science of heat), statics (objects at rest), dynamics (objects in motion), material science (the behavior and characteristics of materials), controls (the electrical signals necessary to operate mechanical parts), chemistry, physics, and machine design.

As an undergraduate majoring in mechanical engineering, I was infatuated with real-world problems like air conditioning and heating, aircraft wing dynamics, and human-powered vehicles. As a graduate student in mechanical engineering, my research is more specialized, focusing specifically on the high-speed machining of Udimat 720, a new nickel-based super alloy that can operate at extremely high temperatures. Used for blades and wheels in gas turbine engines, such as those used in aircraft and for power generation, Udimat 720 can operate at temperatures of over 800° Celsius. This property, which makes it well suited for turbine blades, also makes it difficult to machine. I am working with laser and plasma beams; diamond, cryogenic, and coated tools; and cooling technologies to design and test new methods of manufacturing. This will help the aircraft and energy industries to produce parts more efficiently and less expensively than ever before.

The career possibilities for a mechanical engineer are virtually limitless. I plan to work as a consultant, solving machining issues for companies worldwide. I know that I will never get bored, and my work will have the potential to benefit millions of people. Mechanical engineering is an area to consider if you have a creative mind and a strong desire to figure out how things work—and then how to make them work better.

***Samuel Truesdale*** earned his bachelor's degree from Tennessee State University and is now a second year graduate student in mechanical engineering at Purdue University. His interests include cars, computers, football, and food

## Biomedical Engineering

by Judith Su

When I was a child, I loved *Fantastic Voyage*, Issac Asimov's 1966 science fiction novel about a miniaturized submarine that carries a group of people inside the body of a dying scientist to remove a blood clot in his brain. Although fictional, *Fantastic Voyage* is an example of biomedical engineering—an engineering marvel applied to a biological system and a medical application. While we are far from having tiny medical submarines, today's biomedical engineers are developing technologies, like virtual surgery and the growth of replacement organs, to perform medical rescue missions.

My fascination with medical microtechnology has brought me to my current position as a graduate student in MIT's Bioinstrumentation Engineering and Microanalysis group. We focus on the design and use of novel imaging technologies for biomedical tasks. Our projects range from the molecular to the cellular to the tissue level. At the molecular level, for example, members of our group are working to develop an imaging technology sensitive enough to detect a single molecule, like an antibody. Such a technology would give us new insights into basic biological questions, like how proteins fold, and would also make possible new clinical diagnostic tests to detect genetic and infectious diseases. At the tissue level, our group is designing an endoscopic fluorescence microscope, a non-invasive imaging device that will hopefully be able to distinguish between healthy and malignant tissues, providing a way to diagnose cancer without having to perform a biopsy.

I work at the cellular level, using a novel kind of microscopy to study changes in the internal skeleton (cytoskeleton) of a cell when it adheres to a surface. This is an important process to understand because changes in cellular mechanical properties trigger a cascade of biological responses. Knowing more about this cellular response will give us a better understanding of basic cellular processes, such as how signals are conveyed from outside to inside a cell, as well as disease processes, such as arthritis and atherosclerosis. It will also contribute to the development of tissue engineering by enhancing our ability to grow cells on artificial surfaces.

To study it, I use lithography to create an array of nanometer-high islands of varying sizes and shapes, then add fibroblasts—a kind of cell that is good at adhering to surfaces. When the cells attach to the islands, they spread and take on the shape of the underlying form. Once the cells have adhered, I can stain their cytoskeletons with fluorescent dye and create three-dimensional images of their internal structure. I can then quantify their stiffness by linking magnetic beads to the cytoskeleton via cell-surface receptors and applying a magnetic force. By measuring the beads' displacement over time and fitting them to a mathematical model of the cell's behavior, we can get information such as how stiff the cytoskeleton is for cells under various conditions.

My research is very interdisciplinary. I have to know a lot about many different fields: electronics, programming, optics, biology, chemistry, machining, microfabrication, image processing, and data analysis. Many of these fields are, by themselves, progressing very rapidly. It's quite exhausting to keep up with all of it, but at the same time, it's hard to get bored when there is so much to learn. As the amount of knowledge and opportunities explode, the field is full of excitement, and I feel fortunate to be doing work that both helps people and interests me. ■

***Judith Su*** is from Boca Raton, FL, and graduated from MIT in 2002 with a B.S. in Mechanical Engineering and a minor in Literature. She is now a second-year graduate student in mechanical engineering at MIT. Judith is also a National Science Foundation Graduate Research Fellowship recipient.