AC 2009-240: ETHICAL EXOTICA: SMALL, STICKY CASES FOR ANALYSIS

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Abstract

This paper examines two relatively unknown cases involving molasses storage tank collapses: the Boston Molasses Flood of 1919 and the 1998 Ingenio Melchor Ocampo Sugar Mill spill, in Jalisco, Mexico. Together, these two events unleashed millions of gallons of molasses on unsuspecting communities, resulting in loss of life and environmental degradation. This paper includes background regarding small cases, an explanation of the cases, consequences, and ethical issues involved.

Introduction

Anyone who has taught engineering ethics is familiar with the litany of engineering disasters: Challenger, Bhopal, Hyatt Regency walkways collapse, the DC-10 cargo door latch problem, to name but a few. Using such high profile cases has a number of benefits, not least among them impressing upon students the very public nature of the engineering profession.

But what about the scores of smaller cases, which warrant only brief mention--if any--by the media? Or older cases that have faded into the mists of time? Can students learn important lessons from these as well?

This paper presents two cases, suitable for classroom usage, involving storage tank collapses. When most people think of structural failures, they associate them with buildings, bridges or dams: large structures that, when they fail, can involve significant loss of human life. However, tank collapses can result in general havoc as well.

Specifically, this paper examines container collapses involving molasses: the Boston Molasses Flood of 1919 and 1998 Ingenio Melchor Ocampo Sugar Mill disaster. Although separated in time by nearly 80 years, these incidents have similar characteristics and underscore the necessity of ethical decision-making. This paper includes background regarding small cases, an explanation of the cases, consequences, and ethical issues involved.

Using Small Cases

Small cases offer a number of advantages in a classroom setting. While high profile or complex cases such as Chernobyl or Challenger are valuable for study, the sheer amount of information may be prohibitive for those instructors who take an integrated approach in technical courses, rather than farming out students to the philosophy department for their ethics injection. Small cases are much more contained: “By their nature,” Lynch and Klein note, “small cases can never be presented in full ethnographic detail. . . .”1 Because they are much less detailed than major cases, these small classes are easier to incorporate in a technical class.

While studying ethics in general allows students to exercise their moral imaginations, small cases are especially suited to this approach. As Kenneth Winston, faculty member at Harvard’s Kennedy School of Government, suggests, “. . . students are forced to reflect as much on the
environment of decision making as is the logic of the environment.”² By doing so, they can
develop critical thinking and ethical decision-making skills. Because small cases are so limited,
instructors can spend more time focusing on these skill sets.

Cases also provide media for ethical problem identification and concrete instances for moral
deliberation. As Harris, Pritchard, and Rabins explain, “Through cases, we learn to recognize
the presence of ethical problems and to develop analytical skills necessary to resolving them.”³

Finally, small cases may be more relevant to our students’ professional lives. While, of course,
engineers have been involved in high-profile cases, such as Roger Boisjoly of the Challenger
disaster or Jack Gillum of the Hyatt Regency walkways collapse, chances are that the ethical
challenges our students will face will be of the more mundane, garden variety. These, while of
lesser impact, may be a daily occurrence, and having students examine small cases thus may be
more useful to them later in their lives.

The Cases

Occasionally, while perusing the daily newspaper, one comes across accounts of molasses spills:
in 1990, a ruptured tank in Loveland, Colorado, unleashed half a million gallons of steaming
molasses, closing nearby businesses;⁴ in 2003, a damaged pipeline in Wailuku, Hawaii, leaked
50,000 gallons into the Maui harbor;⁵ in 2007, a ruptured tank at a feed store in Bedford, Indiana,
dumped 1,500 gallons of sticky goo into surrounding streets;⁶ and in 2008, hundreds of gallons
spilled in Oregon stopped traffic on Highway 395 for hours.⁷ While these incidents are messy
and inconvenient, they pale in comparison to what happened in Boston in 1919, a catastrophe
lost in the dusky haze of history, or the 1998 disaster at a sugar mill in Mexico, which devastated
an environmentally sensitive area.

Boston Molasses Flood of 1919

January 15, 1919 dawned bright and clear in Boston. In the bustling, mostly Italian North End,
home to docks and related facilities, a trainyard, and some 28,000 immigrants, Bostonians went
about their business, cheerful in the atypical warm weather. By noon, the temperature had risen
to over 40°F, definitely an unusual winter day: just one day before, it had been a mere 2°F.⁸
But in 45 minutes, the North End, teeming with people, horses and carriages, would be flattened
by a molasses tsunami, spewing from a disintegrating storage tank, destroying buildings, people,
and horses alike in a totally preventable disaster.

In the early years of the twentieth century, the Purity Distilling Company, a subsidiary of US
Industrial Alcohol,⁹ processed molasses into distilled alcohol for a domestic rum-drinking market
and for the munitions industry. Business had been booming in both areas, the latter due to US
involvement in World War I. The inevitable end of the war, however, meant a decrease in
armaments production, which affected profits for alcohol distillers. A diminished domestic
market was also predicted, due to the imminent ratification of the 18th amendment: USIA, in an
effort to increase profits, ramped up for a major production escalation in the years immediately
preceding Prohibition.¹⁰ But to do so required an increase in storage facilities for the molasses
required for distillation.
Thinking ahead to leaner times, Purity Distilling began construction of an enormous storage tank in 1915, capable of holding 2.5 million gallons of molasses, on Commercial Street, in Boston’s North End waterfront area. The location was convenient for Purity, because of its proximity to the trainyard, but controversial, since that area was Boston’s most densely populated. However, due to the “political impotence” of the immigrant residents, the deal went through.\textsuperscript{11}

Construction was plagued from the beginning by a series of delays: the death of a worker, a superstorm which blew through the Northeast, and a lengthy testing protocol, which consisted of filling the completed tank with water to detect leaks, a process that would take weeks. No building plans were filed by contractor Hammond Iron Works, because the tank was considered to be a “receptacle,” rather than a building, although a permit was required for the foundation. Completion of the structure was rushed, and, circumventing the testing protocol, Purity manager Arthur Jell had only 6 inches of water pumped into the tank. When no leaks materialized, he pronounced it “sound.”\textsuperscript{12}

At 50 feet tall, 90 feet wide, and 240 feet in circumference, the charcoal-grey tank dominated its surroundings, towering over the elevated railway, the three-story fire station, and the rickety tenements that housed the area’s immigrant population. Two days after completion, a Cuban tanker unloaded 700,000 gallons of molasses. Workers immediately noticed leaks at the seams and an ominous rumbling from deep within, “the low growl of an angry animal,” as worker Isaac Gonzales described it. Neighborhood residents would collect the molasses in buckets and bring it home for domestic uses. By 1918, the leaks became so pronounced that the owners painted the tank brown, in an effort to disguise the problem, and caulked the seams.\textsuperscript{12} Both Purity workers and residents complained about the leaks and noises, but owners turned a deaf ear.\textsuperscript{13}

In January 1919, a tanker pumped 1.3 million gallons into the tank, nearly filling it, for a total weight of 26 million pounds. The warm new load mixed with colder molasses already in the tank, resulting in a fermentation process that produced gas, stressing the sides of the steel tank.\textsuperscript{12} At 12:40 p.m., on January 15, the added stress literally blew out the sides of the tank and molasses spewed in all directions. The two-story, 160 foot wide tidal wave, moving at an estimated 35 miles per hour, destroyed everything in its path: buildings, animals, and people. The thousands of rivets holding the steel plates together spit out like bullets, and one-ton plate sliced through a column supporting the elevated railway, while another two-ton section landed in a nearby park.\textsuperscript{12} The collapse happened so suddenly, announced only by “a dull, muffled roar,”\textsuperscript{9} that escape was virtually impossible. Later, witnesses would describe the sounds emanating from the tank immediately preceding the collapse as “someone . . . on the inside hammering, trying to get out.”\textsuperscript{10}

Residents at home or at work were caught in the deluge: the suffocating goo lodged in their mouths, and its quicksand-like properties pulled them down and under. Children collecting firewood near the tank were whisked away, and firemen inside their station were trapped when the floors pancaked. All over the affected area, trapped horses were wallowing and thrashing, screeching in panic, their eyes wild with fear. Some buildings splintered into matchsticks or disintegrated like “pasteboard”;\textsuperscript{14} others were torn off their foundations or hurled into the harbor.
In five short minutes, an area of several city blocks was virtually destroyed, while streets further away from the tank were covered with two to three feet of molasses. 

Rescue efforts began immediately, punctuated by gunshots as horses were put out of their misery. When the toll was announced several days later, 21 lay dead, an additional 150 were injured, and scores of horses were shot. The North End lay in ruins, and Boston’s harbor was stained brown, for the second time in 150 years.

A few months after the incident, Purity closed its Massachusetts operations and fired all workers. Families affected by the flood filed some 119 lawsuits against USIA, which were eventually merged into one class action suit in 1920, one of the largest ever in Massachusetts. Prosecution arguments were creative, to say the least: Henry Dolan, a prominent Boston attorney, spoke favorably of USIA, declaring that the tank had been inspected “minutes” before the collapse, when, in fact, there had never been an inspection of anything but the foundation, and tried to blame the collapse on recent anarchist activity: “The company contends that there was no structural weakness, but we do venture the opinion that something from the outside opened up the tank.”

After five years of legal wangling, Judge Hugh Ogden announced the verdict in April 1925, with USIA held liable for the explosion and responsible for $300,000 in damages, or about $30 million in contemporary dollars. Families who lost loved ones received about $6,000 apiece; damages awarded those who were injured varied, according to the severity of the injury.

**Ingenio Melchor Ocampo Sugar Mill**

Sugar cane and its by-products have long been an economic staple in the Ayuquila-Armería River Basin, an enormous area that crosses the states of Jalisco and Colima in west central Mexico. The basin is an environmentally sensitive area, home to a number of native and threatened species, as well as five protected areas. Two dams on the river provide irrigation water for farms downstream, and the entire basin abuts the Sierra de Manantlán Biosphere.

Perched by the river is a sugar cane refinery, the Ingenio Melchor Campo (IMO). The mill itself employs about 300 local workers, more than 10% of sugar cane-related employment in the area. In addition, during the height of harvest, it employs some 1,200 seasonal workers. In 1998, a tank rupture at the refinery caused a 100-ton release of molasses in the Ayuquila River, resulting in a death zone for aquatic fauna nearly 100 kilometers long.

The mill had long been discharging a variety of wastes, including lye used for cleaning the machinery, into the river; discharge was at its highest during November through June, when the refinery was most active. According to Luis Manuel Martinez, watershed research coordinator at the University of Guadalajara, the discharge was a toxic stew of three different pollutants: runoff from sugar cane washing, “process waste,” and sewage. Before harvest, sugar cane fields are burned, and the harvested canes must be washed free of dust and ashes before processing can begin. “Process waste” consists of debris resulting from refining the cane into sugar. The molasses by-product is diverted to two large storage tanks. The effluent, rich in organics, combined with more raw sewage from upstream communities and depleted the river’s oxygen,
vital for aquatic life. The discharge was deadly to fish and crustaceans, but levels returned to normal when mill activity dropped off.\textsuperscript{18}

Operating since 1972, the mill has a history of friction with local inhabitants, some 70\% of whom depend on agriculture. Most communities downstream are considered “marginal,” economically disadvantaged with a lack of electricity and sewer facilities. Since the mill discharge directly affected the local fishing industry, residents were rightly concerned.\textsuperscript{19}

At 9:15 in the morning of March 20, 1998, two researchers from the Manantlán Institute of Ecology and Conservation of Biodiversity were conducting monthly water monitoring when they noticed a brown discharge into the river, distinctly different from the usual. The amount indicated a major release of molasses. One of the storage tanks at the mill had ruptured.\textsuperscript{19}

The cause of the spill is straightforward, although technical details are lacking. The company was storing the molasses due to low demand and “in expectations of better prices in the future.” The amount, however, exceeded mandated safety levels, and one tank ruptured and overflowed, flooding the refining facilities and flowing into the Ayuquila River. For 10 hours the molasses oozed down the river at 1 km per hour, further depleting water oxygen levels: prior to the spill, the biochemical oxygen demand, a standard measure of water vitality, was 7 mg/liter; after the spill, it measured .5 mg/liter, a level incompatible with aquatic life.\textsuperscript{19}

After the spill, the mill was fined an undisclosed sum and partially closed as a result of peasant farmers staging several demonstrations threatening to destroy the facility,\textsuperscript{19} which pressured government agencies to take action. In addition to restoration mitigation, a major sanction forced the company to eliminate discharge into the river.\textsuperscript{16} Instead of dumping directly into the river, IMO would divert effluent into canals, relying on crop action to clean the discharge to acceptable levels.\textsuperscript{18}

IMO also signed a number of agreements regarding mitigation, with two local agencies serving as liaison. While some of these arrangements date to 1994, prior to the molasses incident, IMO reneged on its responsibilities, causing local inhabitants to threaten burning the cane fields and blocking access to the refinery. When the 1998 spill occurred, residents renewed their confrontational stance, and IMO agreed to change its discharge system. Water quality immediately improved; however, reports indicate that the refinery still discharges into the river when water shortages occur.\textsuperscript{18}

\textbf{Using the Cases}

Creative faculty can devise a number of classroom exercises based on these cases. They are most useful for small group discussions: students can identify and explore ethical issues (see following section) or examine international dimensions, such as discrimination against immigrants or cross-registration of professional engineers.

Students can also analyze these cases in light of professional codes of conduct, which serves two purposes: to look at earlier engineering codes and to discover that the codes are really not applicable in these particular cases, thus shattering the illusion that more strict adherence to codes may be a panacea for engineering mishaps.
Students are always surprised to learn that engineering codes prior to 1947 do not include a clause about safeguarding the public safety, health, and welfare. Instead, they focus on relationships between engineers, their employers, and clients. The general public is simply not an issue. More applicable to the Boston case is a discussion of contemporary building codes and why such large storage containers were not considered to be structures and hence did not require engineering expertise for design and maintenance.

Likewise, in the IMO case, the NSPE code is not applicable, although Mexican engineers can cross-register professional status in the state of Texas and the code is thus applicable across international boundaries. The actual problem with the storage tank was not engineering-oriented but rather a bad management decision to hold more molasses than the tank was designed to store. The engineering problem was an environmental one, so an examination of sustainability issues is appropriate.

Finally, in courses that require a term project or other major research component, these cases offer fertile ground for critical thinking. The Boston molasses flood, for example, is often treated as a joke on Internet websites focusing on bizarre ways that people die. Distinguishing fact from fiction requires students to develop and exercise advanced skills for determining the accuracy of Internet information. In the IMO case, just ferreting out information requires that students extend their research capabilities beyond a shotgun Google sweep and learn how to use the professional databases.

**Ethical Issues**

Both of these cases raise multiple ethical issues; those of the Boston incident are more apparent, due to the amount of accessible research material. With the IMO case, data are still forthcoming. However, it is clear from the information available, that there are certainly common traits, ethically speaking, between two incidents separated by 80 years.

*Lying*

Lying constitutes a breach of trust by the liar, and when corporations are involved, the faith of the public may be shattered. In both of these cases, corporate representatives either flat-out lied or, at the very least, misled those directly affected by the events.

There is no question that USIA officials lied, both in their comments directly following the tank rupture, as well as during the court proceedings. They consistently maintained that the “receptacle” was strong enough to hold 2.5 million gallons of molasses and that the explosion was the result of anarchist activity in the area. While it is true that some 40 buildings in Boston were damaged by anarchists, the tank explosion certainly was not the result of outside activity. Moreover, Purity manager Arthur Jell admitted in his testimony that the company sought no engineering expertise and that Hammond Steel, the construction company, had used plates some 10% thinner than indicated in the specifications submitted to the city of Boston for building permits. And there was a significant problem with plate-hole alignment at the seams, which
required insertion of “drift pins,” slender steel shafts used to realign mismatched holes.  

Hence the leaking noticed by residents and workers alike.

IMO officials misled the cane growers and workers of the region when it promised that crop action would cleanse the river water of the refinery’s discharge. In fact, while the company no longer discharges directly into the river and uses irrigation canals instead, the water still contains harmful levels of coliforms and oils. Local cane producers, such as Gabriel Garcia, are concerned about the effects of such harmful bacteria and have refused to accept the irrigation water.  

IMO environmental quality control officer, Guadalupe Nava, notes that tests indicate “no harmful” effects, but admits the presence of “slight organics.” Given the history of the mill’s environmental damage to the area and its reluctance to make good on agreements, one can understand the growers’ skepticism.

Responsibility

Both of the companies involved are illustrations of Milton Friedman’s questionable dictum that “there is one and only one social responsibility of business--to use its resources and engage in activities designed to increase its profits . . . .”  

In Boston, USIA reneged on its moral responsibility to the public in two ways. First, by placing such an enormous tank within spitting distance of a congested neighborhood, it was deliberately endangering the lives and livelihoods of nearby residents. Secondly, the company never sought an engineering opinion in regards to tank construction. While inspection was not required by city building codes for receptacles, the fact that USIA never once consulted an engineer during construction is, at least in the opinion of Stephen Puleo, who has written the only definitive book on this event, decidedly negligent. The word “responsibility” was apparently not in USIA’s vocabulary; the company focused on profit, to the detriment of area residents.

The Mexican spill also reflects a sense of irresponsibility; although this case does not involve loss of human life, the 1998 spill was catastrophic to the local environment: for 30 kilometers downstream, all aquatic life died, most significantly the fish and river shrimp that are a dietary staple of the region; for another 70 kilometers downstream, most aquatic life died. While this incident is the most dramatic example of the mill’s derogatory effect on the environment, for 26 years IMO had been regularly poisoning the river for seven months every year by discharging oxygen-depleting wastes lethal to river life.

“Professional moral responsibility,” writes Sal Restivo, compiler of the recent science, technology, and society encyclopedia, “is forward-looking and shared. Moral responsibility wishes consider how to improve future behavior, not just evaluate past behavior. . . .” Furthermore, he notes, it is shared, collective. Rather than acting altruistically, both USIA and IMO were focused on increasing corporate profit.

Justice
When accidents such as these happen, it is not uncommon that those most affected belong to the impoverished classes, and these cases are no exception. Clearly, both of these events violated the ethical principle of justice; that is, providing for equity.

Those most severely impacted by the Boston molasses spill were the Italian immigrants who populated the North End. Politically, they lacked the influence to fight the location of the tank in 1915, despite their numbers.\textsuperscript{11} Most were not yet citizens, and, as we know from other domestic industrial incidents in the early days of the twentieth century, such as New York’s Triangle Shirtwaist Fire of 1911, which resulted in over 100 young immigrant women losing their lives, immigrants were generally considered to be expendable. In Boston, 21 lost their lives, scores of horses died, and residences, in addition to businesses, were swept away. It is inconceivable that the tank would have been built in a more affluent part of the city; residents would surely have protested against USIA in a way that new immigrants are either unwilling or unable to do.

The communities downstream from the IMO sugar mill took the brunt of the spill, communities which were poorer than Boston’s North End, and equally ineffectual, politically. Living conditions are marginal, with “high illiteracy, minimal years of education, poor communication and sewage systems, and no access to medical services despite a high occurrence of gastrointestinal disorders.”\textsuperscript{18} As a direct result of the spill, fishermen lost their livelihoods for several years, and cane growers still express concern about the bacteria resident in the somewhat sanitized discharge from the refinery. The pollution-spawned diseases affecting humans also plague cattle, resulting in an increased abortion rate, further impacting the economy of the region.\textsuperscript{18}

Both cases aptly illustrate the abuses of corporate power and economic exploitation. Both USIA and IMO took advantage of the uneducated poor in locating their facilities, and both turned deaf ears to local residents’ complaints and concerns, putting profits ahead of community interests. And, since both companies were major employers in their respective areas, workers were, in a sense, held hostage to corporate bottom line considerations.

Conclusions

This year marks the 90th anniversary of the Great Boston Molasses Flood and the 11th for the IMO spill. Curiously, both of these incidents are relatively unknown to a contemporary audience and probably little discussed in ethics curricula. However, both offer fertile ground for examination, and both are especially effective for instructors using an “ethics across the curriculum” approach, which limits the type of cases suitable for the classroom.

And, of course, the common factors in these two events leads students to the sad conclusion that history does indeed repeat itself. Even though we pretend that we learn from the past, we are more like gerbils in a cage, rather than eagles soaring upwards. Hegel was right: “We learn from history that we do not learn from history.”
References


