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TECH TRANSFER

Battelle's researchers fight 'nuclear' grass—and the bureaucracy

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How researchers at Battelle's Northwest Lab waged war to bring a seemingly hopeless idea to market.

*By **Robert Cassidy**, Editor-in-Chief,* R&D *magazine*

YOU'VE HEARD enough fairy tales about technology transfer. This is a true story of how researchers at one Federal lab, spurred by a crusading scientist, moved new technology into the marketplace.

The champion in this case is Peter Van Voris, a 41-year-old biologist, ecologist, and systems analyst at Battelle's Pacific Northwest Laboratory (PNL) in Richland, WA. It was his vision and tenacity in the face of numerous obstacles that took the technology in question—"biobarriers," specifically, slow-release herbicides encapsulated in polymer containers—into commercial application.

Today, that technology is being used in Sunnyvale, CA, to keep sewer lines from being clogged with plant roots; in Chicago, to stop grass from breaking up the runways at O'Hare airport; and in farms across the country, to keep irrigation pipes free of vegetation. It is the basis for several new companies, with more in the works.

But we're getting ahead of the story. To appreciate what Van Voris and his colleagues at Battelle have achieved, you have to go back more than a decade to 1978.

It all started with a game of bridge.

Luck of the draw

Long before Pete Van Voris arrived at PNL, there was Dominic Cataldo.

As a kid growing up in the heart of Cleveland after the war, Cataldo was, in his own words, "a nerd" who "always wanted to be a researcher."

Cataldo, now 47, started college at Ohio State Univ., Columbus, in animal physiology, hoping to become a veterinarian. He switched to plant physiology at Univ. of Dayton, OH, because, as he says with a self-deprecating, almost devilish, laugh (which he tends to do a lot), "plants don't bite."

Cataldo returned to Columbus to begin his PhD studies, finishing at Yale in 1972. There were few jobs for plant physiologists at that time, so he took a postdoctoral position at Univ. of Wisconsin, Madison. When an opportunity came up to join the 1,400 researchers at PNL in 1974, he grabbed it. "My wife said get a job or get out of the house," says Cataldo.

For the next four years, Cataldo puttered around his greenhouse lab, merrily experimenting with his plants. Then came the fateful bridge game that was to change his life.

Among the players that evening was biophysicist Fred Burton. He and W. Eugene Skiens, a polymer chemist, were doing research for the World Health Organization on a slow-release contraceptive device (the precursor of the vaginal ring).

Earlier that day, Cataldo had attended a presentation by Jack Cline, a radioecologist, who was working on physical barriers to plant growth—how to stop plant roots from growing through rocks, concrete, or asphalt.

This problem was of more than passing interest at PNL, which is adjacent to the Dept. of Energy's Hanford nuclear reservation, where tons of low-level and defense nuclear wastes are buried. Tumbleweed roots were growing down through the barriers and "sucking up" radiation from the wastes. As a result, radioactive tumbleweed could be found blowing all over the 570-square-mile reservation.

Rockwell International, which managed Hanford at the time, had to have teams patrol the grounds armed with Geiger counters to catch the tumbleweed and check it for radiation.

"We were playing bridge and talking about these two problems, and it dawned on me that they could be married," recalls Cataldo. "So I said, as a joke, 'Why not put the plant on birth control?' "

Only this time, nobody laughed.

Thus began a three-year effort to find a slow-release herbicide that would keep plants from invading the buried radioactive wastes. With $20,000 from Rockwell, the biobarrier research team began its work.

The technical challenges, although not monumental, still were substantial. The herbicide itself had to be able to halt root

***Ecotoxicologist** Peter Van Voris peers out from behind a "biobarrier" fabric he helped develop. It can be used to stop roots from reaching buried nuclear waste.*

To get enough herbicide in the pellets, the team had to violate the rules of polymer chemistry.

growth without killing the plants. It had to be nontoxic, for environmental reasons, and nonsoluble so that it wouldn't get washed away. The "container" had to be able to release a steady dose of the herbicide for at least 100 years.

During the next year or so, Cataldo and his associates conducted hundreds of tests searching for the right herbicide. Burton and Skiens experimented with a number of polymers to serve as a "container" for the herbicide. Cline did most of the field work, testing various formulations of the herbicide-polymer combinations in Cataldo's greenhouse and at test sites in Colorado and Kentucky.

"We had a pretty good idea what to look for, but it was still a matter of guesswork," says Cataldo.

Plant physiologist *Dominic Cataldo (left) and Van Voris examine the pellets used in their biobarrier products. Cataldo says the idea for the technology came to him while playing a game of bridge.*

By 1981, the team had something they could hold in their hands—bite-sized translucent orange pellets made of polyethylene that contained trifluralin.

Available commercially as Treflan, the herbicide is nontoxic and stable in soil, yet effective—up to a point. Tests showed that the pellets could be expected to stop root growth for anywhere from 7 to 25 years, but then their effectiveness would wear out. The researchers couldn't get enough trifluralin into the pellets to last the critical 100 years.

By this time, however, their research was starting to get noticed by DOE. With $600,000 from a Federal program to solve the uranium mine-tailings problem, the researchers were able to continue their work.

This time they tried adding carbon black, with its great absorptive properties, to the polyethylene.

"Normally, you should only be able to add about 5% carbon black to polyethylene, but Fred found a way to get 35% in," says Cataldo. "All we did was violate a couple of rules of polymer chemistry. Management brought in two experts, including a Nobel laureate, who told us that it couldn't be done, but we didn't care what they said. We just wanted a carrier for the trifluralin."

Although their testing methods were somewhat crude, they were able to cram enough trifluralin into the now-black polymer pellets to guarantee a century of effectiveness.

But then the money ran out, and Battelle management in Columbus, OH, pulled the plug. "They didn't see it going anywhere, and you needed their blessing to get money," recalls Cataldo. Of management's decision, he adds, "They're good at widgets, but bad at abstract stuff."

Just when the project looked dead, Van Voris rode in on his white horse.

Healing the earth

Van Voris came to PNL by a somewhat indirect path. He was reared in Ohio and upstate New York, in a family where invention and industry were a tradition. His maternal grandfather designed pumps and mining gear for use in Colorado mines. His father, a graduate of the Colorado School of Mines and MIT, was a metallurgical engineer and industrialist who developed some of the super-lightweight alloys for use in the early space program.

Van Voris grew up in the shadow of an older brother who had graduated first in his class at Kenyon College, Gambier, OH, and then gone on to a brilliant medical career. He followed his brother in premed at Kenyon, but soon realized he wanted to find cures for Nature's ills as an ecologist.

Van Voris finished his BS in biology, earned a master's in radioecology at State Univ. of New York, Buffalo, and completed his PhD in systems analysis at Univ. of Tennessee, Knoxville.

After teaching for a couple of years, Van Voris joined Oak Ridge (TN) National Lab, studying how plants transport radioactive materials and chemicals in the ecosystem.

"I didn't want to become known as Mr. Plutonium," he says, which is why he switched from radioecology to systems analysis—and why, in 1977, he left ORNL for Battelle's Columbus operation, where he worked on toxic chemicals, industrial waste, and acid rain.

But while he liked the work, he missed the environment of a national lab. "You have all these brilliant people and different activities, and there's more basic science going on," he says. In 1983, he transferred to Battelle's Pacific Northwest Div. as manager of technology commercialization.

Soon after his arrival in Richland, Van Voris met Cataldo. "As soon as I saw the pellets, I knew it was a good idea," he recalls. "I had a feeling that there were commercial problems the technology could solve, beyond the mine-tailings one. It was just sitting there, waiting to be exploited."

Thus began a most unusual partnership between two research scientists.

Though fiercely loyal to each other, Van Voris and Cataldo are something of an odd couple.

Cataldo is given to wearing cowboy shirts and belts with huge buckles. Van Voris favors tailored European dress shirts, preferably in pink, with his initials monogrammed on the pocket.

Van Voris, a football player in high school, is a health nut who enjoys working out with weights and bicycling around the Columbia River countryside. Cataldo's idea of exercise is rock collecting.

Van Voris can only be described as a true Type A personality—driven, energetic, compulsive. He thinks nothing of being on the road 170 days a year—to London to give lectures on global environmental issues, to Chernobyl to consult with Soviet nuclear experts, to Australia to meet potential clients.

His wife gave him a cartoon which he proudly posted on his office door. It shows a woman at the perfume counter of a department store. "My husband is a workaholic," the woman is saying to a sales clerk. "Do you have anything that smells like a desk?"

Cataldo, by contrast, has the laid-back demeanor of the pipe smoker he is. A sign in *his* office shows a jackass over the words, "No amount of science will ever replace dumb luck."

"Pete's the visionary. I'm a nuts-and-bolts person," says Cataldo. "I couldn't see an idea worth a damn." He laughs. "I guess that's the definition of a scientist around here."

At his wedding, someone whispered 'gaskets' in Van Voris's ear.

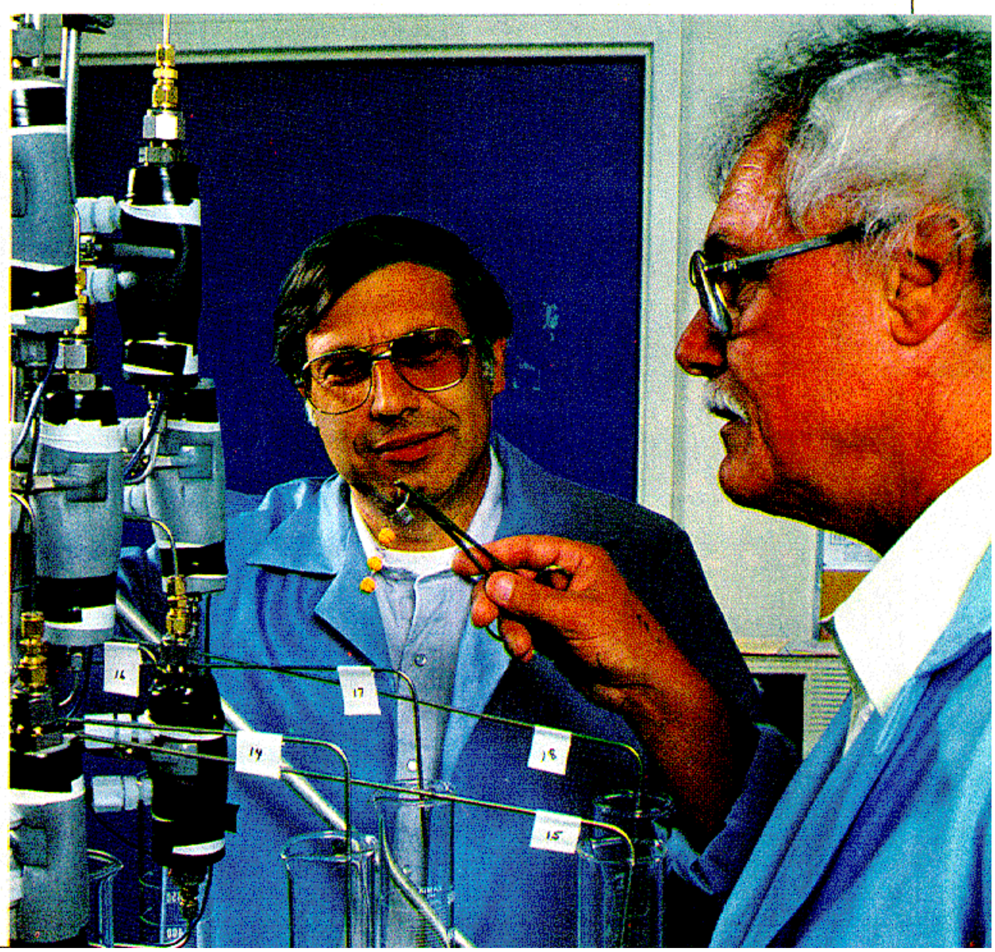
Van Voris says their relationship is a happy mixture of seemingly incompatible ingredients. "It's like putting chocolate and peanut butter together and coming up with Reese's peanut butter cups," he says.

One of the commercial applications Van Voris envisioned for the biobarrier material had to do with sewers. "Remember the scene in *The Graduate* where the guy tells Dustin Hoffman to think about plastics?" he asks. "The same thing happened to me at my wedding, only the word was 'gaskets.' "

Van Voris remembered his "gaskets" contact, Robert Merian, president of Mantiline Corp., Mantua, OH. "He was here two days after I called," says Van Voris. They both realized that if they could encase the trifluralin in a polymer gasket, it could prevent root growth into sewer lines—a huge expense for municipalities and homeowners.

"Take a city like Charlotte, NC," says Van Voris. "That city spends $1.35 a person each year just to rout out its sewer lines, and that's only a temporary solution. If you extend that to the whole United States, it's a $300-million annual cost. Why not prevent the problem in the first place?"

But Merian had three demands before he would put up any money: patent protection, a royalty agreement, and a clear understanding of the U.S.



Alan Scott *(right), a senior research technologist at Battelle, examines the accelerated diffusion assembly with Cataldo. The apparatus was used to test the long-term effectiveness of the pellets.*

Van Voris had to become a self-taught lobbyist to get approval from Federal bureaucrats.

government's rights to any product.

"Remember, this was 1983, way before anyone in DOE was concerned about technology transfer," says Van Voris.

In the absence of a clear licensing procedure, Van Voris became a self-taught lobbyist, browbeating the DOE bureaucracy with 5 am phone calls to Washington, DC.

After a year of making a pest of himself, Van Voris was able to convince DOE to release the patent rights to Battelle, which then was free to license them to private companies. In return, the U.S. government would get royalties and the right to use the technology on Federal projects at no cost.

"That was fair," says Van Voris. "DOE had taken the early risk, and they deserved a cut."

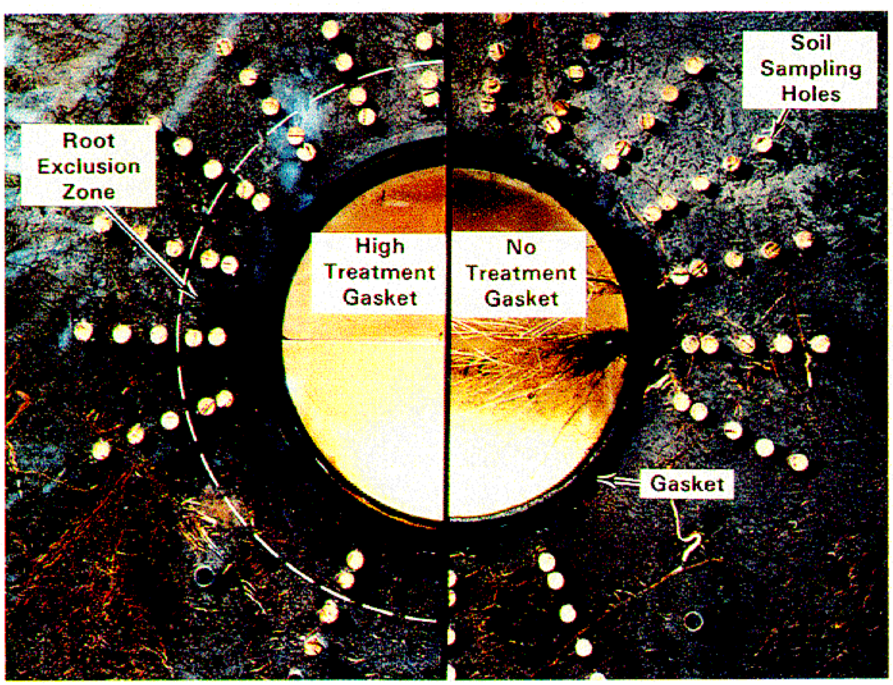
The next bureaucratic hurdle in Van Voris's path came courtesy of the Environmental Protection Agency. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the EPA places strict limits on the use of pesticides like trifluralin.

"The environmental regulators at the state and local levels kept saying we weren't meeting FIFRA standards," says Van Voris. That meant more trips to Washington to find a way to wiggle through EPA regulations.

Van Voris eventually found one, albeit a tiny one: If it could be shown that the pesticide was merely incorporated within an already existing product (as the trifluralin was contained within the sewer gasket), it might fall outside FIFRA's jurisdiction.

Various concentrations of the herbicide trifluralin (Treflan) were tested against controls to determine the best concentration for stopping unwanted root growth.

Sewer gaskets containing trifluralin prevent the intrusion of roots into a sewer pipe. An Ohio company is marketing the product under license from Battelle.



"I went to the director of EPA's registration division in Washington with this, and he looked it over and said, 'Yeah, Pete, there are a lot of gray zones in FIFRA.' " Van Voris took that as a signal to proceed.

Still, it took nearly two years of wrangling to get EPA to exempt the trifluralin-containing polymers from FIFRA. To do so, Van Voris had to convince the manufacturer of Treflan to "extend the technical-grade label" to cover Battelle's uses. "Unfortunately, we have to do this for each new use, but it's better than nothing," says Van Voris.

Meanwhile, back at the lab, the team had to attack a slew of technical problems.

Van Voris wanted to beef up the testing procedure that supposedly proved a 100-year life for the pellets. "What we had was a Rube Goldberg setup that I didn't feel would gain the confidence of industry," he says.

The solution was an "in vitro diffusion assembly" which heats the herbicide-polymer and speeds up the diffusion process. Industry has accepted the results of the tests, which show the product can last well beyond 100 years, but the U.S. Patent & Trademark Office has been less generous in accepting them for patent purposes. "They keep saying that unless we actually test for 100 years, they won't accept our results," says Cataldo.

Next, they returned to the original problem—how to slowly release trifluralin so that roots would not grow through a protective layer. They had to figure out how to array the herbicide-polymer beads for maximum effect—and at the lowest cost. There could be no "holes" in the protective layer for roots to grow through.

It seemed like a simple problem at first, but turned out to be quite difficult. "We tried everything, even boring holes with grain drills and dropping the beads down the holes," says Van Voris. That method failed to give them control over the placement of the beads.

"Then one day I was in the hardware store, and I came across some Typar," says Van Voris, referring to a geotextile made by DuPont.

He called DuPont and spoke to Mi-

Scientists don't appreciate the everyday problems that manufacturers face, says Van Voris.

chael Dewsbury, a product developer, who said he wanted to know more. Pretty soon, they were testing ways to "stick" the beads onto the material.

"I thought it would be so easy," says Van Voris. "We tried using a superglue, but it wouldn't stick. We also tried 'shooting' the pellets onto the fabric with a glue gun, but that didn't work either."

After more trials, DuPont scientist Leon Zimmerman developed a process called through-injection molding to squeeze the melted polymer material between the fabric's interstices.

"That's not such an easy problem to solve, due to the small difference in melt temperature between the polypropylene in the fabric and the polyethylene in the base material of the pellets," says Van Voris. "It's particularly difficult given the width of the fabric (up to five feet) and the speed at which it is manufactured, but Leon figured it out."

DuPont later sold the Typar manufacturing line to InterTech Group, North Charleston, SC. Jerry Zucker, InterTech's owner, brought Dewsbury in from DuPont and invested "heavily," according to Van Voris, to help Battelle refine and develop the biobarrier technology.

Zucker's subsidiary company, Reemay, markets the biobarrier sheets, one of a number of commercial products that Van Voris and his colleagues have been able to develop with industrial partners.

Another InterTech company produces GrowGuard, a polymer-herbicide cord that keeps grass and weeds from growing in pavement cracks. "We heard from a man who has responsibility for 132 airports in Florida, and he told me he hated to mow his runways. That's how GrowGuard came along," says Van Voris. It's being tested at Chicago's O'Hare airport.

Other possibilities for biobarriers include a fungicide to keep telephone poles from rotting (every year, a million of them have to be replaced nationally, according to Van Voris) and a rodenticide to keep rats out of shipping containers.

Add to that seven patents pending, seven reports of invention on other possible products, and four licenses granted for biobarriers in the past few years.

Not bad for a technology that only six years ago had been written off as having no market potential to speak of.

Peter Van Voris: 'Too many good ideas get left in the lab.'

From his experience, Van Voris believes the main reason why technology transfer gets bogged down is that "scientists are not willing to deal with the day-to-day problems.

"If you ask a typical physicist about manufacturing or pricing or marketing, he'll say, 'Hey, I'm a physicist. I don't want to be bothered with those kinds of problems,' " Van Voris says. "Every time we tried adapting this technology to a new use, we came up with new problems—how to disperse the herbicide, how to do master batching, and so on."

Problems like these can be tedious to deal with, he says, but the ability to solve them can spell the difference between success or failure in the real world.

Van Voris's sidekick sees the issue from a different perspective. "People like Pete get a certain reputation," says Cataldo. "Some people think that if you're good at marketing, you must be a weak scientist. I have great respect for Peter's scientific background, but let's face it, there's a big ego involved here, and there aren't many people like him" at PNL.

Van Voris believes that professional jealousy accounts for some of the resentment of his role. "Some people who thought this was all hogwash a few years ago are now trying to jump on the bandwagon," he says. "I'm fairly well known throughout the world in ecotoxicology. To do what I do, you have to be a good scientist just to know when someone's trying to smoke you with a bad idea. Besides, I was involved in solving the 'science' problems, not just the commercialization ones."

He also thinks most scientists fear exposing their ideas to failure in the real world. "They think they've solved the problem by writing an academic paper," he says. "They shy away from seeing that idea tried out in industry. That's why so many good ideas get left in the lab."

L.D. "Don" Williams, PNL's director of technology transfer, agrees that Van Voris's job is a ticklish one. "It isn't easy doing what Pete does," he says. "You need the vision and the stick-to-itiveness to stay with these problems for a long time. We need people like Pete, but we have to recognize that not everyone is going to be like that."

As for the future, Van Voris is tackling some problems with a worldwide scope. He has been allocated $500,000 by PNL director William R. Wiley to look into establishing an international center for global issues at the lab. "We'll be looking at global warming, the ozone layer, toxins, and so on, using the latest computer-modeling techniques," he says.

But that work won't keep him from his main job of finding new clients for the lab's technology. "We got a call from the army the other day," he says. "They may want us to come up with uniforms that will keep mosquitos off the troops for a month at a time."

His eyes brighten, and you can almost see the light bulb glowing over his head. **R&D**

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