Bone-fracture puzzles introduce undergraduates to real-world engineering

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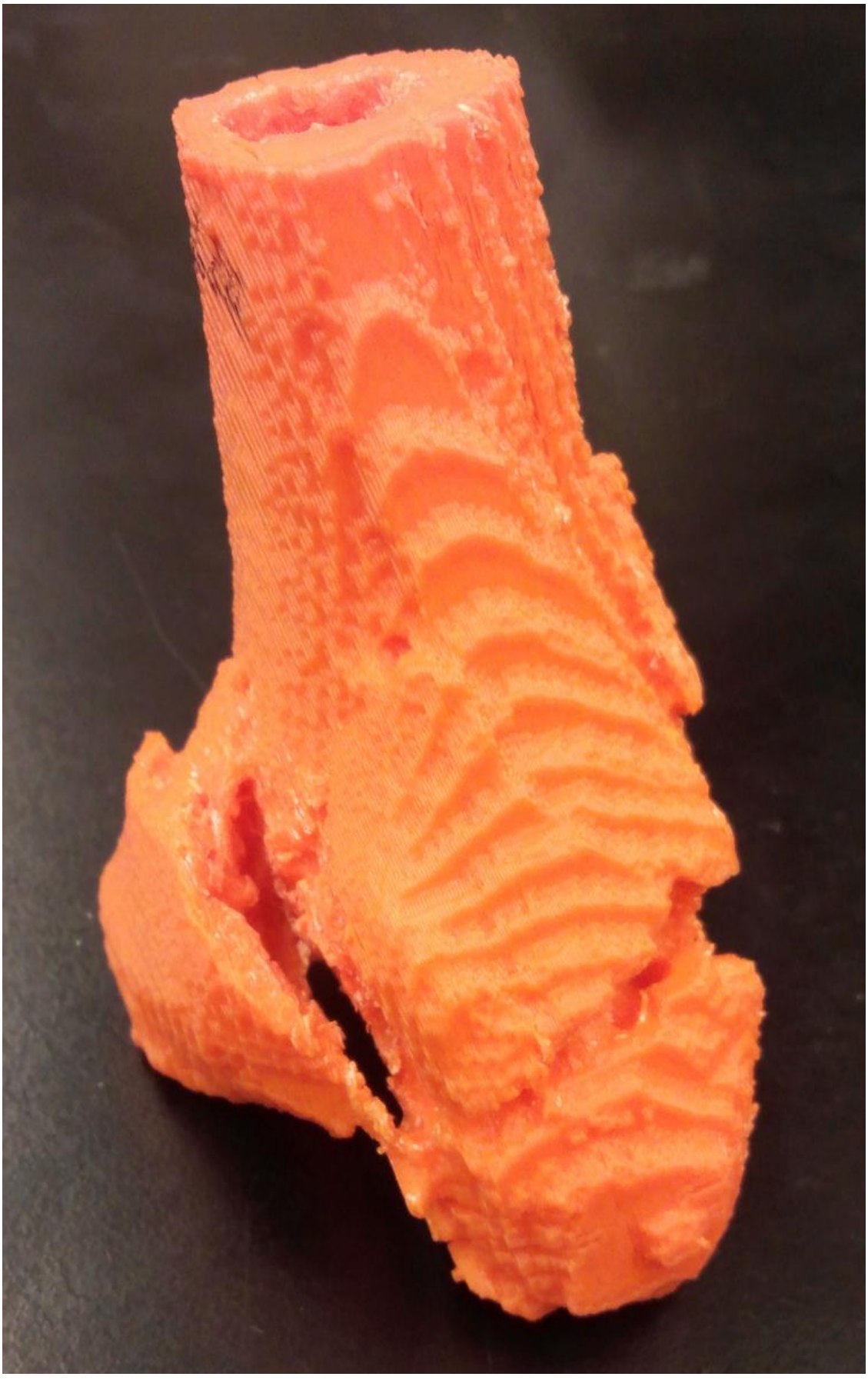

3D-printed bone fracture

In a new project-based class, first-year bioengineering students at the UC San Diego Jacobs School of Engineering produced 3D-printed models of fractured ankles from 2D images of real patients.

"As it stands, many doctors still use 2D or paper images to help them decide how a fractured bone should be repaired," said first-year bioengineering undergraduate Marisa Keller. "Having a 3D model will enable them to make more accurate decisions."

Keller was part of a team of engineering students working on a project conceived by bioengineering professor Robert Sah, a world-leader in cartilage repair and tissue engineering.

"Bioengineering-1 was such a great experience! The class itself embodied everything I had hoped to expect when I chose to study at UC San Diego," said freshman Julie Yip, who was on the same team as Keller. "I knew the university offered endless research opportunities and a leading education, especially in bioengineering; but I never thought I could have the amount of exposure that the class offered this early on in my academic career."

These perspectives highlight the motivation behind the Jacobs School's move to provide more hands-on engineering experiences to first year engineering students. It's part of Dean Albert P. Pisano's mission to make incoming students engineers from day one.

"It's crucial that our freshman get hands-on experiences that show them

why the engineering courses they will be taking are relevant," said Pisano. "When students ask 'when am I ever going to use this?' I want the answer to be: today!"

The format of the class exposed students to multiple perspectives on the possibilities within bioengineering. Professors and guest speakers led each lecture, offering students insight into the speakers' own specific research interests such as new ways to use electrodes, cardiomyocytes for regenerative medicine and Ebola.

At the core of the class were three individual, highly interactive group projects: Electrophysiology for Brain-Body-Machine Interfaces; Treatment of Ebola with Limited Resources; and 3-D Printing at Macro-Micro Scales for Organ and Tissue Engineering.

"Working on a team project was probably my favorite part of the entire course," said Yip. "I had no prior experience working with 3-D printers, and I had never before entertained the idea that I would get to do so anytime soon. I can most accurately describe the experience of developing our 3D bone print from its original CT scans in the following words: 'It was so cool!'"

The 3-D-printed-bone project required the teams of students to define the fracture based on CT scans of normal, fractured, deformed and degenerate bones as well as the histology of normal, developing and diseased cells and tissues. Next, they processed the clinical image data and conducted literature reviews, which allowed them to propose a design solution: a model that, theoretically, doctors could hold in their hand in order to visualize the best course of treatment.

Where many other projects might end there, this one didn't. The students were tasked with generating a prototype of their solution and then evaluating the accuracy of their work against the original CT scan. At the

end of the course, the teams presented their findings to the rest of the class.

"The quality of the print was surprisingly accurate," Keller recalled. "That means that 3-D printing is an effective method for generating models of damaged bones that will help doctors to determine the best course of action or treatment."

With 3-D printing already under their belt, many of the students are looking toward the future.

"The class taught me that the possibilities are endless," said Keller. "Increasingly, 3-D printers are producing products instead of prototypes – soon, 3-D printing will be able to be applied to living tissues, cartilage and bone in place of plastic models."

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