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University Consortium on Instructional Shake Tables

How to enhance civil engineering programs with earthquake simulators

Every year catastrophic earthquakes remind us of the powerful force of nature. And every year, engineers around the world work hard to design and build structures that are capable of sustaining the effects of these seismic events. To succeed, engineers must understand and experience how structures dynamically respond to the earthquake loading.

> *"Quanser simply offered us a complete package…It gives us desired flexibility in performing experiments. No other company was able to give us all that."*

Putting Theory into Practice

"Having the ability to simulate an earthquake gives us a much better understanding of building performance," says Dr. Shirley Dyke from Purdue University in Indiana. Dr. Dyke is the driving force behind University Consortium on Instructional Shake Tables (UCIST), she helped start it in 1999. The main goal of UCIST is to bring earthquake simulators to classrooms. Students early in their undergraduate courses get a chance to develop an understanding of structural dynamics and controls principles through hands-on experiments in addition to classroom lectures. "Hands-on experiments seem to be particularly effective for teaching basic concepts in dynamics and control," continues Dr. Dyke, "they are an attractive supplement to the rather conventional content of several courses."

Student at Washington University in St. Louis performing experiment on Quanser Shake Table using teleoperation capabilities.

Captivating America's Civil Engineering Students

One of the first tasks UCIST faced was to select the right bench-scale seismic simulator. The Shake Table II from Quanser was chosen. "Quanser simply offered us a complete package. The system consists not only of a shake table, but includes accelerometers, test structures, data acquisition and a computer to record data and control the shake table. It gives us desired flexibility in performing experiments. No other company was able to give us all that." With the help of the National Science Foundation (NSF) Instrumentation and Laboratory Improvement Program, UCIST equipped all its member universities with the same Quanser Shake Table II solution. The 23 member universities across North America started to develop earthquake related experiments and share them with other UCIST members. "It is very interesting for the students to come to the laboratory," adds Dr. Dyke. "We can see that they develop interest in the subject early on. During graduate studies, they simply expand on the knowledge they acquired as undergraduate students."

> *" It has been a lot of fun working with Quanser equipment and teaching students things they wouldn't otherwise have a chance to see…"*

Expanding the Program

In less than 10 years, UCIST has grown substantially and embarked on a new phase of its evolution. With over 100 universities from U.S. and abroad joining as members, additional funding was secured to utilize the latest cyberinfrastructure capabilities developed by the National Network for Earthquake Engineering Simulation (NEES). In this phase, UCIST will focus on developing teleparticipation and teleoperation experiments that will allow them to expand hands-on experience to students attending Universities not able to acquire shake tables.

Dr. Dyke has enjoyed the early success of UCIST, and her collaboration with Quanser. "It has been a lot of fun working with Quanser equipment and teaching students things they wouldn't otherwise have a chance to see, the experiments that show them how theory and real world are interconnected,"

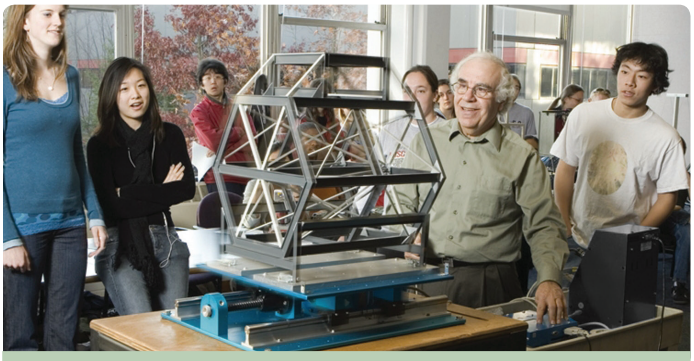
Dr. Shirley Dyke is a Professor of Mechanical Engineering and Civil Engineering at the School of Civil Engineering of Purdue University. Her research and teaching interests include earthquake engineering, structural dynamics and structural control. In 1999, she formed the University Consortium on Instructional Shake Tables (UCIST) to incorporate topics in structural dynamics into the undergraduate curriculum across the United States.

Shaking Some Reality into Civil Engineering Freshmen

The first year of study for engineering students at Cornell University was similar to many universities: all work and no play. "First semester freshmen are overloaded with homework, usually very abstract mathematics and physics," said Dr. Anthony Ingraffea, Professor at the Cornell School of Civil and Environmental Engineering. He recognized that his students were immersed in theory and could benefit from a dose of practical application.

Bridging the Gap Between Theory and Practice

Preparing for the real world, where students will create structures with real costs that must stand up to real conditions, require real-world experiments. Dr. Ingraffea sensed they would respond positively to the opportunity to build actual structures that would have to withstand simulated earthquakes. That is, real experiments with a realistic earthquake experience. "They have all seen videos on YouTube and TV showing what an earthquake looks like, but very few of them have any experience actually seeing the response of a structure."



Dr. Ingraffea and his students testing a structure on the Shake Table II.

The Shake Table II: An Ideal Platform

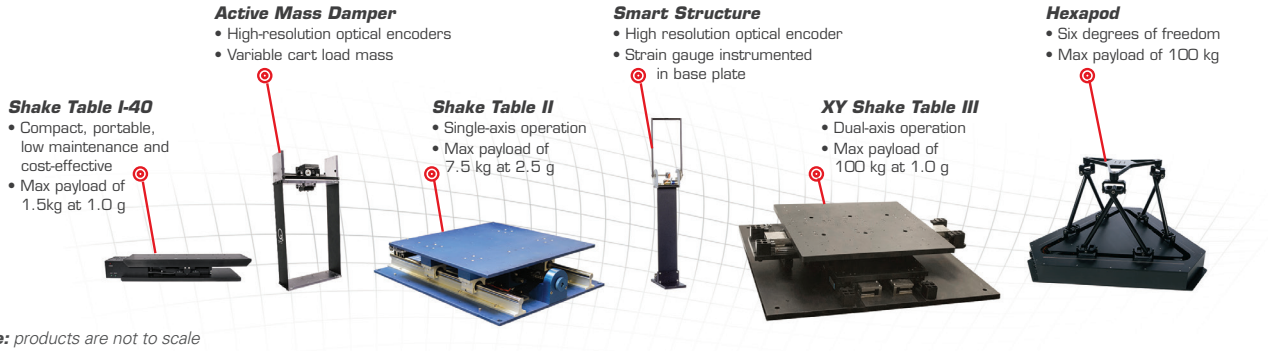
"Quanser had already created it [the Shake Table II] and the device was ideal," says Dr. Ingraffea. Quanser built its Shake Table II in cooperation with UCIST, the University Consortium on Instructional Shake Tables. Since joining forces with Quanser, UCIST has grown from 23 member universities to over 100 worldwide, and UCIST now recommends the Shake Table II as the de facto solution for teaching civil engineers.

The freshmen at Cornell were Ingraffea's first reason for purchasing a Shake Table. "It has been very useful for five generations of freshmen." And while the table simulates earthquakes, Ingraffea's class simulates the real world. He uses the Shake Table II when introducing structural dynamics, and assigns projects to design and build models based on factors that include structural integrity, aesthetics, costs and timelines.

"Then we have the big shake-off!" says Dr. Ingraffea excitedly. Teams load their completed models to the Shake Table II and predict how well they'll perform. "Then we shake them until the structure fails!" The course is all very exciting for the freshmen, and miles away from the hundreds of hours of abstract theory, mathematics and physics they face in their freshman year. As Ingraffea says, "it's a simulated real-life experience for very young engineers."

Dr. Anthony Ingraffea is a Professor at the Cornell University School of Civil and Environmental Engineering. His research concentrates on computer simulation and physical testing of complex fracturing processes. He has authored with his students over 200 papers in these areas and has been a principal investigator in various R&D projects from NSF, NASA, IBM. Professor Ingraffea has received numerous awards for his outstanding teaching at Cornell. In 2008, Professor Ingraffea received the Richard J. Almeida Award from the High Jump Board of Directors for his extraordinary dedication and contribution to the High Jump Program.

Quanser's line of Shake Tables and Smart Structures offers a wide range of options for your teaching and research needs. With their robust design, low maintenance and open configurations, Quanser's Shake Tables and Smart Structures solutions give you all of the tools you need to customize your platform and give you reliable repeatable results.



Note: *products are not to scale*

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