



NC STATE
UNIVERSITY

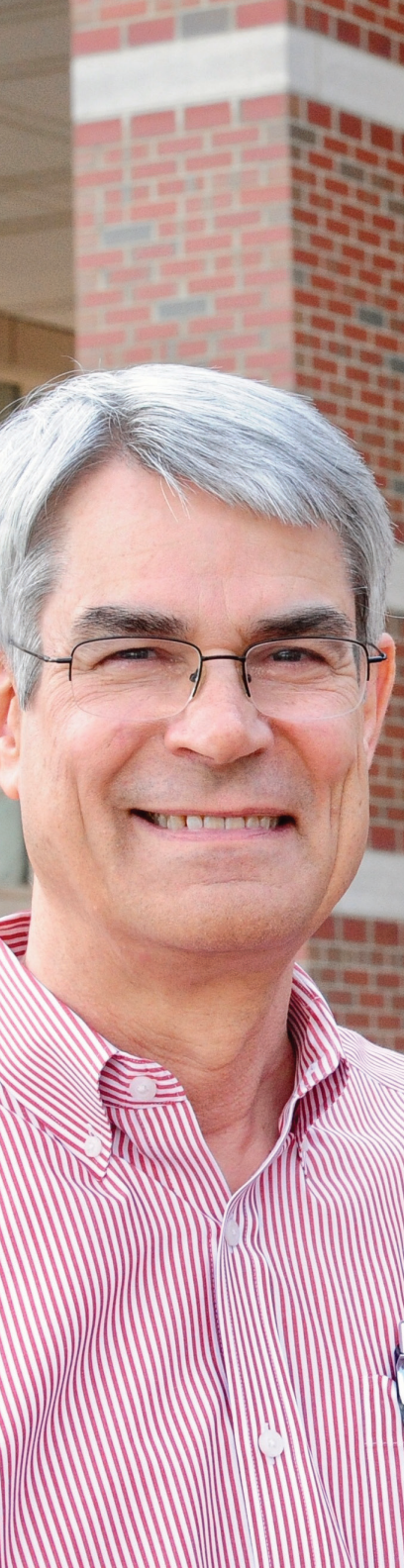
FROM ELECTRIC TO COMPUTER

A History of Electrical and Computer Engineering at NC State



FROM ELECTRIC TO COMPUTER

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When 1917 arrived, it was a very eventful year, with Albert Einstein publishing his first paper on the theory of relativity; the United States entering World War I; and a growing academic department at North Carolina State College separating from Physics to stand on its own as the Department of Electrical Engineering.

Throughout the last century, our Department has continuously prepared outstanding engineers to contribute to the state, the country, and the world. If you have been a part of our Department, I hope you feel a kinship with our first Department Head Professor Browne, his students, and thousands of others who are part of the NC State ECE family. If you are a friend or colleague who has supported us and contributed to our success, we are deeply grateful. I hope we can work together to enhance your success as well.

This booklet presents highlights from the story of how the Department has grown from a small regional program to one of international prominence and impact. I hope you will enjoy it, and I'm excited about what the next 100 years will bring!

A handwritten signature in black ink that reads "Dan Stancil".

Dr. Daniel D. Stancil

Department Head

Electrical and Computer Engineering
North Carolina State University

“Its general purpose is to so teach the principles and application of the sciences, illustrating sound theory by daily practice, as to make out of its students useful and successful men, instead of mere intelligent drones.”

First Annual Catalogue of the North Carolina College of Agriculture and Mechanic Arts, 1890

IN THE BEGINNING

Now home to one of the leading engineering programs in the United States, NC State University started its journey with the Morrill Act of 1862 signed by President Lincoln which created endowments to be used for the establishment of institutions that would provide a “liberal and practical education,” while focusing on the key pursuits of agriculture, mechanical arts, and military tactics. During the Reconstruction period, the North Carolina endowment went to the University of North Carolina located in Chapel Hill. But by the 1880s, there was concern from farmers and young professional North Carolinians that the opportunities offered by the University did not meet the requirements set forth by the Morrill Act.

A group of those progressive young North Carolinians banded together as

1862

Morrill Act creates endowments for establishing new universities.

1872

Leonidas Polk calls for the creation of an agricultural school in a speech at the N.C. State Fair.

the Watauga Club, seeking to bring about the organization of an industrial school in North Carolina. One of the young men in the club destined to rise to leadership positions was Josephus Daniels, who would go on to own *The News & Observer* newspaper, and whose name would grace the longtime home of the Department of Electrical Engineering: Daniels Hall.

The club's efforts were joined by Col. Leonidas Polk, editor of *The Progressive Farmer*, and on March 7, 1887, the state's General Assembly established the North Carolina College of Agriculture and Mechanic Arts, transferring the land-grant endowment to it. Construction began the next year on land donated by R. Stanhope Pullen, with the College opening on October 3, 1889.

When the first course catalog for the College was published that year, it listed in its brief pages a Department of Physics, albeit administered by the Head of the Chemistry Department. The 52 students in that inaugural University class could choose between two curricula — that of agriculture or mechanics. Four years later, alongside topics on battle formations, dairying, and systemic botany, Lieutenant Richard Henderson, U.S. Navy, taught the first electrical engineering course in the Department of Physics—studying electricity and magnetism, including the design of a dynamo and how to

1884

The Watauga Club meets for the first time discussing the creation of an industrial school.

1887

NC General Assembly establishes the North Carolina College of Agriculture and Mechanic Arts.



The campus and grounds of the North Carolina College of Agriculture and Mechanic Arts (1895)

wire a building correctly. Over the following decade, the field of engineering began to take shape as a distinct curriculum within the young university, with electrical engineering remaining a mainstay of that study.

By 1908, the Department of Physics and Electrical Engineering was somewhat established – occupying an office, a laboratory, and a storeroom in the recesses of the Holladay Hall basement, with additional space in the old power house on campus. Notably absent was a classroom, resulting in the need for professors to scour the campus for available classrooms when required.

In 1910, the Department relocated to a newly-constructed building—Winston Hall—which housed the electrical instruction, while the physics instruction remained in Holladay Hall.

1893

First Electrical Course taught at NC A&M by Lt. Henderson, USN.

1895

Authorization is granted to bestow the degree of Master of Science in Electrical Engineering.

WILLIAM BROWNE

William H. Browne, Jr., who had joined in 1908 as the head of the Department of Physics and Electrical Engineering, along with his assistant and one other professor constituted the entirety of the department. With enrollment growing by leaps and bounds, by 1913 they had added a professor of physics to the roster, and would add several more over the next few years—growing to a staff of 22 by mid-century. In addition, the physics component of the department had begun to grow in size and distinction from the engineering aspect, and in his report to University President W. C. Riddick in 1916, he stressed that “It seems not only desirable but proper to recognize the work by establishing a full Department of Physics. I urge that this be done.”

By the start of the fall semester of 1917, Physics and Electrical Engineering were each their own unique departments, with Browne continuing to lead the Department of Electrical Engineering.

An enigmatic gentleman, Professor Browne was instrumental not only in the growth of the department, but also in educating the populace of North Carolina about the opportunities that electrical engineering was beginning

1900

Electrical Engineering is its own separate curricula from civil and mechanical engineering, and a Bachelor's degree is offered.

1908

William H. Browne, Jr. joins the University as department head.



William Hand Browne (c.1920)

to provide, including the radio and alternating current.

Browne, who walked to the College daily from the house he built in 1915 several blocks north of what is now the Memorial Bell Tower, was a victim of the already-increasing urban development of Raleigh when a developer sought to extend Browne's driveway west to Brooks Avenue to pave the way for new housing. The city, eager to honor Browne, desired to bestow his name on this new avenue. Ever unassuming, he was less enthused by the idea, resulting in a

compromise proposed by his wife: "Why not call it after your beard?" And thus, Professor Browne gave the name to Van Dyke Avenue.

1917

The Department of Electrical Engineering is separated from Physics, with Prof. Browne as its head.

1917

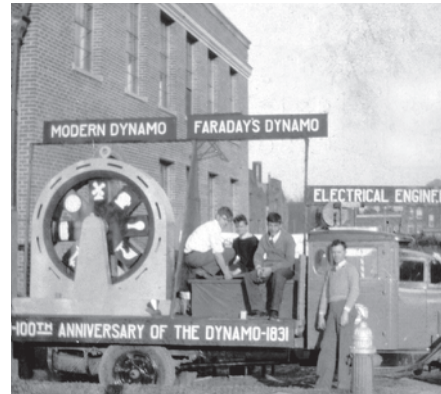
The College name changes to the North Carolina State College of Agriculture and Engineering.

CONSOLIDATION

Despite Physics being allocated its own department, the rapid post-war growth and interest in electrical engineering outpaced the ability to house the growing numbers of electrical engineers in Winston Hall.

Come 1925, a new building was planned, and the Electrical Engineering and Physics Departments once again came together under the same roof, eventually joined by Architectural Engineering who fittingly added two floors to what was named Daniels Hall.

There were definite ups-and-downs for the fledgling department and University through the 1930s. As reported in the January 8th, 1930 edition of the *New York Herald Tribune*, "Professor Browne's class in electrical engineering averaged 12^{1/2} percent in an examination." The result of which was a disappointed note that he tacked to his door that closed stating that, "It would be wise not to bother me for the rest of the week, which I must



A student demonstration of Faraday's Dynamo used at the Engineer's Fair (1931)

1921

Lucille Thomson became the first woman ever to enroll at the University – she studies electrical engineering.

pass in humiliation and prayer.” However, maintaining the competitive nature of the Wolfpack, he later defended his 12½ percent students by offering to stack them up against any other 87½ percent students from any other school in the country.

Through the first half of the 1930s, the future of the department and the now-named North Carolina State College was in question, as the state looked to reduce the duplication of instruction in the now-consolidated University of North Carolina, that would include NC State College. The state’s Consolidation Commission proposed that business and engineering be moved to Chapel Hill, then convert the Raleigh campus into a two-year institution. In a close vote, the University’s commission opted to keep all technical education at State College, resulting in the Department of Electrical Engineering at UNC Chapel Hill moving to Raleigh in 1938, further increasing the size of the department. This affirmation of the status and role of engineering at State College set the pace for the ensuing decades. Electrical engineering became firmly ensconced in the School of Engineering, becoming accredited two years later, and at the same time becoming host to the newest student chapter of the Eta Kappa Nu (HKN) honor society.

1923

The School of Engineering was formed, consisting of the Departments of Electrical Engineering, Civil Engineering, Physics, Textile Engineering, and Mechanical Engineering.

1926

Daniels Hall is built, becoming the long-term home for Electrical Engineering.

POSTWAR GROWTH

The Department saw steady growth well into the second half of the century, with doctoral programs added to the School of Engineering in 1949; the first Ph.D. graduate being from Electrical Engineering in 1953. Prior to the Second World War, there had been but eight Masters degrees in Electrical Engineering awarded, but from 1950 onwards, that too increased rapidly.

By the early 1960s, Electrical Engineering had surpassed Mechanical Engineering to become the largest department on campus in terms of enrollment. In addition, there was a growing need for a graduate program that prepared students to do high-level design and application engineering rather than research. To address this, a non-thesis Master of Electrical Engineering program was proposed in late 1961 by Dr. George B. Hoadley, then department head, and approved for use on March 1, 1963, by the Board of Higher Education.

In the department's early years, research and the graduate program were focused on electric circuits, power, and electromagnetic fields. However, beginning around 1965, there was a shift in emphasis towards modern

1936

The Electrical Engineering curricula is accredited by the Engineers' Council for Professional Development, now ABET.

1938

Engineering instruction is consolidated from UNC Chapel Hill to NC State College, including Electrical Engineering.

electronics—including solid-state materials and devices—and communications. With that growing shift in research focus also came the growing importance of computer systems, resulting in a degree option in computer engineering being adopted in 1976, and implemented in 1978.

The importance of computer engineering continued to grow, and in 1981, proposals were put forward in the department to change the name to better reflect the new focus of its teaching and research. This culminated in the spring of 1983 with the name of the department finally changing to Electrical and Computer Engineering (ECE).



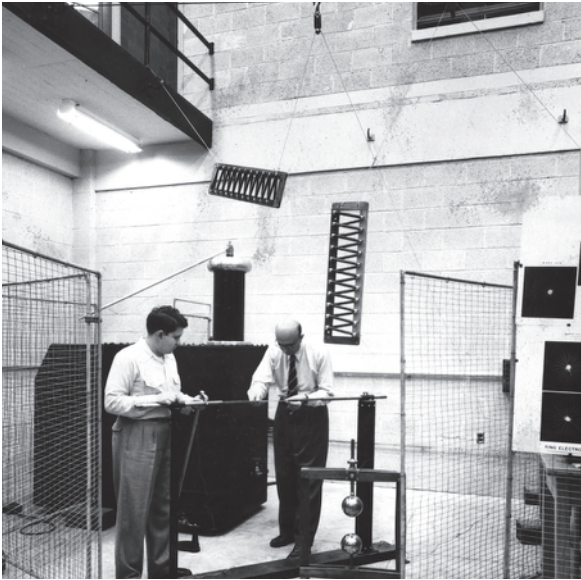
Examining light writing Electrical sign outside Daniels Hall, designed and built by engineering students Bill Wagner and Larry Monteith (1960)

1949

Authorization is granted to bestow the degree of Doctor of Philosophy in Electrical Engineering, with the first degree given in 1953.

1953

The first African-American graduate students enroll at State College, including Robert L. Clemons in Electrical Engineering (Professional Degree in EE 1957).



Dr. Wilhelm F. Gauster (right) performing a rod-gap experiment in the High Voltage Laboratory in Daniels Hall (c. 1950)

RESEARCH CENTRAL

While practical research had always been a desired component in the department, the teaching loads for faculty were high well into the 1980s. Desiring to improve the ability to shape the fields of electrical and computer engineering, Dr. J. Benjamin O'Neal established the first research center in the department in 1981. The Center for Communications and

Signal Processing, sponsored by the National Science Foundation, began an ongoing pattern of cutting-edge research in the department.

1960

Irwin Holmes is the first African American to receive an undergraduate degree from NC State, when he received a bachelor's degree in Electrical Engineering.

1963

The Board of Higher Education in North Carolina approves a non-thesis Master of Electrical Engineering degree at NC State College.

But some of this research would soon be threatened by a national tragedy. Dr. Jimmie J. Wortman's team at NC State, along with the Research Triangle Institute, fabricated 500 space debris detectors (solid state electrical sensors) that were mounted on the surface of the Long Duration Exposure Facility (LDEF), a satellite that was placed into orbit in 1984 by the space shuttle Challenger. Their research was aimed at determining the damage caused by meteoroids and space debris on spacecraft walls. The team expected to record over 500 collisions per day. These detectors would then be returned to NC State's labs after the planned 11-month deployment for analysis. However, the return of the experiment by



Student Debbie Ogden with her textile paint system on a Adage AGT-30 computer (1973)

1978

An degree option in Computer Engineering is approved by the department's faculty in 1976, with the program being implemented in 1978.

1979

Dr. Sarah A. Rajala joins the Electrical Engineering faculty and became the first female Ph.D. faculty member to join the College of Engineering.



Dr. Jimmie J. Wortman (c.1980)

Challenger was indefinitely postponed following unexpected delays, and then the untimely destruction of the space shuttle on January 28, 1986. Facing the approaching loss of the satellite, it was retrieved by the space shuttle Columbia in January 1990, five years later than planned. At the time, this was the heaviest payload returned from orbit, and provided invaluable data collected during its 32,422 Earth orbits that has influenced spacecraft material design to this day.

The department's leadership in both renewable energy and health technology were subjects of its early—and persisting—foci. Dr. Salah Bedair helped pioneer the tandem solar cell in 1980. This was the first realization of the multifunction solar cell, which with high-efficiency in a small footprint, made it ideal for cutting-edge applications on earth and in space, and its

1981

The NSF Center for Communications and Signal Processing (CCSP) is established, led by Dr. J. Benjamin O'Neal.

1983

With the influence of the modern computer, the name is changed to the Department of Electrical and Computer Engineering.

derivatives remain amongst the most efficient solar technology today.

When modern doctors are able to take an X-ray image of a patient and pull up that image on a screen for diagnosis, it is in part thanks to the work of Dr. Arne A. Nilsson's team, which helped pioneer the digitization and image processing of the modern X-ray in 1988. They designed a system where the X-ray image is exposed on a phosphorus plate, then transferred by scanner to disk. That image could then be manipulated to accentuate different aspects, cutting down on the number of X-rays and exposure to radiation a patient receives.



Dr. Arne A. Nilsson (c. 1980)

1985

The Electric Power Systems Research Center was established in July, with Dr. John J. Grainger as its director.

1989

In desperate need of space, ECE's Advanced Electronic Materials Processing (AEMP) Center obtains space in the newly constructed Research I facility on Centennial Campus.



Doctoral candidate Robert J. Moorhead, II at a CALMA station used in the layout of solid state integrated circuit chips (c.1980)

TOWARDS THE NEW CENTURY

The late 1980s and 1990s continued the growing research strength of the department, with much of that success stemming from the half-dozen research centers launched since 1981. In perspective, by the end of the century, there was a 1380% increase in research expenditures since 1980.

The 1988 founding of the Center for Advanced Electronic Material Processing marked NC State as one of the first recipients of a National Science Foundation Engineering Research Center (ERC) program grant, the first of three ERCs the department would host.

Along with the growing research came increased recognition for the department's faculty. Up until 1980, ten faculty members had been

1992

The Power Semiconductor Research Center is established by Dr. B. Jayant Baliga.

recognized as IEEE Fellows. This number would more than quadruple over the next three decades, with numerous other recognitions for the prestigious faculty serving to cement the department's ongoing reputation for excellence. The Department maintained a focus on generating research to be used by industry, exemplified in 1999 when the Memorial Bell Tower was lit red in honor of the 100th patent issued to Dr. B. Jayant Baliga, who had joined the department a decade previous.



Students looking at a electric converted Pontiac Fiero on the brickyard (1991)

There was also an effort to ensure that students were exposed to the practical experience of working in the field they were studying, seeking to prepare them to join the workforce upon graduation. The addition of a senior-level design course in 1992 as part of the undergraduate curriculum set the groundwork for an ongoing tradition of innovation from undergraduate

1992

A senior-level design course is implemented as part of the Bachelor's degree requirements.

1992

The Center for Robotics and Intelligent Machines was established by Dr. Ren Luo.



Dean Larry K. Monteith presenting Distinguished Engineering Alumnus Award to William F. Troxler (1985)

scholars, with projects in subsequent years ranging from elephant-tracking sensors to obstacle avoidance sensors for vehicles to renewable-energy analytics for the power grid. This would see additional growth the following year when Dr. Thomas K. Miller III founded the Engineering Entrepreneurs Program (EEP), taking the student projects even further, urging product development to create fully-marketable products led by interdisciplinary teams.

The Senior Design program received a major boost at the end of 1997 with the opening of the William F. Troxler Design Center in Daniels Hall, providing state-of-the-art 24-hour laboratory space and equipment for students to work with for their design projects. "As a student in engineering at NC State in the early 1950s, I worked on my design projects on my small kitchen table," Troxler (BS EE 1952) explained. "I am proud of my degree from NC State and have wanted to somehow continue my involvement with the University...this design laboratory

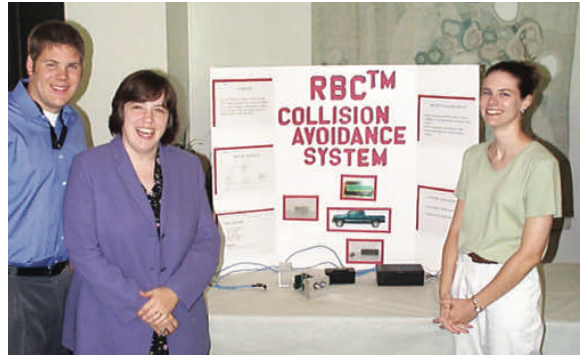
1995

The Center for Advanced Computing and Communications (CACC) formed from the former CCSP.

1997

Located in Daniels Hall, the William F. Troxler Design Center opens in December.

seemed to be the best way to show my appreciation for the education I received from this great institution.” Troxler’s gift—the first time in the College of Engineering’s history that an entire facility renovation was funded by an individual—gave a much-needed boost to ongoing facility challenges the department was facing.



Seniors at Design Day presenting their collision avoidance system (2000)

BUILDING A FUTURE

Many of the faculty’s accomplishments were all the more impressive given the ongoing physical constraints the department was continuing to face. From the 1920s onwards, the repeated concern expressed by department heads was about the lack of space with which to work, and

1997

Engineering Graduate Research Center’s construction completes the previous year, and opens along with Partners I on Centennial Campus.



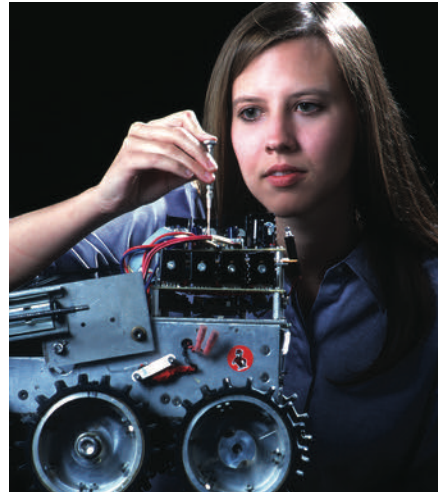
Engineering Graduate Research Center under Construction (1994)

despite repeated renovations to Daniels Hall, that space constraint continued. The growth of the department's activities had resulted in classes and research centers scattered all around the campus. The need for space was so great that there was even an attempt to convert a restroom into lab space—an effort stymied due to pending accessibility legislation and a

university freeze on reducing restroom facilities.

The University, under the leadership of Chancellor Larry K. Monteith, NC State alumnus (BS EE 1960) and former department head of ECE, was seeking to expand south to what would become Centennial Campus, on 355 acres of land from the former Dorothea Dix Hospital. Eager to take advantage of the availability of space, planning began in 1987 for an Engineering Graduate Research Center (EGRC) on the new campus. However, it was not until 1994 that the building was approved by the State Legislature and construction began. Opening in 1997 with ECE as its main occupant, the EGRC would later be named in honor of the former Chancellor – becoming the Monteith Research Center (MRC) in 2005.

While groundbreaking research would continue to make headlines, another groundbreaking occurred in 2003 on the growing Centennial Campus, with Engineering Building II (EB2) opening two years later as the new home for the department, marking the end of almost seven decades in Daniels Hall. This new facility would serve to modernize the lab, office, and teaching space used by ECE, and would consolidate its presence on Centennial Campus, with usage spread between EB2, MRC, and the Keystone Science Center. Much like Daniels Hall, the space in EB2 would continue to evolve to better serve the students and faculty. Through generous donations from Dr. Robert Kolbas and Dr. Robbie Troxler (BS EE 1983 and son of William F. Troxler), the department was able to open a set of MakerSpaces, dedicated to providing new fabrication and electronic creation capabilities to students, significantly bolstering their ability to engage in hands-on learning.



Undergraduate student Amanda England working on her Team HELIOS' robot (named Thumper) for a NASA lunar station competition that they would win (1998)

2003

Ground is broken on Engineering Building II and it opens two years later, with ECE moving out of Daniels Hall to Centennial Campus.



FREEDM's High Bay Laboratory in Keystone Science Center
(2014)

AND BEYOND

The twenty-first century saw momentous changes to the department from the outset. The emphasis on cutting-edge research persisted, seeing the addition of nine research centers, and giving the department the honor of being one of only two departments in the country to host two concurrent NSF Engineering Research Centers—the

Future Renewable Electric Energy Delivery and Management System (FREEDM) and the Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST). These high-profile centers would be joined by the \$140,000,000 PowerAmerica Institute, jointly funded by the U.S. Department of Energy and industry and unveiled at NC State by President Barack Obama in 2014. Much like the last two decades of the twentieth century saw a massive increase in research expenditures, so did the first

2008

The NSF ERC Future Renewable Electric Energy Delivery and Management Systems (FREEDM) is founded.

2010

A Renewable Energy (REES) undergraduate concentration and graduate certificate is implemented.

two of the twenty-first, with those increasing 275% to almost \$41 million per year by 2016.

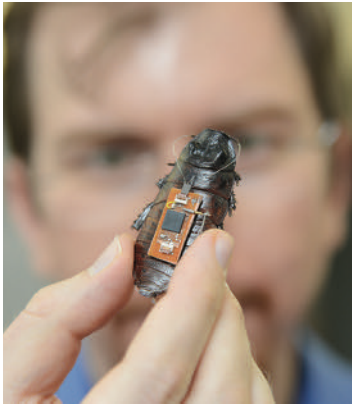
The wide variety of research projects coming out of the department continued, ranging from semiconductors to electric vehicles, and from securing the power grid to treating Parkinson's Disease. With over 25 million people blind due to retinal damage, the positive impact that could be done through engineering was broad. The work done by Dr. Gianluca Lazzi at NC State in 2004 would set the groundwork for perfected artificial retinas, starting with a tiny camera on a pair of glasses that sends signals to a device attached to a retinal implant. After three years of research, Dr. Michael Steer earned the US Army's Commander's Award in 2010 for work saving numerous lives. He developed a technology that allows soldiers to identify improvised explosive devices (IEDs) from a distance, by using electromagnetic energy to illuminate cell phones—often used as IED detonators—and measuring their responses. A fellow professor, Dr. Alper Bozkurt would be featured in *Popular Science* for his research on technologies to assist in search-and-rescue—developing a technique to control both cockroaches and dogs through harnesses fitted with sensors, aiming to fuse biological organisms with synthetic electronic systems.

2012

The NSF Nanosystems ERC for Advanced Self Powered Systems of Integrated Sensors and Technologies (ASSIST) is formed.

2015

The PowerAmerica Institute is unveiled by President Obama, with funding from the U.S. Department of Energy.



Dr. Alper Bozkurt demonstrating one of his sensor-equipped cybercockroaches (2012)

Over its history, the department's focus has ranged from providing instruction to future power engineers and bringing electrical tools to the farming communities of North Carolina, to helping lead the charge into space and a better power grid, pioneering digital systems, medical electronics, renewable energy, and cutting-edge semiconductors.

After over a century of pushing the envelope of electrical and computer engineering, the Department continued as a vital element of the University and the state. It started with its earliest classes taught by a naval officer at a fledgling university, and grew to a department with international renown, almost 1900 students enrolled, and an elite faculty recognized at the highest levels. The department's journey has been filled with an unwavering urge to prepare young engineers to succeed and solve the problems of today and tomorrow while doing some of the coolest things possible.

2016

Thanks to generous endowments the Department unveiled two makerspaces providing new fabrication and electronic testing capabilities.

2017

The Department marks the 100th Anniversary of its founding with celebrations through 2018.

DEPARTMENT HEADS

1908-1944	William H. Browne, Jr.	1988-1993	Tildon H. Glisson
1944-1945	Raymond S. Fouraker (<i>acting</i>)	1993-1995	John R. Hauser (<i>acting</i>)
1945-1954	Cornelius G. Brennecke	1995-2000	Robert M. Kolbas
1954-1974	George B. Hoadley	2000-2003	John J. Grainger (<i>acting</i>)
1974-1978	Larry K. Monteith	2003-2008	Robert J. Trew
1978-1979	James F. Kauffman (<i>acting</i>)	2008-2009	Robert M. Kolbas (<i>acting</i>)
1979-1988	Nino A. Masnari	2009-	Daniel D. Stancil

RESEARCH CENTERS

1981	Center for Communications and Signal Processing (NSF IUCRC)
1982	Microelectronics Center of North Carolina
1985	Electrical Power Research Center (NSF IUCRC)
1988	Advanced Electronic Materials Processing (NSF ERC)
1992	Power Semiconductor Research Center
1992	Center for Robotics and Intelligent Machines
1995	Center for Advanced Computing and Communications
2003	Center for Efficient, Secure and Reliable Computing
2005	Semiconductor Power Electronics Center
2008	Advanced Transportation Energy Center
2008	Future Renewable Electric Energy Delivery and Management Systems (NSF ERC)
2009	Institute for Next Generation IT Systems
2012	Advanced Self-Powered Systems of Integrated Sensors and Technologies (NSF ERC)
2014	PowerAmerica Institute (DOE)
2014	Center for Advanced Power Engineering Research
2016	Center for Advanced Electronics through Machine Learning (NSF IUCRC)



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Electrical & Computer Engineering

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