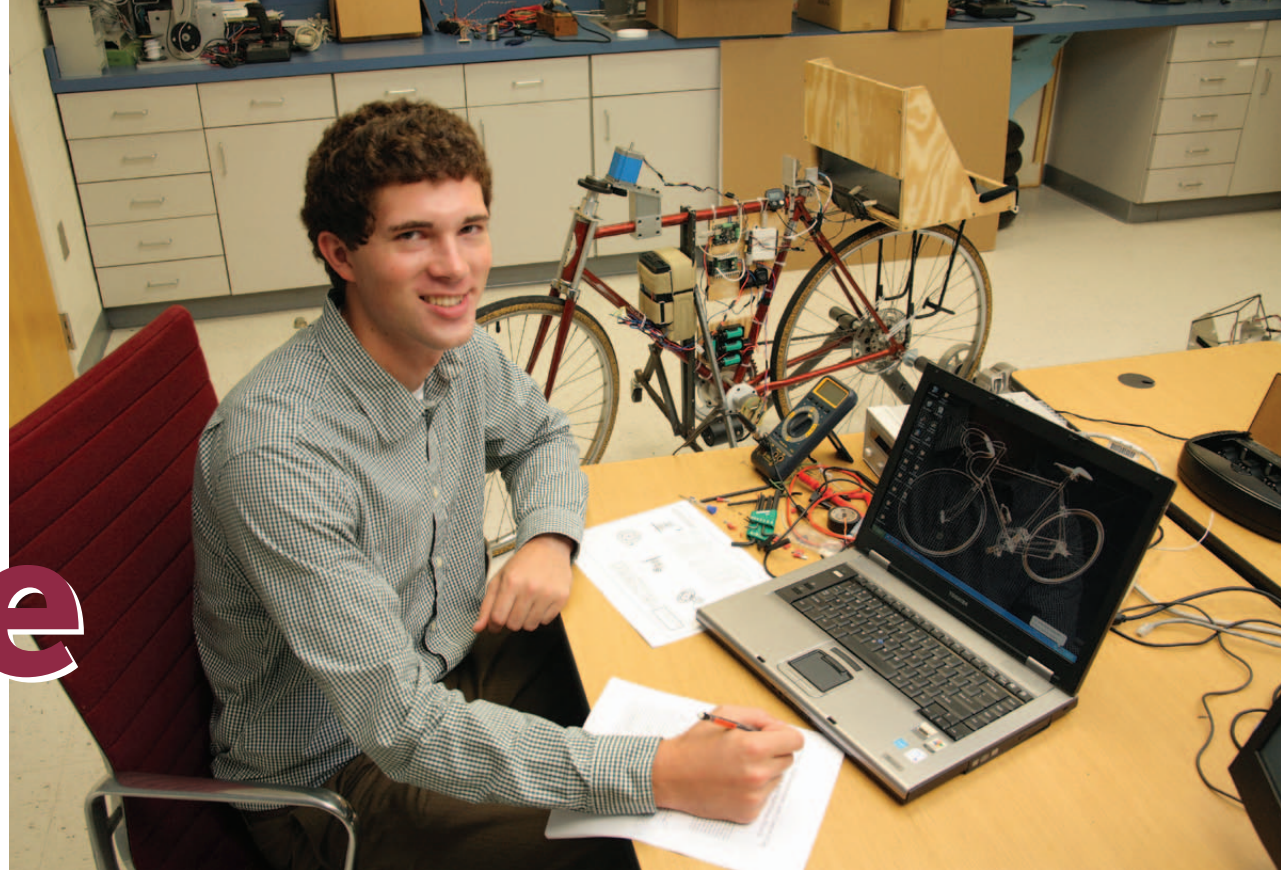
Biking in the Balance



An avid cyclist, senior Blair Williams is developing a computer-control system to keep a bicycle upright without a rider. The engineering research project grew out of mathematics research he conducted at Hope previously.

Personal and scholarly interests have merged for an engineering student working to give his bicycle a mind of its own.

Senior Blair Williams of Fenton, Mich., is developing a computer-control system to keep a bicycle upright without a rider. An avid cyclist, he has created the applied-science initiative himself, based on working with the idea at Hope a year ago as a theoretical problem.

"Last summer [2008], I took part in a mathematics research project on modeling bicycle dynamics with Dr. Tim Pennings," said Williams, who is majoring in mechanical engineering and minoring in mathematics and physics. "The aim was not only to construct an accurate model of a moving bicycle based on the laws of physics, but also to develop a mathematical control algorithm that a computer could use to steer a bicycle so as to keep it upright autonomously."

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>
> **– Senior Blair Williams**

"After completing the modeling of such a control algorithm, I was curious to see it implemented on an actual bicycle," he said. "Since then, I have taken this work from mathematics research and am using it as a basis for an engineering research project with Dr. Miguel Abrahantes."

It's painstaking work. Humans learn to ride equipped with a lifetime of balancing practice. The computer, however, is learning from scratch, and the myriad adjustments that humans make intuitively need to be programmed.

Williams started working on the project this past spring, continued full-time this summer and is now working on it in between his classes. He notes that it will be a while before anyone sees his bike piloting itself down College Avenue or through the winding walks of the central campus, although he has succeeded in keeping the bike upright on its own for some brief runs.

"I'm focusing on just keeping the bike from falling over," he said. "The lean angle—the control—is a hefty project in itself."

Williams's journey began when he approached Dr. Pennings about conducting research in mathematics in 2008. Dr. Pennings asked about his interests, and Williams noted that he enjoyed cycling—and had even competed in his first Triathlon earlier in the school year. Dr. Pennings had written his master's thesis on bicycle dynamics, and was interested in adapting portions of it for use in Mathematics 231.

The result of their work, "Stabilizing a Bicycle: A Modeling Project," became part of the course this fall. Dr. Pennings and Williams have also had an article about their project accepted for publication in Primus, a journal about the teaching of mathematics.

Hope has been a good match for Williams's subsequent focus on application as well. Dr. Abrahantes is an expert on robotics--he and his student researchers are working with an engineering team at the NASA Goddard Space Flight Center, contributing to the modeling and control systems as NASA develops a new space rover.

Williams has also reached beyond campus. He has been active in the college's exchange relationship with Technos International College of Tokyo, both hosting Japanese students and visiting Technos himself in June. While in Japan, he met with Dr. Toshiyuki Murakami of Keio University, an engineer who has designed a self-stabilizing bicycle. He's also connected with a graduate student at MIT who's engaged in a similar project.

"It's just been really neat, with all of the people who've been helping me out along the way," Williams said.

Williams even obtained his own funding for the summer, winning both a NASA Michigan Space Grant and a Hughes Research Scholars award. Beyond his project, he is one of two Hope students whose studies this year are supported through a prestigious Goldwater Scholarship, of which only 278 were awarded nationwide for 2009-10.

His work fits in with his longer-term goals. He plans to pursue a doctorate in mechanical controls, and is interested in developing medical-control devices, such as prosthetic limbs or surgical equipment.

"Good science and engineering is not all about the innovative products produced as a result of all our hard work, but rather it is about the way these technologies affect others' lives," he said. "I think that helping to develop medical controls devices would be most rewarding, as I see it as the most tangible way to utilize my engineering skills to directly change people's lives."

Dr. Pennings gives him high marks for both ability and initiative.

"He's a great example of someone who wants to go beyond the classroom and make the most out of the resources available to them at Hope," Dr. Pennings said. "He came to me—he was the one who initiated it, and he did a great job."