

”Better Living through Chemistry?” DuPont & Teflon

Dr. Marilyn A. Dyrud, Oregon Institute of Technology

Marilyn Dyrud retired in 2017 as a professor emerita in the Communication Department at Oregon Institute of Technology, where she taught classes in writing, speech, rhetoric, and ethics for four decades. She received her BA in 1972 from the University of the Pacific in Stockton, CA, and her graduate degrees from Purdue University: MA in 1974 and PhD in 1980. She became involved in engineering education by joining ASEE in 1983 and is currently active in two divisions: Engineering Ethics and Engineering Technology. She is an ASEE fellow (2008), winner of the James McGraw and Berger Awards (2010, 2013), the communications editor for the Journal of Engineering Technology, and the ETD mini-grant coordinator.

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Introduction

In 1961 DuPont, in collaboration with American entrepreneur Marion Trozzolo, introduced the “Happy Pan” [1] to the delight of cooks all over the country, especially those with a penchant for burning food. Coated with a new substance, Teflon, food magically slid from the pan, leaving little residue and ending the onerous task of scouring. Early ads touted Teflon as “an amazing new concept in cooking” [2] and an antidote for young couples who want more time together: “Happy the young homemaker (and her husband, too!) who gets full set of [brand name]’s TEFLON-Coated Aluminum Cookware” [3]. In addition to cookware, Teflon is used in numerous industries, ranging from pharmaceuticals to textiles to the military.

As a result, virtually every living creature on the planet is contaminated with Teflon. It has been associated with numerous cancers, such as kidney, bladder, ovarian, prostate, and testicular, due to the PFOA (also known as C8) used in manufacturing Teflon [4]. This came as no surprise to DuPont, as the company was fully aware of the danger posed by Teflon and engaged in a decades-long cover-up to hide the problem from the public and employees alike.

This paper recounts the facts of the case, examines the major ethical issues involved, and offers suggestions for classroom usage. Knowledge of the Teflon situation is important not only because it literally affects every person in the world; it is also yet another example of powerful companies that knowingly sell products causing great harm to their users, such as Ford Motor Company’s Pinto and McDonald-Douglas and its ill-fated DC-10, operating purely for profit. Arming students with this knowledge may help them develop the moral fiber as professionals to speak out against corporate ethical intrusions.

Case Summary

On October 9, 1998, Robert Bilott, a Cincinnati corporate defense attorney with more than a passing interest in environmental law, answered his office telephone. On the other end was cattle rancher Wilbur Earl Tennant of Parkersburg, West Virginia, who was convinced that DuPont was illegally dumping toxic chemicals that were killing his stock and starting to affect his own health. For three years, he had contacted appropriate governmental agencies to report his concerns; all turned a blind eye. But after reviewing multiple boxes of evidence presented by Tennant and consulting with colleagues, Bilott agreed to take the case on a contingency basis even though it clearly contradicted his role in his law firm, which was to defend chemical companies against such lawsuits [5]. He did so because he felt it was “the right thing to do” [6]. At the time, Bilott was unaware that this phone call would set the course for the next 20 years of his life.

Earl and his siblings raised their 300 cattle on a 600-acre tract of land located near Washington Works, the largest employer in the area [7]. The plant housed DuPont’s Teflon line. In the early 1980s, Tennant sold 66 acres to DuPont, which intended to use it for nonhazardous waste disposal from Washington Works: ash, plastics, glass, trash, scrap metal, and paper, as specified in a written agreement [5]. The land, rechristened by DuPont as Dry Run Landfill, included a

small creek that ran through the Tennants' pastureland. Cattle grazed in the field and drank the water. Within weeks, they transformed from the docile, friendly animals that the Tennants loved to deranged creatures that charged whenever anyone approached.

Angered by veterinarians' assessment that his animals were dying due to bad husbandry [8], Tennant began collecting evidence—photos and videos of suffering live animals and those that he dissected, which revealed an assortment of tumors, some glowing green, and blackened teeth [9], in addition to purple spots on their lungs, yellow fluid encasing their hearts, and damage to the gallbladder, spleen, and kidneys [10]. The animals had “stringy tails, malformed hooves, giant lesions protruding from their hides and red, receded eyes; cows suffering constant diarrhea, slobbering white slime the consistency of toothpaste, staggering bowlegged like drunks” [6]. Within two years, most of the Tennant herd died, along with a substantial number of deer, birds, fish, and other wildlife. Another video featured a large, clearly marked DuPont pipe feeding green frothy water into the creek [5].

Origins of Teflon

Teflon (polytetrafluoroethylene) was accidentally discovered in the lab of DuPont scientist Roy Plunkett on April 6, 1938, now celebrated annually as National Teflon Day [1]. Plunkett and his assistant were experimenting with refrigeration gases. When he opened the valves on one of the canisters used for storage, it failed to discharge. Instead of gas, the canister contained a white slippery substance. Plunkett was eventually able to reproduce the polymerization process, and Teflon was registered in 1944 [11]. Mass marketing began in 1961, with the introduction of the Happy Pan. Three decades later, Teflon profits would exceed \$1 billion annually [6].

Physical Properties & Consequences

Teflon is a synthetic fluoropolymer that is the most slippery substance on the planet [12]. It is virtually impervious to stains, grease, corrosion, water, heat below 500° F, and friction, as well as being resistant to chemicals [13]. A key ingredient in the manufacture of Teflon is perfluorooctanoic acid (PFOA, also called C8), a processing agent that smooths out Teflon, which tends to clump, “bubble up and get sudsy” without it [8, p. 4]. PFOAs (part of a larger group of chemicals called PFAS, per- and polyfluorooctanoic substances) are listed by the EPA as “forever” chemicals that do not break down in the environment and tend to accumulate in living creatures [14]. It is one of more than 80,000 chemicals that are unregulated and had been grandfathered into the Toxic Substances Control Act (1976), under the assumption that they were safe [15]. The EPA can only regulate known harmful chemicals [10]. Reporting is not required for testing related to unregulated chemicals.

Although most consumers associate Teflon with nonstick cookware, it has many uses as a coating: carpeting, mechanical devices, needles used for injections, fast food wrappers, pizza boxes, microwave popcorn bags, cosmetics, textiles, electronics and computer components, fire-fighting foams, fertilizers, cleaning agents, dental floss, kitty litter, to name a few, and in industries such as aerospace, pharmaceuticals, mining, and the military [16]. In short, it is ubiquitous. As the EPA noted in a 2003 report, “It’s toxic. It’s everywhere. And, it lasts forever” [8, p. 4].

For 50 years, DuPont acquired all of its PFOA from 3M, one of only eight companies supplying the chemical. In 2000 3M ceased producing the substance, which in that year totaled 300,000 tons. DuPont then opened a new PFOA facility in Fayetteville, North Carolina, and maintained production until 2013, slightly ahead of the EPA's 2015 deadline for phase-out [8].

Numerous studies on lab animals indicate that PFAS may damage the liver and immune systems as well as result in "low birth weight, birth defects, delayed development, and newborn deaths" [17]. In humans, who absorb significantly lesser amounts of PFAS than animals, undesirable effects may include a whole host of conditions: "increased cholesterol levels, decreased vaccine response in children, changes in liver enzymes, increased risk of high blood pressure or pre-eclampsia in pregnant women, small decreases in infant birth weights, [and] increased risk of kidney or testicular cancer" [17]. The EPA has classified PFAS as a "likely carcinogen" [18].

Legalities

In summer 1999, Bilott filed a federal lawsuit on behalf of Tennant against DuPont, an action that resulted in backlash against him and his client [19], since the chemical giant was Parkersburg's major employer. Community members, who feared for their jobs with DuPont, openly shunned Tennant on the streets and in restaurants; he was forced to change churches four times [6].

Bilott faced a different type of retaliation, especially during the discovery process. Initially rebuffed by DuPont and irritated by the company's delay tactics, he resorted to a series of legal motions to obtain court injunctions requiring the company to release any documents related to the Tennant case and PFOA, which became the proverbial smoking gun. During the following year, DuPont sent hundreds of boxes of unorganized documents intended to overwhelm Bilott; they literally filled his office with some 60,000 documents [10], totaling more than 110,000 pages and including some dating back 50 years [6]. Although Bilott did not know it, his PFOA document expedition caused a panic at DuPont headquarters. Corporate lawyer Bernard Reilly emailed his colleagues, "The s**t is about to hit the fan in WV. The lawyer for the farmer finally realizes the surfactant [C8] issue.... F**k him" [20].

Bilott doggedly worked his way through the boxes, sorting, organizing, and generally trying to bring order to the chaos. In addition to routine office correspondence, the stash included sensitive data relating to the secret testing of employees for PFOA presence, as well as private internal communiqués. Bilott found the documents to be extremely disturbing and provided him with a wealth of evidence to support not only the Tennant case but potential suits to follow.

Two examples illustrate how DuPont collected its data. In 1962, DuPont gave volunteer workers PFOA-laced cigarettes to smoke, with alarming results: "Nine out of ten people in the highest-dosed group were noticeably ill for an average of nine hours with flu-like symptoms that included chills, backache, fever, and coughing" [21]. In a second experiment, volunteers were asked to smoke six cigarettes, each with a different amount of PFOA, for a total of one millimeter, about the size of a pinhead. Volunteers developed "polymer fume fever," dubbed "Teflon flu" [22], a malady that occurs when Teflon is heated. More severe reactions can include "pulmonary edema, pneumonitis and death" [23]. DuPont told no one of the results—not

employees, not regulators, and not the general public, who were drinking the PFOA that contaminated at least six local water districts. Granted, before the formation of the EPA in 1970, companies engaged in significant pollution of air and land sans penalty. However, does a lack of formal oversight mean that corporations do not have a moral obligation to protect the public safety?

In 1981, DuPont and the EPA received the results of a 3M study on pregnant lab rats fed doses of PFOA. Their pups exhibited numerous anomalies, especially eye deformation. Expressing an apparent concern, DuPont transferred seven pregnant women off the Teflon line for a brief period and began sampling the umbilical cord blood of workers' newborns, discovering that PFAS crossed the placenta [24]. Tests of older children, aged 4-6, revealed PFOA blood levels more than 50 times the average [25]. When confronted with these findings, 3M spokesman Sean Lynch stated: "While the science behind PFAS is complex, the weight of scientific evidence does not show that PFOS or PFOA, two types of PFAS, cause harm in people at current or past levels" [25], a blatant lie.

Two of the pregnant Teflon workers gave birth to babies with similar birth deformities. One of them, Sue Bailey, worked with equipment that pumped Teflon-laden effluent into holding ponds located behind the Washington Works buildings. On more than one occasion, the pumps overflowed, and Bailey was instructed to squeegee the excess, putting her into direct contact with PFOA [26]. She was newly pregnant during this time and later gave birth to a son, Bucky. Little Bucky suffered from similar defects as those reported in the 3M pregnant rat study: "tear duct deformities, only one nostril, an eyelid that started down by his nose, and a condition known as 'keyhole pupil,' which looked like a tear in his iris" [21]. Over the course of his 39-year lifetime, Bucky would endure more than 30 surgeries to date, marry, and father his own son, who does not suffer the physical indignities visited upon his father [27].

Resolution

After years of legal wrangling and roadblocks, the Tennant case was finally settled in 2001, opening the door for the flood to follow as employees and area residents learned that they, too, could be experiencing the ill effects of PFOA. Table 1 details DuPont's settlements over a 20-year period.

Table 1. DuPont settlement amounts*

<i>Year</i>	<i>Reason</i>	<i>Amount (\$)</i>
1997	Damage to Tennants' land and cattle	200,000
2001	Tennant settlement	Undisclosed
2005	Drinking water class action	107,000,000
	Finance medical studies	350,000,000
	Enforcement action	16,500,000
2015	Breast cancer (Bartlett)	1,600,000

2016	Testicular cancer (Freeman)	5,600,000
	Testicular cancer (Vigneron)	12,500,000
2017	Class action lump settlement	670,000,000
Total		1,162,900,000

* Based on text information in [15]

The 10-year gap between 2005 and 2015 reflects the time needed for a blood sampling program; rather than splitting the settlement among the plaintiffs, the court initiated the C8 Health Project. Medical personnel sampled the blood of as many residents in specified areas as possible, most of whom were unaware of the presence of PFOAs in their drinking water. Incentivized by a \$400 stipend per person, more than 70,000 participated in a battery of 50 tests, generating a wealth of data that took scientists eight years to analyze. The project became “the largest private study of living human serum known to exist” [8, p. 98]. After losing three bellwether suits in 2015 and 2016, each featuring progressively larger awards, DuPont settled with the remaining 3,553 potential litigants for a lump sum.

While paying out fines and settlements of more than \$1 billion might seem to be equitable, a simple examination of DuPont’s profits shows that amount to be minimal in light of the company’s annual profits. Between 2008 and 2010, “it reported over \$2 billion in profits, paid no federal income taxes, increased its executive compensations by a whopping 188% and spent almost \$14 million on lobbying for more corporate friendly laws” [28]. Six years later, “DuPont reported \$3.6 billion in profits in 2014, or around \$6,849 per minute” [29]. The company only paid 30-50% of one year’s profits, a relatively small price.

DuPont’s Foreknowledge

What makes this situation truly disturbing is that DuPont proceeded in marketing Teflon-coated products with full knowledge that they were detrimental to living creatures. The company had 60 years’ worth of research by the time it finally phased out PFOA in 2013 clearly showing evidence that the chemical had harmful effects on lab animals and humans. In fact, the chemical had proliferated throughout the world, lamented a DuPont executive [30].

Some trusting technical staff were unaware of the problems with PFOA. Ken Wamsley, a shift lab analyst, was responsible for measuring PFOA levels in various products. At that time, PFOA was used in a powder form that drifted across the lab facilities and blew out of smokestacks (DuPont eventually started using a liquid form to avoid these situations). He was reassured that the chemical was harmless, which he believed, and he treated it like a soap for laundry and bodily cleansing. As health problems mounted, he began to suspect that all was not as he was told, but he said nothing: “I wasn’t about to go against the paycheck that supported my family. So I shut my mouth” [20]. Now, ulcerative colitis has led to rectal cancer and subsequent surgery, which has left him house-bound [21]. He also instituted a personal injury lawsuit against the company.

Senior scientists, chemical engineers, and administrators were, however, fully aware that research indicated numerous detrimental health effects [31]. But no one spoke up, partly out of

fear for their jobs but mostly to maintain the enormous profits realized from Teflon. Despite the alarming results from a 1984 water dispersal study that showed PFOA in public water supplies 74 miles from the plant and an engineering study recommending methods for reducing emissions [21], an emergency management meeting yielded a conscious decision to continue using the substance based on enhanced shareholder profit and the low possibility of detection, only 19% [15]. Even after considering alternatives in the 1970s, when corporate animal and surreptitious human testing was revealing the health hazards associated with its miracle chemical, DuPont chose the status quo because, as stated in an internal memo, “C8 is the devil we know” [30].

Ethical Issues

DuPont is an established company, more than two centuries old. Éleuthère Irénée du Pont, fleeing from the French Revolution, founded a gunpowder company in 1802, christened E.I. du Pont de Nemours & Co. Clients included the US government, which purchased more than one million pounds of gunpowder for use in the War of 1812. A century later, a re-envisioned DuPont was the country’s largest supplier of explosives, so large, in fact, that an antitrust suit was filed, and the parent company spun-off several smaller ventures [32].

The 20th century was a time of diversification and the introduction of serious R & D, leading to products, developed in partnerships with multiple companies, that have become familiar household words: rayon and cellophane (1920s), Freon and nylon (1930s), and, in ensuing years, Mylar, Tyvek, Lycra, Neoprene, Kevlar, Gore-Tex, and Dacron. In 1941, DuPont built the \$350 million plutonium processing facility at Hanford, Washington, for the Manhattan Project. By the 1980s, the company focused solely on chemistry [32].

Even though DuPont had been the subject of numerous antitrust suits and has reformed itself multiple times [32], it is “not some fly-by-night company operating under the radar of regulators,” explained Bilott. “They were one of the biggest corporations in the world, nearly 200 years old and highly respected, a company widely considered an industry leader” [19]. But in regards to Teflon, this “highly respected” company engaged in numerous unethical actions, detailed below.

Lying

Over multiples decades, DuPont seemed to follow a guiding maxim: when in doubt, lie, stonewall, or deflect. Lying began early. Since 1965, DuPont had been aware that lab animals exposed to PFOA presented with enlarged livers, abnormal enzyme levels, excessive weight loss, and, if given high doses, death. Yet DuPont scientists claimed that there was “no conclusive evidence” of harm. Executives claimed that C8 “does not pose a health hazard at low level chronic exposure” [21]. But employees were not receiving “low level” exposure; quite the contrary: PFOA blood levels measured in the 2005 C8 Health Project were up to 224 times the average [8].

Indeed, DuPont established a culture of lying about PFOA among key personnel. Medical director Bruce Karrh, for example, wrote in a 1978 *Bulletin of the New York Academy of Medicine* article that a company “should be candid, and lay all the facts on the table. This is the

only responsible and ethical way to go” [21]. While the sentiment is laudable, the irony is painful.

In a 2004 sworn deposition, then-CEO Charles Holliday testified that PFOA was “safe in the way we use and handle it” and that it had been subjected to “very extensive scientific analysis”; furthermore, “DuPont has used [C8] for more than 50 years with no observed health effects in workers,” a clear lie [33]. In reality, the company had decades of research studies illustrating the opposite.

DuPont’s public relations department even developed “just-in-case” press releases and answers to handle reporters’ questions. All responded to hypothetical questions, such as whether or not DuPont’s decision to continue use of PFOA was based on the cost of proposed remediation. The recommended answer? “No.” Or if asked whether DuPont’s purchase of contaminated land parcels had to do with avoiding public liability, as indicated by internal documents, the answer should be “it made good business sense to do so” [21].

DuPont also hired consulting services to prepare strategies for combating pending litigation. Terry Gaffney, a vice-president of the Weinberg Group, penned a memo detailing a technical assault plan to deal with the EPA and “misguided environmental groups,” based on DuPont’s control of “the debate at all levels” and featuring their own in-house experts. The memo further suggests creating a bogus study to emphasize the “real health benefits” and the “safety and utility” of PFOA [34], perceptions clearly contrary to DuPont’s own in-house study results: the chemical has no “health benefits,” and even though it has a high degree of utility, it is not safe.

In sum, DuPont’s use of deception to hide the dangerous effects of PFOA was not an occasional lie. It was a decades-long, concerted effort to redefine the facts, alter reality, and misguide trusting consumers.

Disclosure

“Secrecy,” notes Sissela Bok in her 1989 book *Secrets*, “is as indispensable to human beings as fire. . . . Both enhance and protect life, yet both can stifle, lay waste, and spread out of all control” [35, p. 18]. Nondisclosure allows an individual or entity to control information by withholding what others can access, especially trade secrets. While most companies content themselves with signed nondisclosure agreements, DuPont emulated a governmental approach, classifying documents as “confidential” or “special control” and issuing guidelines for protecting proprietary information [36]. As a result, the company was able to bury the results of animal and human testing that provided evidence contrary to the public message that PFOA was harmless.

DuPont is certainly not alone in using nondisclosure as a method to protect trade secrets. As Zink explains, “when trade secrets endanger others, broader public interests are at issue. Public health should take priority over commercial interests” [37, p. 1176]. Disclosure is ethically mandatory if the protected information involves the public good, according to Bok: “[T]he secrecy may concern practices so harmful or invasive that they ought to be revealed, no matter how much secrecy would increase business incentives” [35, p. 148]. “Trade secret” is no longer a viable

argument for nondisclosure if the information results in harming the public health, safety, or welfare.

However, DuPont's efforts extended beyond nondisclosure. Starting in 1937, it aggressively suppressed publication of research results. The first case involved pathologist William Hueper, hired by Dupont's Haskell Laboratories to investigate why dye workers were developing bladder cancer. Task completed, Hueper wanted to publish his results. But the company forbade it and subsequently fired him [21].

In the academic arena, DuPont "actively repressed" manuscripts dealing with PFOA. The company pressured journal editors to retract accepted, peer-reviewed papers slated for publication if they dealt with the adverse health effects of PFOA or examined contaminated drinking water, as in the cases of James Dahlgren et al. and Eileen Murphy, head of New Jersey's Water Quality Institute. Murphy published anyway and was fired [15].

No employee engaged in whistleblowing to expose DuPont's strategy, an illustration of the power DuPont held over its workers. It was not until 2005 that Glenn Evers, chief chemical engineer, revealed what he knew about PFOA toxicity and corporate document shredding. A self-described "company man," Evers was responsible at DuPont for developing new uses for food packaging coatings, earning \$250 million for the company over the course of his career. His comments were delivered at a press briefing arranged by the Environmental Working Group (EWG) and were accompanied by internal documents from DuPont; EWG later released them to the EPA, the FDA, and the inspector general of HHS [38]. Although Evers worked for DuPont for 22 years, he was no longer able to maintain silence: "my personal convictions do not allow me to not tell what I know. I've thought and prayed hard about this" [39]. Like many whistleblowers, Evers waited until he left the company to report his concerns. One wonders if he would have made a difference had he exercised his voice earlier.

Disregard for the Public Health

In all of its actions regarding PFOA, DuPont exhibited a seeming indifference to public health issues. The company dumped Teflon effluent indiscriminately. Initially, it followed 3M's advice to incinerate [8]. However, unfettered by environmental regulations, it started dumping directly into the Ohio River, contaminating the water table of 80,000 residents of Ohio and West Virginia [40]. Prior to 1965, the company packaged waste into drum barrels and dumped it into the ocean, until a fisherman snagged one in his net and spawned unwanted publicity. After 1965, it used unlined landfills and ponds and even released it into the air via smokestacks [21].

DuPont began using the Dry Run Landfill in 1986, emptying a total of 4,500 pounds of PFOA [8]. In 50 years, the Parkersburg plant "eventually spread nearly 2.5 million pounds of the chemical into the air and water surrounding its plant, with additional amounts spread around its New Jersey plant as well" [41].

Such actions are flagrant violations of "The Chemical Professional's Code of Conduct," which states, in part, "Chemical professionals should be actively concerned with the health and safety

of co-workers, consumers, and the community. Professionals have a responsibility to serve the public interest and to further advance scientific knowledge” [42].

Corporate Social Responsibility

According to the Corporate Financial Institute, which conducts online training/education for financial professionals, CSR “refers to strategies that companies put into action as part of corporate governance that are designed to ensure the company’s operations are ethical and beneficial for society”; it involves four different areas: environment, human rights, philanthropy, and economics [43]. Companies such as Starbucks, Adidas, and Lego have been recognized especially for eco-awareness [44].

DuPont has also been recognized, not for its CSR but as one of the worst corporations of 2005, by the non-profit watchdog magazine *Multinational Monitor* [45], founded in 1980 by Ralph Nader specifically to examine the activities of companies that transcend national borders [46]. The magazine juxtaposes the comments of whistleblower Evers and the company’s claim of ignorance: “DuPont has claimed that it does not know how the chemicals got there—and that it is not aware that the company’s product is responsible” [45].

Classroom Usage

While most of our students are surely aware of Teflon and may cook with Teflon-coated pans on a daily basis, this author guesstimates that most are probably unaware of PFOA, the extent of contamination, and the adverse health effects associated with it. The following sections list in- and out-of-classroom exercises and are divided into individual (thinking), small group (discussing, researching), and interactive in-class activities. With the small group exercises, the presumption is that groups will share collected information with the entire class. Before beginning any of these, instructors should supply students with a reading list, fact sheet, or other materials focusing on the case.

Thinking

The following are for individual rumination; have students keep notes on 3 x 5 cards for sharing purposes:

- When considering future employment, would you work for a company such as DuPont that has a proven track record of both innovation and highly suspect ethics?
- What do you think are the responsibilities of corporations to the public good?
- Why would a corporation deliberately market a dangerous product?
- How can consumers trust a “respected” company, such as DuPont, when corporate spokespersons continually lie?
- How can you, as an engineer, contribute to your company’s positive image and avoid misleading potential customers?
- Would you whistleblow if you had evidence of wrongdoing? What are you willing to sacrifice?

- Some have recommended promoting whistleblowing, by offering incentives, as a possible solution. What are your thoughts about this possibility?

Discussing

Develop a list of pithy questions for deliberation in small groups, such as

- Why did DuPont continually lie and/or manipulate research information?
- What prevented DuPont employees from whistleblowing?
- How much money is enough? Does corporate greed ever end?
- Consider DuPont's current code of ethics (available at https://www.dupont.com/content/dam/dupont/amer/us/en/corporate/general/Multimedia/documents/020121_English_Code_of_Conduct_Color_Public.pdf). How genuine is it, especially knowing that the 2002 Sarbanes-Oxley Act requires corporations to develop ethics policies and provide ethics training?
- How can we hold DuPont responsible for the damage it has inflicted on both individuals and the environment?
- Watch Tennant's video (available at <https://patabook.com/news/2022/07/08/farmer-wilbur-earl-tennants-historic-video-showing-mysterious-cow-disease/>). What is your initial response? How well does the video make the case for Bilott?
- Watch the feature film based on this case, *Dark Waters*. How can the mass media aid in calling attention to problems that affect the public health? If you wish, consider *Erin Brockovich* and *A Civil Action*, which also examine environmental pollution cases.

Researching

Ask small groups to conduct timed research on one of the following topics, providing additional knowledge to that conveyed in class:

- PFAS Accountability Act (proposed)
- "Madrid Statement"
- Weinberg memo
- Internal Dupont memos/reports/study results (available via EWG websites)
- GenX (DuPont's substitute for PFOA)
- Conduct a "man on the street" style survey to establish student knowledge of how pervasive Teflon is in their individual environments.

This topic also lends itself well to larger research projects. Students could, for example, research PFOA presence in their own hometown neighborhoods and their university sites. Or they could research EPA regulations and enforcement obstacles.

Interactive In-Class Exercises

Creative instructors can devise numerous other exercises to engage students intellectually and emotionally in this case. Two are detailed below:

Round Robin. This is an effective way to open a discussion of ethical issues. Divide students into small groups and ask them to brainstorm a list of ethical issues in the Teflon case. After 10 minutes or so, ask each group to appoint a spokesperson. Then have each spokesperson respond with one issue; keep a running list on the whiteboard. Each group should offer a different issue. By the end of the class period, the board will be full, and students will hopefully have a clear sense of the issues involved.

Debate. Divide students into groups of six and give each group a separate issue to examine within a specific time period. One set of three should argue the affirmative, the other the opposition. Have one member serve as a scribe to record arguments. At the end of the allotted time, ask groups to share their arguments with the entire class and determine the most compelling arguments.

Conclusions

DuPont began commercially producing Teflon in 1951. For half a century, the company withheld vital information from the public. It managed to escape detection due to “lax regulation, a court system friendly to deep-pocketed defendants, and a media largely disinterested in environmental crime” [47].

Ron Bilott’s federal suits obliterated DuPont’s wall of silence and forced a degree of financial restitution for those affected by a miracle chemical that turned out to be not so miraculous after all. This paper has recounted the facts of the case and the major ethical ramifications, offering suggestions for classroom activities. The Teflon case poses serious questions regarding consumer trust in business, employee reluctance to expose wrongdoing, flagrant violations of ethical tenets, and the pitfalls of regulation.

Even though legally the saga is resolved, research into PFOA continues, with alarming findings reported in peer-reviewed journals such as *Human Reproduction*, *Occupational and Environmental Medicine*, and *The Journal of Pediatrics*. The research explains that the consequences of PFOA contamination extend far beyond those initially recognized by the EPA, including “ovarian cancer; prostate cancer; lymphoma; reduced fertility; arthritis; hyperactivity and altered immune responses in children; and hypotonia, or ‘floppiness,’ in infants,” and even very small doses have negative effects [48]. Given PFOA’s status as a “forever chemical,” it will be with us for many generations to come, in our bodies and in the environment, despite a recent preliminary ruling by the EPA that would set PFAS limits at 4 parts per trillion and require removal in water systems with higher measurements [49].

Enforcement of regulations remains an issue. Indeed, according to Wendy Wagner, there is a current dependency on tort litigation instead of regulation [50]. Regulation may also contribute to the mythical Lernaean Hydra effect: when one head is cut off, it regenerates multiple replacements. *Washington Post* writer Joseph Allen compares this to the PFOA ban, which resulted in 268 variations of the substance, “just different enough that they are treated as distinct from a regulatory and market standpoint” [51]. And it is the public that bears the brunt of “repeated substitution of toxic chemicals with equally toxic chemicals” [50]. We are living in a chemical cocoon of sorts, all unwitting guinea pigs for corporate experiments.

Perhaps it is time for the engineering community to become proactive instead of merely following corporate dicta, instead of holding their heads low and continuing to do their jobs, oblivious to the larger picture. As Rob Bilott passionately argues, “Let us hold them accountable. These companies need to own up to what they have done and make it right. We must demand it. And we have the power and moral responsibility to make sure it happens, because our very lives depend on it, and for the sake of the entire planet—and everyone’s future” [52].

References

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