# The radioactive boy scout:

## *When a teenager attempts to build a breeder reactor*

*By Ken Silverstein – Harper's Magazine*, November 1998

> There is hardly a boy or a girl alive who is not keenly interested in finding out about things. And that's exactly what chemistry is: Finding out about things–finding out what things are made of and what changes they undergo. What things? Any thing! Every thing! –*The Golden Book of Chemistry Experiments*

Golf Manor is the kind of place where nothing unusual is supposed to happen, the kind of place where people live precisely because it is more than 25 miles outside of Detroit and all the complications attendant on that city. The kind of place where money buys a bit more land, perhaps a second bathroom, and so reassures residents that they're safely in the bosom of the middle class. Every element of Golf Manor invokes one form of security or another, beginning with the name of the subdivision itself–taken from the 18 hole course at its entrance–and the community in which it is nestled, Commerce Township. The houses and trees are both old and varied enough to make Golf Manor feel more like a neighborhood than a subdivision, and the few features that do convey subdivision–a sign at the entrance saying "We have many children but none to spare. Please drive carefully"–have a certain Back to the Future charm. Most Golf Manor residents remain there until they die, and then they are replaced by young couples with kids. In short, it is the kind of place where, on a typical day, the only thing lurking around the corner is a Mister Softee ice-cream truck.

But June 26, 1995, was not a typical day. Ask Dottie Pease. As she turned down Pinto Drive, Pease saw eleven men swarming across her carefully manicured lawn. Their attention seemed to be focused on the back yard of the house next door, specifically on a large wooden potting shed that abutted the chain-link fence dividing her property from her neighbor's. Three of the men had donned ventilated moon suits and were proceeding to dismantle the potting shed with electric saws, stuffing the pieces of wood into large steel drums emblazoned with radioactive warning signs. Pease had never noticed anything out of the ordinary at the house next door.

A middle-aged couple, Michael Polasek and Patty Hahn, lived there. On some weekends, they were joined by Patty's teenage son, David. As she huddled with a group of nervous neighbors, though, Pease heard one resident claim to have awoken late one night to see the potting shed emitting an eerie glow. "I was pretty disturbed," Pease recalls. "I went inside and called my husband. I said, `Da-a-ve, there are men in funny suits walking around out here. You've got to do something.'"

What the men in the funny suits found was that the potting shed was dangerously irradiated and that the area's 40,000 residents could be at risk. Publicly, the men in white promised the residents of Golf Manor that they had nothing to fear, and to this day neither Pease nor any of the dozen or so people I interviewed knows the real reason that the Environmental Protection Agency briefly invaded their neighborhood. When asked, most mumble something about a chemical spill. The truth is far more bizarre: the Golf Manor Superfund cleanup was provoked by the boy next door, David Hahn, who attempted to build a nuclear breeder reactor in his mother's potting shed as part of a Boy Scout merit-badge project.

It seems remarkable that David's story hasn't already wended its way through all forms of journalism and become the stuff of legend, but at the time the EPA refused to give out David's name, and although a few local reporters learned it, neither he nor any family members agreed to be interviewed. Even the federal and state officials who oversaw the cleanup learned only a small part of what took place in the potting shed at Golf Manor because David, fearing legal repercussions, told them almost nothing about his experiments. Then in 1996, Jay Gourley, a correspondent with the Natural Resources News Service in Washington, D.C., came across a tiny newspaper item about the case and contacted David Hahn. Gourley later passed on his research to me, and I subsequently interviewed the story's protagonists, including David–now a twenty-two-year-old sailor stationed in Norfolk, Virginia.

I met with David in the hope of making sense not only of his experiments but of him. The archetypal American suburban boy learns how to hit a fadeaway jump shot, change a car's oil, perform some minor carpentry feats. If he's a Boy Scout he masters the art of starting a fire by rubbing two sticks together, and if he's a typical adolescent pyro, he transforms tennis-ball cans into cannons. David Hahn taught himself to build a neutron gun. He figured out a way to dupe officials at the Nuclear Regulatory Commission into providing him with crucial information he needed in his attempt to build a breeder reactor, and then he obtained and purified radioactive elements such as radium and thorium.

I had seen childhood photographs of David in which he looked perfectly normal, even angelic, with blond hair and hazel-green eyes, and, as he grew older, gangly limbs and a peach-fuzz mustache. Still, when I went to meet him in Norfolk, I was anticipating some physical manifestation of brilliance or obsession. An Einstein or a Kaczynski. But all I saw was a beefier version of the clean-cut kid in the pictures. David's manner was oddly dispassionate, though polite, until we began to discuss his nuclear adventures. Then, for five hours, lighting and grinding out cigarettes for emphasis, David enthused about laboring in his backyard laboratory. He told me how he used coffee filters and pickle jars to handle deadly substances such as radium and nitric acid, and he sheepishly divulged the various cover stories and aliases he employed to obtain the radioactive materials. A shy and withdrawn teenager, David had confided in only a few friends about his project and never allowed anyone to witness his experiments. His breeder-reactor project was a means–albeit an unorthodox one–of escaping the trauma of adolescence. "I was very emotional as a kid," he told me, "and those experiments gave me a way to get away from that. They gave me some respect."

You–Scientist! –*The Golden Book of Chemistry Experiments*, Chapter 10

In *The Making of the Atomic Bomb*, Richard Rhodes notes that the psychological profiles of pioneering American physicists are remarkably similar. Frequently the eldest son of an emotionally remote, professional man, he–almost all were men–was a voracious reader during childhood, tended to feel lonely, and was shy and aloof from classmates.

David's parents, Ken and Patty Hahn, divorced when he was a toddler. Ken is an automotive engineer for General Motors, as is his second wife, Kathy Missig, whom he married soon after the divorce. David lived with his father and stepmother in a small split-level home in suburban Clinton Township, about thirty miles north of Detroit. Ken Hahn worked extraordinarily long hours for GM. With close-cropped hair and a proclivity for short-sleeved dress shirts, Ken radiates a coolness that, combined with his constant preoccupation, must have been confounding to a child. When asked about his undemonstrative nature, Ken attributes it to his German ancestry. Yet for all his starchiness, it was Kathy who was David's chief disciplinarian.

David spent weekends and holidays with his mother and her boyfriend, Michael Polasek, an amiable but hard-drinking retired forklift operator at GM. Golf Manor is demographically similar to Clinton Township, but the two households could not have been more different emotionally. Patty Hahn committed suicide in the house a few years ago, but Michael still lives there surrounded by pictures of her. ("She was a beautiful person," he says. "She was my whole life.") He keeps five cats and a spotless household, and looks like a member of Sha Na Na.

Despite the fact that David was shuffled between households, his early years were seemingly ordinary. He played baseball and soccer, joined the Boy Scouts, and spent endless hours exploring with his friends. An abrupt change came at the age of ten, when Kathy's father, also an engineer for GM, gave David The Golden Book of Chemistry Experiments. The book promised to open doors to a brave new world–"Chemistry means the difference between poverty and starvation and the abundant life," it stated with unwavering optimism–and offered instructions on how to set up a home laboratory and conduct experiments ranging from simple evaporation and filtration to making rayon and alcohol. David swiftly became immersed and by age twelve was digesting his father's college chemistry textbooks without difficulty. When he spent the night at Golf Manor, his mother would often wake to find him asleep on the living room floor surrounded by open volumes of the Encyclopedia Britannica.

In his father’s house, David set up a laboratory in his small bedroom, where the shelves are still lined with books such as Prudent Practices for Handling Hazardous Chemicals in Laboratories and The Story of Atomic Energy. He bought beakers, Bunsen burners, test tubes, and other items commonly found in a child’s chemistry set. David, though, was not conducting the typical adolescent experiments. By fourteen, an age at which most boys with a penchant for chemistry are conducting rudimentary gunpowder experiments, David had fabricated nitroglycerine.

David’s parents admired his interest in science but were alarmed by the chemical spills and blasts that became a regular event at the Hahn household. After David destroyed his bedroom–the walls were badly pocked, and the carpet was so stained that it had to be ripped out–Ken and Kathy banished his experiments to the basement.

Which was fine with David. Science allowed him to distance himself from his parents, to create and destroy things, to break the rules, and to escape into something he was a success at, while sublimating a teenager’s sense of failure, anger, and embarrassment into some really big explosions. David held a series of after-school jobs at fast-food joints, grocery stores, and furniture warehouses, but work was merely a means of financing his experiments. Never an enthusiastic student and always a horrific speller, David fell behind in school. During his junior year at Chippewa Valley High School–at a time when he was secretly conducting nuclear experiments in his back yard–David nearly failed state math and reading tests required for graduation (though he aced the test in science). Ken Gherardini, who taught David conceptual physics, remembers him as an excellent pupil on the rare occasions when he was interested in classwork but otherwise indifferent to his studies. “His dream in life was to collect a sample of every element on the periodic table,” Gherardini told me with a laugh during an interview at Chippewa Valley before his 8:20 A.M. class. “I don’t know about you, but my dream at that age was to buy a car.”

David’s scientific preoccupation left less and less time for friends, though throughout much of high school he did have a girlfriend, Heather Beaudette, three years his junior. Heather says he was sweet and caring (she once returned from a weeklong trip to Florida to find a pile of lengthy love letters) but not always the perfect date. Heather’s mom, Donna Bunnell, puts it this way: “He was a nice kid and always presentable, but [in the days before her second wedding] we had to tell him not to talk to anybody. He could eat and drink but, for God’s sake, don’t talk to the guests about the food’s chemical composition.”

Not even his scout troop was spared David’s scientific enthusiasm. He once appeared at a scout meeting with a bright orange face caused by an overdose of canthaxanthin, which he was taking to test methods of artificial tanning. One summer at scout camp, David’s fellow campers blew a hole in the communal tent when they accidentally ignited the stockpile of powdered magnesium he had brought to make fireworks. Another year, David was expelled from camp when–while most of his friends were sneaking into the nearby Girl Scouts’ camp–he stole a number of smoke detectors to disassemble for parts he required for his experiments. “Our summer vacation was screwed up when we got a call telling us to pick David up early from camp,” his stepmother recalls with a sigh.

Up to this point the most illicit of David’s concoctions were fireworks and moonshine. But convinced that David’s experiments and increasingly erratic behavior were signs that he was making and selling drugs, Ken and Kathy began to spot-check the public library, where David told them he studied. In variably, David would be there as promised, surrounded by a huge pile of chemistry books. But Ken and Kathy were not assuaged, and, worried that he would level their home, they prohibited David from being there alone, locking him out when they were away, even on quick errands, and setting a time for their return so that he could get back in. Kathy began routinely searching David’s room and disposing of any chemicals and equipment she found hidden under the bed and deep within the closet.

David was not deterred. One night as Ken and Kathy were sitting in the living room watching TV, the house was rocked by an explosion in the basement. There they found David lying semiconscious on the floor, his eyebrows smoking. Unaware that red phosphorus is pyrophoric, David had been pounding it with a screwdriver and ignited it. He was rushed to the hospital to have his eyes flushed, but even months later David had to make regular trips to an ophthalmologist to have pieces of the plastic phosphorus container plucked carefully from his eyes.

Kathy then forbade David from experimenting in her home. So he shifted his base of operations to his mother's potting shed in Golf Manor. Both Patty Hahn and Michael Polasek admired David for the endless hours he spent in his new lab, but neither of them had any idea what he was up to. Sure, they thought it was odd that David often wore a gas mask in the shed and would sometimes discard his clothing after working there until two in the morning, but they chalked it up to their own limited education. Michael says that David tried to explain his experiments but that "what he told me went right over my head." One thing still sticks out, though. David's potting-shed project had something to do with creating energy. "He'd say, `One of these days we're gonna run out of oil.' He wanted to do something about that."

> *The force hidden in the atom will be turned into light and heat and power for everyday uses. Chemists of the future, working with their brother-scientists, the physicists, will find new ways of harnessing and using the atoms of numerous elements–some of them unknown to the scientists of today. Do you want to share in the making of that astonishing and promising future? –The Golden Book of Chemistry Experiments*

Like Michael, few people whom David confided in understood what he was doing. Ken Hahn, who had taken chemistry courses in college, could follow some of what David told him but thought he was exaggerating for attention. "I never saw him turn green or glow in the dark," he says. "I was probably too easy on him."

It probably didn't feel that way to David. Although Ken is immensely proud of David's experiments now that they have a certain notoriety, at the time they represented a breakdown in discipline. As fathers are wont to do, Ken felt the solution lay in a goal that he didn't himself achieve as a child–Eagle Scout. As teenagers are wont to do, David subverted that goal.

In addition to showing "scout spirit," Eagle Scouts must earn twenty-one merit badges. Eleven are mandatory, such as First Aid and Citizenship in the Community. The final ten are optional; scouts can choose from dozens of choices ranging from American Business to Woodwork. David elected to earn a merit badge in Atomic Energy. His scoutmaster, Joe Auito, who lives on a rural road an hour or so north of Detroit and who resembles an aging Deadhead rather than the rock-ribbed conservative I'd expected, says he's the only boy to have done so in the history of Clinton Township Troop 371. David's Atomic Energy merit-badge pamphlet was brazenly pro-nuclear, which is no surprise since it was prepared with the help of Westinghouse Electric, the American Nuclear Society, and the Edison Electric Institute, a trade group of utility companies, some of which run nuclear power plants. The pamphlet judiciously states that America is a democracy and "the people decide what the country will do." The pamphlet goes on to suggest, however, that critics of atomic energy were descended from a long line of naysayers and malcontents, warning that "if America decides for or against nuclear power plants based on fear and misunderstanding, that is wrong. We must first know the truth about atomic energy before we can decide to use it or to stop it."

**1.** Individual atoms of an element have the same number of protons in their nuclei. This "atomic number" determines the element's chemical properties and position in the periodic table. The number of neutrons within atoms of the same elements can vary, however. Known as isotopes, these variations have unique physical properties because the number of neutrons affects the atom's mass. Most elements have at least two naturally occurring, stable isotopes. But isotopes of heavier elements (those with more protons) are often unstable. Called radioisotopes, and often artificially produced, these nuclei undergo some form of radioactive decay–alpha, beta, or gamma–to become more stable. In alpha decay, the nucleus loses two protons and two neutrons, thus transforming into another element two atomic numbers below it on the periodic table. In beta decay, either a neutron is converted into a proton, and the atomic number rises, or the opposite occurs, pushing the atomic number down. Gamma radiation–in which energy is emitted but no transformation occurs–can accompany alpha or beta decay (where the atomic number falls) or can occur on its own. Americium-241, for example, is a radioisotope of americium. Its atomic number is 95, its atomic mass number is 241, and it becomes neptunium-237 through alpha decay.

David was awarded his Atomic Energy merit badge on May 10, 1991, five months shy of his fifteenth birthday. To earn it he made a drawing showing how nuclear fission occurs, visited a hospital radiology unit to learn about the medical uses of radioisotopes,[1] and built a model reactor using a juice can, coat hangers, soda straws, kitchen matches, and rubber bands. By now, though, David had far grander ambitions. As Auito's wife and troop treasurer, Barbara, recalls: "The typical kid [working on the merit badge] would have gone to a doctor's office and asked about the X-ray machine. Dave had to go out and try to build a reactor."

What is a breeder reactor? This simplistic description comes from a publication that David obtained from the Department of Energy (DOE): "Imagine you have a car and begin a long drive. When you start, you have half a tank of gas. When you return home, instead of being nearly empty, your gas tank is full. A breeder reactor is like this magic car. A breeder reactor not only generates electricity, but it also produces new fuel."

All reactors, conventional and breeder, rely on a critical pile of a naturally radioactive element–typically uranium-235 or plutonium-239–as the "fuel" for a sustained chain of reactions known as fission. Fission occurs when a neutron combines with the nucleus of a radioisotope, say uranium-235, transforming it into uranium-236. This new isotope is highly unstable and immediately splits in half, forming two smaller nuclei, and releasing a great deal of radiant energy (some of which is heat) and several neutrons. These neutrons are absorbed by other uranium-235 atoms to begin the process again.

A breeder reactor is configured so that a core of plutonium-239 is surrounded by a "blanket" of uranium-238. When the plutonium gives off neutrons, they are absorbed by the uranium-238 to become uranium-239, which in turn decays by emitting beta rays and is transformed into neptunium-239. Following another stage of "radioactive decay," neptunium becomes plutonium-239, which can replenish the fuel core. The nuclear industry used to tout breeders as the magical solution to the nation's energy needs. The government had opened up two experimental breeders at a test site in Idaho by 1961. Amid great fanfare, in 1963 Detroit Edison opened the Enrico Fermi I power plant, the nation's first and only commercially run breeder reactor. The following decade, Congress appropriated billions of dollars for the Clinch River Breeder Reactor in Tennessee. Hopes ran so high that Glenn Seaborg, chairman of the Atomic Energy Commission during the Nixon years, predicted that breeders would be the backbone of an emerging nuclear economy and that plutonium might be "a logical contender to replace gold as the standard of our monetary system."

Such optimism proved to be unwarranted. The first Idaho breeder had to be shut down after suffering a partial core meltdown; the second breeder generated electricity but not new fuel. The Fermi plant–located just 60 miles from Clinton Township–was plagued by mechanical problems, accidents, and budget overruns, and produced electricity so expensive that Detroit Edison never even bothered to break down the costs. In 1966, the plant's core suffered a partial meltdown after the cooling system malfunctioned; six years later the plant was shut down permanently. In 1983, when it was estimated that completion costs would deplete much of the federal budget for energy research and development, Congress finally killed the Clinch River program.

If he knew of such setbacks, David was in no way deterred by them. His inspiration came from the nuclear pioneers of the late nineteenth and early twentieth centuries: Antoine Henri Becquerel, the French physicist who, along with Pierre and Marie Curie, received the Nobel Prize in chemistry in 1903 for discovering radioactivity; Fredic and Irene Joliot-Curie, who received the prize in 1935 for producing the first artificial radioisotope; Sir James Chadwick, who won the Nobel Prize in physics the same year for discovering the neutron; and Enrico Fermi, who created the world's first sustainable nuclear chain reaction, a crucial step leading to the production of atomic energy and atomic bombs.[2] **2.**

> Another role model, similar to David in temperament, was the Englishman Francis William Aston. He invented the mass spectrograph in 1920, which he used to identify more than 200 isotopes. As a child, writes Richard Rhodes, Aston "made picric-acid bombs from soda-bottle cartridges and designed and launched huge tissue-paper fire balloons…."

Unlike his predecessors, however, David did not have vast financial support from the state, no laboratory save for a musty potting shed, no proper instruments or safety devices, and, by far his chief impediment, no legal means of obtaining radioactive materials. To get around this last obstacle, David utilized a number of cover stories and concocted identities, plus a Geiger-counter kit he ordered from a mail-order house in Scottsdale, Arizona, which he assembled and mounted to the dashboard of his burgundy Pontiac 6000.

David hadn't hit on the idea to try to build a breeder reactor when he began his nuclear experiments at the age of fifteen, but in a step down that path, he was already determined to "irradiate anything" he could. To do that he had to build a "gun" that could bombard isotopes with neutrons. David wrote to a number of groups listed in his merit-badge pamphlet–the DOE, the Nuclear Regulatory Commission (NRC), the American Nuclear Society, the Edison Electric Institute, and the Atomic Industrial Forum, the nuclear-power industry's trade group–in hopes of discovering how he might obtain, from both natural and commercial sources, the radioactive raw materials he needed to build his neutron gun and experiment with it. By writing up to twenty letters a day and claiming to be a physics instructor at Chippewa Valley High School, David says he obtained "tons" of information from those and other groups, though some of it was of only marginal value. The American Nuclear Society sent David a teacher's guide called "Goin' Fission," which featured an Albert Einstein cartoon character: "I'm Albert. Und today, ve are gonna go fission. No, ve don't need any smelly bait and der won't be any fish to clean. I mean fission, not fishin'."

Other organizations proved to be far more helpful, and none more than the NRC. Again posing as a physics teacher, David managed to engage the agency's director of isotope production and distribution, Donald Erb, in a scientific discussion by mail. Erb offered David tips on isolating certain radioactive elements, provided a list of isotopes that can sustain a chain reaction, and imparted a piece of information that would soon prove to be vital to David's plans: "Nothing produces neutrons … as well as beryllium." When David asked Erb about the risks posed by such radioactive materials, the NRC official assured "Professor Hahn" that the "real dangers are very slight," since possession "of any radioactive materials in quantities and forms sufficient to pose any hazard is subject to Nuclear Regulatory Commission (or equivalent) licensing." David says the NRC also sent him pricing data and commercial sources for some of the radioactive wares he wanted to purchase, ostensibly for the benefit of his eager students. "The NRC gave me all the information I needed," he later recalled. "All I had to do was go out and get the materials."

> The newspapers have published numerous diagrams, not very helpful to the average man, of protons and neutrons doing their stuff…. But curiously little has been said, at any rate in print, about the question that is of most urgent interest to all of us, namely, "How difficult are these things to manufacture?" –George Orwell, "You and the Atom Bomb," 1945

Armed with information from his friends in government and industry, David typed up a list of sources for fourteen radioactive isotopes..Americium-241, he learned from the Boy Scout atomic-energy booklet, could be found in smoke detectors; radium-226, in antique luminous dial clocks; uranium-238 and minute quantities of uranium-235, in a black ore called pitchblende; and thorium-232, in Coleman-style gas lanterns.

To obtain americium-241, David contacted smoke-detector companies and claimed that he needed a large number of the devices for a school project. One company agreed to sell him about a hundred broken detectors for a dollar apiece. (He also tried to "collect" detectors while at scout camp.) David wasn't sure where the americium-241 was located, so he wrote to BRK Electronics in Aurora, Illinois. A customer-service representative named Beth Weber wrote back to say she'd be happy to help out with "your report." She explained that each detector contains only a tiny amount of americium-241, which is sealed in a gold matrix "to make sure that corrosion does not break it down and release it." Thanks to Weber's tip, David extracted the americium components and then welded them together with a blowtorch.

As it decays, americium-241 emits alpha rays composed of protons and neutrons. David put the lump of americium inside a hollow block of lead with a tiny hole pricked in one side so that alpha rays would stream out. In front of the lead block he placed a sheet of aluminum. Aluminum atoms absorb alpha rays and in the process kick out neutrons. Since neutrons have no charge, and thus cannot be measured by a Geiger counter, David had no way of knowing whether the gun was working until he recalled that paraffin throws off protons when hit by neutrons. David aimed the apparatus at some paraffin, and his Geiger counter registered what he assumed was a proton stream. His neutron gun, crude but effective, was ready.

With neutron gun in hand, David was ready to irradiate. He could have concentrated on transforming previously non-radioactive elements, but in a decision that was both indicative of his personality and instrumental to his later attempt to build a breeder reactor, he wanted to use the gun on radioisotopes to increase the chances of making them fissionable. He thought that uranium-235, which is used in atomic weapons, would provide the “biggest reaction.” He scoured hundreds of miles of upper Michigan in his Pontiac looking for “hot rocks” with his Geiger counter, but all he could find was a quarter trunkload of pitchblende on the shores of Lake Huron. Deciding to pursue a more bureaucratic approach, he wrote to a Czechoslovakian firm that sells uranium to commercial and university buyers, whose name was provided, he told me, by the NRC. Claiming to be a professor buying materials for a nuclear-research laboratory, he obtained a few samples of a black ore–either pitchblende or uranium dioxide, both of which contain small amounts of uranium-235 and uranium-238.

David pulverized the ores with a hammer, thinking that he could then use nitric acid to isolate uranium. Unable to find a commercial source for nitric acid–probably because it is used in the manufacture of explosives and thus is tightly controlled–David made his own by heating saltpeter and sodium bisulfate, then bubbling the gas that was released through a container of water, producing nitric acid. He then mixed the acid with the powdered ore and boiled it, ending up with something that “looked like a dirty milk shake.” Next he poured the “milk shake” through a coffee filter, hoping that the uranium would pass through the filter. But David miscalculated uranium’s solubility, and whatever amount was present was trapped in the filter, making it difficult to purify further.

Frustrated at his inability to isolate sufficient supplies of uranium, David turned his attention to thorium-232, which when bombarded with neutrons produces uranium-233, a man-made fissionable element (and, although he might not have known it then, one that can be substituted for plutonium in breeder reactors). Discovered in 1828 and named after the Norse god Thor, thorium has a very high melting point, and is thus used in the manufacture of airplane engine parts that reach extremely high temperatures. David knew from his merit-badge pamphlet that the “mantle” used in commercial gas lanterns–the part that looks like a doll’s stocking and conducts the flame–is coated with a compound containing thorium-232. He bought thousands of lantern mantles from surplus stores and, using the blowtorch, reduced them into a pile of ash.

David still had to isolate the thorium-232 from the ash. Fortunately, he remembered reading in one of his dad’s chemistry books that lithium is prone to binding with oxygen–meaning, in this context, that it would rob thorium dioxide of its oxygen content and leave a cleaner form of thorium. David purchased $1,000 worth of lithium batteries and extracted the element by cutting the batteries in half with a pair of wire cutters. He placed the lithium and thorium dioxide together in a ball of aluminum foil and heated the ball with a Bunsen burner. Eureka! David’s method purified thorium to at least 9,000 times the level found in nature and 170 times the level that requires NRC licensing.

At this point, David could have used his americium neutron gun to transform thorium-232 into fissionable uranium-233. But the americium he had was not capable of producing enough neutrons, so he began preparing radium for an improved irradiating gun.

Radium was used in paint that rendered luminescent the faces of clocks and automobile and airplane instrument panels until the late 1960s, when it was discovered that many clock painters, who routinely licked their brushes to make a fine point, died of cancer. David began visiting junkyards and antiques stores in search of radium-coated dashboard panels or clocks. Once he found such an item, he’d chip paint from the instruments and collect it in pill vials. It was slow going until one day, driving through Clinton Township to visit his girlfriend, Heather, he noticed that his Geiger counter went wild as he passed Gloria’s Resale Boutique/Antique. The proprietor, Gloria Genette, still recalls the day when she was called at home by a store employee who said that a polite young man was anxious to buy an old table clock with a tinted green dial but wondered if she’d come down in price. She would. David bought the clock for $10. Inside he discovered a vial of radium paint left behind by a worker either accidentally or as a courtesy so that the clock’s owner could touch up the dial when it began to fade. David was so overjoyed that he dropped by the boutique later that night to leave a note for Gloria, telling her that if she received another “luminus [sic] clock” to contact him immediately. “I will pay any some [sic] of money to obtain one.”

To concentrate the radium, David secured a sample of barium sulfate from the X-ray ward at a local hospital (staff there handed over the substance because they remembered him from his merit-badge project) and heated it until it liquefied. After mixing the barium sulfate with the radium paint chips, he strained the brew through a coffee filter into a beaker that began to glow. This time, David had judged the solubility of the two substances correctly; the radium solution passed through to the beaker. He then dehydrated the solution into crystalline salts, which he could pack into the cavity of another lead block to build a new gun.

Whether David fully realized it or not, by handling purified radium he was truly putting himself in danger. Nevertheless, he now proceeded to acquire another neutron emitter to replace the aluminum used in his previous neutron gun. Faithful to Erb's instructions, he secured a strip of beryllium (which is a much richer source of neutrons than aluminum) from the chemistry department at Macomb Community College–a friend who attended the school swiped it for him–and placed it in front of the lead block that held the radium. His cute little americium gun was now a more powerful radium gun. David began to bombard his thorium and uranium powders in the hopes of producing at least some fissionable atoms. He measured the results with his Geiger counter, but while the thorium seemed to grow more radioactive, the uranium remained a disappointment. Once again, "Professor Hahn" sprang into action, writing his old friend Erb at the NRC to discuss the problem.

The NRC had the answer. David's neutrons were too "fast" for the uranium).[3] He would have to slow them down using a filter of water, deuterium, or tritium. Water would have sufficed, but David likes a challenge. Consulting his list of commercially available radioactive sources, he discovered that tritium, a radioactive material used to boost the power of nuclear weapons, is found in glow-in-the-dark gun and bow sights, which David promptly bought from sporting-goods stores and mail-order catalogues. He removed the tritium contained in a waxy substance inside the sights, and then, using a variety of pseudonyms, returned the sights to the store or manufacturer for repair–each time collecting another tiny quantity of tritium. When he had enough, David smeared the waxy substance over the beryllium strip and targeted the gun at uranium powder. He carefully monitored the results with his Geiger counter over several weeks, and it appeared that the powder was growing more radioactive by the day.

**3.** Manhattan Project scientists discovered that some neutrons can move at speeds of about 17 million miles per hour. If they are slowed down or "moderated," to about 5,000 miles per hour, they have a better chance of being absorbed by another atom.

Now seventeen, David hit on the idea of building a model breeder reactor. He knew that without a critical pile of at least thirty pounds of enriched uranium he had no chance of initiating a sustained chain reaction, but he was determined to get as far as he could by trying to get his various radioisotopes to interact with one another. That way, he now says, "no matter what happened there would be something changing into something–some kind of action going on there." His blueprint was a schematic of a checkerboard breeder reactor he'd seen in one of his father's college textbooks. Ignoring any thought of safety, David took the highly radioactive radium and americium out of their respective lead casings and, after another round of filing and pulverizing, mixed those isotopes with beryllium and aluminum shavings, all of which he wrapped in aluminum foil. What were once the neutron sources for his guns became a makeshift "core" for his reactor. He surrounded this radioactive ball with a "blanket" composed of tiny foil-wrapped cubes of thorium ash and uranium powder, which were stacked in an alternating pattern with carbon cubes and tenuously held together with duct tape.

David monitored his "breeder reactor" at the Golf Manor laboratory with his Geiger counter. "It was radioactive as heck," he says. "The level of radiation after a few weeks was far greater than it was at the time of assembly. I know I transformed some radioactive materials. Even though there was no critical pile, I know that some of the reactions that go on in a breeder reactor went on to a minute extent."

Finally, David, whose safety precautions had thus far consisted of wearing a makeshift lead poncho and throwing away his clothes and changing his shoes following a session in the potting shed, began to realize that, sustained reaction or not, he could be putting himself and others in danger. (One tip-off was when the radiation was detectable through concrete.) Jim Miller, a nuclear-savvy high-school friend in whom David had confided, warned him that real reactors use control rods to regulate nuclear reactions. Miller recommended cobalt, which absorbs neutrons but does not itself become fissionable. "Reactors get hot, it's just a fact," Miller, a nervous, skinny twenty-two-year-old, said during an interview at a Burger King in Clinton Township where he worked as a cook. David purchased a set of cobalt drill bits at a local hardware store and inserted them between the thorium and uranium cubes. But the cobalt wasn't sufficient. When his Geiger counter began picking up radiation five doors down from his mom's house, David decided that he had "too much radioactive stuff in one place" and began to disassemble the reactor. He placed the thorium pellets in a shoebox that he hid in his mother's house, left the radium and americium in the shed, and packed most of the rest of his equipment into the trunk of the Pontiac 6000.

> WASTE DISPOSAL. If you can dump your waste directly into the kitchen drain (NOT into the sink), you are all right. If not, collect it in a plastic pail to be thrown out when you're finished. –*The Golden Book of Chemistry Experiments*

At 2:40 A.M. on August 31, 1994, the Clinton Township police responded to a call concerning a young man who had been spotted in a residential neighborhood, apparently stealing tires from a car. When the police arrived, David told them he was waiting to meet a friend. Unconvinced, officers decided to search his car. When they opened the trunk they discovered a toolbox shut with a padlock and sealed with duct tape for good measure. The trunk also contained over fifty foil-wrapped cubes of mysterious gray powder, small disks and cylindrical metal objects, lantern mantles, mercury switches, a clock face, ores, fireworks, vacuum tubes, and assorted chemicals and acids. The police were especially alarmed by the toolbox, which David warned them was radioactive and which they feared was an atomic bomb.

For reasons that are hard to fathom, Sergeant Joseph Mertes, one of the arresting officers, ordered a car containing what he noted in his report was "a potential improvised explosive device" to be towed to police headquarters. "It probably shouldn't have been done, but we thought that the car had been used in the commission of a crime," Police Chief Al Ernst now says sheepishly. "When I came in at 6:30 in the morning it was already there."

The police called in the Michigan State Police Bomb Squad to examine the Pontiac and the State Department of Public Health (DPH) to supply radiological assistance. The good news, the two teams discovered, was that David's toolbox was not an atomic bomb. The bad news was that David's trunk did contain radioactive materials, including concentrations of thorium–"not found in nature, at least not in Michigan"–and americium. That discovery automatically triggered the Federal Radiological Emergency Response Plan, and state officials soon were embroiled in tense phone consultations with the DOE, EPA, FBI, and NRC.

With the police, David was largely uncooperative and taciturn. He provided his father's address but didn't mention his mother's house or his potting-shed laboratory. It wasn't until Thanksgiving Day that Dave Minnaar, a DPH radiological expert, finally interviewed David. David told Minnaar that he had been trying to make thorium in a form he could use to produce energy and that he hoped "his successes would help him earn his Eagle Scout status." David also finally admitted to having a backyard laboratory.

On November 29, state radiological experts surveyed the potting shed. They found aluminum pie pans, jars of acids, Pyrex cups, milk crates, and other materials strewn about, much of it contaminated with what subsequent official reports would call "excessive levels" of radioactive material, especially americium-241 and thorium-232. How high? A vegetable can, for example, registered at 50,000 counts per minute–about 1,000 times higher than normal levels of background radiation. But although Minnaar's troops didn't know it at the time, they conducted their survey long after David's mother, alerted by Ken and Kathy and petrified that the government would take her home away as a result of her son's experiments, had ransacked the shed and discarded most of what she found, including his neutron gun, the radium, pellets of thorium that were far more radioactive than what the health officials found, and several quarts of radioactive powder. "The funny thing is," David now says, "they only got the garbage, and the garbage got all the good stuff."

After determining that no radioactive materials had leaked outside the shed, state authorities sealed it and petitioned the federal government for help. The NRC licenses nuclear plants and research facilities and deals with any nuclear accidents that take place at those sites. David, of course, was not an NRC-licensed operation, so it was determined that the EPA, which responds to emergencies involving lost or abandoned atomic materials, should be contacted for assistance. In a memo to the EPA's Emergency Response and Enforcement Branch, the Department of Public Health noted that the materials discovered in David's lab were regulated under the Federal Atomic Energy Act and that the "extent of the radioactive material contamination within a private citizen's property beg for a controlled remediation that is beyond our authority or resources to oversee."

EPA officials arrived in Golf Manor on January 25, 1995–five months after David had been stopped by the police–to conduct their own survey of the shed. Their “action memo” noted that conditions at the site “present an imminent and substantial endangerment to public health or welfare or the environment,” and that there was “actual or potential exposure to nearby human populations, animals, or food chain….” The memo further stated that adverse conditions such as heavy wind, rain, or fire could cause the “contaminants to migrate or be released.”

A Superfund cleanup took place between June 26 and 28 at a cost of about $60,000. After the moon-suited workers dismantled the potting shed with electric saws, they loaded the remains into thirty-nine sealed barrels placed aboard a semitrailer bound for Envirocare, a dump facility located in the middle of the Great Salt Lake Desert. There, the remains of David’s experiments were entombed along with tons of low-level radioactive debris from the government’s atomic-bomb factories, plutonium-production facilities, and contaminated industrial sites. According to the official assessment, there was no noticeable damage to flora or fauna in the back yard in Golf Manor, but 40,000 nearby residents could have been put at risk during David’s years of experimentation due to the dangers posed by the release of radioactive dust and radiation.

Last May, I made the 90-mile drive from Detroit to Lansing, where Dave Minnaar works in a dreary building that houses several state environmental agencies. Because Patty Hahn had cleaned out the shed before Minnaar’s men arrived on the scene, he never knew that David had built neutron guns or that he had obtained radium. Nor did he understand, until I told him, that the cubes of thorium powder found by police at the time of David’s arrest were the building blocks for a model breeder reactor. “These are conditions that regulatory agencies never envision,” says Minnaar. “It’s simply presumed that the average person wouldn’t have the technology or materials required to experiment in these areas.”

> “The real danger … lies in the radioactive properties of these elements. [Some] migrate to the bone marrow, where their radiation interferes with the production of red blood cells. Less than one-millionth of a gram can be fatal.” –from David’s notes

David went into a serious depression after the federal authorities shut down his laboratory. Years of painstaking work had been thrown in the garbage or buried beneath the sands of Utah. Students at Chippewa Valley had taken to calling him “Radioactive Boy,” and when his girlfriend, Heather, sent David Valentine’s balloons at his high school, they were seized by the principal, who apparently feared they had been inflated with chemical gases David needed to continue his experiments. In a final indignity, some area scout leaders attempted (and failed) to deny David his Eagle Scout status, saying that his extracurricular merit-badge activities had endangered the community.

In the fall of 1995, Ken and Kathy demanded that David enroll in Macomb Community College. He majored in metallurgy but skipped many of his classes and spent much of the day in bed or driving in circles around their block. Finally, Ken and Kathy gave him an ultimatum: Join the armed forces or move out of the house. They called the local recruiting office, which sent a representative to their house or called nearly every day until David finally gave in. After completing boot camp last year, he was stationed on the nuclear-powered USS Enterprise aircraft carrier.

Alas, David’s duties, as a lowly seaman, are of the deck-swabbing and potato-peeling variety. But long after his shipmates have gone to sleep, David stays up studying topics that interest him–currently steroids, melanin, genetic codes, antioxidants, prototype reactors, amino acids, and criminal law. And it is perhaps best that he does not work on the ship’s eight reactors, for EPA scientists worry that his previous exposure to radioactivity may have greatly cut short his life. All the radioactive materials he experimented with can enter the body through ingestion, inhalation, or skin contact and then deposit in the bones and organs, where they can cause a host of ailments, including cancer. Because it is so potent, the radium that David was exposed to in a relatively small, enclosed space is most worrisome of all. Back in 1995, the EPA arranged for David to undergo a full examination at the nearby Fermi nuclear power plant. David, fearful of what he might learn, refused. Now, though, he’s looking ahead. “I wanted to make a scratch in life,” he explains when I ask him about his early years of nuclear research. “I’ve still got time. I don’t believe I took more than five years off of my life.”