



2015


ANNUAL REPORT

CUICAR

CLEMSON UNIVERSITY INTERNATIONAL CENTER FOR AUTOMOTIVE RESEARCH

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*CU-ICAR'S
2015 ANNUAL REPORT
FOCUSES ON THE*

AUTOMOTIVE ENGINEERING TALENT

WE GENERATE.

Each section of the report provides a deeper look at where and how our Automotive Engineering graduates are adding value and contributing in meaningful ways to the automotive industry, our economic prosperity and our community.

We hope you will enjoy this glimpse into the role CU-ICAR's outstanding alumni are playing in making the future even more promising.

Foreword by Frederick M. Cartwright
Foreword by Dr. Zoran Filipi

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Education



Foreword by Frederick M. Cartwright

Foreword by Dr. Zoran Filipi



2015

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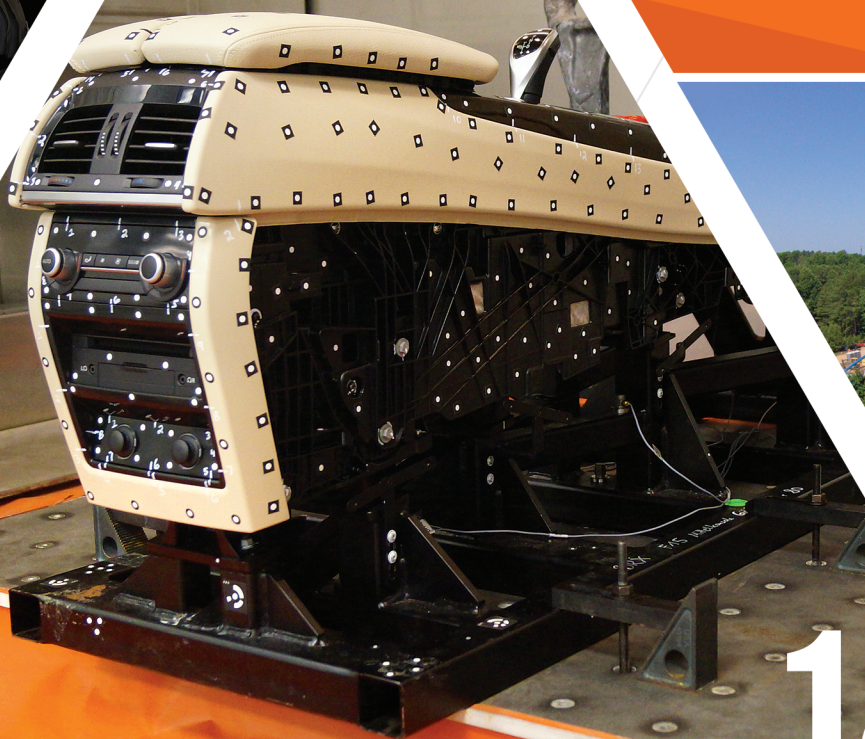
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Research & Development

FREDERICK CARTWRIGHT

One of the basic tenants of CU-ICAR is education – a specialized education, driven by industry need, and focused on advanced degrees in automotive engineering.

Now, 257 graduates later, we can look back on our success as well as think about our future. We hear from our industry partners that the graduates they hire from our Department of Automotive Engineering are some of the best and brightest in their companies. We also hear from our growing alumni base that their experience at CU-ICAR has prepared them to make an immediate impact at their companies. This is great news for all of us. We are accomplishing what we set out to do and that was to be the best-of-the-best in preparing the automotive leaders of tomorrow.

While any organization can claim to be focused on “talent development,” very few can truly be leaders in “the development of the best talent.” We

believe the CU-ICAR experience is uniquely focused on the development of the best talent. Our students gain a deep understanding of the vehicle “system,” a very important aspect of an increasingly-complex (and safe) smart phone on wheels. Students get hands-on, interdisciplinary team experience by participating in such game-changing vehicle projects as Deep Orange. And the very fabric of CU-ICAR’s design is to be collaborative with industry. Students get to interact with industry as a way of life, gaining an early appreciation of industry’s needs, as well as tangibly preparing them for life beyond school.

Shortages of technical talent exist all around the world. In the U.S. auto industry, the lack of skilled trades

workers and engineers is a perennial problem, exacerbated by the recovery and growth of the industry. In a recent Automotive News article (February 16, 2015), responding to a survey of automotive companies, 69 percent of respondents said they expect to suffer a shortage of engineers over the next 12 months. “The lack of engineering talent and skilled labor shortages continue to be top-of-mind,” the survey noted. This means that our job isn’t done. It’s never done and we should never be satisfied. We will remain focused on the industry’s evolving needs and “the development of the best talent,” utilizing the unique fabric that is CU-ICAR, but also flexibly adapting the learning experience to a rapid pace of innovation in automotive technology, global players and business models.

“
We are
accomplishing what
we set out to do
and that was to be
the best-of-the-best in
preparing the
automotive leaders
of tomorrow.
”

- Fred Cartwright



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CLEMSON



“

There is
so much
more on the
road ahead,
and we are
ready for it.

- Dr. Zoran Filipi

”

This is an incredible time to be in the automotive sector and at the helm of the Automotive Engineering Department. We have realized the original vision to create a world-class, multi-disciplinary program focused on automotive industry, and I am excited about the chance to continue growing a pioneering department that is already a success story.

I am honored to serve as the second chairman of the Department of Automotive Engineering (AuE) and Executive Director of the Carroll A. Campbell Graduate Engineering Center.

In 2015, we are living in a true renaissance of automotive research, driven by fuel economy regulation and global market forces. Our faculty members are on the forefront, with continued emphasis on materials and manufacturing, advanced powertrain, and vehicle system integration. Our total external research grants currently exceed \$3M, and industry partners include automotive powerhouses such as BMW, Michelin, Bosch, Fiat Chrysler Automobiles, General Motors, Honda and BorgWarner.

The growth in our Master of Science and PhD programs far exceeded expectations with a total student population over two hundred. We continue to produce top talent with strengths in key disciplines, the ability to work in multi-disciplinary

teams, and understanding of the product development process. Our innovative Deep Orange program enables students to grasp the connection between consumer expectations and vehicle design, something highly valued by the employers. The most recent project, Deep Orange 5, was unveiled at the headquarters of General Motors in Detroit and received wide praise and acclaim.

Clemson University's Department for Automotive Engineering is truly a magnet for the best and brightest, and a "go-to" place for talent. True to our mission, we supply graduates to major employers in SC, as well as the world. We are educating the next generation of industry leaders, and our alumni are likely to influence future decisions about locations of new production plants or engineering centers. It fills my heart with joy to see these young folks spread their wings, and you'll find feature stories about some of them in this report.

We are proud of the recognitions awarded to our faculty. My predecessor in the Chair position, Dr. Imtiaz Haque, was inducted into Thomas Green Clemson Academy of Engineers and Scientists, Dr. Robert Prucka received the Murray Stokely Award, Dr. Fadi Abufarha received the SME Young Faculty Award, and yours truly was elected an ASME Fellow.

I am delighted to lead the Department during this exciting time for the expansion of the CU-ICAR innovation eco-system, cutting edge research, and world-class education. There is so much more on the road ahead, and we are ready for it.

**DR. ZORAN
FILIPI**

**CHAIR &
EXECUTIVE
DIRECTOR,**

Automotive Engineering Timken Endowed Chair in Vehicle System Design

EDUCATION

The Department of Automotive Engineering's (AuE) cutting edge M.S. and Ph.D programs have continued to receive national and international recognition resulting in a record number of applicants for a limited number of spots. The growth in the graduate program since 2007 has been immense and it is now stabilizing around a figure of 200-210 students per year. Currently, 65 of the students are in the PhD program and the rest are Masters with 203 students from 18 different countries registered for the fall 2015 semester. Through May of 2015, AuE graduated a total of 28 Ph.D. and 229 M.S. students. Students from the program continued to draw attention from top industry players with a number of OEMs and Tier 1 suppliers making special visits to the campus just for the purpose of recruitment.



257 **DEGREES AWARDED**
 229 M.S. | 28 Ph.D.



203 **STUDENTS ENROLLED**
 138 M.S. seeking graduate students
 65 Ph.D. seeking graduate students



95% of Automotive Engineering Alumni are employed in the Automotive Industry.



18 Diverse student body with students from 18 different countries

7% Employed internationally after graduation



TOP ALUMNI EMPLOYERS

1. Ford Motor Company
2. Fiat Chrysler Automobiles
3. BMW Group
4. Cummins Inc.
5. Honda R&D Americas Inc

TOP EMPLOYING STATES AFTER GRADUATION

- 37% Michigan
- 22% South Carolina
- 6% Ohio
- 5% Indiana
- 5% California

GRADUATE INDUSTRY INTERNSHIPS

Today's automotive market is undergoing a revolution powered by connectivity, fuel efficiency, advanced materials and advance manufacturing. Tomorrow's challenges require a workforce with a special set of skills and Clemson University is poised to educate this top talent. Beyond the classroom, the Department of Automotive Engineering curriculum requires each Masters student to complete a 6 month industry internship. These professional experiences allow students to apply the knowledge they have acquired in the classroom while gaining real-world perspective.



Aaron Buster

Scientist, Southwest Research Institute

Masters of Science in Automotive Engineering
2015 Estimated Graduation

At CU-ICAR, all the courses are dedicated to the automotive field. Instead of getting a mechanical engineering degree with a few automotive classes, you are at a dedicated academic and research facility. The programs and assignments are directly applicable to my current internship. I wanted a focused degree on automotive engineering, received exactly that and am currently applying all the concepts at Southwest Research Institute. My manager said, "Aaron was able to jump in with very little guidance from our more experienced engineers and to make productive contributions to our research programs.... I can say I'm very pleased with the evident level of education CU-ICAR provides to their students."



Jaideep Singh

Testing Engineer, Honda R&D Americas. Inc.

Masters of Science in Automotive Engineering
2016 Estimated Graduation

Every course at CU-ICAR is well tailored to meet industry requirements. The knowledge of powertrain design and manufacturing processes helped me prepare for my current internship. The most important thing I learned at CU-ICAR beyond the academic scope is an ability to work on complex automotive problems with a team of different individuals from different countries and with different mindsets. My current Internship at Honda R&D has helped me realize the strength of my education at CU-ICAR even more. The kind of work I am doing at my internship is very similar to the kind of projects I have done in my course work. After the internship I will be able to appreciate the projects even more and would be motivated to work hard towards my graduation.

Preetam Ramesh

BERN Intern, Robert Bosch LLC

Masters of Science in Automotive Engineering
2016 Estimated Graduation

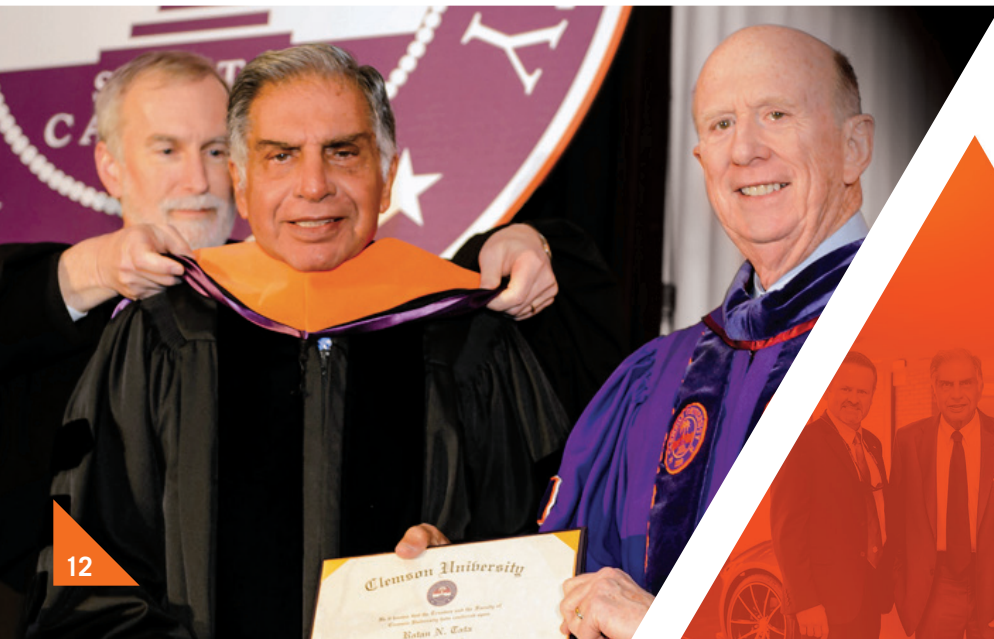
My internship has made me further appreciate the importance of the industry-oriented education offered at CU-ICAR. My internship involves building and testing oxygen sensors on a daily basis. The “Engine Combustion and Emissions” course offered by Dr. Prucka and Dr. Onori has played a huge role in preparing me for my internship, from the interview phase to analyzing and interpreting test results on a daily basis at Bosch. Moreover, the courses at CU-ICAR have given me the ability to approach and solve various problems at work logically and systematically.

RATAN TATA HONORARY DEGREE

The 2015 South Carolina Auto Summit concluded with a special ceremony by Clemson University presenting chairman emeritus of India's Tata Motors Ratan Tata with an honorary Doctorate of Automotive Engineering. Hundreds of industry and academic leaders gathered for this recognition of Mr. Tata's "enormous contributions to worldwide innovation."

As a part of the event, Tata was interviewed by Automotive News CEO, Keith Crane. This conversation between two distinguished automotive leaders provided insight for student, faculty, and industry attendees, to Tata's road to success.

Tata was the chairman of the major Tata companies, including Tata Motors, Tata Steel, Tata Consultancy Services, Tata Power, Tata Global Beverages, Tata Chemicals, Indian Hotels and Tata Teleservices. During his tenure, the group's revenues grew tremendously and totaled over \$100 billion in 2011-12. Tata Motors is India's largest automotive manufacturer and is making significant strides in global expansion.



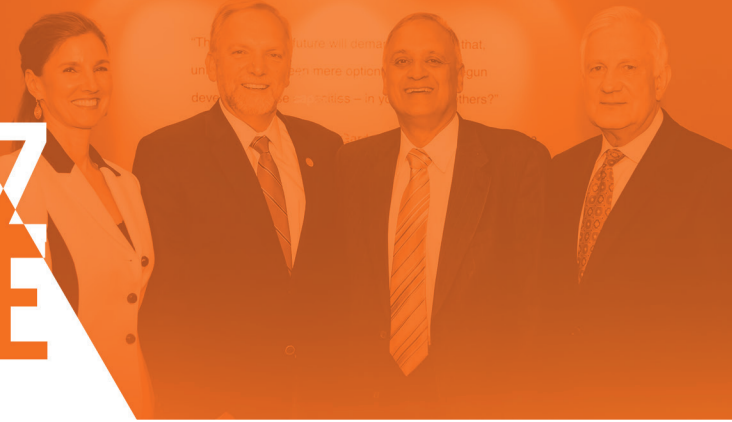
“

Mr. Tata epitomizes all that CU-ICAR stands for: international leadership in the advancement of the automotive industry and the fostering of economic development that benefits the local community, state and region.”

—Frederick Cartwright
Executive Director

”

DR. IMTIAZ HAQUE



In welcoming a great new leader and innovator to the Campbell Center, Dr. Zoran Filipi, we are honoring the accomplishments Dr. Imtiaz Haque has achieved in his time at Clemson University.

Dr. Haque was the Executive Director of the Carroll A. Campbell Graduate Engineering Center and Founding Chair of the Department of Automotive Engineering at Clemson University. He also served as past chair of the Department of Mechanical Engineering at Clemson University. Dr. Haque is a Fellow of the American Society of Mechanical Engineers and a member of the Society of Automotive Engineers. Dr. Haque has served as a consultant to numerous entities including industry and government. He is an active researcher and scholar having published extensively in areas related to vehicle and multi-body dynamics.

To recognize the magnitude of influence Dr. Haque has had in his years at Clemson University and CU-ICAR, the student lounge in the Campbell Center is now: The Dr. Imtiaz Haque Student Lounge. With great contributions from BMW Manufacturing Company, JTEKT North America/Koyo

Bearings, Michelin North America, Sage Automotive Interiors, and The Timken Company, this room was named after Dr. Haque because of his unwavering ability to connect with students.

In addition to the student lounge, Haque was also inducted into the Thomas Green Clemson Academy. “This award is the highest honor bestowed by the College of Engineering and Science,” said the dean, Anand Gramopadhye. “And just to illustrate how special this award is, fewer than .2 percent of the college’s alumni are academy members.”

“Clemson grows people,” Dr. Haque commented. “Clemson allows you to dream, and Clemson supports your dream. And that is really important. I hope we never, ever lose that. Clemson is about people.”



This award is the highest honor bestowed by the College of Engineering and Science.

—Dr. Anand Gramopadhye
Dean of the College of
Engineering & Science



DEEP ORANGE 5

In April, students at CU-ICAR unveiled its newest concept vehicle, sponsored by General Motors, at the GM Renaissance Center in Detroit, Michigan.

Deep Orange 5, the fifth generation of Clemson's concept vehicle program, is designed for generations Y and Z (young adults) who will live in mega cities in 2020. The vehicle enables social networking and mobility to go hand-in-hand, ultimately forming an emotional connection between the user and vehicle.

Each year, Clemson develops a new and distinct prototype vehicle with a specific market focus and technical objectives.

Deep Orange is a framework that immerses graduate automotive engineering students into the world of a future original equipment manufacturer and/or supplier. Students, multi-disciplinary faculty and participating industry partners work collaboratively to produce a new vehicle prototype each year.

The students were able to tackle the challenge of creating an urban mobility vehicle by incorporating cutting edge technology into each aspect.

“ We were very impressed with their holistic approach and final result of this accelerated product development process.

—Janet Goings
Associate Director of Research and
Development at General Motors

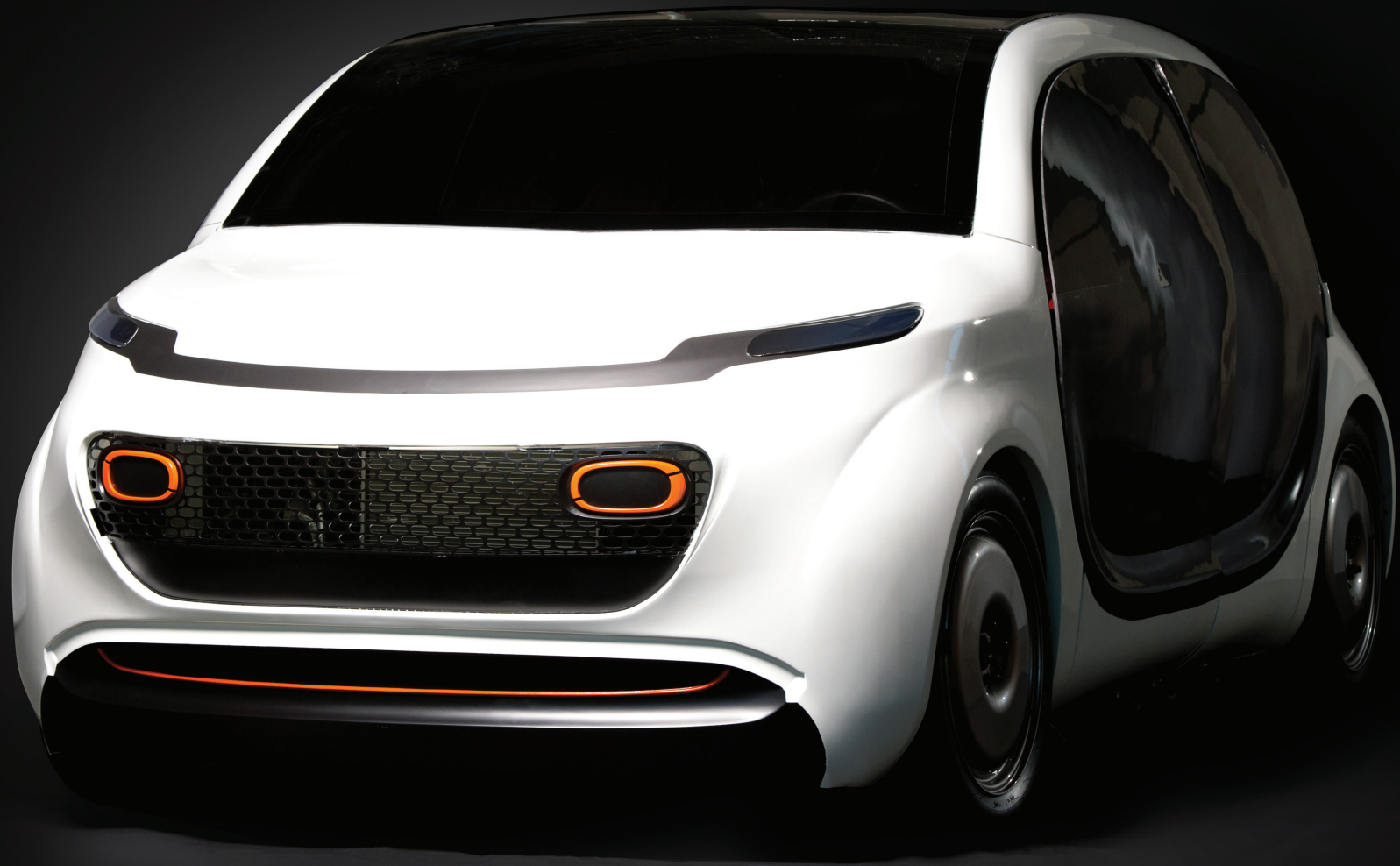


Rivkah Saldanha

When Rivkah took on the task as project leader for Deep Orange 5, she inherited the responsibility of managing a highly talented group of engineers. These responsibilities include everything from scheduling and budgeting, to promoting creativity and collaboration among students. “Dealing with people is one of the lessons I’ve learned how to consider where everyone is coming from. Being able to get people to think, to listen to each other, to collaborate with each other”

Janet Going, the associate director of Research and Development for General Motors said, “In the role of project manager, she’s having to balance a lot of different parameters, metrics, requirements, and make sure the whole vehicle is coming together...She had great perseverance, a willingness to listen and learn, and would step up to the hard choices when they had to be made.”

Rivkah’s hard work paid off. Upon graduating CU-ICAR, she will be joining General Motors as an Associate Architect Engineer.



Lightweight

The vehicle structure is designed for lightness while maintaining sufficient integrity to comply with all relevant crashworthiness standards. The purpose built construction makes extensive use of carbon fiber reinforced plastics, and aerospace aluminum and honeycomb composites.



City Friendly

Wide-opening double-hinged doors with integrated side sills and B-pillarless design allow for comfortable egress/ingress in tight urban parking spaces. A two-piece rear hatch concept allows for full opening even in restricted spaces.



Mobility Lifestyle

A unique transformative interior supports a multitude of vehicle usage modes (driving, socializing, working, relaxing, storing, etc.) connecting seamlessly with the complex lifestyles of the generation Y/Z target consumer. The digital vehicle messaging offers a new way to connect with the outside world.

A photograph of three people smiling in front of a window with greenery outside. On the left is a man in a suit and tie. In the center is a woman in a black blazer and necklace. On the right is another man in a suit and tie. The background is a bright, slightly blurred indoor setting.

AWARDS & FELLOWSHIPS

BOSCH Fellowship Award

Vismita Sonagra, Graduate Research Assistant

Vismita Sonagra, a graduate research assistant in engine systems for the performance aftermarket, received \$20,000 to continue her outreach to boost K-12 education in science, technology, engineering and math (STEM).

The award was made possible earlier this year by a \$500,000 grant from the Bosch Community Fund, which established an endowment in perpetuity for automotive-engineering fellowships. The Bosch Community Fund is the charitable foundation of Robert Bosch LLC.

The program is aimed at inspiring the next generation of engineers and scientists and diversifying the workforce. Awards target exemplary students who are from groups with low representation in engineering and science, including women and minorities.

Sonagra's award was announced by Mike Mansuetti, who received a mechanical engineering degree from Clemson University in 1987 and is now president of Robert Bosch LLC.

“Vismita is well on her way, and we are excited by the potential of those who will follow in her footsteps in the future. Together, Bosch and Clemson will help move students into STEM-related careers and... reach their full potential.

—Mike Mansuetti,
President of Robert Bosch, LLC

2015 Fellowships

Graduate fellowships help Clemson recruit and develop exceptional engineers who are passionate about shaping the future of the automotive industry. CU-ICAR's fellowship partners have direct communication with our top automotive engineers and are helping diversify and grow the talent pool.

BMW M.S. Fellowship

Melvin Babbs
Mitchell Fanning
Robert Knizek

Bridgestone Fellowship

Amrita Shah
Yang Yang

Deep Orange Award for Excellence

Sponsored by Toyota
Christopher Flegel
Aviral Singh

FEV Engine Technology Incorporated Fellowship

Jaideep Singh

Fulbright Scholar Award

Vinicius Ribeiro Leao
Breno Schwambach Costa

GEM Fellowship

Melvin Babbs

Mazda/GATE Fellowship

Mitchell Beckman
Patrick Clarke
Skylar Stamey

Robert Bosch LLC Fellowship

Vismita Sonagra

Safety-Kleen Fellowship

Mark Benton

Stäubli Fellowship

Melvin Babbs
Chandler Cook



Student Awards

Ph.D. Student of the Year
Mahmoud Abdelhamid

M.S. Student of the Year
Frederick Giffels



RESEARCH & DEVELOPMENT

CU-ICAR's research portfolio and philosophy are driven by industry needs. We continuously analyze the market and survey industry partners, industry leaders and automotive companies to determine their technology and R&D focus. Based on that knowledge, today the research clusters and "technology identity" of CU-ICAR are centered in the following seven areas: Advanced Powertrain, Vehicular Electronics, Manufacturing & Materials, Vehicle-to-Vehicle Infrastructure, Vehicle Performance, Human Factors/HMI, and Systems Integration.

FISCAL YEAR 2015:



26 *TOTAL PROJECTS*



22 *Industry Projects*



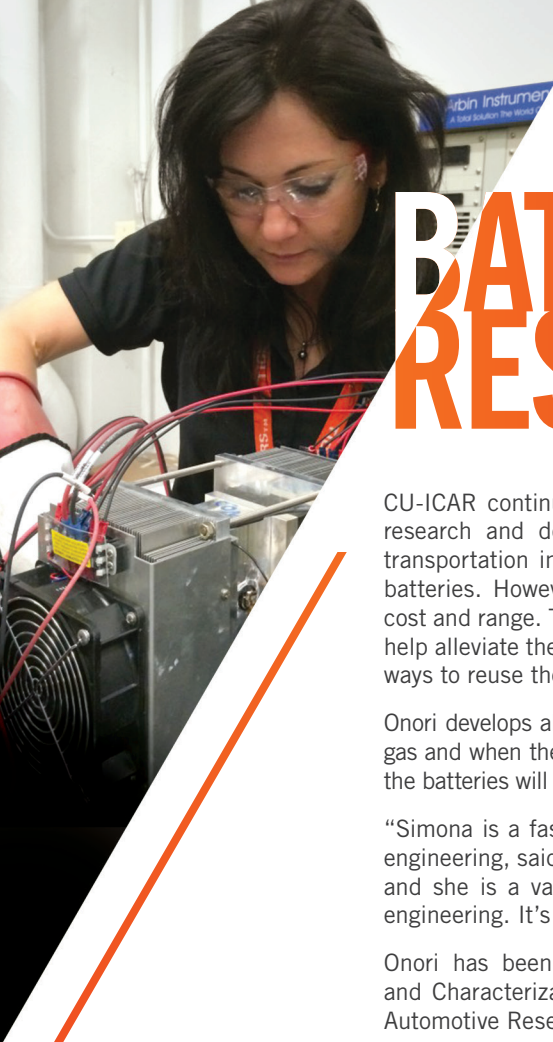
4 *Nonprofit, government & education projects*



\$3.6 million
in research & sponsored programs received by the Department of Automotive Engineering



84% *Over 80% of research conducted at CU-ICAR was sponsored by automotive companies in FY 2015*



BATTERY RESEARCH

CU-ICAR continues to be at the forefront of emerging technology academic research and development. The current understanding of technology and transportation indicate that the future of automobile propulsion systems are batteries. However, batteries have yet to overcome two logistical problems: cost and range. The research that Simona Onori conducts here at Clemson can help alleviate the latter of the two by helping batteries last longer and find new ways to reuse them once they retire from the road.

Onori develops algorithms that help hybrid cars decide when they should run on gas and when they should draw energy from the batteries. Relying too heavily on the batteries will quickly wear them out, so it can be a delicate balance, she said.

“Simona is a fast-rising expert in her field,” Zoran Filipi, chair of automotive engineering, said. “Her work has been published in several respected journals, and she is a valued member of the team in the department of automotive engineering. It’s easy to see why she is in such high demand worldwide.”

Onori has been putting lithium-ion batteries to test in the Battery Aging and Characterization Lab at the Clemson University International Center for Automotive Research.

Each hybrid car has a battery pack that contains hundreds of battery cells, each of which looks like an oversized AA battery. Onori puts those battery cells in a device called a Peltier Junction that allows her to control the temperature as she charges and discharges the cell.

In so doing, she can simulate how a battery would perform in any environment from the desert to the tundra.

Her experiments are opening new insights into how batteries degrade when used in hybrid, plug-in hybrid and electric vehicles. With the data, she works to improve vehicle efficiency and mileage.



My research aims at the development of algorithms to better utilize batteries in hybrid & electric vehicles.

—Dr. Simona Onori



CU-ICAR & DRIVESAFETY

Johnell Brooks of CU-ICAR and DriveSafety, a Utah based driving simulator company, have developed driving simulation systems specifically designed for rehabilitation and training purposes.

The partnership was established in 2010 with the vision of providing rehabilitation tools for clinicians to help individuals regain driving skills after experiencing functional losses. While the program was originally designed to assist aging drivers maintain their independence as long as safety possible, the program was quickly expanded to serve a diverse population ranging from wounded warriors to young adults on the Autism spectrum.

The CU-ICAR/DriveSafety partnership's approach to product development supports collaboration among clinicians, teachers and researchers. The driving simulators are now in nearly 40 civilian hospitals, occupational therapy clinics, schools, vocational rehabilitation programs, medical device companies, and U.S. Army, Navy, and VA hospitals.

The partners are developing new services, applications and technologies to improve the quality of patient rehabilitation and clinical effectiveness. At the same time, the team is creating marketable products and billable services which require a skilled workforce.

This program exemplifies CU-ICAR's mission of research, teaching, outreach and economic development where public and private partnerships among universities, health care facilities and industry work together to increase the quality of life of the citizens in the state of South Carolina and beyond.



Ken Melnick

South Carolina DriveSafety operations leader since March 2014



Simulators in the field

- 7 DriveSafety CDS-200 (entry-level version)
- 21 DriveSafety CDS-250 (original simulator)
- 10 DriveSafety CDS-250W (wheelchair version)



Over 80 invention disclosures since 2010




38 locations across the globe

Moldex3D

MOLDING INNOVATION



MOLDEX 3D PARTNERSHIP



This gift will further position Clemson and our lab at the forefront of injection molding research and training.

—Dr. Srikanth Pilla

In April 2015, CU-ICAR partnered with yet another elite industry corporation. Clemson received a \$1.625 million gift from CoreTech System Co. Ltd. (Moldex3D) to support education and research.

The software will advance Assistant Professor Srikanth Pilla's research and educational capabilities in injection molding, specifically on supercritical fluid assisted foam injection molding.

“This gift enhances the unique capabilities that we can do in my research lab at CU-ICAR and will prepare students for industry with hands-on experience,” Pilla said. “When using thermoplastic materials for body panels, interior parts and other components, injection molding with Moldex3D software is an important technology.”

“Moldex3D's simulation capability advances the fundamental understanding of my research lab's experimental research and reduces overall costs by being able to understand process physics and properties involved prior to physical experimentation,” Pilla further said. “With existing experimental infrastructure that includes the nation's only integrated MuCell® molding machine, this gift will further position Clemson and our lab at the forefront of injection molding research and training.”

Clemson's expansion of its industry partner portfolio continues to be a catalyst for the development of top tier automotive engineering students.



ALUMNI IN RESEARCH

Nandini Gowda Kodebyl Raju

Nandini Gowda graduated with a Master's in Automotive Engineering in August 2015 with a concentration in Advanced Powertrains. Pursuing research in advanced engine concepts, she was appointed an Advanced Short Term Research Opportunity (ASTRO) at Oakridge National Laboratories' National Transportation Research Center. Her responsibilities at the lab include one dimensional cycle simulations of light-duty advanced combustion multi-cylinder engines to investigate air-handling systems. Her research includes the design and analysis of different exhaust gas recirculation systems such as high pressure loop, low pressure loop EGR with Variable Geometry Turbines and dual stage turbochargers for advanced combustion strategies.

"I chose CU-ICAR because of the world class faculty and curriculum for advanced powertrains. It is a good amalgamation of practical and theoretical curriculum; hence it prepared me for both industry and research fields.

I was exposed to advanced combustion and engine concepts in Dr. Phillip's advanced IC engine concepts class, which aided me in obtaining my position at ORNL. During the course we reviewed, designed and simulated advanced engine concepts and presented to the engines research group at CU-ICAR. It was a constant collaborative learning process and frequent guest lecturers provided insight into current research conducted in the field of engines. The knowledge I gained at CU-ICAR has been instrumental in helping me achieve career pursuits and aspirations. "

Employer:

Oak Ridge Associated Universities
(National Transportation Research Center, Oakridge National lab)

Title:

Advanced Short Term Research Opportunity (ASTRO) Student Intern

Date of Hire:

February 24, 2015

Master's Degree:

Automotive Engineering

Professional Goal:

To work on engine concepts to improve engines fuel efficiency and also to reduce emissions

Awards/Honors:

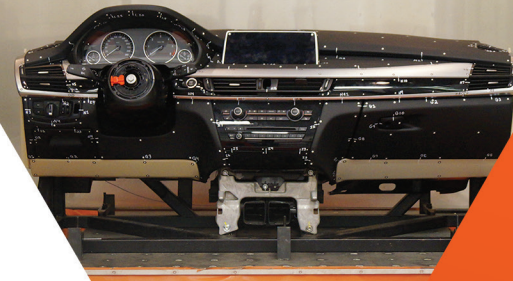
Southern Automotive Women's Forum (SAWF) Scholarship Recipient 2014

COMPONENT TESTING LAB

The Component Testing Laboratory at CU-ICAR has achieved accreditation to the recognized standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories, according to the American Association of Laboratory Accreditation (A2LA).

This milestone was reached shortly after the 2-year anniversary of this lab opening at CU-ICAR in Greenville, SC to perform validation testing of components for automotive suppliers and OEMs. The CU-ICAR Component Testing Lab joins thousands of like-minded, A2LA-accredited facilities that understand the value of providing high quality services that are backed by defensible data. Now certified to perform mechanical testing in compliance with several automotive, international industrial, and military standards, this accreditation process took careful planning and process development by lab personnel to achieve and maintain this important standard of technical competence. The accreditation of this lab reinforces what current customers already recognized in this testing facility, and

strengthens its viability to be used by new customers within the automotive supply chains and companies in other industries. The Component Testing Laboratory was launched by Clemson University in September 2012 to fulfill a testing need identified within the automotive industry of Upstate South Carolina and to strengthen business, academic, and research relationships on the CU-ICAR campus. It is also the first organization within Clemson University to achieve accreditation to this international standard.





ECONOMIC ENGAGEMENT

CAMPUS VISION

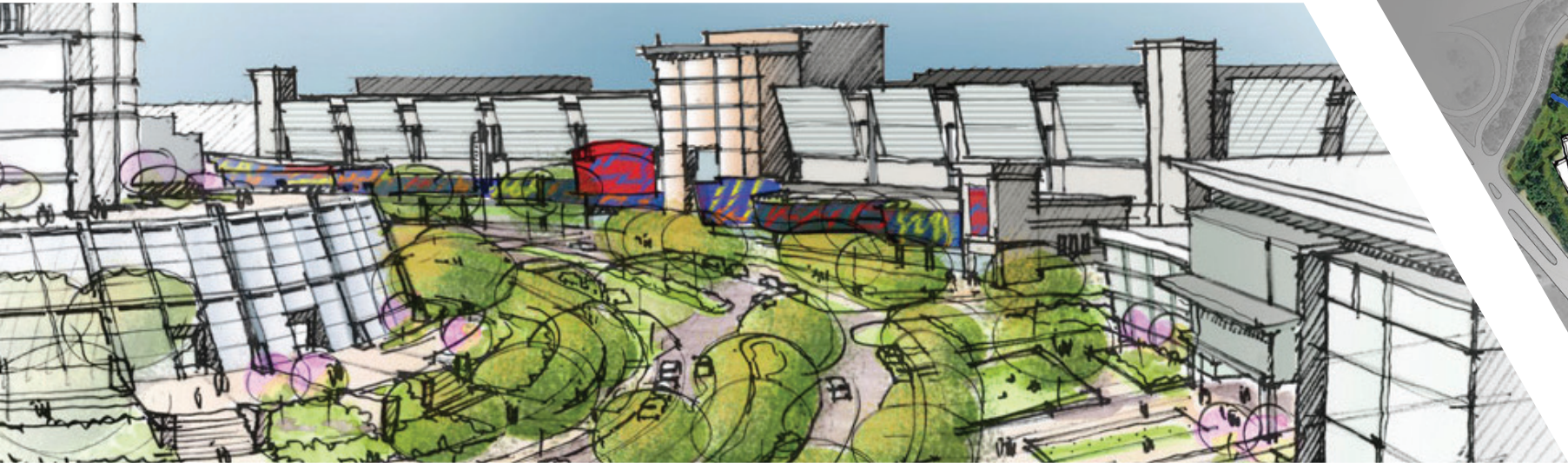
“Before everything else, getting ready is the secret of success.”

—Henry Ford

The vision for CU-ICAR is “to be the premier research, education and innovation enterprise in the world.” This is no small task and requires the long-term commitment of talent and resources from multiple stakeholders. As Henry Ford once said, “Before everything else, getting ready is the secret of success.” CU-ICAR has been getting ready. The launch of a successful Automotive Engineering program, contributions in key areas of research and completion of Technology Neighborhood I have been our first steps. We have built a strong foundation, upon which we can expect even greater success. In 2015 we completed a series of stakeholder meetings, involving industry, university and community leaders. Recommendations from these stakeholders help us set the stage for what is to come at CU-ICAR. Planning will continue into 2016.

In 2015, we are celebrating 10 years since the original Master Plan for CU-ICAR was developed. Quoting from this Master Plan, CU-ICAR is about “people—students, faculty, scientists, technologists, visitors and friends,” all coming to a campus designed to “bring people together” and provide “spaces for people to meet, talk, plan and celebrate.” CU-ICAR was initially conceived to “be a shining technology city” with each Neighborhood “a dense urban cluster of buildings” focused on bringing people together. These ingredients make up a recipe for an international icon, one that our many partners can be proud of.

CU-ICAR MASTER PLAN

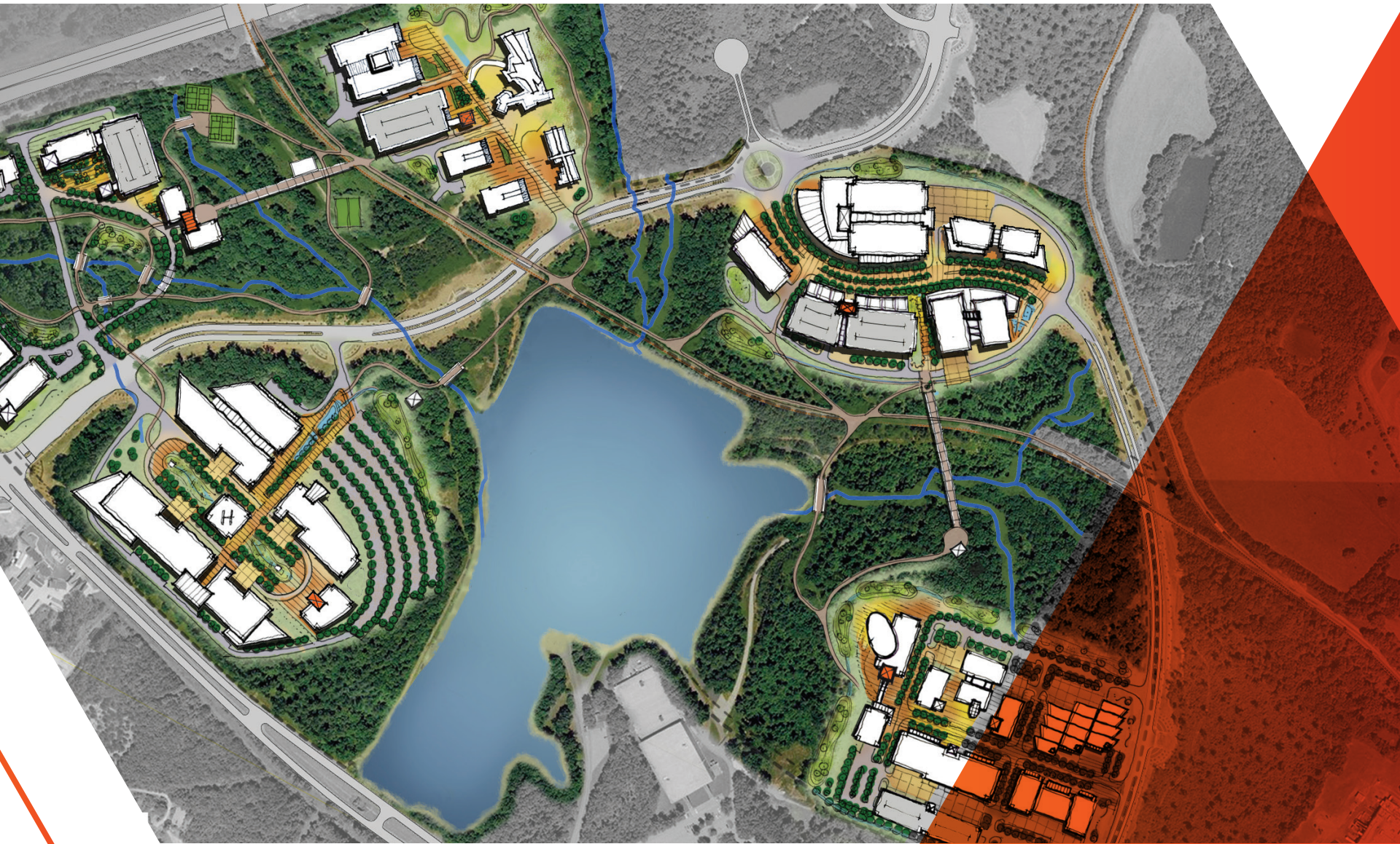


Clemson University Land Stewardship Foundation, Inc. (CULSF) plays a pivotal role in expanding and managing the CU-ICAR Campus. Operating with its own independent board of directors and president, CULSF is a 501(c)(3) affiliate of Clemson University and the Clemson University Foundation. As property owner, CULSF identifies and pursues opportunities to maximize the educational, research and economic development mission of CU-ICAR.

In 2005, CULSF played an integral role in creating the CU-ICAR Master Plan. This original document established the vision for the CU-ICAR's automotive ecosystem and what you see today. Recognizing the changing needs of the global automotive industry and how it has evolved, CULSF, in concert with

industry, university and our many stakeholders, is collaborating to build upon the vision for the campus while reacting to a changing automotive environment.

In 2015 the U.S. Economic Development Administration (EDA) granted \$395,000 in funds from the Regional Innovation Strategies program's Science and Research Park Development Grants competition to CULSF to fund the development of a new master plan for CU-ICAR. The new Master Plan will address the demands for workforce development, education, and the nature of the surrounding community, which have all changed substantially over the last decade and will better position CU-ICAR to serve its multiple constituencies and to become an even stronger force driving the South Carolina economy.



CENTER FOR MANUFACTURING INNOVATION



Greenville Technical College joined with Clemson University and partners including Governor Nikki Haley, Upstate advanced manufacturers, Greenville County Council, and other leaders to break ground on the Center for Manufacturing Innovation (CMI) today, where education for the advanced manufacturing workforce will be provided to serve the automotive, transportation, and other high-tech sectors.

The number one goal for the CMI is to increase the number of skilled workers for manufacturing in order to close the skills gap that has hampered the progress of many Upstate employers. Manufacturing in Greenville County is an

economic powerhouse, first in Gross Regional Product and total earnings for all industries. It is responsible for nearly all annual capital investment in the area and has the highest multiplier effect of any sector.

The Center for Manufacturing Innovation (CMI) will be located at the Millennium Campus adjacent to the Clemson University International Center for Automotive Research (CU-ICAR) Technology Neighborhood 1, offering education designed to meet industry needs including dual credit programs in partnership with Greenville County Schools, programs that allow a student to move from associate degree to bachelor's

degree, and workforce training and certificate programs that increase the qualifications of manufacturing employees.

“The Center for Manufacturing Innovation is another great example of the partnership between Clemson and Greenville Tech,” said Clemson’s President, James Clements. “This center has the potential to transform manufacturing education in the Upstate, which will make a huge difference that will eventually be felt across South Carolina, and I am thankful for all of the people who worked to make this happen.”

ONE RESEARCH DRIVE

In November 2014, CU-ICAR broke ground on One Research Drive, the sixth and final building in Technology Neighborhood I. The \$14-million, 82,000-square-foot multi-tenant building will help attract more automotive companies to campus, create new jobs and bring more engineers into the workforce. One Research Drive is expected to create 220 jobs and generate \$2.6 million in private investment at the outset.

Clemson University President James P. Clements said, "To keep moving forward, we need world-class facilities that give our students a place to learn, our researchers a place to develop cutting-edge breakthroughs and our industry partners an innovative environment in which to flourish. One Research Drive will do all three. It's not just a building. It's an engine for economic growth."

A long-time supporter of CU-ICAR is helping fund One Research Drive. The U.S. Commerce Department's Economic Development Administration (EDA) is providing \$2 million for the building.

"Supporting innovation is a key priority for the president, the Commerce Department and EDA," said U.S. Assistant Secretary of Commerce for Economic Development Jay Williams. "EDA is proud of the role it played in supporting the groundbreaking research and development taking place at CU-ICAR, and we look forward to seeing the exciting new technologies and ideas that come out of this facility."



NATIONAL RECOGNITION



APLU Innovation & Economic Prosperity University

“We’re honored to be recognized as one of the top universities in the country for our programs in innovation and economic development that promote prosperity for our citizens, state and region.

Contributing to economic opportunity is central to Clemson’s mission, and innovation and economic engagement will continue to be integrated into Clemson’s teaching, research, and outreach missions through the new 2020 Forward plan.

—James P. Clements, Ph.D
Clemson University President

In 2015, Clemson University received recognition as an Innovation and Economic Prosperity University by the Association of Public and Land-grant Universities (APLU) as a result of Clemson’s strong commitment to leadership in regional economic engagement.

The designation recognizes universities for working with public and private sector partners in their states and regions to support economic development through a variety of activities, including innovation and entrepreneurship, technology transfer, talent and workforce development, and community development.

CU-ICAR has played a pivotal role in Clemson receiving this designation. One example of campus partnership and infrastructure expansion is the development of One Research Drive, which is expected to create 220 jobs and generate \$2.6 million in private investment at the outset. The other is the Center for Manufacturing Innovation, with Clemson and Greenville Technical College collaborating between manufacturers to enhance development and implementation of advanced manufacturing technologies.

“Public universities serve as economic engines for their local communities and states by conducting cutting edge research to reach new breakthroughs and developing the talent to help existing businesses grow stronger and enabling new ones to develop and thrive,” APLU President Peter McPherson said. “The 18 institutions in the 2015 class of Innovation and Economic Prosperity Universities serve as wonderful models of how public research universities extend beyond their campuses to engage their communities in economic development that creates jobs and improves lives.”



**MAGNET
VENUE**

The background of the page is a photograph of an automotive workshop, overlaid with a semi-transparent orange filter. The scene shows several cars, some with their hoods open, and people working on them. A sign with a bicycle icon and the text "LANE BEGINS" is visible in the background. A diagonal orange line runs from the top right towards the bottom left, separating the image from the text area.

CAMPUS ECOSYSTEM

The CU-ICAR campus is an automotive ecosystem that makes connections, builds relationships and educates the workforce of tomorrow. We are a community where industry literally meets academia and innovation drives development.

Our ecosystem expands beyond the confines of our buildings and extends into our community and across the Upstate. With the creation of a STEAM middle school, a center for advanced manufacturing, and a wireless charging test bed, 2015 has proven to be a year of growth and development for the CU-ICAR ecosystem.

DR. PHINNIZE J. FISHER MIDDLE SCHOOL

In the fall of 2014, the inaugural class of Dr. Phinnize J. Fisher Middle School burst through the doors to find a new construction school, purposefully designed and constructed to compliment a STEAM—science, technology, engineering, art and math—curriculum.

Located just down the road on CU-ICAR's Millennium Campus, Fisher Middle School is the culmination of plans that have been in the works since 2011. The STEAM Education seeks to transform the typical teacher-centered classroom by encouraging a transdisciplinary curriculum that is driven by problem-solving, discovery, exploratory learning, and an experience that requires each student to actively engage in a situation in order to find

its solution. The STEAM Middle School will provide a continuous pathway of education through opportunities that create STEAM-literate graduates ready to accept the challenges of the curriculum at high school, advanced education, and the needs of tomorrow's workforce.

All 340 sixth-graders at Fisher Middle School toured CU-ICAR's Carroll A. Campbell Jr. Graduate Engineering Center. After the tour, approximately 40 Fisher Middle School students became honorary automotive engineers as part of a mentorship program. Throughout the school year, Clemson University students faculty and staff acted as mentors, bringing hands on activities and projects to provide real-world insight to the middle school students.



ITIC MASTER PLAN

Located 7 miles from CU-ICAR, the International Transportation Innovation Center (ITIC) is a \$40 million world-class research and testing facility promoting sustainable transportation and networked vehicle communication. ITIC encompasses nearly 600 acres at the South Carolina Technology & Aviation Center in Greenville, SC.

At the 2015 SC Automotive Summit, ITIC announced the development of a Master Plan with contracted German engineering firm, Tilke GmbH & Co. The continued development of ITIC means expansion of infrastructure and capabilities to promote advanced

technology megatrends including vehicle automation, vehicle connectivity, enhanced wireless charging and zero emissions vehicles.

Current Features Include:

- 1.5 mile concrete straightaway test track
- 1+ mile asphalt straightaway test track
- Six block urban test grid
- 2.5 mile interstate-grade test track (expandable up to 17.5 miles)
- Scalable wireless power transfer test bed for electrified vehicles

The magnitude of what the ITIC Master Plan represents to the automotive industry cannot be overstated. The sheer size and scope of the property and its anticipated offerings are certain to make it an indispensable testing facility for automotive manufacturers, suppliers, R&D experts, race teams, and so many others.

—Johannes Hogrebe,
Tilke GmbH & Co.



MILLENNIUM DRIVE

Over 200 cars and nearly 3,000 people attended the 2nd annual CU-ICAR auto festival.



On Saturday March 28, 2015 CU-ICAR hosted its second annual community event, The Millennium Drive International Car Cruise.

Nearly 3,000 people flooded the campus to experience the auto festival, which featured a diverse display of over 200 exotic and domestic cars that cruised up and down the Millennium Campus' Boulevard. The Millennium Drive brought the Upstate community together to share in a day of celebration. Car clubs, car collectors, auto dealers, racers and car enthusiasts of all ages gathered at CU-ICAR to share their passion for the automobile. With a surplus of vehicle applications this year, the sheer variety was a car lover's dream.

The day's events kicked off early in the morning with the Millennium 5K road race. Runners raced a 3.1 mile course along the same streets where cars would later cruise. Proceeds from the race were donated to The South Carolina Chapter of The Leukemia & Lymphoma Society.

A new portion of the festival featured Science, Technology, Engineering and Math (STEM) exhibits along CU-ICAR's Research Drive. General Electric, BMW Manufacturing, MTC Federal Credit Union and iMAGINE Upstate set up hands-on activities and demonstrations of innovation at work. K-12 students experienced automotive iPad apps that brought vehicle designs to life, interacted with BMW engineers and saw how 3D printers contribute to prototyping and manufacturing.

INGENIOUS SC!

In February 2015, CU-ICAR hosted the first Ingenious SC! event as the kickoff to the 4th Annual South Carolina Automotive Summit. Ingenious SC! was created to spotlight automotive related research and development in South Carolina and specifically, highlighted Clemson University faculty intellectual property.

During the event, key executives from OEM and Tier 1 automotive companies shared their intrapreneurial processes, venture capitalists defined their approach to identifying and investing in new technologies, and Clemson University faculty presented cutting edge research to gauge the commercialization interest from industry laying the foundation for potential new investment. Participating organizations included Robert Bosch LLC, BMW Group, SCRA, GM Ventures and Michelin NA.


Stay tuned for Ingenious SC! 2016, as this approach will be refined and repeated at the 5th Annual SC Automotive Summit, February 24–26, 2016.



Ingenious SC! was created to spotlight automotive related research & development in SC.

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