

January 28, 2011

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Recommended Citation

St. Martin, Greg, "2011-01-28: Undergraduates design clean, green heating machine" (2011). *News@Northeastern*. Paper 797.
<http://hdl.handle.net/2047/d20002040>

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Undergraduates design clean, green heating machine



A group of engineering majors designed a low-cost bioreactor for their senior capstone project. Photo by Lauren McFalls.

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Calls to curb the world's dependence on fossil fuels have grown louder in recent years, and scientists worldwide continue to push for breakthroughs in the green technology industry. Last year, five Northeastern University engineering students found themselves in the heart of this global issue—designing a low-cost bioreactor that produces clean biofuels.

The students — Dave Christianson, Elizabeth Duffy, Bryan Keen, Andrew Mazzotta, and Jameson Stark —were tasked with their senior capstone project by Joule Unlimited Inc., a Cambridge, Mass.-based firm. The company's technology involves collecting sunlight and waste carbon dioxide and converting it into clean, renewable energy using specially designed microbes. The process takes place in a bioreactor, where these engineered

organisms synthesize and secrete liquid biofuels in large volumes.

Their project strongly aligns with Northeastern's research mission to solve global challenges, with a focus on sustainability, health, and security.

"It kind of encompassed everything we'd learned over the years into one project, which was very appropriate," Christianson said.

The capstone evolved out of a co-op Keen completed at Joule in spring 2010. During his **experiential learning** opportunity, Joule officials offered Keen the chance to design a lab-scale bioreactor that provides an optimal environment for producing biofuels efficiently. The design had to allow for variation of key parameters such as light intensity, temperature, and sparging (introducing air and carbon dioxide into the microbe culture) so that various environmental settings can be used to test microbe productivity.

The final design was the result of months of hard work and collaboration to optimize each component and bring them all together to devise an elaborate, high-tech unit. "That's what engineering is, making those little tweaks that make everything work," Mazzotta said.

The students said they also developed a strong work ethic throughout the process, and as Jeffrey Ruberti — an associate professor of **mechanical and industrial engineering** who served as the students' adviser — pushed them to back everything up with math and theory, their confidence grew.

"This group did an amazing engineering job. They really dug in," Ruberti said.

"The mini-bioreactor project was truly multidisciplinary, requiring knowledge of fluid mechanics, heat transfer, mechanical design, optics, and instrumentation, along with some biology. The students clearly worked hard and their resulting design is impressive," said Stuart Jacobsen, an engineer at Joule.

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