

CAREER CHOICES

Exposing the Dangers of Tobacco Smoke

Over a span of nearly two decades James Repace has carved out a career studying the harmful effects of tobacco smoke on indoor air quality. Along the way he has picked up some powerful enemies—among them the Philip Morris Cos, RJ Reynolds Tobacco Co and several members of Congress. These days of course the problem of “secondhand smoke” is widely recognized, and bans on smoking in public places can be found throughout the country. But when Repace began his research, in 1976, people were only beginning to recognize environmental tobacco smoke as a public health hazard.

Repace wasn't planning to take on the tobacco industry when he decided to become a physicist. He was only a ninth-grader at the time. Having abandoned an earlier ambition to be a rocket scientist (it was the 1950s, after all), he never again wavered from what he calls his “very single-minded desire to do physics.”

In 1956 Repace enrolled at what was then the Polytechnic Institute of Brooklyn, commuting an hour and fifteen minutes each way from his parents' home in Mount Vernon, New York. “I was the first in my family ever to go to college, so I had no knowledge that that wasn't the best way to do it.” After graduating in 1962 with a BS in physics, he landed a summer job in the nuclear medicine lab of Grasslands Hospital in Westchester County, New York, where he administered radiodiagnostic tests and lectured medical residents on radiation physics. Repace quickly developed an appreciation for biology, which until then he had dismissed as “a wholly nonquantitative science,” and he enjoyed working with patients. That work led to Repace's next job, as a junior physicist at De-lafield Hospital in New York City.

Following his marriage in 1964 to Hilarine Schultheis he decided that supporting a family on his \$5000-a-year salary would be difficult. Looking back, Repace guesses that he would have done quite well had he stayed in medical physics, which later became a much larger—and more lucrative—field. Instead he joined RCA Laboratories in Princeton, New Jersey, where he worked in the insulator



SURGEON GENERAL C. EVERETT KOOP (right) awards the Surgeon General's Medalion to James Repace in 1989 for his work on environmental tobacco smoke.

physics group that was headed by Joseph Dresner and included a number of other PhD physicists. Every Friday morning researchers gathered to present their work, and heated arguments were typically the result. “I always think back on it as the ‘Brass Knuckle School of Physics,’” Repace says. “It wasn't ill-intentioned—the idea was that you'd get at the truth, and if you were wrong you were forced to admit it sooner or later.” While at RCA he also took night courses at Brooklyn Poly, completing his MS in physics in 1968.

With two children now added to the family, Repace once again decided to make a career move. He submitted a one-page application to the American Institute of Physics' career placement service and promptly received half a dozen offers, including ones from Westinghouse Electric Corp and *Physical Review Letters*. He opted for the Naval Research Laboratory in Washington, DC. “Believe it or not, I was studying the salinity of the paleolithic oceans, measuring the halflives of trace elements in fossil barnacles and comparing them to extant barnacles.” After a year and a half he transferred to the electronics division of NRL. “To sum it up in one sentence, my job there was making the world safe for ballistic missiles,” Repace notes wryly.

He had also started working part-

time on his physics doctorate at Catholic University. But after his wife gave birth to triplets in 1969 and another child soon followed, he stopped his graduate studies, with some reluctance, and returned full-time to NRL.

Becoming radicalized

Doing someone a favor was to change Repace's life. A friend asked him to take notes during a hearing on enforcing the newly established Clean Air Act of 1970, and he agreed. “This whole procession of polluters—from the smoke stack industries and the oil companies and so on—came in and argued against enforcement.” As he listened, Repace recalled several frightening asthma attacks he had suffered while living in New York City; during one episode the air quality had been so bad he had nearly passed out. Toward the end of the hearing, the audience was given a chance to comment. “I was fuming at that point. I found myself walking to the podium and delivering this five-minute extemporaneous speech, and I got a standing ovation from the audience,” Repace says. “I think in that moment, I was radicalized. I felt that what I wanted to do in my life was to bring my talents, the stuff I had learned about physics, to air pollution control problems.”

He set out to educate himself

about air pollution. He pored over *Fundamentals of Air Pollution* by Samuel J. Williamson, a physicist at New York University, and he studied a series of audiotapes put out by the Environmental Protection Agency. He then put his new knowledge to the test and wrote an environmental impact statement arguing against a sewage sludge incinerator that was to be built 1 kilometer upwind of NRL.

"I began to realize that part of the way you solve environmental problems and public health problems is to make the public aware that there is a problem," Repace says. He became increasingly active as a citizen-environmentalist and for a time was head of the Prince George's Environmental Coalition in suburban Maryland.

One day in 1975, after listening to Repace argue to shut down a small sewage sludge incinerator, a local official approached him and asked, "Why are you so concerned about this tiny incinerator? Why aren't you looking at pollution from cigarettes?" And as he thought about it afterwards, Repace says, "I realized that I had never seen the outdoor air as dirty as the air in a room full of smokers."

With that, Repace shifted his attention indoors. In 1976 he and Alfred H. Lowrey, a PhD theoretical chemist at the Naval Research Lab, began developing a model for predicting levels of tobacco smoke in enclosed spaces. Their model took into account the number of smokers, the volume of air, the air exchange rate and any background pollution present. They found the typical indoor "respiratory suspended particulate" level to be 20 micrograms per cubic meter. By contrast, for the air in a typical restaurant where smokers were present, they calculated a tenfold rise in the RSP level after just a half-hour, with 83% of the RSP coming from tobacco smoke.

To test their model, Lowrey, Repace and Clara Govin, a friend who founded the Group Against Smokers' Pollution, did a controlled experiment, using a conference room at the Maryland Department of Environmental Health and several of the department's nurses who smoked. They also conducted a variety of field measurements using a piezobalance—a piezoelectric quartz-crystal oscillator whose mass would increase as particles stuck to it. With the help of John O'Hara, a friend who worked at the National Security Agency, they took readings in cocktail lounges, bingo halls, bowling alleys, a hospital emergency waiting room and even a bagel bakery. They also sampled air in cars traveling along US Highway

50 in Maryland and the beltway around Washington, DC, during rush hour. In the end their model proved sound. Lowrey and Repace published their findings in a 1980 article in *Science* (volume 208, page 464).

Shortly before that paper appeared Repace moved to EPA, where he still works.

The price paid

Throughout his career, Repace says, his physics background has served him well: in his earlier work in medical physics, electronics and oceanography and in his later work on public health and environmental issues. He is therefore troubled at the difficulties confronted by the younger generation of scientists, which includes his son Max, now a physics graduate student at the University of Maryland, College Park. "Society today doesn't seem to value science, or scientists, as much," he notes.

Not that his own path has been any walk in the woods. Both his research and his willingness to speak out on the harms of environmental tobacco smoke have earned him a certain notoriety among tobacco producers and their friends. In 1987 he was the subject of a seven-month investigation by EPA's Office of the Inspector General, instigated by Representative Don Sundquist of Tennessee (a top tobacco growing state). Although the investigation failed to turn up anything incriminating, his managers at EPA distanced him from any further work on tobacco smoke. "I began to pay a price for being outspoken," Repace says. "The only real surprise was that it had taken so long to happen."

That's why, although Repace's work on tobacco smoke has been the focus of his research career, it quite often has not been part of his official duties as a government scientist. A disclaimer appears in fine print in each of his published papers: "This work was performed by the author in his private capacity. No official support or endorsement by the US EPA is intended or should be inferred."

In the waning days of the Bush Administration, the Department of Labor's Occupational Safety and Health Administration began working on an indoor air quality rule, to regulate environmental tobacco smoke and other indoor pollutants in the workplace. Repace was brought in by OSHA to assist. The public hearings on the rule, held from September 1994 to March of this year, were particularly enlightening for Repace. "The tobacco companies' lawyers—we counted about 25 of them the first

day—represent probably the best legal talent money can buy." After all of OSHA's expert witnesses had testified and been cross-examined, often for 8 or 10 hours, the biggest US cigarette manufacturer, Philip Morris, pulled out of the hearings. In a letter, the company gave three reasons for doing so; reason number two was Repace's presence on the OSHA panel. (At the time of this writing the fate of the proposed indoor air quality rule is unclear, given the de-regulatory mood on Capitol Hill.)

These days Repace is back at EPA, and his independent research on environmental tobacco smoke continues. That work has taken him far afield from mainstream physics. His curriculum vitae lists papers published in the *British Medical Journal*, *Environment International* and the *Saint Louis University Public Law Review*.

In a 1993 paper in *Risk Analysis*, he and Lowrey outlined the dosimetry for environmental tobacco smoke based on how nicotine, a smoking by-product, is absorbed into the body and metabolized into cotinine. They developed a pharmacokinetic model for predicting the level of cotinine in blood and urine; when compared with the levels observed in clinical epidemiological studies, the model was accurate to within 5–15%. Repace soon hopes to use data from the National Health and Nutrition Survey to verify the model using a nationwide sample. He is also collaborating with Steven Bayard and Jennifer Jinot of EPA's Office of Research and Development on a model for predicting the levels of airborne nicotine in the workplace and of cotinine in saliva. "We have enough data collected by others that we can do a Monte Carlo analysis and simulate the entire distribution of nicotine and cotinine with a high degree of precision."

The ability to measure and predict environmental tobacco smoke accurately will do much to refute the tobacco companies' contentions, Repace says. "They argue that we can't quantify exposure very well and that exposure in the workplace in particular is very small." Wrangling with the politics of tobacco seems to give Repace at least as much pleasure as the intellectual challenge of the science. "If the tobacco industry hadn't been such an adversary, I think I would have gotten bored years ago and moved on." And with the validation of his models by new data, Repace hopes he will soon know the satisfaction of telling his probacco critics, "I told you so."

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