Seeding the

30 YEARS OF THE WILLIAM R. KENAN, JR. INSTITUTE FOR ENGINEERING, TECHNOLOGY AND SCIENCE





Inside



A Shared Vision



Research Innovation and Collab



Technology, Entrepreneurship,



Strengthening Classrooms



Public Engagement



Challenges for the Future

boration	16
Commercialization	32
	54
	66
	78

4

As we reflect on the 30-year history of KIETS, we can be extremely pleased by how well our academic and industry partners, inside and outside NC State, have been able to use and leverage the seed funding we have provided.

They have developed research and educational programs, started new companies, and reached out to an array of external stakeholders for the benefit of tens of thousands of individuals worldwide. We are deeply indebted to Frank Hawkins Kenan for his vision and wisdom in establishing KIETS and to the Kenan family for its steadfast support of all our efforts. I personally thank the board of directors of the Kenan Fund and the board of trustees of KIETS for allowing us the flexibility to try out new ideas and take on innovative and sometimes risky projects that take time to incubate and mature.

I am also profoundly grateful to NC State's administration. Every chancellor who has chaired the KIETS Board of Trustees over these 30 years has given us the freedom to experiment and the ability to work with other groups outside the university. In a real sense, the university is our best partner. We have learned to follow their lead in many ventures, and in some cases, the university has adopted our practices and methods for enhancing innovation and collaboration. This strategy has served us well and puts us in a great position to rely on our generous partners in industry, business, and government as we look forward to our work over the next 30 years.

From a very personal perspective, my ability to serve as KIETS Director since 1999 has greatly enriched my academic career, and indeed my life, by enabling me to reach out and work with dedicated individuals and groups that I would not have met on a normal academic path. I have learned a lot from the experience, and I like to think it has made me a better man.

This university always keeps its focus on serving the people of North Carolina. We are proud to be a land grant university. The spirit of service is embedded in our culture and in our DNA. KIETS is honored to share this vision, and we are glad to be a part of this grand effort to serve our communities statewide.

Frank Hawkins Kenan understood the University's chemistry. He saw that NC State was the perfect spot to begin seeding the future, investing in the talent of faculty and students on the fuzzy edge of discovery and innovation, so they could use "science, engineering and technology as a force for improving the economic and social well-being of the nation and the world."

We are often asked what we have learned in 30 years of applying this "venture philanthropy" approach to fund new academic ventures. Here are some reflections, based on both our successes and our failures.

- A little goes a long way over time.
- We trust our project partners and give projects freedom to develop without imposing administrative requirements and burdens.
- Strong leadership, an expansive vision, and deep passion are all keys to success for any new venture.
- We are comfortable taking risks with ideas that could fail.
- We keep our eyes on global trends, and look for local talent and strength to help address future challenges.
- We recognize that innovation must start in the K-12 classroom. If we invest in the best teacher leaders in North Carolina, they will help others innovate and take risks.
- We strive to help university faculty and students to navigate and get more comfortable with the entrepreneurial side of invention and innovation.
- We believe in funding the development of ideas for the curriculum, the research lab, and the marketplace.
- We favor problem-solving approaches that encompass the expertise and experience of communities wrestling with challenges to help guide the work of the researchers and academics. We do not fix; we assess and collaborate.

Through these efforts we have played a key role in changing the culture of the university over these 30 years, by working across silos, valuing diverse perspectives, and by being inclusive and collaborative.

RUBEN CARBONELL Director Kenan Institute for Engineering, Technology and Science November 1, 2022



A Shared Vision

A NEW MODEL OF ACADEMIC VENTURE PHILANTHROPY

What were the developments in engineering, technology, and science that were making headlines thirty years ago? Remarkably, 1992 was the year that the World Wide Web first

became accessible to the public. The company America Online had only begun to offer individual email accounts, while Mosaic--the first user-friendly Internet browser-gave Windows and Macintosh computer owners a way to point, click, and connect to the first primitive websites.

That same year, NC State University launched The William R. Kenan, Jr. Institute for Engineering, Technology and Science (KIETS). This innovative collaboration among partners in industry, government, and academia, now 30 years old, was the brainchild of North Carolina business leader and philanthropist Frank Hawkins Kenan (1912-1996). Kenan wanted to accelerate the generation of intellectual property, new and improved products, and novel manufacturing techniques, all developed in North Carolina. It was a form of "venture philanthropy" rarely seen at the time.

Based on his entrepreneurial experience, Kenan believed that issuing small challenge grants to various projects and programs would encourage matching

KIETS MISSION

To develop

partnerships in basic research, education, commercialization, and public outreach with individuals and organizations dedicated to the advancement of science, engineering, and technology as a force in improving the economic and social well-being of the nation and the world.



gifts and leverage other donors' dollars. The projects he envisioned would likely begin in an NC State research lab, could be evaluated by a team of commercialization experts in the business school, patented by the university, and carried to market by private entrepreneurs. This practice of seeding high-risk, high-reward ventures was at the heart of Kenan's vision and remains in practice today.



Frank Hawkins Kenan, a 1935 graduate of UNC-Chapel Hill, purchased Tops Petroleum, which expanded to become Kenan Transport, at one time the largest transportation company in the Southeast. Kenan also worked in land development and was among the original directors of the Research Triangle Park. In the 1970s, he became CEO of Flagler System, Inc., the Palm Beach-based resort property management company that has been in his family since 1896.

Dick Daugherty, who served for nearly three decades as vice president and general manager of IBM's research facility in North Carolina's Research Triangle Park, agreed to serve on the KIETS board from its inception. Daugherty remembers Frank Kenan's promise at the launch: "Everything we do is going to be first class, and I want

it to be correct, ethical." Kenan said. "I want it to be leading edge. I want to take risks." Daugherty adds, "I think that set the tone for what we are still doing 30 years later."



Dan Drake

Dan Drake was JP Morgan's representative to the William R. Kenan, Jr. Charitable Trust and was involved on the ground floor in the creation of both KIETS and the Kenan Institute for the Arts. "Frank Kenan," Drake says, "was very collegial and pleasant. He was highly intelligent, and he and his wife Betty were fun to be around. But Frank also had some very definite ideas about what he thought was right, and where he thought society should be going. When he proposed these two new institutes and the funds to back them up, he really did have a sense of what was important in the world."

Kenan had already established the Kenan Institute of Private Enterprise in 1985 at the University of North Carolina in Chapel Hill. Next, he wanted to create separate philanthropic vehicles for the sciences and the arts. Along with his son, Thomas S. Kenan III, Frank saw the arts

as a complement to science. Dan Drake explained: "The arts and science fit together and played a role in Frank's basic thesis that it was up to the private sector and to academia and government to work together to get things done." The Kenan Institute for Engineering, Technology, and Science at NC State and The Thomas S. Kenan III Institute for the Arts were set up and running within a year.

RIGHT PLACE, RIGHT TIME, RIGHT PEOPLE

rank Kenan persuaded the trustees of the William R. Kenan, Jr. Charitable Trust to invest \$20 million in the new William R. Kenan, Jr. Fund for

Engineering, Technology, and Science, to be chaired by Dan Drake. The annual proceeds from the invested principal would provide the seed funding for innovative projects. The Institute would be headquartered at NC State, the largest land grant university in North Carolina. Hal Hopfenberg, a distinguished NC State professor of chemical and biomolecular engineering, was selected as the first KIETS director.

NC State alumnus William C. Friday, by then the Executive Director of the William R. Kenan, Jr. Charitable Trust, would champion all four of the Kenan Institutes that were established over the decade from 1985 to 1995. Friday, who had retired from his unparalleled 30-year tenure as president of North Carolina's University System, knew North Carolina like no one



Hal Hopfenberg

nimble consensus builder.

As Hal Hopfenberg explains, "Friday was able to inspire the confidence and participation of an initial KIETS Board that included a Nobel laureate and an impressive list of CEOs, all NC State alumni. Mr. Friday could pick up the phone and in that wonderful voice of his, say 'Hello old friend, how are you?' and by the end of the call, these corporate giants would have said yes!"

The first KIETS board of directors

Dick Daugherty

else-its strengths and its challenges. He had forged sturdy relationships across the state and understood the ingredients required for academic inquiry to flourish. During his years at the helm of the state's university system, Friday had been a

included IBM executive Dick Daugherty and the presidents of DuPont, AT&T/ Bell Labs, Kimley-Horn Associates, Unifi Corporation, and Central Carolina Bank. "To have a board of this distinction at the start made

THE KENAN **INSTITUTES**

The Frank Hawkins Kenan Institute of Private Enterprise at UNC Kenan-Flagler **Business School** (est. 1985)

The William R. Kenan, Jr. Institute for Engineering, Technology and Science at NC State (est. 1992)

The Thomas S. Kenan Institute for the Arts at UNC School of the Arts (est. 1993)

The Kenan Institute for Ethics at Duke University (est. 1999)



Thomas S. Kenan III



From left to right: Bill Friday, Frank Kenan, Larry Monteith, and C.D. Spangler.

the rest of it pretty easy," Hopfenberg says. "These were the leaders of not just NC State. They were national leaders." Frank Kenan also knew that KIETS's long-term success would depend on the institutional buy-in of NC State's senior leadership. "It was great wisdom that the bylaws of the Institute required the



Larry Montieth

chancellor of NC State to serve as ex officio chairman of the board," says Hopfenberg.

Larry Monteith was NC State's chancellor in 1992. His long career-first as an NC State undergraduate, faculty member, dean of electrical engineering, and finally chancellor of the university-had made him the seasoned leader needed at a time of accelerating growth for NC State. Monteith, a plain-spoken man whose calm demeanor and disciplined optimism carried him through periods of turmoil on campus, became a staunch supporter of KIETS.

Monteith also shepherded the sometimescontroversial development of Centennial Campus, already under construction in 1992. This research and educational hub created a physical partnership between the university and the private sector and would host a range of corporate tenants and small business startups. Eventually, Centennial Campus became the new home for the College of Textiles, the College of Engineering, and the innovative James B. Hunt Library, where KIETS is housed today. It was also the motivation for the establishment of the Centennial Biomedical Campus on the grounds of the College of Veterinary Medicine.

After his retirement, Larry Monteith continued to tout the value of venture philanthropy as he had seen it practiced through KIETS. He promoted the idea that local communities and other universities in the state needed to stimulate business startups with their own venture funds. Monteith still believes that public/private partnerships are essential to North Carolina's future health and prosperity.

COLLABORATION, **INNOVATION, RESULTS**

o, what happens when visionary philanthropy connects brilliant scientists and engineers with entrepreneurs--all working toward a mission to improve lives, foster economic growth, and meet intractable social challenges? Thirty years later, the \$20 million dollar Kenan Fund for Engineering, Technology and Science provides approximately \$1.5 million per year for the Institute's modest operations and enables the board to make some 25 to 30 investments in promising projects every year. "We don't really keep the proceeds of the fund, so it is not venture capital," says KIETS's current director Ruben Carbonell, who succeeded Hal Hopfenberg in 1999. "It is venture philanthropy, and by most accounts, it's not a lot of money that we have to invest each year, but these funds are able to generate a significant return on investment, as measured by the success of the grantees." The average support that KIETS provides is \$35,000, though the operation has invested as little as \$1,000 and as much as \$200,000 in a single project during the first 30 years.

KIETS does not solicit grantees nor issue requests for proposals. "The funds we allocate are gifts without strings or overhead," Carbonell says. "Those who receive funds from us don't have to spend the grant within a specified period, and we give them great flexibility to pursue all avenues to their success."



Biopharmaceuticals (NIIMBL), and is a Training and Education Center (BTEC)

KIETS's first director, Hal Hopfenberg, set an important precedent. "We do our own talent search for projects," he says, "and that's worked out beautifully." Throughout a project's term, the KIETS team is ready and available to provide technical assistance, additional contacts with experts, or help to identify other potential partners and funders. "I think people understand that it is leadership with a light touch," Hopfenberg adds. Regular oversight of the entire enterprise comes with twice yearly meetings of the boards of the Kenan Fund and KIETS. Says Hopfenberg, "They ask 'what is your budget, what's the actual, what's the difference?' It's all done with great discipline, which keeps the director and staff motivated."

Ruben Carbonell is the Frank Hawkins Kenan Distinguished Professor of Chemical and Biomolecular Engineering. He also serves as Senior Technology Strategist to the National Institute for Innovation in Manufacturing Distinguished Fellow of the Biomanufacturing

Hopfenberg also says his long experience

with NC State's Chemical Engineering Department helped to set the tone and culture of KIETS from the beginning. "Back when I began my career at NC State in 1967," he says, "we did not have a great research portfolio in the department, but we had mutual respect. That sense of collegiality in Chemical Engineering has been maintained even as it has become a very competitive



Raj Narayan is KIETS Associate Director. A licensed attorney, he specializes in technology commercialization and is a Professor of the Practice of Entrepreneurship, an NC State ICorps Program Instructor, and Mentor to TEC Program teams and Social Innovation Fellows. He is a Marshall Fellow, Eisenhower Fellow, and William C. Friday Fellow and chairs the UNC School of Law Institute for Innovation Board of Advisers.

NC State, researchers jockeying for laboratory space, for money, for resources, and for students. Maintaining collegiality, however, has been important to everything we do in the Kenan Institute." From the earliest

group of superstars at

days of the Institute, Ruben Carbonell, also a faculty member in chemical engineering, worked closely with Hal Hopfenberg to establish the consistent values, norms, and practices that KIETS has maintained over its three decades. Appointed director in 1999 after

Hopfenberg retired, Carbonell recognizes his work at KIETS as a service to the university in addition to his other duties and appointments at NC State. These other roles help Carbonell connect with researchers and graduate and undergraduate programs across the campus, as well as with industry, government and nonprofit partners across

the state, the nation, and the world.

In addition to KIETS's mandate to engage in innovations that will benefit the public, the Institute insists on collaboration among the partners, and works hard to leverage multiple financial resources for the various projects. KIETS has also developed a strong ethos of shared power, both internally with staff and externally with its multiple project partners.

The organization takes a multidisciplinary approach. Raj Narayan, the associate director of KIETS and professor of the practice of entrepreneurship, explains: "Interdisciplinary work is key to all that we do. We don't operate in silos. We work



Cordella Rashid is KIETS Assistant Director for Grants and Finance. She oversees the budgets, contracts and grants needs of the Kenan Fellows Program and Climate Leaders Program. She guides proposal budget development, oversight of sponsored research efforts for federal, state and foundation grants and contracts, and human resources administration for KIETS. She also represents the Kenan Institute and Chancellor's Unit on the NC State Staff Senate.

across disciplines, integrating expertise in ways that connect research to education to technology commercialization and to public policy and engagement." KIETS regularly interacts with NC State's schools and colleges beyond sciences and engineering, including education, the humanities and social sciences, design, and management.

Although KIETS operates with a modest staff of four, mutual respect is at the heart of the team. Cordella Rashid is assistant director for grants and finance. In her role she regularly provides technical assistance to the program partners in the form of strategic approaches and best budgeting practices to create successful proposals. "Not only are we an incubator of groundbreaking research technology," Rashid says, "but in my time here we have really worked on empowering women and people of color in the field, especially in K-12 education. Respect for diversity and equity have been extremely important within our Institute and on campus. It's one of the major initiatives that we have been charged with--making sure we make business decisions that also take diversity into account."

KIETS program associate Tara Spivey agrees. "The part of our work that I enjoy the most is seeing the end results of our projects. Whether it's students or faculty that we're helping or underserved communities, knowing that a project touched lives in a community is a great reward."

"We believe in cross fertilization," Carbonell adds, "and we have learned how to work together as engineers and scientists with social scientists, business people, and



Tara Spivey is the University Program Associate for KIETS. She provides administrative and programmatic support for all KIETS activities including the Kenan Fellows Program and Climate Leaders Program. She is also the Hunt Library building liaison and guides KIETS IT and technical support needs. In addition to her KIETS role, she helped mentor Social Innovation Fellows and is a William C. Friday Fellow.

educators who all offer input, especially when we have the public and government involved in a project."

Randy Woodson, NC State's current chancellor and ex officio chair of the KIETS Board, suggests that the impact of KIETS derives from "having highly engaged, very visible, and very inquisitive staff. These folks are inherently curious," Woodson says. "They are constantly sniffing around the university looking for emerging trends and new expertise on the faculty. They know the players, and they are the matchmakers, always thinking about how to bring the right people together to understand and solve the challenges our state faces."

NC State University ranks second among all U.S. public universities in research technology transfer and commercialization, according to a comprehensive analysis recently released. NC State also ranks second among universities-public and private-without medical schools, and seventh among all U.S. universities in technology transfer.



NC State Chancellor Randy Woodson

KIETS thus helped to create the template for how NC State now conducts large, game-changing research projects and translates them into on-the-ground results across the state. "KIETS's success in attracting funds from other sources often comes from its insistence and dedication to collaboration," Woodson adds. "This organization has proved its talent for finding the projects that have the potential to become home runs for NC State and for the State of North Carolina."

A RANGE OF PROJECTS

ecause KIETS has operated with little fanfare for 30 years, this anniversary year offers an opportunity to celebrate and share some stories

about the diverse projects and initiatives that have been seeded by the organization. Though Frank Kenan passed away in 1996, his clear-eyed vision and determination to maintain the initial mission of KIETS.

has prevailed. Today, with the guidance of family members Betty Kenan and Tom Kenan, and veteran leaders Dan Drake and Dick Daugherty, and many others, the organization has stretched its work across North Carolina and beyond. The Institute has fostered high tech research and engineering breakthroughs, new technology development and commercialization, professional development for K-12 teachers, public engagement in emerging health and environmental issues critical to the state, and it has brought useful products and processes to the marketplace.

The chapters that follow highlight some of the significant accomplishments of KIETS, specifically:

Research collaboration and innovation

are carried out with partners, including the NC Biotechnology Center, the National Science Foundation, the Golden LEAF Biomanufacturing Training and Education Center (BTEC), the Novo Nordisk Foundation, and many other entities working in such fields as agriculture, bioengineering, genetics, pharmaceuticals, public health, and renewable energy.





New business development comes from KIETS's support and mentoring of students who participate in the **Technology Entrepreneurship and** Commercialization (TEC) Program. Through this platform faculty and students work to identify commercial applications for products and processes that have come out of NC State and U.S. government labs. Program partners then determine potential pathways to commercialization through

startup businesses.







KIETS's education work extends into the classrooms of public school teachers across North Carolina through the Kenan Fellows Program for Teacher Leadership. High achieving teachers selected for this program build their capacity to provide the most current STEM curricula for their students while working with practitioners in industrial labs, research businesses, and agricultural settings to empower teachers within their classrooms. Beyond this flagship program, KIETS has supported museums, camps, and other youth-focused programs that encourage students to examine the possibilities available through careers in science and engineering.





KIETS supports **public engagement** opportunities in science, technology, and engineering topics through media programming and public dialogue on policy issues. This work is carried out through its partnership with the Institute for Emerging Issues headquartered at NC State. More recently, Innovate NC offered seed funding to accelerate entrepreneurial activity across the state through a learning collaborative among select cities.



systems, and sea level rise through partnerships with NC Sea Grant, the Coastal Federation, and NC Land of Water. KIETS's work during the COVID pandemic and in new drug development and manufacturing, have led to the identification of other emerging public health issues requiring a strategic response.

Future challenges to the environment and global health have been given high priority through the KIETS Climate Leaders Program and a variety of projects addressing food safety, energy and water





Research Collaboration and Innovation

IN THE BEGINNING...

When KIETS was chartered in 1992, the seeds of a new economy for North Carolina were just starting to take root. The vitality of tobacco, textiles, and furniture-making had diminished

beyond recognition, and the state's leaders had set their sights on research and technology as keys to future economic growth.

The North Carolina Biotechnology Center (NCBC), established in Research Triangle Park in 1984, was promoting the region's assets in the life sciences, including its major research universities and four medical schools. As the first state-sponsored, public-private partnership in biotechnology in the United States, the Center's formal

mission was to catalyze the development and commercialization of biotechnology by enhancing research, creating new jobs and products, and fostering collaborations across academia, government, and industry. The NC Biotech Center aimed to jumpstart new research projects. They also sought to encourage the recruitment of world-class research faculty at Triangle universities and to secure major lab equipment that could be used by multiple researchers in the region. In

Associate Director).

1997-2017 **COLLABORATIVE FUNDING GRANT PROGRAM BY THE NUMBERS**

114

academic-industry research partnerships funded

9

NC universities represented in the projects

\$1,356,635

in matching funds supplied by company sponsors

\$8,139,079

awarded in total

\$80,000,000

in follow-on funding raised by grantees for each dollar provided jointly by NC Biotech and KIETS

Source: NC Biotechnology Center

1988, according to the Biotech Center's first directory of companies in the field, there were 83 biotech companies in North Carolina employing some 1,300 people. Many of the firms that were established or enlarging their presence in the state back then were global giants, including Glaxo, Organon Teknica, Ciba-Geigy, Roche, BASF, Hoechst Celanese, and Novo Nordisk. Still, there was a long way to go to build a true biotechnology infrastructure in the state. Early on, KIETS's founding director Hal Hopfenberg met with the Biotech Center's director Charles Hamner to discuss how to bring people together to foster biotech collaborations. Then Tom Laundon, who joined the Biotech Center in 1993 as its first Vice President for Economic Development, met with Hal Hopfenberg (then KIETS Director) and Mark Bensen, (KIETS

"We talked about how we needed to find an innovative way for smaller companies to connect with our Triangle universities," Laundon says. A serial life sciences entrepreneur, Laundon has focused his expertise on the development of small- to medium-sized enterprises throughout his career. He believed strongly that biotech startups would be just as important to the future of the life sciences industry in North Carolina as the corporate giants that already had a presence here. In 1996, KIETS and the NCBC established the Collaborative Funding Grant

Program (CFG). "The idea was to support projects that grad students or postdocs could take on to help these smaller companies," Laundon says. The funding came through a three-way match from KIETS, the Biotech Center, and the companies who would benefit from the research. Local universities that were also involved in the research projects made investments in the CFG.

"It went very well," Laundon says. "The researchers made valuable contributions through their work, and this grant program had the highest metrics of any we created. For every dollar put into the program, the measurable return was 60 times the initial investment."



Maria Price Rapoza

Maria Price Rapoza served as Vice President of Science and Technology at the NC Biotech Center from 2002 to 2015. "The Collaborative Funding Grant Program was the longest running partnership that KIETS established with the Center," she says. "Although there are plenty of visible accomplishments, we would be selling the program short if the research dollars were the only measure considered. Lots of behind-the-scenes relationships and trusted partnerships developed. The

landscape is hugely different now than it was in the 1990s," Rapoza adds. She is now Executive Director of the Duke University Cardiovascular Research Center. "Every time I turn around these days, new job announcements are popping up in the life sciences. The visionary team at KIETS laid the groundwork."



Rob Lindberg

Rob Lindberg succeeded Maria Rapoza at the Biotech Center and presided over the final years of the Collaborative Funding Grant Program. From the grantee side of the equation, Lindberg notes: "Many of the company partners were startup companies for which the principal investigator on the grant was the scientific founder of the company. CFG projects were often instrumental in enabling the company to meet key technical milestones such as proof-of-concept or the development of a working prototype—achievements that were necessary to garner additional investments in the company."

"And through it all," adds Tom Laundon, "KIETS always remained open to talking about new ideas, new projects. In the early 90s we really didn't have a biotech ecosystem," he says. "Now I think it's a selfsustaining enterprise. The network KIETS helped to build has been essential." According to the Economic **Development Partnership of North** Carolina, as of 2022, the state is now number one in biomanufacturing in the United States as measured by total employment. It is also number three in pharma manufacturing. Some 730 biotechnology companies are operating in the state. These companies support more than 66,000 employees.

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explosive growth North Carolina's technology industry er the last three decades produced enormous opportunities for students coming out of NC State and other universities. An industry that barely existed thirty years ago in the state now needs a skilled workforce that includes well-trained engineers. biologists, and other research scientists. After NC State's Centennial Campus came online, it became evident that the vision of Chancellor Larry Monteith and others was spot on. The Precision Engineering Center in the Research 1 Building was the first to be occupied on Centennial Campus in 1988, and construction on the Engineering Graduate



Tom Laundon

HANDS-ON LEARNING...

Research Center would follow. The College of Engineering was soon to be surrounded by large and small corporate tenants and startups, many of them engaged in biotechnology research. With a grant of nearly \$39 million from the Golden LEAF Foundation in 2003, NC State was poised to go even further, adding bioprocessing services and training alongside its facilities for education and research.



The 77,000-square-foot Golden LEAF **Biomanufacturing Training and** Education Center (BTEC) opened in 2007, ready to offer students hands-on training and lab experience in biomanufacturing processes and packaging in a sterile environment. KIETS director Ruben Carbonell was also BTEC director from 2008 through 2017. He played a key role in establishing its national and international reputation as a provider of academic and professional development programs and process and analytical services.



Gary Gilleskie

As current director Gary Gilleskie describes it: "Biomanufacturing simply means creating products-for medical or agricultural applications usually-that are derived from the cells of living things. These are not products made through chemical synthesis where you mix chemicals A and B to get C, a drug or substance with very limited active ingredients. The biological agents being produced-medicines, vaccines, diagnostics, enzymes-are manufactured from living organisms such as cells or bacteria. Highly skilled people are needed to design and run these biomanufacturing processes."

The demand for bioprocessing skills will continue growing with the industry in North Carolina. At the same time, as the pace of new discoveries accelerates, professional development opportunities for employees already working in the field are also a critical need. BTEC has received support from KIETS to develop student training curricula and professional development seminars for the current

workforce. The instruction combines lab work with classroom learning. Distance education, which became especially important during the COVID pandemic, has also been added. "This training is generally very hands on," says Gilleskie, "and we are still working on new ways to expand our virtual reach. KIETS has been a steady partner for us."

When the opportunity arose for BTEC faculty and students to collaborate with the Technical University of Denmark to create an exchange program called Accelerated Innovation in Manufacturing Biologics (AIM-Bio), KIETS helped support activities that strengthened the new relationships between students in Denmark and North Carolina. "Kenan provided funds to support an annual symposium for students, faculty, and other international experts, and they have helped us hire an evaluation team to analyze the impact of this collaboration," says Gilleskie.

The AIM-Bio Program, which began in 2020 and is generously funded by the Novo Nordisk Foundation, is designed to drive innovation in the research and manufacture of biopharmaceuticals. It is active through multiple departments at both institutions in the U.S. and Denmark. Not only do students and faculty collaborate across universities, but both institutions are involved in the creation of additional courses offered through BTEC to professionals in the biomanufacturing field. KIETS director, Ruben Carbonell, played a key role in developing the proposal for AIM-Bio and has served on the AIM-Bio

Advisory Board from its inception. KIETS has also supported BTEC 's Institute for Innovation in Manufacturing Biopharmaceuticals,

created to grow U.S. biopharmaceutical manufacturing and to sustain the nation's competitive edge in the industry. "Ruben Carbonell had a big hand in starting NIIMBL, which was led by the National Institute for Standards and Technology and the U.S. Department of Commerce," Gary required host institutions to provide

21

involvement in NIIMBL, The National

a nationwide, public/private consortium



Gilleskie explains. "Numerous universities joined to get the collaboration going." Since 2018, BTEC has been involved in a several large NIIMBL initiatives that some cost sharing to win participation

Ruben Carbonell



in the project. With small grants and critical endorsement from KIETS, BTEC was chosen for these programs. With NIIMBL funding, BTEC has developed new professional development courses in automation and gene therapy and has taken on research projects involving improved process control to lower costs and enhance product quality. The Center was also involved in research related to the making of RNA for the novel Coronavirus vaccines. "These projects take us deeper into areas that we consider very important," says Gilleskie.

The **Bioseparations/Bioprocessing** Development Center (BBDC) is part of these NIIMBL projects, and a critical component of the technical assistance BTEC now offers to the biotech industry. The bioprocessing and analytical work that BTEC performs for industry clients is managed by BTEC staff, graduate, and postdoctoral students. Their time on these projects is not funded by the state, so KIETS's supplemental funding gives BTEC the capacity to offer these services.



Jon Horowitz

"About five or six years ago, NC State also embarked on a project to create a core facility called METRIC," says molecular biologist Jon Horowitz who serves as Assistant Vice Chancellor for Research. The Molecular, **Education, Technology and Research Innovation Center** provides "the best analytic chemistry and biochemistry equipment in the Southeast,"

Horowitz explains. Advanced tools in mass spectrometry, magnetic resonance spectroscopy, and X-ray crystallography had never been available in the region. "KIETS and the METRIC Pilot Project Program formed an alliance to recruit individuals to take advantage of these new instruments and to teach others how to use them," Horowitz says. METRIC is another example of how NC State is on the leading edge of bioprocessing.

Most recently, during the COVID pandemic, BTEC reached out to KIETS, requesting partial support to produce sufficient hand sanitizer for the entire NC State campus. "As demand shot up and supplies were limited in the early days of the virus, the FDA opened up their rules for manufacturing hand sanitizer," Gilleskie explains. "Kenan provided the funds we needed to retool quickly."

In addition to the production of hand sanitizer with BTEC, KIETS supported NC State's Nonwovens Institute (NWI) in their response to the pandemic. NWI quickly tooled up to manufacture a new generation of spun-bond filters to make surgical masks. "We have large pilot facilities for production on Centennial Campus," says Behnam Pourdeyhimi, who directs NWI, the world's first accredited academic program for the interdisciplinary field of engineered fabrics. "We not only made filters for N95 masks for health care providers, but the KIETS support enabled us to go up the chain and produce millions of the pleated masks worn by others, including NC State faculty, students, and staff."



Behnam Pourdeyhimi

NWI collaborated with Freundenburg Nonwovens, a manufacturer with facilities in Durham, to mass produce the masks. The Office of the Vice Chancellor for Research and Innovation and KIETS helped NWI to purchase the machines required. This equipment is still available to the Institute for future projects. Pourdeyhimi says he turned to KIETS based on a positive experience years ago with Ruben Carbonell in the production of nonwoven fabrics that are used to purify antibodies and other therapeutics. "The Kenan Institute responded quickly to us, and we very much

enjoyed working with them," he says. Gilleskie praises the BTEC staff for its expertise and is grateful for the many collaborations they have established on campus and with other nearby institutions, including North Carolina Central University's Biomanufacturing Research Institute and Technology Enterprise (BRITE) and the North Carolina Community College System, where students can also plug into BTEC's offerings.

They're also great communicators."



"As we hoped, BTEC has evolved into a facility and organization that is meeting its mission of creating a skilled workforce as well as any on the planet," says Gilleskie. "We are the best-known cross-disciplinary biotech instructional center in the world now." "We all work together," Gilleskie continues. "And the number of visitors we have coming through to see what we're doing and how we are doing it affirms our position at the top. KIETS's participation has been indispensable. They know our field of research very well and have shepherded our requests quickly and with great flexibility.

GAME-CHANGING IDEAS, CROSSING BOUNDARIES...



Provost and Executive Vice Chancellor Warwick Arden



Alan Rebar

hanging norms is never easy, but NC State has effectively placed a strategic priority on interdisciplinary work across the entire institution, says Provost Warwick Arden. "Interdisciplinary efforts by our faculty have accelerated in the last decade, and it has been remarkable to witness." By bridging traditional departmental and college boundaries, NC State has now emerged as a hub for innovation in biomedical engineering, food safety, big data, materials science, and translational medicine, among others. "These activities benefit enormously from the synergy of faculty collaboration across disciplines," Arden adds, "and KIETS has been a tremendous partner in building this energy and enhancing our capacity for innovation."

Beginning in 2010, the Office of Research and Innovation and KIETS established a joint project known as the **Research and Innovation Seed Funding Program** (**RISF**). "This very popular internal funding program allows faculty to submit proposals to work on research projects with two or three colleagues in other disciplines," explains Alan Rebar, who helped launch the program. Rebar, a veterinary pathologist, served as Vice Chancellor for Research, Innovation and Economic Development before his retirement at the end of 2018. "The RISF proposals are peer reviewed by members of the University Research

Council—10 colleagues—who look at about 80 proposals each cycle and fund six to ten of them, depending on the amount requested," he explains.

Rebar notes that these research projects tend to be very successful in attracting follow-on funding. Another benefit of the RISF grants is the participation of graduate students, who often work with faculty on these efforts and gain valuable insights on the role of collaboration across disciplines.

RISF is exemplary of a KIETS projectthe proposals are simple, the term of work and the amount of funds are limited, and the impact is potentially significant. "A relatively small investment is used to create innovation across disciplines and leverage funds many times multiplied from additional sources," Rebar adds.

Approximately \$2.1 million has been invested in RISF awards by KIETS and the Office of Research Innovation since its inception, according to Associate Vice Chancellor for Research Jonathan Horowitz. "More than \$23 million in extramural funding has been secured because of these awards."

The RISF program has also been recently expanded to offer additional seed funding focused on special topic areas that will stimulate novel, interdisciplinary research projects in the post-pandemic era. Currently the program is calling for a focus on Global Health and Climate Change, areas which federal funding agencies have emphasized as a critical need. KIETS and NC State have now set aside \$800,000 over two fiscal years to support projects addressing these research topics. The popularity and success of RISF

among faculty led to the creation of another, larger endeavor called GRIP, the Game-Changing Research Incentive Program. Based on a similar initiative that had been effective at Purdue University, Alan Rebar asked KIETS to consider investing \$100,000 per year for three years in this more expansive idea. Associate Vice Chancellor Jonathan Horowitz suggested that GRIP also approach the Research Triangle Institute as a third investor. The Research Triangle Institute (RTI) enthusiastically agreed to participate in GRIP and invested a total of \$575,000 over the first three years, beginning in 2017.

For researchers considering this grant opportunity, the stakes had been raisedthe idea being, "go big or go home." GRIP aimed to stimulate the formation of new interdisciplinary teams focused on solving society's most demanding challenges, and the sponsors raised \$2.3 million to launch the program. KIETS director Ruben Carbonell wrote guidelines for the proposals that researchers would submit. He encouraged them to form teams of researchers from anywhere in the Triangle. The goal was to foster broader collaborations that would be both internal and external to NC State.

In response to its first call for twopage letters of intent, GRIP received 59 responses spanning 10 NC State colleges, 52 departments, and 33 NC State faculty. Fully half of the teams also included RTI personnel. From these, the GRIP organizers narrowed the field and solicited ten full proposals. Six teams were then selected to make 10-minute presentations to the GRIP panel. Four teams ultimately received \$575,000 each over three years. A fifth team with a smaller project received \$210,000 over two years. These first GRIP projects addressed such issues as improving water sustainability through nanotechnology, enhancing genetic discovery and prediction, examining how to provide computer science training for all K-12 students, and using 3D printing for the biofabrication of fibrous tissues for medical

and therapeutic purposes.

Mladen Vouk, NC State's Vice Chancellor for Research, asserts that the GRIP Program has in turn "seeded additional grants we have just received this year." NC State has recently gained approval from the National Science Foundation to establish a new Science and Technology Center on phosphorus sustainability which comes with \$25 million over five years and is renewable, and another \$20 million over five years from NSF to support an Artificial Intelligence Center. GRIP grants have also resulted in a startup company that has attracted \$2.7 million in venture capital to date and at least five new patents for the University. "KIETS is a unique resource for a major

university," says Alan Rebar. "We had nothing at Purdue to compare to it. It is very creative in figuring out how to accelerate projects by investing small amounts that leverage additional funds."

vision has been so valuable."

Jon Horowitz agrees. "Someone could look at KIETS cynically and say they are a very nice bank, but they have a vision. They came to us with the idea of expanding the RISF grants to push more resources toward Global Health and Climate Change. Their

SPINNING OUT **NEW INITIATIVES...**



C State's talented faculty and students continue testing new ideas. They are fabricating products and processes and setting

standards for best practices in industry, science, technology, research, and business. As Vice Chancellor for Research Mladen Vouk puts it, "KIETS has been there as a partner, weaving and seeding." Here are some additional institutes, centers, and initiatives that have benefited from KIETS's support and have borne fruit over these first three decades:



Mladen Vouk

1997: The Kenan Center for Utilization of CO2 in Manufacturing and the NSF Science and Technology Center on **Environmentally Responsible Solvents** and Processes

In 1994, Joe DeSimone, a young chemist at UNC-Chapel Hill, developed a range of molecules that could be dissolved

in carbon dioxide instead of water or organic solvents. These molecules had a wide range of potential applications. For example, some could be used as polymers to coat and protect various surfaces, others had applications as detergents. If successful, this approach would reduce the use of water and harmful organic solvents in manufacturing, and the amount of CO2 released into the atmosphere. DeSimone, a bench scientist, wanted to work with engineers at NC State to help him develop new processes that would make his vision a reality.



Joe DeSimone and Ruben Carbonell

As it turned out, DeSimone's project would require a large interdisciplinary team-one of the first that KIETS supported. KIETS's first director Hal Hopfenberg encouraged the department head of Chemical Engineering at the time, Ruben Carbonell, to get involved. DeSimone and Carbonell approached KIETS with the idea of forming an industry consortium to identify the most important problems to address by using this technology and to make progress on its implementation. KIETS provided support for the formation of the Kenan Center for the Utilization of CO2 in Manufacturing, an industrial

consortium that blossomed from two to sixteen members in about two years. This successful effort led to the establishment of the NSF Science and Technology Center for Environmentally Responsible Solvents and Processes, a 10-year, \$20 million grant from the National Science Foundation, which at the time was the largest grant awarded to any university in the UNC System.

One of the first processes the group developed was the world's only carbon dioxide-based dry cleaning machine and detergents-a process that is still used in Germany today. A polymer created by DeSimone was tested as a potential spray coating for antiquities in Italy to protect them from the ravages of air pollution. The application was never adopted by the Italian government, but it drew keen interest from several museums and historians of material culture. The DuPont corporation built a plant in Wilmington, NC to make fluoropolymers using CO2 as the solvent. The technologies developed by this group evolved over time into many other significant applications that are currently being used for 3D printing of athletic shoes, vaccine delivery, and the manufacture of next-generation batteries.

"This is the project that keeps on giving," says Ruben Carbonell. "We learned so much about collaboration, leveraging of resources, and cross-disciplinary work." Joe DeSimone was the very first faculty member with joint appointments at UNC-Chapel Hill and NC State, and Ruben Carbonell would become director of the Kenan Institute for Engineering, Technology, and Science the same year the NSF Science and Technology Center was awarded. Both men were inducted into the National Academy of Engineering.



Statistical and Applied Mathematical Sciences Institute (SAMSI)

From 2002 to 2017, SAMSI brought together researchers from various fields of applied mathematics, statistics, and science to support joint research and collaboration-a natural fit for KIETS's mission. Over the Institute's 15 years, KIETS partnered with SAMSI to help in the execution of research programs that relied on advanced principles of mathematics and statistics. They tackled an extremely wide range of topics-from improving predictions for hurricanes and tornadoes, modeling the flow of hot rock, gas and ash from volcanic eruptions, to epidemiological modeling and forensics. SAMSI ran math institutes for postdocs and faculty from the Triangle universities. These events soon expanded to include mathematics and science researchers

from around the world. The program also expanded vertically to include programming for undergraduates and finally to embrace the K-12 classroom.

"Naturally, we brought the Kenan Fellows for Teacher Leadership to SAMSI, and they developed research ideas that they could take back to their classrooms," explains statistician Jim Berger, one of three directors of SAMSI over its lifespan.



Richard Smith

"Ruben Carbonell's contributions were essential to this effort. He helped us outline the teachers' activities, and we began bringing in one or two Kenan Fellows each year to work with us," says biostatistician Richard Smith, SAMSI's second director. In one project that Smith oversaw, AP statistics students in high school

helped track air quality data available on the Internet to determine whether North Carolina's air was getting better or worse over time, a precursor to the significant contributions of SAMSI to the field of environmental and climate studies.

"The teachers were great fun to work with," says Duke statistician David Banks, the last director of SAMSI. "KIETS also helped make it possible for us to bring undergraduates from NC State to study uncertainty quantification for a week-long program."

"Working with Kenan was relaxed, and they made it easy to maintain accountability," says Jim Berger. Richard Smith agrees: "We would sometimes go back for funds for new programs, and if the request was reasonable, they would help us. Any interaction with KIETS staff was the sweet spot in my day."

The three directors also noted how KIETS was helpful over the years in writing letters of support for the renewal of their main supporting grants from the National Science Foundation. During its tenure, SAMSI was one of eight mathematical institutes funded by NSF's Division of Mathematical Sciences, but it was the only group that focused on statistics and applied mathematics at the time. Among its many collaborations, the organization also worked with social scientists in the fields of epidemiological modeling and forensic statistics.

Genetic Engineering and Society Center (GES) and Agricultural Biotechnology Food Energy Water Systems (AgBioFEWS)

The Center for Genetic Engineering and Society (GES) at NC State is a distinctive example of the marriage of science, engineering, public policy, and ethics. Co-directed by Agriculture Professor Fred Gould and Professor Jennifer Kuzma of the School of Public and International Affairs, GES is an interdisciplinary center that is concerned with the technical, ethical, and societal dimensions of the emerging field of genetic engineering.

"Genetic engineering can be very controversial," says Jennifer Kuzma. 'Some people have fears about this technology-who owns it, who is funding it-and we are working to improve understanding, engage students across many fields, and tackle these difficult questions." While the Center is supported by National Science Foundation funds,



Jennifer Kuzma

KIETS has also played a supporting role in the Center's programming.

Through an NSF program called IGERT, (Integrative Graduate Education and Research Traineeship), GES was granted funds to select cohorts of seven to nine Ph.D. students per year as Fellows from a variety of fields, including economics, anthropology, agronomy, public administration, biology, and genetics. Each participant brings their divergent expertise as a lens to consider what responsible innovation looks like in genetics and what are best practices in the technological governance of new products and services, specifically as it relates to genetically modified organisms. In addition to their primary graduate program, Fellows in the program earn a graduate minor in Genetic Engineering and Society.

NC State's first IGERT cohort traveled to Iquito, Peru, "the largest city in the world you cannot reach by road," as Fred Gould describes it. Iquito is bordered by

qualitative research," Gould says.

the genetic modification of mice to



Fred Gould

the Amazon River on one side and an impassable rainforest on the other. The students experienced first-hand the threats posed by malaria and dengue fever from dangerous populations of mosquitoes. They looked at the potential efficacy of genetic pest management as opposed to conventional pesticides. "The students spent two weeks in primitive quarters and got to know each other well during this field experience that involved mostly In the second iteration of the program, a cohort of students traveled to California to witness how invasive mice on islands off the Pacific coast were compromising the island's endemic biodiversity and harming agriculture and human health. Students compared the relative costs of chemical control of these pests versus achieve population suppression, in each case taking account of the ethical and biological hazards of both options.







Fred Gould with a student

For the last several years, a similar graduate training program led by GES in Agricultural Biotechnology has been sending academically diverse cohorts of Ph.D. students to eastern North Carolina to consider current and potential biotechnologies that may be used to improve food, energy, and water systems in the region. These students also work collaboratively in the field to learn about rural communities, farms, and the local cultures while considering the social implications of introducing new, genetically based crop and pest technologies.

"At the beginning, we were the only center in this space and the only program taking such an interdisciplinary approach," says Kuzma. "NSF funding is restricted, and we have been able to conduct additional workshops and to engage international students in these programs through the support of the Kenan Institute."

"KIETS funding supports the extras, which gives us more flexibility, and it has even made it possible for us to include an undocumented DREAMER in one of our cohorts," says Gould.

"We have been very pleased how the diverse disciplines and people in the program have remained closely connected as they have gone on to secure very good jobs in the field. One of our graduates was immediately given tenure in an academic post. Another is now at the Research Triangle Institute. Others have gone on to work in government and business," Kuzma concludes.



Future Renewable Electric Energy Delivery and Management Systems (FREEDM)

The architecture for a future electric power distribution system is being modeled at NC State in collaboration with institutions in Ireland and Northern Ireland. The goal of the FREEDM project is to prove the concept of a flexible energy-sharing distribution system for use on a residential scale. This Center, funded by the National Science Foundation through its Engineering Research Centers (ERC) program, with additional support from KIETS, is offering researchers, graduate and undergraduate students, and K-12 teachers and students (including Kenan Fellows) an opportunity to analyze and understand developing technologies for new energy grids around the globe. The FREEDM initiative has already produced 16 inventions, nine registered patents, and interacted with 34 companies in its work toward a future of reliable and renewable energy.

CHANCELLOR LARRY MONTEITH'S VISION

Dedicated research facilities and collaborations across universities were essential to the nation's success in World War II, as top scientists and engineers were rapidly mobilized to serve the country's military needs. As former chancellor Larry Monteith once explained, "There was a large research establishment—about 10 or 12 universities in the country-that had done basic research for the war effort."

Monteith cited Vannevar Bush in particular, who headed the U.S. Office of Scientific Research and Development. Bush, who was an MIT-based engineer, inventor, and founder of the Raytheon Company, was a principal in the creation of the National Science Foundation. He stated publicly that post-war America should continue this great research enterprise for civilian development. "Stanford University developed a research park back then," said Monteith, "but North Carolina and the Southeast were not ready to take advantage of the idea." It would be 1958 before Research Triangle Park was conceived.

The federal government ultimately recognized that universities were generating significant intellectual property, but they weren't getting patents on the findings because they had no reason to. Through the Bayh-Dole Act of 1980, the government finally "enabled universities to get those patents, keep them, own them, sell them, lease them, and use them," Monteith explained. "That got the universities thinking more seriously about the value of their research beyond publishing papers,

giving degrees, and discovery." Chancellor Larry Monteith, who Centennial Campus during his tenure, property created by NC State faculty

often in consultation with NC State



Frank Kenan and Larry Monteith

shepherded much of the construction of envisioned NC State becoming a home to scores of startup companies and larger private ventures, creating new jobs for North Carolina citizens as a result. He imagined the successful commercialization of intellectual and students, government entities, and innovative companies from around the world. Monteith sought to engage business leaders like Frank Kenan, Dan Drake, and Dick Daugherty to move the needle on entrepreneurship as a strategic, operational emphasis for the University. Today 70-plus corporate partners have firmly established a significant presence on Centennial Campus. They conduct research and development, engineers, scientists, and technologists. NC State also offers lab and fabrication space, marketing and management consultation, and other resources for resident startups to launch, build, and scale their new ventures.



Larry Monteith

CENTENNIAL CAMPUS **BY THE NUMBERS**

70

partners call Centennial Campus home

5,600

employees work at those companies

1,500

students hired as interns or full-time employees by Centennial partners

70%

of partners come from industry

16,000

people cross **Centennial Campus** each day

Source: NC State website



Technology, **Entrepreneurship**, **Commercialization**

It's 6:15 on a weekday evening near the end of the spring semester. On the fourth floor of the Hunt Library, in the suite of offices and meeting rooms dedicated to The Institute for Emerging

Issues (IEI), an elegant spread of appetizers and soft drinks is set out on tables in the foyer. Graduate students from the Poole College of Management and their counterparts from the College of Engineering and College of Sciences are dressed in appropriate business attire for the presentations they are about to make in a classroom outfitted with big screens. The students are keyed up, greeting guests, and checking their phones. The crowd swells as faculty members, prospective investors, and

some of NC State's corporate partners from Centennial Campus come in for the hors d'oeuvres. Even a few parents are here, eager to see what their graduate students have been working so hard to prepare on the eve of their commencement into professional life. This event is not a simulation. The student teams have created five company concepts founded on real intellectual property developed at NC State, some in conjunction with government entities. The students will be giving

the presentations they will soon repeat in business plan competitions and at fundraising opportunities. Expert guests

are here to ask tough questions and provide advice.

At the appointed hour, the participants take their places in the meeting room, and Lisa Chang steps forward. She is NC State's Director of Technology Entrepreneurship and Commercialization (TEC) and a lecturer in the Poole College of Management. She is a graduate of the program she now directs and was named the 2019 John S.

Risley Entrepreneur of the Year at NC State. Chang in turn introduces her colleague Steve Barr, a professor of Technology Management at Poole. Barr is currently the lead instructional faculty member for the TEC program and was recipient of the Alumni Association Distinguished Graduate Professorship Award for 2021 for his contributions to the program's growth.

presentations by our five teams-they've worked hard-represent thousands of hours they've put in. What you'll be seeing is the culmination of all their work. It's a business pitch-to show you a highgrowth business option based on the real intellectual property they selected from a large portfolio we provided to them at the beginning of last semester." This yearlong course is a requirement for the TEC concentration in the Jenkins MBA within the Poole College of Management. The concentration pairs masters and Ph.D. student teams to evaluate the potential for commercializing innovations and creating startup companies. The five teams, assembled up front, wish each other well. They will pitch their concepts with colorful slide decks projected on the screens behind them.

Chang addresses the audience: "The

The first product is a crop defense system for cucumber farmers, allowing growers to detect the spores that lead to a disease called downy mildew. Being



Steve Barr

Lisa Chang











able to monitor the inevitable arrival of this menace lets the farmers get a jump on when and what to spray to prevent damage. The team's target market happens to have a large presence in North Carolina, growers for the Mt. Olive Pickle Company, an industry leader.

The second team offers a proposal to create a solid-state battery to replace the common lithium-ion batteries now used to power cell phones, electric cars, and other devices. The current products on the market are prone to what one team member calls "thermal runaway," a heat up leading to explosions and fires that have harmed people and ruined their devices, resulting in nearly \$5 billion in lost revenues for one cell phone manufacturer. The team's product, E packtrolyte, features coin-sized battery cells that aim to eliminate the liquid electrolyte. The team will need three years of funding to prove their concept. Wolfpack Medical, the third group, has adopted a design from a U.S. Navy anesthesiologist which was outsourced to NC State. The product—a junctional tourniquet that is less bulky, less expensive, and more reliable than present designs-is ripe for development. The team suggests that this tourniquet, designed to stop major bleeds that otherwise may result in a trauma patient's death, would be a tremendous asset on the military battlefield. It would also find users among emergency medical personnel, law enforcement, and various industries such as mining. The team proposes to carry the new device through the FDA

TEC CERTIFICATE PROGRAM BY THE NUMBERS

500+

student graduates of the program

25+ new business startups

400

people employed by hese ventures

\$700,000,000

raised in support of the startups.

approval process and to raise the resources necessary to manufacture the tourniquets at a local injection molding plant.

Team four has examined the viability of a product named SIREN that attracts male moths using a pheromone. The moth species known in the larval stage as Fall Army Worm destroys crops, particularly in Kenya. "We have the chemistry and the packaging," says one of the students. "We believe we can provide this solution for \$45 per acre and reduce pesticide use. We are confusing the moth, not poisoning it!" The audience offers questions about who would pay for the product-the farmers, the government, or a nonprofit?

The final group, Team Subsense, includes three biomedical engineering graduate students who have worked with a new fabric containing an interwoven sensor capable of detecting the human symptoms of too much heat exposure, including dehydration and fatigue. Putting this wearable solution into clothing used by construction workers, miners, and other outdoor laborers, would, they argue, reduce the rate of injury on the job, lower insurance costs, and optimize productivity in the field. The group needs resources to test user compliance, the quality of the signal emitted by the detectors, and the feasibility of the monitoring process.

Over the years, successful startups have come out of these pitch sessions which have been conducted since 1995 with support from KIETS.

Associate Director Raj Narayan served as director of the TEC Program when he ioined KIETS in 1998. He still teaches in the program as a Professor of the Practice of Entrepreneurship. Trained as an attorney, Narayan also earned a Master of Science in Management with a concentration in high tech entrepreneurship from the Poole College of Management and is an alumnus of the TEC program.

"The Technology Entrepreneurship and Commercialization (TEC) Program is a game-changing university initiative, founded with a grant from the National Science Foundation, in partnership with support from KIETS" says Narayan. "Several companies have been spun out of the TEC program and have generated significant venture funding and job creation. The Kenan Institute has been a core partner since TEC's inception. For me, what has been especially rewarding is working with the faculty, graduate students, and executives in residence over the past 25 years. We are always learning new, important, and enduring lessons together with every entrepreneurial endeavor. The TEC program has provided us with a very fertile arena and collaborative community of thoughtful practitioners. They continue to lead forward in their careers and amplify the value of their contributions in our communities."

Center for Innovation Management Studies (CIMS)

In alignment with the development of the TEC program, NC State was also host to the Center for Innovation Management Studies that operated at the university from 2000 to 2020. Innovation management studies is a field developed



Center for Innovation Management Studies (CIMS) hosted at the Poole College of Management

"to answer industry's pressing questions about how to measure innovation and how it contributes to top line growth in a company," as Michelle Grainger puts it. Grainger is the former managing director of this virtual research center, which served clients worldwide. Though CIMS was mostly self-funded by grants and industry members, there was no funding available from the State of North Carolina when the organization relocated to NC State after 26 years at Lehigh University in Pennsylvania. KIETS immediately stepped in to provide initial operating support to stand up the center in North Carolina and to facilitate new connections with local industries.

Grainger, a Cary native and NC State graduate in Management and International Business, was also new to the field of innovation management. She was hired to lead the Center and to engage faculty and

business leaders from around the world. She looked to Raj Narayan and Ruben Carbonell for mentoring and coaching in the early years as she grew into her role.



Michelle Grainger



KIETS immediately saw the benefit of the organization to the campus, region, and state as it went about putting young interns and researchers in front of Fortune 50 and 100 companies to share their findings about innovation and its impact.

"We had a tremendous internship program," says Grainger. "We took undergraduate interns to board meetings and worked on specific projects funded by KIETS and others. Our membership grew and included companies such as IBM, BP, Exxon Mobil, Steelcase, Proctor & Gamble, and Biogen. At our summits on innovation, we had leading corporations candidly sharing their successes and struggles with their counterparts from other industries." Though the Center closed in 2020, Grainger has continued her innovative work as executive director of the NC Sweet Potato Commission, assisting producers in the state that grows more sweet potatoes than any other in the U.S.

CROSSING BOUNDARIES, **BUILDING NEW PARTNERSHIPS**

hirty years ago, it was a revolutionary idea-having faculty and students engage in the process of taking university-based research out of the ivory tower and into the marketplace. Allowing science and engineering professors and their students to partner with their peers in business and marketing and to commercialize their own innovative products and services was a foreign concept. Back in the day, academic departments tended to operate in silos. Disciplinary boundaries were rarely crossed. Instead, the process called "technology transfer" was managed administratively in most colleges and universities. Faculty were not involved in decision making about the commercialization of intellectual property created on campus. Creativity and collaboration were stymied by this traditional arrangement.

At a land grant university such as NC State, however, extending campus knowledge and know-how into the public sphere through such disciplines as agriculture, forestry, food science, and materials science has been wired into the Wolfpack DNA. Visionary business leaders and university supporters like Frank Kenan, Dick Daugherty, and Dan Drake understood the potential of transferring game-changing research in science, technology, and engineering into products, services, and



Michael Zapata

jobs to benefit the local and national economy. North Carolina Governor James B. Hunt was also on board with the concept.

At first, however, some faculty were less enthusiastic. "When we first started this idea of entrepreneurship," says Michael Zapata, the founding director of TEC, "I'd say only 10 to 20 percent of faculty thought it appropriate to get involved in commercialization."

"Dick Daugherty and Steve Markham were two mentors who taught me about business and government affairs, how to leverage and advocate for greater support for business development and entrepreneurship. Back then though, we weren't sure if we'd even be able to operate the TEC program on campus," Zapata continued.

"Dick Daugherty wanted to do something big-to create an entire ecosystem of entrepreneurship at NC State," Zapata explained, "and he paid for the international research to discover and document the best practices in commercialization around the world." The grant from the National Science Foundation that followed helped to set the ecosystem in motion.

Lipsinc – digital lip synchronization technology developed around 1998, Michael Zapata, CEO.

ArrayXPress- a genomics services company producing microarrays that can put sophisticated analysis laboratories on miniature chips and automate the hunt for drug targets and compounds. Founded in 2003.

Kyma Technologies – a semiconductor fabrication company that provides engineering services-including device design-equipment maintenance, and machining. Launched in 1998 by NC State Materials Science and Engineering Professor Jerome Cuomo and his graduate student Mark Williams.

Xanofi – an advanced nanotechnology materials company using a unique process to manufacture nanofibers in liquids, improving products in filtration, acoustics, energy, medical and other markets. Roger Debo, Board Chair, spun out of NC State in 2010.

Tethis— creating novel plant-based, biodegradable, plastic-free materials that are superabsorbent and skin safe. These biopolymers are useful in diapers, hair care products, cosmetics, and packaging. Founded by TEC grad Scot Bolin, CEO.

Locus Biosciences- a clinical-stage pharmaceutical company developing phage therapies based on CRISPR-Cas3 gene editing technology. Launched in 2015 by TEC Executive-in-Residence Paul Garofolo along with NC State Professor Chase Beisel.

STARTUP COMPANIES THAT CAME OUT OF THE **TEC PROGRAM AT NC STATE**

Liposcience – a provider of specialized cardiovascular diagnostic laboratory tests based on nuclear magnetic resonance (NMR) technology, Steve Markham, CFO. Sold to LabCorp in 2014.



Steve Markham

The algorithm that Steve Markham and Michael Zapata came up with from the initial research was basically a string of if-then questions to determine the potential risk and reward of a company concept. The process became NC State's blueprint for determining the commercialization potential of the intellectual properties that the university had on file. Zapata and his successors, Raj Narayan, Roger Debo, and Lisa Chang, all continued to work with the algorithm with teams of students,

testing the viability of an enormous range of potential startups. Meanwhile, Steve Markham is now the Executive Director of NC State Innovation and Entrepreneurship, a university-wide post.

Says Lisa Chang: "In the TEC course we set the stage immediately for a new learning process that is shared across disciplines. The first barriers among these teams of students from business and science/engineering are the languages everyone needs to learn to communicate with each other. Respect for each other's expertise is critical. Then the students commit to answering a series of questions and to perform data collection and analysis."





Lisa Chang with students

This iterative process of documenting what the teams already know and what they want to know includes questions about size, scale, the developmental stages of a product, the feasibility, and the identified markets. These factors begin to help students frame a hypothesis. "Often," says Chang, "we do customer discovery interviews-what does the end user want and need? We examine the inherent risks in a project, what risks can be mitigated, and which cannot. And we estimate how much money it will cost."



Roger Debo

For his part, Roger Debo, the third director of TEC, has recently retired. During his career he was an advisor/consultant for 10 companies, the interim CEO or board member for five startups and served as board chair for Xanofi, an NC State spin out. These business experts have helped to prove that commercialization can be of great benefit to faculty in the long run. They recognize the critical role of the Kenan Institute in the early days of TEC and are grateful for its sustained support and creativity over time.

Today, the proof is in the companies that have been developed since 1995.

AN ENTREPRENEURIAL ECOSYSTEM



and graduate entrepreneurship Entrepreneur magazine.



Roger Debo with students

rom its founding in 1992,KIETS has seeded a surprising range of entrepreneurial initiatives at NC State, by making small financial investments in people and nascent organizations and by collaborating in the development of undergraduate, graduate, and faculty entrepreneurial initiatives. KIETS has thus played a central role in creating what people on campus regularly refer to as NC State's "entrepreneurial ecosystem." In KIETS's 30th anniversary year, NC State was ranked first in the Southeast and fifteenth in the nation for its undergraduate programs by The Princeton Review and

Lisa Chang says entrepreneurism is now so pervasive on the NC State campus that it would be impossible to map its presence. "It's in every building and every department," she says. A raft of new initiatives and facilities on and off campus affirm this perspective.

PLANTING SEEDS FOR SUCCESS

enior Vice Provost for Entrepreneurship Thomas Kenan Miller III retired in 2022, but his visionary impact on NC Stateparticularly in the development of the entrepreneurial ecosystem that now thrives on campus and beyond-is still growing. "Tom's work on entrepreneurship has been critical to our ability to leverage support for new ventures at NC State," says KIETS director Ruben Carbonell.

In 1993 Miller established the NC State University Engineering Entrepreneurs Program, challenging students to change the world and radically improve the human condition.

Miller was named the *Raleigh News* & Observer's 'Tar Heel of the Week' in January of 2000 for his work with engineering student entrepreneurs. He also founded and served as president of X Engineering Software Systems Corporation, developer of the first native X-Window spreadsheet.

In 2008 Miller became Executive Director of the NC State Entrepreneurship Initiative, a campus-wide effort to empower students as entrepreneurial thinkers, leaders, and doers.

In 2014, Miller created the **Entrepreneurship Initiative Fellows** program to support newly graduated NC State students who wished to pursue their venture full time after graduation. The program was endowed by a group



Tom Miller

of alumni and renamed the Dr. Thomas Kenan Miller III Fellows Program in 2017 to help student entrepreneurs pursue their ventures following graduation. In addition to financial assistance Fellows receive:

- Mentorship from the NC State Entrepreneurship team, including monthly meetups and workshops, focused on enhancing entrepreneurial skills.
- Continued access to NC State startup spaces, including the Entrepreneurship Garage, and NCSU Libraries, to provide work and prototyping spaces at no cost.
- Assistance navigating university and community resources for post-graduate entrepreneurs, such as NC State's Alumni Entrepreneurs.
- Access to human capital both inside and outside the university that provides resources and services for new ventures such as pitch clinics and legal services.

Albright Entrepreneurs Village is a

living/learning residence hall for graduate and undergraduate students who want to explore their entrepreneurial interests in a supportive and creative environment. Programming in the residence hall provides opportunities for students to meet startup founders, get acquainted with potential mentors, and engage with alumni entrepreneurs. Special classes and social meetups on site are augmented by off-campus tours of local ventures. Longer trips to entrepreneurial centers around the country, such as Silicon Valley and New York City, are also popular with students. Residents regularly participate in competitions and simulations with prizes for their performance. Albright Village began in 2014 with 12 students and has reached 180 residents at capacity. The program is now primarily driven by student leaders.

Haley Huie, an NC State alumna who helped to build and direct Albright Village, is now professor of the practice and director of the Entrepreneurship **Clinic**, a program in which students act as consultants for ventures that range from early-stage startups to established companies. The clinic is based on a medical model. Small teams of students work with an "attending" expert or local company owner to tackle the current needs of the "patient" -- in this case, the company. Students are first charged with developing a strategic action plan to solve a particular business need. Undergrads then perform such diagnostic tasks as market research, business opportunity analysis, or a



Raleigh native Leigh Kathryn Bonner is from a farm family that raised honeybees for four generations. In her freshman year at NC State, she signed up for "Introduction to Beekeeping" with the same professor that her uncle had studied with years before. Dr. John Ambrose pulled no punches with the class when he explained the serious environmental danger posed by habitat degradation and the loss of bee populations worldwide. Bonner was moved by what

she learned, but she continued with her major in International Studies along with a double minor in Spanish and Nonprofit Management. In the highly entrepreneurial climate of NC State, however, she also got an idea—why not raise bees in urban environments to increase the global population of bees while also teaching city dwellers about the power and impact of bees on the planet?

knew that the bees did well in urban environments-when they have stable living environments,

42



As she recently explained, "I

they're not as stressed out. They have diversity of food. They have longer blooming periods where food is available to them, so the bees statistically do quite well in urban environments."

Bee Downtown was the startup she launched in her junior year. Bonner formulated her corporate logo and prototype "bee box" in the Garage at NC State. She also entered the Lulu E-games for undergraduates. That year she came in first place for her prototype and second place for her business plan. Still, she didn't have enough resources to carry her ideas to fruition. Learning of Bonner's promise, the Kenan Institute stepped in, providing resources to accelerate her ideas and to engage mentors, including KIETS Associate Director Raj Narayan and Retired Colonel Joseph Lebeouf, who had served as Dean of Leadership at West Point Academy.

Bee Downtown is now a million-dollar enterprise with some 500 hives installed from New York to Tampa, all situated in urban environments, mostly on the campuses of major corporations. The company also provides leadership training and guided facilitation to employees of the host companies, using bee behavior and the core values of the hive as its curriculum.



Haley Huie

competitive analysis for the firm. The project may involve a for profit or nonprofit venture. Most are local companies, but the program reaches beyond Raleigh to serve regional enterprises, too.

Typically, participants who work in the clinic are entrepreneurship majors or minors, but every undergraduate major at NC State is represented among the students. Soon the program will expand to offer entrepreneurial projects in textiles and industrial design, says Huie. Raleigh Founded—the largest coworking hub in the capital city-is home to the clinic, giving students a chance to immerse themselves in the city and expand their off-campus networks. The Clinic program is already oversubscribed. Huie says the demand is so great they could probably serve another 100 students per year.

Students who are creating their own ventures or beginning to fabricate a new product can become members and share access to the NC State Entrepreneurship Garage, a 23,000

square foot prototyping space developed in partnership with Raleigh Founded, on Centennial Campus. Some 800 to 1,000 members of this co-working space join each year to gain access to Class 4 lasers, CNC woodworking equipment, 3D printers and other rental tools. Following appropriate safety training, students can tinker in the Garage at all hours. The facility is also the place for what Huie calls 'beneficial collisions" among students, faculty, and Raleigh entrepreneurs.

Huie notes that KIETS's early-stage support of Albright Village activities and its funding for the prototyping equipment in the Garage have been critical to development of NC State's entrepreneurial ecosystem. "Raj Narayan has been such a champion for our young entrepreneurs in aligning resources, making powerful connections for us, and responding right away when we call with an idea. He has continued over time to check in with us as we have experienced this amazing growth." Huie, who grew up in Kannapolis, NC, earned her undergraduate degree in public relations and journalism at NC State. After a brief stint in northern Virginia as a reporter, she worked as a business strategist in California's Bay Area. "There's a totally different sense of community in Raleigh-Durham," she says, "and the can-do attitude of people here far exceeds anything I have experienced elsewhere." Huie is especially excited to create connections with the community

of young entrepreneurs developing new startups in downtown Raleigh, a destination which, she says, holds

great appeal for her students, many of whom opt to stay in the area and will contribute to North Carolina's economic development over time.

Another beneficiary of KIETS's early support is the Social Innovation Fellows program within the broader Social Innovation and Entrepreneurship (SIE) program, led by Elizabeth Benefield. Launched in 2017 through the College of Humanities and Social Sciences, this yearlong, team-based, experiential learning opportunity is designed for undergraduate and graduate students. The program explores the ethics and sustainability issues inherent in entrepreneurial ventures that are not likely to create fortunes but instead work to change the fortunes of the disadvantaged. It focuses primarily on values-driven projects that are aimed at societal and environmental problems. Profitability in these kinds of projects is generally measured in social impact, not dollars.

Using the United Nations' Sustainable Development Goals as a template, interdisciplinary teams of students tackle real-world challenges. They work with an annual array of for-profit, nonprofit, and B-corps organizations statewide and beyond to gain expertise and hands-on experience in social problem solving. Recent venture partner organizations that have engaged students include NC Sea Grant (protecting coastal and wetland ecosystems), NC Interfaith Power and Light (a climate change mitigation program of the NC Council of Churches), Karma Wallet (a consumer tool evaluating brands and companies based on their environmental

the problem of food deserts in U.S. Ugandan villages).

Each cohort of fellows selected for the program builds, where possible, on the work of previous cohorts. Often these challenges align with the service-learning efforts of NC State's Caldwell Fellows and Goodnight Scholars, many of whom extend their initial work through the Social Innovation Fellows, creating another strand in the strong web of entrepreneurial initiatives on campus.



Narayan and others.

and social impact), Sankofa Farms (tackling communities), and All We Are (a Raleighbased nonprofit installing solar panels in

Benefield came to NC State in 2014 from the University of North Carolina where she was, for many years, involved in the School of Social Work. Her initial assignment at NC State was to create programming relevant to Social Entrepreneurship and Innovation. Along the way, she launched the Fellows program in consultation with KIETS's Raj

"We invite our students to fall in love with the problem, not the solution," Benefield

Fellows and team mentor Raj Narayan discuss United Nations Goal 12: responsible consumption and production during an innovation lab.

explains. "I believe NC State students are really focused on having an impact to benefit others, which is important to them in creating new ventures and initiatives."

To help students identify their own ethical compass and personal mission, the program teaches adaptive leadership skills, uses the tools of appreciative inquiry, and emphasizes the recognition of multiple cultural perspectives to develop inclusive collaborations and diverse teams. "We are shaping future changemakers, global citizens, and empathic leaders," says Benefield.

A recent speaker at a forum sponsored by SIE explained that in her global work to lower infant mortality, especially in African countries, she had a simple request of her NC State audience: "We need engineers to make mats for pregnant women to use when giving birth," the woman said.

"It was a lightbulb moment for our students," says Benefield. "They were excited to consider the design of such a product to improve the hygiene and safety of childbirth in developing nations. And in this era of debates about gender inequality, climate change, and the threat of future pandemics, students have a profound desire to engage deeply. Students say to me, I want to start a venture that does aood in the world."

Benefield notes that when the University announced the establishment of a minor in Global Health studies, 86 students signed up immediately. "We see that level of interest here, too," she says. "SIE is having to turn students away at our

Elizabeth Benefield

current capacity, so there is growth ahead for this program. We are deeply indebted to the Kenan Institute for support and encouragement as we continue to develop this distinctive approach to social entrepreneurship. KIETS is one of those campus institutions that truly understands and resonates with Millennials and Gen Z'ers who want to be involved with purpose-driven work in the world."

With the concurrent growth of the Social Innovation Fellows Program and the TEC curriculum in the Poole College of Management, KIETS's Associate Director Raj Narayan began to wonder whether a learning-by-doing approach to entrepreneurship would work at the high school level. He considered the possibilities after spending a couple of hours getting to know Dan Jackson, a veteran teacher from Wake County's Apex Friendship High School, who was referred to him by Nancy Cattrell, a Kenan Fellow teaching at the same high school.

Learning by doing has always been Jackson's mantra, and the accomplishments of his high school honors students in business, marketing, and entrepreneurship prove his classroom impact. Jackson had already been assigning his students the task of developing startup business plans. As a final exercise in the class, he would bring in a panel of local bankers and other business investors to witness the students' presentations of their plans. When he met with Narayan at the KIETS offices in the Hunt Library, the opportunities for mentors suddenly mushroomed.



Apex Friendship High School and KIETS collaborated to create the **Applied** Synergies Partnership Program (ASaP). Following the TEC model of developing new business concepts to solve societal problems, Jackson began working with Steve Barr and Lisa Chang in the TEC program and was able to invite innovation coaches from NC State to his high school classroom. The students also visited Raleigh Founded and the Garage on field trips and were soon fabricating their own products and logos with the tools available. "Some of the students' business plans took on a high-tech flavor, once they were exposed to the NC State entrepreneurship students," Jackson says.

When Jackson's students presented their ventures in high school business competitions, they placed high among

Zach Abramczyk is a rising senior at NC State, majoring in Business Administration with a concentration in Finance. He is also Managing Director of Bell Tower Capital Management, NC State's student-managed investment fund. Prior to joining Regions Bank as an investment banking summer analyst, he worked as an investment intern with NC State's Office of Investments for a year and a half.

"ASaP and KIETS provided me with a platform to develop real-world skills like public speaking, critical thinking, project management, and a plethora of other soft skills through a hands-on,

> their peers. Nine students earned a chance to attend the annual DECA International Career Development Conference. KIETS jumped in to support the expenses for Jackson's champions who didn't have the means to travel to the conference. "The great thing about KIETS," says Jackson, "is that they are about supporting teachers. But beyond that, the real guts of their mission is to influence students in the classroom. It ripples from K-12 to the college classroom, and it accelerates. Students go farther faster because of

> KIETS's support!"

of Management. Jackson's students

entrepreneurial education. The ASaP courses I participated in made me a better person and professional, impacting my life well beyond the realm of business. Through ASaP courses and the KIETS platform I co-led three, year-long research projects, one of which involved writing a complete business plan for the Student **Organization DECA. All three projects** were presented at state- and internationallevel competitions. It was through one of these plans I landed an internship with a local software startup, jump-starting my professional journey and allowing me to gain real-world entrepreneurial experience as a high school student."

One group of Jackson's students had the opportunity to present their startup plan alongside the TEC teams at the spring presentations in the Poole College were also keynote speakers for a dinner



Dan Jackson

sponsored by the Social Entrepreneurship and Innovation program at NC State. The teenagers passionately described what they had learned about social entrepreneurship in devising projects to solve societal problems.

In addition to support from KIETS and the eGarage, Apex Friendship High School came to campus to make connections with NC State Libraries, the NC State Entrepreneurship Clinic, the NC State Social Entrepreneurship and Innovation program, and the Biomanufacturing Training and Education Center (BTEC).

FUELING THE ENTREPRENEURSHIP ENGINE



C State's entrepreneurial ecosystem could not have reached its current expansive moment without the support and

resources of many entities which have served as partners in KIETS's efforts. From the start, KIETS has focused on high risk, high reward projects, using seed funding that has been leveraged by grants and investments from others. Both philanthropic and traditional venture capital are tapped in these efforts.

NC State's Office of Research Commercialization is the clearinghouse for new ventures. It stewards all the intellectual property created at the university. Half of that task is providing compliance with federal and state regulations for patents, the disclosure of

new inventions, the sale of intellectual property, and the receipt of royalties that come into the university from properties that have been taken to market. "The other half of our task," says Assistant Vice Chancellor for Research Commercialization Wade Fulghum, "is helping very early technologies developed at NC State to move toward licensing and the launch of startup companies." Fulghum says the growth in startup ventures has been profoundly shaped, in part, by recognizing this work as an economic development strategy for the State of North Carolina. This core value that Frank Kenan emphasized and Chancellor Larry Monteith strongly promoted continues.



Wade Fulghum

"KIETS has made a tremendous contribution over these 30 years," says Fulghum. "They have shown by example how one program can lead to another, and they've kept on funding successful ventures, one after another." As a result, NC State has been among the early wave of

universities that have developed their own entrepreneurial ecosystems on campus.

"This idea," Fulghum says, "is now becoming a national norm. But beyond the seed funding KIETS has provided, Raj Narayan has served as a subject matter expert to us. Given his history with the TEC program, I see him as an ambassador for NC State ventures. He has a very forward-looking perspective, and his ability to identify winning projects has been phenomenal."

When Chancellor Randy Woodson was appointed, he picked up the torch and charged university leaders to double the number of startups being launched each year. "We were launching about five back then," says Fulghum." By FY 2021, NC State was launching 20 new ventures annually. To date, 190 startups and spinoffs based on NC State research have attracted some \$1.7 billion in venture capital, placing the university #4 in the nation for startups launched among universities without a medical school and #1 nationwide in active licenses and options.

With the Innovation Seed Funding (RISF) initiative described in the previous chapter, faculty have access to initial support for basic research across disciplines. The Game-Changing Research Incentive Program (GRIP) provides even more generous support for collaborative research. The phase that followstranslating the research into products suitable for the marketplace—also requires financial support and technical assistance. New concepts and products coming from NC State research labs often flow into

the TEC Program as faculty and students engage in the commercialization process. The Chancellor's Innovation Fund (CIF), founded by Randy Woodson at the beginning of his tenure, awards up to \$50,000 to support short-term, commercially focused research projects led by faculty. Raj Narayan serves alongside Michael Zapata on the selection panel for these proposals, helping university researchers broaden their networks and accelerate their prospects for follow-on funding. Some of these ventures go on to compete for support from the Daugherty Endowment Program, which is designed to support ventures that have already formed

a corporation.

Encouraging researchers to develop products with the end user in mind is a core value at NC State. In 2010 when the National Science Foundation created the ICorps Program, NC State began developing its own early training sessions for researchers who would be seeking federal funds to advance their ideas toward the marketplace. NC State ICorps, now led by Amy Parker and with support from



Amy Parker, ICorps

KIETS, helps researchers understand how to shape their nascent research into market-ready products and services that will meet the needs of the end user.

Recently the Office of Research Commercialization has joined with nine other leading research universities to become one of five ICorps Hubs selected nationwide by the National Science Foundation. NC State will receive \$2M over five years and will serve as one of three partner organizations, leading efforts to attract, train, and match industry mentors with ICorps teams from all universities in the Mid-Atlantic Hub. ICorps mentors help teams of researchers conduct market research and master the art of customer discovery through cold calls to potential end users. This five-week training program qualifies researchers for membership in the NSF's National Innovation Network and allows them to apply for additional funding to commercialize their products. Federal support for projects comes from a variety of sources, including the National Science Foundation, the Department of Energy, the Department of Defense, NASA,



Daugherty Endowment competition winners with Tom Miller (far left) and Raj Narayan (far right).

and the National Institutes of Health, among others. In all cases, economic development is the end goal.

"The largest single source of start up support for the commercialization of intellectual property is the federal government," says Wade Fulghum. It can come through the Small Business Innovation Research Program (SBIR) and the Small Business Technology Transfer Program (STTR). Making application to these programs is a challenging and intensive process. "It may take new entrepreneurs, unaccustomed to government grant guidelines, a year or two to prepare complex proposals for new ventures," Fulghum adds.

In collaboration with KIETS, the Office of Research Commercialization has established a formalized support process for new ventures that are drafting SBIR and STTR proposals. Through the **Spark Plug Program**, NC State researchers and startups apply for assistance to pay for the services of First Flight Ventures, an organization in Research Triangle Park that provides grant writing assistance to maximize the potential for success on these complex proposals.

Another critical source of support for new entrepreneurs comes through the Daugherty Endowment at NC State. "When Dick Daugherty decided he wanted to launch the **Daugherty Endowment**, KIETS agreed to match the annual payout from the endowment," says Amy Lubas, Director of Strategic Projects for NC State. "To date, the Endowment and KIETS have collectively given \$500,000 to seed entrepreneurial projects in this category." The Daugherty Endowment funds an annual competition for officially registered startup companies that have licensed NC State intellectual property within the past three years. This event helps the NC State Office of Partnerships and Office of Research Commercialization identify target companies working with NC State's intellectual property. The prize money can be used for critical early-stage business expenses with no strings attached.



Dick Daugherty

Many university staff have noted how the lack of stringent expectations and the flexibility in use of funds offered by Daugherty and KIETS have been critical to the success of new product development. "In any given year," Lubas says, "around 40 companies meet the criteria for Daugherty funding. Sometimes the unrestricted resources are used for a marketing study to help a company better understand its potential audiences. It may also be used

CELEBRATING 30 YEARS OF THE KENAN INSTITUTE FOR ENGINEERING, TECHNOLOGY AND SCIENCE

SEEDING THE FUTURE

to assist companies that can move more quickly to market."

While federal grants for startups are more restricted, Daugherty's early-stage support-matched dollar for dollar by KIETS to expand the pool of resources—comes with no strings. It can be used for business expenses such as travel or accounting, to attend conferences, or hire a patent attorney.

"In almost every case, Daugherty helps the young startup to leverage other funds from other sources," says Lubas. The 40plus startup companies that Daugherty has seeded to date have received close to \$40 million in follow-on funding after receiving the initial funds from Daugherty/KIETS. "Seventy-five percent still have a faculty member running the company, but all of them have a faculty associate," Lubas adds.

Lubas's office works with economic development entities and builds partnerships with corporate interests all



Abby Phillips

over the state. "We can never say enough good things about Dick Daugherty," she says. "He was engaged with the Office of Partnerships from the beginning, which is why he chose this direction for his endowment. He has helped this university in so many ways. He is a force and a huge asset to NC State. He leads by example, and people follow today in the same way that he led the IBM facility in Research Triangle Park."

Following a successful model developed by Duke University, NC State has also established the Wolfpack Investor Network (WIN). This coalition of angel investors, which NC State alumni can join with an annual fee, offers members several opportunities a year to hear from eight to 10 early-stage companies looking for ground floor investors. Pitch sessions, networking with the local entrepreneurial community, and social time with fellow alumni are part of the appeal. "Members are alumni helping out fellow alumni and getting a glimpse of what kind of intellectual property the university is creating," says Abby Phillips, Assistant Director for Member Services.

KIETS has been a funding partner with WIN from the beginning. As a member of the Steering Committee, Raj Narayan helped in structuring the organization. "We relied on Kenan to get us off the ground, and they have continued to give us seed funds every year," Phillips added.

Housed in the KIETS offices at the Hunt Library, the WIN staff do not lead any investment deals; they work with other similar investment networks and share



WIN members at a presentation

best practices. They are a member of the Triangle Venture Alliance, which includes similar membership groups from the University of North Carolina and Duke. WIN collaborates with NC State graduate students with expertise in business, engineering, and other disciplines to create due diligence reports for WIN portfolio companies. Lisa Chang, director of the TEC program, sources students for the diligence studies needed.

By 2022, the WIN program had selected 33 portfolio companies with three companies having exited the program, yielding a return on investment ranging from 1.5 to 14 times the original investment made by the initial WIN partners. Phillips

says the exit and payout to investors can take five to seven years of work on the part of these companies. In the case of those already liquidated, two of the ventures were acquired by other companies and the third was liquidated through a merger with another firm.

"The Wolfpack Investor Network provides a way for NC State alumni to show their team spirit beyond athletics and beyond philanthropic gifts," says Phillips. "These serial entrepreneurs are amazing. Some are students who are no more than 24 years old, yet we've had two companies come out of an MBA class project with a single technology, and both companies are thriving."



Strengthening **Classrooms**

THE KENAN FELLOWS PROGRAM FOR TEACHER LEADERSHIP

The StateView Hotel on Centennial Campus sits on a rise facing west. On a lush April afternoon, sunlight pours into the ample windows surrounding a large meeting space in one wing of

the building. Here, more than two dozen K-12 teachers from across North Carolina, already natty in cocktail attire, are setting up project demonstrations on long tables. As Kenan Fellows, these highly motivated classroom leaders have worked for the past year with corporate and faculty mentors to devise ways to make STEM education as inspiring and relevant to their students as possible. Their projects were first conceived during a three-week summer internship with North Carolina experts in agriculture, manufacturing,

pharmaceuticals, energy, environmental science, and other STEM fields. Earlier in the day the Fellows presented their projects to each other, and now they are welcoming their faculty and corporate mentors, KIETS board members, and other invited guests-including Kenan Fellows from past cohorts-to learn about their fellowship year of intensive professional development. Many donors to the program will also be present to share in the results of their investments in these teacher leaders.

Kenan Fellows spend 3-4 weeks on-site with their mentor company in a summer internship.

The full fellowship lasts one year and includes 80 hours of leadershipbuilding professional development and a final project implemented during the school year.

This banquet and celebration is the first in three years because of precautions taken during the Covid pandemic. The excitement about a face-to-face gathering is palpable among the participants and staff. A sense of pride, accomplishment, and collegiality lights up their faces. Many Fellows from the previous two cohorts will join the group for the dinner and speakers to follow.

Jill Francis has more than 20 years of classroom experience. She teaches **Biology and AP Environmental Science** at Chase High School in Rutherfordton, North Carolina. Francis created a Project-Based Learning unit for AP Environmental Science. During her summer internship she had worked closely with Biltmore Farms in Asheville and her mentor there, Carol Steen. She studied the planning and philosophy behind The Ramble in Biltmore Forest, a model community of homes on 1,000 acres of preserved forest with trails and other natural amenities. Francis used a site map of the Asheville development



Jill Francis's Kenan Fellowship was supported by Meta.

to introduce her students to a real-world challenge closer to home. She wanted her students to consider all the possible environmental impacts on a tract of land in the foothills of the South Mountains that had been under consideration by Rutherford County's planning department for mixed use housing and town homes.

Francis divided her students into five teams and charged them to look first at the economics-what would be the most financially profitable use of the local land? The students then examined the soil and water impacts of various development options and the existing flora and fauna on the property. They discussed the "labor shed," meaning the proximity of workers to the land should it be put to industrial, residential, or retail use. They talked to wildlife biologists and engineers. They went to the property and took soil samples. Francis asked them to consider who would be the stakeholder groups in the county most concerned about this property.

The students looked at ecotourism as an economic development engine. (Rutherford County, which is already home to Lake Lure and Chimney Rock State Park, also has a new rail/trail project underway for cyclists.) Students learned how the endangered gray bat and the many species of migratory butterflies in the area might be affected or protected during development. One team looked at the idea of a solar farm on the land but concluded that it would spoil the view on the property. Another team proposed that the property be conserved and remain undeveloped.

Each student group had the option

of making a map using GIS technology or applying 3D modeling software to print a multidimensional representation of their proposed development for the tract with a 3D printer. The students' final presentations considered all the environmental impacts of the potential development and the challenges among competing interests, including environmental advocates, voters, policymakers, developers, and visitors to their county. As word got around about this unforgettable classroom exercise which her students thoroughly enjoyed, Jill Francis got calls from other environmental science teachers in the region, wanting to adopt her curriculum.

This is how the Kenan Fellows Program works.

At another table nearby, Laura McKinney had set up a double-paned, aluminum clad window like you might see on display in a home improvements store. On the exterior side of the window sample, she had turned on a heat lamp. On the interior side of the window, she set up a device to measure the radiant energy that was coming through the window, mimicking the sunlight that would shine through and warm the interior of a house in the summer.

"The company that makes this product, Atrium Windows and Doors, is five minutes from my school," McKinney explained, "and they are the second largest employer in Davidson County." McKinney is the first Kenan Fellow to be selected from her county and she was thrilled to find such a close-by teaching



by Cornerstone Building Brands.

resource for her Earth Science students and her own summer internship. "I have always struggled with a way to make the math involved in calculating energy conversions more readily understandable to my students," she says. "With this window display, they got it instantly!"

Not only is McKinney teaching her students about energy resources and consumption, but she is also mindful of preparing them for future jobs, especially those who want to stay close to home. "Getting a foot in the door at Atrium is great for our students. Now they know about a potential employer and once they turn 18, they could qualify for paid opportunities for additional schooling with

Laura McKinney's internship was sponsored

THE KENAN **FELLOWS**

- Deepen content knowledge through an immersive internship at a STEM industry setting.
- Learn about career pathways and STEM skills students need to succeed in the local and state workforce.
- Collaborate and connect with other educators, business leaders, and university researchers.
- Receive a \$5,000 stipend along with the 80 hours of tailored professional development.



Keith Burgess, a 2019-20 Kenan Fellow, teaches middle school science in Charlotte Mecklenburg Schools and is a winner of the Burroughs Wellcome Fund Career Award for Science and Mathematics Teachers. He is also working on his doctorate. "The Kenan Fellows

Program has been the most influential organization in shaping my pedagogical development as an educator. The expansive classroom strategies I received from KFP allow me to deliver high impact instruction to the students I teach. I'll forever be grateful for the opportunity to be part of this amazing teacher network. '



Yetta Williams' project was sponsored by the Burroughs Wellcome Fund.

Atrium Windows and Doors."

Across the room, Yetta Williams, a teacher at Spring Valley Elementary School in Durham has created a display outlining her project created with mentors Alfred Mays of the Burroughs Wellcome Fund and Julie Pittman from the NC Department of Education.

A fourth-grade math and science teacher, Williams worked with three organizations-No Child Hungry NC, Village of Wisdom, and Burroughs Wellcome Fund's "Diversity in Leadership" initiative.

She designed a project with the primary goal of having her students imagine how to eliminate food deserts and provide nutrition and clean water to communities without these amenities. Her students grew strawberries, beets, herbs, garlic, and spinach on the school grounds while they also learned about racial identity, social justice, inclusion, empowerment in community, and how to adopt a "Can Do Attitude."

Thanks to a grant from the Merck Foundation, Williams also took part in a statewide, cross-curricular series on food and the environment at the 2021 Mountains to the Sea Institute.

Through the school year Williams and her students researched the challenges of food insecurity in Durham and among the homeless. They learned how to make healthy food choices, and how to plant and share vegetables with neighbors. They developed PowerPoint stories and presented them to community leaders who visited the school and toured their garden.

As Roy, a fourth-grader at Spring Valley Elementary told a guest, "What I like about Ms. Williams is that she makes you feel confident about yourself, and she wants the best for you and she wants you to have a good life."

BRINGING SCIENCE TEACHERS FORWARD...



ccording to Education Week magazine, the linking of the words science, technology, engineering, and math appeared in print in professional education

discussions as early as the mid-1980s. But it would be 2005 before the nowubiquitous acronym, STEM, gained popular awareness with the establishment of a STEM caucus in Congress. (Today there is a Women in STEM caucus, too.) KIETS, however, was already fielding inquiries in 1999 from North Carolina public school teachers and colleagues in NC State's

College of Education about how KIETS might help improve K-12 science education across the state.

Applying their normal investigative procedures, Ruben Carbonell and Raj Narayan organized a one-day workshop led by Deborah Mangum, a Raleigh innovation consultant. KIETS wanted to know what STEM teachers really needed. The group they assembled included teachers, principals, corporate leaders, and representatives from the NC Department of Public Instruction. The meeting was hosted by SAS, the data analytics and software firm often called upon to provide thought leadership on pressing social challenges. Ann

Goodnight, SAS's Senior Director of Community Relations, was a key voice in the early development of the program as were Professor Hiller Spires of NC State's College of Education and representatives from IBM in Research Triangle Park. What KIETS learned at the workshop was that science teachers felt isolated and undervalued. STEM classrooms in public schools had limited resources, and teachers had limited access to the latest technologies and real-world developments in the field. Teachers wanted to be seen as professionals. They wanted more resources for curriculum development and hands-on learning for themselves and their students. They



ENGINEER GIRL

As part of its education and outreach mission, **KIETS** has provided support to EngineerGirl, a lively website designed to inspire the next generation of women with information about career opportunities in engineering and design, histories of women engineers, news from the field, and exercises/ experiments in design that girls can do at home. They also sponsor an annual writing contest, a video series, and an ambassador program. Simil Raghavan is a program officer with the National Academy of Engineering (NAE), and she manages the EngineerGirl program. "The Kenan Institute for Engineering, Technology, and Science at NC State was wonderful to work with," she says. "They listen carefully to program direction, and they actively work to make beneficial connections."



Joann Blumenfeld, a 2015-16 Kenan Fellow, was named one of TIME's 10 Innovative Teachers for 2022. She teaches in Wake County Public Schools. Blumenfeld was featured for her work with Catalyst, a high school program she founded in 2014 at the NC State Science House, which helps to better prepare students with disabilities for STEM careers.

"Being a Kenan Fellow taught me that we need to be innovators. and we must strive to create a better education system so all students can be successful. I put the skills I learned as a Kenan Fellow to use in the program I started: Catalyst: Creating **Opportunities in STEM** for Students with disabilities."

wanted more information on jobs in the field. The possibility of internships that would lead to curricula based on real applications of science, technology, engineering, and math emerged as a priority in the discussions.

Initially the program was called the Kenan Fellows for Curriculum and Leadership Development, then shortened to the Kenan Fellows Program for Teacher Leadership, with a focus on empowering teachers to take leading roles in their classrooms and communities. Deborah Mangum was hired as the program's first director.

Charles Coble, a former science teacher and KIETS board member who served as the Vice President for Policy Programs and Studies of the Education Commission of the States (ECS) and Dean of the School of Education at East Carolina University for many years, explained that curriculum development should actually

be a measure of teacher leadership, so leadership development became the primary focus of the program. Inventive and compelling lesson plans have naturally followed as demonstrated by the teachers selected for the program.

As the evening's celebration finally began at the StateView Hotel, the Kenan Fellows heard from a range of inspiring speakers. KIETS director Ruben Carbonell thanked the families who had supported the Fellows' participation in the program over the years. He acknowledged the generous support of industry, academic institutions, and local school systems. He thanked the retiring director Elaine Franklin, who had brought new initiatives to the Fellows program.

The much-anticipated keynote address that night came from Tabari Wallace, recent Special Adviser to the State Superintendent for Principal Engagement. A former math teacher soon to receive his doctorate,



Kenan Fellows Program Staff Top Row: Amneris Solano, Tara Spivey, Randy Pinion Bottom Row: Darrell Kain, Cordella Rashid, Elaine Franklin, Mark Townley, Carrie Horton,

Wallace spoke passionately about the profound pressure classroom teachers had experienced during the Covid pandemic. He praised these teacher/leaders for sustaining themselves and their students during the most extreme circumstances.



Tabari Wallace

The Kenan Fellows Program started with eight teachers in the Triangle area and has grown into a statewide network of 540 educators in 71 out of 100 NC counties. To date, 90 percent of Kenan Fellows remain in education five years after completing the fellowship. One hundred percent of educators said the program made them a better teacher, and on average, Kenan Fellows alumni lead 45 hours of professional development in a year.

Besides classroom projects, Fellows have also completed educational products for industry partners and community engagement events across the state.

The Kenan Fellows Program affirms the expertise, passion, professionalism, and commitment of the best K-12 educators in North Carolina.

ELAINE FRANKLIN. **FELLOWS PROGRAM** 2013-2022



AN INTERVIEW WITH DIRECTOR OF KENAN FOR TEACHER LEADERSHIP,

Elaine Franklin joined the Kenan Fellows Program as director in 2013. Before that she was executive director of the North Carolina Center for the Advancement of Teaching (NCCAT). She is also the former Director of the Center for Mathematics and Science Education (CMSE) at Western Carolina University. In the first three decades of her career, Franklin was a classroom teacher.

What attracted you to the Kenan Fellows Program?

I was drawn to the idea of working with our high performing teachers—really great teachers and giving them that extra boost from professional experiences that would help them become effective leaders in and beyond the classroom.

What is the essence of the Kenan Fellows Program?

The founding idea was not only to have this Readership program for teachers but to bring them into a working relationship with professionals in other fields, particularly STEM fields. That is wholly unique, and I don't think there are many programs around the country that do this, even now.

What is one of your principal beliefs about teaching?

I have never seen teaching as something that should be siloed and kept within the school walls. It should be very connected to what happens outside the school walls. We, as teachers, should be able to help our students also make those connections to the world of jobs, careers, innovation, and creativity.

How have you helped to expand the program during your nine-year tenure as director?

We've made a continuous effort to move around The state, particularly reaching out to rural areas of North Carolina. We've worked strategically in regions where we didn't have much of a footprint to identify funding partners and other entities who could host and mentor our fellows. We select 25 to 30 Fellows per year, so we are getting closer to having Kenan Fellows and alumni of the program who represent every county in the state.

Now that the Fellows Program has been around for more than 20 years, what do you see as the most meaningful impact?

It's interesting because so many of the teachers A that come into this program don't want to leave the classroom. They aspire to be leaders. They want to have a voice. They want to have influence, but they also want to teach. They know the importance of that job, and that is really inspiring.

At our last five-year assessment, we saw a retention rate of more than 90 percent among these teacher leaders who had been through our program. Sure, we've had some who wanted to have more of a voice in policy. An example is LaTanya Pattillo, a Kenan Fellow from 2012, who served for four years as the teacher advisor to North Carolina Governor Roy Cooper. Others have decided to go on and earn their doctorates. They have become teachers of teachers, and they are working in colleges of education in various parts of the country.

What do you hear from Fellows about what they most valued in the fellowship experience?

Besides the networking with passionate Colleagues, we hear that they have learned new ways of organizing their work. They go into these companies for their internships, and they see the way that teams in business work. They begin to realize the value of getting students out of their isolation and put them into problem-solving groups. When students work together on a project, they communicate with each other. Teachers have restructured their classrooms. They are creating more project-based learning, which is, of course, a major focus of the Kenan Fellows Program.

Can you mention some of the corporate and industrial partners who have worked with the Fellows?

The North Carolina Electric Cooperatives have Abeen an incredible partner for us because they're in every county. We've been able to place a partner with them every year in different parts of the state, and they do really neat stuff-like taking a teacher up in a bucket truck to get a closer look at the equipment on a light pole. Teachers can take those kinds of experiences back to their students with stories and pictures, and maybe the status of that teacher rises in the eyes of her students as she rises up in that bucket truck.

The North Carolina Farm Bureau has also been a strong partner with a huge variety of opportunities for our teachers to learn up close about agriculture, a huge industry in our state. Biogen goes way back with us as a fabulous partner that has also encouraged other biotech companies around the Triangle to work with us. All of these partners help North Carolina students understand what their future can be in the state's science, engineering, and technology-based workforce.



Kenan Fellow Kari Cobb - NC Electric Cooperatives

Your team has created the new STEMwork program, an additional facet of the Kenan Fellows Program. Can you describe that?

STEMwork is a year-long blended (online and A offline) professional development program that includes eight online asynchronous sessions, face-toface industry visits, and meet-ups with facilitators and their team members. For 2022-23 we have 20 school districts lined up to fully implement the program. Each school district will have an alumnus of the Kenan Fellows Program who will lead a team of five to seven other teachers through a condensed version of our internship program. This group will also go into businesses and industries in their community on day trips. They'll spend a half or full day to get a better idea of what the STEM-related jobs are in their communities and to build career awareness among the teachers. They will be developing personal relationships with local firms so that they can then go back to the classroom and design a project-based learning unit that is connected to the local economy. Our STEMwork website already has eight online modules that we developed to help those teachers work through building their learning project. The Kenan fellow who works with them will also be guiding them along the way. The idea is that they have a person who's local, who's done this in their classroom, and can be their advisor. In other words, these veterans of the Kenan Fellows Program will be our extension agents. With STEMwork, we will have at least a hundred additional teachers who will be getting this kind of experience and exposure through the Kenan Fellows Program and sharing the possibilities with their students.

EDUCATORS OF EXCELLENCE **AT THE NORTH CAROLINA MUSEUM OF NATURAL SCIENCES**

s director of the North Carolina Museum of Natural Sciences from 1990 to 2012, Dr. Betsv Bennett led the creative transformation of this state-sponsored educational facility into the Southeast's largest natural history museum. Today the museum not only hosts more than a million visitors each year, including legions of school groups, but it also conducts research and conservation initiatives statewide. In one of his many advisory roles



Betsy Bennett

on and off the NC State campus, KIETS director Ruben Carbonell was appointed by the governor to serve on the Museum Advisory Commission for the facility which is in downtown Raleigh. The partnership that began with that appointment has provided invaluable technical support and networking opportunities for the museum.

"Ruben was always giving me good advice about how to work with the scientific community and NC State," said Bennett. Early on in his advisory role Carbonell took a special interest in the museum's work with public schools. Then-director of education Mary Ann Brittain had created a program for science teachers that was strikingly similar to the Kenan Fellows in both philosophy and execution.

"Mary Ann believed if you took K-12 teachers out of their comfort zones to another country during the summer, they would be better able to learn about the natural systems at work in that country and in their own backyards. She knew they could also use that direct experience in the field to create new curricula for their students back home," Bennett explained.

Initially called "Teacher Treks," Brittain took teachers into the field across North Carolina and to Belize, the Amazon, and Yellowstone National Park to explore new habitats and wildlife. The practical field experiences inspired teachers and gave them effective techniques and new ideas for teaching the natural sciences in their home classrooms.

It didn't take long for Bennett and Brittain to join forces with the Kenan Fellows Program for Teacher Leadership. Soon, at

least two Kenan Fellows were participating each year in the treks abroad. The Museum eventually renamed the program the "Educators of Excellence Institutes."

"Ruben wrote a grant to the National Science Foundation to support the Kenan Fellows' collaboration with us, and that grant helped the Museum and KIETS leverage additional funds for both our programs," said Bennett. "Then we began planning for a new Nature Research Center adjacent to the Museum. Ruben and KIETS Associate Director Raj Narayan helped us negotiate with NC State for professional staffing."



NC Museum of Natural Sciences

Bennett was aiming to build a series of laboratories framed in glass in the Nature Research Center, a separate wing of the Museum that now occupies an entire city block in Raleigh. She wanted to identify a team of researchers-inresidence who could work in this setting, allowing museum visitors to witness them conducting experiments and other investigations. Her ambitious idea also included joint appointments (and shared

salaries) that would be provided by the museum and several universities in the UNC system, including NC State. Dan Solomon, now Emeritus Professor of Statistics and Emeritus Dean of the College of Sciences at North Carolina State University, jumped at the chance to support the joint appointment of an NC State scientist as director of the new Nature Research Center. Working with academic leaders and philanthropists across the state, the museum eventually created six joint appointments, including the director of the Nature Research Center, three additional science researchers from NC State, one astronomer from Appalachian State, and a microbiologist from North Carolina Central University, all working part time in residence at the museum. KIETS has continued to assist in program development at the Nature Research Center. Meanwhile, the Museum of Natural Sciences has also expanded to include facilities in the towns of Whiteville and Greenville, at Contentnea Creek in Grifton, and at the Prairie Ridge Ecostation on the

edge of Raleigh.

"I think KIETS is an extraordinary organization, and I admire Ruben and Raj for their strategies and success in acquiring matching funds," said Bennett, who joined the KIETS board upon her retirement from the museum in 2012. "Not only are they big thinkers, but they are great financial stewards. They are always challenging organizations to go to the next level. Their support has also recently helped to leverage state funds for the new North Carolina Children's Museum."



Jeff Milbourne, Ph.D., a 2010 Kenan Fellow, is a 2015 recipient of the Presidential Award for Excellence in Mathematics and Science Teaching for grades seven through 12. He is also a 2014-15 Albert Einstein Distinguished Educator Fellow. He earned his doctorate in Science Education in 2016 from NC State University and is now a STEM coordinator at the California Polytechnic State University.

"Professional development opportunities tend to snowball, such that you can often trace your journey back to a single experience. For me, that experience was the Kenan Fellowship: the program provided me with the network, opportunities, and mindset that ultimately led me to Washington, where I worked on federal education policy."



Public Engagement

IDENTIFYING NEEDS, SETTING GOALS

KIETS public outreach projects over the years have been consistent—reflecting Frank Kenan's forward-looking approach to generating economic development in North Carolina, providing educational

opportunities in STEM-related fields, and leveraging funds to identify problems and deliver solutions.

From its modest beginnings in 1986, The Emerging Issues Forum-launched by Governor Jim Hunt and housed at NC State-was fundamentally created to enhance the economic prosperity of North Carolina. Established as a nonprofit, non-political entity, the forum set out to gather a group of international, national, and statewide thought leaders and stakeholders on a yearly

basis to consider various challenges and opportunities facing the state and region. The aim was to strengthen public awareness and understanding of the issues, find common ground among diverse populations, and move toward setting goals and addressing challenges. For more than three decades now, this annual gathering has brought attention to a range of critical topics, including early childhood development, healthcare, generational divides,

energy, finance, technological

THROUGH THE YEARS: INSTITUTE FOR EMERGING ISSUES TOPICS

2015

Innovation Reconstructed

- · Ray Kurzweil, renowned inventor, tech guru, and Google engineering director
- ADM Michael S. Rogers, Director, National Security Agency
- Steve O'Donnell, EVP Racing Operations & Chief Racing Dev. Officer, NASCAR

2014

Teachers and the Great Economic Debate

- Amanda Ripley, Author,
- The Smartest Kids in the World
- JPasi Sahlberg, Director General, Centre for Int'l Mobility and Cooperation (Helsinki)
- Hon. William Haslem, Governor, State of Tennessee

2011

An Idea Exchange for Healthcare

- Clayton Christensen, Professor, Harvard Business School
- Indra Nooyi, Chairman and CEO, PepsiCo
- Sanjay Gupta, M.D., Chief Medical Correspondent and Neurosurgeon, CNN

2008

North Carolina's Energy Futures:

Realizing a State of Opportunity

- Thomas Friedman, The New York Times
- Jeffrey Immelt, Chair and CEO, General Electric
- Kenneth Lewis, Chairman, CEO and President, Bank of America
- Rajendra Pachauri, Chairman, Intergovernmental Panel on Climate Change

2007

Transforming Higher Education: A Competitive

- Advantage for North Carolina
- Margaret Spellings, U.S. Secretary of Education
- Ja Song, Former Minister of Education, South Korea
- Lawrence Summers, Charles W. Eliot University
- Professor, Harvard University

2005

My Health Is Your Business: Making Healthcare Work in North Carolina

- Bill Clinton, 42nd President of the U.S.
- Newt Gingrich, Former Speaker, U.S. House of Representatives
- Steven Reinemund, Chairman and CEO, PepsiCo
- Phil Bredesen, Governor, State of Tennessee

2003

- Jump Starting Innovation: Government, Universities & Entrepreneurs
- Louis Gerstner, Jr., Former Chairman, IBM Corporation
- Mary Harney, Deputy Prime Minister, Ireland

2002

Biotechnology and Humanity at the Crossroads

of a New Era

- Tommy Thompson, Former Secretary, U.S. Department of Health and Human Services
- John Edwards, Former U.S. Senator, State of North Carolina
- Kathleen Kennedy Townsend, Former Lt. Governor, State of Maryland

innovations, higher education, public schools, the global economy, the environment, entrepreneurship, creativity, manufacturing, and power in politics. Top experts in their fields and high-profile speakers from around the globe come to North Carolina to discuss these issues in a public venue with significant media attention.

In 2000 when NC State Chancellor Marye Anne Fox asked KIETS to take over the management of the Emerging Issues Forum, which had previously been administered through the provost's office, KIETS director Ruben Carbonell accepted the challenge and suggested at once that the Forum be expanded.

"We were identifying national trends on issues that are of particular importance to North Carolina," says Carbonell. "We had 800 or more in attendance each year, and they enjoyed the day tremendously, but there was nothing more concrete than that. I told the Chancellor that I would like to involve faculty and students in choosing the topic, preparing the forum, and developing outreach activities for legislators. We wanted to reach into those communities or parts of the state that are affected by these issues."

Chancellor Fox was open to the idea, but she told Carbonell that no funds were available to underwrite such an expansion. Carbonell immediately turned to the KIETS Board and asked them to set aside funds to hire a director and incubate the organization for five years. The board agreed. Funds were raised to sponsor the forum itself, and Noah Pickus, a political scientist from Duke, was hired to run the new organization,



Left to Right: Raj Narayan, Betty Kenan, Noah Pickus

"The Institute began to grow years as director, Noah Pickus told a reporter: "We accomplished proof of

which was renamed The Institute for

Emerging Issues (IEI). The NC Legislature also granted a small budget for operations. organically," says Carbonell. Of his three concept. We demonstrated that when we have both a new economy and new political administration in the state, there is a pressing need for an organization that raises big picture issues and gets leaders in business and the universities to address long term as well as immediate issues." In January 2007, Anita Brown-Graham, who had served on the IEI board, was appointed to direct the organization. Brown-Graham, trained as an attorney, had taught at the UNC School of Government from

1994 to 2006, specializing in governmental liability and economic development aimed at revitalizing communities. She served as director of IEI from 2007-2016. During her tenure the White House named her a 2013 Champion of Change for her work at IEI. Most recently, the *Triangle Business Journal* awarded her the inaugural 2021 Andrea Harris Trailblazer Award, first for her role at IEI and now as the leader of the NC Impact Initiative at UNC Chapel Hill.

"Anita took IEI to its full height," says Carbonell. "It had been established as a formal institute within the UNC System. It began to receive funding from a huge range of grantors, and Governor Jim Hunt became extremely active again in the organization."

At IEI Brown-Graham worked closely with a group of leaders who were talking about naming a building for Governor



Anita Brown-Graham



Jim Hunt

Hunt on the NC State campus to recognize all that he had done for the university, a process which ultimately led to the creation of the Hunt Library on Centennial Campus.

"I had the real pleasure, the once-in-alifetime pleasure, of being associated and deeply engaged in the construction of the amazing Hunt Library." Brown-Graham says. "Then, in moving into the library, we quadrupled the size of our team and became an even better partner with the Kenan Institute."

"It's satisfying to think back on this," says Carbonell. "What began as a modest operation took five years of incubation. You don't do these things overnight, but we hung in there, and the KIETS board allowed us to continue."

In 2016 IEI transitioned to the Office of the Provost at NC State as a universitywide public policy institute, which was part of the dream to begin with—a dream that was made true by the talents of all the directors and interim directors—Noah Pickus, Raj Narayan, Luke Bierman, Anita Brown-Graham, Leslie Boney, Sarah





Langer Hall and the highly experienced and influential Board of Trustees and staff.

Another outreach project, **Innovate NC**, began as a special endeavor by the Kenan Fund to invite collaborations among the four Kenan Institutes. The Kenan Creative Collaboratory was created to incubate innovative projects that focus on research, education, economic development, performance, ethics, or policy and practice, along with topics that cut across these areas. Kenan Creative Collaboratory projects may draw participants from two or more of the four institutions that house a Kenan Institute. KIETS worked with the Kenan Institute of Private Enterprise at UNC-Chapel Hill to support the IEI and Innovate NC.

Beginning in 2015, IEI partnered with five communities across the state to launch Innovate NC. A local innovation council of diverse citizens was established in the cities of Asheville, Wilmington, Greensboro, Wilson, and Pembroke. Each team was charged with mapping the assets of their local communities to inform the development of strategic plans for accelerating entrepreneurial innovations tailored to each city. The longterm goal was to build and sustain local innovation ecosystems and to share best practices across the state with other cities.



BRIDGING THE DIVIDES

y 2017, under the leadership of Leslie Boney, the former UNC System Vice President for International, Community and Economic

Engagement, IEI began focusing for the first time on crowdsourcing North Carolinians across the entire state to learn what emerging issues were of greatest concerns to everyday citizens. They found that bridging the many divides that have developed in North Carolina over recent years is a profound concern. The divides are multifaceted—between rural and urban, across diverse groups in the same communities, and with gaps in the availability of technology, economic opportunity, and mental health services for all citizens.



Leslie Boney



Rural Faith Communities Conference

In response to these findings, IEI established relationships with more than 30 community-based initiatives across North Carolina and developed projects addressing gaps between rural and urban communities, gaps in broadband availability, and the variable levels of educational attainment across regions. The first regionally based Emerging Issues Forums in 2018 and 2019 brought IEI's signature forum out of Raleigh and was more accessible to participants in every part of the state.

With the challenges presented by the Covid pandemic in 2020, IEI moved to virtual convenings and continues its work in bridging divides across the state through programs delivered both virtually and on the local level.

As Leslie Boney told reporters at the announcement of his retirement in 2022, "It's been my lifelong goal to work at NC State, my model of how a university can boost social and economic prosperity when it extends itself, teaching and listening and learning in its surrounding communities." Now, under the leadership of interim director Sarah Langer Hall, a 12-year

veteran of the organization, IEI continues to work across disciplines while reaching into local communities on multiple fronts. IEI has been building relationships with rural faith communities with a grant from the Duke Endowment. This project taps local churches as anchor institutions to help address food insecurity among rural communities and to promote family health and safety.

IEI is also helping students from nine North Carolina universities to identify a big issue they want to examine and address together. PILOT 21 (Policy Innovation Leaders for Tomorrow), sponsored by the Z. Smith Reynolds Foundation, has identified students at Duke, NC A&T State, NC Central, NC State, Shaw, UNC Asheville, UNC-Chapel Hill, UNC Wilmington, and

Wake Forest with a passion for public policy who will work together to devise policy solutions to critical community problems. With multiple corporate supporters, IEI is also highlighting the inequities in broadband availability across the state through a project called **BAND-NC** which provides technical assistance, training, and mini-grants to communities across the state to develop and implement digital

inclusion plans.

IEI, like so many other programs seeded by KIETS, has successfully evolved from KIETS's immediate purview and is an important NC State initiative led through the Provost's office. Their offices in the Hunt Library are close to KIETS headquarters, and the synergy and partnership continue.



IEI has a digital presence in the Hunt Library in addition to its offices

EXTENDING STEM

nder the rubric of public engagement, KIETS has also broadened its support of annual activities related to STEM education. The

Maria Mitchell Association Women of Science (STEM) Symposium

offers inspiration and support to STEM educators and women at all stages in their science careers. These symposia are distinctive for their hands-on, experiential learning and the opportunities for mentorship provided for younger women.

Maria Mitchell was America's first professional woman astronomer. She lived in Nantucket Massachusetts, and was also a librarian, naturalist, and educator. The King of Denmark awarded her a medal for the discovery of a telescopic comet in 1847, and she eventually became a professor of astronomy at Vassar College. Mitchell



Maria Mitchell Association Women of Science Symposium

was a founder of the Association for the Advancement of Women and the first woman member of the American Academy of Arts and Sciences. She also became one of the first women to work for the federal government. The Maria Mitchell Association provides additional opportunities for women in the sciences, including a museum internship, post baccalaureate research fellowships, and a range of high school and undergraduate internships.

It was only natural for KIETS to offer support to the Maria Mitchell Association, making the 2022 virtual symposium available to a wider audience, including students, staff, and faculty at NC State. KIETS has also helped with speaker recruitment, including the keynote presentation by Dr. Nancy Gray of the Gordon Research Conferences, a longtime KIETS partner. Shawna Young, an alumna of the Kenan Fellows Program for Teacher Leadership and executive director of the Scratch Foundation was also invited to speak. KIETS's resources allowed the proceedings to be accessible for those who are hard of hearing.



In 2001, Dr. Chris Brown, a Professor of Plant and Microbial Biology at NC State, approached KIETS about supporting his research in astrobiology, which is the study of how plants grow in outer space. KIETS collaborated with the Office of the Vice Chancellor for Research at NC State, and the Office of the Vice President of Research for the UNC General Administration to develop the NC Space Initiative (NCSI), which was housed at KIETS. Brown was appointed director and served until 2007, leading research, outreach, and education in space-related STEM topics and promoting economic development efforts in the aviation and aerospace industry.

NCSI supported several programs including the Habitation Institute, a multiinstitutional scientific partnership with Rutgers University and the Army Research Office focused on the discovery and testing of new technologies to support human activities within controlled environments on Earth and in space. NCSI also developed Adventures of the Agronauts, an online, agriculturally-themed science curriculum originally developed for elementary school students. Working with a Kenan Fellow teacher leader, Agronauts was expanded to include relevant topics for middle school students, and adapted for use by museums, 4H clubs, and home schools.

Through NCSI, Brown and KIETS Associate Director Raj Narayan also led an effort to analyze the aero/space cluster to determine its role as an economic driver for North Carolina. Partners in the analysis included the NC Department of Commerce, the Vice Chancellor for

Extension and Engagement at NC State, the NC Community College System, and several national organizations and industry representatives. The result was a whitepaper, Ready to Soar: Aviation and Aerospace in NC, which was used to inform the NC Department of Commerce's efforts in recruiting aviation and aerospace companies in NC.



NCSI report Ready to Soar

Brown also became the director of the NC Space Grant during his tenure at NCSI. Beginning in 1991, NC Space Grant established its headquarters at NC State and began collaborating with colleges and universities across the state to publicly promote aeronautics and space-related sciences. As an entry point for STEM students and teachers with dreams of space exploration and rocket science, the program provides scholarships for future teachers, internships with NASA, and other competitive opportunities for teams of K-12 students to learn about careers in the space industry. Today, NC Space Grant is led by Dr. Susan White, Director of NC Sea Grant,

THE GORDON-KENAN **GRADUATE RESEARCH** SEMINARS PARTNERSHIP

he cascading effect of KIETS's seed funding is perhaps nowhere more evident than in the long partnership with the nonprofit membership

organization, Gordon Research Conferences (GRC). GRC provides an

international forum for researchers working in the biological, chemical, physical, and engineering sciences. The organization hosts conferences worldwide with content created by the members themselves. GRC began in the late 1920s on the campus of Johns Hopkins University and has expanded to include nearly 40,000 annual participants in nearly 400 events each year. These conferences provide a vehicle for researchers to advance the frontiers of science by candidly discussing their pre-publication research. The meetings allow researchers from around the globe, who may often be working alone or in small teams, to present new and risky ideas to colleagues in a supportive and collaborative environment. Informal networking and community building is also a function of the organization. The attributes and values of GRC were a natural fit with KIETS.

In the 1990s, KIETS joined with GRC to provide seed funding for the Gordon-Kenan Summer School-two, three-week-long science courses held in the North Carolina mountains and taught by members of the GRC community to science students at the college level. By 2001, this program had

morphed into a new opportunity for graduate students in the sciences. The Gordon-Kenan Graduate Research Seminars

(GKRS), which are now ongoing, provide a two-day meeting designed specifically for graduate students, post-doctoral students, and other scientists with comparable levels of experience. Under the early leadership of Carlyle Storm, the late director emeritus of GRC, the seminar was held at the conclusion of the Gordon Research Conference, which caters to senior scientists.

Then came Nancy Gray, the first woman appointed president and CEO of GRC in 2003. Gray recalled from her own days as a graduate student in organic chemistry the thrill of meeting the extraordinary scientists at the Gordon Research Conference and found it to be a life-changing experience. In her new leadership role at GRC, she suggested that the seminars for up-andcoming researchers would have more impact if they were offered before the main event for senior scientists.

"Today the students present in their own seminars and then flow right into the conference," Gray explains. "That way, they are better prepared to hobnob with their mentors who may include Nobel Laureates and other senior scientists in attendance." Since this expansion of the program, the growth in student participation has been phenomenal. Ninety-five percent of graduate research seminar participants go on to attend the Gordon Research Conference that follows their own seminars.

KIETS's funding has provided a measurable impact. According to GRC, since 2001 KIETS has provided seed funding for 200 new

Gordon-Kenan Research Seminars. The funding has also helped leverage \$10,470,671 from private and federal sources and helped provide registration and travel support for 4,074 GKRS registrants, which is roughly 44% of all the participants over this period.

KIETS also supports the creation of approximately 16 brand new graduate level seminars each year. "If these seminars stand on their own financially via registrations, they are repeated in subsequent years," Gray says. "As of now, we are offering 365 graduate seminars over our two-year cycle."

In the two decades from 2001 to 2021, the chairs of the Gordon Kenan Research Seminars and the Gordon Research

Conferences have raised nearly \$3.7 million in federal funding and nearly \$6.8 million from private industry partners. In North Carolina alone, these investments have had a profound impact on the scientific community. During the two decades ending in 2001, 4, 365 scientists from North Carolina have attended 2,968 GRC conferences or seminars. In addition, NC State scientists have Nancy Gray participated as speaker/

presenters 279 times and have chaired 17 GRC conferences or seminars.

Not only has GRC's partnership with KIETS been a magnet for additional funding, but the programs have also begun to consider the challenges of diversity and inclusion in the scientific field. GRC has intentionally

Equity and inclusion have been key "We are committed at KIETS—on our "At a minimum we have assured their percentage of representation in their disciplines," Nancy Gray says. "In the seminars overall, 50 percent or more are chaired by women scientists." As an organization, GRC has also created an ongoing forum for conversations about unconscious bias, safety in the scientific workplace, and barriers to equity and career advancement among underrepresented groups. KIETS and the Gordon Research

emphasized and promoted equity and inclusion in its choices of speakers and others in leadership roles, something Nancy Gray is very proud of in her role. operating principles for KIETS as well. Says KIETS associate director Raj Narayan, own team and in the support we provide to our partners-to encourage diversity and inclusion from all the communities we serve, including those traditionally underrepresented in the past." that women present their research at these seminars in equal proportion to Conference are paving the way to a future in science in which the next generation of leading-edge researchers will better represent the diversity of the world in which they make discoveries, solve problems, and improve the lives of citizens around the globe.



As an organization, GRC has also created an ongoing forum for conversations about unconscious bias, safety in the scientific workplace, and to equity and career advancement among underrepresented groups.



Challenges For The Future

AT THE "FUZZY EDGE" OF DISCOVERY

As the Kenan Institute for Engineering, Technology, and Science reaches beyond the 30-year mark, two challenges-climate change and global health—will be priorities in future.

As director Ruben Carbonell likes to say, "We work at the fuzzy edge of discovery." It is fitting then, that this work of global importance to North Carolina's environmental and human health begins at the edge of what was once the "New World," first encountered in 1584 by English explorers on what is now North Carolina's Outer Banks.

Roanoke Island and its two villages-Manteo and Wanchese—each named for the indigenous leaders of the tribes who met the English when they landed

here, is still a place of robust research and discovery. The Coastal Studies Institute (CSI), located on the leeward side of the island, represents a multiinstitutional research and educational partnership of the UNC System. The university partners include North Carolina State, UNC-Chapel Hill, UNC Wilmington, and Elizabeth City State. Two major environmental groups supported by KIETS-NC Sea Grant and the North Carolina Coastal Federation-also have a significant presence here.

An early KIETS partner, Professor Stanley Riggs, retired in 1999 after 33 years of teaching at East Carolina University. But Riggs has not stopped preaching



Stan Riggs

about the dangers of overdevelopment on the North Carolina coastline. His book, North Carolina: Land of Water, presents a vision for saving what he calls "the golden goose we have been trying to kill." Riggs is referring to the extraordinary natural resources-trees, rivers, wildlife, and the fragile Outer Banks-that comprise the

predominantly rural eastern half of the state. Riggs was the academic driver behind the Coastal Studies Institute, and before that he was the founding faculty member in the Department of Marine Sciences at ECU.

Over the years, KIETS has supported Riggs in his systems approach to helping North Carolina's poorest eastern counties preserve their natural assets and increase awareness of their value among residents, school children, and public officials. Riggs wants to increase environmental tourism, clean and maintain the region's riverine resources, and preserve old growth forests-some 3,000 years old. Even as Riggs is stepping away from his public role as founder of the nonprofit organization, NC Land of Water (NC LOW), he is encouraging KIETS and other groups to set up a field science program in the region for local students, university researchers, and interns from a variety of disciplines.

After years of conducting multi-million dollar research projects in the state, Riggs is pessimistic about the fate of North Carolina's barrier islands. "The change is not happening fast enough," he says. "The



Coastal Studies Institute

right hurricane could take them right off the map. North Carolina failed in the 1990s when we had a chance to fix that."

Riggs has also written the optimistic story of North Carolina's Cape Lookout farther south, near Morehead City. "It was doomed when a railroad was planned to run out to that end of the coastline, but we recognized the disaster in time to save it in 1976 and make it a National Seashore. Now it is the most viable coastal system in the United States, if not the world," Riggs says. "It was a graveyard of trash and junk. We can do it again for other parts of the coast if the power base in the region gets behind it." Stan Riggs continues to stay connected with KIETS as the organization moves into its fourth decade and welcomes KIETS's collaborations with other partners in the region.

Farther down Roanoke Island below the **Coastal Studies Institute is the Wanchese** Marine Industrial Park. The village of Wanchese, bordered by the Roanoke and Pamlico Sounds, is a hub of fishing, seafood processing, and boat building. Along the shoreline, fragile wetlands are battered by erosion from storms, sea level rise, and boat wakes. To combat this destruction, the NC Coastal Federation, another KIETS partner, has built a project to demonstrate effective sills or barriers that are made alternately of wood, oyster shells, and granite. Each design can be emulated by private landowners, and through this demonstration project, the Federation is encouraging shoreline protection up and down the coast.



and local officials in Bertie County, NC

The Coastal Federation is the state's only nonprofit organization that focuses exclusively on "protecting and restoring the coast of North Carolina through education, advocacy, and habitat preservation and restoration." The Federation depends on its members and many partners in industry, government, and academia to carry out its mission. Near the Federation's satellite office in Wanchese, a short dock extends eastward into Broad Creek on the Roanoke Sound where partially submerged cages containing young oysters cultivated from spat (oyster seed) are secured on posts and bobbing in the whitecaps on one side of the dock. This half-acre oyster farm is also a demonstration project showing an example of the increasingly successful mariculture industry that's being developed on North Carolina's coast. The future viability of the region's fishing and mariculture urgently depends on public understanding of the threats to our food and water by toxins in stormwater runoff, unbridled shoreline development, and

global warming.

Stan Riggs and Tom Earnhardt with KIETS staff

KIETS worked with the Coastal Studies Institute and the Coastal Federation in the development of its transformative Oyster *Blueprint*, now in its fourth edition. The plan calls for the restoration of oyster habitat through the planting of recycled oyster shells and the patching of existing reefs along the state's estuarine shoreline. North Carolina has 2.2 million acres of shallow sounds, rivers, and creeks that make up one of the largest estuarine systems in the United States. The Blueprint mandates the support of oyster farming as demonstrated in Wanchese. It also calls for safeguarding designated oyster sanctuaries up and down the coastline that have been closed to oyster harvesting but remain open to hook and line fishing.

"KIETS's support has been instrumental in our oyster development work," says Federation founder and director Todd Miller. "Most recently, KIETS has helped with our watershed management plan for the Newport River, a critical oyster habitat, and they helped to fund NC State researchers who are helping us assess



Ryan Bethea, NCCF Board Member and Founder of Oysters Carolina



Todd Miller

water quality in the region." Two NC State faculty—Natalie Nelson, an Agriculture and Biological Engineering professor, and Angela Harris, a civil engineer with a specialty in water quality and global environmental health—are currently working with the Coastal Federation with KIETS's support.

The state's goal through the Blueprint is to build oyster farming to a \$100 million industry by 2030. In 2020, the industry was valued at \$20 million. Enhancing the state's wild oyster habitat is also fundamental to the viability of the state's fishing industry. "By comparison to the neighboring oyster population in the Chesapeake Bay," says Miller, "their population has gotten so low that Virginia must seed the habitat they are restoring. We were starting to head in that direction in North Carolina, but our interventions are working, and we still have wild spat growing naturally on our new recycled reefs." On the Pamlico Sound, the Federation set out to restore 500 acres of wild oyster habitat with the endorsement of KIETS and a grant from the National Oceanic and Atmospheric Administration (NOAA). "We are now at 400 acres and expect to finish building reefs in three years to reach our goal," says Miller. Restoring wild oysters in the Pamlico also has a positive impact on white, pink, and brown shrimp, and fish species such as grouper and sheep's head. The commitment to this work is long term and ranks high among the many projects that KIETS will be monitoring in future years.

In addition to its mariculture work, KIETS is supporting the ongoing effort to understand the threat posed by warming water temperatures and the probable link to climate change. A shellfish pathologist from the NC State Veterinary School, Tal Ben-Horin, is working with NC State's Center for Marine Sciences and Technology in Morehead City to assess mortality reports among shellfish from pathogens that thrive in warmer waters. As might be expected, KIETS has also placed Kenan Fellows teachers in summer internship opportunities with the Coastal Federation. Says Todd Miller: "I appreciate that the Kenan Institute has made an effort to understand our rural communities, the local culture, and the real needs and challenges we face in Eastern North Carolina."

NC Sea Grant, another long-term KIETS partner headquartered in Raleigh, funds research that benefits North Carolina's coastal communities, the seafood industry, and notably, the state's enormous living assets of freshwater from rivers and creeks. The organization is part of the UNC System, serving all 17 universities and the community colleges. NC Sea Grant provides resources and information for individuals and communities on coastal resilience and watershed protection, including infrastructure solutions to flooding, dune recovery, hurricane recovery strategies, wastewater treatment and stormwater management, and transportation alternatives. Sea Grant promotes environmental literacy by working with K-12 schoolchildren and their teachers through activities that include writing about environmental



NC Sea Grant works to protect North Carolina's coastal waters and its many freshwater rivers, creeks, streams and lakes.

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issues, participating in trash cleanup, understanding the dangers of aquatic plastics, and appreciating the value of the state's fishery resources.

In the last 30 years coastal development has mushroomed in North Carolina. Climate change was not part of the conversation when KIETS began its work, though water quality, harmful algal blooms in freshwater, storm water challenges, and hurricanes were at the forefront of environmental concerns. "Now," says NC Sea Grant executive director Susan White, "water is the biggest driver. We have seen years of drought impacting our reservoirs and drinking water, mostly in other states, and we know hurricanes are a challenge. We are considered a wet state, but we are not prepared. We need to be thinking about having too much water at the wrong time and too little water at the wrong time-both of which will happen with our changing climate. We've already seen it." Sea Grant provides educational

opportunities and fellowships for undergraduate and graduate students in aquaculture, community policies and practices around storm and wastewater, wetland reconstruction, and sea level rise.

White says that KIETS has always been accessible and supportive to Sea Grant. "One of the major benefits of working with KIETS is their network and their willingness to share. They see connections across partners that I wouldn't have noticed. They are always willing to brainstorm. And I was also able to help as they were developing their Climate Leaders Program."

The KIETS Climate Leaders Program,

housed in the suite of offices where KIETS is headquartered in the Hunt Library, is a brand-new program. The first cohort of climate scholars was selected in 2022. All are full-time NC State students-two undergraduates and eight graduate students. Each is paired with a faculty mentor for a year, and they participate in internships, much like the Kenan Fellows Program for Teacher Leadership. "Our goal," says CLP program manager Amanda Mueller, "is to give our students the opportunity to connect and communicate with world leaders in the climate realm."

Like other Kenan-funded projects, the participants are from diverse backgrounds and academic disciplines. They work together with the goal of building a greater appreciation for the partnerships and collaboration required in solving climate challenges. Among the first cohort are students with backgrounds in landscape design, economics, public policy, engineering, and natural sciences. Each cohort will also focus on developing leadership and communication skills, participating in community engagement, and deepening their knowledge of climate science.

"What I am loving about the many conversations we have had around how to structure the program," says Mueller, "is the emphasis on community engagement and leadership skills. We are emphasizing the ability to find out what individual community needs are and what the problem is behind the need. Our focus is not on fixing the problem for people but

on how we can work together to address it. Climate change affects everyone, and whether we agree on how it's happening or why it's happening, the ultimate effects are still there."



Amanda Meuller

In the long run, Mueller hopes to build a program that is self-sustaining, with contributions from the collaborating institutions who benefit from having interns work with them. In this effort, she has been supported by Ruoying (Roy) He, a Distinguished Professor of Marine, Earth and Atmospheric Sciences at NC State and an expert on the development of predictive models for water currents and how they interact with air currents to affect the environmental quality of our coastal waters. KIETS has supported his work for years, and he has played a key role as KIETS's first Senior Faculty Fellow in guiding the direction and planning for the CLP.

The climate challenges ahead are inextricably linked to global health. KIETS's work in these two complementary areas reflects the systematic way that the Institute has developed strategies for addressing the enduring problems of our time. A recent study published in the journal Nature



Ruoying (Roy) He

Climate Change notes that over half of all known infectious diseases that threaten humans have been worsened by climate change. As KIETS continues to support and engage thought leaders and researchers in the areas of climate change and global health, they will examine and investigate these connections.

With its distinguished track record of support for research from federal agencies and private sources, and with KIETS's networking and support, NC State is certain to be involved in current and future work on threats to global health. KIETS was at the ready when the Coronavirus first struck, infusing supplemental funds in the development of hand sanitizer at BTEC and next-generation masks by the Nonwovens Institute (NWI) in the College of Textiles. BTEC was able to provide hand sanitizer made in its facility to local schools, the university, and the NC Museum of Natural Sciences. Behnam Pourdeyhimi, NWI Executive Director, was able to leverage KIETS funding with additional grants from NIIMBL and industry partners to produce millions of masks during the height of the COVID pandemic.



Susan White



Jethro Ssengonzi is a third year Ph.D. student in the Civil, Construction, and Environmental Engineering **Department at NC** State University. "The wide scale deployment of variable renewable energy technologies (VREs) offers a pathway to decarbonize the electric grid. During my Climate Fellows internship opportunity at the National Renewable **Energy Laboratory** (NREL), I will focus on understanding and comparing existing NREL models to my own computational model around peak demand."



Katy Hollinger, from Lancaster, PA, is a third year Ph.D. student in the Department of Marine, Earth, and **Atmospheric Sciences.** "I am running computer model simulations of hurricanes in North Carolina to understand how they may change as the climate continues to warm. For my internship as a Climate Fellow, I am working with a hydrologist at UNC-Chapel Hill to build a flood model for the river network in eastern North Carolina."

Faculty members Robert Handfield from the Poole College of Management and Ali Hajbabaie from Civil Engineering also played key roles in the U.S. response to COVID. They helped to solve supply chain challenges in the distribution of test kits and vaccines nationwide. Startup companies supported by KIETS grants have also tackled the technological problems in disease management issuing from new strains of infection coming from animals and other environmental sources.

NC State is uniquely positioned with the range and scope of its agricultural, veterinary, engineering, and biotechnological capabilities to address future health related issues. NC State research on food, water, and air is ongoing. The University ranks 6th in research expenditures among public universities without a medical school. To help create new research partnerships and to foster new technology developments, specifically in the areas of climate change and global health, KIETS has raised considerably its contributions to the Research and Innovation Seed Funding (RISF) program



Professor Joe Sagues in the Biological & Agricultural Engineering Department at NC State University received support from the RISF program.

for a three-year period. RISF provides incentives for faculty to work together and develop multi-disciplinary, high-impact research programs.

The Center for Human Health and the Environment, which serves as the nexus of environmental health science research at NC State, is supported by the National



Robert Handfield

Institutes of Health. The presence of the National Institute of Environmental Health in Research Triangle Park is another organization that adds to the local network. NC State also serves as the host institution for the Southeast Climate Adaptation Science Center, which works with natural and cultural resource managers to gather the data and build the tools needed to help fish, wildlife, and ecosystems adapt to the impacts of changing climate and land use. NC State and KIETS also stand at the nexus of science and manufacturing through their relationship to the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) as this organization continues its work to accelerate manufacturing innovations and capabilities to treat diseases with biopharmaceuticals.



2022 student researchers from Agricultural Biotechnology in our Food, Energy and Water Systems.

The KIETS-supported programs at BTEC, with significant leverage from the Novo Nordisk Foundation (AIM-Bio), and NIIMBL are in an ideal position to play a key role in the development of new technologies for the prevention, treatment, and cure of a wide variety of chronic and deadly diseases. The development process begins with drug discovery at a basic level and then requires process technologies for development and manufacturing to assure that drugs produced are affordable, safe, and effective.

"The production of biopharmaceuticals is undergoing a revolution," says KIETS Director Ruben Carbonell. "Not only due to the need for faster, more efficient development and manufacturing approaches, but by the increasing number of new drug modalities that are being investigated in clinical trials." The novel mRNA vaccines produced for treating COVID have greatly accelerated the area of gene and cell therapy as a way of treating large numbers of other diseases, and North Carolina has become a true hub of innovation for these types of drugs.

To reduce supply chain issues, the world needs new, less costly, and more accessible vaccines that are easy to transport and to

inject. In addition, there are many other cardiometabolic and infectious diseases for which there are no effective treatments. "In the years to come, the demands for personalized medicine delivered at bedside will increase," says Carbonell. "These are exciting times, and KIETS anticipates helping NC State play key roles in the development of all these new technologies." "Ultimately," says KIETS Associate Director Raj Narayan, "we try to create and support initiatives that are going to have a long-term impact, not just in North Carolina, but across the United States and across the globe. The way we do that is by working with others and helping them realize their visions for the kind of change they want to

see in the world."

same strategies."

Narayan notes that bringing together a variety of disciplines-connecting research to education to technology-will continue to create a rich platform for KIETS. "We are a small organization that is trying to have a big impact," he says. "More often than not, financial support is just one means to an end. It is the intellectual and human capital that makes the difference. In climate change and global health, we will pursue these



Kyle Vogt-Lowell is entering the third year of his Ph.D. program in Chemical and Biomolecular Engineering. Originally from Fort Lauderdale, FL, he studied biology to pursue a career in medicine, but has changed paths to focus on fighting climate change.

"This semester, I'm working for Sustaera, a Cary-based startup that's developing a direct air capture (DAC) technology capable of removing carbon dioxide directly from the atmosphere. DAC is one of a few technologies that removes more carbon dioxide from the atmosphere than is generated from the operation."

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We are also very appreciative of the leadership of NC State including the Chancellors, Vice Chancellors, Provosts, Deans, Directors, Department Heads, Faculty, Students and Staff with whom we have collaborated over the past 30 years. Your collaboration has helped us "think and do" in significant ways.

Many thanks to our university, industry, government and non-profit partners who have been critical to the success of our programs and work together with their significant investments of time, money and effort. We look forward to sustaining and continuing to build enduring, authentic partnerships with you.

Thank you to the outstanding KIETS team members over the years for your incredible work and commitment in leading meaningful and impactful programs that have touched and benefitted the lives of others.

We also would like to acknowledge and thank Georgann Eubanks, Donna Campbell, Alexander Isley and his team for their efforts, collaboration and wonderful work documenting and celebrating KIETS 30-year history.

We look forward to the next 30 years for KIETS and having you with us on this journey as we serve together to make a positive impact in the world.

Written by Georgann Eubanks, Minnow Media

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