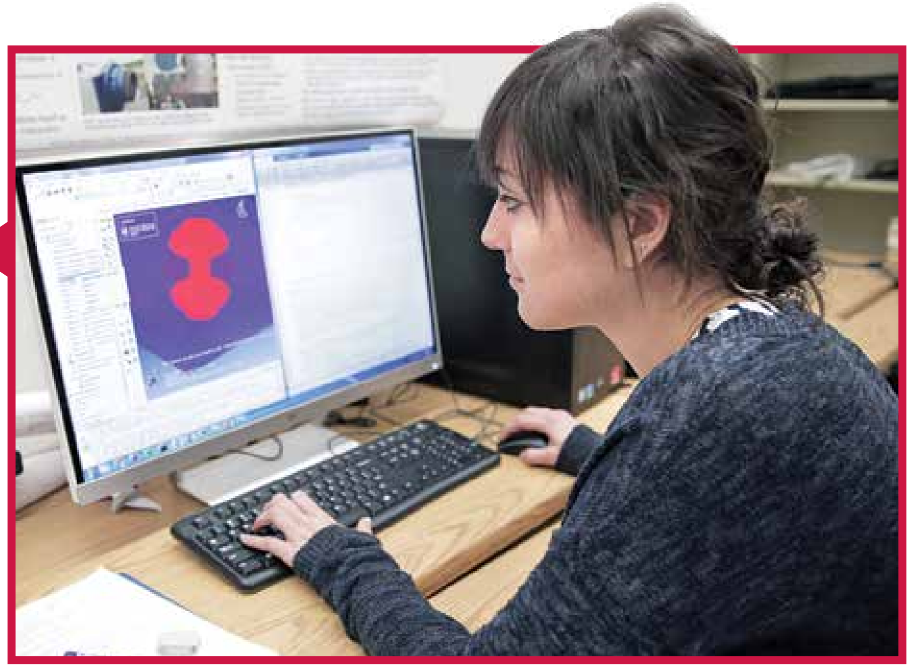
UNDERGRADUATE FELLOWSHIP HELPS STUDENT PURSUE HER GOALS

Bolts hold many aspects of our world together; without them, that world would fall apart. And Emily Jewell, who is double-majoring in engineering mechanics and math, is doing research to make sure that doesn't happen.



Emily Jewell models a bolted joint.

Photos: Stephanie Precourt

In 2016, Jewell received a Hilldale Fellowship to work on a project involving bolt interfaces with her faculty advisor Matt Allen. Jewell is one of 100 UW-Madison undergrad students with independent research projects to receive a Hilldale Fellowship in 2016.

The fellowship supports Jewell as she studies the nonlinearities of bolted joints by looking at surface contact and energy dissipation. When a preloaded, tightened bolt joins two components of a structure, the components will slowly slip relative to one another. Jewell studies this slippage at a microscopic level and how it causes energy dissipation known as damping.

There is currently no efficient method for analyzing and modeling damping at bolt joints, and existing methods are computationally and financially expensive. Jewell's work strives to replace current costly analysis methods with a quasi-static method that will quickly and accurately predict the damping at the bolt joint. Still, computationally, her models take a couple of hours to run, so one of the most challenging parts of this work is making sure that the inputs of the model are immaculate before she submits it. "Sometimes you get the results and they just don't make sense," Jewell says. "Then you realize a tiny mistake in the input that has cost you several hours of research."

But the frustration of lost time is part of the learning process that makes the work rewarding in the end. The most rewarding part, Jewell says, is when she submits a clean model and gets results that match up with others' existing theories or experimental data.

Jewell shares these results with collaborators from the Milwaukee School of Engineering and Michigan State University during weekly or bimonthly Skype meetings. Through this collaboration, Jewell gains insights from collaborators and gets to see how research is done at different institutions.

Jewell presented the results of her research at the UW-Madison Undergraduate Research Symposium in May 2017 and also at an ASME conference. She views the Hilldale fellowship as one step on a path to future scholarship: The fellowship helped her earn a prestigious 2017 Goldwater Scholarship and lays the foundation for her goal of a PhD in aerospace engineering.

"It's a gateway for my future," she says.

amplitude to pump the vibration into high frequencies where it is more quickly dissipated. This is similar to how a gong pumps vibration to high frequencies when struck hard," Allen says. "In the past, engineers have always designed aircraft and spacecraft so that the vibration stays linear because that is all that current computer models can reliably predict."

But from a design aspect, nonlinear structures are superior, Allen says—or, they would be if humans were able to use nonlinearity properly.

"For instance, humans are nonlinear," Allen says. "Your muscles, tendons and joints all behave nonlinearly. It makes us more resilient and tougher, so we can survive impacts and vibration. In contrast, a highly linear structure like a crystal glass responds dramatically to vibration at the right frequencies, shattering when the stresses become large enough."

The ability to properly account for nonlinearity would be useful for all sorts of industries, not just advanced aircraft. As a result, Allen's lab is full of machines that companies have donated to see if Allen's group can test or model them.

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