IT'S A SMALL WORLD AFTER ALL

NANOTECHNOLOGY RESEARCHER ALEXIS ABRAMSON TALKS WITH *CASE MAGAZINE* ABOUT THE PLETHORA OF NANO RESEARCH HAPPENING ON CAMPUS—AND ABOUT THE "NANOPEDIA," A BIG RESOURCE ON A SMALL SUBJECT.

Alexis Abramson, the Warren E. Rupp Assistant Professor of Mechanical and Aerospace Engineering, joined the Case faculty in January 2003. She came from the University of California, Berkeley, where she completed her doctoral degree and conducted postdoctoral research. With David Smith, research professor in the department of electrical engineering and computer science, Prof. Abramson recently received $100,000 from the National Science Foundation to develop "The Web Encyclopedia of Nanotechnology: The Nanopedia," a web-based multimedia and interactive electronic resource on nanotechnology.

CASE MAGAZINE: Tell us about the Nanopedia. What is it and what's the goal of it?

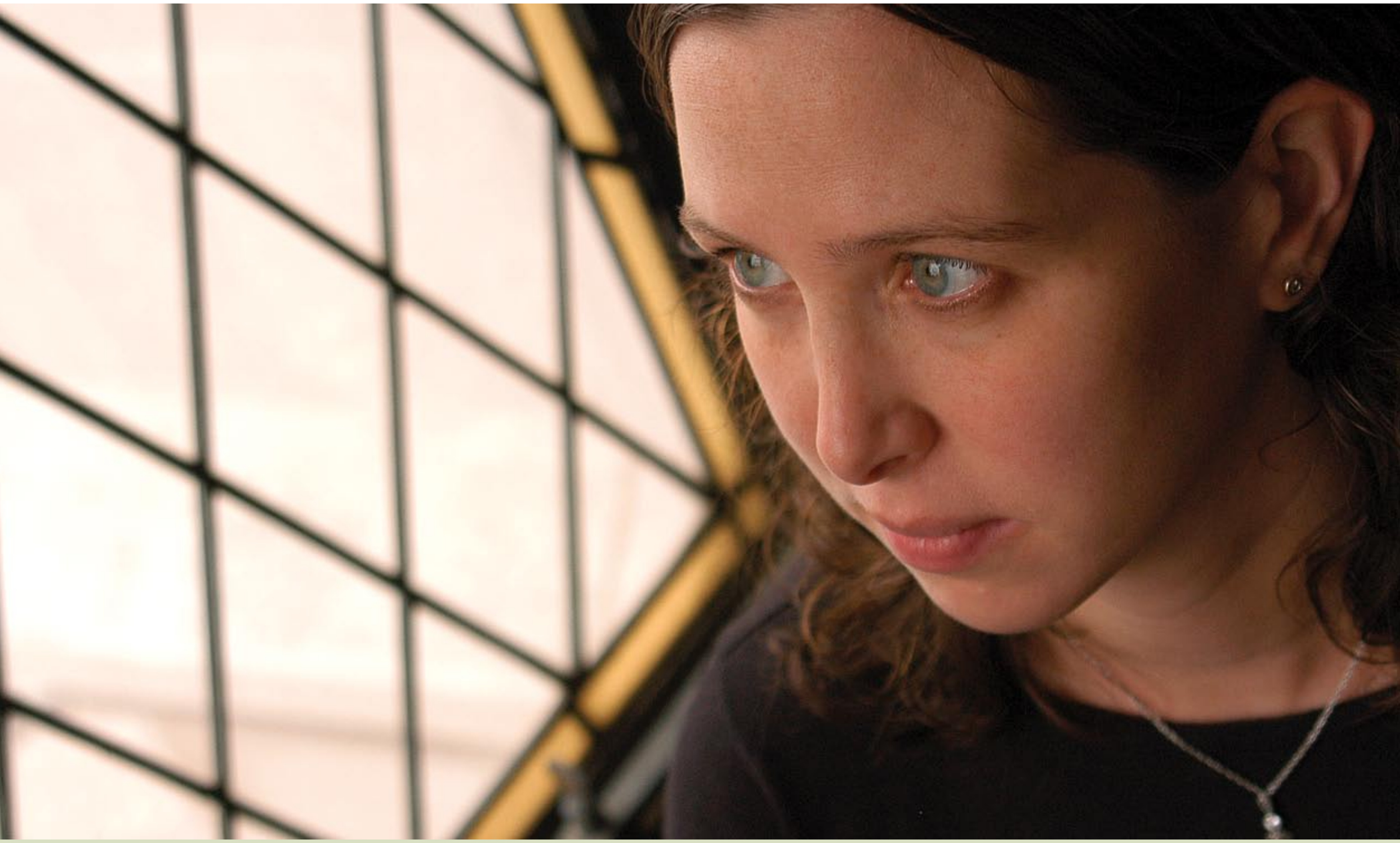
ALEXIS ABRAMSON: The Nanopedia is essentially a web-based encyclopedia of nanotechnology. But unlike your typical paper-based encyclopedia, it allows you to traverse science, news, technology, etc.—as it relates to nanotechnology—in a very interactive manner that puts the user in the driver's seat with him or her negotiating the appropriate path of learning. The goal of the project is to develop, for the public, this resource fully to include information on virtually every topic that relates to nanotechnology. It will take on a life of its own, eventually, with user input—using a controlled editorial structure—from around the world.

CASE: How did it come about?

AA: There is a real need for improving the way that the public—but specifically, our children—learn science. I have been involved in numerous science-education projects to find new ways to teach science to further stimulate interest in the subject matter. As a result, Dave Smith came to me with the initial idea of a "Totalpedia," which we decided to focus on nanotechnology—leading to the "Nanopedia." The Nanopedia has evolved in many ways since then.

CASE: Who is it aimed at?

AA: Our initial prototype of the Nanopedia is suitable for the average high school student. However, we hope to make the resource ultimately interactive so that anyone



with any background could access information at a level suitable for his or her background. For example, an entry on carbon nanotubes might demonstrate—in an animation—how carbon can be rolled up into these neat looking but tiny tubes, and the entry would include tidbits of "fun" information ranging from why these structures are so interesting to a more sophisticated explanation of the electronic band structure and a discussion of phonon transport.

CASE: How are you tackling the project?

AA: We are currently developing the prototype of the Nanopedia, and plan to continue this effort while applying for large federal—and other—grants, to supplement the NSF grant. A large grant will enable us to make it into the ultimate resource with hundreds of thousands of entries using a computationally assisted editorial structure that allows input from scientists and engineers from around the world.

CASE: When do you expect the Nanopedia to be available to the public?

AA: The prototype is available now. We welcome people to visit the Nanopedia in its continually evolving form by going to www.totalpedia.com and clicking on "Nanopedia."

CASE: For the uninitiated, what exactly is nanotechnology?

AA: The definition of nanotechnology is somewhat controversial—and it should be, because one material may be "nano" at a particular length scale while a different material may not be. Basically, nanotechnology deals with the manipulation of matter with size characteristics below approximately 100 nanometers that results in new properties or behavior that would otherwise not be achieved at larger length scales.

CASE: Nano seems to be breaking into the mainstream. Why is that?

AA: Nanotechnology has been around for a long time—we just didn't call it "nano." For example, stained glass gives us beautiful colors because of nanoscale characteristics. In the last twenty or so years, science has improved its ability to examine, characterize, and manipulate at the nanoscale in ways that were not possible before. As the science has evolved, the technology has evolved, and we see everyday products in our lives today that have engineered nanoscale characteristics, such as stain-resistant pants or longer-lasting tennis balls or faster and smaller computer chips. But with every new technology, there are many unknowns, and that often leads to public curiosity or even fear. This is also a reason the public has become more interested.

CASE: How is Case demonstrating its commitment in this research area?

AA: Case has over sixty faculty members currently involved in nano-related research, education, and commercialization. Nanotechnology spans many disciplines, and there is nano activity in the sciences, engineering, medicine, dentistry, and management. Nonetheless, Case is focusing its efforts on our strengths in nano: nanomedicine, nanomaterials, and nanomanufacturing.

Moreover, under the guidance of Provost John Anderson, a steering committee on nanotechnology has been activated to coordinate the efforts of the university in this regard. Case is helping to lead the nano-effort in Northeast Ohio through our collaborations among scientists, engineers, clinicians, and businesses with an eye toward growing our local economy. Case will continue to work with other Northeast Ohio institutions and businesses in order to strengthen interdisciplinary research and help revitalize the economy through commercialization activities. These activities will be aimed at the creation of new enterprises, training of the technical workforce, and a retooling of existing industry for twenty-first-century technology.

CASE: Is there any one person who has taken the lead at Case?

AA: The members of the Nanotechnology Steering Committee, chaired by Ken Singer in physics and under the guidance of Dr. Anderson, are working together. Kathy Kash in physics took the lead role in the "Wright Center of Innovation for Midwest Nanotechnologies"—a proposal that was submitted to the State of Ohio in September 2004 for approximately $18 million. Anne Hiltner in macromolecular science and engineering is the primary investigator for an NSF Science and Technology Center proposal that is pending: "Center for Layered Polymeric Systems," with a budget of approximately $20 million. Pam Davis, a faculty member in the medical school, recently headed up a BRTT [Biomedical Research and Technology Transfer] proposal submitted to the State of Ohio on "Targeted Nanoparticles for Imaging and Therapeutics," with a budget request of over $7 million. I managed Case's involvement in the recent Cleveland Clinic NanoMedicine Summit. And there are many more examples of people taking the lead.

CASE: What is it about nano research that makes it so interdisciplinary?

AA: Nanotechnology is practically by definition interdisciplinary, because it affects practically all aspects of science or engineering where small length scales are prevalent. It is important that all of the unique properties of materials at this length scale be well understood in order to truly move forward with the research. Therefore, collaboration among researchers who may traditionally not interact is that much more important. Case's nano research sees a great deal of interdisciplinary work—my students have to be chemists and biologists in addition to mechanical engineers—and the numbers of collaborations among researchers both within Case and with outside institutions are increasing.

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CASE: How is Case's growing research effort in nanotechnology important for the university, and what potential does Case's work represent for the region? The nation?

AA: There are many examples of how Case research has and will have a huge impact on the university, the region, and the nation. I'll highlight just a few. Magic bullets: These are discriminating "nanovessels" that, for example, will carry medicine directly to and only to tumors. These have the potential to eliminate the debilitating side effects of cancer chemotherapy, while improving effectiveness. Fuel cell materials: Extremely tiny fibers, particles, and ultra-thin multilayer polymer films can be used for key components of fuel cells to increase efficiency and lower cost. These fuel cells are expected to be vital to twenty-first-century energy technology. Biomaterials: By mimicking nature at the subcellular level, composites containing proteins and nanomineralites and synthetic surfaces that behave like cell membranes will lead to a new generation of materials for medical replacement of bones, arteries, and other tissues. Smart paint: Functional nanoparticles could lead to paints that indicate failures in the structures that they cover. For example, such paint could identify stress points in bridges in order to avoid catastrophic failures.

CASE: Earlier you mentioned your involvement in the recent two-day Cleveland Clinic NanoMedicine Summit 2004, which Case co-sponsored. How rewarding was that? What came out of the conference?

AA: The NanoMedicine Summit brought together scientists, engineers, clinicians, and business people to identify clinical opportunities that nanotechnology might bring to the medical world. I believe that, in the short amount of time we came together, we did just that by stimulating research ideas and directions, initiating collaborations, and educating the various camps in various ways. Just to get all these people in the same room was rewarding in and of itself!

CASE: What research projects are you working on now?

AA: The Nanoengineering Laboratory, under my guidance, is working on various projects. One of the main foci of the lab is in the area of thermoelectrics—solid-state cooling, or refrigerators with no moving parts. What's been shown theoretically, and to a certain extent experimentally, is that, as you get down to the nanoscale, the thermoelectric efficiency of some materials just skyrockets. If we can take advantage of this phenomenon, we could potentially replace energy conversion devices—for cooling technologies or electrical energy production—in many applications with thermoelectrics. As a result, we are working to make and characterize nanocomposites that demonstrate unique thermoelectric properties.

Moreover, we are testing a thermoelectric material found in nature that exists below the skin of sharks—a type of gel that the shark uses to sense thermal gradients in the water. By improving our understanding of this substance, we could potentially use this knowledge to redesign thermoelectric materials for certain applications, and in particular for applications requiring biocompatibility.

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