

Ethics and Whistleblowing: Moral Quandaries

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Introduction

Whistleblowers have been alternately reviled and admired for decades. Some become major news stories: Daniel Ellsberg, a Department of Defense consultant who released the Pentagon Papers, a 7,000 page top secret study of US decision-making in Vietnam, to *The New York Times* and 17 other newspapers in 1971;¹ W. Mark Felt, “Deep Throat” of Watergate fame, who served for several years as informant to Bob Woodward, then a rookie reporter for *The Washington Post*;² Marc Hodler, International Olympics Committee member, who revealed the bribery involved in awarding the 2002 games to Salt Lake City;³ and, most recently, Edward Snowden, formerly of the National Security Agency, who in 2013 released classified documents related to US government surveillance.⁴ Others have had their exploits immortalized on film: Karen Silkwood, a technician and union activist at the Kerr-McGee plutonium fuel production plant in Crescent, Oklahoma, who testified before the Atomic Energy Commission about issues related to worker health and safety;⁵ and New York City police officer Frank Serpico, who revealed widespread bribery and corruption in the NYPD.⁶

Still others toil away in quiet ignominy; these include engineers and scientists who finally voice concerns related to public safety, many after years of toeing the company line. Their stories have much to teach our students as they transition into professional life, and students are eager to learn. In fact, in the nearly 20 years that I have been teaching ethics, I find that students express the most interest in course materials related to whistleblowing.

While studying ethics is more or less mandated by ABET-ETAC Criterion 3 outcome h, requiring that students display “an understanding of and a commitment to address professional and ethical responsibilities,”⁷ engineering ethicists Harris, Davis, Pritchard, and Rabins offer a more compelling reason: to acquaint students with “the standards of professional practice” because “[e]ngineering ethics is part of thinking like an engineer.”⁸ And while whistleblowing is a phenomenon occurring in all professions, it is most common in engineering and technology. Thus helping students discover this aspect of ethics looks to the future, preparing them for situations that they may experience professionally.

This paper addresses the issue of whistleblowing by technical professionals and focuses on definitions and motivations, cases, after-effects, and classroom usage.

Definitions and Motivations

The term “whistleblower,” in its current context, is a relatively new addition to the language. According to the *Oxford English Dictionary*, which traces the history of words as they enter the English language, whistleblower first emerged as “blow the whistle” in a 1934 P. G. Wodehouse book; “whistle blower” dates to 1958 newspaper article.⁹ Various sources attribute contemporary lineage to two actions: unarmed British bobbies, who blow a whistle to call attention to a crime being committed,¹⁰ or sports referees, who use the shrill sound to stop play following a rules infraction.¹¹ Consumer advocate Ralph Nader is credited with popularizing the term during the 1970 Conference on Professional Responsibility and a 1971 ACM conference; in both venues, he noted that “whistleblower” is much more complimentary than labeling someone as a “squealer” or “stool pigeon.” “Whistleblower” has a more positive connotation.¹²

Linguist and former presidential speech writer William Safire muses on the transformation of the word, first as two words, “whistle blower,” separating actor and action; then as a hyphenated construction, “whistle-blower,” which Safire characterizes as a type of linguistic “purgatory”; and finally emerging as a singular noun, “whistleblower,” a step up, psychologically, from “leaker.”¹³

In science and engineering circles, the term has a specific meaning: a whistleblower is an employee or former employee who holds documented evidence of organizational wrongdoing, has sought resolution through the internal chain of command, and, dissatisfied by disinterest and/or lack of action, turns to an external entity or individual for corrective action. The Government Accountability Project, a nonprofit advocacy group, defines a whistleblower as “An employee who discloses information that s/he reasonably believes is evidence of illegality, gross waste or fraud, mismanagement, abuse of power, general wrongdoing, or a substantial and specific danger to public health and safety.”¹⁴ Generally, a whistleblower’s actions are “forward looking,” as ethicist Vivian Weil notes;¹⁵ the whistleblower speaks up before an incident occurs, seeking to prevent harm. Myron and Penina Glazer, who interviewed 64 whistleblowers for their book *The Whistleblowers*, note that several criteria apply to an act of “justifiable” whistleblowing:

1. The action “stem[s] from appropriate moral motives.”
2. The individual has exhausted “all available internal procedures” before going outside the organization.
3. Documentation “would persuade a reasonable person” of wrongdoing.
4. The violation would result in “serious danger.”
5. The individual displays appropriate “responsibilities for avoiding and/or exposing moral violations.”
6. The action will “have some reasonable chance of success.”¹⁶

Most importantly, whistleblowing is an act of last resort, invoked when other avenues fail to produce corrective action and the potential for harm is imminent.¹⁷ The whistleblower will likely face retaliation, including termination, demotion, removal of job responsibilities, and, in some

industries, black-balling. The action itself violates ethical principles such as confidentiality, since many employees sign non-disclosure agreements; fidelity, because whistleblowing involves a conflict of loyalty; and trust, between employer and employee, employee and peers.

Despite the above, engineers who whistleblow are following their code of ethics, as most include a whistleblowing clause. In the NSPE code, for example, under “Rules of Practice,” the first provision states that engineers should “hold paramount the safety, health, and welfare of the public.” The first bullet under that section contains the whistleblowing stipulation: “If engineers’ judgment is overruled under circumstances that endanger life or property, they shall notify their employer or client and such other authority as may be appropriate.”¹⁸ “Such other authority” may include an external contact that would publicize and hopefully alleviate the problem: a governmental regulatory agency, a newspaper or other media outlet, powerful individuals with the authority to effect change.

Given the retaliation that occurs despite protective legislation, why would a person decide to blow the whistle? Several studies have probed the psychological underpinnings of whistleblowing. C. Fred Alford, for example, spent several years listening to whistleblowers tell their stories, looking for common characteristics. What he discovered is that whistleblowers are a surprisingly disparate group;¹⁹ however, they share two key perspectives: first, they are “shocked in a way that the rest of us aren’t,” due to a certain naïveté or intense loyalty to the company; and second, “[t]hey couldn’t live with themselves anymore without doing something,” thus necessitating action.²⁰

Waytz, Dungan, and Young’s 2013 article discusses their experiences with 654 participants over a series of five experiments involving either writing or responding to questionnaires. They discovered that whistleblowers tended to use moral terms, such as “fairness” and “justice” in describing their experiences, whereas those who took no action used the word “loyalty” more frequently. Regardless of the medium, the same terms recurred, leading the researchers to conclude, “People who valued fairness more than loyalty expressed greater willingness to blow the whistle, whereas people who valued loyalty more than fairness were more hesitant.”²¹

Joan Sieber’s very thoughtful “The Psychology of Whistleblowing” examines specific human characteristics that contribute to a whistleblowing tendency, including context evaluation, bias, the “need for self control,” and a deep-seated “belief in a just world.” External factors may involve managerial autocracy or group processes, such as groupthink,²² both of which were apparent in the ill-fated decision to launch the space shuttle Challenger. In identifying behaviors that lead to whistleblowing, Sieber concludes that taking action “calls for highly mature and self-controlled behavior, careful investigation, and extreme mindfulness of the ease with which impulsive behavior can result in harm to all involved.”²²

While the literature tends to call for action before the event occurs, in reality a healthy number of whistleblowers wait until after the incident occurs; Challenger, discussed below, is perhaps the best example of *post hoc* whistleblowing. This is particularly true in engineering, partly due to corporate culture and a sense of loyalty to the employer. Michael Davis, however, suggests that

post hoc whistleblowers “are generally deeply involved in the activity they reveal.”²³ In Davis’ “theory of complicity,” employees are morally obligated to whistleblow if

- What you reveal derives from your work for an organization.
- You are a voluntary member of that organization.
- You believe that the organization, though legitimate, is engaged in serious moral wrongdoing.
- You believe that your work for that organization will contribute (more or less directly) if (but *not* only if) you do not publically reveal what you know.²³

One of Alford’s interviewees expressed it well: “I wasn’t against the system, I *was* the system! I just didn’t realize that there were two systems.”²⁰ *Post hoc* whistleblowers reach a point where they simply cannot live with the knowledge any longer and feel intense internal pressure to act.

Of the three whistleblowers examined below, only one, Walter Tamosaitis at the Hanford Nuclear Reservation, fits the traditional definition of a whistleblower; Roger Boisjoly of Challenger fame and Cate Jenkins of the EPA blew the whistle after the fact.

Cases

The field of ethics is replete with technical language and abstraction. While approaching professional ethics through moral theory might appeal to a philosophy major, our engineering and engineering technology students are more hands-on, applications-oriented. Teasing a theory from the case via class discussion rather than imposing a theory on a case through lecture is simply more engaging, especially since cases are stories and stories have a special appeal. In addition, cases involve the emotions as well as the intellect and are thus a preferable method for teaching ethics in technical fields, engaging the whole person.

The three cases below illustrate individuals who have made major personal sacrifices to expose the truth and preserve the public health and safety. Each is a dramatic example of moral courage and integrity.

Roger Boisjoly and the Challenger Disaster

Anyone who was conscious and breathing in January 1986 probably remembers the Challenger disaster, one of the “Ur” cases in engineering ethics. Widely taught, it also brought to the forefront of public attention the plight of the whistleblower, someone who sacrifices his/her own personal welfare for a greater good.

The Challenger launch was broadcast live, with millions of schoolchildren anxiously awaiting the science experiments to be performed by Concord High School teacher Christa McAuliffe, the first “teacher in space.” It was the culmination of many months of publicity—first the competition and winnowing of applications, with one to be chosen out of more than 10,000 submitted;²⁴ the intense media coverage: personal interviews with the astronauts, “slice of life”

feature stories, many focusing on McAuliffe and her family; then spotlights on the astronaut training sessions, again focusing on McAuliffe's "oh wow" experiences. After 10 months of media scrutiny, the public felt "as if we knew her," as one person-on-the-street interviewee noted after the disaster.²⁵

On January 28, 1986, at 11:38 a.m. EST, the space shuttle Challenger lifted off its launch pad at Cape Canaveral, headed for the stars. A mere 73 seconds later, it exploded. Against a brilliant blue sky, the solid rocket boosters shot off to the sides, trailing dense white smoke; the external fuel tank transformed into a dazzling orange fireball; and the intact crew cabin plunged towards the sea from a height of 65,000 feet.²⁶ "A major malfunction," announced Stephen Nesbitt of Mission Control.²⁷

The world mourned.

Twenty-six years earlier, an energetic, bright-eyed Roger Boisjoly graduated from Lowell Technological Institute with his bachelor's degree in general engineering and took his first job with Hamilton Standard, in the Electronics Department. Two years later, he traded electronics for aerospace, landing a position at Autonetics. For the next 18 years, he focused solely on that industry, working his way up through companies like Hughes Aircraft and Rockwell to the prestigious position of project engineering manager for the shuttle program's solid rocket boosters (SRBs), under contract by Morton Thiokol, Inc. in Brigham City, Utah.²⁸ Seven years later, there was Challenger.

Designated as technical troubleshooter to solve design problems with the SRB joints, Boisjoly examined data from a prior flight of January 14, 1985, and discovered significant o-ring erosion and blowby in two field joints, due, apparently, to the low ambient air temperature at the time of launch, which precluded the o-rings' normal expansion. In short, some joints leaked, threatening every shuttle mission.²⁹ He presented this information at a meeting with Marshall Space Flight Center personnel and discussed it with colleagues; eventually, frustrated by Thiokol's lack of action and inadequate funding, he wrote in a July 1985 memo,

If the same scenario [as in a prior flight] should occur in a field joint (and it could), then it is a jump ball as to the success or failure of the joint because the secondary O-ring cannot respond to the clevis opening rate and may not be capable of pressurization. The result would be a catastrophe of the highest order—loss of human life. . . .

It is my honest and very real fear that if we do not take immediate action to dedicate a team to solve the problem, with the field joint having the number one priority, then we stand in jeopardy of losing a flight along with all the launch pad facilities.²⁹

Boisjoly, in fact, wrote numerous memos and activity reports to management in the year prior to Challenger, enough to fill a dozen cardboard boxes,²⁸ detailing technical issues that required solutions. Heedless to his and his colleagues' pleas, management sent shuttles up and they came down, in a process that Richard Feynman, Nobel laureate and member of the Rogers

Commission investigatory committee, has described as Russian roulette: “the shuttle flies and nothing happens. Then it is suggested, therefore, that risk is no longer so high. For the next flight we can lower our standards a little bit because we got away with it last time.”³⁰ However, “[w]hen playing Russian roulette, the fact that the first shot got off safely is of little comfort for the next.”³¹ Eventually, a player gets the bullet; for NASA, that bullet was Challenger.

A pre-launch telecon on the evening of January 27, between personnel at Thiokol, Kennedy Space Center, and Marshall Space Flight Center, revealed significant differences of opinion between management, who favored launch, and engineers, who voiced technical concerns, with a series of viewgraphs to illustrate their data. However, their concerns fell on deaf ears. NASA’s Larry Mulloy pronounced the data “inconclusive”;²⁹ engineering staff were delegated to off-line status, and Thiokol’s engineering manager, Robert Lund, was told to “take off your engineering hat and put on your management hat.”²⁹ Minus their technical experts, management made a decision—the wrong one.

For a month, the public assumed that Challenger was a terrible accident, wrought by some mysterious combination of odd circumstances. In the latter part of February, however, the world learned the truth via the testimony of Thiokol engineers Boisjoly, Arnie Thompson, and Allan McDonald, who consciously ignored advice from company attorneys to answer yes or no and offer nothing.²⁹ Their comments and Feynman’s simple experiment of putting a clamped o-ring into a glass of ice water turned the perception of “accident” into “disaster” and blew NASA’s elaborate rhetorical cover. The root cause of the Challenger disaster was cold weather, barely above freezing at launch, which affected the o-rings’ ability to expand and fill a gap in the joint created by launch pressures. This was far from a rare occurrence: Challenger was to be the 25th flight of a shuttle, and 14 prior flights had exhibited either o-ring erosion, blowby, or both, some at fairly warm temperatures.³⁰

In the wake of the disaster, Thiokol treated the three whistleblowers in a fashion common to that time: it killed the messengers. Of the three, Boisjoly has been the most vocal, giving presentations at professional conferences and guest lectures at a host of US universities, including my own, and he suffered great anxiety, sorrow, and guilt over the loss of Challenger. As McDonald notes in his memoirs, “Roger and I already felt like lepers. But when we returned to Utah . . . our colleagues treated us as if we had just been arrested for child sexual abuse.”³² Boisjoly notes that “whistleblowers are treated with contempt by former colleagues and others.”³³ He was eventually diagnosed with PTSD, took medical leave, and was terminated; McDonald was initially demoted but, with longevity and perseverance, was eventually promoted to a vice presidency. Thompson also stayed with Thiokol and, after initial alienation, became a manager on the project to redesign the solid rocket motors.³²

The treatment of the three engineers may seem shocking to us today, but it was typical of the times. According to a 1987 study of 84 whistleblowers in the journal *ethikos*, those who expose corporate or governmental wrongdoing are subject to harassment from superiors and peers, demotion or termination, loss of job responsibilities, monitoring of activities and communications, forced retirement, and legal action (for release of proprietary information). The

extreme stress associated with whistleblowing can spawn a whole host of symptoms, for not only the whistleblowers but spouses as well: increased alcohol consumption/drug use/smoking, weight gain or loss, feelings of panic and powerlessness, increased anxiety and anger, paranoia, depression, feelings of isolation, loss of sleep, among many others. About 10% of whistleblowers attempt suicide.³⁴

In the corporate world, it was “business as usual,” according to whistleblower Donald Soeken.³⁴ No heads rolled at Thiokol after Challenger, and the company retained its lucrative NASA contract. The shuttle program was suspended for three years as SRB joints underwent a redesign. NASA saw some early retirements as a result of Challenger, but little was accomplished to correct faulty decision-making procedures, cited in the Rogers Commission report as a contributing factor. In fact, the 2003 Columbia disaster has been attributed, in part, to the culture of NASA, characterized by a groupthink mentality.³⁵

While the situation for whistleblowers has improved since the days of Boisjoly, retaliation is still apparent, as the next case illustrates.

Walter Tamosaitis and the Hanford Nuclear Reservation

In 2010, engineer Walter Tamosaitis, a long-term employee of Bechtel subcontractor URS Energy & Construction, voiced concerns about cleanup operations at Washington’s Hanford nuclear facility; shortly thereafter, he found himself removed from the premises and ensconced in a windowless basement office, sans furniture, at corporate headquarters, with two aging copy machines for company. While technically still an employee, he was given only menial tasks and had no responsibility.³⁶ One day, in response to a phone call from his wife, Tamosaitis went upstairs, only to find darkness and locked offices. “I thought the Rapture had occurred,” he mused. “And I said, ‘Well, [expletive]. I’m the good guy, it can’t be the Rapture. I should be gone, and they should be here.’”³⁷

Hanford Nuclear Reservation, perched on a bluff above the Columbia River in southeastern Washington, is one of the most polluted areas in the country, site of a major, three-pronged cleanup operation for the past 30 years. Established in 1943 by DuPont as the site for a breeder reactor to produce plutonium for the Manhattan Project, during the Cold War era, Hanford’s reactors, now numbering nine, produced materials for the US atomic weapons program.³⁸ The last reactor ceased operation in 1987, and millions of gallons of radioactive waste languish in huge underground storage tanks, slated for vitrification. Nearby lie the K-Basins, huge swimming pool-like structures that hold most of the nation’s spent fuel rods, about 2,300 tons.³⁹ Overall, the pollution spawned by Hanford challenges credulity; as a report by the *Seattle Daily Journal of Commerce* details, “Hanford contamination is located at 1,377 sites: 158 containing chemical hazardous waste, 100 containing radioactive waste, 996 containing mixed chemical and radioactive waste, and 123 containing nonhazardous waste. It has been estimated that at least 1.2 million cubic yards, enough to cover a football field 700 feet deep, contain radioactive contaminants.”³⁹

In the early days of the Manhattan Project, engineers focused their energies on the production of plutonium to power the first atomic bomb and paid little heed to waste products: “They buried it. Millions of gallons of radioactive effluent went into trenches, ponds, holes drilled in the ground and the Columbia River. The most dangerous waste was conducted into underground single-walled tanks meant to last ten years.”⁴⁰ Finally, in 1968, the facility was slated for new storage structures; it took nearly 20 years to construct 28 double-walled tanks.⁴⁰ The 1986 Chernobyl incident, however, resulted in new pressure on Hanford to clean up its mess—now amounting to 56 million gallons of highly radioactive waste, some leaking through the aging tanks.⁴¹

That decade also witnessed the release of proprietary documents, via the Freedom of Information Act, detailing the decades-long secret discharges of radioactive materials into the environment: in 1949, for example, a 200x40-mile plume of iodine-131, dubbed “The Green Run,” covered the Northwest, the result of an “intentional release,” and in the 1950s, the reactors “dumped a daily average of 50,000 curies of radioactive material into the Columbia.” By comparison, the 1979 Three Mile Island incident released only 15-24 curies of iodine-131,⁴² a modest amount by Hanford standards, but enough to result in elevated cancer rates, particularly leukemia, decades later.⁴³ Between 1944 and 1947, Hanford released an estimated 685,000 curies. While Hanford management maintained that the area was as “safe as mother’s milk,”³⁹ the plant basically irradiated the residents of the Pacific Northwest.

Currently, the tanks are deteriorating: just recently, in April, a 1 million gallon tank leaked more than 3,000 gallons of radioactive materials;⁴⁴ the vapors sickened 11 workers. And another tank is apparently leaking cesium-137 and strontium-90.⁴¹ These are just two among 177 underground tanks, only 28 of which have double walls; 67 tanks are currently leaking into the soil, and 19 more are suspect.⁴⁵ Clearly, time is of the essence.

Yet the cleanup process has been plagued by inertia: since the signing of the Tri-Party Agreement in 1989, virtually nothing has happened. Construction of a vitrification plant for waste treatment was announced in 1991 but did not begin until 2002, with Bechtel as the lead contractor; in 2005, work stopped due to earthquake concerns. It resumed again in 2010 because of a court order but was suspended two years later, due to technical concerns.⁴⁶ Current projections set the completion date as 2039,⁴⁷ and the cost of the entire cleanup operation is estimated at nearly \$115 billion.⁴⁸

Enter Walter Tamosaitis, who has spent his entire professional career working for the companies associated with Hanford: General Electric, DuPont, URS, all under the umbrella of the DOE. Tamosaitis earned a bachelor’s degree in mechanical engineering and an MS and PhD in systems engineering, in addition to a certificate in entrepreneurial business management and PE licensure. At Hanford, he worked on the vitrification plant project from 2003 to 2010, as manager of research and technology,⁴⁹ responsible for a \$500 million budget and supervision of 100 employees.⁵⁰

Tamosaitis’ concerns, which he shared with Bechtel management and the DOE for at least seven years, focused on plant technology, especially the mixing vats. The basic waste treatment process

is to move the tank effluents to mixing vessels through a complex pipe labyrinth. In these vessels, effluents are premixed by jets of air before processing into glass logs,⁵⁰ to be stored in secure areas until the radioactive elements degrade. However, the plant has a number of significant design issues:

- Effluents in the tank require separation into various types, and some of the tanks contain such a variety of compounds that separation would be nearly impossible.
- Over the decades, effluents settled in layers, with a hard substance on the bottom of the tanks, a viscous sludge on top of that, and chemical liquids floating on top.
- Pipes could clog during the transport process.
- Sludge might fall to the bottom of the mixing vats and reach criticality.
- Hydrogen gas could accumulate in the vats, causing an explosion.
- Due to the corrosive nature of the effluents, leakage might occur.⁵¹

Overall, during the seven years of his oversight, Tamosaitis identified more than 150 technical and operational concerns and conveyed that information in writing to the DOE and URS. In 2010, he recommended suspending the project until design issues were resolved. URS promptly removed him from the project; collected his keys, badge, and Blackberry; and banished him from the premises. Suspension would cause Bechtel to miss yet another deadline, costing the company \$55 million.⁵²

After ostracizing Tamosaitis, Bechtel and URS sent a letter to employees, defending their action, reaffirming their commitment to safety, and reassuring their workers that they do not sacrifice safety for money. The list below has a few salient (and exaggerated/ironic) excerpts from that missive:

- Safety has and always will be paramount to the success of the WTP Project [Waste Treatment and Immobilization Plant]
- . . . Bechtel National and URS strongly disagree with and are vigorously contesting Tamosaitis' retaliation claim and all related allegations of wrongdoing.
- Tamosaitis was not fired. He remains employed by URS.
- We will learn even more as we operate WTP, and feedback from the operation will help us determine how best to treat the waste for which we have less confidence.
- We have also heard accusations that it is in Bechtel's and URS' financial interest to imprudently hurry the project. This is false and illogical.⁵³

In 2013, Tamosaitis was terminated, a move he interpreted as retaliation for voicing his concerns. He made headlines across the country. The *Los Angeles Times*, for example, indicates that Tamosaitis' apprehensions about safety were shared by other Hanford managers as well as federal agencies, such as the Defense Nuclear Facilities Safety Board.⁵⁴ Word of his termination quickly spread among his co-workers and engendered a certain level of fear. "I've heard people tell me," he said, "that if they'll do this to you, it scares me what they would do to me."⁵⁰ Two US senators wrote strongly worded letters to the Secretary of Energy in his defense, Ron Wyden

(Oregon) and Edward J. Markey (Massachusetts).⁵⁵ And Tamosiatis himself testified before a Senate subcommittee, raising concerns of mismanagement and willful retaliation against employees critical of managers.⁴⁹

But this story has a somewhat happy ending. Tamosaitis claimed whistleblower status and filed a lawsuit against Bechtel. After five years of legal wrangling, he was awarded a \$4.1 million settlement from Aecom, which had purchased URS. The company noted that it settled “to avoid the cost and distraction of litigation relating to events that occurred over five years ago. The company strongly disagrees that it retaliated against him in any manner.”⁵⁶

Cate Jenkins and the Environmental Protection Agency

While only a small percentage of the national population is aware of the Hanford situation, the collapse of the World Trade Center struck a deep emotional chord, forcing us all to reevaluate our worldview. When the towers fell, huge billowing clouds of dust, more than 1 million tons,⁵⁷ engulfed lower Manhattan and spread across the city, blocking sunlight and covering roads, buildings, and people with a gray ash. The finest particulates, more resembling talcum powder than ash, insinuated themselves into surrounding businesses, residences, and people’s lungs.

Without hesitation, rescuers flooded the area, digging through the unstable 10-story mounds of jagged metal debris searching for survivors. Most were unprotected—in the heat of the moment, speed was more important than respirators or even thin paper masks, although boxfuls of protective devices were available.⁵⁸ Completely focused on the rescue mission, they breathed in the lethal air. In retrospect, a number have regretted not using the respirators, but at the time felt that they were too cumbersome for the athletic work required.⁵⁹

And now they are dying. According to an eight-year study of 13,000 first responders—91.6% of the total—they are paying for their heroism with reduced lung function as revealed by annual tests. On average, damage from breathing in the noxious dust has resulted in accelerated aging, from 10-12 years. More importantly, the victims do not recover, as do those who inhale smoke in, for example, a house fire.⁶⁰

Not only first responders were affected: anyone in the area was susceptible to potentially negative health effects. Bystanders and residents of the area, some 400,000, were also impacted by the foul air. Now they suffer from physical disorders, “chronic cough, shortness of breath, sinus congestion, certain cancers,” as well as psychological ailments: stress and depression.⁶¹ Although visually spectacular, the plume contained literally thousands of potentially toxic substances: the disintegrated remains of 10 million tons⁶² of buildings (concrete, drywall, carpeting, glass, metals, insulation, foam, wood), electrical supplies (wiring, copper, plastics), computers and office equipment, assorted metals, people, tons of acid-treated paper, 91,000 liters of jet fuel—all melded into a mixture of asbestos, plastics, paint, lead, PCBs, dioxins, and a variety of other chemicals incompatible with life. According to the USGS, which conducted some of the earliest dust tests, a partial list of common chemicals includes aluminum, cadmium,

calcium, chromium, iron, silicon, magnesium, molybdenum, organic carbons, potassium, silicon, sodium, titanium, zinc.⁶³

Paul Liroy, from Rutgers University's Environmental and Occupational Health Sciences Institute, has extensively analyzed samples of the dust cloud and notes that, initially, the focus was on asbestos,⁵⁸ which accounted for only about 4% of the total.⁶⁴ Commentators confused short-term effects with long-term exposure, leading to a minor media-engendered panic. The emphasis on asbestos, Liroy suggests, overshadowed other concerns, many of which were more immediately threatening to the public health than asbestos exposure. In fact, about 30% of the dust cloud consisted of glass fibers, and 50% was a mix of titanium and zinc.⁵⁸ Each of these items has a detrimental effect on the human body: glass fibers affect the respiratory system⁶⁵ and can lodge deep in the lungs,⁵⁸ titanium exposure can result in allergic effects and skin disorders,⁶⁶ and heavy doses of zinc can lead to respiratory diseases, although traces of the element are essential for normal development.⁶⁷

A rainstorm on September 14 cleared the air and washed away much of the surface dust. Thermal images from nine days later showed fewer hot spots.⁶⁸ However, deep in the debris, fires still smoldered, burning at 1,000° C; they continued until December 19, spewing more toxins into the air.⁶² According to a UC Davis study headed by scientist Thomas Cahill, "The debris pile acted like a chemical factory. It cooked together the components of the buildings and their contents, including enormous numbers of computers, and gave off gases of toxic metals, acids and organics."⁶⁹

Two days after the towers fell, EPA head Christine Todd Whitman issued a statement: "We have not seen any reason—any readings that have indicated any health hazard."⁵⁹ She repeated similar comments in TV news interviews: while acknowledging that the air contained levels of lead and asbestos, she continued to maintain that "concentrations are such that they don't pose a health hazard. We're going to make sure that everybody's safe."⁷⁰ Even though Whitman made those comments without supporting evidence, New Yorkers felt free to walk the streets, move back into their residences, and try to resurrect a semblance of normal life. First responders continued their work at Ground Zero. But they coughed as they strolled and worked, the "WTC cough," the result of caustic pulverized concrete particulates deposited deep in lung tissue.⁷¹

Not everyone agreed with Whitman's optimistic assessment of Manhattan's streets. On September 13, the date of Whitman's initial pronouncement, the air was still stained yellow with airborne particulates, and even a casual walk stirred up a swirl of potentially lethal dust.⁵⁸

Cate Jenkins is one such dissenter. In 1979, armed with a PhD in Chemistry, she accepted a position as an environmental scientist at the EPA, investigating the wood preservation industry's use of dioxins.⁷² By 1987, she had "already become a well known whistleblower," reporting on fraud, waste, and abuse,⁷² which she views as her duty. As she stated in an interview with *Nature*, "I do have an obligation under the law to report fraud, waste and abuse to the proper authorities."⁷³ Three years later, she was embroiled in a major controversy. Vietnam vets, who had been exposed to Monsanto's Agent Orange defoliant, were falling ill and suffering from a

broad range of maladies, ranging from skin disorders to cancer.⁷⁴ The culprit was dioxin, which, according to Monsanto studies, was relatively harmless: “human beings, unlike other animals, are relatively immune to this man-made chemical.”⁷² Convinced that Monsanto had falsified and manipulated data, Jenkins released a 150-page report entitled “Diseases Significantly Associated with Agent Orange and Dioxin.”⁷⁵

In return for her advocacy role, Jenkins was harassed and vilified by both Monsanto and her employer. EPA policy analyst William Sanjour’s 1994 memo details some of the comments made by Jenkins’ former manager: “Cate Jenkins has a very intelligent mind and it’s a shame it can’t be focused differently”; “management has been too soft in the past in dealing with Cate’s activities.”⁷² In August 1990, Jenkins was reassigned to an office position, with most of her job responsibilities withdrawn until her reinstatement two years later.

Jenkins is hardly a physically imposing figure: a child victim of polio, she stands a mere 5'4", “wears glasses with large lenses, weighs less than 120 pounds, and is known in the EPA office as physically weak.”⁷⁶ Yet what she lacks in stature, she makes up for in determination and grit, as illustrated by her most recent opposition to the EPA’s stance on WTC dust.

When Whitman proclaimed that the air in Manhattan was safe, Jenkins was disturbed and launched her own investigation of the initial USGS conclusions and the EPA assessment, focusing on the data and research quality. The results prompted her to write a 134-page report contained in a memo to members of the Congressional Subcommittee on Superfund and Environmental Health, then chaired by Hillary Clinton, charging governmental agencies, including USGS and the EPA, of scientific fraud in their examination of the dust samples and conclusions regarding the WTC dust cloud. They deliberately underplayed the dust’s corrosive nature, which could “cause irreversible chemical burns to human tissues” and increase “the toxic properties of other pollutants from the WTC by facilitating their entry into the body through the respiratory system.”⁷⁷

Her conclusions are supported by a 2003 report from the inspector general of the EPA, which takes the EPA to task for its pronouncement of the air as safe, when, in fact, “it did not have sufficient data and analyses to make such a blanket statement.”⁷⁸ Furthermore, the report notes that EPA statements did not include important caveats; they applied only to

- long-term health effects—not short-term or acute health effects
- the general public—not Ground Zero workers
- outdoor air—not indoor air
- healthy adults—not sensitive sub-populations such as children and the elderly
- asbestos—not other air pollutants⁷⁸

The situation is complicated by the Bush administration directing the EPA to soften its statements, according to a *New York Times* article. The following two examples show that the White House not only softened the language but changed meaning as well. Then-NSA head Condaleeza Rice vetted the releases:⁷⁹

Original headline: “EPA Initiating Emergency Response Activities, Testing Terrorized Sites For Environmental Hazards”
 Revised headline: “EPA Initiating Emergency Response Activities, **Reassures Public About Environmental Hazards**”
 Original: “Even at low levels, EPA considers asbestos hazardous in this situation”
 Revised: **“Short-term, low-level exposure of the type that might have been produced by the collapse of the World Trade Center buildings is unlikely to cause significant health effects.”**⁸⁰

While reassuring the public is an important consideration, the above goes well beyond “reassurance”; the EPA press releases are simply lies, or, as Jenkins has noted, “orchestrated falsifications,” illustrative of a pattern apparent in the agency since 1980.⁷⁷

USGS participated in the same type of data manipulation, deliberately underplaying the corrosive nature of the dust in findings released in February 2002. The following October, however, the agency reported pH levels a full point higher; since the pH scale is logarithmic, this means that breathing WTC dust with a pH of 12.3 would be similar to drinking Drano (pH value, 12.2).⁷⁷

For her efforts, Jenkins was fired in 2010, under charges that she was “intimidating” and “threatened to kill her supervisor,” who stood a full 8" taller and outweighed her substantially.⁷⁶ Appealing to the Merit Systems Protection Board, Jenkins was reinstated in 2012, under a procedures ruling, and relegated to administrative leave.⁸¹ In 2015, in conjunction with the non-profit advocacy group Public Employees for Environmental Responsibility, Jenkins filed a petition against the EPA, that required it to strengthen its rules regarding caustic substances.⁸² Currently, however, the EPA is considering denying the petition, stating that “it is not possible to establish a causal connection” between WTC dust and the deteriorating health status of first responders.⁸³

The year 2015 also marked a clear judicial reprimand against the EPA for its cover-up of the WTC dust situation and treatment of Jenkins. According to US Department of Labor Judge Linda Chapman, the EPA demonstrated “egregious” behavior: it “failed and failed miserably” to comply with court orders, destroyed documents, and worked “a fraud on the Court.” In regards to its treatment of Jenkins, the judge stated that the EPA violated provisions of several federal whistleblower protection laws, a clear victory for the beleaguered chemist.⁸⁴

The case of Cate Jenkins is a disturbing example of what happens when a person with a commitment to public advocacy runs contrary to a powerful regulatory agency unwilling to admit a mistake. Although Whitman has since apologized for endangering the public health, stating, “I’m very sorry that people are dying and if the EPA and I in any way contributed to that, I’m sorry,”⁸⁵ it comes 15 years too late. And, ultimately, her apology is irrelevant: in the final assessment, 2,753 families lost loved ones, 37,000 people are sickened by breathing Whitman’s

“safe” air,⁸⁵ hundreds experienced painful and lingering deaths from acute respiratory diseases, and all of us have had our lives changed—for the rest of our lives.

These three cases dramatically illustrate the perils of whistleblowing in both the private and public sectors. And, sadly, the message of whistleblowing is not positive; those who suffer are not the wrongdoers but those who report the wrongdoing—those who subscribe to a higher morality and seek to safeguard the public health and safety. However, dismal as they are, things have improved since Challenger, as the next section details.

After-Effects

Other than heightened public awareness, one of the most beneficial after-effects of highly publicized whistleblowing cases has been the passage of protective legislation. While the OSH Act has been in place since 1970 and section 11(c) protects workers from retaliation,⁸⁶ enforcement is “weak” and inspections are minimal.⁸⁷

Two 1989 acts further defined protective measures for whistleblowers. The False Claims Act, a federal statute, allows whistleblowers to sue businesses for perpetrating fraud against the federal government or a government official, such as a Congressional representative or judiciary official. Fraud can include waste, abuse, or creation of false documentation. The FCA actually dates to 1863, when contractor fraud was rampant during the Civil War. Those who pursue a legal course are offered protection from reprisal and up to 25% of awarded damages.⁸⁸

The Whistleblower Protection Act, passed in 1989 and amended in 2012, shields individuals who report “any disclosure of information” of actions that are illegal or exhibit “gross mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety.”⁸⁹ The act prohibits retaliation against an employee who discloses information as well as employees who refuse to participate in wrongful activities.⁸⁹ The amended act clarifies “disclosures” and offers protection for government scientists, such as Cate Jenkins, “who challenge censorship or make disclosures related to the integrity of the scientific process.” In addition, the enhanced act clarifies procedural matters and includes provisions for educating employees about their rights as whistleblowers.⁹⁰

While both of these laws offer substantial protection, they apply only to government workers and, as the cases of Tamosaitis and Jenkins illustrate, retaliation still occurs. It took the collapse of Enron for legislation protecting workers in the private sector to emerge.

The Sarbanes-Oxley Act, 2002, focuses primarily on preventing fraud and accounting irregularities in publically traded companies, such as Enron, WorldCom, and other telecom giants that collapsed in 2001.⁹¹ However, it includes a section that addresses retaliation against whistleblowers. Specifically, “interference with the lawful employment or livelihood of any person” who discloses wrongdoing is punishable by a fine and/or incarceration.⁹²

More sweeping changes are apparent in the 2004 amendments to the organizational guidelines in the US Sentencing Commission. These apply to all companies, not just SEC-traded, and detail

corporate ethical responsibilities. Included are provisions requiring a functional ethics and compliance program, an ethics code or statement, oversight and annual training, and a safe reporting outlet for employees, with a condition for anonymity, if requested.⁹³

While the position of whistleblower is still a precarious one, current legislation offers protection unavailable to the Challenger engineers. Retaliation still occurs, but affected employees can claim whistleblower status and, if the situation warrants, sue their employers, as did Walter Tamosaitis.

Whistleblowers can also connect with numerous support groups to alleviate the psychological effects—a simple Google search reveals more than 200,000 resources currently available, such as the Whistleblower Support Fund, which offers legal, educational, and counseling services;⁹⁴ the National Whistleblower Center, which provides a reporting outlet, in addition to non-profit legal services;⁹⁵ and the Government Accountability Project, celebrating its 40th anniversary in 2017. GAP, a non-profit advocacy group, is dedicated to serving the public interest by exposing the truth and supporting corporate social responsibility. To date, it has offered support to 6,000 whistleblowers.⁹⁶

Classroom Usage

When Roger Boisjoly first visited our campus in 1990, I bribed my students with extra credit if they would attend his public lecture and write a short memo explaining their reactions to his talk. I need not have bothered with the bribe; they all attended and came away enlightened and, to a degree, inspired. Sean best expressed the students' response: "On the night of April 26, I listened to a talk on ethics from a man that I have never heard of but now admire greatly. His talk on ethical decisions really got through to me. I now believe that a man should make the honest and right decision on a subject, no matter what the consequences." While it is true that most of our students will never be involved in a Challenger-like disaster, whistleblowers' stories have much to teach us about decision-making, courage, and personal integrity.

Creative instructors can develop a number of activities for incorporating information on whistleblowing into their technical classes. The following are a few simple pedagogical suggestions:

Discussion is an obvious and fruitful venture. Instructors can introduce background materials and details of the disaster, augmented by other appropriate media, and ask students pithy questions to consider in small groups, which then report out to the larger group. Challenger is a good example of a tried-and-true topic, since much information is available, including video of Boisjoly's public testimony during the Rogers Commission hearings. Although for our traditional students Challenger is ancient history, an ABC video of related news stories helps bring the incident to life.²⁵

Research is another obvious outlet. In the past, I have had my students research local whistleblowers rather than highly publicized cases; even in my tiny town, whistleblowing has

occurred in government agencies such as the Forest Service and Fish and Wildlife. Area-specific topics may also be fodder for research; my community, for example, was the residence of several Native American tribes, and occasionally, artifacts are discovered during construction excavations. According to federal law, work must cease and the contractor must bring in archaeologists to evaluate the find. Sometimes, however, this does not happen, and the artifacts are destroyed; a whistleblower later reveals the action. Having students research such esoteric incidents serves a number of purposes: in addition to learning about whistleblowing on a local level, they also become familiar with the history of indigenous peoples and the importance of their artifacts as well as federal laws governing the disposition of those items. This type of assignment even requires them to read the local newspaper, which meticulously reports such events. The topic is particularly relevant to civil engineering students studying land or transportation developments that require excavations.

Incorporating ethical theory, specifically virtue ethics, is another method for teaching whistleblowing. By studying the virtues, students learn the importance of character in action, which dates back thousands of years. Aristotle defined virtue as an habitual characteristic, as demonstrated by an individual's actions, a consistent behavior that represents a mean between deficiency and excess: courage, for example, is the mean between cowardice and foolhardiness. Living a virtuous life leads to the Good, the goal of life.⁹⁷

Whistleblowers are virtuous people, despite some unsavory stereotypes. They evidence compassion for others, a concern for moral standards, a dedication to truth, and a commitment to the public health and safety. Whistleblowers remind us of the importance of acting altruistically rather than selfishly, of considering the welfare of others before our own, and of committing our actions to improving the world around us. Discussing virtue ethics can also shed new light on the engineer's responsibility to "hold paramount" the public health, safety, and welfare.

Students reveal their reactions to the material on whistleblowing through reflection papers, class discussions, and, in some cases, their research projects. One group, for example, titled their final project "Karen Silkwood: America's First Nuclear Martyr." They were appalled that Silkwood had been deliberately contaminated with plutonium by corporate personnel and outraged that she was killed for her efforts to protect co-workers.⁹⁸

Comments from course evaluations also reveal the impact of an applied ethics course on student thinking. The following is a representative sampling; these are typical comments from students in virtually every major OIT offers.

- Good course, glad I took it
- I know I will apply what I learned in my future profession. I really liked the class.
- I appreciate the values related to real life.
- I really enjoyed this class. If it weren't for this class, I never would have looked up my code of ethics for my future career.
- Awesome class!

Of course, not everyone agrees: “Why is this course required by the great state of Oregon for graduation? The course was fun, no complaints there. But it was a waste of time and money.”

Conclusions

In Greek, the word “whistleblower” translates as “guardian of the public trust.”⁹⁹ The three whistleblowers described in this paper functioned as precisely that: by their actions, they attempted to call attention to corporate or government wrongdoing that either had or could have had disastrous consequences for those affected. Their fundamental concern was for truth. Lack of truth resulted in the deaths of seven astronauts and a shadow that still lingers over the US space program. Lack of truth resulted in thousands of people developing respiratory disorders and a distrust of a major regulatory agency. Lack of truth could result in a nuclear event affecting millions of people and their descendants. In each of these incidents, someone had to tell the truth. Roger Boisjoly, Walter Tamosaitis, and Cate Jenkins consciously made that life-changing decision.

In an ideal world, whistleblowers would be unnecessary. Business and government would be forthcoming about deficiencies and correct them willingly; those who report problems would be praised, not fired. But the solution for whistleblowing calls for a cultural shift and an acceptance of those who are serious about moral responsibility. As an editorial in *The Economist* suggests, “wrongdoing is less likely to occur in the first place if employees know that their bosses are more inclined to hug a whistleblower than to put him in a headlock.”¹⁰⁰ While that may not be immediately forthcoming, teaching our students about whistleblowing is certainly a step in the right direction.

References

1. Ellsberg, D. (n.d.). *Daniel Ellsberg's website*. Retrieved from <http://www.ellsberg.net/bio>
2. O'Connor, J. D. (2005). I'm the guy they called Deep Throat. *Vanity Fair*. Retrieved from <http://www.vanityfair.com/news/politics/2005/07/deepthroat200507>
3. Mark Hoder; exposed scandal in selection of Olympics' host cities. (2006, October 20). *The Washington Post*. Retrieved from <http://www.washingtonpost.com/wp-dyn/content/article/2006/10/19/AR2006101901725.html>
4. *Edward Snowden: Leaks that exposed US spy programme*. (2014, January 17). BBC. Retrieved from <http://www.bbc.com/news/world-us-canada-23123964>
5. *Karen Silkwood biography*. (2016). Retrieved from <http://www.biography.com/people/karen-silkwood-9542402#legacy>
6. *Frank Serpico*. (2016). Retrieved from <http://www.americanswhotellthetruth.org/portraits/frank-serpico>
7. ABET. (2014). *Criteria for accrediting engineering technology programs*. Retrieved from <http://www.abet.org/wp-content/uploads/2015/05/T001-15-16-ETAC-Criteria-05-04-15.pdf>
8. Harris, C. E., Davis, M., Pritchard, M. S., & Rabins, M. J. (1996). Engineering ethics: What? why? how? and when? *Journal of Engineering Education*, 85(4), 93-96.
9. *The compact edition of the Oxford English Dictionary*. (1971). New York: Oxford University Press.
10. *The whistleblower directory*. (n.d.). Retrieved from <http://whistleblowerdirectory.com/whistleblower-definitions/>
11. *Consumer protection and whistleblowing*. (n.d.). Retrieved from <http://www.whistleblowingprotection.org/?q=node/19>
12. Zimmer, B. (2013, July 12). The epithet Nader made respectable. *Wall Street Journal*. Retrieved from <http://www.wsj.com/articles/SB10001424127887323368704578596083294221030>

13. Safire, W. (1983, February 6). On language; blowing my whistle. *The New York Times*. Retrieved from <http://www.nytimes.com/1983/02/06/magazine/on-language-blowing-my-whistle.html>
14. Government Accountability Project. (2016). *What is a whistleblower?* Retrieved from <https://www.whistleblower.org/what-whistleblower>
15. Weil, V. (1996). *Whistleblowing: What have we learned since the Challenger?* Retrieved from <https://www.nspe.org/resources/ethics/ethics-resources/other-resources/whistleblowing-what-have-we-learned-challenger>
16. Glazer, M. P., & Glazer, P. M. (1989). *The whistleblowers: Exposing corruption in government and industry*. New York: Basic Books.
17. Mintz, S. (2010). *The ethics of whistle-blowing and employment confidentiality agreements*. Retrieved from <http://www.workplaceethicsadvice.com/2015/04/the-ethics-of-whistle-blowing-and-employment-confidentiality-agreements.html>
18. NSPE. (2016). *Code of ethics*. Retrieved from <https://www.nspe.org/resources/ethics/code-ethics>
19. Alford, C. F. (2001). *Whistleblowers: Broken lives and organizational power*. Ithaca, NY: Cornell University Press.
20. Severns, M. (2013, June 13). What really drives a whistleblower like Edward Snowden? *Mother Jones*. Retrieved from <http://www.motherjones.com/politics/2013/06/snowden-whistleblower-interview-alford>
21. Waytz, A., Dungan, J., & Young, L. (2013, August 2). The whistle-blower's quandary. *The New York Times*. Retrieved from http://www.nytimes.com/2013/08/04/opinion/sunday/the-whistle-blowers-quandary.html?_r=0
22. Sieber, J. E. (1998). The psychology of whistleblowing. *Science and Engineering Ethics*, 4(1), 7-23.
23. Davis, M. (1996). Some paradoxes of whistleblowing. *Business and Professional Ethics Journal*, 15(1), 3-19.
24. *Teacher-in-space*. (2015). Retrieved from <http://www.worldspaceflight.com/bios/teacher.php>
25. ABC News. (1987). *From disaster to discovery: The Challenger explosion and the rebirth of America's space shuttle*. [Video.] Note: this video is available on YouTube at <https://www.youtube.com/watch?v=UlsFcZDJlqg>
26. Isikoff, M. (1986, March 10). Remains of crew of shuttle found. *The Washington Post*. Retrieved from <http://www.washingtonpost.com/wp-dyn/content/article/2006/01/25/AR2006012501455.html>
27. Workman, K. (2016, January 28). The Challenger space shuttle disaster, thirty years later. *The New York Times*. Retrieved from http://www.nytimes.com/interactive/2016/01/29/science/space/challenger-explosion-30-year-anniversary.html?_r=0
28. Boisjoly, R. M. (1990). Conversations with author.
29. Boisjoly, R. M. (1987). Ethical decisions: Morton Thiokol and the space shuttle Challenger disaster. In *Proceedings of the ASME Winter Annual Meeting*. Boston, MA. [Note: this paper is available at the Online Ethics Center, <http://www.onlineethics.org/Resources/thiokolshuttle.aspx>]
30. Vaughan, D. (1996). *The Challenger launch decision: Risky technology, culture, and deviance at NASA*. Chicago: University of Chicago Press.
31. Feynman, R. P. (1988). "What do you care what other people think?" *Further adventures of a curious character*. New York: Bantam Books.
32. McDonald, A. J., & Hansen, J. R. (2009). *Truth, lies, and o-rings: Inside the space shuttle Challenger disaster*. Gainesville, FL: University Press of Florida.
33. Boisjoly, R. M. (1996). *The space shuttle Challenger disaster: A paradigm for changing workplace/career ethics*. Paper presented at the meeting of the Association for Practical and Professional Ethics. St. Louis, MO.
34. Whistle blowers face retaliation, dismissal, study shows. (1987). *ethikos*, 1(2), 4-10.
35. Schwartz, J., & Wald, M. L. (2003, March 9). NASA's curse? "Groupthink" is 30 years old, and still going strong. *The New York Times*. Retrieved from <http://www.nytimes.com/2003/03/09/weekinreview/the-nation-nasa-s-curse-groupthink-is-30-years-old-and-still-going-strong.html>
36. Davidson, J. (2011, December 8). After complaint, he landed in basement. *The Washington Post*. Retrieved from https://www.washingtonpost.com/politics/after-complaint-he-landed-in-basement/2011/12/08/gIQA3O2agO_story.html?tid=a_inl
37. Fahrenthold, D. A. (2014, August 3). For whistleblowers, a bold move can be followed by one to department basement. *The Washington Post*. Retrieved from <https://www.washingtonpost.com/politics/for->

- whistleblowers-bold-move-can-be-followed-by-one-to-department-basement/2014/08/03/39d12656-182f-11e4-9e3b-7f2f110c6265_story.html
38. US Department of Energy. (n.d.). *Hanford history*. Retrieved from <http://www.hanford.gov/page.cfm/HanfordHistory>
 39. Du Bey, R. A., Martin, C. S., & Walton, R. B. (1998, August 20). "Downwinders" still press their case against Hanford. *Seattle Journal of Commerce*. Retrieved from <https://www.djc.com/special/enviro98/10043971.htm>
 40. Brown, K. (2015, January 21). How the atomic age left us a half-century of radioactive waste. *Time*. Retrieved from <http://time.com/3672177/hanford-radioactive-waste-history/>
 41. Nazaryan, A. (2016, May 3). Nuclear waste leaking at "American Fukushima" in Northwest. *Newsweek*. Retrieved from <http://www.newsweek.com/hanford-nuclear-reservation-radioactive-waste-454808>
 42. Physicians for Social Responsibility. (2015). *Hanford history: How did we get where we are?* Retrieved from <http://www.psr.org/chapters/washington/hanford/hanford-history.html>
 43. Wing, S., Richardson, D., Armstrong, D., & Crawford-Brown, D. (1997). A reevaluation of cancer incidence near the Three Mile Island nuclear plant: The collision of evidence and assumptions. *Environmental Health Perspectives*, 105(1), 52-57.
 44. Cary, A. (2016, April 18). Significant amount of waste leaks within Hanford tank. *Tri-City Herald*. Retrieved from <http://www.tri-cityherald.com/news/local/hanford/article72452207.html>
 45. Boddie, K. (2014, April 24). *6 reasons to know about Hanford's nuclear waste*. Retrieved from <http://koin.com/2014/04/24/6-things-know-hanfords-nuclear-waste/>
 46. Timeline: 25 years of Hanford cleanup. (2014, May 11). *Tri-City Herald*. Retrieved from <http://www.tri-cityherald.com/news/local/hanford/article32178795.html>
 47. Cary, A. (2015, November 14). DOE proposes full start of Hanford vit plant in 2039. *Tri-City Herald*. Retrieved from <http://www.tri-cityherald.com/news/local/hanford/article44970720.html>
 48. Cary, A. (2013, February 22). Estimated cost to finish Hanford cleanup now at \$114.8. *Tri-City Herald*. Retrieved from <http://www.tri-cityherald.com/news/local/hanford/article32113842.html>
 49. Subcommittee on Financial Contracting Oversight. (2013, March 11). *Dr. Walter Tamosaitis statement for the record*. Retrieved from FCO 2014-03-11.pdf
 50. Rosenfeld, D. (2010, October 12). *Veteran Hanford engineer says DOE's multi-billion dollar Hanford nuclear waste processing plant might not work properly and has serious potential safety problems*. Retrieved from <https://dcbureau.org/20101012764/natural-resources-news-service/veteran-hanford-engineer-says-does-multi-billion-dollar-hanford-nuclear-waste-processing-plant-might-not-work-properly-and-has-serious-potential-safety-problems.html>
 51. Brown, V. (2013, May 9). Hanford nuclear waste cleanup plant may be too dangerous. *Scientific American*. Retrieved from <http://www.scientificamerican.com/article/hanford-nuclear-cleanup-problems/>
 52. Malone, P. (2015, September 1). *Nuclear cleanup project haunted by legacy of design failures and whistleblower retaliation*. The Center for Public Integrity. Retrieved from <https://www.publicintegrity.org/2015/09/01/17922/nuclear-cleanup-project-haunted-legacy-design-failures-and-whistleblower>
 53. King, A. (2011, July 28). *Read the entire Bechtel and URS letter to employees*. Retrieved from <http://knkx.org/post/read-entire-bechtel-and-urs-letter-employees>
 54. Vartabedian, R. (2013, October 3). Company fires scientists who warned of Hanford waste site problems. *Los Angeles Times*. Retrieved from <http://articles.latimes.com/2013/oct/03/nation/la-na-hanford-layoff-20131004>
 55. Vartabedian, R. (2013, October 9). Senators urge protection of Hanford whistleblower Tamosaitis. *Los Angeles Times*. Retrieved from <http://articles.latimes.com/2013/oct/09/nation/la-na-nn-tamosaitis-hanford-cleanup-20131009>
 56. Emshwiller, J. R. (2015, August 13). Settlement reached in Hanford whistleblower suit. *Wall Street Journal*. Retrieved from <http://www.wsj.com/articles/settlement-reached-in-hanford-whistleblower-suit-1439422793>
 57. Dalton, L. (2003, October 20). Chemical analysis of a disaster. *Chemical & Engineering News*, 81(42), 26-30.
 58. Liroy, P. (2010). *Dust: The inside story of its role in the September 11th aftermath*. London: Rowan & Littlefield.
 59. Klatell, J. (2006, September 8). *EPA lied about WTC air*. Retrieved from <http://www.cbsnews.com/news/insider-epa-lied-about-wtc-air/>

60. Grady, D. (2010, April 7). Lung function of 9/11 rescuers fell, study finds. *The New York Times*. Retrieved from <http://www.nytimes.com/2010/04/08/nyregion/08lung.html>
61. Lum, E. (2015, September 11). *Health effects from 9/11: Lessons learned*. Retrieved from <https://blogs.cdc.gov/niosh-science-blog/2015/09/11/9-11-2015/>
62. Biello, D. (2011, September 7). What was in the World Trade Center plume? *Scientific American*. Retrieved from <http://www.scientificamerican.com/article/what-was-in-the-world-trade-center-plume/>
63. USGS. (2002, January 11). *Chemical compositions of the WTC dusts and girder coating materia*. Retrieved from <http://pubs.usgs.gov/of/2001/ofr-01-0429/chem1/index.html>
64. Cook, G., & Robertson, T. (2011, September 14). Asbestos dust poses threat to rescue crews. *The Boston Globe*. Retrieved from http://archive.boston.com/news/packages/underattack/globe_stories/0914/Asbestos_dust_poses_threat_to_rescue_crews+.shtml
65. Landrigan, P. J., Lioy, P. J., Thurston, G., Berkowitz, G., Chen, L. C., Chillrud, S. N., Gavette, S. H. ... Small, C. (2004, May). Health and environmental consequences of the World Trade Center disaster. *Environmental Health Perspectives*, 112(6), 731-739.
66. *Titanium exposure and its effect on human health*. (2016). Retrieved from <https://iaomt.org/wp-content/uploads/Titanium-Exposure-and-its-Effect-on-Human-Health.pdf>
67. Plum, L. M., Rink, L., & Haase, H. (2010, April). The essential toxin: Impact of zinc on human health. *International Journal of Environmental Research and Public Health*, 7(4), 1324-1365.
68. USGS. (2001). *Images of the World Trade Center site show thermal hot spots on September 16 and 23, 2001*. Retrieved from <http://pubs.usgs.gov/of/2001/ofr-01-0429/thermal.r09.html>
69. Kerlin, K. (2003, September 10). *Trade center debris pile was a chemical factory, says new study*. Retrieved from <https://www.ucdavis.edu/news/trade-center-debris-pile-was-chemical-factory-says-new-study>
70. *Christie Whitman says air is safe days after 911*. (2001). Retrieved from <https://www.youtube.com/watch?v=BxdtHY59b4>
71. Prezant, D. J., Weiden, M., Banauch, G. I., McGuinness, G., Rom, W. N., Aldrich, T. K., & Kelly, K. J. (2002, September 12). Cough and bronchial responsiveness in firefighters at the World Trade Center site. *New England Journal of Medicine*, 347, 806-815. doi: 10.1056/NEJMoa021300
72. Sanjour, W. (1994, July 20). *Memorandum*. Retrieved from <http://www.williamsanjour.name/monsanto.htm>
73. Tollefson, J. (2012, May 17). Speaking science to power: EPA researcher gets her job back—for the second time. *Nature*. Retrieved from <http://www.nature.com/news/speaking-science-to-power-1.10647>
74. Institute of Medicine Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides. (1994). *Veterans and Agent Orange: Health effects of herbicides used in Vietnam*. Washington, D.C.: National Academies Press.
75. Villianatos, E. G., & Jenkins, M. (2014). *Poison spring: The secret history of pollution and the EPA*. London: Bloomsbury Press.
76. Yehle, E. (2013, September 13). *EPA: Agency mounts another effort to fire whistle-blowing chemist*. Retrieved from <http://www.eenews.net/stories/1059987217>
77. Jenkins, C. (2007, May 6). *Complaint and additional evidence of pH fraud by: USGS, OSHA, ATSDR, NYC, EPA, and EPA-funded scientists*. Retrieved from <http://www.journalof911studies.com/volume/200704/DrJenkinsRequestsSenateInvestigationOnWTCdust.pdf>
78. Office of the Inspector General. (2003, August 21). *Evaluation report: EPA's response to the World Trade Center Collapse: Challenges, successes, and areas for improvement* (Report no. 2003-P-00012). Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/wtc_report_20030821.pdf
79. Union of Concerned Scientists. (2003). *World Trade Center rescue workers believed EPA, ended up sick*. Retrieved from <http://www.ucsusa.org/our-work/center-science-and-democracy/promoting-scientific-integrity/ground-zero-air-pollution.html#.VF9at4VDoY>
80. Arak, J. (2003, August 9). W. House molded EPA's 9/11 reports. *The New York Times*. Retrieved from <http://www.cbsnews.com/news/w-house-molded-epas-9-11-reports/>
81. Goldenberg, S. (2012, May 7). EPA scientist who warned of caustic dust from Ground Zero wins job back. *The Guardian*. Retrieved from <https://www.theguardian.com/world/2012/may/07/cate-jenkins-epa-ground-zero-dust?newsfeed=true>

82. Sacks, S. (2015, March 16). As 9/11 first responder death toll mounts, E.P.A. considers new rules on toxic dust. *The District Sentinel*. Retrieved from <https://www.districtsentinel.com/as-911-first-responder-death-toll-mounts-e-p-a-considers-new-rules-on-toxic-dust/>
83. Gallagher & Kennedy. (2016, April). Who knew the EPA hazardous waste corrosivity characteristic notice had a salacious back story? *Environmental News Alert*. Retrieved from <http://gknet.com/assets/Environmental-News-Alert-April-2016.pdf>
84. PEER. (2015, April 22). "Egregious" EPA misconduct delivers whistleblower win. Retrieved from <http://www.truth-out.org/speakout/item/30373-egregious-epa-misconduct-delivers-whistleblower-win>
85. Walters, J. (2016, September 10). Former EPA head admits she was wrong to tell New Yorkers post-9/11 air was safe. *The Guardian*. Retrieved from <https://www.theguardian.com/us-news/2016/sep/10/epa-head-wrong-911-air-safe-new-york-christine-todd-whitman>
86. OSHA. (2015, June). *OSHA fact sheet: Filing whistleblower complaints under section 11(c) of the OSH Act of 1970*. Retrieved from <https://www.osha.gov/Publications/OSHA3812.pdf>
87. Elk, M. (2013, November 1). *OSHA weaknesses force workers to choose: Report safety violations, or keep their jobs?* Retrieved from http://inthesetimes.com/working/entry/15809/osha_weaknesses_force_workers_to_choose_report_safety_violations_or_keep_th
88. *What is the False Claims Act?* (n.d.). Retrieved from <http://www.whistleblowingprotection.org/?q=node/24>
89. Whitaker, L. P. (2007, March 12). *The Whistleblower Protection Act: An overview*. CRS Report for Congress (Report no. RL33918). Retrieved from <https://www.fas.org/sgp/crs/natsec/RL33918.pdf>
90. Zuckerman, J. (2012, November-December). *Congress strengthens whistleblower protections for federal employees*. American Bar Association. Retrieved from http://www.americanbar.org/content/newsletter/groups/labor_law/ll_flash/1212_abalel_flash/lel_flash12_2012spec.html
91. Rosenbush, S. (2016). *5 lessons of the WorldCom debacle*. Retrieved from <http://www.bloomberg.com/news/articles/2005-03-15/five-lessons-of-the-worldcom-debacle>
92. *Public law 107-204*. (2002, July 30). Retrieved from <https://www.sec.gov/about/laws/soa2002.pdf>
93. *Amendments to the sentencing guidelines*. (2004, November 1). Retrieved from http://www.ussc.gov/sites/default/files/pdf/amendment-process/official-text-amendments/20040501_Amendments.pdf
94. Whistleblower Support Fund. (n.d.). *About us*. Retrieved from <http://whistleblowing.us/about-us/>
95. National Whistleblowing Center. (2016). *About us*. Retrieved from <http://www.whistleblowers.org/about-us>
96. GAP. (2016). *About*. Retrieved from <https://www.whistleblower.org/truth-be-told-it-isn%E2%80%99t-tagline-it%E2%80%99s-our-driving-purpose>
97. Aristotle. (2009). *Nicomachean ethics*. (W. D. Ross, trans.). Retrieved from <http://classics.mit.edu/Aristotle/nicomachaen.html> (Original work written 350 BCE)
98. Rashke, R. L. (2000). *The killing of Karen Silkwood: The real story behind the Kerr-McGee plutonium case*. 2nd ed. Ithaca, NY: Cornell University Press.
99. Kiriakou, J. (2015, October 14). The sad fate of America's whistleblowers. *Other Words*. Retrieved from <http://otherwords.org/the-sad-fate-of-americas-whistleblowers/>
100. The age of the whistleblower. (2015, December 5). *The Economist*. Retrieved from <http://www.economist.com/news/business/21679455-life-getting-better-those-who-expose-wrongdoing-companies-continue-fight>

Biography

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