Hyatt Regency Walkway Collapse Case Study

Abstract:
On July 17th, 1981, at Kansas City Hyatt Regency, two suspended walkways in the atrium lobby collapsed resulting in hundred of deaths and serious injuries. The two walkways failed because the constructed beam connections on the walkways were different from the initially planned design. Insufficient communication between the consulting engineering firm and fabricator led to the unfortunate situation where neither party performed any engineering analysis on the constructed design. In addition, the owner failed to supervise the consulting engineering firms and contractors to ensure the safety of the building. The tragedy could have been prevented if all the parties had applied the following ethical frameworks: virtue ethics and utilitarianism. Then they would have foresaw the tragedy. Civil engineering students and professionals in the construction industry reading can learn both technical and ethical lessons from the case study to help them to prevent a similar tragedy.

Engineers have a great responsibility to ensure their decisions and works are technically and ethically correct in order to protect the public safety and property. Careful engineering is the foundation of elegant design. Elegant design is usually very high-risk because mistakes can be easily made without extra caution. For example, a suspended walkway in a building serves as a bridge as well as creates the illusion of walking on the air, but it requires superior and careful engineering to ensure the quality of the walkway. On July 17th, 1981, at Kansas City Hyatt Regency, the fourth floor walkway collapsed onto the second floor walkway during a tea dance in the atrium lobby resulting in 114 deaths and 200 additional injuries (Morin and Fischer, 2006). Studies and investigators pointed out that the lack of communication between the engineering firm and steel fabricator ultimately led to this accident. This tragedy was completely preventable if the engineers and fabricator had made their decisions based on the safety of the public and ethical frameworks rather than the benefits of saving time and costs.

After one year of business of the Hyatt Regency Hotel at Kansas City, on the evening of July 17th, 1981, 1500 to 2000 dancers gathered at the atrium enjoying regular "tea dances," a local tradition since the hotel opened. About fifty people were standing on the fourth story skywalk, and a hundred on the second story skywalk looking down into the lobby and two hundred people underneath the second story skywalk (Staff, 2001). At 7:05 pm, people on the walkways heard a loud crack because of the failure of a double-rod hanger beam connection at the fourth floor walkway. Since the second floor walkway was connected to the fourth floor walkway, both walkways collapsed onto the atrium. Although the emergency rescue team arrived shortly, the sudden collapse still killed 114 people and injured 200 more people. The licenses of all the engineers involved in this project were revoked.

Crown Center Redevelopment Corporation (CCRC), as the owner, introduced the project of Hyatt Regency Hotel in Kansas City Missouri in early 1976. The 40-story building was a part of the urban development and an attractive landmark as the tallest building in the city. Gillum-Calaco, Inc. (G.C.E. International, Inc.), was chosen as the consulting structural engineering firm of the project (The Engineering Library, 2012). However, G.C.E subcontracted the actual designing work to its secondary firm, Jack D. Gillum & Associate, Ltd. Therefore, Jack Gillum, the supervisor of all engineering activities in Jack D. Gillum & Associate, became the Hyatt project's lead engineer. One impressive signature of this building was the spacious and open entrance lobby. The lobby had three elevated walkways from the second to the forth story allowing people to overlook the entrance lobby. In December of 1978, Havens Steel Company, a steel fabricator, entered the contract and agreed to fabricate and erect the atrium steel of the project. Havens Steel then requested G.C.E to change the design from the single to double-rod hanger beam connection at the fourth floor walkways due to impracticality of the single rod design. However, Havens Steel and G.C.E only discussed this change in the phone informally (Texas A&M University, 2009). Eventually, the project engineer in G.C.E approved the change without performing any engineering analysis and notifying Jack Gillum, so Havens Steel fabricated the beam connections at the fourth floor walkways according to the approved questionable design, resulting in the collapse of the two walkways.

After the tragedy, the National Bureau of Standards (NBS) investigation team confirmed that the reason for the collapse was that one of the connections supporting the fourth floor walkway broke (Morin and Fischer, 2006). NBS concluded the walkway "had only minimal capacity to resist their own weight" (Montgomery, 2001). NBS found only the blueprint of the initial design in the plans submitted to the Kansas City Hall. There was no official record indicating the change of the design. In the initial design, the second and the forth story walkways were supported by a continuous steel rod attached to the roof truss above and held in place by nuts. Thus, each beam connection only carries the load from a single walkway. However, Havens Steel found the design was impractical because it was impossible for them to build such a long rod, so Havens Steel suggested using a double hanger rod box beam connection instead of a single hanger rod connection. Figure 1 showed the planned drawing as well as the failed connection. The modified design increased the "punching" effect of the upper supporting rod significantly. "Punching" is the phenomenon where the upper supporting rod tears through the box-beam, which was clearly shown in Figure 2, the photo of the failed connection taken by the investigators. The picture showed that the box beam was completely punched through while the nut and washer at the lower threaded end of a support rod was still in place. This effect happened because the modified design doubled the required capacity of the connections. Reinforcement such as adding a bearing pad between the beam and nuts (shown in Figure 3) or changing the halo beam design to a back-to-back channel design (shown in Figure 4) was required to achieve the doubled capacity, but the built design did not apply any possible reinforcement methods.

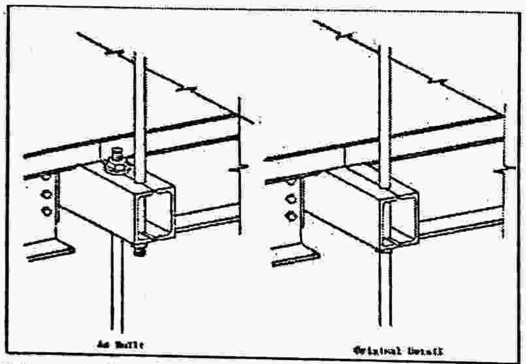

Figure 1. The original and built design of the beam connection

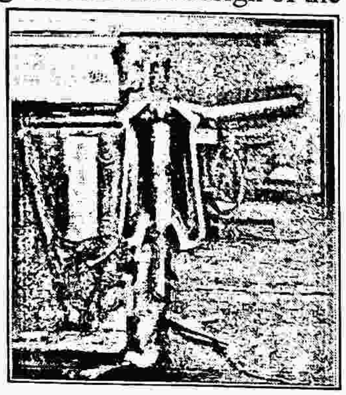

Figure 2. End view of the box beam

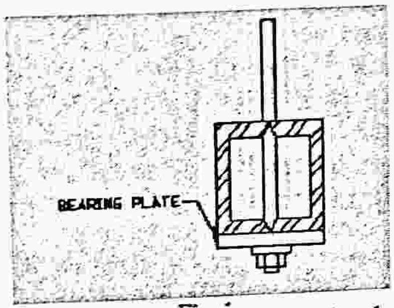

Figure 3. Adding bearing plate under the beam

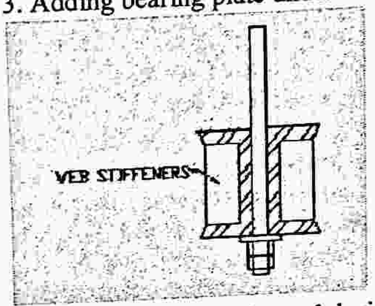

Figure 4. Back-to-back channel design

The primary cause of the mentioned technical issues was only the miscommunication between G.C.E and Havens Steel. The structural engineers of G.C.E failed to communicate with Havens Steel effectively regarding the responsibility of designing the connection. Jack Gillum, stated, "Any first-year engineering student could figure [the mistake of the modified design] out" (Montgomery, 2001). Yet, the modified design submitted by Havens Steel had never been checked in detail by any party because of the confusion regarding the responsibility for each party. On the one hand, the responsible project engineer in G.C.E assumed Havens Steel came up with the modified design of the connections based on the calculations using the correct load capacity. On the other hand, Havens Steel found another subcontractor to design the connections expecting that the subcontractor also did the appropriate engineering analysis. However, the subcontractor only imitated the design using an easier method without being concerned about the actual load capacity. This serious miscommunication happened because G.C.E played the political game, but did not recognize its own responsibility, as the assigned consulting structural engineering firm, to guarantee the quality of all designs. G.C.E tried to shift the blame onto Havens Steels during the court hearing and claimed they never received any phone call from Havens Steel because this change had only been talked about informally between the G.C.E project engineer and Havens Steel (Santa Clara University, 2010). However, it was G.C.E's fault undoubtedly since Havens Steel was only responsible for fabricating the connections based on the approved drawings. The G.C.E project engineer did not recognize his responsibility of confirming the accuracy of the changed design as well as notifying the management team, but approved the changed design mysteriously and quietly. Therefore, Havens Steel assumed the "approved" designs were sufficient and fabricated the connections accordingly. As a result, no one realized the flaw of the double rod hanger connections.

In addition, CCRC was at fault because CCRC overlooked the important details that would have prevented the tragedy and put a lot of pressure onto G.C.E. This project was being built as a "fast track" project. "Fast track" project means when one part of the hotel is being built, other sections are still being designed. In such a fast-paced environment, it is difficult to keep track of all the details (Morin and Fischer, 2006). On October 14, 1979, after the change of the design of the walkway, part of the atrium roof collapsed during the construction of the hotel (The Engineering Library, 2012). This accident should have warned the engineers indicating mistakes had been made. CCRC hired an independent engineering firm, Seiden-Page, to investigate the incident and submit the investigation report to G.C.E. Jack Gillum promised that he would ensure the safety of all steel connections in the structure, so he requested on-site project representation during the construction phase as well as to monitor the fabrication process to ensure the quality. However, CCRC neglected Jack Gillum's requests and insisted the building was safe, so it refused further necessary actions because CCRC did not want to incur additional costs of on-site inspection. In addition, CCRC did not want to waste any time on the incident since the project had already fallen behind the schedule. Therefore, G.C.E did not have enough information and time to investigate the collapse completely. If not for CCRC's pressure, Jack Gillum would have been able to go through all drawings of the walkways and discover the connections of the fourth floor walkway that were modified without his approval.

The miscommunication and oversight could have been avoided if virtue ethics and utilitarianism were applied during the decision making process. These two frameworks are the most relevant to apply in this tragedy. Firstly, virtue ethics is an ethical theory that focuses on the nature of the acting person. This theory indicates which good or desirable characteristics people should have or develop to be moral. The most important virtue that the engineers should have is responsibility in the sense that they should always make decisions that protect the safety of the public. Secondly, utilitarianism focuses on the consequences of actions. Actions are judged by the amount of pleasure and pain they bring about. In other words, an individual should choose the actions that bring the greatest happiness for the greatest number of people. Engineers need to make decision that protect the safety of the public, so they should also have the ability to, for example, weigh the consequences of not checking the design against saving money and time. If they had made such a comparison, they would have performed the engineering analysis on the changed design.

All the engineers involved in this incident were irresponsible towards their professional duty. Responsibility is one of the most important virtues for engineers because People's lives are relying on engineers' decisions. Engineers take short cuts easily due to the influence of the project owners' pressure, time restrictions, etc. Without recognizing their responsibility, engineers tend to think that no one will realize that they cut corners as long as accidents do not happen. The reason the structural engineers in G.C.E did not design the walkway connections according to the Kansas City Building Code was because they assumed that there would not be so many people standing on the walkways. NBS pointed out that even though the connection was never modified, the initial connection could only support 90 kN, which was only 60% of the ultimate capacity required by the Kansas City Building Code (Martin, 2014). If the engineers designed the connections correctly, a complete collapse would have been prevented. In fact, from the first day that G.C.E agreed to take care of all the structural engineering of the project, G.C.E had the responsibility to make sure all the designs they established were based on concrete engineering analysis. G.C.E failed to fulfill the contract with CCRC as well as its professional duty. Jack Gillum admitted that he never saw the modified drawing because he again assumed engineers in his engineering firm would check everything for which they were responsible (Montgomery, 2011). Even though Jack Gillum did not acknowledge the change of the design, it was still the project engineer's duty to ensure the correctness of Havens Steel's proposed solution. The project engineer just skimmed through the suggested drawings "from the stand point of whether the two offset rod loads would introduce a span-wise bending problem for the box beam" and approved the change informally without identifying the lack of the supporting capacity decreased significantly (Morin and Fischer, 2006). Engineers Professional Code clearly stated that the engineers' duty is to "hold paramount the safety, health and welfare of the public"(National Society of Professional Engineers). However, Jack Gillum and the G.C.E project engineer completely ignored about the responsibility for the contract, or for their professional duty. Jack Gillum and the project engineer were probably taking care of many other things in addition to the change of the connection simultaneously, leading them to neglect their responsibility. In addition, even though CCRC did not listened to the G.C.E's requests to do the on-site inspections after the first collapse, G.C.E should have persuaded CCRC to either accept their requests or find another solutions because again it was G.C.E's responsibility to use their engineering knowledge to protect the public safety. Therefore, in this tragedy, G.C.E completely failed to take the responsibility to ensure the sufficiency of the buildings resulting serious injuries and deaths.

Moreover, if the engineers and management team had thought about utilitarianism in the sense that the consequences of their ignorance of the correctness of the designs caused the collapse of the walkways, they would have checked the design before constructing or fabricating the inefficient designs. CCRC only tried to save the cost and time so that they could open the hotel on time. However, they failed to recognize that their reputation completely bankrupted because of the collapse of walkways. It was difficult for CCRC to regain people's trust after the tragedy. People would not work with them or visit their hotels anymore because people would think that CCRC's other or future projects were as dangerous as the Hyatt Regency hotel. In addition, the city hall would not approve CCRC's projects so easily because the city hall assumed there would be high possibilities for CCRC to take shortcuts again. Therefore, if CCRC had recognized the negative consequences, CCRC would respect G.C.E's requests and give enough time for G.C.E to come up sufficient designs.

G.C.E also only cared about their short-term benefits. G.C.E saved the time and made CCRC happy by not checking the calculations of the modified design and allowing CCRC to continue the construction process. All the engineers, including Jack Gillum, lost their licenses because of the tragedy. Jack Gillum not only could never be a structural engineer anymore, but also suffered from self-blaming of his negligence of causing hundreds of deaths for the rest of his life. If he had thought about all negative consequences, he would have insisted for the on-site inspection and designed the connections according to the Building Code. Therefore, both G.C.E and CCRC were blinded by the short-term benefits, and thus failed to foresee the serious consequences of their unethical decisions.

Therefore, this disaster could have been avoided if the consulting firm, owner, fabricator and contractor had made decisions based on the virtue ethics and utilitarianism. According to the virtue ethics, the engineers in G.C.E should have been followed their professional duty to design the building based on the Kansas City Building Code. Since this was a "fast track" project, the project engineer in G.C.E and Haven Steels could have established an efficient way to communicate instead of playing a political game by expecting the other had the responsibility to perform the engineering analysis. They should have talked about the responsibility of the beam connection design explicitly from the first day of Havens Steel entered into the contract. It not only saved the time on guessing, but also ensured the safety of the design. Because of the improvement of technologies, the communication between parties becomes more efficient. Calculations and changes can be performed and recorded by computer models easily, so that engineers can modify and confirm the design effortlessly. Consulting firm and fabricator can know exactly what the other party changes, preventing excuses of not recognizing the changes. It is also very easy to distribute electronic files to different parties to ensure the transparency of the projects.

Moreover, CCRC should require all parties to record all the changes officially so that people involved in this project acknowledged the changes and increased the probability of recognizing potential issues. CCRC should keep a copy of all versions of the blueprints and calculations to ensure the responsible parties following up all the necessary changes. CCRC should require G.C.E to come up a time line of investigation after the first collapse as well as an accurate estimation of on-site inspections, so that CCRC could reduce the unnecessary costs, but still address the issue.

Professional organization, such as American Society of Civil Engineering and American Institute of Steel Construction (AISC), and government also should provide more specific guidelines and regulations to prevent miscommunication. AISC revised *the Code of Standard Practice* providing a "framework for a common understanding of acceptable standards when contracting for structural steel construction" after this incident on 1986 (Charles and Fischer, 2006). In addition, government can enforce consulting engineering firms to submit necessary calculations and drawings so that the government can review the calculations to ensure that the designs at least meet the requirement of the city building code. Governments can also request more on-site inspections for fast track projects like the Hyatt Regency to prevent contractors and owners cutting corners. Therefore, it requires all parties to think about the virtue of protecting the safety of the public and to weigh the consequences of various actions in order to prevent similar disasters.

In conclusion, the collapse of the walkways could absolutely be avoided. This tragedy demonstrates good communication between designers, contractors and fabricator is necessary to prevent occurrence of mistakes especially in fast track projects. In addition, each party should keep in mind the importance of moral virtues at all time, so benefits, especially, time and costs, would not blind their visions predicting any possible accidents to ensure the safety of the public. In this tragedy, engineers overlooked their reasonability and failed to foresee the serious consequences of their actions resulting in neglecting the public safety and making unethical decisions. To prevent similar tragedies, engineers have to recognize their professional duty and responsibility that their decisions can affect hundreds of lives, so that they will make decisions appropriately based on their engineering knowledge. Project owners should ensure effective communication between different parties by requiring official records for changes and necessary documents. Lastly, government and public organization should provide more specific details in their guidelines and regulations. It is an extremely important lesson for the construction industry that a "simple mistake" can lead to such a serious design because of insufficient communication between parties. Therefore, the construction industry should commit themselves on ensuring good communication and perform ethically regarding the safety of the public so that such a catastrophe would not happen anymore.

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Ethical Case Study: The 1976 Seveso Disaster

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October 26, 2016

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Abstract

Safety in chemical manufacturing is paramount and steps are continuously made to improve methods and regulations in coordination with ethical standards. In Seveso, Italy in 1976, there was a failure in a chemical reactor, causing a possibly hazardous dioxin to be released into the area. An inadequate amount of precautions were taken in the design of the reactor including a lack of backup systems and ways to monitor reactor temperature. This led directly to the disaster. Additionally, the company responsible failed to notify local residents about the chemical exposure until 10 days after the reactor failed, increasing the negative impacts. Looking through an ethical framework of deontology, it is clear that actions before and after the disaster were ethically wrong. They failed the universality principle because they didn't follow universal maxims about safety and their actions cannot be applied universally. Additionally, their actions failed the reciprocity principle because they encroached on the moral autonomy of the local citizens, violating their rights to safety and privacy. To prevent this disaster, the responsible parties should have taken additional precautionary measures and should have notified the public sooner. In the future, more regulation should be put in place to control safety measures, increase oversight, and regulate the ways to communication with the public. In response to this disaster, the European Union has implemented the Seveso Directive,

which deals with many of the problems in the Seveso plant. However, chemical disasters still occur and we must continue to increase safety measures.

Problem Statement

Chemical manufacturing is an important aspect of our modern world from plastics to fertilizers and prescription drugs. However, there are hazards involved in manufacturing and disasters have happened. In 1976, a chemical plant near Seveso, Italy released a cloud of possibly hazardous particles including a dioxin. The failure was caused by ethical lapses in the monitoring of the plant and the impact of the disaster was worsened by a failure to immediately notify and evacuate exposed individuals. It is important to study and learn from the Seveso incident to prevent this type of disaster from happening again. A larger failure in a chemical plant could cause more widespread and intense consequences. Additionally, public trust is eroded when incidents occur and it's important that the people near chemical plants feel safe. To prevent future disasters like the one in Seveso, there should be stronger legislation concerning safety measures in manufacturing chemicals and proper steps to take following an incident that may have exposed the public to potentially dangerous substances.

Background

In 1976, a chemical manufacturing plant near Seveso, Italy had a reactor failure, exposing a large population to possibly dangerous levels of dioxin. Since 1970, the plant, owned by ICMESA under a company called Givaudan, which was a subsidiary of Hoffman-La Roche, had been producing 2, 4, 5-tricholorophenol (TCP). TCP was then used as a component in the manufacture of hexachlorophene, an antiseptic agent. A by-product of the reaction to make TCP, shown in figure 1, was TCDD ((2,3,7,8-tetrachlorodibenzodioxin) (Homberger, et al., 1979). Creating TCDD was unavoidable in the batch reaction especially at temperatures over 180°c but it was only created in trace amounts under normal conditions (Hay, 1979).

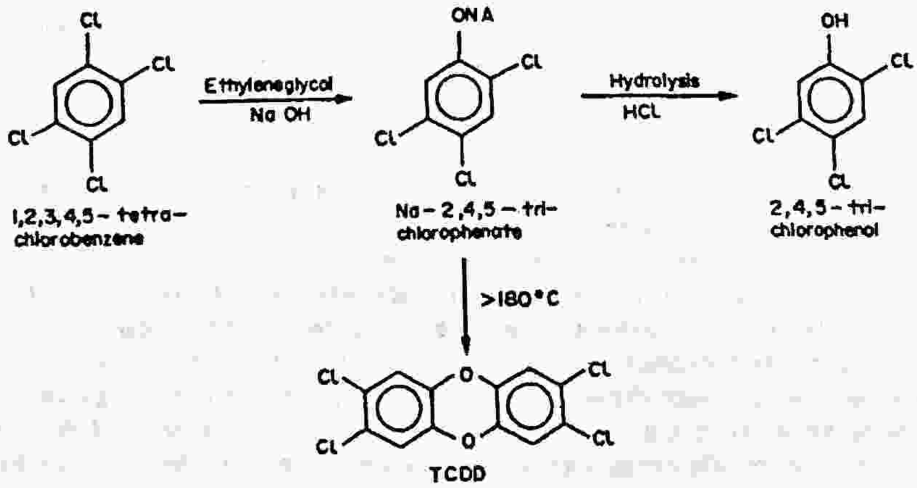

Figure 1: Key reaction used in the Seveso plant to make TCP. The dioxin TCDD is also created in a side reaction. (Homberger, et al., 1979)

ICMESA was aware that if the temperature of the reactor reached 230°c an uncontrollable exothermic side reaction would take place and the temperature would continue to rise, creating a significant amount of TCDD. The rising temperature caused by the exothermic reaction might increase the pressure in the tank and cause a failure in the system. Though they were aware if this fact, they did not take necessary precautions to detect whether an increase in temperature was occurring in the tank.

On July 10th 1976, the day of the accident, the condition of the reactor at the end of the run was noted as "unusual" and it was "the first time it had been left in that condition" (Hay, 1979). Unbeknownst to the workers, while the plant was empty, exothermic side reactions they had been warned about occurred, and the safety valve ruptured, spewing chemicals into the air that deposited over approximately fifteen km^2 (Homberger, et al., 1979). Figure 2 shows a map of the effected areas. Reportedly, children were "playing in the snow-like crystals" that fell from the sky, unaware that they were exposing themselves to dangerous substances (Nordheimer, 1983). Amongst the chemicals was the potentially hazardous TCDD and it is currently estimated that 34 kg or more of the substance was released into the countryside (Bertazzi et al., 1998). Though it was over a large area, this amount of dioxin release had never been seen before and even a small amount could due significant harm.

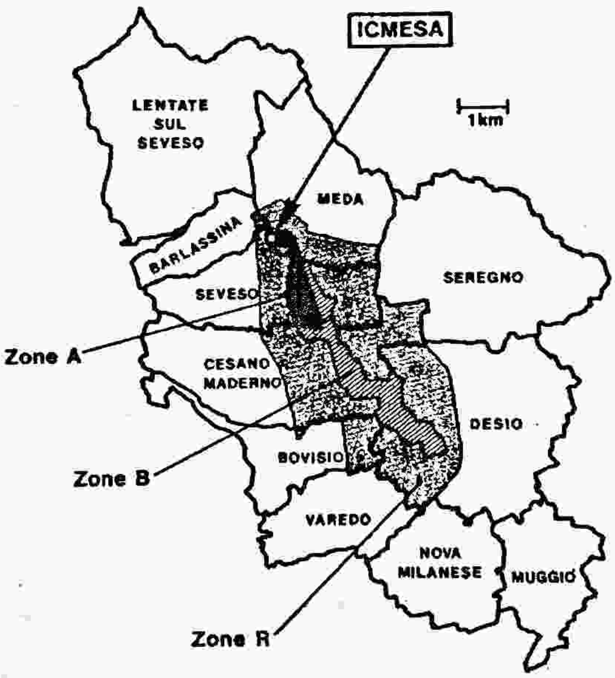

Figure 2: Areas impacted by the fallout from the reactor failure. Zone A was the most exposed, followed by Zone B, then Zone R. (Bertazzi, 1991)

The effects of the chemical exposure were seen immediately. 4% of domestic animals in contaminated zones died spontaneously and the rest of the animals were slaughtered to prevent food chain contamination (Homberger, et al., 1979). Approximately 200 cases of choloracne, a skin disease caused by exposure to dioxin, were reported mostly among children in the area (Bertazzi et al., 1998). Despite these dangerous effects, the residents of Seveso and the surrounding areas were not made aware of their possible exposure to dioxin until ten days after the plant failure. When they were finally notified, approximately 700 people were evacuated from Zone A (Bertazzi, 1991). Little was known at the time about the impacts of dioxin but it had been shown to be dangerous for animals and was demonstrated as a carcinogen in lab research (Bertazzi et al., 1998). ICMESA was negligent in not informing the citizens.

Today, there remain questions about the long-term impact of the dioxin exposure. There has been an increase rate in some types of cancers but not an increase in overall cancer rates. Because of small sample sizes and incomplete historical records, no definite conclusions could be drawn, though it seems that the long-term effects are less severe than originally predicted (Schneider, 1993). However, the psychosocial effects of the incident were significant. Among the residents, there was fear about what the effects might be especially since some scientists claimed that dioxin was "perhaps the most dangerous poison ever to be invented by man" (Eckholm, 1986). Reports claim that up to 100 women in Seveso had abortions for fear of birth defects caused by contamination (Hay, 1979). A review of a movie, which interviews families impacted by the disaster, notes, "what comes through is that the uncertainty itself, and the feeling that officials could not be trusted, caused much of the suffering in Seveso" (Eckholm, 1986). Though the physical impacts of the disaster were minimal, the psychological damage done was irreversible and incurable.

Engineering Failure

The true cause of the accident was largely unknown and debated for a long period of time following the reaction failure. Ultimately, it was concluded that the events occurred during an extended period of reactions and temperature increase. First there was an unexpected build-up of heat in the upper level of the liquid reactor after it was shut down. A slow exothermic reaction began, induced by this heat, causing the temperature to continue to rise. This temperature then led to a series of rapid exothermic reactions that quickly raised the temperature of the reactor even more. As the temperature increased, the pressure increased, and the bursting disk ruptured causing the contents of the reactor to eject into the air (Cardillo, et al., 1984).

Throughout this period of increasing heat, which occurred over seven hours, there were many failures that could have been prevented through proper engineering. First, the initial build up of heat could have been avoided with constant stirring of the reactor. Instead of the heat building up on the surface of the liquid it would have been distributed throughout, evenly heating the entire reactor mixture by a negligible amount. This wasn't the case however, because the plant had to be shut down for the weekend in accordance with Italian law, which left the reactor in an unstable state (Kletz, 1998). Additionally, the number of side reactions that took place in the reactor shows the lack of knowledge in the design of the system. There are two possible scenarios. First, the developers of the plant were unaware of the possible side reactions in which case they should have done additional testing and research to look for conceivable failures. Second, they knew and chose not to put in proper safety features in case a chain of exothermic reactions caused the reactor to overheat. Both cases show negligence on the side of the designers.

As a last line of defense, a catchpot device would have stopped the chemicals from reaching the atmosphere. However, the designers didn't deem it necessary, believing that a runaway wouldn't occur despite the fact that similar situations had happened in other plants (Kletz, 1998). The final mistake was the lack of oversight of the reactor. Since the plant was closed down, there were no workers presents to ensure the safety of the process and check for issues. Additionally, the design of the reactor lacked ways to detect rising temperatures and pressures. The heating was localized to the top layer while the rest of the liquid stayed generally at the initial temperature, and since the reactor was connected to the atmosphere, a standard pressure measure wouldn't have worked (Cardillo, et al., 1984). Still, the problem occurred over a seven-hour period and should have been caught by some safety measure.

Ethical Analysis

One way to look back at a situation and learn more from it is through ethical analysis. This tool places a specific ethical framework on a condition to make sense of the morality. One such framework is deontology, a branch of normative ethics, which strives to tell people how they should act and what choices are best. Deontology judges actions based on a specific set of absolute rules and it does not allow for any exceptions. All choices are either wrong or right based on these rules, independent of the consequences. It doesn't matter what the results were (good or bad) as long as the action followed an absolute moral code.

The two main principles of deontology, which will be used to analyze the Seveso incident, are the universality principle and the reciprocity principle. The universality principle states that one can only act on a maxim if it can apply in all situations. This maxim must be applicable as a universal law that all people agree should be followed. A complication to the universality principle is when multiple conflicting maxims can be assigned to an action. In this case, the most important norm called the self-evident norm takes precedence to the less important one, called the prima facie norm. Picking the self-evident norm can be challenging and is subject to opinion. The second main principle is the reciprocity principle, which emphasizes the importance of personal moral autonomy. Every person has a right to decide his or her own fate, which suggests that people shouldn't be used as means to an end. Deontology, and more specifically, the two moral principles discussed, can be applied to the Seveso accident to determine whether the actions taken by ICMESA were ethically right (Poel, 2011) (Browne, 2016).

Looking at the technical problems that led to the accident, there are several cases where ethical lapses played a role in the disaster. First, the developers of the plant were not aware of all of the side reactions that could take place. They knew some of them but not the ones that started the problem in the reactor. Givaudan, one of the companies that owned the plant, claimed the accident was "unforeseen" (Hay, 1979). These actions fail the universality principle. The company followed the maxim: "It is acceptable to run a reaction without knowing all the possibilities". However, this maxim clearly cannot be universalized. If dangerous reactions were run with no previous knowledge, there would be chemical disasters all the time. More generally, the action fails the true universal maxim: do your research. It is important, ethically, to know all the aspects that could potentially impact a situation, especially one as possibly dangerous as a chemical manufacturing reactor. Though they claim they could not have predicted the accident, careful study would have shown that the incident was possible and preventable.

Another ethical failure was the lack of backup systems in case of emergency. As previously discussed, designers didn't put in a catchpot that would have prevented the chemicals from entering the atmosphere. Even though similar incidents had happened before, developers did not believe it could happen in the Seveso plant (Kletz, 1998). According to the universality principle, this action was unethical because the designers failed to take necessary precautions to prevent a disaster that had happened before. The maxim in this case would be "companies don't need to look to past events for safety guidelines". Again, this fails because it cannot be universally applied. In reality, it is widely said, "those who don't learn from history are doomed to repeat it". It was inevitable that another similar incident would occur because they unethically ignoring the other situations. Ignoring other failures also fails the reciprocity principle because they did not take into account the other people who would be affected. There were many surrounding towns that were impacted by the fallout. Had the designers been thinking of more than just themselves, they would have taken the additional precautions to prevent the chemicals from entering the atmosphere after the failure.

Finally, the improper shut down of the plant goes against the ethical rules of deontology. By law, the plant had to be closed down for the weekend but that does not excuse the action taken (Kletz, 1998). The company acted on the maxim: "always follow the law". This is a universal maxim so at first it seems the company did act ethically but in reality, the universality principle is not satisfied. In this case, there are competing universal maxims so the idea of self-evident and prima facie norms comes in. Here, the maxim "safety first" is the self-evident norm and overrides the prima facie "follow the law". It is important to follow laws but safety is more important. Ideally, the situation should have been handled differently so that both maxims could be followed.

On the social side of the accident, ethical issues in the handling of the situation increased the severity of the consequences. The largest ethical lapse was in the notification of the impacted citizens. Those who were exposed to possibly toxic dioxin weren't informed until 10 days after the incident. At that point, people in the worst area were evacuated though they had already been exposed. This action fails the universality principle because it is universally accepted that people deserve to know if they have been exposed to a potentially dangerous chemical. Similarly, the lack of action fails the reciprocity principle because the people of Seveso should have had the choice of what to do but they weren't told all the necessary information to make an informed decision for their health. They weren't given full personal moral autonomy. Even though the impacts of the fallout turned out not to be fatal, deontological principles do not take consequences into account so the failure to inform the public is ethically wrong according to this framework.

On another side, the actions taken by some scientists and members of the media could be seen as ethical failures. Right after the accident and throughout the decades following it, numerous tests were conducted on the people of Seveso and they were the subjects of great media attention. Through the universality principle, this is wrong because it doesn't follow the maxim: respect other's privacy. The people of Seveso deserved to make their own choices about their situation. Using the reciprocity principle, one can ask what the citizens of Seveso gained from the numerous studies conducted on them? In some ways, they were used as a means, as lab rats to study to impact of dioxin fallout. Though the studies might have yielded crucial research, deontology puts personal choice ahead of the possible good that could be done. Ethical analysis shows vast mishandling of the Seveso disaster with respect to the rights and autonomy of the residents.

Recommendations

In order to prevent the Seveso disaster, several steps should have been taken. First, the plant shouldn't have been shut down before the reactor was finished running. If the reactor were emptied before everyone left, there would have been no chance for this accident to occur. The Italian regulations at the time forced the plant to be shut down for the weekend but that does not justify ignoring safety concerns. It is problematic for the company to go against a law but ethically speaking safety is the most important thing. In the future, the regulation should change to promote the safety of chemical plants above other factors, allowing manufacturers to assess their situations and choose the best course of action.

Second, a catchpot system should have been implemented. With such a system, the chemicals would not have been emitted into the atmosphere but instead, diverted. Ethically, this follows the reciprocity principle which puts others first. The company should have thought about the people that might be impacted by the fallout before deciding not to implement certain safety features. It would cost ICMESA more money but that is a small price to pay compared to the lives of the impacted people. Additionally, the amount of money to fix the reactor and settle lawsuits from those affected was much greater than the initial cost of additional safety features.

Lastly, the public should have been notified immediately after the fall out. Even though they may not have known exactly what chemicals were emitted, it is ethical to inform the public no matter what, if they may have been exposed to something. It is understandable that they may have wanted to avoid panicking the public. It wasn't verified that dioxin had been released right away and the effects of dioxin were largely unknown. Indeed, in the long-term view, the physical impacts have been minimal. However, deontology puts moral autonomy above all else. The families of Seveso deserved to know the possibilities right away.

In response to the disaster, new actions should be taken to prevent a similar situation from happening again. First, there should be more detailed inspections and requirements for chemical manufacturing plants. Plants should be continually checked to make sure all plans are being followed and there are no abnormalities that have not been dealt with. Additionally, this legislation should make it mandatory that there be solutions in place in case a disaster should happen. It may be expensive for plants to comply with these restrictions but ethically speaking, it is important to put the safety of others first. Next, there should be plans about how to properly notify the public following an incident. A formalized chain of information would make it easier and more reliable to get useful information to people who may be affected by a recent disaster. It may take more time to notify the public since multiple layers must be gone through first but this will decrease the chance that the public is unnecessarily panicked. Additionally, according to the reciprocity principle, the public deserves full moral autonomy in making their decisions and must be informed of possible chemical exposure.

Conclusion

The study of the Seveso Disasters has shown how crucial it is to take precautions and research all aspects when dealing with chemical manufacturing. A mistake in just one area can cause massive damage to a plant and terrible consequences to people impacted by its fallout. This is why there must be more oversight in chemical plants. The public deserves to know when they may have been exposed to toxic chemicals whether or not those chemicals are truly devastating. Ethically speaking, individual moral autonomy is paramount.

Since the accident, many steps have been taken to prevent a similar disaster from happening again. In 1982, the European Union adopted the Seveso Directive, which places more regulations on the manufacturing industry. As industry continues to change and develop, the Directive has been amended: once in 1996 and then again in 2012, to include more regulations that both prevent accidents and limit consequence for people and the environment. Around the globe, it has been a model for how to regulate industry. Since the EU's adoption of the Seveso Directive, there has been a low frequency of major accidents (European Commission, 2016). However, even with legislation, disasters still occur. The Bhopal disaster in India in 1984 is considered the world's worst industrial disaster causing more than 15,000 deaths in the years following it (BBC, 2010). We will always continue working to make the chemical manufacturing industry safer through increased regulation and ethical guidelines.

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ENGR 185EW: Holistic Grading Rubric for Writing Assignments

"A" Range: The paper is <u>superior</u>. "A" work uses the assignment as the occasion for a piece of writing compelling enough to engage readers on its own terms. It clearly and logically presents its central argument(s) as well as the significance of its argument(s). Its insights are communicated with enough thoughtfulness and cogency to command readers' respect, if not their assent. It complements its fresh thought by creating a distinctive voice through aptly chosen words and through sentences that are both grammatically accurate and sophisticated. "A" work exhibits ***excellence*** in all of the individual grading criteria; it is far beyond merely adequate.

"B" Range: The paper is <u>good</u>. "B" work meets all of an assignment's expectations with <u>clear competence</u>. Usually lacking "A" work's fresh thought or approach or its compelling development, "B" work nevertheless demonstrates its author's ability to respond intelligently to the assignment's demands, to structure and focus the writing clearly, to select significant details and examples and comment on them effectively, to choose words accurately, and to revise sentences for concision and emphasis. "B" work is ***sufficient*** in all of the individual grading criteria but not extraordinary; it is characterized by very few errors of reasoning or written expression.

"C" Range: The paper is <u>fair</u>. "C" work has a serviceable structure, and provides enough elaboration with appropriate examples or analysis to make its intent understandable. Its sentences are usually grammatically correct and its paragraphs are usually coherent; however, it lacks the focus, development, logic, and/or stylistic precision necessary for a higher grade. "C" work ***meets basic expectations for the assignment***, but there are often problems with the argument, reasoning, structure, and/or writing.

"D": The paper is <u>inadequate</u>. Although "D" work may demonstrate competence in some areas, the paper will exhibit pervasive weaknesses such as: failure to articulate a main argument or to maintain a focus; failure to meaningfully engage an important aspect of the assignment; skimpy or illogical development; repeated and distracting errors in grammar, mechanics, or diction. "D" work exhibits significant problems of coherence in structure, argument, and written expression.

"F": Failing performance. "F" work fails to meet basic expectations for the assignment. "F" work may misunderstand or disregard the assignment's intent. It may be difficult for a reader to detect any pattern of organization and/or it may have enough errors in Standard English sentence mechanics to make it difficult to follow the author's thought. "F" grades can be assigned for un-submitted or incomplete work and also for work that fails to meet an assignment's demands or the minimum standards of university discourse. "F" grades will also be assigned to any papers that contain plagiarized material.

Grading Rubric for Ethical Case Study Postmortem

Rating Scale:

4 = Excellent: *outstanding, inspired* thought and/or communication—far beyond merely adequate.
3 = Good: sufficient in all criteria but not extraordinary; very few errors of reasoning or written expression.
2 = Fair: meets the basic expectations for the assignment, but there are often problems with the argument, reasoning, structure, and/or writing.
1 = Poor: barely meets the most basic expectations for the assignment; shows only a slight semblance of coherence in structure, argument, and written expression.
0 = Completely unacceptable: fails to demonstrate basic expectations for or even understanding of the assignment.

Grading Criteria
Introduction / Thesis • Introduction contains the problem statement and thesis; provides sufficient background material; defines important terms; orients reader to the rest of the paper. • Clearly stated thesis outlines topic focus and ethical argument. • Thesis serves as the controlling idea for the rest of the paper.
Adhered to the assignment • Comprehensive and clear analysis of the major issues surrounding the engineering failure. • Thorough discussion of available courses of action and constraints on decision-makers. • Highlights ethical issue(s) involved in the case. • Explains and clearly applies appropriate ethical principle to the case. • Presents possible solutions that exhibit critical, creative, and rational thinking.
Research / Sources • *Relevant* sources are used appropriately—i.e., to reinforce a point the writer is making or to provide background and context on the case. • Summaries/paraphrases/quotes of sources are well-integrated with the rest of the paper (i.e., smoothly presented and commented upon). • All research is cited appropriately in the text using the correct format (i.e., parenthetical citation) and all sources are in the correct format in the References List.
Organization / Exposition • Paper is logically and intelligently organized to fit the progression of the argument. • Paragraphs have clear, focused points that support the argument of the exploration of the problem. • Paragraphs are well-developed—they advance the argument by making good claims, using good evidence, and commenting on the significance of the evidence to support the claims. • Sentences, paragraphs, and sections of the paper progress logically and smoothly to build the argument.
Conclusion • Summarizes argument and main points while avoiding redundancy. • Provides closure to the paper and makes reader aware of the broader context of the paper's discussion. • Answers the question of why the argument matters.
Grammar / Style • Paper is highly readable—sentences and paragraphs are clear and concise; word choice is precise. • Paper is free of serious problems with grammar, punctuation, or spelling that might disrupt communication between the reader and the writer.
Overall Assessment