh market peaches and apples.
Herbicide phytotoxicity, morphology and early disease detection in turfgrasses.
Weed management in cucurbit crops.
Temperature effects on growth and flowering of kiwifruit.
Extending shelf life of floricultural crops by manipulation of postharvest environment.

Plant Pathology and Physiology
Forage legume viruses.
Biology and control of viruses and mycoplasmas in corn and sorghum diseases.
Biochemical and residual properties of pesticides.
Biological control of weeds with fungal plant pathogens.
Etiology and control of plant diseases of ornamental plants.
Factors contributing to and control of peach tree short life in South Carolina.
Biological and chemical control for nematodes and diseases of peach and apple trees.
Causes and control of diseases of woody ornamental plants with emphasis on camellias.
Herbicide resistance and metabolism in tissue culture.
Causes and control of diseases of cereal grains with emphasis on powdery mildew of wheat.
Disease etiology and resistance in Southern pea and other vegetables.
Biology of genetically changing rootknot and cyst nematodes of soybeans.
Distribution, ecology and pathogenicity of rootknot nematode.
Control of peach tree short life in South Carolina.
Physiological indicators of stress in peach trees affected by peach tree short life.

Poultry Science
Nutritional and hormonal factors influencing structure and quality of eggshells.
Preserving turkey and chicken semen, and factors affecting semen production in turkeys.
Control of food and water intake in poultry.
Dietary factors affecting chole-calciferol metabolism in poultry.
Natural and processed ingredient influence on production of poultry.
Live mutant Pasteurella multocida vaccine for prevention of fowl cholera in turkeys.
Monitoring fowl cholera immunity in turkeys.
Factors affecting the ability of the hen to sequester sperm.
Improved detection and bacterin efficacy of turkey mycoplasmosis.
Development of new processes and technologies for the processing of poultry products.
Secretory cell in the genesis of the immune response.
Reproductive efficiency of turkeys.

Coastal Research and Education Center
Urban horticulture for coastal South Carolina (horticulture).
Vegetable breeding: developing improved cultivars and germplasm (horticulture).
Breeding fresh market tomatoes for bareground unstaked production (horticulture).
Disease control on cucurbits and tomatoes (plant pathology and physiology).
Storage potential of selected S.C. vegetables using modified atmosphere packaging (horticulture).

Edisto Research and Education Center
Tactics for management of soybean pest complexes (entomology).
Breeding soybeans for resistance to insect and nematode pests (entomology).
Endemic and imported natural enemies in management of soybean insect pests (entomology).
Assessment of progress in breeding for soil-pest resistance in sweet potatoes (horticulture).
In vitro propagation, hybridization and selection schemes for the improvement of cucurbits and sweet potatoes (horticulture).
Biology and management of selected soybean diseases (plant pathology and physiology).
Genetic mechanisms for soybean germplasm development (agronomy and soils.)
Breeding and development of multiline varieties of pickling cucumbers (horticulture).
Breeding and evaluating sweet potatoes for food and industrial uses (horticulture).
Agronomic evaluation of quality forages in the S.C. Coastal Plain (agronomy and soils).
Engineering improvement and management of forage harvesting and conditioning systems (agricultural engineering).
Breeding of watermelon and evaluation of muskmelon varieties (horticulture).
Physical and chemical characteristics of forages and their relationships to forage quality (animal science).

Pee Dee Research and Education Center
Impact of integrated crop management practices on European corn borer and related stalk boring insects (entomology).
Bionomics and control of insects on cotton (entomology).
Effect of European corn borer population density on injury to corn (entomology).
Economic management of tobacco insect pests (entomology).
Breeding cotton for improved yield, fiber quality and resistance to insects (agronomy and soils).
Mycotoxins of corn and other feed grains (plant pathology and physiology).
Breeding disease and nematode resistant flue-cured tobacco for yield, quality and harvestability (agronomy and soils).
Suppression of aflatoxin and nematodes in corn through cultural practices (plant pathology and physiology).
Tobacco disease and nematode control (plant pathology and physiology).
Cultural practices and variety development for flue-cured tobacco (agronomy and soils).
Improving tobacco bulk curing sytems (agricultural engineering).
Nitrogen and phosphorus starter fertilizer rates and ratios on well-fertilized soils (agronomy and soils).
Improving plastic mulch and row cover crop systems for vegetable production (horticulture).

Sandhill Research and Education Center
Cultural and management practices of pecans (horticulture).
Potential new crops and multiple-cropping schemes for vegetable systems (horticulture).
Orchard groundcover management systems for peaches (horticulture).
Rootstock and interstock effects on peach physiology (horticulture).
Production systems for cool season vegetable crops (horticulture).
Viruses and viral diseases of peach (plant pathology and physiology).

Technical Contributions

2589 PROBABILITIES OF NEGATIVE ESTIMATES OF GENETIC VARIANCES
by W.C. Bridges Jr. and S.J. Knapp [Experimental Statistics].

2590 INTERACTION CONCEPTS FOR ANALYSIS OF RESPONSES TO MIXTURES OF
NEMATODE POPULATIONS by P.M. Burrows [Experimental Statistics].

2591 RESISTANCE OF COMMON COCKLEBUR (XANTHIUM STRUMARIUM) TO THE
ORGANIC ARSENICAL HERBICIDES by E. Haigler, B.J. Gossett, J. Harris and J. Toler
[Agronomy and Soils].

2592 DIGITAL CONTROLLER FOR SPEED SYNCHRONIZATION OF NURSERY CAN
HANDLER by R.E. Young and J.L. Dunlap, Jr. [Agricultural Engineering].
2593 EARWIGS (DERMAPTERA) OF SOUTH CAROLINA, WITH A KEY TO THE EASTERN NORTH AMERICAN SPECIES AND A CHECKLIST OF THE NORTH AMERICAN FAUNA by K.M. Hoffman [Entomology].

2594 AN APPLICATION OF THE DISK METHOD: RESPONSES TO GROWTH REGULATORS by R. Anderson and N.D. Camper [Plant Pathology and Physiology].

2595 HIGHER CLASSIFICATION OF TRIPLECTIDINAE (TRICHOPTERA: LEPTOCERIDAE) by J.C. Morse and R.W. Holzenthal [Entomology].

2596 MICROCOMPUTER CONTROL OF A TWO-STAGE COMBUSTOR by J.L. Dunlap Jr. and F.A. Payne [Agricultural Engineering].

2597 PHYLOGENY OF THE POLYCENTROPUS INSULARIS SPECIES-GROUP (TRICHOPTERA: POLYCENTROPODIDAE) by S.W. Hamilton [Entomology].

2598 'SOUTHERN DELITE' SWEET POTATO by A. Jones, P.D. Dukes and J.M. Schalk [USDA, Agricultural Research Service, U.S. Vegetable Laboratory, Charleston].

2599 HISTORICAL BIOGEOGRAPHY OF TWO GROUPS OF CARIBBEAN POLYCENTROPUS (TRICHOPTERA: POLYCENTROPODIDAE) by S. Hamilton [Entomology].

2600 FREQUENCY OF MORTALITY IN FOUR PEACH CULTIVARS FOLLOWING FALL PRUNING by J.E. Lawrence, G.E. Carter Jr. and E.I. Zehr [Plant Pathology and Physiology].

2601 A LARGE CHAMBER FOR CONTROLLED FREEZING by K.E. Johnson, D.C. Coston and D.W. Cain [Horticulture].

2602 DEVELOPING A SIMPLIFIED SUSCEPTIBILITY TEST FOR THE GERMAN COCKROACH, BLATTELLAGERMANICA (L.) by K.S. Jordan and P.A. Zungoli [Entomology].

2603 BLUEBIRD TRANSMITTER PACKAGE by D. Allen and J. Sweeney [Aquaculture, Fisheries and Wildlife].

2604 USING TELONE II IN ESTABLISHED PEACH ORCHARDS TO CONTROL RING NEMATODES by E.I. Zehr [Plant Pathology].

2605 THE EFFECT OF MOUND DISTURBANCE ON RED IMPORTED FIRE ANT (HYMENOPTERA: FORMICIDAE) CONTROL AND COLONY RELOCATION by L.A. Lemke and J.B. Kissam [Entomology].

2606 EVALUATION OF VARIOUS INSECTICIDES AND HOME REMEDIES FOR CONTROL OF INDIVIDUAL RED IMPORTED FIRE ANT COLONIES by L.A. Lemke and J.B. Kissam [Entomology].

2607 BIOLOGY OF REDBREAST SUNFISH IN BEAVER PONDS by D.S. Levine, A.G. Eversole and H.A. Loyacano [Aquaculture, Fisheries and Wildlife].

2608 EVALUATING RELATIVE HUMIDITY SENSORS FOR MEASURING MOISTURE CONTENT OF STORED GRAINS by J.M. Bunn and M.J. Buschormohle [Agricultural Engineering].
2609 A MECHANICAL OYSTER HARVESTER FOR SOUTH CAROLINA ESTUARIES by J.A. Collier and D.M. McLaughlin [Agricultural Engineering].

2610 CHRONIC PYRIDOXINE INTOXICATION IN RATS by L.M. Bacon and D.E. Turk [Food Science].

2611 METABOLISM OF AFLATOXIN B1 BY BOVINE LYMPHOCYTES IN VITRO: INTERCONVERSION OF AFLATOXIN B1 AND AFLATOXICOL by S. Gangjee and A.B. Bodine [Dairy Science].

2612 AN ASSESSMENT OF THE PREDATORY ABILITY OF CALLEIDA DECORA (FAB.) ON VELVETBEAN CATERPILLAR, ANTICARSIA GEMMATALIS HUBNER, IN SOYBEAN by B.W. Fuller [Entomology].

2613 DEVELOPMENT AND TESTING OF AN ENZYME IMMUNOASSAY SYSTEM FOR DETECTING PORCINE RELAXIN by J.R. Diehl [Animal Science].

2614 INSECTICIDE EFFECTS ON THE INTERACTIONS BETWEEN MICROPLTIS DEMOLITOR (HYMENOPTERA: BRACONIDAE) AND HELIOTHIS ZEA (LEPIDOPTERA NOCTUIDAE) by J.D. Culin and W.P. DuBose [Entomology].

2615 EFFECT OF FATS AND FATTY ACID COMBINATIONS ON RUMINAL FERMENTATION IN SEMI-CONTINUOUS IN VITRO CULTURES by T. C. Jenkins [Animal Science].

2616 EFFECTS OF TWO ISOLATES AND FOUR POPULATION LEVELS ON MELOIDOGYNE AREBAREA ON SOYBEAN by E. Hiatt, E.R. Shipe and S. Lewis [Agronomy and Soils].

2617 TOBACCO RINGSPOT VIRUS FROM SQUASH GROWN IN SOUTH CAROLINA AND TRANSMISSION OF THE VIRUS THROUGH SEED OF SMOOTH PIGWEED by B. Sammans and O. W. Barnett [Plant Pathology and Physiology].


2619 PROTEIN QUALITY METHODS FOR SEAFOODS by J.C. Acton and C.L. Rudd [Food Science].

2620 A PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR) SENSOR by L.C. Grappadelli and D.C. Coston [Horticulture].

2621 THREE INEXPENSIVE AQUATIC INVERTEBRATE SAMPLERS by W.R. English [Entomology].


2623 KINETICS OF SULFATE ADSORPTION AND DESORPTION BY CELCII SOIL USING MISCIBLE DISPLACEMENT by S. Hodges and C. Johnson [Agronomy and Soils].

2624 TRAINING SYSTEMS FOR SECOND YEAR PRODUCTION OF FALL PLANTED STRAWBERRIES by J.D. Caldwell and L.W. Grimes [Horticulture].
2625 INFLUENCE OF CORE AERATION, TOPDRESSING AND VERTICAL MOWING ON BERMUDAGRASS PUTTING GREEN TURF OVERSEEDED WITH PERENNIAL RYEGRASS by A.R. Mazur and D.F. Wagner [Horticulture].


2627 MINERALIZATION OF ISOBUTYLIDENE DIUREA AND UREA WITH AND WITHOUT NITRAPHYRIN IN A HIGHLY ORGANIC MEDIUM by M.A. Nash, A.R. Mazur and D.F. Wagner [Horticulture].

2628 GROWTH AND QUALITY OF HINODEGIRI AZALEA AS INFLUENCED BY ISOBUTYLIDENE DIUREA, UREA AND NITRAPHYRIN by M.A. Nash, D.F. Wagner and A.R. Mazur [Horticulture].

2629 HOST COMPATIBILITY IN PLANTS by S.A. Lewis [Plant Pathology].

2670 REGISTRATION OF WILLIAMS WHEAT by W.D. Graham, G. Kingsland and R. Gambrell [Agronomy and Soils].

2671 PLASTIC MULCH COLOR EFFECTS ON REFLECTED LIGHT AND TOMATO PLANT DEVELOPMENT by D.R. Decoteau, M.J. Kasperbauer, D.D. Daniels and P.G. Hunt [Horticulture].

2672 EFFECT OF FLUAZIFOP ON THE GROWTH OF FIVE VEGETABLE CROPS IN A GREENHOUSE by T.G. Boucounis, T. Whitwell and W.L. Ogle [Horticulture].


2674 A DIESEL-HYDRAULIC OYSTER HARVESTER DRIVE SYSTEM by J.A. Collier and D.M. McLaughlin [Agricultural Engineering].

2675 RELATIVE EFFICIENCIES OF TWO EUROPEAN CORN BORER SEX PHEROMONE BLENDS IN SOUTH CAROLINA by J.A. DuRant and D.G. Manley [Entomology].

2676 INDEPENDENT ACTION OF AN IRIDESCENT VIRUS AND A NUCLEAR POLYHEDROSIS VIRUS IN LARVE OF ANTICARSIA GEMMATALLIS LEPIDOPTER: NOCTUIDAE] by P.J. Seiburth and G.R. Carner [Entomology].


2678 INHERITANCE OF POLYGENIC RACE 2 ANTHRACNOSE RESISTANCE IN CUCUMBERS by D.C. Linde, B. Bridges and B.B. Rhodes [Horticulture/Experimental Statistics].

2679 RESPONSE OF PERENNIAL CULTURED STRAWBERRIES TO FALL PLANTING by J.D. Caldwell and L.W. Grimes [Horticulture].

2680 PEACH ROOTSTOCK CHARACTERIZATION BY PROTEIN ANALYSIS by M. Mazzola and G.E. Carter Jr. [Plant Pathology and Physiology].
2681 EFFECTS OF A NUCLEAR POLYHEDROSIS VIRUS ON FOLIAGE CONSUMPTION BY THE VELVETBEAN CATERPILLAR by R.M. Beach, G.R. Carner and S.G. Turpinseed [Entomology].

2682 INHERITANCE OF PERMETHRIN RESISTANCE IN THE TOBACCO BUDWORM, HELIOTHIS VIRESCENS (LEPIDOPTERA: NOCTUIDAE) by G.T. Payne, R.G. Blenk and T. M. Brown [Entomology].

2683 EFFECTS OF LARGE-SCALE AERIAL APPLICATIONS OF PRO-DRONE ON THE ANT FAUNA IN SOUTHWESTERN SOUTH CAROLINA by L.A. Lemke, J.B. Kissam and P. M. Horton [Entomology].

2684 IMPACT OF RED IMPORTED FIRE ANT PREDATION ON HORN FLIES IN A SOUTH CAROLINA CATTLE PASTURE TREATED WITH PRO-DRONE by L.A. Lemke and J.B. Kissam [Entomology].


2686 ARENA REPELLENCY TEST FOR EVALUATING CHEMICAL REPELLENCY IN BLATTELLA GERMANICA (L.) (ORTHOPTERA: BLATTELLIDAE) by P. Zungoli, E. Benson and D.M. Chambers [Entomology].


2688 FORAGE-LIVESTOCK SYSTEM COMPUTER MODEL USED AS TEACHING AID FOR DECISION MAKING by W.C. Stringer, N. Hill and B.W. Pinkerton [Agronomy and Soils].

2689 FORBEEF—A COMPUTER MODEL FOR FORAGE-BEEF CATTLE SYSTEMS by W.C. Stringer, et al. [Agronomy and Soils].


2691 CONTROL OF HOPLOHAIRUS COLUMBUS ON LATE PLANTED GLYCINE MAX WITH ALDICARB by J.D. Mueller and G.D. Sanders [Plant Pathology and Physiology].

2692 DEGRADATION OF CARBOFURAN IN PRETREATED AND NON-PRETREATED SOIL by N.D. Camper, M.M. Fleming and H.D. Skipper [Plant Pathology and Physiology/Agronomy and Soils].


2694 QUALITY AND SHELF LIFE OF INDIVIDUALLY SHRINK-WRAPPED PEACHES by S.E. Bhowmik and C.M. Sebris [Food Science].

2695 EFFECT OF FLUORESCENT LIGHT ON FLAVOR AND RIBOFLAVIN CONTENT OF MILK HELD IN MODIFIED HALF-GALLON CONTAINERS by J.C. Moskin [Dairy Science/Food Science].
2696 CHEMISTRY OF FLAVOR DEVELOPMENT IN CHOCOLATE by J.C. Hoskin [Dairy Science/Food Science].

2697 THE INFLUENCE OF LIPID SUPPLEMENTS ON RUMINAL FERMENTATION IN NORMAL AND LOW-LIPID IN VITRO CULTURES by T.C. Jenkins [Animal Science].

2698 DERIVATION AND PRESENTATION OF PLANT-GROWTH-ENVIRONMENT RELATIONSHIPS by J.R. Haun and D.C. Coston [Horticulture].

2699 STUDIES ON GRAFTING CAMELLIAS; THE USE OF ONE-LEAF, ONE-BUD SCIONS by L.W. Baxter Jr., S.G. Fagan and S.B. Segars [Plant Pathology and Physiology].


2702 VEGETATIVE GROWTH AFTER FLOWERING IN DETERMINATE SOYBEANS by B. Guice and S.U. Wallace [Agronomy and Soils].

2703 A MODIFIED SCREENING TEST FOR DETERMINING HETERODERA GLYCINES RESISTANCE IN SOYBEANS by J.M. Halbrendt, S.A. Lewis and E. Shipe [Plant Pathology and Physiology].

2704 ESSENTIAL ROLE OF ADENOSYLCOBALAMIN FOR LEUCINE SYNTHESIS FROM BETA-LEUCINE IN THE DOMESTIC CHICKEN by N.E. Ward, J.E. Jones and D.V. Maurice [Poultry Science].

2705 MODIFICATION OF AN ALL-TERRAIN VEHICLE FOR EXPERIMENTAL AND PRACTICAL HERBICIDE APPLICATION by B. Guice, E.C. Murdock and J. Toler [Agronomy and Soils].

2706 EFFECT OF IRRIGATION ON PERSISTENCE AND FORAGE YIELD OF ALFALFA by J.S. Rice, V.L. Quisenberry and C.N. Nolan [Agronomy and Soils].

2707 AUTOMATED SYSTEM FOR DETAILED MEASUREMENT OF SOIL WATER POTENTIAL PROFILES USING WATERMARK BRAND SENSORS by D.F. Armstrong, J.T. Ligon and M.F. McLeod [Agricultural Engineering].


2709 NORTHERN HYBRIDIZATION ANALYSIS OF MITOCHONDRIAL GENE EXPRESSION IN MAIZE CYTOPLASM WITH VARIED NUCLEAR BACKGROUNDS by N.H. Walker, A.G. Abbott and J. Qin [Agronomy and Soils].


2711 SOYBEAN SEEDLING EMERGENCE AT HIGH TEMPERATURES by S.U. Wallace [Agronomy and Soils].


2714 EVALUATION OF TWO EXPERIMENTAL BAITS, UC86874 AND UC84572, FOR CONTROL OF RED IMPORTED FIRE ANTS, 1985 by L.A. Lemke, C. Jeter and J.B. Kissam [Entomology].

2715 DISTRIBUTION AND SELECTED NATURAL HABITATS OF THE FORMOSAN SUBTERRANEAN TERMITE (ISOPTERA: RHINOTERMITIDAE) IN SOUTH CAROLINA by D.M. Chambers, P.A. Zungoli and H.S. Hill Jr. [Entomology].

2716 PHOSPHOLIPID CONTENT OF THE CHICKEN SHELL GLAND AND ITS RELATIONSHIP TO EGG SHELL STRENGTH by D.J. Castaldo and D.V. Maurice [Poultry Science].

2717 GROWTH AND HORMONES IN CATTLE; EFFECT OF CASTRATION AND AN ANABOLIC IMPLANT ON GROWTH AND OESTRADIOL 1-7 ON GROWTH AND SERUM HORMONES IN CATTLE by D.M. Henricks, T. Giminez and T.W. Gettys [Animal Science].

2718 IDENTIFICATION OF GRASS AND MORNINGGLORY SPECIES WITH SIMPLE DICHOTOMOUS KEYS by E.C. Murdock, B. Guice and J. Toler [Agronomy].

2719 SOIL MOISTURE WITHDRAWAL BY ROOTS IN NON-IRRIGATED AND TRICKLE-IRRIGATED PEACH ORCHARDS: I. CONCEPTS by C.F. Armstrong and J.T. Ligon [Agricultural Engineering].

2720 SOIL MOISTURE WITHDRAWAL BY ROOTS IN NON-IRRIGATED AND TRICKLE-IRRIGATED PEACH ORCHARDS: II. FIELD EXPERIMENTATION by C.F. Armstrong and J.T. Ligon [Agricultural Engineering].

2721 WATER BALANCE SIMULATION PROCEDURES FOR NON-IRRIGATED AND TRICKLE-IRRIGATED PEACH TREES by C.F. Armstrong and J.T. Ligon [Agricultural Engineering].


2723 AN EVALUATION OF THE RELATIONSHIP BETWEEN FOOD CONSUMPTION RATE AND EQUILIBRIUM BODY WEIGHT IN MALE RATS by T.W. Gettys, S. Mills and D.M. Henricks [Animal Science].

2724 A UNIQUE COLLECTION/ELEVATION CONVEYOR FOR FRUIT HARVESTERS by R.E. Williamson, C.M. McHugh, C.E. Hood Jr., E.T. Sims Jr. and D.C. Coston [Agricultural Engineering].

2725 ENERGY FOR CONSERVATION TILLAGE IN COASTAL PLAIN SOILS by A. Khalilian, T.H. Garner, H.L. Musen, R.B. Dodd and S.A. Hale [Agricultural Engineering].
2726 BETTER CONTROL OF CAMELLIA FLOWER BLIGHT CAUSED BY *CIBORINIA CAMELLIAE* Kohn by L.W. Baxter Jr., S.B. Segars and S.G. Fagan [Plant Pathology and Physiology].

2727 CALLUS FROM *CAMELLIA SINENSIS* and *C. JAPONICA* STEM TISSUE by C.H. Frisch and N.D. Camper [Plant Pathology and Physiology].


2729 EFFECT OF AN INTRAOVARIAN B-ADRENERGIC ANTAGONIST OR AGONIST ON CORPUS LUTEUM FUNCTION IN THE COW by C.A. Johnson and T. Gimenez [Animal Science].

2730 EFFECT OF TRIFLURALIN ON PROTEIN SYNTHESIS IN CORN ROOT TIPS by N.D. Camper and K.L. Ellers [Plant Pathology and Physiology].

2731 IMPLICATIONS OF REPRODUCTIVE GENETICS ON THE CULTURE OF *MERCE­NARIA MERCE­NARIA* by R.S. Knaub and A.G. Eversole [Aquaculture, Fisheries and Wildlife].

2732 EFFECT OF AN INTRAOVARIAN CALCIUM-CHANNEL BLOCKER ON CORPUS LUTEUM FUNCTION IN THE PREGNANT COW by C.A. Johnson and T. Gimenez [Animal Science].

2733 BREEDING SOUNDNESS EXAMINATION OF YEARLING BEEF BULLS FOLLOWING 140-DAY PERFORMANCE TESTING PROGRAMS by J.C. Spitzer, F.M. Hopkins, H.W. Webster, F.D. Kirkpatrick and H.S. Hill [Animal Science/Experimental Statistics].

2734 A NEW NORTH AMERICAN SPECIES IN THE *SIMULIAM VERNUM* GROUP *DIPTERA: SIMULIIDAE*) AND ANALYSIS OF ITS POLYTENE CHROMOSOMES by P.H. Adler [Entomology].

2735 BEHAVIORAL TIME BUDGET FOR LARVAE OF *HELIOTHIS ZEA* (*LEPIDOPTERA: NOCTUIDAE*) by P.H. Adler and C.R. L. Adler [Entomology].

2736 REGISTRATION OF 'PD-3' COTTON by T.W. Culp, R.F. Moore, L.H. Harvey and J.B. Pitner [Agronomy and Soils].

2737 THE EFFECT OF FRUIT ON PHOTOSYNTHETIC RATES OF ADJACENT LEAVES IN PEACH by T.E. Elkner and D.C. Coston [Horticulture].

2738 THE MICROBIOLOGICAL ASPECTS OF SQUAB PROCESSING by M.A. Hall and A. Kaegi [Poultry Science].

2739 INFLUENCE OF SEVERAL PLANT GROWTH REGULATORS ON BERMUDAGRASS PUTTING GREEN TURF OVERSEED WITH PERENNIAL RYEGRASS by A.R. Mazur [Horticulture].
COOPERATIVE EXTENSION SERVICE

As the educational outreach arm of the Clemson University College of Agricultural Sciences, the Cooperative Extension Service provides information and statewide continuing education programs that can make life easier and more enjoyable for every South Carolinian. The programs cover 16 disciplines relating to agriculture and natural resources, home economics, 4-H and youth development, and community development. In addition to general education information, special programs are included for limited-resource farmers and the economically disadvantaged. They are made possible through an agreement between Clemson University and the United States Department of Agriculture.

Funded by federal, state and county governments, the Extension Service was created in 1914 as a nationwide system designed to carry education from land grant universities to the people. For 72 years Extension has worked closely with South Carolinians helping them build a better life through dissemination of practical, useful information within its assigned areas of responsibility.

Originally conceived to help rural people, Extension responded to the changing needs of those it served by broadening its scope of activities to include urban and suburban problems.

Clemson University, through its Extension Service, maintains an office manned by agents in each county. A professional staff of Extension subject-matter specialists at the University and four Research and Education Centers around the state compiles information from research and translates it into data the people of South Carolina can use day-to-day.

From basic cooking demonstrations to irrigation field tours, Extension staff members are teachers carrying Clemson University educational programs to all areas of the state.

The Extension program is organized around these broad categories: agriculture and natural resources (including special programs for limited resource farmers), 4-H and youth development, home economics, community development and 1890 programs conducted by South Carolina State College in cooperation with the Clemson University Extension Service.

Highlights of Extension activities in the departments that deal with agriculture and natural resources at the University follow.

Agricultural Economics

The function of Extension Agricultural Economics is to provide educational information and training to farmers, Extension agents, agribusinesses and consumers about agricultural marketing, farm and financial management, agricultural policy and international trade. Workshops, county meetings, publications and audio-visual support were the major teaching and training methods.

Program priorities continued to be focused on the farm financial crisis and implementing management, marketing and policy programs to help farmers deal with financial stress. A $58,400 grant was received for the second year from the Extension Service-USDA to help fund the Clemson University Management Assistance Program (CUMAP). This program was targeted specifically to farmers who were experiencing serious financial problems and needed assistance in evaluating their financial alternatives. Financial management and marketing programs also were provided to farmers who were not as severely financially stressed and who wanted to do both short- and long-range planning.

Highlights of the farm management, marketing and agricultural policy programs included:

• A team of CUMAP advisers consisting of 13 agricultural agents and 12 home economists received 100 hours of in-service training in financial management and related areas. These agents have provided detailed financial analysis to more than 400 farm families.

• A toll-free telephone hotline into the department was maintained for farm families to request financial planning assistance of CUMAP advisers. Two hundred requests for assistance were received through the toll-free line.

• The first farm management association in South Carolina was organized. A fieldman
has been hired to work with the association. To date, funds for the fieldman have
come from grant monies and fees for association membership.

• Six county workshops on financial management were conducted with 180 farmers
and spouses attending.

• Co-sponsored with the South Carolina Bar two programs entitled “Representing
Farmers in Financial Cases” and “Strategies for Financially Stressed Farmers, Legal
and Financial Options.” More than 70 attorneys and 162 farmers participated in
these seminars.

• Organizations and professional groups such as Farm Bureau, CPA Association,
South Carolina Bar and the South Carolina Chapter of the American Academy of
Family Physicians are providing volunteer support and assistance to the CUMAP
program.

• Twenty marketing workshops and seminars were presented to more than 500
farmers in the state. Many more were reached with marketing and farm management
information through commodity meetings, newsletters, TV programs and news
articles.

• Sponsored a statewide conference as part of a national conference on “Mid-course
Corrections in Agricultural Policy.” Provided leadership in planning and conduct-
ing two regional international trade and policy related conferences.

• Conducted a statewide survey and analysis of the extent of financial stress among
South Carolina farmers.

• Provided the leadership and coordination for developing a three-state study on the
impact of the drought. The South Carolina results were presented to the state’s Con-
gressional Delegation to use in policy decisions for disaster programs for farmers.

• Conducted 4-H programs in agricultural policy, marketing and agribusiness.

• Co-sponsored a statewide meeting on alternative enterprises for agriculture in South
Carolina.

• Conducted multidisciplinary programs with livestock specialists in swine, beef
cattle, poultry and dairying. Special emphasis has been given to economic analysis
of livestock-forage systems and poultry as alternative enterprises.

• Provided educational leadership in establishing cooperatives for small farmers in
South Carolina.

• Prepared computer analyses and worksheets to help farmers determine their most
profitable level of participation in farm programs.

• Served as advisers to tobacco, cotton, peanuts, feed grains, beef cattle, swine,
poultry and dairy organizations.

• Placed management and marketing information on CUFAN—Clemson University
Forestry and Agricultural Network.

Literature development received major emphasis. Series of leaflets were developed on interna-
tional trade policy, alternatives to dealing with the farm financial problems, enterprise budgets for
crop and livestock enterprises and weekly newsletters. Computer programs were also a major thrust
with statewide leadership given to management and marketing applications using microcomputers.

Agricultural Engineering

“Get Fired Up,” an in-school 4-H fire safety program was expanded and reached 12,000 fifth
grade students and an estimated 45,000 family members in 28 counties. Continuing expansion of
this program in the coming year has been made possible by financial support from the legislature
and insurance companies in South Carolina.

Emergency medical and fire rescue personnel are being trained to respond to agricultural
accidents. Special training has been given in removing persons trapped in grain bins.

Small farm irrigation technology has been enhanced by the use of computer software on these
special problems. On large farms, conservation of irrigation water is a high priority. Furrow diking
is a compatible practice. Interest in chemigation has emphasized the need for educational programs on protecting water supplies from contamination. This year training was provided to regulatory personnel dealing with the new Backflow Prevention law which becomes effective in June 1988.

Timely weather information is made available to the South Carolina agricultural community by the Agricultural Weather Office. Twice daily, at 5:30 a.m. and 10:30 a.m., advisories are prepared for the broadcast media. Bimonthly 30-day forecasts are prepared for both the broadcast and print media.

Weather data from observation sites throughout the state and in bordering counties are stored in databases for use in several commodity management models. Climatological summaries are prepared for dissemination to users of the Weekly Weather and Crop Report. Special summaries are prepared for other Extension specialists who use timely weather information in educational programs. Most of the weather information available over the National Weather Service Wire is now available to users of the Clemson University Forestry and Agricultural Network (CUFAN) and other users of Clemson University computer systems.

A CUFAN-assisted computerized aeration advisory for grain storage program in South Carolina was initiated. This program will aid in grain storage management and will help improve the quality of grain being stored.

Computer training is becoming more popular among South Carolina 4-H’ers. Beginning and advanced training is available for 4-H’ers who have had a wide range of previous computer experience. More than 286 4-H’ers have received hands-on instruction at the 4-H electric project Amp Camp.

Machinery management programs have been conducted dealing with hay production, herbicide incorporation and vegetable cooling. Ten counties have had demonstrations and training on proper herbicide application. A grant was obtained to purchase training kits for pesticide applicator training for the certification program. A survey was made of the tobacco marketed in warehouses in South Carolina for proper moisture content. The results of the survey will help advise farmers on the best moisture content for the leaf when they sell it.

A year of planning has been completed in preparation for a major thrust in home moisture control. In-depth training of Clemson Extension staff in residential moisture control will continue to be a focal point of the family housing program.

Livestock waste lagoons, which serve a large segment of South Carolina’s swine, poultry and dairy industries, have been the subject of better design, construction and operating procedures. This effort, cooperatively conducted by the Clemson Extension Service, the USDA - Soil Conservation Service and the S.C. Department of Health and Environmental Control, has benefited the livestock producer, the consumer, and the water, air and soil resources of the state.

**Agronomy and Soils**

Agronomic crops such as soybeans, tobacco, cotton, corn and wheat continue to account for the major portion of the state’s primary agricultural economy. The emphasis of the Agronomy and Soils Department’s Extension activities has been on increased efficiency and improved profitability. The technology is available to help many producers make significant increases in their production and marketing efficiencies. The transfer of this technology is being done by a program management team of Extension specialists from this and other departments as well as county Extension agents.

Principal thrusts of the team are: (1) to show producers how to assess their resources, especially the productive capability of their soils; (2) to match those capabilities with the most appropriate enterprises; and (3) to improve the efficiency of their operations by adopting recommended practices and procedures. The program is delivered through a combination of workshops, shortcourses, field days and media presentations. Media presentations include information on CUFAN (Clemson’s new computer network), stand-alone computer decision-aid software, Extension publications, and newspaper, TV, radio and popular press presentations.

Many of the stand-alone programs use computer-based expert systems, which allow producers to quickly assemble and sort through a number of critical management factors to arrive at the most
cost-effective production recommendations. Information such as which herbicide to use for a troublesome weed, or how to irrigate crops profitably is presented on the CUFAN network.

Team activities are augmented by several working groups for specific commodities. Highlights of the working groups are:

- **Tobacco.** High quality leaf and all the management practices that contribute to maintaining this advantage for U.S. tobacco on the world market are stressed.

- **Soybeans.** Increased efficiency through better management practices, many of which add little or no cost to production, are emphasized. An example is the selection of the best variety for conditions in a given field. Intercropping of small grains, that is, planting the soybean crop before the small grain is harvested, is a practice being explored which appears to offer the grower a more efficient systems approach for increasing profits.

- **Corn.** The program puts emphasis on population management, making reliable estimates of plant nutrient requirements, and more timely applications of fertilizers.

- **Cotton.** The validation of GOSSYM, the implementation of COTTONTEX and emphasis on the production of high-quality fiber are the main points of the cotton educational program. GOSSYM is a computer growth simulation model that helps producers manage water and apply nutrients, as well as apply timely pest control procedures. It was developed by Mississippi State, the Agricultural Research Service and Clemson University. COTTONTEX is a videotex computer program that provides quick access to Clemson’s cotton production recommendations in an interactive format.

- **Forage-Livestock Systems.** Forages may prove to be the most sensible and profitable alternative crop for many traditional row crop producers. Clemson’s forage-livestock Extension program is truly a team effort that involves the departments of Animal Science, Dairy Science, Agricultural Economics and Rural Sociology, Agricultural Engineering, and Agronomy and Soils. Expanded use of alfalfa and other forages as cash crops and better pasture management are but a few of the areas of emphasis within this program.

- **Soil Management.** Soil testing, fertilizer recommendations and other soil management procedures like weed control are part of the commodity-oriented programs. A new facet of this Extension activity will be the use of agricultural land for recycling of wastes and nonagricultural land-use considerations.

- **Conservation.** Increasing awareness of the various federal conservation programs recently offered to producers has been a major thrust in this area. Close contact with other agencies such as ASCS, SCS and S.C. Land Resources Commission is critical to the success of an effective educational program.

**Animal Science**

Educating the public can sometimes be a tricky business. Most educators have the ability to teach, but reaching the audience is not always easy. In South Carolina, most cattle owners are part-time farmers with jobs and commitments requiring their time and attention away from the farm. Therefore, reaching these folks is no easy challenge.

Formal educational meetings in the local Extension office or the school cafeteria have become traditional and repetitive. Improving these programs with new appeal, a refreshing approach, a more informal setting or hands-on demonstrations might improve both attendance and response of the audience. In Texas, cow-calf clinics held at local stockyards have met with success and could possibly meet a need here in South Carolina.

For two years South Carolina area livestock agents and the Animal Science Department have cooperated with four stockyards in staging cow-calf clinics. The average attendance per clinic has been 140 cattlemen or approximately 560 producers per year. In our state, that’s an excellent response and the comments have been most favorable. Something new, something different and a
change of pace has resulted in a positive response from the public. Additional stockyards will hold
similar meetings in the future, and they too will serve to make contact with new clientele. Cattle
used to demonstrate subject matter covered by the speakers has certainly had appeal. Cattlemen
feel at ease in the stockyard surroundings and tend to ask more questions than in a more formal
setting. Also, the presence of cattle and the facilities available allow for hands-on participation.

In general, people may be resistant to change. However, progress most often results from change.
As educators, we must constantly change to meet the needs of our public. There is a better way
of doing things, and in our case, the stockyard clinics have definitely been a better way.

**Aquaculture, Fisheries and Wildlife**

A multidisciplinary research and Extension team has been concentrating on catfish production
systems. The staff completed 15 training meetings, short courses and workshops on farm alterna­
tives, catfish production, diseases, water quality and aquaculture loans. A fish disease diagnostic
lab with complete diagnostic capabilities has been completed at Clemson University and is
operational. A satellite lab located downstate is also completed and functional. A number of articles
and Extension bulletins were published on catfish production.

Demonstrations on fingerling production and cage culture were completed in five counties. This
work demonstrated research results that show catfish conversions on optimal diets of 1.2:1 in cages.
Cage culture using existing impounded water has been expanded into a highly successful 4-H
program. This program expanded from 45 cages in 1986 to 60 cages in 1987. An endowment is
being explored to permanently support this project.

Considerable time and effort was spent aiding potential commercial catfish producers. One of
these recently announced plans is to build a multimillion-dollar integrated catfish production and
processing facility. A spin-off of this project resulted in strong local support for a permanent
demonstration facility in Hampton County to show aquacultural production practices so that farmers
and landowners may consider aquaculture as an enterprise for that area of the state. Demonstrations
are planned in pond construction, brood fish production and cage fish production. This facility is
under construction.

The Aquaculture, Fisheries and Wildlife Cooperative (Clemson University and the S.C. Wildlife
and Marine Resources Department) conducted landowner workshops, provided landowner assis­
tance and published several Extension bulletins. The A.F.W. Cooperative is successfully using
SCW&MRD biologists and scientists as technical support personnel for county and state Extension
programs.

The Marine Extension Program, the Extension component of the S.C. Sea Grant Consortium,
participated in numerous local, state, regional, national and international aquaculture meetings and
activities. Landowner assistance was provided on a number of species such as crawfish and shrimp.
Publications include shrimp culture in tidal impoundments and integrated crawfish and waterfowl
management. The Marine Extension program specialist also worked with other A.F.W. faculty on
the S.C. aquaculture plan.

Another major Extension program addresses a new industry in South Carolina that is part of a
national phenomenon of rapidly expanding commercial recreation on private lands. In 1984 South
Carolina landowners leased about 5 million acres to sportsmen, generating as much as $9 million.
Integrated programs are being developed to optimize total economic returns from forests, wildlife
and agricultural resources.

Demand for landowner assistance is overwhelming. Several workshops have been conducted for
landowners and resource professionals. This program is ranked next to the top of a national list
of programs to be funded through the U.S. Fish and Wildlife Service.

**Community Development**

The Extension Community Development program helps rural communities improve the quality
of life by providing educational and technical assistance to solve community problems. Emphasis
is placed on helping community leaders, elected and appointed local officials, community-based organizations and professional staff of other agencies solve community problems by using available resources to maximum advantage.

Community development projects include helping local governments identify and prioritize needed community services, training local leaders to participate more effectively in community problem-solving processes, and helping communities locate sources of financial and technical assistance to accomplish projects.

Highlights of Community Development programs include:

- **South Carolina Governor's Rural Development Leaders School is co-sponsored by Extension.** Specialists provide leadership in planning and carrying out the school, which provides training in rural development processes to rural elected and appointed officials, staff of rural service agencies and organizations, and lay leaders from throughout the state. To date, more than 600 persons have participated in the training.

- **South Carolina Governor's Community Improvement Program encourages counties, through Extension-supported community improvement committees, to compete for awards that recognize achievements in county community improvement programs.** Currently, 29 of 46 counties participate in this program. The program culminates in an “Emphasis/South Carolina” annual awards banquet. More than 300 persons attended this year’s banquet.

- **Community revitalization planning has been offered to several rural communities.** The town of Allendale was awarded one of several new prisons to be built in the state. It is estimated that more than $6 million a year will be brought into the community through wages and services. Extension and Department of Agricultural Economics research faculty were asked to conduct business needs surveys and impact analysis studies to help the community in planning to accommodate the expected growth.

- **The results of a community problem identification survey conducted in 1986 by an Extension community development specialist in Pelion were used by the town to justify the need for a satellite health clinic to the Lexington County Hospital Board. The town now has a doctor and clinic for which mayor Elsie Stuart gives Extension major credit.**

**Dairy Science**

Milk production of South Carolina DHIA herds in 1986 averaged 15,124 pounds per cow per year. This is up 10 percent from the production level in 1985 and up 75 percent from 1970. The value of milk produced per cow was $2,060 per year. Feed cost per hundredweight of milk was $5.68 in 1986, down from $5.92 in 1985. This lowered feed cost was extremely important in helping keep many of the state’s dairy producers in business.

Extension programs in Dairy Science during the past year have centered on (1) improving dairy herd feeding programs by use of forage and feed testing with computer ration formulation; (2) improving milk quality by reducing somatic cell counts in milk produced by South Carolina dairy herds; and (3) use of dairy production records. Use of these management practices offered by Clemson University resulted in a 10 percent increase in milk production with a potential savings of up to $10,000,000 with the 45,000 dairy cows in the state.

There were 167 herds in South Carolina enrolled in the Dairy Herd Improvement (DHI) program averaging 15,124 pounds of milk and 584 pounds of fat. Average milk and fat production increased 689 and 28 pounds, respectively, from the previous year. South Carolina has the highest percentage of herds on test, 69 percent, of all states in the country. There are currently 21 herds enrolled in the Direct Access to Records by Telephone (DART) program. Extension effort has been directed toward increasing the use of records.
A series of seminars was conducted on improving milk quality by lowering somatic cell counts. This was a cooperative effort between the Clemson Extension Service, South Carolina Department of Health and Environmental Control and the South Carolina Farm Bureau-Dairy Division. The presentation on DHI somatic cell records resulted in an increase of 14 farms receiving the DHI somatic cell count profile.

The least-cost computer feeding program was used during the year with more than 500 least-cost dairy rations formulated by Extension dairy scientists and area Extension agents. In addition, more than 1,500 feed and forage samples were submitted for chemical analysis. Dairy science nutrition programs are being developed for CUFAN (Clemson University Forestry and Agriculture Network).

Extension dairy scientists worked with dairy organizations on marketing, merchandising and promoting milk and other dairy foods. Further educational programs in dairy product use are being implemented.

**Entomology**

Entomologists have long suspected that many of our common pesticides are affected by spray water pH. Most modern pesticides, especially the organophosphates, are compound molecules that break easily into two or more inactive, smaller molecules when exposed to extremes of pH. Many water sources used by South Carolina growers to fill their sprayers contain alkaline water (pH greater than 7).

Extension entomologists conducted a survey of water sources used by growers in the coastal area of South Carolina. Pond water sampled showed an average pH of 8.2. Wells sampled in several areas had an average pH of 6.7 City water from several municipal systems had an average pH of 7.9. For many common pesticides, hydrolysis (breakdown) would occur in a matter of minutes at pH levels in these ranges.

Failures of some pesticides to control the pests for which they are intended may be due to this problem. Extension Entomology is gathering information on hydrolysis (breakdown) rates of selected pesticides and also preparing information on how to lower pH values of spray tank water. This will help growers and other pesticide applicators avoid the hydrolysis problems and obtain the desired results from their spray treatments.

**Food Science**

Extension Food Science program activities included 193 on-site food processor plant advisories dealing with processing techniques, equipment, packaging, sanitation and quality assurance problems; plus another 325 informational responses (other than on-site) to food processors, Extension personnel, citizens and other agencies both in and outside the state. These efforts represent an estimated $4.5 million to clientele in terms of increased processing efficiencies, new facility start-ups, product quality improvements, reduced incidences of spoilage and avoidance of food-borne illness outbreaks.

Examples of project accomplishments include optimization of the freezing time procedure for 40-pound boxes of syrup-packed peach slices, and enabling an oyster canner to complete its annual pack using frozen Korean oyster meats when local oyster beds were closed to harvesting. This averted an estimated loss in annual oyster sales of $1 million. Other examples include providing advisories and processing schedules which helped two homemakers start a commercial acidified vegetable/relish glass canning venture, another group to begin construction of a $100,000 facility to freeze crabs and crawfish, and a third venture to begin marketing frozen sweet potato products from a new $2.1 million plant.

Other demonstrations established safe commercial canning process schedules for ready-to-eat meat hash in E-Z open portion packed cans enabling the company to expand its supermarket product line. Similarly, an innovative food service central kitchen operation was enabled to begin vacuum
packing portion-controlled menu/sauce items for frozen distribution to satellite heat-and-serve walk-up outlets. In all, more than 30 new venture advisories were provided to assist clientele in the development of facility layouts, processing/preserving procedures, packaging options and/or compliance with state and federal regulations to commercially manufacture diet cookies, hot sauces, barbecue, packaged beans and rice, iced tea, smoked turkey, dog and cat cookie treats, wineries, bamboo shoots, salad dressings, pickled pigs feet, fried pork skins, dry slaw, sourdough breads, spaghetti sauces, sweet potato tarts, mineral water, mushrooms, pureed vegetable sauce bases, and pasta, as a few examples. In addition, 14 on-site processing advisories were provided to community canneries sponsored by high school/low-income agencies.

More than 98 notices (averaging 56.1 contacts per notice) of proposals, changes and new federal and state regulations were distributed to 1,100 South Carolina food industry companies by Extension Food Science’s food regulation information filter center. This enabled processors to participate in the promulgation of responsible regulations and avoid possible citations, fines or adverse publicity by having lead time to implement necessary regulatory compliance changes. Educational public service information material on listeria, sulfites, food irradiation, food additives, safety and food packaging were developed and incorporated into 13 press releases, two TV shows, a radio program, two referred journal papers, two Extension bulletins, four Extension leaflets, two CUFAN network pages, and six professional/trade association presentations reaching an estimated 750,000 South Carolinians.

Other program activities provided leadership in several food processing, trade and professional associations and serving as the Institute of Food Technologist regional communications representative for South Carolina.

Forestry

In the forestry arena educators continue to struggle with finding techniques to interest landowners in becoming better informed about forestry opportunities. One group of people overlooked as a resource is landowners who are already committed to and who understand the benefits of good forest management. In an effort to involve these landowners, the Extension Service has worked with the South Carolina Tree Farm Committee to develop a Master Tree Farmer Program. Four workshops have been held, and 51 participants have graduated from the programs. They received 25 hours of instruction and agreed to provide an equal amount of time to promote forest management with their peers. The program is proving to be very successful and is being considered by a national organization for use across the nation.

Extension Forestry continues to work with the U.S. Forest Service and is coordinating two major workshops for foresters at the district level. A sales layout and harvesting program and a silviculture certification program are currently being offered each year. Approximately 30 foresters attend six weeks of training for each of these programs.

At the request of the South Carolina Seed Certification Department, Extension Forestry is serving as an advisory group to develop and implement a state certification program. In addition, Extension Forestry is working as part of a regional task force to develop standards for seed certification. This effort will be the foundation for forestry seed certification for years to come.

The South Carolina Forestry Commission and Extension have revised and renewed a memorandum of understanding that has existed between the two agencies since 1941. The new memorandum continues and refines a process of defining roles of each agency in the forestry community. This eliminates duplication of effort and allows maximum benefit of state tax dollars for forestry.

Since early 1986 Extension has been gathering input from across the state concerning problems and direction the agency should undertake. In forestry, efforts will be geared to resolving the reforestation problem which continues to plague South Carolina, and market development where additional primary and secondary industries will be sought to make better use of the resource in certain areas of the state.
Horticulture

South Carolina horticulture is a complex amalgamation of commercial producers, home gardeners, service and supply industries and allied organizations. Commodities are equally diverse, ranging from well established and productive industries such as the fruit and vegetable industries, to a rapidly growing ornamentals industry, to a fledgling small fruits and nuts industry. Home horticulture encompasses all commodities to varying degrees.

Information delivery systems are designed to meet the needs of the target audience in the most effective manner. Home horticulture interests are served by an equally varied menu of offerings. Extension specialists conducted more than 20 field days, shortcourses or special programs to educate or train growers and county staffs. More than 2,000 professionals attended these events. Fifty-six county meetings were held. Forty-four newsletters, leaflets or other written instruments were developed or revised. Extension specialists report that between 2,500 and 3,000 growers, professionals or homeowners benefited directly from the information they prepared or presented last year.

Plant Pathology and Physiology

Extension Plant Pathology and Physiology strengthened the capabilities of the Clemson Plant Problem Clinic in 1986. The clinic handles about 3,000 diagnoses each year. Accuracy and rapid diagnosis are important for many inquiries, but often difficult to attain. To enhance accuracy, new procedures were implemented and additional equipment was added. More specific media preparations are used to culture given pathogens.

Specific tests such as ELISA have been added to quickly identify several common viruses harmful to crop plants. New microscopic equipment used to better identify certain fungi causing diseases to turf grasses was obtained. All clinic replies to counties now are made electronically. This cuts about three days off the reply time. Progress has been made toward establishing a data bank in which all diagnostic inputs will be placed as a procedure is completed. County personnel as well as subscribers to the CUFAN system will be able to find the status of a plant problem diagnosis at any time. Such a service will be valuable to the commercial producer, who must make decisions about pesticide applications daily.

Individual specialists have developed computer software diagnostics to assist county agents and growers with decision making. Some of the information is for larger crops such as soybeans and some is disease information for a given crop. Tomato disease diagnostics is an example. We anticipate that over the next few years the learning experiences at the grower level and at the Extension specialist level will provide the background for developing useful, easy-to-use computer software diagnostics for South Carolina users for most crops.

Plant Pathology and Physiology Extension specialists continued educational programs in integrated pest management, field demonstrations and disease control schedules. One of our goals is to bring the latest information in our field to assist with production problems in the state.

Poultry Science

Poultry and egg supplies continued to increase to meet the demands. Preliminary South Carolina farm market values for poultry in 1986 were up to about $215 million. Turkey values increased 23.4 percent in 1986 to meet an increasing demand, especially for further processed products. Broiler values increased 22.4 percent and egg values increased 10.3 percent. Rapid expansion of broiler and turkey production facilities continues into 1987.

Extension works closely with poultry producers as well as with consumer education. Information meetings were conducted with county personnel from some counties to update them on the turkey industry. Public meetings were conducted in conjunction with integrators regarding expansion into new areas. Cash flow projections are still needed by farmers considering poultry enterprises and by lenders interested in the poultry business. A pertinent seminar on housing and ventilation was
well attended by poultry producers from the Southeast and from as far away as the West Coast. Poultry and egg embryology projects continue to be among the most popular 4-H programs.

A fly and waste management conference involving Extension, DHEC, the Soil Conservation Service and poultry industry leaders was instituted. Considerable effort went toward developing materials for the CUFAN network and in training faculty and staff in computer competency. In conjunction with the S.C. Poultry Improvement Association, Extension conducted breeder flock testing and hatchery inspections. Educational programs also involved game birds and small flocks.

Clemson/Sea Grant Marine Extension Program

The Clemson/Sea Grant Marine Extension Program (MEP) is an outreach effort of the South Carolina Sea Grant Consortium and the Clemson Extension Service. Through a staff of three specialists in Beaufort, Charleston and Georgetown, it addresses constituent needs in four major program areas: living marine resources, coastal industries, coastal processes and marine education. To multiply its efforts, the MEP interacts with local, state and national agencies such as the S.C. Wildlife and Marine Resources Department, National Weather Service, the National Marine Fisheries Service, the National Marine Manufacturers Association and the other Sea Grant programs in all coastal and Great Lake states.

The golden crab research initiated by the MEP and SCWMRD in 1985 has led to a full research proposal funded by the Gulf and South Atlantic Fisheries Development Foundation. The fisheries specialist at the SCWMRD in conjunction with MEP are determining the golden crab habitats, how many there are and how rapidly they reproduce. Golden crab is a large deep-water crab that has only recently been considered as a potential new species for commercial fishermen to harvest as other species are being overfished.

The MEP is now a part of a cooperative agreement between Clemson University and SCWMRD. Through this agreement various activities such as penaeid shrimp demonstrations and marine information base development are coordinated between the agencies involved.

The MEP aquaculture specialist has been heavily involved with the development of a state aquaculture plan for the state legislature. This document will help determine where the emphasis will be placed in future aquaculture research and marketing.

Following preliminary investigations into the status of coastal construction, the MEP, with assistance from Clemson’s Civil Engineering Department, coordinated a forum on coastal construction. Held in Charleston June 10-11, 1987, it drew more than 100 contractors, bankers, developers and building officials who discussed how to get better buildings on the coast.

In the 1980s it has become clear that local community leaders will have to be aware of more issues and technology than they have in the past. This is especially true in the coastal region of South Carolina where population dynamics are straining resources to their limits. To answer the need for better informed leaders, the MEP instituted “Leadership Beaufort” for 25 volunteer future community leaders. Topics such as history, economics, planning development and the environment were explained to the leaders who then discussed how these issues affect the coast where they live.

Intermodal transportation is revolutionizing the cargo business in the port of Charleston. Working with the industry and the College of Charleston, the MEP helped develop a curriculum aimed at college-level students and working industry staff. Through these courses and an intern program, people in industry can become better educated on systems involved with transferring containers from ship to train or truck. At this time these courses are difficult to find elsewhere.

From April 1985 to January 1987 the MEP/PRT docent program helped more than 6,000 park visitors have interpretive tours on beaches and coastal parks from volunteer guides trained by MEP-coordinated workshops. Before this program, park staffs were unable to handle the growing demand for information from a curious public due to limited budgets and staff.
Special Programs

Extension's Special Programs area assists small farm families with low income and limited resources by providing educational information designed to improve their living standards. Extension personnel are used to identify problems and establish objectives in crop and livestock production, marketing, nutrition, housing, youth development and family life.

Small Farms Program

The small farm is defined as a farm operated by a family that provides most of the labor and management, depends on that operation for a significant part of their income and has total income below the median non-metropolitan family income for the state. Videotapes, computers and other forms of mass media communications are used to reach large audiences. Extension uses on-farm demonstrations, tours and field trips to reach the small-scale farmer.

A swine cooperative organized in 1981 to help small-scale hog producers in Clarendon and Williamsburg counties has grown rapidly, resulting in the creation of a spin-off cooperative. Begun initially with 45 gilts and nine boars made possible through a Heifer Project International grant, the cooperative now assists 24 families. It has helped these producers raise higher grade hogs worth more at the market and has used the proceeds generated to pass on the gift.

In the wake of the success of this cooperative the Williamsburg-Clarendon Farmers Cooperative was organized. Although it's just being formed, it already has 45 members who will benefit from volume purchases of swine feed at lower prices. This cooperative will be operational soon.

Selling the farm product is still a problem for the small farmer. The direct-to-consumer markets (farmers' markets) continue to help more than 1,000 small farmers annually sell horticultural crops with cash sales in excess of $2 million.

Home Economics

Home Economics Extension programs relate research to improving the quality of life for individuals and families and providing the link between agricultural production and consumption. Programming utilizes a broad knowledge base in family resource management, family stability and human development, food and nutrition, housing, textiles and clothing, and volunteer leadership development. Extension Home Economics is committed to helping the more than three million South Carolinians with programs aimed at improving family economic stability and security, energy use, environment, food and health, and action in public policy impacting families.

Extension Home Economics provides leadership in networking with other agencies and organizations to pool resources for effective educational programs to address a multitude of social and economic problems. County Extension agents and state specialists working with volunteer leaders, community leaders and business and industry personnel are providing research-based educational programs to assist South Carolinians.

Family Resource Management

Although unemployment is down nationwide to 6.3 percent, 15 of the state's 46 counties recorded unemployment of 8 percent or greater as of May 1987. Reduced work hours and depressed farm economy dictate wise use of resources to maintain a quality life. The need for human capital development was recognized by Extension staff, community leaders and lay people for revitalization of rural America.

During 1986-87 in South Carolina, buying power through money saved or generated increased by $20,554 as: (1) 8,267 individuals or families learned and applied new skills; (2) 3,714 persons or families used wise shopping and credit practices; (3) 4,952 persons or families employed skills in financial management; and (4) 2,019 people or families gained confidence as consumers.

County agent training in financial management, counseling skills, establishing home-based businesses and the job search process will reach such target groups as unemployed, farm families, young families, those in mid life and those approaching retirement.
Family Stability and Human Development

A companion to economic crises for rural South Carolina is physical and psychological stress. Stress programs were conducted, and distribution of Extension Home Economics and Agriculture Department mass media packets on Coping with Change received excellent use by newspapers. "Baby Talk," a publication to strengthen parenting skills, was mailed to about 2,000 parents in 1986-87. Workshops on Strengthening Families, Coping with Change and The Importance of Friendship were conducted for more than 3,860 people. In all of these topic areas, a sample of participants reported positive behavioral change as a result of the programs.

The series "I Am A Person," "Pointers for Parents of Preschoolers" and "Your Family: Making It Work" were subscribed to by 2,224 parents. Programs on parenting were conducted for 467 parents, and 20 parents participated in Parent Child Interaction.

Foods and Nutrition

In another area of family and human development, the statistics are grim. South Carolina has the highest infant mortality and low birth weight rate as well as the ninth highest teen pregnancy rate in the nation. Low birth weight is the major contributor to infant death and can, in most cases, be prevented through early and regular prenatal care and adequate nutrition education for the mother. A savings of $25,000 can be realized for every low birth weight baby that can be born healthy.

Extension Home Economics has provided major leadership to a public education coalition called Healthy Mothers, Healthy Babies. This informal network of more than 70 professional, voluntary and governmental organizations has maternal and infant health as a common focus. A majority of South Carolina counties have organized local Healthy Mother, Healthy Baby coalitions. Each has identified local problems and combined local resources to address these problems. About 20 coalitions have identified teen pregnancy as a major problem.

Extension pooled its resources with the State Department of Education, Office of School Food Services and the Central South Carolina chapter of the American Red Cross in an educational program called Better Eating for Better Health. About 100 instructors have been certified, more than any other state in the nation. The program has been offered in 42 counties. Participating adults have cited many dietary improvements as well as an increase in nutrition knowledge.

The second major program developed by Extension Home Economics human nutrition is a weight control program called Diet Puzzle. Sound nutrition principles, low-calorie food preparation methods, a reasonable low-calorie diet, exercise and lifestyle modification techniques are used in this 12-week program. About 35 percent of the participants have lost 12 or more pounds.

The Expanded Food and Nutrition Education Program (EFNEP) is a federally funded program administered by the Clemson Extension Service. Its primary purpose is to improve the diets of low-income families, thereby enabling them to enjoy better health, improved stamina and increased productivity. About 16 percent of the state's population (303,233) have incomes below the poverty guidelines.

The educational activities of adult EFNEP are conducted by 81 paraprofessionals. They locate low-income families through referrals and through door-knocking. Homemakers are instructed in their homes or in small groups. This type of approach is used because the majority of low-income homemakers have little formal education, are very reluctant to attend large group meetings or are severely limited in transportation. More than 4,000 low-income families (20,000 persons) were reached last year through adult EFNEP.

Low-income youth are taught good nutrition habits through youth EFNEP. In South Carolina they are always taught in small groups led by volunteers. In 1986-87, 721 volunteers devoted 10,272 hours to EFNEP. About 75 percent of the volunteer leaders in the state were previously enrolled in EFNEP. Training in nutrition subject matter and teaching methods is given to youth EFNEP group leaders by the program assistants. Almost 6,800 youth were reached through this program. After graduating, about a third of them continued in regular 4-H programs.

Housing

With housing costs at record highs, Extension educational programs in housing assist South Carolina families who are increasingly using alternatives to traditional housing and who are
maintaining their homes better. Examples of housing education and related economic impacts are as follows:

Five hundred and one families planned new or remodeled homes, kitchen and storage with Extension help ($292,755); 1,664 families prevented or controlled moisture damage in homes ($871,000); two Extension Homemaker Club leader programs trained 38 leaders who taught 400 members about moisture problem prevention; 125 Extension Homemakers Council members installed smoke detectors in their homes; 15 homeowners used Extension information to select and install wood stoves safely; 162 consumers investigated modular or manufactured housing as an affordable housing alternative; 75 families did home repairs and/or maintainence.

Last year nearly 200 consumers and builders attended five two-night seminars on planning new and remodeled homes. Three counties answered consumer questions at Extension housing booths at regional home shows. One county housing home economist helped people during the show and 50 persons who called after the show.

The young homemakers section of the South Carolina Extension Homemakers Council combined forces with the Extension Home Economics Department to train 26 volunteers teaching infant and toddler safety in their communities. The Talks on Toddler Safety program, now operating in all counties, teaches the correct selection, use and maintenance of furniture and equipment used with infants and toddlers. More than 25,000 people were reached by this program in its first five months.

Extension volunteers are the teachers who deliver information through workshops, exhibits, media and special interest meetings. These volunteers have already contributed time valued at $2,000 based on minimum wage.

Textiles and Clothing

Continued economic pressures have resulted in middle- and low-income families looking for ways to clothe their families without increasing their budgets. With more women working, the need for clothing has increased and free time decreased. Clothing and textiles programs have been presented throughout the state in an effort to alleviate some of these pressures.

During the past year 310 clothing construction, restyling and accessories classes have reached about 2,600 people in South Carolina. The estimated value of the classes and the garments made in them is $73,500. Extension clothing and textiles programs on selection, wardrobe planning, stain removal, care of heirlooms and quality have had an economic impact on South Carolina. The cost of classes alone for the 4,174 people attending the 386 classes would amount to at least $50,000. The minimum value of items conserved at home, rather than through a conservator, and value of clothes saved through stain removal would be $35,000. This does not consider the clothing dollars saved when putting the knowledge and skills learned into practice.

Volunteers donated a total of 634 hours in clothing- and textiles-related projects. At an estimated value of $4.50 per hour, this would amount to approximately $3,000.

Volunteer Leadership Development

South Carolina’s population increased 20.4 percent since 1970 to 3,119,208 in 1980. This indicates an increase in the potential audience needing Extension Home Economics information. Reductions in appropriations and staff have emphasized the need for volunteer leadership development to continue and expand the impact of the Extension Homemakers organization.

The South Carolina Extension Homemakers Council has active councils in all 46 counties of the state. The value of Extension Homemakers volunteer time is estimated to be $1,000,000 annually.

Extension Home Economics specialists develop leader lessons which Extension Homemakers use to teach clientele. Extension agents have recruited and trained 600 leaders to teach skills and knowledge through leader lessons to 6,000 clients this past year. Fifty new organization leaders have been recruited and trained.

A grant of $3,000 was received this year through the Kellogg Foundation to develop a leadership/public policy program called Family Community Leadership (FCL). Four county teams of six members each have been trained and are now making the program available in their counties. Plans are to apply for a larger grant to expand the program to at least 32 counties and reach more than 4,500 people in the next two years.
Extension Home Economics programs are making a major contribution to improve quality of life for South Carolinians. Critical issues are addressed to help individuals and families maximize resources and develop human capital.

4-H and Youth Development

The mission of the 4-H and Youth Development Program is to help youth ages 9-19 in South Carolina become self-directed, productive individuals who can make a positive contribution to our state and nation through developing appropriate life skills.

The learn-by-doing approach enables a participant to become actively involved in the learning process. These experiences assist the 4-Her in day-to-day living and also provide an opportunity to explore careers. The land-grant system is uniquely qualified to accomplish this in South Carolina communities.

The most successful 4-H programs are accomplished through organized community 4-H groups taught by adult or teen volunteers. In South Carolina, 3,467 adult volunteer and teen leaders gave leadership to 4-H programs in 1986. There were 13,411 youth enrolled in 2,623 4-H units and 43,772 youth enrolled in special-interest programs, including school enrichment programs, Expanded Food and Nutrition Education programs, individual study or instructional TV. Also, 5,720 youth participated in 4-H camping programs conducted at the two state-owned 4-H camps, Camp Bob Cooper and Camp Long.

Sixty-seven percent of the 4-Hers live in rural areas and 33 percent in areas of 10,000 or more population. These 4-H curriculum areas have more than 5,000 participants:

- Individual/family resources: 27,847
- Health/safety: 13,883
- Natural resources: 12,490
- Animals/poultry: 10,330
- Mechanical science: 7,749
- Plant sciences/crops: 6,086

The primary emphasis for 4-H continues to be the empowerment of the volunteer in the local community to work with a group of youth in exploring a subject of interest and concern. Objectives are to provide educational experiences to increase the competency, coping skills and contributory skills of the 4-Her. Once a 4-Her learns a skill, opportunities are provided to pass it on to another.

The 4-H audience includes the youngster, his/her family, the volunteer and the local community. 4-H provides the community an opportunity to develop the youth with the aid of their land-grant institution, coordinated by a resident county Extension professional who is a member of the Clemson University staff.

The 4-H camping effort in South Carolina was enhanced in 1986 by continued upgrading of grounds and facilities at each site and the formation of a planning committee to provide recommendations on camp future needs.

The impact on the lives of the youth, their families and their communities can be documented through the personal achievements of selected participants:

- $11,000 saved from the 4-H garden program was used for a college education.
- Writing and receiving a grant to establish a health clinic in a local high school ($100,000) to have it staffed with local teen 4-H’ers.
- Speaking to more than 5,000 people in a 4-H public speaking career; being selected as the national 4-H public speaking winner and receiving a $1,000 scholarship.
- Serving as the catalyst to establish a county litter control officer position.
- Turning a 600-acre swampland into a wildlife refuge.
- Establishing the foundation animals for a family purebred beef animal enterprise.
- Learning to operate and program computers; use this knowledge to teach other youth; write programs for local school teachers, assisting them in the management of their responsibilities.
• Choosing a career in dairy science; coming to Clemson University and becoming president of the student body.
• Beginning a catfish production enterprise and encouraging expansion as a family enterprise.
• Despite severe hearing loss, becoming the national 4-H health program winner and receiving a $1,000 scholarship.
• Studies reveal that one hour of paid professional staff time generates 10 hours of volunteer time devoted to youth concerns in South Carolina.

The personal achievements of youth, families and volunteers attest to the impact the 4-H program has had and will continue to have on South Carolina residents (young and old).

DIVISION OF REGULATORY AND PUBLIC SERVICE PROGRAMS

Regulatory and Public Service Programs is one of five administrative divisions within the College of Agricultural Sciences. It was established in 1970 and is comprised of the director’s office and four departments—Fertilizer and Pesticide Control, Plant Industry, Seed Certification and a portion of Agricultural Chemical Services.

The mission of the division is to ensure compliance by the regulated industries and individuals with the legislative mandates and regulations promulgated thereunder. It also provides assistance and services to those affected to educate and help them achieve compliance. Division programs promote the use of certified seeds and plants; provide the services needed for certification of crops and plants; assure that fertilizers, lime, pesticides and seeds meet the standards to produce marketable and profitable crops; provide inspections to monitor pesticide treatments by the pest control industry; and provide inspection to assist the state’s plant industry in maintaining plant material and agricultural commodities pest free.

Following are highlights of division activities for 1986-87.

Department of Agricultural Chemical Services

This department performs the chemical analyses reported by the Department of Fertilizer and Pesticide Control. Most samples analyzed were multi-component, with more than 25,000 individual analyses made. The laboratory has concentrated on improved methodology, instrumentation and organization to analyze all samples quickly and accurately. The department performed more than 47,500 analyses for the S.C. Agricultural Experiment Station. In addition, the Agricultural Service Laboratory processed more than 79,150 soil samples, 4,600 plant and feed samples, and 5,700 samples for nematodes.

Department of Plant Industry

The Crop Pest Act

Nursery Inspections: A total of 569 nurseries, greenhouses and vegetable transplant growers and 941 nursery dealers, including nine dealers outside the state, were licensed to sell plant material. An additional 306 establishments were visited on routine inspections to determine compliance with quarantines and regulations to provide assistance with pest problems. Twenty-seven other nurseries were not certified on the initial inspection due to pests, weeds or other problems.

Phytosanitary Certification: Nearly 325 phytosanitary certificates (185 state and 136 federal) were issued for various agricultural planting seed, plant material and other commodities. The plant
material consisted mainly of orchids and chrysanthemum cuttings destined to other states, Puerto Rico, Canada and 41 other foreign countries. Sixty-three phytosanitary certificates were issued for shipments of plant material to Canada. The majority of the foreign shipments were to Kenya, Great Britain, Spain, Saudia Arabia and Japan.

Miscellaneous Inspections: Twenty-five regular certificates of plant inspection were issued for assorted houseplants being moved within the United States. Inspections of tobacco plant beds were again made for Pee Dee area growers in connection with North Carolina's import permit requirements. A total of 50 import applications were received from the N.C. Department of Agriculture this year for growers seeking S.C. plants.

Post-entry Inspections: Only four post-entry inspections were conducted. All involved feijoa plants from New Zealand and research being conducted at the Coastal Research and Education Center.

Sweet Potato Inspections: Fifty-seven inspections were conducted for approximately 20 growers in the Pee Dee, Sandhill and Coastal Plains regions.

Phony Peach: The 1986 survey for phony peach disease was conducted in the Ridge, Sandhill and Coastal Plains areas. Four temporary inspectors were hired. About 1.3 million trees were surveyed with 439 (.03 percent) found diseased.

Bee Disease Act: The number of colonies inspected was 4,350. Evidence of American and European foulbrood disease was minimal. A total of 2,739 colonies and 220 empty supers was certified for movement to other states. More than 300 other beekeeper contacts were made relative to bee problems. Numerous educational activities were conducted during the year including presentations, demonstrations and news articles.

Cooperative State/Federal Programs: The department and USDA renewed the cooperative agreement in 1986 whereby the state would hire seasonal employees. About 75 were hired to survey and perform control activities. Most began work in the spring, with additional employees hired during the summer. All were terminated at the end of the federal fiscal year.

Witchweed: Statistics for 1986 show that 11 new farms with 528 acres were infested with witchweed. Approximately 5,023 actual and 9,500 aggregate acres were treated. Since the beginning of the witchweed program, 2,204 farms in six counties and 58,695 acres in South Carolina have been released from quarantine. Five counties representing 20,970 acres remain under quarantine in South Carolina.

Gypsy Moth: In 1986, 497 adult male moths were trapped as compared to 240 in 1985. The majority (464) were trapped in Horry County. This has been the trend in the past because of the tremendous influx of tourists during the summer to the beaches and campgrounds in the Myrtle Beach and Grand Strand area.

Imported Fire Ant: The imported fire ant continues to spread and infests practically all counties in the state. Since last year, they have been found in Abbeville County. This pest continues to pose problems for nurserymen and turf growers, especially the latter as the acreage has increased the past several years.

Boll Weevil: The eradication program is continuing in the state. In 1987 only 39 weevils have been trapped from 34 fields in the eradication zone. The buffer zone is a different story as large numbers of weevils have been trapped. Treatments are being applied to all cotton fields where necessary. Diapause treatments are scheduled for this fall. Plans are currently being made to implement the eradication program in Georgia, Alabama and Florida this fall. This will greatly benefit South Carolina producers and should result in fewer weevils in the buffer zone next year. The grower assessment for 1987 was $10 per acre and will be no more than this amount in 1988.

National Plant Pest Survey and Detection Program

Japanese Beetle: Thirty-five traps were placed in the northern portion of Lee County. Beetles were suspected in this area, and the survey results proved positive. Approximately 500 beetles were caught during a one-month span. The results are important in conducting regulatory activities.

Exotic Pest Detection: Eighty-nine traps were placed in cotton, apple and peach orchards in Oconee, Orangeburg and Saluda counties. The purpose was to determine if certain exotic pests were present. All traps were negative for the plum fruit moth, summer fruit tortrix moth, false codling moth, Egyptian cotton leafworm and the African cotton leafworm.
Department of Seed Certification

Seed certification is a program of standards imposed on seed and plant production that ensures varietal purity, good germination and freedom from noxious weed seeds. Participation in the program is voluntary.

Clemson University was designated by law in 1945 as the agency for inaugurating and carrying out a program of certification of pure seed and plants in South Carolina. The Seed Certification Department of Clemson and other seed certification agencies in the United States must comply with standards for certification of seed in federal seed act regulations.

Departmental field work in 1986-87 involved inspections of 30,324 acres of crops for certified seed production. Inspections included 73 varieties of 13 crops for 204 farmer/growers and 35 seed-producing firms. Each field was inspected to determine that the crop was true to variety and free of noxious weeds and seed-borne diseases.

Major acreages of crops inspected were soybeans, 19,019; small grains, 8,571; cotton, 1,566; and peanuts 687. In addition, other field work involved grow-out plantings of 184 samples of South Carolina certified soybeans and small grains for comparison to producer or processors’ samples of the same seed lots. During 1986-87, 347,426 certified seed tags were issued to growers whose seed met standards both in the field and the laboratory. Thirty-five facilities were inspected and approved during the year for custom processing of South Carolina certified seed.

Department of Fertilizer and Pesticide Control

The Department of Fertilizer and Pesticide Control is responsible for enforcing the provisions of a number of laws and regulations. The South Carolina Liming Materials Acts are primarily designed to ensure the consumer is receiving high quality fertilizer and lime.

Some of the major activities of this department relative to these statutes from July 1, 1986, to June 30, 1987, follow:

- Fertilizer usage data—tons sold: 461,929
- No. of fertilizer samples procured and analyzed: 4,437
- No. of fertilizer samples not meeting guarantee: 774
- No. lime material & samples procured & analyzed: 1,614
- Total number of liming material samples not meeting guarantee: 16
- Percent of liming material samples deficient: 9.8
- Total number individual deficiencies in liming material samples: 21
- Fertilizer penalties collected, payable to State Treasurer: 30,802.00
- Lime penalties collected, payable to State Treasurer: 1,524.00
- Fertilizer registration fees collected, payable to State Treasurer: 8,684.00
- Lime registration fees collected, payable to State Treasurer: 730.00
- Lime permit fees collected, payable to State Treasurer: 1,850.00
- Soil amendment registration fees: 50.00
- Fertilizer taxes turned over to State Treasurer: $116,595.00

**Actually recorded by State Treasurer July 1, 1986-June 30, 1987, but may not correspond to final fees paid for the fiscal year.

Fertilizer Movement and Quality Control in 1986-87

The fertilizer tonnage sold this year was down significantly from 1986-87. The 461,929 tons sold is the lowest yearly total since 1932. Overall 17.0 percent of fertilizer samples did not meet the guarantees within the investigational allowances. This deficiency rate was 0.3 percent lower than in 1985-86. Other than deficiencies, the greatest problem in the fertilizer and lime areas continues to be the lack of proper labeling.
South Carolina Pesticide Control Act

This act and regulations mandate not only quality control monitoring but also regulate the sale, use and application of all pesticides used in South Carolina. This department uses a strong preventive education program coupled with fair enforcement actions when necessary to help ensure productivity while preventing adverse effects on man or the environment.

In an effort to improve its education and enforcement capabilities, this department has pursued external sources of funds where possible without decreasing the flexibility of the pesticide program. These efforts have resulted in two grants totaling $143,000 from EPA. The department has also made a concerted effort to increase efficiency by using state-of-the-art data management. All fees collected under this act are sent to the state treasurer.

Registration and Quality Control: In 1986, 716 companies registered 7,541 pesticide products for sale in South Carolina. A total of 1,168 pesticide samples were collected and analyzed with three found deficient in the guaranteed percentage of one or more ingredients. Stop-sale notices were issued on all deficient products. Registration fees totaling $132,006 were deposited.

Using provisions of the Federal Pesticide Control Act, the department issued eight Section 24(C) special local need registrations. Two section 18 emergency exemptions were solicited and were granted by EPA.

Certification: Pesticide dealers and applicators must be certified and licensed to buy, sell or apply pesticides classified for restricted use. Last year 9,078 private applicators licenses, 1,609 commercial applicators licenses, 786 noncommercial licenses and 375 pesticide dealers licenses were issued. Certification fees totaling $48,204.46 were collected.

Education and Enforcement: Pesticide personnel made frequent contact with pesticide dealers, Extension directors and various applicators and pest control operators. Numerous structural pest inspections were conducted. The promulgation of structural pest control regulations in 1980 and mandatory licensing in 1983 has significantly increased the workload in this area, but is providing a valuable service to both the industry and consumers. Although strong enforcement measures were required in some instances, most pest control companies are voluntarily correcting violations and refunding charges for unnecessary pest control activities.

Seventy-two civil penalties ranging from $50 to $5,500 (total $18,000) were assessed, and three criminal prosecutions resulted in convictions. Using the formal hearing process, two license suspensions were issued; each suspension was for two years. Ninety-four investigations were conducted on potential pesticide misuse or noncompliance with regulations. Numerous stop-sale notices were issued for unregistered products, sale of restricted products by unlicensed dealers and other violations. Warning letters were issued in 133 instances. Overall compliance with the act by members of the agribusiness industry has been excellent.

Administration of the department’s regulatory programs resulted in $358,445 being sent to the state treasurer.

Department of Agricultural Chemical Services

This department performs the chemical analyses reported by the Department of Fertilizer and Pesticide Control. Most samples analyzed were multi-component, with more than 25,000 individual analyses made. The laboratory has concentrated on improved methodology, instrumentation and organization to analyze all samples quickly and accurately.

The department performed more than 47,500 analyses for the S.C. Agricultural Experiment Station. In addition, the Agricultural Service Laboratory processed more than 79,100 soil samples, 4,600 plant and feed samples, and 5,700 samples for nematodes.
LIVESTOCK-POULTRY HEALTH DIVISION

The Livestock-Poultry Health Division conducts a number of regulatory programs in consumer protection and animal health and the diagnosis of various disease problems in South Carolina livestock.

The division's three main areas of responsibility are the administration of the South Carolina Meat and Poultry Inspection Programs, the Livestock Regulatory Programs and the Diagnostic Laboratory.

The Animal and Plant Health Inspection Service, USDA, cooperates with the Livestock-Poultry Health Division in carrying out certain animal disease eradication programs conducted on a national basis. It also provides 50 percent of the funds for administering the South Carolina Meat and Poultry Inspection Program.

Following are highlights of this division during 1986-87.

Meat and Poultry Inspection

This department's responsibilities cover the wholesomeness of meat and poultry slaughtered and the food products processed at all processing plants in the state except a small number of plants that operate under federal jurisdiction.

There are 113 meat and poultry plants under state inspection. The full-time staff is six veterinarians, 55 inspectors, a compliance/evaluation officer and two administrative personnel. More than 100 million pounds of red meat and poultry are inspected annually in state plants. The state's programs continue to meet standards that classify it as equal to the federal meat and poultry inspection program.

Animal Diagnostic Laboratory

The laboratory is staffed by six veterinarians and 11 technicians. It provides diagnostic services in animal pathology, bacteriology, virology and serology for the regulatory programs as well as diagnostic help to practicing veterinarians and livestock and poultry owners in the state. During the year, the laboratory handled more than 3,000 cases and conducted more than 200,000 laboratory tests and examinations.

Cooperative Disease Eradication Programs

National disease eradication programs have been established in this country to eradicate certain national livestock diseases that cause great economic loss to these commodity groups and pose potential public health problems.

Presently our major programs are aimed at the eradication of avian influenza and salmonella pullorum in poultry, brucellosis and tuberculosis in cattle, and pseudorabies in swine. During the year we had an outbreak of brucellosis in cattle as a result of infected animals being shipped into South Carolina from Georgia through North Carolina.

Livestock Auction Market Inspection

All livestock going through auction markets are inspected for evidence of contagious and infectious diseases. Regulatory personnel attended 1,156 sales and inspected 428,227 animals. This division furnishes a veterinarian for each public auction of livestock to perform the necessary tests, vaccinations and other tasks to ensure that all animals meet intrastate and interstate requirements for sale and movement.
The College of Forest and Recreation Resources was founded in 1970 to promote the wise management, use and stewardship of South Carolina's forest resources and to enhance the quality of life of its people through a rewarding use of leisure. The scope of this college's programs is not confined to campus boundaries, but spans the entire state and touches the lives of all South Carolinians. All teaching, research and public service activities in forest management, wood utilization, recreation resources and services, and tourism management are the responsibility of our two departments—the Department of Forestry and the Department of Parks, Recreation and Tourism Management.

Forestry and recreation comprise an integral part of South Carolina's economy. When one realizes that the forest products industry adds more than $3 billion (approximately 30,000 employees) and that recreation and tourism contribute more than $3.5 billion (approximately 82,000 employees) annually to the economy of South Carolina, it is easy to recognize the importance of this college's contribution to the state's overall economic health.

**Department of Forestry**

The Department of Forestry's programs in education, research and extension are unique within the state of South Carolina. As such, the department plays an important role in educating many of the foresters who manage the 12.5 million acres of forest land in the state. This resource is responsible for more than $3 billion in annual sales of forest products produced by more than 1,000 wood-using industries in the state. To this end, Clemson's curricula in forest management and wood utilization emphasize the role of the forester as a steward of our forest resources. Research programs emphasize problem solving and gaining fuller understanding of the forest and its use. Extension programs are designed to be sensitive to the needs of forest landowners with special emphasis on small, private landowners.

**Teaching**

During the academic year, 19 candidates received the Bachelor of Science degree. Five graduate degrees were awarded: three Master of Science degrees and two Ph.D.s.

The hallmark in the teaching program for the past year was the completion of the five-year interim reaccreditation for the Society of American Foresters. This report, due to the Society in August 1987, culminates an in-house review of the department’s teaching programs. Committees were organized in August 1986 to prepare this report and an initial draft was completed in March. Many of the curricula changes the Society recommended in its 1981 accreditation process have been instituted.

A course in Forest Products Marketing was offered for the first time and is taught by a recently hired professional experienced in the forest products industry. This course will probably be a requirement in the wood utilization curriculum and an elective for forest management majors. Another course being offered for the first time, Urban Tree Care, along with other new courses will broaden the education of both professional and non-professional majors in other colleges at Clemson.

With the approval of the bond issue to renovate the basement of Lehotsky Hall, the department, along with the PRTM Department, is designing needed space for short courses, new laboratories and graduate student offices. This addition will be an asset to the department's Ph.D. research program, which requires more space than can adequately be provided in the present setting. The department's offering of short courses to outside user groups also will be enhanced by the addition of an attractive facility to stage these events.

For the seventh consecutive year, the Forestry faculty taught two three-week continuing education sessions in silviculture to U.S. Forest Service personnel. For the fourth year, the department sponsored the U.S. Forest Service short course on Sale Layout and Timber Harvesting. This six-week course attracted federal foresters from all over the Eastern United States.
Research

Research in the Department of Forestry is undertaken in timber production, forest management and wood utilization and is supported by state appropriations, federal McIntire-Stennis funds and outside grants. The Forestry faculty produced approximately 40 scientific and professional publications including six department bulletins and research papers.

The timber-production area is made up of scientists in forest soils, silviculture, entomology, genetics, pathology and tree physiology. They are concerned with ways of increasing forest productivity.

Some of the major ongoing projects in this area are the biology and production of littleleaf-affected shortleaf pine stands, the effects of nursery practice and field performance as related to the physiological properties of loblolly pine, intraspecific variation and physiology of loblolly pine to waterlogging, the use of prescribed fire as a primary means of site preparation after clearcutting in southern hardwoods, and a dendroecological analysis of loblolly pine tree ring chronologies.

The department's research mission was enhanced by the selection of the Clemson Experimental Forest as one of five sites chosen in the South to study the effect of air pollution on forest trees. Funding totaling $450,000 from the Southern Commercial Forest Research Cooperative has been used to initiate the study site. By 1992, this investment will attract researchers from throughout the U.S. to study shortleaf pine and related commercial species in relation to various air pollutants. Because of the location, it will also give Clemson researchers a head start in applying for further funding.

With funding from the legislature, a college biometrician was hired in October 1986 and is helping college faculty, staff and students design and analyze experiments. This expertise has gone a long way toward helping college scientists develop proposals for outside funding, analyze data and prepare manuscripts—all of which will further the department’s research mission.

Research in the forest management area seeks solutions to forest-based, multiple-use problems. Major areas of research include investigation of habitat utilization by wild turkey pouls in the Southern Appalachian Mountains, timber-wildlife habitat relationships in loblolly pine stands of the Piedmont, the impact of beaver on Piedmont forests, and impact of recreation on vegetation.

The National Wild Turkey Federation and the U.S. Forest Service continue to support research on wild turkeys in both the mountains and Piedmont.

Wood utilization research continued to grow with the addition of a new faculty member in forest products marketing. This person will concentrate on developing more efficient and profitable ways of selling forest products. Progress continues to be made in the wood chemistry area. Work continues on research on wood plasticization and surface characterization of weathered wood. A special project undertaken by the department in cooperation with the National Park Service is to make an assessment of the preservation treatments conducted on the USS Cairo, a Civil War battleship on display in Vicksburg, Mississippi.

Five of the department's faculty are located in the South Carolina Coastal Plain, either at the Belle W. Baruch Forest Science Institute near Georgetown or the Forest Sciences Laboratory in Charleston. All work in the area of biological productivity, in which there are 12 state or McIntire-Stennis projects under way.

Major projects ongoing along the coast are as follows: evaluation of randomness of pollination and potential for inbreeding in southern pine seed orchards, inbreeding depression in selected populations of loblolly pine, hydrologic monitoring of the Hobcaw Barony, and the ecology of the fox squirrel in South Carolina.

The National Science Foundation continued support for a study that monitors the input of nutrients back and forth from forest to salt marsh. Westvaco Corporation supports a project studying the effect of harvest, site preparation and planting on pools of nitrogen and phosphorous in the loblolly pine ecosystem.

Extension

One of the major thrusts of Extension Forestry for the past three years has been to work with forest industries, the South Carolina Forestry Commission and others to promote reforestation of nonindustrial private forest lands. During the past two years, 9,000 and 14,000 acres of land have
been reforested as a result of this activity. These figures, while gratifying, are only a beginning in solving the reforestation problem. Regeneration of nonindustrial private lands is now occurring on four of every 10 acres. Extension plans to continue making reforestation a primary forestry thrust. Activities will concentrate on awareness of forest regeneration, development of the stewardship ethic among landowners and professional education. An overall goal for the next four years is to increase reforestation to 75 percent of the lands being harvested.

A new program emphasis for Forestry Extension has been market development. Activities have been geared toward establishing a networking and reporting system for primary and secondary industry development, identification of opportunities for industrial development, and enhancement of wood use by educating architects, engineers and builders.

The use of area forestry agents for activities at the local level has been pilot tested. These positions have led to a dramatic increase in forestry educational activities and have resulted in a positive response by the general public and landowners to forest management. Extension feels these positions have demonstrated a direction for future educational activities. Extension needs to place area extension agents in all counties in South Carolina within the next five years.

Department of Parks, Recreation and Tourism Management

Teaching

Instructional personnel are dedicated to excellence in education at the bachelor’s, master’s and doctoral levels. Professional preparation for careers in public and private leisure-service agencies include county and municipal leisure services, state and county recreation resource management systems, therapeutic recreation settings, and the broad field of travel and tourism management. Highlights within the department’s instructional program for 1986-87 program included:

- Initiation of the new Ph.D. program.
- Continued course refinement and new course development to reflect new adjustments in the respective fields.
- Increase in student credit-hour production, a reflection of an increase in departmental undergraduate enrollment and marketing of PRTM courses to non-majors.
- Adjustments in course sequencing to reflect course offerings as demands change.
- Faculty development to keep pace with the growing student demand for the travel and tourism emphasis area.

Public Service/Research

Research dollars have been applied to local problems in South Carolina, especially economic benefit models from local festivals, and developing traveler profiles in South Carolina tourist regions. Faculty continue to actively pursue research which will bring national visibility to Clemson and South Carolina. Data from a recreation survey were gathered and allowed Clemson to obtain contracts for analysis of these data. This could lead to recognition as a national recreation data depository and analysis center.

Faculty made presentations at seven national and 12 regional meetings. Forty-five publications were generated, with about one-third appearing in national refereed journals. Faculty are continually requested to serve as referees or special editors of research publications. The National Parks Service Cooperative Research Unit, administratively housed in this department, has increased involvement of this faculty and was instrumental in attracting a faculty member from Purdue to Clemson for this academic year. Recreation planning for military bases has been undertaken. Visibility in tourism research is projected through the newly approved Institute for Recreation, Travel and Tourism.

Public Service/Extension

Although extension-related requests increased in number from 53 in 1986 to 57 in 1987, their sources and nature were dramatically different. Within the state, three educational institutions, four private citizens, five government agencies, three newspapers and 11 businesses all requested and received information or other assistance. Nearly all requests were tourism-related.
Requests from 33 agencies of various types across the country were successfully processed. Most were informational assistance only. Assistance was also rendered to one Canadian university and to the Kenya Ministry of Tourism and Wildlife. These out-of-state requests indicate the highly respectable reputation enjoyed by the PRTM program.

Classroom projects were used to provide tourism development feasibility studies to a dozen South Carolina towns and counties. Two festivals were analyzed for economic impact and marketing effectiveness in the same manner. This is an ongoing process, providing a mutually beneficial product for students and communities at minimal costs.

Clemson University Outdoor Laboratory
During the fiscal year 1986-87, use of the Clemson University Outdoor Laboratory continued to increase. Capacity residential camp enrollments for special populations occurred during the summer sessions. In September two weeks of Senior Adventure Camp attracted more than 100 senior adults from South Carolina. Growth was realized in service to groups and organizations throughout the non-summer months. During the 12-month period, seven residential summer camps served more than 800 handicapped children, teenagers and adults, and nearly 200 other groups totaling more than 10,000 persons were served by the Outdoor Laboratory staff.

Record-breaking financial support was received from the South Carolina Jaycees. This allowed the Jaycees to meet their summer commitment to the camp for mentally handicapped citizens ($22,000), their pledge for Rainbow for Hope ($25,000), and provide more than $30,000 for special gifts to the Outdoor Laboratory. The South Carolina Sertomans, in addition to fully funding Camp Sertoma, completed Project Splash fundraising ($130,000) to build an aquatic facility at the Outdoor Laboratory. Groundbreaking occurred in June, and the project should be completed in 1988. The South Carolina Lions, the South Carolina Department of Youth Services and the South Carolina Hemophilia Foundation continued to support camp activities for special youth. The Muscular Dystrophy Association also used the facility for a camping program for the first time. Several major professional groups used Outdoor Laboratory facilities for extended periods.

The endowment program for the Outdoor Laboratory, Rainbow for Hope, continued to grow steadily. The South Carolina Jaycees met their 1986 pledge of $25,000. The Knights of Columbus completed a pledge of $15,000. Phase I was concluded in February, and Phase II began in September. On September 17, a major celebration was held to present to Clemson University the first gift from the Rainbow Fund.

As the year concluded, new projects and needs surfaced. Request will be made for additional personnel to maintain appropriate levels of support and service. Attention will also be focused on purchases of vitally needed equipment. The conversion of some group cabins to different housing arrangements is being considered. A significant contribution of materials for this effort has been received from Owens-Corning Fiberglas.

Professional Development Programs
The number and diversity of programs and the number of participants has stabilized. During the past year, 16 professional development programs have been provided for state and local government, the U.S. Forest Service, the National Park Service, the Corps of Engineers, South Carolina swimming pool operators, tourism personnel, outdoor recreation planners, and educators. These programs served approximately 870 clients and grossed a total of about $230,000. Services rendered are at the maximum level until staff can be added specifically for the professional development programs.

Regional Resources Development Institute
Created in 1981 as the Energy and Resource Development Institute, the Regional Resources Development Institute (RRDI) is a cooperative venture between the Southern Appalachian Research/Resource Management Cooperative (SARRMC) and Clemson University. The Institute's purpose is to stimulate and coordinate research in natural resource allocation and management, energy conservation, conflict management over natural resource uses, regional tourism assessment and development, and natural resource policy assessment. RRDI's projects involve scientists and
graduate students of SARRMC member organizations and involve site studies throughout the entire Southeastern United States.

During 1986-87 seven agency reports were presented, three public participation research workshops were conducted, four presentations were given at national research symposiums, six manuscripts were prepared and submitted for publication, and one co-authored textbook was delivered to the publisher.

RRDI has established a reputation for engaging in applied research related to agency environmental conflict management situations. Current research programs include:

- Assessing Threats to National Parks studies sites in South Carolina and Georgia.
- The National Parks and their Communities examines the role of the National Parks for stimulating local and regional economics.
- South Carolina Today & Tomorrow examines characteristics of S.C. counties in contrast to other Southeast counties along I-85.

RRDI is a vehicle for cooperative research. It enhances the College of Forest and Recreation Resources' ability to attract funds from federal land management agencies and to attract graduate students by providing research opportunities that are both timely and tangible.

In January 1986 RRDI initiated an initiative entitled South Carolina Today & Tomorrow, which will be its focus for the next five years. The programs of this initiative will examine quality of life issues in the context of regional development. The program is based upon citizen input and participation in the economic development of their communities, counties and regions within South Carolina. Through this new program RRDI plans to serve as a catalyst for faculty and graduate students interested in improving the quality of life, allocation of resources and citizen participation in regional development in South Carolina and the Southeastern region.

To improve our position for the South Carolina Today & Tomorrow program, RRDI has joined the Southern Growth Policy Board (SGPB) as an associate member. As an initial activity, RRDI co-sponsored an Upstate Economic Development Conference January 16, 1986, with 10 upstate counties, local cities and towns and chambers of commerce forming the "I-85 Economic Development Workgroup." During the conference a survey was conducted to assess opinion leaders' perceptions of the importance of various issues to local and regional economic development. These data will provide the basis for pursuing additional industrial and state support for the Today & Tomorrow program. Additional support has been developed through the Appalachian Council of Governments.

**Computer Laboratory**

The third full year of operation for the college's microcomputer laboratory was successful. As well as instruction for undergraduate and graduate students in the college, personnel from the National Park Service, U.S. Forest Service, U.S. Army Corps of Engineers, Office of Professional Development in the Department of Management, Continuing Engineering Education, the National Recreation and Park Association, and representatives from private industry used the laboratory for computer skill enhancement. The PRTM Department sponsored the second youth Computer Camp attended by nearly 50 youth from four states. The camp had a gross income of more than $12,000. Actual attendance at the computer laboratory exceeded 20,000 participant hours with more than $7,000 in laboratory income in addition to camp fees. This income allowed the purchase of additional computer hardware and software to further enhance the college's ability to incorporate personal computer technology into the management of today's varied and extensive leisure and forestry industries. Courses have been developed within the college devoted to the use of the personal computer as a management tool, courses have been identified that utilize components of personal computer technology, and new state and national workshops conducted. Eight courses regularly use the computer lab.

The College of Forest and Recreation Resources is committed to becoming the technological leader in both the forestry and leisure service fields. The utilization of the computer laboratory is a major step in reaching this goal of technological growth.
The Libraries' year was marked by a mixture of significant high points and some disappointing low points. High points were in the areas of improved services and automation. The major low point came with the dramatic increase in the cost of periodical subscriptions resulting from inflation and the devaluation of the dollar. These increases in periodical costs resulted in the significant reduction in purchases of monographic works.

Services

The circulation module on the NOTIS system was implemented early this fiscal year. The new system expedites the circulation of materials, and allows LUIS users to determine which items are available, which have been checked out and the date they are due to be returned prior to coming to the Libraries.

Another major effort was extension of the resources of the Clemson University Libraries to off-campus constituencies. Staff met with the faculties of the research stations to inform them of services available, and an electronic mail system was created to facilitate ordering Libraries materials. Similar meetings were held with Extension agents across the state to explain LUIS and other services available to them and their clients.

The Libraries are especially appreciative of the efforts made by the College of Agricultural Sciences in allowing use of the CUFAN network to extend access to LUIS to libraries and groups off campus. Twelve libraries of differing types and locations were selected to test the new CUFAN network to gain access to LUIS, the CUFAN database and the electronic mail capability. The Libraries were also permitted to become an Information Provider on the CUFAN and Vue-Text databases, providing pages of information about library hours, events and LUIS. Further, arrangements were made to allow the Libraries to add bibliographies of new materials in these two databases. These activities have allowed the Libraries to become much more visible on and off the campus.

Another activity that extended the Libraries' efforts was a significant increase in the number of tours and presentations made by the Reference staff to outside groups such as secondary school students.

LUIS was enhanced in several ways during the year, making it an even greater information tool for Libraries users. The terminals in Sirrine Library now access the University Placement Service database.

One of the enhancements provided with the new version of NOTIS allowed the Libraries to provide additional information screens to LUIS users. These screens not only provide more detailed instructions on the use of the system, but also provide the hours of operation of the three libraries and information about Libraries events. Our Cataloging Unit is adding the holding information about serials to the LUIS database, which will allow users in most instances to determine not only if the Libraries have the serial title, but the particular volume and year needed. When this information is complete, the Libraries will be able to remove the current visible file indexes.

During the year the Architecture Library was able to permanently extend its Sunday hours from 2:00 p.m. until 10:00 p.m. Also, the binding schedule was changed from monthly to biweekly, almost cutting in half the time materials are removed from the shelves for binding.

Late last fiscal year the federal government approved a Shared Regional Government Depository Plan for South Carolina. This plan provided for the first time this fiscal year a regional depository in the state, permitting the numerous Selective Depositories to discard depository documents no longer needed. Moreover, the plan guarantees that between the two shared regional depositories, Clemson and USC, all materials available to depository libraries will be available in South Carolina.

Last year we reported on two new services initiated: InfoTrac™ and Do-It-Yourself Searching. Both services have been extremely well received and used during this fiscal year. We added the government document database to InfoTrac™ resulting in much greater use of our extensive government document collection. Do-It-Yourself Searching was so popular we had to reduce the
time of each session from 30 minutes to 20 minutes to accommodate the demand. The Beta Test of the Science Citation Index CD ROM database was added this year. This database has been received very well by the scientific community on campus.

Collections

The major disappointment this year was the impact of inflation and the devaluation of the dollar on our library materials budget. We subscribe to a significant number of foreign journals, primarily in the sciences, a high-cost field. The high-cost items tended to be most impacted by the devaluation of the dollar.

The net result for the year was that we had to divert approximately $100,000 of funds earmarked for book purchases to cover the increased cost of periodical subscriptions. With the dollar continuing to decline, our budget planning for 1987-88 calls for further reductions in book purchasing by another $100,000 to cover the anticipated increases of periodical subscriptions during 1987-88. The amount of money available for book purchases is half what it was in 1985-86 and two-thirds of 1986-87. Obviously, we cannot continue covering these increases from existing budgets. We will have to receive a major infusion of funds, cancel a number of our most expensive subscriptions or a combination of the two for 1988-89.

On a more positive note, several of our collections were improved during the year as a result of donations. Our manuscript collections were enhanced with the acquisition of the congressional papers of Governor Carroll Campbell, the manuscripts of Betsy Byars, the research files of Wright Bryan and the corporate papers of the Lowenstein-Orr Mills. In the Thurmond Collection, we were able to acquire some long-sought-after records and to reach agreement with Senator Thurmond on a schedule for opening parts of his papers to researchers.

Our collection of South Carolina Experiment Station and Extension materials was improved with acquisitions from the College of Agricultural Sciences and a retiring faculty member. We were designated a depository for the EPA depository documents related to the Superfund cleanup in Pickens County.

The Libraries began to venture into new formats of information with the addition of videocassettes in the Architecture Library. A study was begun to determine the need for alternate formats such as videocassettes and computer data tapes to be managed by Cooper Library. We anticipate the completion of that study and follow-up during the fall of 1987.

Automation

In addition to implementing the new circulation module as noted above under "Services," the staff worked to implement a new and improved version of the NOTIS software in the acquisition module and in the public accessible modules. Added in these areas were new information screens, which provide LUIS users more information about the Libraries as well as better instruction on the use of the system. Initial preparation also was begun to implement a dramatic new feature to LUIS, keyword searching, which will be available during the early part of 1987-88.

Other LUIS improvements include the completion of the retrospective conversion of the bibliographic records for the Libraries' serials titles. The conversion of the bibliographic records for the monograph titles is in the final stages with basic completion slated for December 1987. During the year, planning was done for the addition of the bibliographic records for the materials housed in our government document collections. These items have never been cataloged and access has been limited. While the new government document database on InfoTrac™ has helped considerably, the inclusion of bibliographic records for a significant portion of this material will improve accessibility to this large and valuable collection. Another improvement to the NOTIS database being addressed by the Libraries is authority control. During the year a specification document was prepared, bids sought and a contract awarded for the creation of an authority control tape.

Late in the year the Computer Center acquired the BRS Search™ software, which will be the basis for a new information retrieval system to be made available to the campus. This new service is named DORIS, Document Retrieval Information Service. With the BRS Search™ software, we will be able to load a variety of databases and provide access to all terminals on the Clemson network. The Libraries have already negotiated an agreement to load a portion of the AGRICOLA
database. This is the premier agricultural database, and it will be available not only to campus users but to Experiment Station and Extension offices as well as via the CUFAN network.

Other databases being considered by the Libraries include the ERIC database in education, a textile database and several technical databases owned by the National Technical Information Service. DORIS will also be used to search local full text databases such as the Business Manual, Faculty Manual and state contract purchasing lists.

Records Management and University Archives
The addition of Dennis Taylor as University archivist got the Records Management and University Archives fully under way. A highlight was the largest transfer of records to the archives since 1983. One significant transfer was the bound volumes of the Board of Trustee minutes. Other transfers included records from the colleges of Architecture, Agricultural Sciences and Nursing.

Library Usage
Overall use of the Libraries was up, especially during the extended hours for the exam periods of the two full semesters. Special Collections reported an overall increase of its collections by 52 percent with a 118 percent increase in the use of University Archives materials. Our interlibrary loan activities increased substantially in both amounts of materials borrowed from other libraries and materials loaned to other libraries. We remain a net lender in the interlibrary loan program with our three top borrowers being S.C. corporations. This is another indication of the Libraries assisting the University in fulfilling its land-grant role in the state.

Fund Raising
During the year the Shirley Endowment was increased by a gift of $300,000 to be used for the improvement of the humanities collections. As such, this gift was matched with $100,000 to the Shirley Endowment from the National Endowment for the Humanities.

The Libraries also received a $6,000 grant from the Sirrine Foundation to survey the textile records held in South Carolina.

Personnel
Two new positions were added to the Libraries faculty. Deana Astle was appointed head, Technical Services Division. Astle came to us from the University of Missouri and is providing overall leadership of our cataloging and acquisitions operations. Dennis Taylor came to us from Emory University to assume the position of University archivist. Initially employed as a part of the National Historical Records and Publications Commission grant, Taylor has now been moved into a permanent position on the faculty.
## Libraries Statistics
### 1986—1987

<table>
<thead>
<tr>
<th>Collections</th>
<th>Accessioned</th>
<th>Withdrawn</th>
<th>Cataloged</th>
<th>TOTAL</th>
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<tr>
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<td>Uncataloged:</td>
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<td></td>
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</tr>
<tr>
<td>Gunnin</td>
<td></td>
<td></td>
<td></td>
<td>2,019</td>
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<tr>
<td>Sirrine</td>
<td></td>
<td></td>
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<td>3,169</td>
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### Documents and Reports...........................................................................629,461

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<td>Public Documents</td>
<td>2,224</td>
<td>670,561</td>
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<tr>
<td>Other</td>
<td>19,123</td>
<td>484,368</td>
<td>31,449</td>
<td>132,147</td>
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<tr>
<td>Total</td>
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<td>1,154,929</td>
<td>31,449</td>
<td>266,704</td>
</tr>
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</table>

### GRAND TOTAL

| Printed Materials | 1,568,225 |
| Slides (Gunnin)   | 68,840    |
| Maps (Cooper)     | 26,776    |

### Current Serial Subscriptions 1985/86 1986/87

| Periodicals     | 5,920  | 5,854   |
| Other Serials   | 1,137  | 1,122   |
| Total           | 7,057  | 6,976   |

### Circulation

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<tr>
<th>Door Count of Users</th>
<th>1985/86</th>
<th>1986/87</th>
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<tbody>
<tr>
<td>Cooper</td>
<td>730,165</td>
<td>757,496</td>
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<tr>
<td>Gunnin</td>
<td>51,011</td>
<td>74,527</td>
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<tr>
<td>Sirrine</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Total</td>
<td>781,176</td>
<td>832,023</td>
</tr>
</tbody>
</table>

### Books Circulated

| Cooper              | 213,573 | 204,915 |
| Gunnin (Excluding slides & equipment) | 13,394 | 12,804 |
| Sirrine             | 8,410   | 8,847   |
| Total               | 235,377 | 226,566 |

### Reference Services

<table>
<thead>
<tr>
<th>Inquiries</th>
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<tr>
<td>Directional</td>
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<td>4,103</td>
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<tr>
<td>Reference</td>
<td>37,476</td>
<td>38,590</td>
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<tr>
<td>Research</td>
<td>556</td>
<td>473</td>
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<tr>
<td>Total</td>
<td>42,757</td>
<td>43,166</td>
</tr>
</tbody>
</table>

### Computer Searches

| Quick              | 37     | 14     |
| Do-It-Yourself     | 210    | 1,516  |
| Reference          | 11     | 68     |
| Research           | 284    | 206    |
| Total              | 542    | 1,804  |

### Interlibrary Loans

| Loaned            | 5,208  | 6,076  |
| Borrowed          | 4,552  | 5,588  |
| Total             | 9,760  | 11,664 |
Computing and Information Technology

Computer Center

During the 1986-87 year, the Computer Center significantly increased its revenue-generating business and helped reduce the impact of budget reductions on the rest of the University.

The center solved the problem of inadequate space to house the University's computing facilities. A computer operations center is being constructed at the Clemson Research Park, about eight miles from campus, to house the Information Systems Development group and the mainframe operations of the Computer Center. This building, which will be leased for 20 years, is scheduled for completion in December 1987.

The mainframe computer that will be housed in the new building is a National Advanced Systems (NAS) AS/XL-560, which was acquired in November 1986. During the year the Computer Center signed a joint development agreement with NAS which included the placement of a vector processor at Clemson. This device, which attaches to the NAS mainframe, gives the mainframe supercomputer capabilities for scientific work, making it of particular value to Clemson researchers.

The center has continued to enhance the computing network on campus and around the state. The high-speed Ethernet network has been installed to all major academic buildings on campus, connected to and complementing the NAS network, which reaches to all buildings. A subcommittee of the Computer Advisory Committee is studying the possibility of extending the network to the dormitories by means other than the existing phone lines. Center staff maintain the CUFAN network on behalf of the College of Agricultural Sciences, with both the college and the center sharing in the use and the cost of the associated equipment.

The number of microcomputer and terminal facilities on campus has continued its rapid growth. The center has found ways to fund this growth despite the general budgetary constraints. Growth is not expected to slow down in the near future. The integration of the use of the computer into the curriculum is accelerating, thus placing increasing demands on the center to generate funding to provide additional equipment and services.

The installation of office automation systems has proceeded at a steady pace. DCIT provides consulting services to departments wishing to venture into office automation and will provide facilities management services if required. This coordination of office automation activities is resulting in the gradual development of a coherent and efficient campus-wide office automation network, which provides access to a complete range of computing services.

Clemson continues to provide computing services to its students, faculty, administration and outside customers which are second-to-none in terms of quality, range and low cost. While the Computer Center is committed to continuing and even improving that level of support, the state's financial circumstances are going to make that task extremely difficult. Replacement of contracts with state agencies will be harder as those agencies cut back, and the level of support within the University is likely to decline. The center will have to rely on its own talents to generate the resources needed to continue to provide the kind of computing services to which Clemson computer users have grown accustomed. Fortunately, the center has proven that, if allowed to aggressively pursue business opportunities, it can rise above adverse financial circumstances.

Administrative Programming Services

Administrative Programming Services (DAPS) develops and purchases computerized information systems for the University. These systems provide support for all administrative and academic operations. Historically, University systems have been highly centralized and accessible by only relatively few people. DAPS is now designing systems to be used by as many administrators, faculty, staff and students as possible. It is hoped that the only barriers to information access that exist will be those imposed because of the inherent security of certain information.

DAPS follows a yearly Information Systems Plan developed jointly with key administrators. In spite of a reduction in manpower, all goals established for 1986 except those withdrawn by the user were accomplished. Several goals are general in nature and are not the direct result of a user request. An example of such a goal is that of establishing an Information Access Project to promote the use of non-traditional software tools to retrieve and analyze information from University databases.
Other goals deal with the development of data systems such as the one developed to keep track of all University facilities, classrooms, labs and land. It is assumed that systems developed in prior years will be supported and updated as necessary. Another ongoing goal is to maintain all software at a level compatible with technological advancements provided by external software and hardware vendors.

Unlike multiple systems development groups found at most similar universities, DAPS supports the systems activities of all Clemson administrative areas. There is decreasing distinction between the administrative and academic computing networks. Student terminals often access portions of the same databases accessed by administrators. Likewise, administrators have access to resources such as the library catalog and the CUFAN network. Students are now being assigned a computer identifier that is used for course work, electronic mail and student administrative systems such as placement.

A sampling of 1986/87 accomplishments is as follows:

- Installed the Facilities Information System for managing data on buildings, rooms, utilities and land.
- Developed a data system for maintaining vendor data and to report such information to the state government.
- Developed a security data system to control all on-line applications.
- Implemented a major maintenance release of the personnel data system.
- Began revising the University budget process. Supported the existing process.
- Assisted the Computer Center in providing office automation support in administrative offices.
- Trained University staff in the use of new information retrieval tools such as the natural language INTELLECT and the Culprit database tool.
- Revised the internal accounting systems run in Alumni and Development.
- Installed new versions of the library automation system (NOTIS), including circulation using bar codes.
- Conducted feasibility studies leading to the purchase of mail incentive software and text management software for full text retrieval from document files.
- Helped design automated academic transcripts.
- Performed detail design of a degree progress system for students and faculty.
- Enhanced the student placement system to help job interviews.
- Provided post-implementation support for the new financial aid/student receivables system.
- Installed a transfer credit evaluation system for Undergraduate Admissions.
- Wrote software to assist in evaluating exam scheduling options.
- Established a structure to provide access to major operational reports that are submitted to governing bodies.
- Significantly improved the FTE reporting on the Scheduled Instruction and Faculty Workload Analysis Report.

**Information Systems Development**

The Information Systems Development (ISD) group continued to grow during 1986-87 as several major contracts approached their revenue-producing capacity.

The increase in the number of employees over the past year has more than exhausted the capacity of the ISD office space resulting in extremely difficult working conditions. This situation will be resolved by the end of 1987, however, when the computer operations center at the Clemson Research Park is completed.

ISD has signed a three-year contract with the South Carolina Health and Human Services Finance Commission (HHSFC) to maintain and operate the state’s Medicaid Management Information System (MMIS). A major achievement of ISD during 1986-87 was to transfer operational control of MMIS from the Department of Social Services to Clemson and HHSFC. This complex transfer was completed with no problems to the health service providers or recipients and reflected well upon Clemson University.
ISD continues to provide systems development and programming services to numerous state agencies, including the Department of Social Services, the Department of Health and Environmental Control and the TEC system. Further growth from existing contracts is not expected, and future growth of ISD will come from new contracts.

Since ISD is dependent upon other state agencies for its revenue, and since those agencies are facing severe budget reductions, the outlook for ISD in the near term is unclear. If the group is to maintain its current level of activity, and certainly if it is to grow, an aggressive marketing campaign of ISD services will be required. Fortunately the group has a good record in this regard and remains optimistic about its growth prospects.

**Graduate School**

The responsibilities of the Graduate School broadened considerably in the 1986-87 academic year because of the transfer of the International Services Office from the vice president for student affairs to the vice president for academic affairs. All efforts related to international studies and exchanges, except for admission of undergraduates, will be administered by the acting assistant dean for international programs. Presently, Dr. Frankie Felder is acting in that capacity. Also under the jurisdiction of the Graduate School are all activities concerned with Telecampus, the delivery of graduate courses through live audio/video connections. Ms. Myra Marshall is director of the Telecampus Program.

A new program approved in the year was the master’s degree in building science and management. Students began enrolling in August 1987.

Enrollment for the 1986 fall semester was 2,700, including 148 in the Clemson-at-Furman MBA Program. Total enrollment in degree programs was 2,151 (1,182 full-time) with 420 enrolled in doctoral degree programs. Advanced degrees awarded during the year totaled 648, including 64 doctoral degrees.

One hundred and twenty-four students received fellowships, representing more than 10 percent of those eligible. Graduate assistanships were awarded to 1,001 or 84.69 percent of those eligible. Approximately 27 percent of the assistantships were supported by research funds.

**The Strom Thurmond Institute of Government and Public Affairs**

The Strom Thurmond Institute is the main program component of The Strom Thurmond Center for Excellence in Government and Public Service, which composes a planned institute and archives building, a multi-purpose auditorium facility and a continuing education building. The Thurmond Center is funded entirely by private contributions and will make possible an endowment to support the six programs of the Thurmond Institute:

- The Thurmond Seminars in Government and Politics
- The Strom and Nancy Thurmond High School Achievement Program
- The Thurmond Scholars Program
- The Institute Lecture Series
- The Institute Distinguished Lecturers Program
- The Institute Governmental Research Program

Since its inception in July 1982, the institute has sponsored public programs featuring a number of leading opinion makers addressing such subjects as the proposed balanced budget amendment, nuclear arms freeze, terrorism, El Salvador, improvement of public education, farm and food policy, and civilian-military cooperation in defense research and engineering. Speakers featured have included Sen. and Mrs. Thurmond; Sen. Patrick Leahy, D-Vt.; Dr. Edward Teller; U.S. Rep. Michael Barnes, D-Md.; Dr. Helen Caldicott; Secretary of Commerce Malcolm Baldridge; Prime Minister Eugenia Charles of Dominica; Ted Turner; John Connally; Undersecretary of Defense Richard DeLauer; Admiral Hyman Rickover; Reverend Jesse Jackson; and members of the Clemson University faculty.

94
The institute has ongoing governmental research programs in state and local government, volunteerism and civic participation, natural resources policy and defense studies. The institute has a major research contract with the state of South Carolina to develop a long-range water policy for the state. The study involves six departments at Clemson University and two departments at the University of South Carolina.

The institute publishes a lecture series, working papers on a variety of public subjects and proceedings of other programs it sponsors.

**Undergraduate Studies**

The Undergraduate Studies Office is responsible for undergraduate academic programs and curricula, academic standards, scholarships and awards, University-wide lectures, new faculty-staff orientation, summer sessions, the Clemson Career Workshop, the Junior Scholars Program, the Honors Program and special post-graduate scholarship programs.

The Clemson Career Workshops bring academically outstanding minority students to campus before their junior and senior years in high school. The 1987 program included 360 students at both levels. Clemson expects 40 new freshmen recruited by this program to enroll in fall 1987.

The Honors Program enrolled 5 percent of the undergraduate student body in 1986-87, and 36 students were graduated with Senior Departmental Honors in December, May and August. Five Clemson seniors received Fulbright scholarships for foreign country study in 1987, bringing the number to 27 in the past eight years.

The Junior Scholars program brings academically talented students who are between the ninth and twelfth grades for an academic enrichment program. The program, which is in its third year, enrolled 234 students this year.

Undergraduate Studies is also responsible for planning the Clemson University Centennial. The celebration of that event will begin April 6, 1988.

**University Research**

The Office of University Research provides information and assistance concerning all aspects of the University research effort to faculty members, departments, colleges and other administrative units. The office helps prepare and submit applications for sponsored research, instruction and public service programs. During 1986-87 the office processed 798 faculty proposals.

The office also provides University liaison between the institution and all public and private, national and local organizations or entities concerned with any aspect of research support, regulation or administration.

Guidance and executive support were provided to the University Committee for the Protection of Human Subjects; the Biomedical Research Support Grant Committee, the University Research Grant Committee; the Animal Research Committee; the Institution Biosafety Committee and the Clemson University Patent Committee.
VICE PRESIDENT FOR ADMINISTRATION AND SECRETARY OF THE BOARD OF TRUSTEES

The position of vice president for administration was created on August 1, 1985, when Hugh J. Clausen assumed its duties and succeeded Joseph B. McDevitt as secretary of the Board of Trustees.

The director of public safety, who supervises the police and fire departments, and the director of traffic and parking report to the vice president for administration. The University municipal judge relies on this vice president for administrative and logistical support. The internal auditor reports to the secretary of the Board of Trustees, who, in turn, reports directly to the chairman of the Board.

The vice president for administration assumed supervisory responsibility for Human Resources in October 1986 when the Office of the Assistant to the President for Human Resources was transferred to the vice president for administration and the title of the supervisor of the Office of Human Resources was changed to assistant vice president for human resources.

The Office of the Vice President for Administration and Secretary of the Board of Trustees is located in Sikes Hall. Expenditures for the fiscal year ending June 30, 1987, were $2,310,897.

Fire Department

During 1986-87, the Fire Department experienced an approximate 15.2 percent increase in emergency responses over FY '85-'86 with a total of 7,346 emergency responses. Approximately 30 percent of all emergency responses by the Fire Department were to off-campus locations.

Property damages for this reporting period were the highest recorded for any recent fiscal year. The estimated property loss for this period was $750,000. This escalated amount was due in part to the Village Green Apartment complex fire, the cause of which was determined to be of a suspicious nature.

The Fire Department has obtained tentative permission from the South Carolina Fire Marshal's Office, Fire Academy, to use the on-campus training facility to provide advanced training to our firefighters and other area fire departments. The facility is one of the most comprehensive of its kind in this area. Local industry has shown an interest in using it to train fire brigade personnel.

The department continues its efforts to have 100 percent of its personnel certified by the Fire Marshal's Office and the Fire Academy in interior structural fire fighting. All personnel actively involved in fire suppression efforts are currently certified as such.

The Fire Department is completing a management personnel search and making preparations to conduct interviews to fill the fire safety surveyor position.

The Fire Department has recently adopted a preventive maintenance program for its emergency vehicles. The city of Clemson is being asked to share in the implementation of this program.

The department conducted public relations programs both in the city of Clemson and on campus to promote fire safety. Also, the department applied for and was awarded a $10,000 grant to promote fire safety in and for the Clemson area.

Human Resources

The Office of Human Resources is charged with coordinating and directing the efforts of the University to meet the objectives of affirmative action, equal employment opportunity and the goals of the state desegregation plan.

The department is actively involved in recruiting black faculty, staff and graduate students and has been instrumental in the past year in developing and implementing comprehensive programs for attracting them into those categories. Nationally, black representation in predominantly white institutions has been decreasing, but at Clemson it has remained constant in the faculty-staff areas. With new programs having been developed in the past year to search out and attract blacks to our campus, even greater representation is expected.
Emphasis also has been placed on establishing educational programs for faculty, staff and students to increase the awareness of and to prevent sexual harassment and AIDS. The department has been actively involved in planning a university center and a national conference on the vital issues affecting blacks in higher education.

Internal Auditing

The staff of the Internal Auditing Division consists of six members: a director, an audits manager, an EDP specialist, two staff auditors and an administrative assistant. The director reports administratively to the secretary of the Board of Trustees. Departmental expenditures for the year were $220,851.

The division provides an ongoing, independent audit function for the University as a service to management. Audit parameters include financial, compliance and operational review, as well as special requests.

Municipal Judge

The staff of the University's municipal judge consists of the judge and an administrative specialist who serves as judge in the regular judge's absence. Formerly called the University recorder (Recorder's Courts were abolished in 1980 by act of the General Assembly), the judge for the municipality of Clemson University hears appeals and renders decisions on all campus parking violations brought before the court, tries all persons charged with violating any ordinance passed by the Board of Trustees and any state laws that fall within the jurisdiction of the municipal judge (any crime for which the maximum penalty that can be imposed does not exceed $218 or 30 days in jail). The municipal judge also issues bench warrants, search warrants and arrest warrants for incidents arising on campus. Expenditures for 1986-87 were $27,462.29.

Parking and Vehicle Registration

The Department of Parking and Vehicle Registration maintains parking and traffic records for the academic calendar year. From August 15, 1986, to August 14, 1987, 13,563 student and 6,580 employee parking decals were issued, and $24,262 was deposited to the miscellaneous income account.

The Clemson University Police wrote 62,104 parking tickets. Parking fines collected by the department and deposited to the miscellaneous income account totaled $146,130, while $403,595 was transferred to the Accounting Office for collection. The Accounting Office has collected $493,716 of outstanding debts. The Student Traffic Review Board heard appeals from 1,682 students involving 2,192 parking tickets, or about 3.5 percent of the tickets written.

Police Department

The Police Department provides services to maintain the security of persons and property on campus:

- Public awareness programs educate the campus citizens in methods which deter criminal activity, assist police and/or suggest responsible behavior that promotes safety and security.
- Uniformed patrol officers move about campus to deter and detect criminal activity, preserve order, direct traffic, investigate accidents and enforce state laws and University parking regulations.
• Investigators assemble facts and evidence to document a reported incident, identify offenders and assist in the administration of justice.
• Other services include performing background investigations, transporting sick/injured students to the infirmary, monitoring intrusion and fire alarms, providing dispatch services for fire and emergency medical service personnel, providing dispatch and notification services for maintenance personnel during evenings and after hours, and maintaining parking and traffic signs and street markings.

During 1986-87 the Police Department responded to 6,728 calls for service. Traffic safety efforts resulted in 702 traffic citations and more than 62,000 parking citations written. Reported property losses due to criminal activity totaled $94,977. Police made 201 arrests and recovered $26,255 in stolen property. Amounts returned to victims by offenders diverted to the Pre-Trial Intervention program have not been tabulated. Investigation of fraudulent check cases assisted in the collection of $22,173 for the University. In addition to normal activities, the department provided services for 148 special events held on campus.

Crime rate statistics for 1986 as indicated in SLED’s *Crime in South Carolina 1986* compared favorably with those of the surrounding area. Compared to last year, property loss decreased by 3 percent and the recovery rate for stolen property increased by 21 percent.

During the year three awareness programs were developed by the department, two of which were presented: Defensive Driving and Male Sexual Awareness. The department made public awareness program presentations to more than 900 people. Crime prevention security surveys were completed for 28 University departments. Other achievements included the testing of an expanded parking enforcement program and the addition of side berms to the firing range. The additional safety provided by the berms at the range allowed it to be certified safe for rifle fire by the military. Professional development training provided to department personnel included the certification of an additional instructor for in-service training programs and the certification of additional officers as traffic radar and breathalyzer operators. Planned recertification of personnel in emergency preparedness was not accomplished due to the loss of two sworn positions and several personnel being out for extended periods due to illness.

At the end of the year Lieutenant Dennis Elrod and Patrolman Bill Norwood retired. The department will miss their combined total of 36 years’ experience.
### BUSINESS AND FINANCE

**Statement of Current Funds, Revenues, Expenditures and Other Changes**

**For the Year Ended June 30, 1987**

#### Revenues

<table>
<thead>
<tr>
<th>Source</th>
<th>Unrestricted</th>
<th>Restricted</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Fees</td>
<td>$ 29,979,179.89</td>
<td></td>
<td>$ 29,979,179.89</td>
</tr>
<tr>
<td>Federal Appropriations</td>
<td>10,355,050.89</td>
<td></td>
<td>10,355,050.89</td>
</tr>
<tr>
<td>State Appropriations</td>
<td>93,674,715.45</td>
<td></td>
<td>93,674,715.45</td>
</tr>
<tr>
<td>Local Appropriations</td>
<td>.00</td>
<td></td>
<td>.00</td>
</tr>
<tr>
<td>Federal Grants and Contracts</td>
<td>1,272,824.64</td>
<td>$ 9,072,304.79</td>
<td>$ 10,345,129.43</td>
</tr>
<tr>
<td>State Grants and Contracts</td>
<td>65,122.39</td>
<td>1,152,688.56</td>
<td>1,217,810.95</td>
</tr>
<tr>
<td>Local Grants and Contracts</td>
<td>512.52</td>
<td>40,833.35</td>
<td>41,345.87</td>
</tr>
<tr>
<td>Private Gifts, Grants and Contracts</td>
<td>832,107.15</td>
<td>9,149,235.61</td>
<td>9,981,342.76</td>
</tr>
<tr>
<td>Endowment Income</td>
<td>9,266.36</td>
<td>317,975.49</td>
<td>327,241.85</td>
</tr>
<tr>
<td>Sales and Services of Educational Departments</td>
<td>1,484,720.38</td>
<td></td>
<td>1,484,720.38</td>
</tr>
<tr>
<td>Sales and Services of Auxiliary Enterprises</td>
<td>36,236,083.55</td>
<td></td>
<td>36,236,083.55</td>
</tr>
<tr>
<td>Other Sources</td>
<td>8,128,347.93</td>
<td>706,061.62</td>
<td>8,834,409.55</td>
</tr>
</tbody>
</table>

**Total Revenues**

$182,037,931.15  $20,439,099.42  $202,477,030.57

#### Expenditures and Mandatory Transfers

<table>
<thead>
<tr>
<th>Category</th>
<th>Unrestricted</th>
<th>Restricted</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational and General Expenditures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruction</td>
<td>$ 50,497,400.26</td>
<td>1,940,165.17</td>
<td>$ 52,437,565.43</td>
</tr>
<tr>
<td>Research</td>
<td>11,483,785.70</td>
<td>7,076,472.24</td>
<td>18,560,257.94</td>
</tr>
<tr>
<td>Research-Agricultural Experiment Station</td>
<td>15,807,292.23</td>
<td>2,212,238.79</td>
<td>18,019,531.02</td>
</tr>
<tr>
<td>Extension and Public Service</td>
<td>1,143,805.10</td>
<td>1,374,292.25</td>
<td>2,518,097.35</td>
</tr>
<tr>
<td>Extension and Public Service - Cooperative Extension Service</td>
<td>23,898,039.76</td>
<td>728,119.36</td>
<td>24,626,159.12</td>
</tr>
<tr>
<td>Extension and Public Service - Regulatory Service</td>
<td>3,893,261.62</td>
<td>1,071,033.09</td>
<td>4,964,294.71</td>
</tr>
<tr>
<td>Academic Support</td>
<td>10,638,945.60</td>
<td>688,842.90</td>
<td>11,327,788.50</td>
</tr>
<tr>
<td>Student Services</td>
<td>4,587,972.12</td>
<td>203,878.30</td>
<td>4,791,850.42</td>
</tr>
<tr>
<td>Institutional Support</td>
<td>10,659,965.65</td>
<td>65,711.15</td>
<td>10,725,676.80</td>
</tr>
<tr>
<td>Operation and Maintenance of Plant</td>
<td>11,086,236.13</td>
<td>1,054.81</td>
<td>11,087,290.94</td>
</tr>
<tr>
<td>Scholarships and Fellowships</td>
<td>94,411.45</td>
<td>5,055,900.04</td>
<td>5,150,341.49</td>
</tr>
<tr>
<td>Mandatory Transfers for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect Cost Remitted to State</td>
<td>344,075.52</td>
<td></td>
<td>344,075.52</td>
</tr>
</tbody>
</table>

**Total**

$144,135,221.14  $20,417,708.10  $164,552,929.24

**Auxiliary Enterprises:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Unrestricted</th>
<th>Restricted</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary Enterprises Expenditures</td>
<td>$ 33,953,505.66</td>
<td></td>
<td>$ 33,974,896.98</td>
</tr>
<tr>
<td>Mandatory Transfers for Debt Service and Bond Resolutions Requirements</td>
<td>4,451,753.00</td>
<td></td>
<td>4,451,753.00</td>
</tr>
</tbody>
</table>

**Total**

$ 38,405,258.66 $ 21,391.32  $ 38,426,649.98

**Total Expenditures and Mandatory Transfers**

$182,540,479.80  $20,439,099.42  $202,979,579.22

#### Other Transfers and Additions/(Deductions)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect Cost Recovered</td>
<td>$(2,172,385.21)</td>
</tr>
<tr>
<td>Current Funds Endowed</td>
<td>(4,000.00)</td>
</tr>
<tr>
<td>Nonmandatory Transfer Among Funds</td>
<td>$(2,717,929.54)</td>
</tr>
<tr>
<td>Excess of Restricted Receipts over Transfers to Revenues</td>
<td>5,719,832.85</td>
</tr>
<tr>
<td>Realized Losses on Investments and Administrative Costs</td>
<td>(21,658.64)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>(40,109.92)</td>
</tr>
</tbody>
</table>

**Total Other Transfers and Additions/(Deductions)**

$ (2,717,929.54) $ 359,844.51  $ (2,358,085.03)

**Net Increase/(Decrease) in Fund Balance**

$ (3,220,478.19)  $ 359,844.51  $ (2,860,633.68)
INSTITUTIONAL ADVANCEMENT

The purposes of the Institutional Advancement Division are to attract private support for academics, to provide services for Clemson alumni and friends, and to meet the University's promotion and media-relations needs. In March 1987, Dr. Gary A. Ransdell became vice president for institutional advancement and began a process of reviewing and reorganizing the division to increase its functional effectiveness and service to the University. Among the changes, which became effective July 1, 1987, a new administrative unit called Advancement Services was created to provide accounting, budgeting, research and related support for the division's existing units. Those units are the Development Office, Alumni Relations and University Relations. A report on each follows.

Alumni Relations

In the land-grant tradition of service to all its graduates and friends, the major thrust of the Alumni Relations Office is to provide programs that serve that constituency and help graduates keep in touch with their alma mater. These programs take the form of Clemson Club meetings, seminars, constituent group activities, special class activities, career services and continuing education.

Clemson alumni are recognized the world over for their spirit and loyalty to the University, in the academic arena as well as on athletic fields. Members of the "Clemson family" have served in national, international, state and local affairs, making significant contributions to benefit the citizenry of which they are such a vital part. The Alumni Association has an extensive recognition program designed to make others aware of the successes and accomplishments of men and women who wear the Clemson ring with such pride and do so much to promote the teaching, research and public service commitment of the University.

All functions and services of the international Alumni Association are coordinated at the Clemson Alumni Center. This 14,000-square-foot structure was built, equipped and furnished by alumni of the institution through a special three-year capital campaign. All alumni relations activities of the University are housed here as well, including an extensive computerized records-keeping system that has won national acclaim as one of best in higher education. Accurate records of address, employment and biographical information are retained on Clemson graduates, as well as those who express a desire to become involved with Clemson in any way.

Alumni of the University continue to support the annual Loyalty Fund with gifts that make possible an extensive scholarship program for students, fund alumni professorships that identify Clemson's best classroom teachers, and provide awards for distinguished achievements in research, public service and teaching.

Development Office

The objectives of Clemson's private support efforts are deliberate and broad-based. They encompass growth in the unrestricted permanent endowment, expansion of all phases of general and endowment support for faculty, increased sources of student financial aid and further development of the annual Loyalty Fund program, which enhances the total academic environment.

While state appropriations are a part of the total support for the educational activities at Clemson, more than 50 percent of the total budget must come from other sources. In that context, the ultimate quality of the University rests with private support from business, industry, alumni and friends of the University.

More than $7.3 million was contributed from July 1, 1986, through June 30, 1987, as Clemson's fund-raising program set an all-time record in private support for academics. The total represents gifts from all support groups, including alumni. Some 12,634 donors contributed.
Alumni participated at a record level in the Loyalty Fund. Clemson’s alumni-participation percentage is about 25 percent (11,850 people), more than twice the national average. Loyalty Fund gifts from alumni and friends exceeded $1 million last year.

The mission of the Development Office is to attract, to the fullest extent possible, the private support of Clemson’s constituent support groups to supplement the University’s tax-assisted budget in order to maintain and enhance academic excellence at all levels. The development staff, consisting of six full-time professionals, conducts annual and capital giving programs utilizing many alumni and other volunteers.

Also a primary responsibility of the development staff is the coordination of all academic fundraising programs campuswide. The Deans’ Advancement Council was established by the Development Office to help deans, department heads and professors cultivate and solicit private gifts for their schools, colleges or units. The council, which is chaired by a college dean, comprises all deans and representatives from the library, athletics, various institutes and other campus entities.

Private support from the Loyalty Fund provides money for scholarships, professorships, library acquisitions and a myriad of projects and activities aimed at strengthening academic programs. Since less than 50 percent of the University’s budget is provided by the state, private support as a supplement to state assistance is critically important to Clemson’s mission of teaching, research and service.

As Clemson approaches its Centennial celebration in 1989, the Development Office will conduct the University’s first fund-raising effort for construction and endowment funds. This major gifts effort will seek contributions from alumni, friends, corporations, foundations and other groups to strengthen Clemson’s endowment as a means of preparing for the University’s next 100 years.

University Relations

The University Relations Office provides services in the areas of news and public information, electronic and photographic support, publications and graphics, visitor programs, constituent communications, and general public relations counsel to the University’s academic and administrative divisions, including the Cooperative Extension Service and the S.C. Agricultural Experiment Station.

Department of Agricultural Communications

The Department of Agricultural Communications serves the communications needs of the public service agencies in the College of Agricultural Sciences. A primary goal is to provide the people of South Carolina information that will help them improve their productivity and standard of living. This is accomplished by providing news articles, columns and features for the general media, both print and broadcast, and for specialized publications; by providing agriculture, health, nutrition, home care and other publications of value to homeowners, growers, families and young people; by developing exhibits for use throughout South Carolina; and by working with Extension employees to develop their communication skills.

In 1986-87, the department:

- Produced 328 publication and exhibit projects.
- Generated 260 news releases (multiple versions count as one).
- Had more than 1,000 media contacts.
- Sent more than 400 “News To Use” items electronically to county Extension agents for columns and radio programs.
- Produced 260 agricultural news radio programs aired statewide.
- Sent 52 “Home and Outdoors” question-and-answer consumer columns to media statewide.
- Made major contributions to the University Relations holiday news packets, editorial column service and constituent periodicals.
- Took the lead role in devising and implementing the University’s public relations strategy for a biotechnology initiative.
Constituent Communications

The Constituent Communications program was created to assume editorial responsibility for the "Clemson World" magazine, formerly produced by Alumni Relations, and "Clemson University News" tabloid, formerly produced by News Services, and to provide editorial and communications counsel and support for special projects, such as the University’s Centennial celebration, which begins in April 1988. Three issues of the magazine and four of the tabloid were produced during the year, and steps were taken to coordinate the publications’ editorial content and production schedules, to cut costs without losing quality, and to attract more faculty and alumni involvement in the publications.

Special projects included developing materials for "Clemson University: The Second Century," the University’s academic-emphasis plan; the President’s Advisory Council of business and industry executives; announcement of the Research Investment Act; and the inauguration of President Max Lennon.

Department of Electronic and Photographic Services

The Department of Electronic and Photographic Services (Communications Center) provides a broad range of audio and visual production services to support the public service, administrative, development, research and instructional activities of the University. Services include television, audio, multi-image, photographic and cinematographic production, audio and video teleconferencing, art and graphics support, and audio-visual equipment and resources loans.

In 1986-87:

- More than 1,000 television, radio and multi-image projects were completed.
- Design of a Telecampus TV classroom was completed, and construction was begun.
- Nearly 70,000 photographs were shot, processed and printed in-house.
- More than 4,700 loans of audio-visual library items and equipment were accomplished.

Department of News Services

The Department of News Services provides the University with a means of communication to the public through external news media and internal news vehicles, including calendars of events and the weekly campus newsletter. Staff members generate news and feature stories about the University’s educational, public service and research programs for use by state, regional and national news media and in constituent publications, including the quarterly "Clemson World" magazine, the "Clemson University News" tabloid and special newsletters. Services also include editing and marketing regular faculty-written columns, editorials and book reviews; coordinating coverage of campus events, speakers and Board of Trustees meetings; handling news conferences and major public relations campaigns; and acting as liaisons between the University and the print and broadcast media.

In 1986-87, News Services produced:

- 360 news releases (multiple tailored hometown releases count as one).
- 50 news media tip sheets.
- 52 history book review columns.
- 52 children’s book review columns.
- 52 “Living Well” columns.
- 24 editorials.
- 3 feature packets (back-to-school, Christmas, tourism), with an average of 8 stories in each packet.
- 50 issues of the University “Newsletter.”
- 12 calendars of events.
- 6 “New Specials.”
- Daily “Executive News Briefings.”
- Public relations campaigns for the National Dropout Prevention Center, the University’s asbestos-abatement plan and Agri-Biotech Initiative.
Department of Publications and Graphics Services

The Department of Publications and Graphics Services ensures that Clemson University’s printed communications maintain the highest standards of writing and design and that they project an accurate image to the University’s various publics. To that end, a professional staff of writers, designers and production personnel provides the services needed to create and coordinate a publication project from the planning stage through delivery of the finished product.

In 1986-87, the department had in production 525 jobs (brochures, fliers, posters, programs, letterheads, catalogs, directories and exhibits) directed toward student recruitment, fund raising, providing information, and promoting the activities and services of the University. Highlights of the year include:

- Turnaround time on most jobs was decreased, even as the number of jobs in production increased.
- Twenty-eight percent of the jobs in production were typeset on campus, either at the Computer Center or on the department’s McIntosh/LaserWriter equipment, at an estimated $12,000 cost savings to the University.
- In March, the department received a $2,500 equipment donation from Apple Computer.
- By increasing its vendor pool, the department encouraged more competition among printers and realized savings in printing costs.
- The department completed three market research projects to determine how best to meet the needs of our target audiences.
- The department presented no-cost professional-development opportunities by coordinating computer-applications demonstrations and regular bimonthly publications reviews.
- The department offered to other University offices, at no cost and for the first time, a Clemson display system and graphics.

Visitor Programs

Visitor Programs administers the Visitors Center, the Board of Visitors program, the Speakers Service and two campus landmark houses, Fort Hill and Hanover House.

The Board of Visitors program includes two-year membership commitments, two campus visits annually and a membership roster of 30 business and community leaders. Members are assigned to four working committees: academic affairs, legislative relations, media and research. A major project during the year was a survey of Clemson alumni, state legislators, education officials, and community and economic leaders in South Carolina to determine their perceptions of higher education in general and Clemson in particular and to help the University focus its efforts to improve awareness, understanding and support of Clemson.

The University’s full-service Visitors Center provides a variety of services to meet the information needs of an increasing number of campus visitors. Services include general information, guided and self-guided tours, audio-visuals and publications. Since its opening on June 4, 1984, the center has served 70,555 people, including 47,350 visitors to the facility. Also, 1,364 walking tours have been given, and 650 tour schedules have been arranged for 23,205 individuals who visited the campus as part of school or community groups.

The Speakers Service continued to make Clemson’s Alumni Professors available as speakers for meetings of civic groups, and historic Fort Hill and Hanover House welcomed visitors throughout the year.
The 1986-87 academic year marked the highest on-campus enrollment, with 12,152 students registered for classes — 10,985 full time and 1,167 part time. An additional 910 were in various off-campus programs, bringing the total enrollment to 13,062, a slight increase from last year. Of the total enrollment, 2,702 were graduate students.

The College of Engineering again had the highest on-campus enrollment with 3,369 students. The College of Commerce and Industry was second with 2,681, followed in order by Sciences (1533), Education (1423), Liberal Arts (993), Agricultural Sciences (649), Architecture (546), Forest and Recreation Resources (500), and Nursing (363).

Higher education continued to become increasingly accessible as evidenced by the number of freshmen entering college with advanced standing. In the 1986-87 fall semester, new high school graduates entered Clemson with advanced standing by means of College Board Advanced Placement courses (481 students, 4,785 credit hours) and by concurrent enrollment in high school and college or enrollment in summer school (96 students, 580 credit hours).

At Clemson, performance in high school has proven to be the best single predictor of success in the freshman year. The class ranks of entering freshmen remained essentially unchanged, with 37 percent of the class entering in fall 1986 ranked in the top 10 percent of their class, 63 percent in the top 20 percent, and 93 percent in the top 50 percent. In 1986, the freshman class average Scholastic Achievement Test (SAT) score of 1,025 compared with an average of 906 reported by the College Board for all high school seniors. It is also the highest average among state-supported institutions in South Carolina.

Of the 7,623 new applications for admission processed for 1986-87, 5,123 were accepted, and 2,735 actually enrolled (including freshmen and transfer students). Clemson students come from all 46 South Carolina counties, 50 states, Puerto Rico, the District of Columbia, the Virgin Islands and 83 foreign countries.

South Carolina residents accounted for 70 percent of the 12,893 students, including those enrolled in off-campus programs. Greenville County continued to have the most students enrolled on campus (1,119). Pickens County was second with 972, followed in order by Anderson, Oconee, Spartanburg and Charleston counties. Most out-of-state students came from North Carolina (545), Georgia (516) and Florida (459).

Computerized pre-registration helped the record number of students get off to a smooth start for fall classes. More than 90 percent were pre-registered and had their course schedules completed before they arrived on campus to begin classes.

<table>
<thead>
<tr>
<th>Year</th>
<th>Undergraduate</th>
<th>Graduate and Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-73</td>
<td>7,686</td>
<td>2,071</td>
<td>9,757</td>
</tr>
<tr>
<td>1973-74</td>
<td>7,910</td>
<td>2,202</td>
<td>10,112</td>
</tr>
<tr>
<td>1974-75</td>
<td>8,171</td>
<td>2,415</td>
<td>10,586</td>
</tr>
<tr>
<td>1975-76</td>
<td>8,576</td>
<td>2,785</td>
<td>11,361</td>
</tr>
<tr>
<td>1976-77</td>
<td>8,620</td>
<td>2,763</td>
<td>11,383</td>
</tr>
<tr>
<td>1977-78</td>
<td>8,708</td>
<td>2,566</td>
<td>11,274</td>
</tr>
<tr>
<td>1978-79</td>
<td>8,925</td>
<td>2,553</td>
<td>11,478</td>
</tr>
<tr>
<td>1979-80</td>
<td>9,291</td>
<td>2,457</td>
<td>11,748</td>
</tr>
<tr>
<td>1980-81</td>
<td>9,427</td>
<td>2,152</td>
<td>11,579</td>
</tr>
<tr>
<td>1981-82</td>
<td>9,918</td>
<td>2,008</td>
<td>11,926</td>
</tr>
<tr>
<td>1982-83</td>
<td>10,151</td>
<td>1,983</td>
<td>12,134</td>
</tr>
<tr>
<td>1983-84</td>
<td>10,217</td>
<td>2,242</td>
<td>12,459</td>
</tr>
<tr>
<td>1984-85</td>
<td>10,488</td>
<td>2,438</td>
<td>12,926</td>
</tr>
<tr>
<td>1985-86</td>
<td>10,434</td>
<td>2,459</td>
<td>12,893</td>
</tr>
<tr>
<td>1986-87</td>
<td>10,360</td>
<td>2,702</td>
<td>13,062</td>
</tr>
</tbody>
</table>
The 1986-87 figures include 692 students attending off-campus institutes and 149 in the Clemson-Furman University Master of Business Administration degree program.

The on-campus enrollment of women at Clemson reached an all-time high during the 1986 fall semester. There were 5,161, of which 4,468 were undergraduates. Enrollment of undergraduate women increased one percent over last year, and women now constitute approximately 42 percent of the on-campus undergraduate enrollment.

The Clemson student body continues to be a working group, receiving a significant amount of financial assistance in the form of loans, grants, scholarships and employment. Clemson awarded 445 long-term loans totaling $514,325. The University also approved and certified 2,618 guaranteed student loans from a variety of lending institutions. Excluding donor-selected scholarships, 955 scholarships and grants valued at $817,214 were awarded. The number of students receiving Pell Grants was 1,199, with awards totaling $1,610,286. In all, an estimated 68 percent of the student body received an estimated total of $23 million in financial assistance.

Students at Clemson University enjoyed educational experiences outside the classroom through participation in student organizations. The number of organizations has increased steadily, and Clemson now recognizes more than 260 student groups. Half of these groups directly complement the academic experience by providing career-oriented fellowship, programs and trips to professional conferences. Our students also enjoy competition, socialization and fellowship in sports, social and religious organizations. In addition, more than 40 groups have been formed to associate students interested in fine arts, media, military, government and community service.

Student Government continues to add new programs for the student body. Approximately 300 people this year represented the students in the senate, court system and Student Traffic Review Board, and 93 students were appointed to University committees. This year’s services included copy machines, typewriters, refrigerator rentals, security shuttles and free legal aid. The Student Government-sponsored Career Expo was even more popular this year than last, and revenue from that project allowed the Student Government Office to move into the “computer age.”

The TAPS yearbook, The Tiger newspaper and WSBF radio are enjoying a resurgence of student involvement. Chronicle, Clemson’s variety magazine, was revived after two years without publication and will produce two issues in the coming year.

Clemson’s 11 sororities and 19 fraternities claimed a total membership of more than 2,500 students. Sorority women emphasized academic excellence and maintained an average grade point ratio of 2.84, which was higher than the University’s overall female student average of 2.70. The Interfraternity Council was proud to have regained a grade point average above the overall men’s average. The Pan Greek Council continued to take the lead in programming for Clemson’s minority students.

Career Services, composed of Placement and Cooperative Education, provides students with information on career opportunities, teaches job search skills, offers the chance for work experience and coordinates industry contacts with the University.

An employer database was brought on line in the fall of 1986 allowing students to research employers from selected terminals on campus. This fall we will implement a computerized sign-up system, which will allow students to sign up for interviews from these terminals. The number of job offers to this year’s class was down about 12 percent from last year, but the average salary offer was higher for most disciplines.

The 1986-87 academic year was a period of continued growth for the Cooperative Education Program. Student enrollment and student earnings rose to 614 and $3.65 million, respectively. In addition, 35 employers initiated cooperative education agreements with Clemson University during the past year.

The Clemson University Union accomplished and surpassed its 1986-87 goal by providing more than 800 social, cultural, educational and recreational events for the campus community. These programs were planned by more than 250 student volunteers with the leadership of the Union Board and assisted by a professional staff. Included in the various events throughout the year were the First Friday spirit concert held in the amphitheater; the featured attraction during Homecoming, the legendary George Burns; the David Lee Roth, Huey Lewis and the News, and Hank Williams, Jr. concerts in Littlejohn Coliseum; the Performing Artist Series highlighted by the Preservation
Hall Jazz Band; a spring outdoor reggae concert in the amphitheater; and more than 60 University Union short courses. The Union provides an atmosphere where students can develop leadership, communication, business and interpersonal skills, and sponsors worthwhile co-curricular events for the total campus population.

In many ways 1986-87 was Clemson's most successful athletic year ever. The Tigers tied the ACC record for league championships in an academic year with seven (football, women's cross country, women's tennis, men's tennis, men's indoor track, women's swimming and golf). Additionally, Clemson had 10 teams finish in the top 20 in the various national polls and an 11th was in the top 20 at one time or another. The most top 20 teams Clemson had previously in final polls over the course of an academic year was nine, established in 1981-82 and 1982-83. Clemson was successful in the major sports of football, basketball and baseball and was one of only two schools in the nation to rank in the top 20 in football, basketball and baseball in the final polls. Clemson was the only school in the nation with a first-round draft pick in each of the major sports.

Number and Percent of Black Students

<table>
<thead>
<tr>
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<th>Number</th>
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<td>1975</td>
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<td>1986</td>
<td>714</td>
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Student Faculty Ratio (Full-Time Equivalent)

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<td>1973</td>
<td>16.8:1</td>
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<td>1975</td>
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<td>1978</td>
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</tr>
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<td>1979</td>
<td>16.0:1</td>
</tr>
<tr>
<td>1980</td>
<td>15.6:1</td>
</tr>
<tr>
<td>1981</td>
<td>16.4:1</td>
</tr>
<tr>
<td>1982</td>
<td>16.6:1</td>
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<tr>
<td>1983</td>
<td>17.0:1</td>
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<td>1985</td>
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<td>1986</td>
<td>16.9:1</td>
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### Average College Board of Freshmen

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<td>1974</td>
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<td>983</td>
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<td>1976</td>
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<td>1983</td>
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<td>1984</td>
<td>1,012</td>
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<tr>
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### Number in Freshman Class

(New Students)

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<td>1975</td>
<td>1,901</td>
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<td>1976</td>
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<td>1982</td>
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<td>1983</td>
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### Number of Teachers

(Full-Time Equivalent Teaching Faculty)

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<th>Year</th>
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<td>1973</td>
<td>578.4</td>
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<td>1984</td>
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<td>1985</td>
<td>797.3</td>
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<td>1986</td>
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### Number of On-Campus Students in Summer School

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<td>1974</td>
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<td>1975</td>
<td>6,275</td>
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<td>1976</td>
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<td>1977</td>
<td>6,301</td>
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<td>1978</td>
<td>6,393</td>
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<td>1979</td>
<td>6,708</td>
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<td>1980</td>
<td>6,858</td>
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<td>1981</td>
<td>6,897</td>
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<td>1982</td>
<td>7,149</td>
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<tr>
<td>1983</td>
<td>7,442</td>
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<td>1984</td>
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<td>1985</td>
<td>8,126</td>
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### Number of Dorm Beds and Percent Being Used

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<tr>
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<td>5,330</td>
<td>102</td>
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<tr>
<td>1974</td>
<td>5,592*</td>
<td>101</td>
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<tr>
<td>1975</td>
<td>5,616*</td>
<td>103</td>
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<tr>
<td>1976</td>
<td>5,625*</td>
<td>103</td>
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<td>1978</td>
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<td>1982</td>
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<td>105</td>
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<td>1983</td>
<td>7,113*</td>
<td>104</td>
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<tr>
<td>1984</td>
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<td>102</td>
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<td>1985</td>
<td>6,986</td>
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<tr>
<td>1986</td>
<td>6,910</td>
<td>101</td>
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</table>

* Includes beds in the Clemson House.

1974 - 252  
1975 - 262  
1976 - 271  
1977 - 308  
1978 - 317  
1979 - 324  
1980 - 329  
1981 - 330  
1982 - 328  
1983 - 331  
1984 - 331  
1985 - 333  
1986 - 349
### Fall Semester 1986 Enrollment by Colleges and Degrees Awarded
December 1985-August 1986

<table>
<thead>
<tr>
<th>College/Major</th>
<th>Fall Semester</th>
<th>Associate</th>
<th>Bachelor's</th>
<th>Master's</th>
<th>Specialist</th>
<th>Doctorates</th>
<th>Total</th>
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</thead>
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<tr>
<td>Agricultural Sciences</td>
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<td>103</td>
<td>64</td>
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<tr>
<td>Architecture</td>
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<td>89</td>
<td>42</td>
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<td>0</td>
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<td>Commerce &amp; Industry</td>
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<td>554</td>
<td>88</td>
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<td>651</td>
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<td>185</td>
<td>163</td>
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<td>9</td>
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<td>613</td>
<td>123</td>
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<td>6</td>
<td>742</td>
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<td>Forest &amp; Recreation Resources</td>
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<td>0</td>
<td>100</td>
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<td>0</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>570</strong></td>
<td><strong>5</strong></td>
<td><strong>48</strong></td>
<td><strong>2,764</strong></td>
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</tbody>
</table>

Degrees awarded since 1896 (through August 1986) total 59,904 of which 426 have been associate degrees; 48,195 bachelor's degrees; 10,311 master's degrees; 135 education specialist degrees; and 837 doctorates. Includes 458 Clemson-Furman MBA degrees awarded May 1972-August 1986.
## 1986-87 Clemson Sports

<table>
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<tr>
<th>Sport</th>
<th>Home</th>
<th>Away</th>
<th>Neutral</th>
<th>ACC</th>
<th>Overall</th>
<th>PCT.</th>
<th>ACC Regular Finish</th>
<th>ACC Trn. Finish</th>
<th>National Ranking</th>
<th>1st Team All-ACC Players</th>
<th>All America Players**</th>
<th>Academic All-Americans</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3-1-1</td>
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<td>5-1-1</td>
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<td>2</td>
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<td>1</td>
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<td></td>
<td>na</td>
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<td>5th</td>
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<td>0</td>
</tr>
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<td>*Golf</td>
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| Men's Totals         | 72-18-1| 40-22-3| 19-13-1| 45-19-1| 131-53-5 | .706 | 2 Firsts         | 2 Firsts        | 7 Top 20         | 43                          | 12               | 2                      |
| Women's Totals       | 21-18  | 14-20-0| 17-11-0| 16-15-0| 52-49-0  | .515 | 1 First          | 3 Firsts        | 3 Top 20         | 18                          | 10               | 4                      |
| Overall Totals       | 93-36-1| 54-42-2| 36-24-1| 61-34-1| 183-102-5| .640 | 3 Firsts         | 5 Firsts        | 10 Top 20        | 61                          | 22               | 6                      |

*Denotes ACC Champion.

**First, second or third team selections.

ACC Coach of the Year

*Cliff Ellis—Basketball; Wade Williams—Indoor Track; *Larry Penley—Golf; Bob Boettner—Women's Swimming; *District Coach of Year.