

CAREER CHOICES

This is the first in an occasional series on physicists and their career choices. In presenting these profiles, we hope to highlight the rich diversity and the broad range of careers open to those with physics training.

A PHYSICIST CARVES A NICHE IN INDUSTRIAL ECOLOGY

Two years ago, physicist Valerie Thomas found herself thinking more and more about the ill effects of environmental pollution. As a research associate specializing in nuclear arms control issues at Princeton University's Center for Energy and Environmental Studies, she was fortuitously situated to act: She decided to join a new research group at the center that is dealing with what group members term "industrial ecology."

"The whole idea of industrial ecology," explains Thomas, "is to think of industry as an inherent part of the ecosystem it is affecting. We look at the cycles of materials flowing from industry to the environment and try to imagine the evolution of a new system that is more compatible with the environment." The ideal new system would not only minimize waste but would use waste materials as input for the next production cycle.

In addition to Thomas, the industrial ecology group consists of a chemistry professor, a professor from the department of civil engineering and operations research, a professor from the Woodrow Wilson School of International and Public Affairs and center director Robert Socolow. Funding for the group currently comes from a diverse mixture of government agencies, private foundations and industry.

Heavy metals—such as lead and cadmium—and organics—such as dioxin—have serious implications for human health and are of particular interest to Thomas. Much of her work involves the use of data already available in the literature to shed new light on the production of pollutants and their pathways through the industrial ecosystem and into the environment. "We look at how these materials are used, where they go and what their effects are, and we ask how these pathways could be changed and what would be the effects of the changes," she says.

A study of cadmium and lead coauthored by Thomas and Princeton



Valerie Thomas, a physicist at Princeton University's Center for Energy and Environmental Studies, demonstrates the use of a home lead-testing kit.

colleague Thomas Spiro and presented at the 1992 Global Change Institute on Industrial Ecology in Snowmass, Colorado, illustrates how this type of investigation can uncover new and sometimes surprising conclusions. It showed that most of the documented environmental and health effects of both cadmium and lead appear to come from relatively minor uses of these metals. About half of refined cadmium, for example, is used in batteries, with the rest being used in other industrial products. But the main sources of the cadmium to which Americans are exposed are phosphate fertilizers, one of many products in which cadmium appears as an impurity. One lesson, say the authors, is that targeting the main exposure routes is much more effective than simply reducing the total amount of cadmium used in products.

Similarly, recycling is not a panacea. Consider the case of lead. The primary use of lead is in batteries, a high percentage of which are already recycled. But the human health problems due to lead exposure are mostly caused by so-called dissipative products, such as paint and leaded gasoline, which cannot be recycled.

This kind of analysis does not call

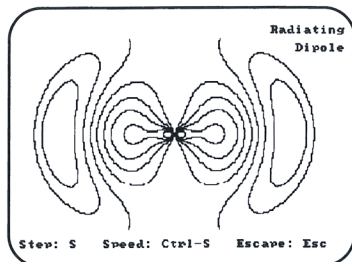
for sophisticated mathematics. "I don't need Green's functions for this kind of work," notes Thomas. Moreover, trying to understand processes such as soil erosion, transport into ground water and absorption by plants, which affect the pathway of pollutants through the environment, sounds like a problem for chemists and biologists. However, Thomas believes that her physics training brings an important perspective to industrial ecology. "Rather than going to a big computer program, I would be more likely to use the back of an envelope. I tend to break complicated environmental problems into smaller ones that I can solve. That's what I learned in physics."

So why does a physicist become an environmental researcher? Thomas's story is a not uncommon one. "I was asking myself, What do I really want to do?" As an undergraduate at Swarthmore College, she majored in physics, the subject that interested her the most at the time. She graduated in 1981 with high honors. For graduate school, Thomas chose Cornell University. Like many, she was struck by the excitement and adventure of seeking to understand the fundamental nature of matter. Her 1986 thesis, "Aspects of Two-Dimen-

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sional Quantum Field Theories," analyzed the captivating prospect of catalyzing the decay of protons with magnetic monopoles.

Midway through her graduate studies, Thomas took a step that would lead away from a traditional career in academic physics. She joined the November 11th Committee (named after the Veterans Day date of the group's first symposium) organized by physics professor Peter Stein to help educate the campus and local community about arms control issues. The committee consisted primarily of physics graduate students and postdocs.

After graduation Thomas took the next step on her new path. "I knew I didn't want to try for a postdoc in theoretical physics," she recalls, "but I had learned that several positions in arms control and national security were available. I figured there would be no problem, but when every place I applied to rejected me, I felt devastated." In the end, however, Thomas did land a position in the department of engineering and public policy at Carnegie Mellon University, where for two years she studied how the production of solid-fuel missiles could be detected by satellites or other means.

In 1988 Thomas moved to Princeton to work with Frank Von Hippel and Harold Feiveson, who were leaders of an arms control group in the Center for Energy and Environmental Studies. The subject of her research shifted slightly to verification of the presence or absence of nuclear sea-launched cruise missiles on board ships at sea. At the time, the US was arguing against the inclusion of sea-launched cruise missiles in the START treaty because they were too easy to hide.

As she became increasingly involved with arms control issues, Thomas found that the nature of her work did not line up well with her talents and interests. She found herself thinking increasingly about environmental issues and, as a result, decided to shift course once again. "My hypothesis was that, for the environment more than for arms control, there were scientific questions that didn't have answers yet, that these answers were needed, and that ways to solve the problems could be found. It seemed to be a better match for me."

The transition was made easier for Thomas when the center allowed her to split her time between arms control and the environment. Once she had some experience under her belt, she began working full time on environmental issues. "I tell people that it is

really important to spend as much time as possible beforehand getting up to speed before asking for a job in a new field," Thomas says. "My volunteer arms control work at Cornell helped me make the change into that area. It was very important that the center allowed me to stay and start working on environmental problems."

While at Princeton, Thomas helped assemble the American delegation to an international summer school held in 1989 in Moscow to encourage scientists to address public policy issues independently of their governments. The school was such a success that a similar summer school was held the following year in the US, and a third and fourth took place in Moscow (1991) and Shanghai (1992). The schools have had both arms control and environmental parts, with Thomas generally organizing the environmental half.

A major new study of lead pollution in Moscow—a subject about which very little is known at present—is one outcome of Thomas's participation in these schools. Russian colleagues are now collecting lead samples from various locations in and around six day-care centers because children are the most affected by lead poisoning. The samples (paint, soil, dust, water, gasoline and so on) will be analyzed in Moscow and at Princeton, providing Thomas an opportunity to do quantitative analysis using atomic absorption spectroscopy. Thomas has just written a proposal to obtain funding for the project.

As a member of the research staff, Thomas is beginning to have an impact. "I'm just now becoming productive," she says. However, she does not have a permanent position at the center and expects to be looking for a job in the next year. "I really like doing the type of research that I'm doing now, and I would like to do it in an academic environment," she says.

In the past there have been limited opportunities of this type. In addition to the center at Princeton, the department of engineering and public policy at Carnegie Mellon and the energy and resources group at the University of California, Berkeley, come to mind. Spurred in part by the Federal global change initiative, however, interdisciplinary environmental science departments and programs are coming into existence at other schools. Although these often have biology-ecology or engineering-water resources orientations, Thomas concludes that there may well be opportunities for physicists, provided that they have the right kind of experience.

—ARTHUR L. ROBINSON ■