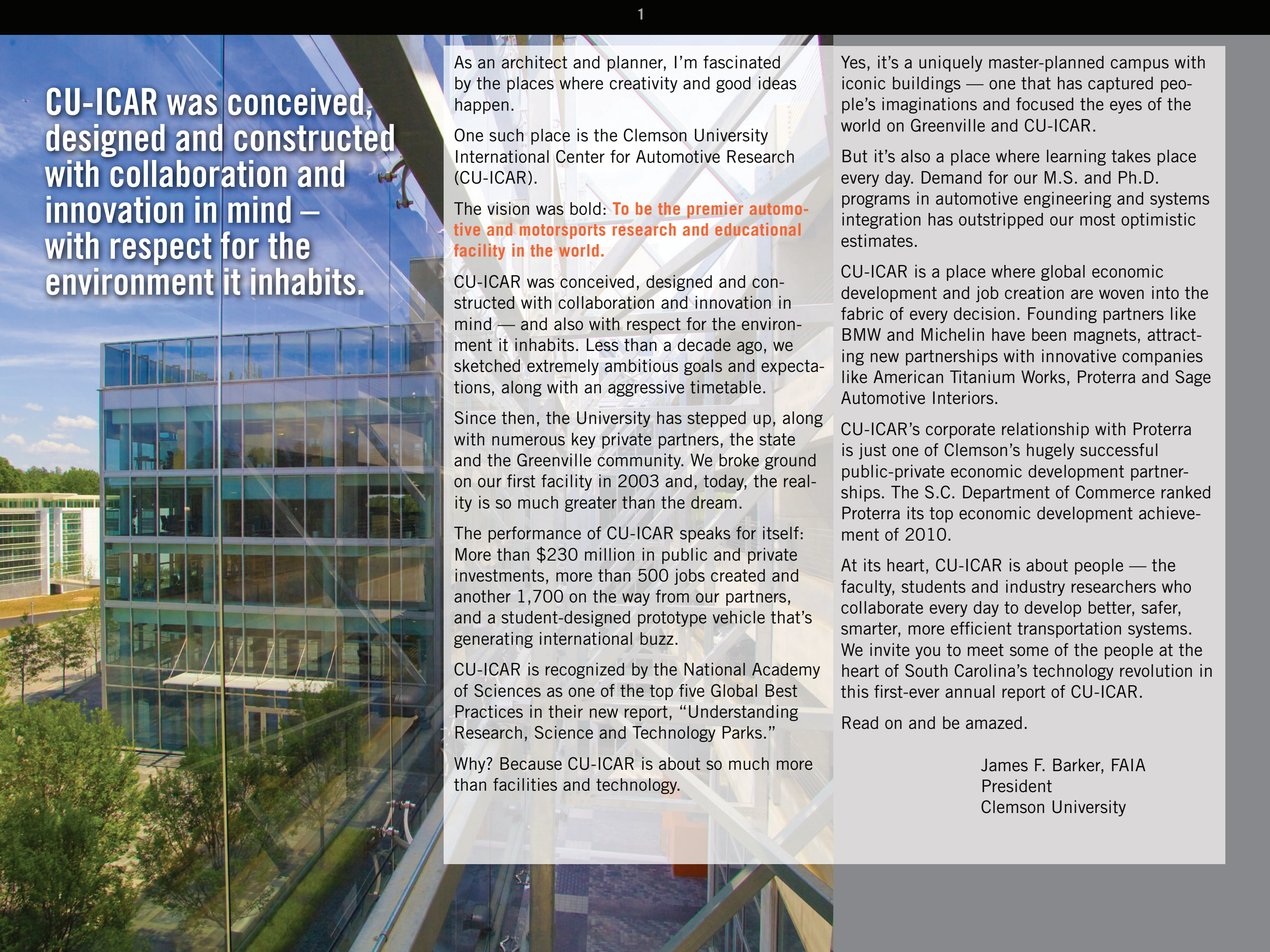


CLEMSON UNIVERSITY INTERNATIONAL CENTER FOR AUTOMOTIVE RESEARCH
2010 -2011 ANNUAL REPORT





**CU-ICAR was conceived,
designed and constructed
with collaboration and
innovation in mind —
with respect for the
environment it inhabits.**

As an architect and planner, I'm fascinated by the places where creativity and good ideas happen.

One such place is the Clemson University International Center for Automotive Research (CU-ICAR).

The vision was bold: **To be the premier automotive and motorsports research and educational facility in the world.**

CU-ICAR was conceived, designed and constructed with collaboration and innovation in mind — and also with respect for the environment it inhabits. Less than a decade ago, we sketched extremely ambitious goals and expectations, along with an aggressive timetable.

Since then, the University has stepped up, along with numerous key private partners, the state and the Greenville community. We broke ground on our first facility in 2003 and, today, the reality is so much greater than the dream.

The performance of CU-ICAR speaks for itself: More than \$230 million in public and private investments, more than 500 jobs created and another 1,700 on the way from our partners, and a student-designed prototype vehicle that's generating international buzz.

CU-ICAR is recognized by the National Academy of Sciences as one of the top five Global Best Practices in their new report, "Understanding Research, Science and Technology Parks."

Why? Because CU-ICAR is about so much more than facilities and technology.

Yes, it's a uniquely master-planned campus with iconic buildings — one that has captured people's imaginations and focused the eyes of the world on Greenville and CU-ICAR.

But it's also a place where learning takes place every day. Demand for our M.S. and Ph.D. programs in automotive engineering and systems integration has outstripped our most optimistic estimates.

CU-ICAR is a place where global economic development and job creation are woven into the fabric of every decision. Founding partners like BMW and Michelin have been magnets, attracting new partnerships with innovative companies like American Titanium Works, Proterra and Sage Automotive Interiors.

CU-ICAR's corporate relationship with Proterra is just one of Clemson's hugely successful public-private economic development partnerships. The S.C. Department of Commerce ranked Proterra its top economic development achievement of 2010.

At its heart, CU-ICAR is about people — the faculty, students and industry researchers who collaborate every day to develop better, safer, smarter, more efficient transportation systems. We invite you to meet some of the people at the heart of South Carolina's technology revolution in this first-ever annual report of CU-ICAR.

Read on and be amazed.

James F. Barker, FAIA
President
Clemson University



Chu



LaHood



Immelt

“I suspect they’re some of the smartest people in America.”

— U.S. Transportation Secretary Ray LaHood

Clemson’s College of Engineering and Science is a uniquely configured academic entity that’s become an incubator for collaboration. The innovative combination of engineering and science disciplines facilitates study and research across departmental boundaries and provides fertile ground for nurturing a vision like CU-ICAR.

We’re looking back on an eventful year. The first Deep Orange vehicle was unveiled, and our groundbreaking graduate program received a great deal of much-deserved attention. Deep Orange has added an OEM perspective to our automotive graduate program — one that’s putting our graduates ahead of the competition in the workplace.

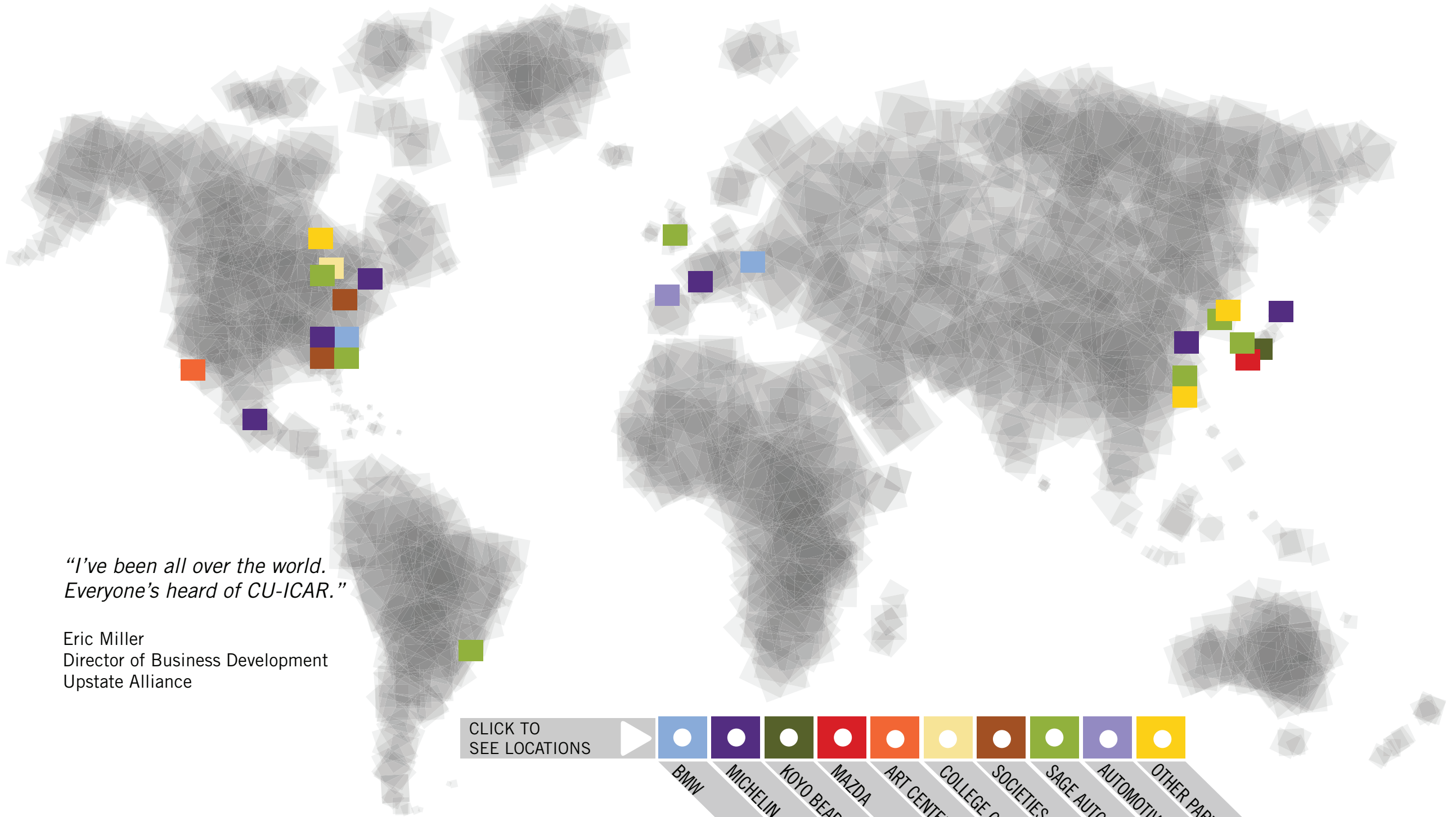
We’ve placed the automotive engineering graduate program under the auspices of its own department. With its focus on systems integration and product development, the program is one of the most unique in the world. With an automotive engineering department, we can provide support to faculty, students and staff to make it one of the best in the world.

Two days after President Obama’s call for “American innovation” during his 2011 State of the Union address, a member of his cabinet visited the Upstate and hailed relationships like those between CU-ICAR and its industry partners. **U.S. Transportation Secretary Ray LaHood** met with about a dozen students from CU-ICAR’s Carroll A. Campbell Graduate Engineering Center and said they represent the nation’s future research and development potential. He commented, “I suspect they’re some of the smartest people in America.”

CU-ICAR graduate students certainly are some of the smartest people in the world. When they take their place in the global marketplace, the automotive industry will be forever transformed.

Esin Gulari, Ph.D.
Dean
College of Engineering and Science
Clemson University

FOCUSED START. INTERNATIONAL VISION. GLOBAL IMPACT.



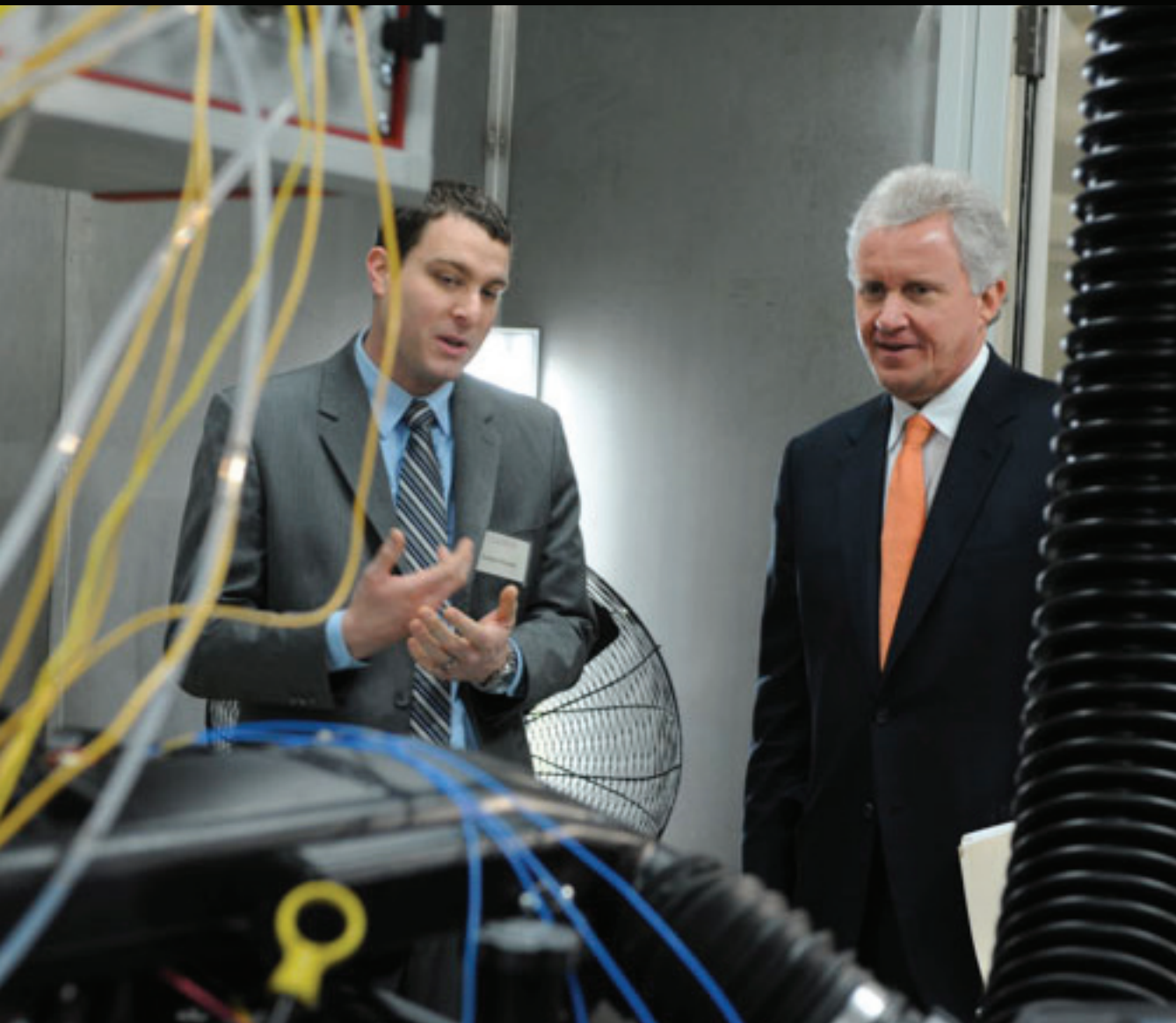
*"I've been all over the world.
Everyone's heard of CU-ICAR."*

Eric Miller
Director of Business Development
Upstate Alliance

CLICK TO
SEE LOCATIONS



- BMW
- MICHELIN
- KOYO BEARINGS USA
- MAZDA
- ART CENTER COLLEGE OF DESIGN
- COLLEGE OF CREATIVE STUDIES
- SOCIETIES OF AUTOMOBILE ENGINEERS
- SAGE AUTOMOTIVE
- OTHER PARTNER LOCATIONS



“CU-ICAR’s very clear vision is what made us choose them. I’ve seen a lot of parks that universities have put together. I’ve never seen anything like this that has such a unified vision and ability to execute that vision. It’s really, really impressive.”

Nabil Elkouh, Ph.D.
Chief Technology Officer
American Titanium Works

Economic development at most research parks is driven by real estate transactions and job counts.

Not at CU-ICAR...

CU-ICAR is driven by the program objectives of Clemson University, which are crafted in conjunction with our partners in the private sector and government entities. Indicators of CU-ICAR’s successful economic development are found in newly formed relationships, joint research and development efforts, industry diversity within the campus network and the attraction of innovative companies.

CU-ICAR was founded on the idea that successful economic development and world-class academics can be amplified by diverse strategic relationships.

When a unified group of diverse individuals and companies collectively decides to achieve a goal, the overall success can far surpass any of their achievements as individuals.



BUSINESS MODEL

CU-ICAR is a community that seeks to help companies make new connections, build relationships and benefit from tangible value due to their involvement with Clemson University. This begins by listening and understanding what can be done to assist new partners in becoming successful. From those initial communications, the CU-ICAR staff can reach out within the University framework — as well as its existing partner network — to leverage resources, build bridges and open doors. It is through this process that CU-ICAR is building a world-class automotive reputation.

Over the past seven years, the world has seen the remarkable emergence of CU-ICAR as it has transformed from a bold vision to a dynamic reality. Designed as a program-driven research campus, industry and University partners have come together, driving innovation and creating hundreds of new jobs. And there's more to come.

This year, the 60,000-square-foot Center for Emerging Technologies will open its doors to dozens of new companies, while other new construction is on the horizon.

As planned, CU-ICAR has become a thriving technology community. Industry and government agencies are increasingly discerning that this is the place to do business.

CU-ICAR students and faculty, partnered with the best and brightest from industry, are creating the technologies and products that result in growth reaching far beyond the CU-ICAR research campus — to our city, our state and our country.

CAMPUS METRICS	RESULTS THIS YEAR	RESULTS SINCE 2004
Number of partners on site	12	19
Number of research partners	6	30
Number of employees	100	775
Indirect and induced jobs	275	1,992 *
Total investment	\$11 million	\$250 million
Number of buildings	1	5
Constructed square footage	60,000	760,000

** Based on the October 2007 Battelle study, "Research Park Generation of Jobs in the Overall Economy"*

ANNOUNCED PARTNERS	# JOBS	TOTAL INVESTMENT
American Titanium Works	400	\$420 million
Proterra	1,300	\$68 million






ARCHITECTURAL AND DEVELOPMENT **INTEGRITY**

As the sole landowner of real property on the CU-ICAR campus, the Clemson University Real Estate Foundation (CUREF), a 501c (3) charitable organization, plays an integral role in the planning and development of the property. Clemson University, through various efforts that include partnership development and research initiatives, works in partnership with CUREF to plan and execute the CU-ICAR development strategy.

Clemson University's commitment to the success of CU-ICAR includes the acquisition of the land within the campus boundary and the development of new facilities for University and partner utilization. A high degree of architectural and development integrity is maintained with thoughtfully developed covenants, codes and restrictions designed to protect the investment of current and future CU-ICAR partners.

A large, modern, multi-story building with a white facade and extensive glass windows, featuring a prominent cantilevered upper section.

BMW INFORMATION TECHNOLOGY RESEARCH CENTER

A modern building with a complex, multi-level design, featuring a mix of brick, wood paneling, and large glass windows, set against a dark sky.

CARROLL A. CAMPBELL JR.
GRADUATE ENGINEERING CENTER

A modern building with a curved glass facade and a prominent white structural element, set against a clear blue sky.

KOYO BEARINGS USA, JTEKT GROUP

BMW is CU-ICAR's pioneering private-sector partner. The company invested state economic development incentive funds to construct the BMW Information Technology Research Center, an 84,000-square-foot IT office building, and the Carroll A. Campbell Jr. Graduate Engineering Center, a 90,000-square-foot, LEED Silver-certified academic facility that serves as the University research core at CU-ICAR. Both facilities are state-owned and play a critical role in the success of the CU-ICAR campus.

Koyo Bearings USA, JTEKT Group is located in the 117,000-square-foot facility at the top of the Technology Neighborhood I plaza. This LEED Gold-certified facility provides the Koyo organization with engineering and high-bay lab infrastructure.



PARTNERSHIP PLACE AND AUTOPARK



PARTNERSHIP OFFICES



ST. FRANCIS VRUM FITNESS CENTER



GREEN ROOF TERRACE



GALLERY

Located at the core of Technology Neighborhood I, the CU-ICAR Partnership Place and AutoPark houses the partnership offices, the gallery, a green roof terrace and the St. Francis Vrum Fitness Center. Additionally, a 1,200-space parking garage is attached to serve the parking needs for the entire Technology Neighborhood I development. The Center for Emerging Technologies (CET) facility, scheduled for completion in the summer of 2011, will offer 35,000 square feet of flexible office space coupled with 26,000 square feet of open high-bay labs and a multiuse area. The CET building, funded in part by a \$3 million U.S. Department of Commerce Economic Development Administration grant, will contain multiple tenants in the mobility, energy and transportation industries. It will also complement the international-style architecture of the CU-ICAR development.

Development projects currently underway on the CU-ICAR campus include the Proterra Research and Development Assembly Headquarters. This approximately 200,000-square-foot facility will be located on approximately 25 acres along Innovation Drive in Technology Neighborhood III. The headquarters for American Titanium Works will be located on approximately seven acres in Technology Neighborhood V.

A STRATEGICALLY FOCUSED RESEARCH CAMPUS

The CU-ICAR campus in Greenville, S.C., is midway between Charlotte, N.C., and Atlanta, Ga., on the Interstate 85 corridor. The development represents a strategically focused automotive and motorsports research campus. Its master plan is organized into five distinct technology neighborhoods designed to foster interaction among the partners, employees, faculty and students on the campus. At full build-out, CU-ICAR will provide more than 3 million square feet of sustainably developed building space across 250 acres. Of the total campus property, approximately 65 acres are developed or committed for future projects representing roughly 600,000 square feet of occupied space.



"We are very excited that CU-ICAR is the recipient of our 2010 International Economic Development Award. This campus is an outstanding example of the connection between public higher education and private industry, new knowledge and innovation. It is continuing to grow the automotive industry — an important and competitive cluster — in the Upstate, South Carolina, and the Southeast."

Anne S. Ellefson
 Managing Director
 Haynsworth Sinkler Boyd, P.A.

CU-ICAR WELCOMES NEW CAMPUS PARTNERS

PROTERRA

Proterra is the leading innovator of zero-emission, commercial vehicle solutions. Early in 2010, Proterra announced plans to build a full-scale, state-of-the-art research and development center and manufacturing plant on the CU-ICAR campus. This decision gives the company access to tremendous research and development resources while constructing the EcoRide™ BE-35, a line of next-generation, zero-emission vehicles, and FastFill™ charging stations. Proterra's goal is to construct more than 1,500 buses per year and employ 1,300 people over the next five years. The new Proterra facility will be located in Technology Neighborhood III on approximately 25 acres and will occupy more than 200,000 square feet of space.



KOYO BEARINGS USA

A 118,000-square-foot, LEED Gold-certified Collaboration 3 building hosts Koyo Bearings USA, a division of the JTEKT Group. Koyo Bearings USA was formed when JTEKT purchased the needle roller bearing portion of the Torrington Company from Timken in 2009. Globally, JTEKT is a leading manufacturer of steering systems, driveline components, bearings and machine tools with operations in 70 locations and \$11 billion in sales. The Koyo Bearings division provides industry-leading technology in roller bearings and related assemblies for automotive and other industrial sectors. The Greenville Technical Center at CU-ICAR is Koyo Bearings' primary location for needle bearing design and technology development, including prototyping, product testing and manufacturing process development.



SAGE AUTOMOTIVE INTERIORS

Sage Automotive Interiors develops and manufactures innovative automotive body cloth and headliners preferred by automotive manufacturers around the world. The company will locate its international headquarters in the newly constructed Center for Emerging Technologies in Technology Neighborhood I. Global offices and manufacturing locations for Sage include facilities in the United States, Japan, China, Brazil, Korea and Europe.



DRIVEN TO EXCELLENCE



AWARDS AND RECOGNITIONS

- Minority Economic Development Institute Corporate Suppliers Minority Business Award
- American Institute of Architects S.C. Chapter Special Citation Award for CU-ICAR Innovation Place Tower and AutoPark
- U.S. Environmental Protection Agency Green Energy Power Partner Recognition
- 2007 Power Partner Award from Duke Energy
- 2008 Award of Merit from the Association of Building Contractors, Carolinas Chapter for the Campbell Graduate Engineering Center
- Sky Energy Renewable Energy Certificate of Recognition for Green Power
- Finalist in the 2009 Economic Development Administration's Excellence in Economic Development Awards
- LEED-CS Gold-certified – Collaboration Building 3
- First LEED-CS Gold building in South Carolina
- LEED-NC Silver-certified – Campbell Graduate Engineering Center
- LEED-NC Gold-certified – CU-ICAR Innovation Place Tower
- First LEED-NC (New Construction) Gold building for Clemson University
- First S.C. state-funded LEED-NC Gold building
- First LEED-NC Gold building in Greenville, S.C.

NEW CU-ICAR ALLIANCES — 2010

Interest in collaboration from OEM suppliers and industry organizations continued in 2010. CU-ICAR continues to develop strong strategic alliances at the local, national and international levels.

Examples include these industry, academic and government entities:

- Automotive Intelligence Center — Bilbao, Spain
- Specialty Equipment Manufacturers Association — U.S.A.
- University of Ingolstadt Applied Sciences — Germany
- S.C. Research Authority — Local Scope
- S.C. Automotive Council — Local Scope
- Original Equipment Suppliers Association — U.S.A.

DRIVEN TO EXCELLENCE



CAMPUS RECOGNITION

- Recognized in Battelle's study on "Trends in North American Research Parks: 21st Century Direction."
- Recognized as an example of five Global Best Practices by the National Academies of Sciences in their report, "Understanding Research, Science and Technology Parks."
- \$3 million Economic Development Administration Grant awarded by the U.S. Department of Commerce for a new multitenant building known as the Center for Emerging Technologies (CET).
- U.S. Department of Agriculture granted a \$740,000 zero-interest loan toward the construction of CET.
- The Association of University Research Parks, an international organization representing university-related research parks around the world, presented CU-ICAR with its Emerging Research/Science Park Award.

ACADEMIC PROGRAM RECOGNITION

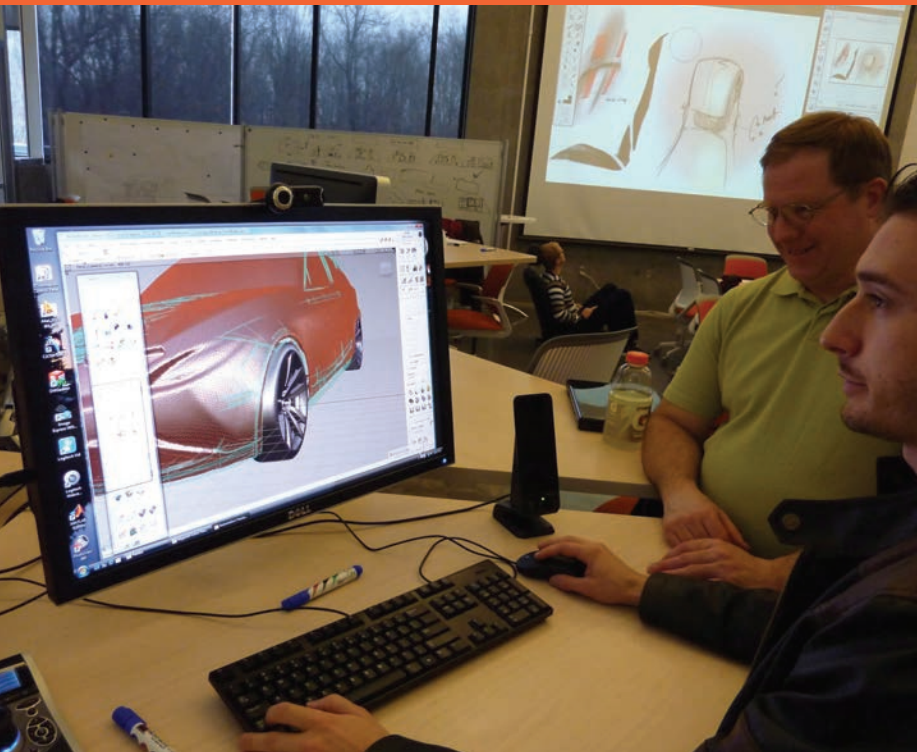
By itself, CU-ICAR put Clemson square on the list of top automotive programs in the nation. In addition, the University boasts a strong vehicle dynamics program and is located within 160 miles of almost every NASCAR shop. (Source: *edmunds.com* Top 10 Automotive Colleges and Universities in the U.S.)

- 1) University of Michigan/Michigan State and Michigan Technical University
- 2) Indiana University/Purdue University Indianapolis
- 3) Cornell University
- 4) Kettering University
- 5) University of Texas (UT) – UT-Austin/UT-Arlington/Texas A&M
- 6) Virginia Polytechnic Institute and State University
- 7) University of California - Davis
- 8) California Polytechnic State University - San Luis Obispo
- 9) **Clemson University**
- 10) Georgia Institute of Technology

DEPARTMENT OF AUTOMOTIVE ENGINEERING

The Clemson University Board of Trustees approved the creation of the Department of Automotive Engineering (AE) effective July 2010, using existing staff, equipment and facilities. The interdisciplinary nature of automotive engineering was the impetus for the creation of this department. The unit previously was managed through Clemson's mechanical engineering department. Imtiaz Haque was named as founding chair of the new department.

The AE department is the first of its kind in the United States. It offers both master's and doctoral degrees in automotive engineering with a focus on systems integration and conducts automotive-focused, industry- and government-sponsored research. It currently has 107 graduate students and nine faculty members.



FACULTY AWARDS 2010 / 2011



"The faculty at CU-ICAR supply a wealth of knowledge on a variety of functions ranging from analytical tool development to comprehensive testing capabilities."

David Novak
Senior Vice President of Engineering, Koyo Bearings USA LLC

Beshah Ayalew

NSF CAREER Award

Todd Hubing

IEEE Electromagnetic Compatibility Society's 2010 Laurence G. Cumming Award

Tom Kurfess

SME Education Award, 2010

Laine Mears

2011 Governor's Young Researcher Award
SAE 2011 Ralph Teetor Young Educator Award
NSF CAREER Award
2010 College of Engineering and Science Faculty Collaboration Award

Mohammed Omar

SME Outstanding Young Manufacturing Award for 2011
2011 Murray-Stokely Award for Teaching Excellence

Published Textbooks:

The Automotive Body Manufacturing Systems and Processes,
John Wiley and Sons, 2010

Dedicated Processing Routines for Industrial Thermal Imaging, VDM Verlag, 2010

Pierluigi Pisu

Published Textbook:

Hierarchical Model-Based Diagnostics: Theoretical Results and Applications to Vehicle Systems, VDM Verlag, 2010

ATTRACTING STUDENTS FROM AROUND THE GLOBE

"CU-ICAR is a great place to learn. I was fortunate enough to witness its early stages and I've observed the evolution of the program. I fully expect the program to continue to grow and improve. The sky's the limit for CU-ICAR."

Marshall Saunders '10
CU-ICAR Graduate
Engineering and Operations Management Development Program
BMW Manufacturing



M.S. STUDENTS Ph.D. STUDENTS

UNITED STATES	23	19
CHINA	5	9
EGYPT	1	-
GERMANY	2	1
INDIA	30	2
PAKISTAN	2	1
THAILAND	1	-
TRINIDAD AND TOBAGO	1	-
VENEZUELA	1	-
COLOMBIA	-	1
ITALY	-	2
JORDAN	-	3
MALAYSIA	-	1
TURKEY	-	1
UKRAINE	-	1

CU-ICAR SCHOLARSHIPS AND FELLOWSHIPS

CU-ICAR has secured several scholarships and fellowships from its generous partners totaling more than \$150,000. These gifts grant students with high potential an opportunity to join the academic program and contribute their enthusiasm and knowledge toward creating a brighter future for the automotive industry. Among those valued contributors to the CU-ICAR scholarships and fellowships program include Staubli Corp., BMW, Automation Engineering Corp., Altair and the Mazda Corporate Foundation.

CU-ICAR ALUMNI SPOTLIGHT

**JOHN LIMROTH**

Michelin Americas

Research Company

Traction Performance Engineer

**First Ph.D. in automotive
engineering in the United States**

Date of hire: December 2009

Hometown: Austin, Texas

Graduation year: Ph.D. Automotive
Engineering, 2009

Professional goal: A career in
automotive engineering

What was the most memorable experience you had at CU-ICAR?

My greatest moment was presenting my Ph.D. dissertation defense.

How has your education at CU-ICAR prepared you for your current job?

Primarily, CU-ICAR prepared me in the fundamentals of mechanical engineering — especially the technical areas of vehicle dynamics and tire mechanics.

What is the most important thing you learned at CU-ICAR?

The program provides its students all of the technical training necessary to excel in today's automotive environment.

Looking back, how do you feel about your experience at CU-ICAR?

It was a great experience for me. The program gave me the opportunity to experience automotive engineering and simultaneously allowed me to make contacts within the automotive industry. I've seen CU-ICAR grow and develop over time, and I can't wait to see what the future has in store.

What advantages does CU-ICAR have over other automotive/technology/engineering schools?

The main advantage CU-ICAR has over other automotive engineering programs is its close connection with companies within the industry. The program has strong relationships with both OEMs and suppliers. Also, it exposes students to

the automotive industry from an international perspective. CU-ICAR helped me develop an awareness of the industry's international scope, which is very helpful in my current job at Michelin.

Has CU-ICAR helped you in the process of obtaining your professional goals?

CU-ICAR's partnerships are very beneficial for their students. The program helped me establish a relationship with Michelin, which led to a full-time position after graduation. It helps students build relationships with potential employers by bringing in guest lecturers and external professors from companies that have become partners — professors who have been successful within the industry.

Do you have any other thoughts about CU-ICAR?

The seminar series offers glimpses inside the industry and allows students to make lucrative contacts. There was a course in tire mechanics taught by Tim Rhyne, and I now work with him at Michelin every day. This working relationship has benefited me substantially, and I can't thank CU-ICAR enough.

CU-ICAR ALUMNI SPOTLIGHT



MARSHALL SAUNDERS
BMW Manufacturing Co.
Engineering and Operations
Management Development Program

Date of hire: 2011

Hometown: New Orleans, Louisiana

Graduation year: M.S. Automotive Engineering, 2010

Professional goal: Run my own company

What was the most memorable experience you had at CU-ICAR?

My most memorable experience was the Deep Orange project. It helped me learn different aspects of the process of automotive engineering. Just as any other project, there were ups and downs, but as a whole, it gave me valuable hands-on know-how.

How has your education at CU-ICAR prepared you for your current job?

CU-ICAR has provided me with a solid base of practical experience, and I received an education that will be very valuable in the next couple of years.

What's the most important thing you learned at CU-ICAR?

CU-ICAR has allowed me the opportunity to work with many different people. I learned about the importance of teamwork in producing a quality product. Teamwork's not only important within the automotive industry but in life as well.

Looking back, how do you feel about your experience at CU-ICAR?

I'm so glad I attended CU-ICAR. If I had a chance to do it all over again, I wouldn't change a single thing. I'd recommend the experience to anyone who's interested in the growing, fast-paced world of automotive engineering. It provides students with a hands-on, practical education and helps students adjust to the real-world working environment they'll face after graduation.

What advantages does CU-ICAR have over other automotive/technology/engineering schools?

CU-ICAR's major advantage over other schools is its facilities. They're top-notch. Also, the local support of different automotive companies, such as BMW, is absolutely priceless. Those local relationships will contribute to CU-ICAR's growth — as well as the automotive industry as a whole.

How has CU-ICAR helped you in the process of obtaining your professional goals?

It gave me the opportunity to participate in multiple research projects — such as Deep Orange — that offered invaluable experiences. CU-ICAR's connections within the automotive industry are very beneficial to its students. During my time there, I was able to establish a working relationship with BMW associates, which helped me obtain a full-time position at BMW.

Do you have any other thoughts about CU-ICAR?

CU-ICAR is a great place to learn. I was fortunate enough to witness its early stages, and I've observed the evolution of the program. I fully expect the program to continue to grow and improve. The sky's the limit for CU-ICAR!

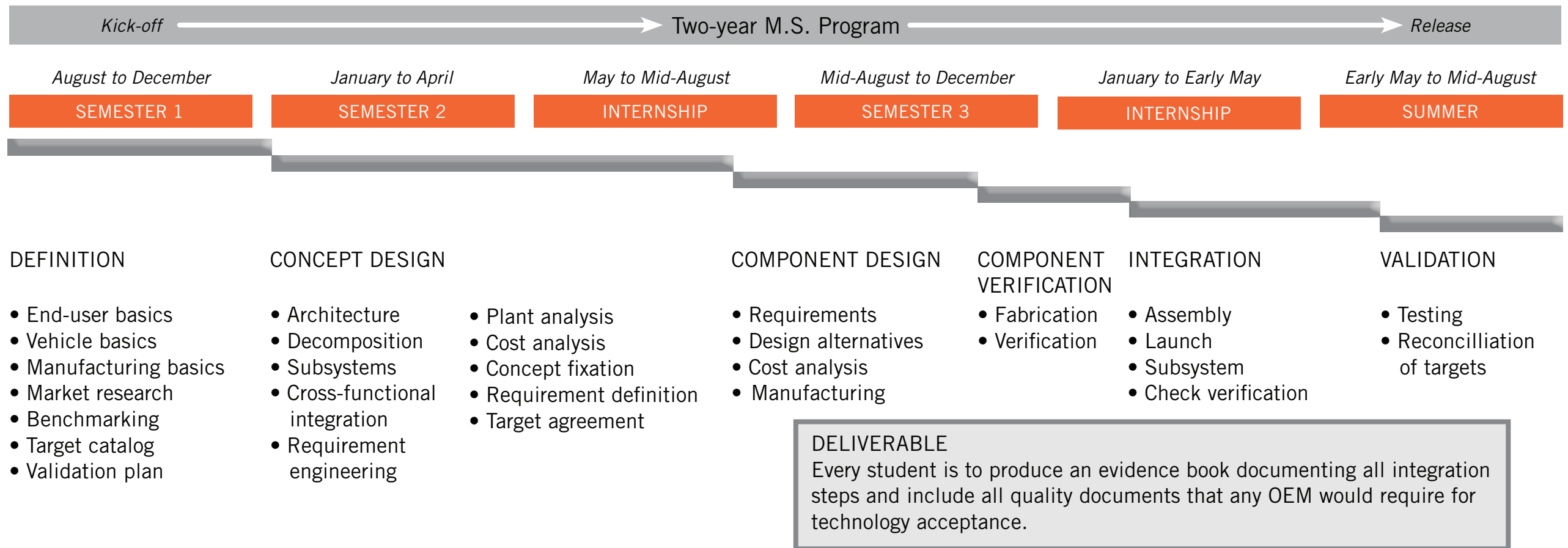
DEEP ORANGE

CURRICULUM REDESIGN AROUND DEEP ORANGE MODEL



The Deep Orange framework is part of the automotive engineering program at Clemson University and implements the “engineering studio” approach to teaching by immersing the students in the OEM setting. Within Deep Orange, students, cross-disciplinary faculty and participating industry partners team up to produce a vehicle prototype. A new Deep Orange vehicle design is produced every year, representing the culmination of everything the students have researched from their entry into the program until graduation. This experience provides hands-on experience in vehicle design, engineering, development, prototyping, production and implementation. The overarching goal is to use this platform to educate the future workforce while providing academia, entrepreneurs and industry partners an opportunity to collaborate with graduate students and showcase future technologies. The Deep Orange program is the core of the automotive engineering curriculum, with all students supported by an established industry consortium. Industry participation and mentoring play a crucial role.

SYSTEMS ENGINEERING APPROACH TO VEHICLE ENGINEERING



In order for the **Deep Orange** program to follow a path similar to a vehicle development process, the automotive engineering curriculum has been updated. During the first semester, the graduate students learn how to determine the needs and wants of their future customer by conducting market analyses and viability assessments. They then translate these outcomes into tangible engineering values and targets. Understanding the economic, regulatory and legal mechanisms is of crucial importance in this early phase. All the students go through an “engineering boot

camp” in the first semester that consists of courses on product design, vehicle systems and functions, production, and electrical/electronic systems and functions. In their second semester, all students take a course on systems integration methods and branch out into other courses that fill their respective technical specialty track requirements. These courses in different vehicle systems and processes also equip Deep Orange team members with a variety of skill areas vital to the success of the project. Specialists from CU-ICAR industry partners

teach some of these courses — such as tire behavior and performance. As the automotive engineering students continue with the Deep Orange track, they take a course in systems integration application to develop their comprehensive plans and timing as well as kick off detailed design activities. Once the design is completed, they spend the bulk of their time on the fabrication, assembly and validation of the vehicle. A summary of overall activities for their two-year cycle is shown above.

DEEP ORANGE I HIGHLIGHTS

In March 2009, the first Deep Orange project began with 13 graduate students about to enter the last year of their study. The duration of the Deep Orange pilot project was thus 15 months instead of the targeted two-year project cycle. The prototype was designed to target the Generation Y customer segment based on market research sponsored by Deloitte.

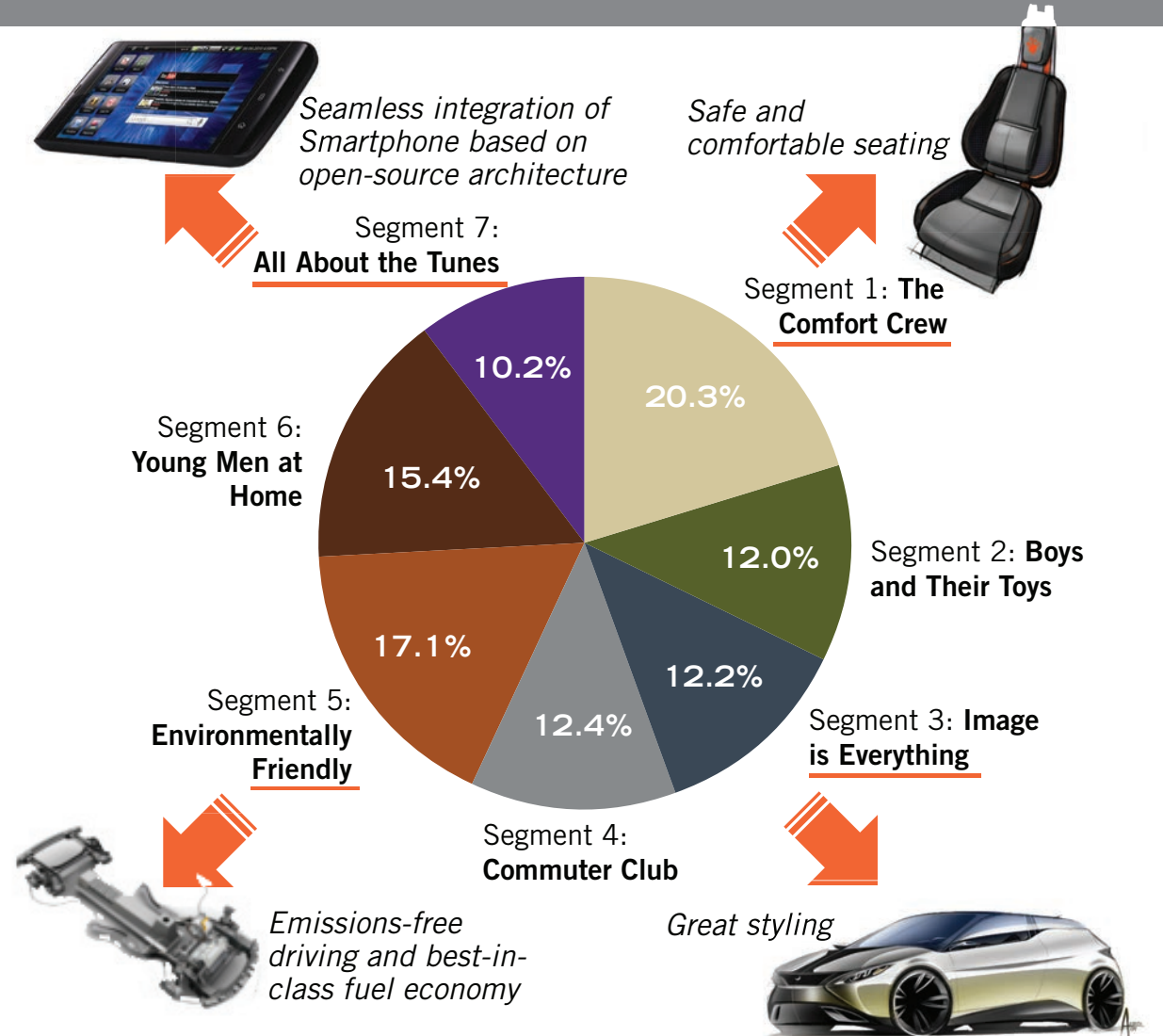
The Deep Orange project goes beyond fundamental engineering challenges to develop a vehicle that appeals to the target customer in all aspects. In order to make a vehicle that is visually and functionally integrated and appeals to its target market, the pilot team from Clemson collaborated with the Art Center College of Design (ACCD) in

Pasadena, Calif. The Deep Orange pilot project had 22 industry partners in specialties ranging from battery and driveline technologies to information technology and application support.

The marketing highlight included presence at the SEMA show in Las Vegas and L.A. Auto Show in November of 2010. Both venues showcased the final deliverables of the first Deep Orange project created by CU-ICAR (engineering vehicle prototype) and ACCD (full scale exterior and interior model).



SELECTION OF TARGET SEGMENTS FOR A GENERATION-Y VEHICLE

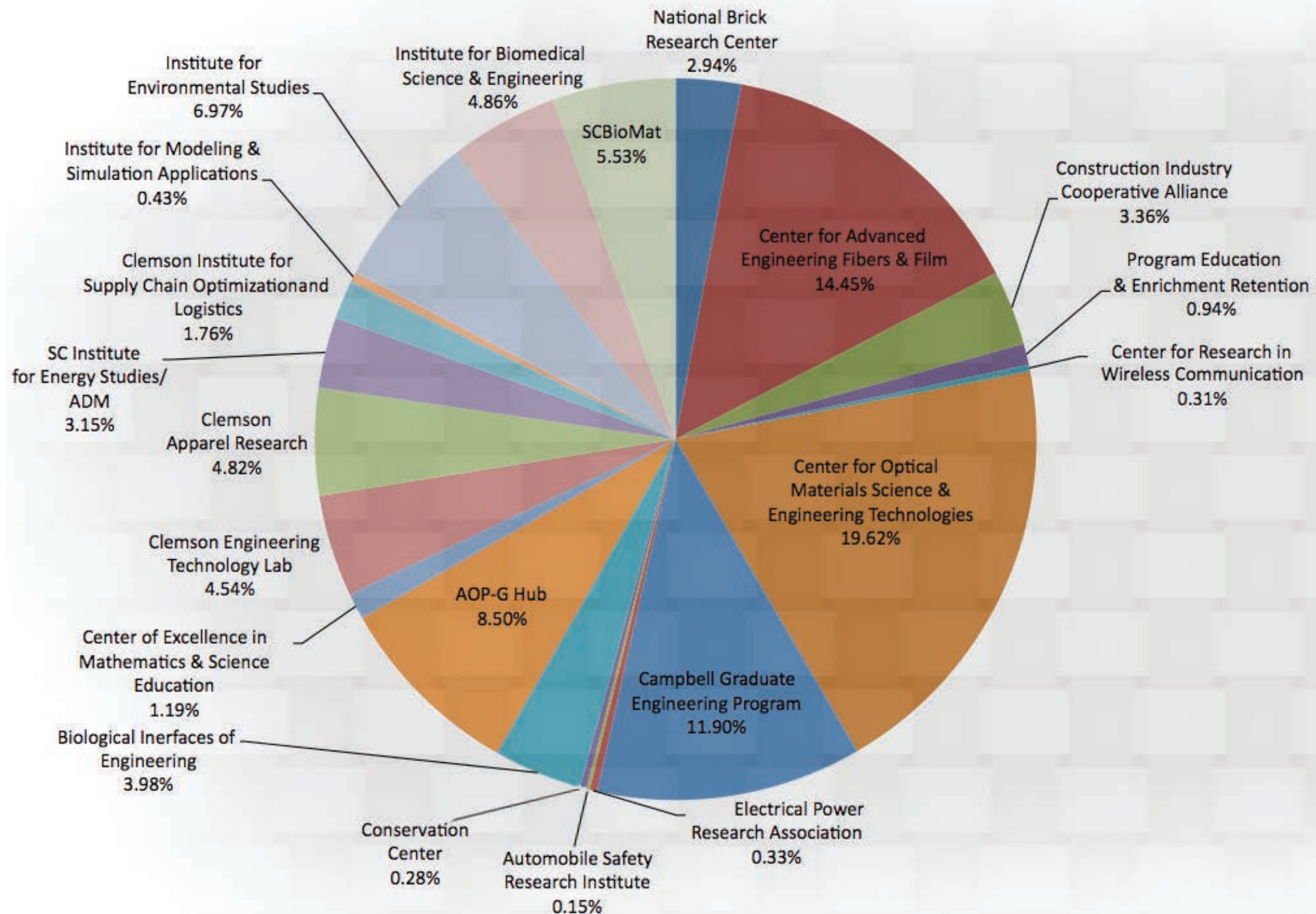


Since 2006, Clemson University has increased automotive-related research expenditures by 84 percent. Without question, CU-ICAR has greatly contributed to the growth of this research field.

As evidenced by the graphic, approximately 12 percent of the overall FY2010 research expenditures for the College of Engineering and Science are attributed to research being conducted within the Carroll A. Campbell Jr. Graduate Engineering Center on the CU-ICAR campus.

To date, CU-ICAR has received more than \$130 million of industry pledges and in-kind contributions.

CoES CENTER / INSTITUTE RESEARCH EXPENDITURE SUMMARY FY2010



NEW RESEARCH FOCUS AREA IN CLEAN TRANSPORTATION AND ADVANCED VEHICLE COMMUNICATION



The automotive industry is at the beginning of a major transformation away from the traditional model of vehicles powered by combustion engines and driving on roads that are providing information in one direction (from the infrastructure to the driver). The new model of vehicles will be driven by electrical power or biofuel, while bi-directionally communicating with the road, the energy supply infrastructure and the information technology infrastructure. Because significant growth of the automotive market is due to emerging markets, the transformation is essential from an environmental perspective.

CU-ICAR is actively developing a portfolio of research services and activities around the ecosystems for sustainable mobility and the networked vehicle.

Key topics include:

- new powertrain and material concepts,
- new energy storage and energy management concepts,
- new energy transfer and alternative fuel supply concepts,
- new concepts to integrate the vehicle with the power and communication grid,
- application development for mobile devices used in context with the networked vehicle,
- remotely controlled vehicles.

NEW INFRASTRUCTURE INITIATIVES

In order to support changing trends in the automotive industry, CU-ICAR is planning major improvements to its infrastructure capabilities.

PROJECT GREEN IS A JOINT ECONOMIC DEVELOPMENT INITIATIVE BETWEEN CU-ICAR AND THE S.C. TECHNOLOGY AND AVIATION CENTER for creating unique testing and R&D capabilities for public and private stakeholders in the domain of sustainable mobility and connected transportation systems. The S.C. Technology and Aviation center recently acquired 501c3 status for its new National Clean Transportation Technology and Innovation Center. To accommodate the Project Green initiative, part of an existing airport infrastructure located near the CU-ICAR campus will be redeveloped.

The conceptual design phase of Project Green was completed in 2011, generously supported by partners such as AdvanceSC, Duke Energy, Piedmont Natural Gas, Greenville Area Development Corp. and AT&T.

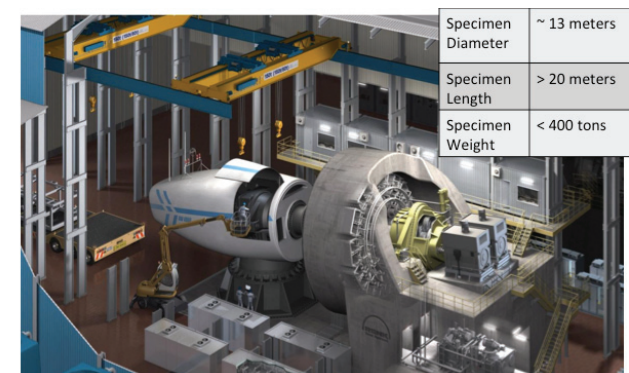


IN PARTNERSHIP WITH DRIVESAFETY INC., CU-ICAR HAS DESIGNED AND DEVELOPED A DRIVING SIMULATOR specifically designed for clinical settings called the DriveSafety CDS-250. Clemson houses two CDS-250 simulators — one in the psychology department on the main campus and one at CU-ICAR. Worldwide, there are 11 simulators in military and VA hospitals and one in Berlin, Germany. The research team uses the Clemson simulators along with their partnering institutions, the Greenville Hospital System University Medical Center and Palmetto Health, to

- enable drivers to maximize independence as long as safely possible;
- maximize solutions to assess the “total” driver — inside and outside of the vehicle — through interdisciplinary partnerships between universities, health care facilities, government agencies and industries;
- improve the quality of patient care and clinical effectiveness through new services, equipment and technologies.



ON NOVEMBER 23, 2009, THE U.S. DEPARTMENT OF ENERGY AWARDED CLEMSON UNIVERSITY A \$45 MILLION GRANT, which was matched by \$53 million of public and private funds — to develop the world’s largest wind turbine drivetrain testing facility. The facility will be housed at the Clemson University Restoration Institute (CURI) in North Charleston. Development of CURI’s energy systems campus is modeled on the CU-ICAR concept to house academic programs and play a significant economic development role in South Carolina.



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