The Moral of Virtue Ethics Perspective to The Union Carbide Disaster In Bhopal India

STS Research Paper
Presented to the Faculty of the
School of Engineering and Applied Science
University of Virginia

By

Naseem Agha

April 13th, 2020

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signed: ___Naseem Agha_______________________

Approved: _______________________________________ Date ________________________
Benjamin J. Laugelli, Lecturer, Department of Engineering and Society

Introduction

On December 3rd of 1984, more than 28 pounds of methyl isocyanate, or MIC, a reactive, very toxic, and volatile gas was released to the atmosphere by the Union Carbide (UC) pesticide plant in Bhopal, India. As a result, at least 3800 people died immediately (the number is still uncertain), 200,000 were injured, 2,000 animals died, and the environment was impacted badly(CSB, 2014). This tragedy was recorded to be the worst industrial accident in history. The incident investigation showed that the incident was a result of a water leak to a storage tank containing the MIC liquid, which is highly reactive with water, causing a runaway reaction that overheated the tank releasing gas through the tank's vapor management system(Gruhn, n.d.).

In the wake of Bhopal, new laws were established by Congress to ensure chemical process safety through reforming chemical emergency response, increasing risk analysis programs, developing prepared worst-case release reports, and establishing the Chemical Safety Board (CSB, 2014). However, in spite of all the precautionary measures that have been taken since 1990, accidents are still occurring in the United States. This is because most investigations are focused on knowing the immediate cause of the incident, thinking that when the immediate cause of the incident is known, the mitigative measures for the next one will take place to prevent it. However, knowing the immediate cause is not enough to prevent incidents from happening in the future due to its continuous occurrence. Instead, we should understand the root cause of the incident by investigating what and why the water leaked in the first place, who was behind it, and who should be held accountable for such a catastrophic crisis.

I will examine the morality of different groups of engineers involved in the incident from the UC company and the Indian inspection agency. Drawing on virtue ethics I argue that the engineers of Union Carbide and the Indian Inspection agency acted immorally because they failed to practice virtue characteristics for responsible engineering that were developed by Pritchard; Ability to communicate clearly and informatively and seeing the “big picture” as well as the details of smaller domains.

Background

Union Carbide, a very well known American multinational chemical company, its main location was in West Virginia, was contracted for a pesticide manufacturing process in Bhopal, India, in 1979. The process included the use of raw materials to generate intermediate products (MIC), which was stored in a tank first then fed to a reactor to make the final product. During plant maintenance, water leaked through the valves into the storage tank that contains MIC while cleaning the built-up materials inside pipes and valves that were causing system breakdown. Resulting in an exothermic runaway reaction that leads to an increase in temperature redundant which then causes a pressure buildup within the tank, leaking MIC byproduct to the atmosphere(Gruhn, n.d.).

Literature Review

Most of the research literature focuses on the root cause analysis related to the technical failure that led to the Bhopal incident; the founded research papers explain the failure related to the process operation, the risk analysis, management, communications, and more. However, I could not find an article that evaluates the morality of the involved parties. This includes the norms and ethical decisions made by the engineers responsible for the Bhopal plant, the engineers who recommended the changes needed to handle the process of MIC in the plant of West Virginia, and the engineers working in the Indian inspection agencies.

Hu et. al. (2015) used the Bhopal incident as a case study to reason its root cause and provide solutions to the abnormal situations by using Dynamic Bayesian network (DBN) framework for the fault propagation behavior study. In which defining problems within the processing system that already exist or may occur during the process. This approach is based on a model that divided the fault propagation into three stages including the hazard scenarios development, DBN development, and DBN root cause reasoning. Hu et. al. mentioned that if this model was used during the design process, an improvement to the effectiveness of the process of the system would be observed and distinguished. However, Hu et. al. failed to evaluate the morality of the different groups of engineers involved and thus, failed to come across another potential factor to the root cause of the incident.

Labib, A. (2015) Studied the trends of the root cause of major incidents such as Bhopal and Fukushima by using an analysis of fault tree and block diagrams of the reliability of engineering techniques. Labib identified the root cause of the incidents using fault tree diagrams and blocks to visualize the problem and connect it to the consequence. He then used it as a learning model to teach future engineers how to prevent them. However, he failed to include the moral and ethical actions of the company personnel in those diagrams to teach future engineers the importance of ethical implications.

Even the Chemical Safety Board succeed in providing a very detailed root cause analysis report of the Bhopal incident explaining the factors contributing to the failure of the process such as equipment failure, the lack of communications, emergency response plan, but they were satisfied with only giving recommendation to what needs to be done to prevent the accident from happening in future and yet, failed to address the morality of the engineers who were responsible for the operation of the plant(Joseph et. al. 2005.)

Despite the successful analysis of the root cause of the Bhopal incident by these scholars, all only focused on the technical failure and the root cause of the crisis but failed to judge and address the morality of the Union carbide engineer's and the Indian inspections engineer's actions.

Therefore, this paper will focus on providing a detailed analysis of the engineer's actions using a virtue ethics framework and leveraging the principle of collective responsibility since it is hard to point fingers at individuals within the Union Carbide company and the Indian inspection agencies. I will be doing that by highlighting the problem of many hands that is discussed by van de Poel & Royakkers by using various virtues to evaluate different engineering groups to teach future engineers the importance of obligations they have.

Conceptual Framework

I will be using a virtue ethics framework to analyze the morality of the actions of Union Carbide company engineers and the Indian inspection agency. Virtue Ethics is an ethical theory that focuses on the nature of the acting person. This theory was developed by Aristotle indicating the criteria of good and desirable characteristics needed for people to be moral (van de Poel & Royakkers, 2011). Aristotle defined a state or a level where a person can reach the highest level of humanity by being good and doing good which he called the state of good. According to van de Poel and Royakker's article, "In order for someone to reach a state of good, a person should have the intellectual virtue that enables one to make the right choice for action. It consists of the ability to choose the right mean between two vices." (van de Poel & Royakkers, 2011). To illustrate this, van de Poel and Royakkkers (2011) explain, "moral virtue is the middle course between two extremes of evil." This means that if someone wants to reach the highest state of being human described by Aristotle, one needs to balance that essential ratio to keep humans on the middle course. For example, courage is the virtue that sets between cowardice and recklessness (van de Poel and Royakkkers, 2011).

Since virtue ethics examines a person's action to determine if it is morally acceptable or not, Michael Pritchard made it easier for us to understand this concept through his article, Responsible Engineers. Pritchard used a collection of evidence from the engineering code and ethics and combined it with virtue ethics principles to make his own concise list of virtues that can define responsible engineers easily known as the virtues for morally responsible engineers as shown in figure 1:

1. professionalism
2. ability to communicate clearly and informatively
3. cooperativeness (being a good "team player")
4. willingness to compromise
5. perseverance
6. habit of documenting work thoroughly and clearly
7. commitment to objectivity
8. openness to correction
9. commitment to quality
10. being imaginative
11. see the "big picture" as well as the details of smaller domains

Figure 1: Pritchard's list of Virtues for morally responsible engineers (Pritchard, 2001)

According to Pritchard, lacking any of these virtues would result in morally irresponsible engineers as he was explaining the two lists of virtues and responsible engineers:

> Admittedly, having these dispositions is not sufficient for responsible engineering practice. However, lacking them detracts from responsible engineering practice in general, and exemplary practice in particular. Furthermore, having these dispositions is a fundamental part of what we admire in those engineers who are likely to be identified as morally commendable. It is fundamental because, without these dispositions in addition to the more obvious virtues of honesty, justice, and benevolence (to take three traditional

moral virtues), there is little reason to expect even competent engineering practice (Pritchard,2001).

In order to be able to analyze the morality of the engineers involved, I need to examine who was responsible and how decisions were made. Van de Puel &Royakkkers 2011, expressed that it is difficult if not impossible to hold individuals responsible when a group of people are involved; they mention "Especially for an outsider it is usually very difficult, if not impossible, to know who contributed to, or could have prevented a certain action, how knew or could have known what." As a result, van de Puel & Royakkkers 2011 introduced collective responsibility; The responsibility of a collective person. This will help judge the actions of multiple people using the problem of many hands analysis where it can hold a group of people responsible for a disaster. The problem of many hands can be defined as the occurrence of the situation in which the collective can reasonably be held morally responsible for an outcome(van Puel &Royakkkers, 2011).

With that being said, I will be analyzing the decisions were made by the engineers of Union Carbide (UC) and the Indian inspection agency as groups in the following section using the two virtues defined by Pritchard: Ability to communicate clearly and informatively and seeing the "big picture" as well as the details of smaller domains.

Analysis

The Union Carbide engineers lack the two traits of virtues that are required for someone to be a morally responsible engineer: Ability to communicate clearly and informatively and seeing the "big picture" as well as the details of smaller domains. Looking at the decisions made by the different groups of engineers, It is obvious that those engineers were missing these virtues and thus, make them morally irresponsible. As it was mentioned in Pritchard's article, missing one virtue is enough to hold the engineers to be morally irresponsible (Pritchard, 2001). What if their judgment lacked two? Could that be a reason for a catastrophic crisis? Does this sound familiar? Therefore, based on the decisions that were made by the engineers, I believe that the engineers are held morally irresponsible. This can be illustrated through the following paragraphs that will demonstrate each virtue examination to the morality of different groups of engineers; the engineers of the WV, the engineers of Bhopal, and the Indian inspection engineers using virtue frameworks.

Ability to Communicate Clearly and Informatively

One of the virtues that were violated by Union Carbide engineers is the ability to communicate clearly and informatively. Communication is key to effectiveness in the workplace, but let us first understand what workplace communication means. Aburumman et al. defined workplace communication as "The transmitting of information between one person or group and another person or group in an organization. It can include emails, text messages, voicemails, notes, etc"(Aburumman et al. 2019). The importance of communication, specifically for this case is to prevent a safety hazard that was found and prevented in one branch of the company but failed to apply in another, three months prior to the accident.

The engineers that were responsible for the design in West Virginia did changes to the procedure in West Virginia but failed to inform the engineers in Bhopal to change theirs too. According to the NBC News 2014, "the safety team windup problems handling MIC three months before the deadly leak in Bhopal, India." The safety team (one of the engineering groups) in West Virginia (WV) cite has reported the hazard of MIC runaway reaction stating “ a runaway reaction can occur in one of the MIC side reactions that can lead to a catastrophic failure of the tank.” they also added, “the tank with MIC was not inspected often enough to guard against contamination, a little water in the tank, for instance, could cause the chemical to heat rapidly, turn to gas and blow”. From this, we can see that the West Virginia safety team knew that MIC can cause a catastrophic disaster if not being properly handled. They also knew that the MIC storage tank was not being inspected and maintained periodically to ensure no contamination occurs. The institute of WV took corrective actions immediately, but they failed to inform the plant in Bhopal so that the engineers in Bhopal can implement the changes to their plant as well.

The UC safety team failed to honor the AlChE code of ethics. The codes of ethics for AlChE highlighted the importance of taking into consideration the safety, health, and welfare of the public when designing a process system. The AlchE code of ethics stated, “Hold paramount the safety, health, and welfare of the public and protect the environment in the performance of their professional duties.”(AlChE board, 2015). Additionally, Pritchard explained that engineers are expected to communicate thoroughly and informatively when it comes to public safety, health, and welfare. Pritchard stated, “Under the Rules of Practice, the NSPE code offers guidance for only two kinds of circumstance that have to do specifically with protecting public safety, health, and welfare: 1) an engineer should inform appropriate persons if his or her engineering judgment is overruled when the public is endangered; and 2) an engineer should approve only those engineering documents that protect the public safety, health, and welfare”(Pritchard, 2011). According to the AlchE code of ethics and Pritchard, the UC safety team did not care about the safety, health, and welfare of the Indian community, their animal and environment when they did not communicate the safety hazard to the plant in Bhopal. Violating the AlChE code of ethics and not being consistent with the virtue ethics of being able to communicate clearly and informatively when they found the facts about the chemical used in the plant in Bhopal.

Seeing the big picture as well as the details of smaller domains

The second virtue the group of engineers in Bhopal lacked was seeing the big picture as well as the details of smaller domains. As engineers, we should be responsible for the process assigned starting from raw material reaching the final product. This includes process safety, maintenance, communication, emergency response plan, and economy(Duhon, 2014). The engineers in Bhopal failed to maintain the process sustainable even though they designed all the proper safety steps in case a leak occurred during the design process. They also failed to design an emergency response plan in case a catastrophic event occurred when they knew that part of the process was a present of a dangerous chemical (Duhon, 2014).

Here are some facts, during the chemical leak, It was too late to control the release when the workers reported the issue to the control room because the hot, boiling liquid and vapor were already being discharged to the tank's vapor management system(Gruhn, n.d.). The system was designed to neutralize vapors if escaped, but it was initially off and was not designed for this size of release (Gruhn, n.d.). Furthermore, a flare system was designed to burn off excess material, however, the system piping was severely corroded that the safety layer could not help(Gruhn, n.d.). And finally, a water spray system was designed to neutralize the material, but the material was released at a height above an improvised water spray system and thus could not help(Gruhn, n.d.).

It is clear that the engineers of Bhopal did not follow up on maintaining the equipment in good shape and working properly. As a result, most of the safety measures taken during the design to prevent the leak from happening did not work because it was not inspected as well.

With that being said, I hold the engineers of Bhopal morally irresponsible because they violated the virtue of seeing the big picture as well as the details of smaller domains. Not to mention violating the engineer's code of ethics to ensure the safety, health, and welfare of the public and protect the environment in the performance of their professional duties(AlchE board, 2015). The UC engineers failed to see the consequence that resulted from their actions towards public safety, health, welfare, and the environment. More than 3800 people were killed , 200,000 people were injured, 2000 animals were killed, and the environment was destroyed.

During the investigation, The government of India tried to hold the company accountable for the crisis emphasizing it is the Union Carbide company's fault for not taking proper safety measures related to chemical proper storage and equipment maintenance since those were the immediate cause of the incident(Reinhold, 1985). It is true that the company is responsible for the incident, but that does not make the Indian government less responsible. The lack of regulation, inspection, and enforcement of worker's safety by the indian government towards the invested companies, pushed companies such as UC and others to pay less attention to maintain the equipment and the process safe. The companies had no strict rules set by the Indian government so that they can follow nor consequences that the companies would face. For example, based on Reinhold's article, the department of labor in Bhopal only had 15 inspectors to inspect more than 8000 plants at the time, two of them were assigned to UC who were mechanical engineers with no backgrounds of chemical hazards (Reinhold, 1985). Furthermore, the inspector's office lacked the basic factors needed for them to monitor the UC plant such as inspection instruments, communication materials such as typewriters and telephones, and transportation (Reinhold, 1985). Thus, the government did not care about the people of India when they did not provide their employees with the necessary knowledge and equipment to fulfill the proper requirement for successful inspections. As a result, the Indian government and their inspector's engineers hold the same responsibility as the engineers of UC in Bhopal for the incident. Thus, I can hold my claim that the Indian inspection agencies are morally irresponsible by violating the virtue of seeing the big picture behind the true meaning of inspection by looking at the details of little domains.

Conclusion

It was determined that the Union Carbide engineers, as well as the Indian safety inspectors, were morally irresponsible for decisions they made in the Bhopal plant which resulted in a catastrophic incident to be ranked the worst in history. The analysis was drawn using a virtue ethics framework, applying collective responsibility to different groups of engineers to examine the virtues necessary for morally responsible engineers: Ability to communicate clearly and informatively and seeing the "big picture" as well as the details of smaller domains. The engineers failed the virtues mentioned above as well as failed the people that were living within two miles from the plant. Resulting in the worst industrial crisis in history.

The engineers need to understand the importance of the ethical implications discussed earlier and its impact on the world. As engineers, we are responsible for people's safety, animals, and the environment around us in addition to our responsibilities to deliver a safe and reliable design. To do this we need to make sure to communicate the hazards to all parties involved, looking at the big picture and who can be affected by going thoroughly through the design details and maintaining it safe and sustainable. Thus, it is essential to take responsibility for those factors to ensure mitigations, as well as preventive measures, are taken so that the Bhopal crisis does not happen again.

References

Aburumman et al. 2019. Evaluating the effectiveness of workplace interventions in improving safety culture: A systematic review. *Safety Science. 115*, 376-392. Retrieved from: https://doi.org/10.1016/j.ssci.2019.02.027

Boverns, M., Miceli, M.(1999). The quest for responsibility: accountability and citizenship in complex organizations. *Administrative Science Quarterly*. 44. 846 retrieved from : DOI: 10.237/2667065.

Chemical Safety Board, 2014. On 30th anniversary of fatal chemical release that killed thousands in Bhopal, India, CSB safety message warns it could happen again. Retrieved March, 1st. 2020 from: https://www.csb.gov/on-30th-anniversary-of-fatal-chemical-release-that-killed-thousands-in-bhopal-india-csb-safety-message-warns-it-could-happen-again-/

Chemical Engineering Code of Ethics. (2015). Code of ethics. Retrieved March 1, 2020, from https://www.aiche.org/about/code-ethics.

Duhon, H. May 3rd, 2014. Bhopal: a root cause analysis of the deadliest industrial accident in history. *Society of Petroleum Engineer*. *3*(3) Retrieved from: https://pubs.spe.org/en/ogf/ogf-article-detail/?art=141

Gruhn, P. n.d. The next Bhopal. *Global functional Safety Consultant aeSolutions.* Retrieved from: http://wilmingtonisa.org/docs/The%20Next%20Bhopal%20(presentation%20handout).pdf

Hu, J., Zhang, L., Cai, Z., Wang, Y., & Wang, A.(2015).Fault propagation behavior study and root cause reasoning with dynamic Bayesian network based framework. *Process Safety and Environmental Protection. 97. 25-36.* Retrieved from: https://doi.org/10.1016/j.psep.2015.02.003

Jing, L. & Stephansson, O.(2007).Fundamentals of Discrete Element Methods for Rock Engineering. *Developments in Geotechnical Engineering. 85.*447-538. Retrieved from: https://doi.org/10.1016/S0165-1250(07)85012-7

Joseph, G., Kaszinak, M., & Long, L. (2005). Lessons after Bhopal: CSB a catalyst for change. *Journal of Loss Prevention in the Process Industries*. *18*(4-6). 537-548. Retrieved from: https://doi.org/10.1016/j.jlp.2005.07.009

Labib, A.(2015). Learning (and unlearning) from failures: 30 years on from Bhopal to Fukushima an analysis through reliability engineering techniques. Process Safety and Environmental Protection. *97*. 80-90. Retrieved from: https://doi.org/10.1016/j.psep.2015.03.008

Pritchard, M. (2001). Responsible engineering: The importance of character and imagination. Science and Engineering Ethics, 7(3), 391–402.

Reinhold, R. 1985. Disaster in Bhopal: where does blame lie?. *The New York Times.* NY. retrieved from: https://www.nytimes.com/1985/01/31/world/disaster-in-bhopal-where-does-blame-lie.html

NBC new. Dec 5th, 2014. Union Carbide disaster in Bhopal India | Flashback | NBC News. retrieved March 1st, 2020 from: https://www.youtube.com/watch?v=FHJs3TwgsUQ

van de Poel, I., & Royakkers, L. (2011). Ethics, technology, and engineering: An introduction. Hoboken, NJ: Blackwell Publishing Ltd.

Word counts: 3408