Deepwater Horizon Spill: A Networked Approach

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

By

Kousuke Angelo Tapia Iijima

March 1, 2024

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.

ADVISOR
Benjamin J. Laugelli, Assistant Professor, Department of Engineering and Society

Introduction

While drilling in the Macondo oil well on April 20, 2010, the Deepwater Horizon oil rig underwent catastrophic failures that resulted in its explosion and the biggest spill in recorded history (Pallardy, 2023). This incident killed 11 people and injured 17, but its long term impacts caused major damages to the ecosystem in the Gulf of Mexico, including marine life, as well as the thousands of residents that lived along the coast. British Petroleum (BP) was the operator of the rig and was thus considered the main culprit both legally and in the public's eye.

Current scholarly discourse offers a comprehensive list of causes and events leading up to the Deepwater Horizon disaster. However, this understanding often presents each of these causes in isolation, often ignoring how they interacted with each other and built up to the incident. Without a holistic approach that closely examines that interconnectedness, the true cause of the incident will alway remain elusive.

For that reason, I argue that this catastrophe did not occur solely due to the actions of any single entity but rather arose from the intricate and ineffective interplay between them. This assertion will become evident as I start examining the technical, human, and systemic failures that worked together to culminate into a serious tragedy. To frame my analysis, I will be utilizing the STS framework of Actor Network Theory (ANT), which approaches socio-technical systems as diverse and heterogeneous networks of actors that all play pivotal roles in determining their success as a whole. In support of my claim, I will evaluate peer-reviewed articles and various accident reports that examined the circumstances surrounding the disaster.

Background

The Deepwater Horizon (DWH) rig was built and owned by American drilling company Transocean and had been under lease to BP during the time of the incident (Reader, 2013). The rig had already been drilling the Macondo well for several months, but encountered difficulties that led BP to make the decision to seal the well for later use (Rose & Hunt, 2012). That is where a chain of complications started to occur due to the improper cement seal that was placed on the well by drilling contractor Halliburton, which led to hydrocarbons entering the well bore and up the drill pipe. There were measures in place to counter this kind of situation, notably the blowout preventer (BOP), which was an enormous electromechanical device that sat at the entrance of the well on the seafloor (Rose & Hunt, 2012). The BOP's main responsibility is to stop oil and other hydrocarbons from going up to the surface. The BOP was activated once the crew noticed that drilling mud was splashing onto the rig, but some issues within the device led to its complete failure and the hydrocarbons were able to get to the surface and find an ignition source.

Literature Review

Scholars have attempted to explain the causes of the Deepwater Horizon disaster in its entirety by examining the complexity that is inherent in large organizations such as regulatory bodies or companies like BP. More specifically, they took a closer look at technical challenges, lack of regulatory oversight, and organizational actions that surrounded the incident. Among those factors, some of the actors that have been identified are government agencies, oil companies, and drilling contractors. However, most literature has treated each entity as separate/independent from each other, and have therefore not properly addressed how exactly the interplay between each of them led to an undesirable outcome. Some scholarship even hints at the idea that even if certain actors played their role appropriately, it would have not made any difference in preventing the incident.

The article "Oil Spill Causation and the Deepwater Horizon Spill" by Rich S. Kurtz (2013) looks into the factors behind the disaster by primarily focusing on the regulations and organizational dynamics pertaining to offshore drilling operations. It goes into lengthy discussion over some of the key participants and what their roles were leading up to the explosion. From there, Kurtz synthesizes some of the predominant qualitative aspects that many oil spills share in common and argues that regulatory enforcement and organizational compliance are essential for spill prevention (Kurtz, 2013). In a similar manner,Venkat Pranesh et al. (2017), effectively compiles a significant amount of information regarding the spill in their study of the "Lack of dynamic leadership skills and human failure contribution analysis to manage risk in deep water horizon oil platform," and specifically utilizes many human/social factors to conduct a risk assessment of the incident. The study concludes that the well blowout was "entirely due to human errors and poor dynamic leadership skills" prevalent in Transocean and BP employees (Pranseh et al., 2017).

While Kurtz acknowledges various contributing factors, he does not explicitly elaborate on how poor regulatory enforcement and lax adherence were detrimental in this case and even mentions the idea that amending regulations would have no effect on the actions of BP. Likewise, Pranesh et al. presents numerous valid reasons, but fails to capture the entire network by not addressing the technical and systemic interactions. For that reason, my claim will be able to advance the understanding of this incident by pointing out the importance of closely examining the interactions of every actor with each other. By doing so, I aim to provide a nuanced approach to understanding the factors that led to this incident.

Conceptual Framework

To frame my analysis, I will be using Actor Network Theory (ANT), since it provides an adequate method of approaching complicated socio-technical systems such as the Deepwater Horizon disaster. This framework is well suited for this case, since it will allow me to thoroughly identify the various entities within the network and evaluate their interactions in order to uncover some insights about the causes of the incident.

Originally formulated by scholars Michel Callon, Bruno Latour, and John Law, Actor-Network Theory (ANT) states that any given system in the world can be viewed as a network consisting of multiple actors (Cressman, 2009). These actors are characterized as heterogeneous entities (both human and non-human) that have the power to contribute significantly to the overall function of the network. Among those actors is the network builder, who is essentially responsible for facilitating any interaction among actors and making sure that they are working towards the goal. The formation of such a network can be described by the concept of translation, which explains the process of properly establishing and managing an actor network. This process is led by the network builder and made up of four main stages: problemitization, interessement, enrolment, and mobilisation (Callon, 1986). Those four stages essentially consist of identifying a problem, recruiting the necessary actors, assigning roles to those actors, and effectively choosing a representative (usually the network builder). Through translation, actors are able to operate as a "black box," whose complexity is concealed by the synergistic and cohesive operation of the network (Nickerson, 2024).

When it comes to thinking about the primary actors within any kind of system, it is normal to assume that those actors are sentient beings such as humans. However, within the framework of ANT, there is no such distinction, so it is possible to classify many different entities as actors. Examples could include natural forces, conceptual factors, and even inanimate objects. This proves to be advantageous, as it facilitates the process of identifying relevant actors that may have been initially overlooked. As a result, one ends up with a better perspective on what the network dynamics actually are.

Using ANT will allow me to focus my analysis on each actor as an individual, as well as how well it performed its role in the bigger context of the Deepwater Horizon network that it belongs to. More specifically, I will be closely examining the process of translation by which the network was organized. I will place emphasis on how each actor failed at the enrolment stage in particular, which involves the process by which actors are assigned a role that they commit to fulfill. By approaching the case in this manner, I aim to move beyond simplistic explanations that rely on sole causes and instead explore the broader dynamics that were at play.

Analysis

To begin my analysis I present the following table that identifies and classifies some of the actors that comprised the Deepwater Horizon network. Note that the list of actors is not exhaustive.

Technical Actors	Social Actors	Natural Actors	Economic Actors	Conceptual Actors
Cement slurry	BP (Network Builder)	Hydrocarbons	Operational costs	Engineering expertise
Blowout preventer	MMS	Ocean	Profits	
	Transocean	Drilling Site		
	Halliburton			

Socio Technical Failures

The blowout's multifaceted cause can be elucidated by examining the failed interactions between the technical actors and how the issues they caused were allowed to persist by some of the social and economical actors. The two technical actors of interest are the cement slurry and blowout preventer that were used in the rig's operation. As previously mentioned, the collapse of the cement plug is what set off the chain of events. BP, the network builder, released an investigation report on the accident which stated that the choice of using a "light, nitrified foam cement slurry" to plug the well was detrimental to the structural integrity of the well and was thus ineffective at resisting the pressure exerted by the hydrocarbons ("Deepwater Horizon Accident Investigation Report," 2010). Even with the collapse of the cement, the BOP should have been there as a back up, but BP's report also found that the emergency pods responsible for activating the BOP's emergency shut off protocols were faulty prior to the accident. They found a "fault in a critical solenoid valve in the yellow control pod and that the blue control pod AMF batteries had insufficient charge" ("Deepwater Horizon Accident Investigation Report," 2010). With two critical actors not performing their roles, it was just a matter of time before a disaster happened. From a technical standpoint, the interaction of those two actors could be considered the primary causes; however, by reasoning with the concepts of ANT, the failure of one actor in the network is likely a direct reflection of another one. Now that the presence of those rogue actors has been established, an explanation must follow as to how they were allowed to get to that point in the first place. While they hold great agency as actors of the network, these particular actors cannot act independently and thus need some sort of mechanism that allows them to fail the way they did. This is where the other social and economic actors come into play. With the complexities and high risks that are encountered in oil drilling operations, one of the main roles that BP (social actor) must fulfill is to uphold the safety of its activities. As such, they would be expected to be responsible for routine safety checks and repairs, but it was found that "prior equipment testing had built up a backlog of hundreds of maintenance needs" that were not properly addressed before starting the Macondo well operation (Kurtz, 2013). And of course, the emergency pods of the BOP were included in that list. This demonstrates that the technical actors failed at fulfilling their roles only because BP failed at theirs. BP's actions regarding the lack of equipment upkeep can certainly be partly attributed to their greediness in trying to reduce costs, but they were also influenced by yet another set of actors. BP management became impatient with the progress of the Macondo well operation as the project was already "tens of millions of dollars over budget," which was mainly attributed to the challenges that stemmed from their lack of experience drilling in that area (Kurtz, 2013). By examining that situation, even more actors can be identified: operational costs (economic) and a challenging drilling site (natural). At this point, a road map of sorts becomes apparent as I have shown how the action's of a particular actor can either directly or indirectly affect another one. Both the technical and social actors described in this section failed at the enrolment stage of translation, which further proves my claim that the causes of this incident are made up of nuanced interactions between actors.

A Different Approach

Instead of thoroughly trying to understand the interplay of factors that caused the incident, some proponents of Normal Accident theory may simply dismiss a case like this as being inevitable. Normal Accident Theory proposes the premise that systems that are highly complex and tightly coupled are bound to fail at some point (Perrow, 1984). One such example comes from John M. Jennings, a Washington University professor, who states that the "Deepwater Horizon Spill had the hallmarks of a normal accident," and that one must be cautious about adding additional safeguards to a system because they can increase the likelihood of its failure (Jennings, 2019). There is certain merit to that argument in the sense that if there are more parts, then clearly, more parts can and will fail at some point. It can be easy to apply this line of thinking to the DWH spill since there were many thousands of components that went into the operation such as the cement that was used to cap the well or the electrical components of the BOP. However, this approach is flawed in stating that extensive safety measures make systems less stable and could be detrimental to comprehending the causes of the incident. For example, if the operators of the rig wanted to prevent the breakdown of the cement that they used, they could have simply predicted its ineffectiveness by conducting proper testing before and after the cement had been placed. In fact, BP did have a protocol to test the stability of the cement, but the results had been interpreted incorrectly due to the absence of a previous report that found the slurry to be unstable (Reader, 2014). The information stated in that missing report was crucial to subsequent testing for cement stability, but it was hidden by Halliburton out of fear of delays and cost overruns (Mills & Koliba, 2014). Therefore, in a scenario where all the actors fulfilled their roles appropriately, having additional measures can actually promote the stability of the system rather than bring about its collapse like Jennings suggests. This point also implies that it is actually crucial to approach a system like this through the lens of ANT rather than dismissing it as something inevitable.

Systemic Failures

To further demonstrate the convoluted interactions that led to the disaster, we can look beyond the actors that directly surrounded the drilling operation and instead extend the scope to the failures of the overall system under which the DWH rig acted. The Gulf of Mexico is one of the most productive oil sites for the United States, and with over 4,000 active wells at the time of the incident, they had many regulations in place to oversee those activities. One such example is the Oil Pollution Act of 1924 , which was the first piece of legislation that addressed coastal oil spills (Kurtz, 2013). Leading up to the 2010 disaster, this act underwent many revisions and ultimately led to the establishment of the Oil Pollution Act of 1990 (OPA 90), which mandated the creation of public-private networks to oversee the prevention of oil spill accidents. Additionally, the OPA 90 assigned the Mineral Management Services (MMS) agency the responsibility of enforcing the regulations and collecting royalties from companies that drilled in US territorial waters (Mills & Koliba, 2015). However, since many of the responsibilities such as safety inspections were essentially being outsourced to third party private contractors, the actual implementation of the regulations was very loose (Mills & Koliba, 2015). To illustrate this point, the National Commision on the BP Deepwater Horizon Oil Spill and Offshore Drilling found that the MMS made no efforts to audit or verify the inspections that were being allegedly conducted, both in a general sense and specifically regarding the blowout preventer (National Commission, 2011). That piece of information is key to demonstrating that the MMS, as a social actor, was yet another key contributing factor of the disaster. This can be noted by its ineffective interaction with the technical and other social actors. To put it simply, by failing to fulfill its role of ensuring that industry entities such as BP adhered to the best safety practices (like proper inspections), the MMS destabilized and adversely affected the actors in the network. While it can be seen that the MMS allowed BP to fail in its responsibilities, this was not a one sided interaction between two actors. BP also contributed greatly to the lack of regulatory oversight by constantly interfering with it. Post-spill investigations brought to light that there had been persistent patterns of "bribes, payoffs, illegal gifts, lucrative personal contracts, lavish parties, football tickets, hunting trips, expensive meals, and sexual favors between oil company personnel and MMS officials" (Ladd, 2012). This is indicative of BP's clear prioritization of its financial interests over the whole well-being of its operations. As a result, it failed to fulfill many of its roles as the network builder and thus also contributed to the collapse of the DWH network. In essence, there were prevalent systemic failures that allowed the human actors to fail in their roles; however, the failures of the human actors also exacerbated the systemic issues, resulting in a feedback loop of damaging exchanges. As discussed throughout the paper, the negligence exhibited by the MMS and oil companies extended into many parts of the network, ultimately manifesting all the way down the chain of actors in the form of the cement and BOP failures. Thus, the facts highlighted in these interactions demonstrate the complex dynamic between the social actors, which further supports the idea that they should not be examined separately.

Conclusion

In conclusion, I have argued that the Deep Water Horizon spill was not solely caused by the action of any individual entity on its own, but rather emerged from the intricate interactions among them. This premise was demonstrated by using Actor Network Theory to analyze the technical, social, and systemic failures that occurred and how they influenced each other to collapse together as a network. One of the key takeaways was the way in which those actors indirectly influenced each other in unexpected ways.

My argument holds significance due to the new understanding that it offers readers about the underlying causes of the spill. It allows a transition from simplistic explanations towards more holistic approaches that will allow the reader to better ascertain and think critically about socio-technological cases such as this one. The approach that was used in this paper could also be applied in the real world by potentially helping engineers enhance their practices when it comes to risk mitigation and response.

References

BP. (2010). Deepwater Horizon Accident Investigation Report, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/issue-briefings/deepwater-horizon-accident-investigation-report.pdf

Callon, M. (1984, May 2). Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. Sociological Review, 32(1), 196 - 233.

Cressman, D. (2009). *A Brief Overview of Actor-Network Theory: Punctualization, Heterogeneous Engineering & Translation*. Simon Fraser University. https://summit.sfu.ca/item/13593

Jennings, J. M. (2019, August 1). *The Normal Accident Theory*. JohnMJennings. https://johnmjennings.com/the-normal-accident-theory/

Kurtz, R. S. (2013, July 1). Oil Spill Causation and the Deepwater Horizon Spill. *Review of Policy Research*, 30(4), 366 - 380.

Ladd, A. E. (2012, January 1). Pandora's Well: Hubris, Deregulation, Fossil Fuels, and the BP Oil Disaster in the Gulf. *American Behavioral Scientist*, 56(1), 104 - 127.

Mills, R. W., & Koliba, C. J. (2015, March 1). The challenge of accountability in complex regulatory networks: The case of the Deepwater Horizon oil spill. *Regulation & Governance*, 9(1), 77 - 95.

National Commission. (2011, January 10). Deep Water: The Gulf Oil Disaster And The Future Of Offshore Drilling - Report to the President (BP Oil Spill Commission Report). [Government]. National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. https://www.govinfo.gov/app/details/GPO-OILCOMMISSION

Nickerson, C. (2024, February 13). *Latour's Actor Network Theory*. Simply Psychology. https://www.simplypsychology.org/actor-network-theory.html

Pallardy, R. (2023, December 29). *Deepwater Horizon oil spill*. Encyclopedia Britannica. https://www.britannica.com/event/Deepwater-Horizon-oil-spill

Perrow, C. (1984) Normal Accidents: Living with High-Risk Technologies. *Basic Books*, New York.

Pranesh, V., Palanichamy, K., Saidat, O., & Peter, N. (2017, February 1). Lack of dynamic leadership skills and human failure contribution analysis to manage risk in deep water horizon oil platform. *Safety Science*, 92, 85 - 93.

Reader, T. W., & O'Connor, P. (2014, March 1). The Deepwater Horizon explosion: non-technical skills, safety culture, and system complexity. *Journal of Risk Research*, 17(3), 405 - 424.

Rose, M. A., & Hunt, B. (2012, February 1). Learning from Engineering Failures: A Case Study of the Deepwater Horizon. *Technology and Engineering Teacher*, 71(5), 5 - 11.