

## Vibration and climate testing of automotive components

The Clemson University International Center for Automotive Research (CU-ICAR) in South Carolina, USA, is aiming to become the premier automotive and motorsports research and educational centre in the world. In 2012, as part of their ambition to connect with industries also based in South Carolina, CU-ICAR built a Component Testing Laboratory to perform durability and validation testing for BMW and their suppliers, as well as other vehicle manufacturers. By paring the needs of automotive companies with the research of their students and faculties, CU-ICAR is assisting mutually beneficial development.



## Background

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*The Component Testing laboratory is located in the Center for Emerging Technologies, where emerging or established companies can develop technologies that complement the research of the faculty and students*

*The development of the facility was funded entirely by Clemson University, a public, land-grant research university located in Clemson, South Carolina*



The Clemson University International Center for Automotive Research (CU-ICAR) is an advanced-technology research campus where academia, industry and government organisations collaborate. It is focused on automotive and motorsports research and ranked within the top ten automotive colleges and universities in the U.S.

The CU-ICAR campus is an automotive ecosystem that helps companies make connections and build relationships. With the addition of the Center for Emerging Technologies in 2012, CU-ICAR currently has 20 Campus Partners from around the world. CU-ICAR boasts over \$14 million in state-of-the-art full-vehicle, material and engine/powertrain testing facilities and equipment.

“One huge benefit of CU-ICAR,” says Rob McDaris, Lab/Project Manager, “is that it helps us to prepare students for industry, while the automotive testing facility links automotive manufacturers and their suppliers to academia.”

**“I saw many examples of durable LDS shakers around the world and obtained many personal references, and I knew that I wanted a Brüel & Kjær LDS solution”**

*Carlos A. Montes*

## Component Testing Laboratory

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This laboratory is focused on supporting local manufacturers by testing and developing automotive components and systems. Opened in September 2012, the laboratory lets CU-ICAR offer testing services for interior components to tier-one automotive suppliers – complementing their established full-vehicle testing and systems-integration research.

The facility aims to add value to automotive companies in South Carolina, to help those companies become more competitive. As Clemson University President James F. Barker says, “The Component Testing Laboratory is a response to the industry’s need for local testing of interior components.”

The laboratory is divided into two test chambers: the solar chamber and the vibration chamber where the LDS shaker is situated, along with an environmental testing facility.

As Carlos A. Montes, Lead Engineer for Research and Testing, says “A typical test for interior components for BMW simulates the life-cycle, so the component or system is also tested under climatic conditions.”

**The laboratory lets CU-ICAR offer testing services for interior components to tier-one automotive suppliers**

## Vibration test system

At the system's heart is an LDS V875 long-stroke shaker with a slip table. The environmental chamber fits over either the slip table or the vertical vibration table during temperature and humidity testing.

The LDS V875 is an air-cooled unit with a 3-inch (long) stroke, equipped with a head expander measuring 48 × 48 inches. The slip table is the same size. Two customised floor plug seals are designed for use with the chamber, to ensure a tight fit throughout the long testing periods.

It is designed to test in two axes – vertical and horizontal – and to be very quick to transition between the two possibilities. The shaker can also be easily moved by means of a specially designed air glide system.

As a result of special customisation, the shaker can take a maximum load of 3000 pounds (1360.78 kg).

Test control is with an LDS Laser Controller using white noise, sine, swept-sine, or road-load data as test data input.

### Performance specifications

#### Shaker:

- Force rating: 29 kN (6500 lbs)
- Displacement peak-to-peak: 50.8 mm (2 inches) minimum
- Velocity: 1.8 m/s (71 inches/sec)
- Acceleration: 735 m/sec<sup>2</sup> (75 g)

#### Climatic chamber:

- From -50 °C up to 140 °C
- The temperature gradient changes at 2 °C per minute.

*The environmental chamber fits over the shaker for both vertical and horizontal testing, using two customised floor plug seals*



## Squeak and rattle

"Squeak and rattle testing can be performed either before or after the vibration test," says Rob, "and we run the shaker in 'quiet mode'. We use a directional microphone and agreed objective procedures to measure the noise." This low-noise operation mode keeps noise under NR35, in accordance with ISO 1996.

## Acquiring the vibration test system

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Carlos started to define the vibration test system in July 2011, and shortly after that he designed the lab layout and requested a quote. The new facility was commissioned on 11 September 2012.

As Carlos says, "I knew what I wanted, and I'm very pleased with the LDS system delivered by Brüel & Kjær. It meets all our technical requirements and provides excellent value. Brüel & Kjær is a global company, and I saw many examples of durable LDS shakers around the world and obtained many personal references, and I knew that I wanted a Brüel & Kjær LDS solution. The installation and commissioning went extremely well and I am very proud of our facility, and grateful for the fantastic support for this project from Dr Imtiaz Haque, the Director of CU-ICAR."

## The bigger picture

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"This is a commercial venture," says Rob, "and our objective is to leverage the research and outreach missions of Clemson University by engagement with the needs of industry. The system has been certified by BMW and we are currently talking to other potential customers, both automotive manufacturers and suppliers in the US and Europe."

"We are also planning to use the system for degree projects for post-graduate students. The graduate engineering centre can accommodate up to 200 of them."

CU-ICAR is currently conducting research into advanced powertrains, automotive system integration, human factors, manufacturing and materials, vehicle performance, vehicle-to-vehicle and vehicle-infrastructure integration, and vehicular electronics.

*The Component Testing Laboratory was opened on 11 September 2012 following 2.5 million dollars of investment. Here the shaker's air supply can be seen.*



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*Rob McDaris*

Not including the building, the total investment in equipment for their Component Testing Laboratory was about 2.5 million dollars. So it represents a significant investment, which reflects the confidence in the value it can offer. As Rob says, "Having this facility close to the BMW manufacturing plant avoids sending components and systems to Europe for testing, thus saving transportation costs, but especially time."

## Future

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The facility covers an area of some 250 acres (1 km<sup>2</sup>), so there is plenty of space for organic growth, and they have plans to increase their remit. According to Rob, "We are currently considering an expansion into automotive NVH testing, for which a focus would be to develop objective processes for noise source identification of automotive components and systems, and also in the interior of vehicles. And we would expect, based on our cooperation with Brüel & Kjær, to have further discussions with them."

Although CU-ICAR is currently focused on the automotive industries, in the near future they expect to see developments in aerospace and transportation in general.

## People

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### **Carlos A. Montes, Lead Engineer for Research and Testing**

Carlos obtained his first degree in electrical engineering at San Jose University in Costa Rica, and followed it with a masters and doctorate in mechanical engineering at Clemson University.



### **Rob McDaris, Lab/Project Manager**

Rob has been at CU-ICAR since May 2012. He previously worked for BMW as a manager of tool design and development, and has more than four years of expertise as an engineering consultant in the automotive and aero industries. He has a degree in mechanical engineering from the University of Tennessee.



### **Dr Imtiaz Haque**

Dr Imtiaz Haque is the Founding Chair and Executive Director of CU-ICAR. He has been involved with the design, modeling, and simulation of mechanical systems including vehicles and transmissions since 1975.