Exploring the Technical and Non-Technical Actors Involved in the Derailment of Amtrak Cascades Passenger Train 501

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Anand Kanumuru

Spring 2023

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 Laugelli, Department of Engineering and Society

Introduction

On December 18, 2017, an Amtrak Cascades passenger train carrying more than 70 passengers derailed near Dupont, Washington. This accident resulted in three casualties, more than 80 people injured, and significant infrastructural damage ("*3 Dead, Scores Injured after Amtrak Train Plunges off Bridge onto I-5"*, 2017). According to the National Transportation Safety Board (NTSB), the derailment was caused by a locomotive engineer not adequately slowing the train during a hazardous curve. However, this interpretation fails to consider the other technical and non-technical factors that played a significant role in the incident. By not accounting for social, organizational, and other aspects of the transportation system that contributed to the train derailment, we cannot gain a comprehensive overview that allows us to understand why the train derailment occurred. Furthermore, engineers and leaders in the locomotive industry will not be aware of current issues that must be improved to prevent future accidents.

I will investigate how the technical and non-technical factors related to the Amtrak Cascades passenger train derailment interacted together to cause the incident. To frame this analysis, I will use the Actor-Network theory (ANT) to argue that organizational, societal, and political pressures were important actors that ultimately caused the Amtrak passenger train derailment. ANT examines how a system of "actors" associate together for a common cause. To analyze the actors in the network, I will utilize information from research studies that have documented the impact of these factors on the locomotive industry.

Literature Review

Previous analyses have investigated how technical and human errors have played a major role in causing the Amtrak Cascades passenger train derailment in Dupont, Washington and other locomotive accidents in general. However, there has not been sufficient attention given to other sociotechnical factors that have worked in conjunction with formerly mentioned technical and human errors.

In *Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates* (Liu et al., 2012), researchers gathered train accident data from the United States Department of Transportation. This included studying the type of track the accident occurred on and the speed of derailments. On Class I main lines, which are most similar to the national passenger railroads that Amtrak uses, broken rails, bearing failures, and broken wheels are the most common causes of train car derailment. On tracks that operate with lower speeds, human-related factors were more prevalent. Some examples of these include improper use of switches and violation of switching rules.

Similarly, the Federal Railroad Administration (FRA) wanted to understand the potential safety implications of adopting remote control locomotive (RCL) operations in a human-centered investigation and analysis frame (Reinach & Viale, 2006). Since the accident and investigation methodology usually revolve around mechanical and technological failure, Reinach & Vivale wanted to explore the role of human-based error. After analyzing various unique accidents, they were able to identify various factors that were common to all the scenarios. These included attentional failures and memory lapses, inadequate supervision, and more. This article goes on to explain that human error is a “consequence not a cause”. Since human error is caused by “upstream workplace and organizational factors”, exploring the context to limit the recurrence of issues is necessary.

Although both these sources provide some insight into the factors that cause train derailments like the one in Dupont, Washington, they do not offer a nuanced explanation of the participating network of actors. I will elaborate and expand on the ideas of Liu et al. and Reinach & Vivale using ANT to provide a more thorough explanation of the causes of the Amtrak passenger train derailment in 2017.

Conceptual Framework

To frame my case, I will draw on ANT because it will allow me to discuss how many different components are related and work together to explain the train derailment. Rather than solely putting blame on technical issues, user error, or other sociotechnical factors, I will be able to characterize how each entity plays an important role.

In ANT, a system of "actors" associate together for a common purpose. Actors are not necessarily "willful or intentional agents" but are any human or non-human entities that can influence a sociotechnical system (Crawford, 2020). These actors can be technical, social, economic, conceptual, or more. By focusing on the relationships in which actors participate, I can observe how these relationships influence the shape of a network (Dwiartama & Rosin, 2014). The overall process of forming and maintaining an actor-network is known as translation. To begin, the formation of a network requires a network builder to identify a problem and recognize the actors that are required to play a role in it. This first step is known as problematization. From there, the network builder works to recruit actors into the network through interessement (Shiga, 2007). Once the networker has strategically solidified a list of required actors, they must assign specific roles to each actor in enrolment. It is important to note that each actor accepts and performs their designated role. Lastly, a process known as mobilization is needed for the network builder to secure their role and represent the various actors. Overall, an essential aspect of ANT states that actors in a network are equivalent in value. Furthermore, each individual actor only has power and purpose in the context of the network.

Without the strength of the interconnections among all the actors, there is no power (Callon, 2001).

This theory offers a valuable perspective for comprehensively analyzing the factors that lead to the tragic Amtrak passenger train derailment. I will use ANT to explore how organizational issues within Amtrak and other regulatory bodies related to the locomotive industry created conditions that lead to the derailment. Additionally, I will investigate the broader social context like how the excitement for further rail development played a role. Lastly, I will evaluate the influence of political organizations and lobbying on this scenario. Performing these tasks will explain how these factors worked in conjunction with technical and human errors.

Analysis

Organization Issues. There were several organizations that were involved in the train derailment. These include Amtrak, Central Puget Sound Regional Transit Authority (CPSRTA), Washington State Department of Transportation (WSDOT), and the Federal Railroad Administration (FRA). As actors within the network, they contributed to the failure of the technology through negligence and an unwillingness to take important and required actions.

When discussing this tragedy, the most common issue that arises is that the Amtrak engineer did not slow down the train as it approached a hazardous curve in the track. Although the train was supposed to enter at 30 MPH, it continued to travel at 80 MPH. This can partially be explained by the CPSRTA's failure to implement an effective mitigation strategy for overspeeding during this hazardous curve in replacement of Positive Train Control (PTC) (National Transportation Safety Board, 2019). Positive Train Control is a system that can automatically stop trains when onboard engineers are not receptive to warnings of upcoming speed reductions (Badugu & Movva, 2013). However, this system was not fully in place and tested before the commencement of the rail. If the CPSRTA felt the responsibility to oversee the installation of a plausible alternative, the mistake made by the engineer likely would have been irrelevant. At that time, the lead locomotive was the brand-new Siemens Charger. The inadequate training experience that the Amtrak engineer received for this technology also played a major role in this accident. Even though the trainees were exposed to the new display screens and controls, they were never able to operate the locomotive. They also did not experience the activation of the overspeed alarm system. Before the journey on December 18, 2017, he only had an estimated 60 seconds to completely familiarize himself with the operation of the locomotive (National Transportation Safety Board, 2019). Furthermore, the engineer was relatively unfamiliar with the geographical territory and had only operated one roundtrip in the same area before. Amtrak placed the engineer in a difficult situation by not allotting him the proper amount of training. Although the engineer is the one who did not slow down the train, Amtrak showed severe negligence by not requiring more rigorous training standards. It is the responsibility of the WSDOT to provide oversight and approval of the CPSRTA's safety certification process. In this case, WSDOT allowed for rail operations to begin without the proper certification and verification progress being completed (National Transportation Safety Board, 2019). By not regulating this, the WSDOT communicated to the CPSRTA that the status quo is sufficient and that safety is not of the utmost importance. If more safeguards were in place, it is possible that the scope of the incident could have been reduced.

Another important issue was the lack of a safety management system program at Amtrak. For a long time, the NTSB has recommended the implementation of a safety management system program that communicates an organization-wide approach to managing safety risks and developing effective safety risk controls. In fact, this practice has become a standard practice for commercial aviation companies. A comprehensive policy aims to define organizational safety goals, outline requirements and methods to achieve those goals, and identify all the hazards that could emerge. Additionally, there is usually a continued measurement of the effectiveness of safety measures (National Transportation Safety Board, 2019). Without this official documentation in place, it becomes difficult for companies like Amtrak to stay organized and ready to deal with safety hazards. Several other Amtrak derailments and accidents could have been prevented if this was required at the company.

Lastly, the WSDOT, CPSRTA, FRA, and Amtrak were all involved in the preparation of the beginning of this specific passenger rail. Unfortunately, the roles and responsibilities of each governing organization was not clearly defined or assigned (National Transportation Safety Board, 2019). This meant that no one had the responsibility of being engaged and assertive when it came to discussing important safety hazards. If these groups were more proactive in their collaboration, designed safety hazards could have prevented the overspeeding that lead to the eventual accident.

Advancement Over Safety. For decades, the American passenger rail system has been criticized due to its lack of advancements compared to its European counterparts. Although the United States was a rail pioneer in the 19th century, the lack of development since then has been commonly brought up (Yglesias, 2015). This societal pressure has created a strong desire to prioritize advancement and deadlines over everything, which is a social actor that is part of the network that ultimately contributed to the failure of the technology.

According to Jennifer Homendy, the Chair of the NTSB, Amtrak, WSDOT, FRA, and CPSRTA have all shown a specific focus on developing projects that can reduce travel time, increase overall ridership, and provide an efficient alternative to other forms of transport.

Naturally, the safety of passengers became less relevant in discussions. In 2009, the FRA approved a petition by Amtrak to exempt Talgo VI train cars from rigorous passenger railcar crashworthiness standards (National Transportation Safety Board, 2019). These were the same type of train cars that were carrying passengers in the train derailment in Dupont, Washington. By doing this, they were able to further develop the rail in the area rather than being slowed down by regulatory burdens. This contributed to the train derailment because higher quality standards for Talgo VI passenger cars likely would've reduced the damage sustained by victims in the accident (National Transportation Safety Board, 2019).

Similarly, the focus on advancement and efficiency had created a toxic environment at Amtrak that has bred a "culture of fear… and a normalization of deviance from rules" (Silverman, 2017). This was seen in the tension-filled relationships that management held with labor. In an effort to emphasize profits and advancement, Amtrak policies often resulted in workers with sleep deprivation and being exposed to excessive noise and vibration. Next, it was common for management and labor to blame each other for safety violations rather than collaborate to develop effective solutions to problems. A former senior official at Amtrak noted that when the focus was on charging employees with rule and safety violations, it was difficult to identify and resolve the root causes of incidents. Furthermore, this disincentivized workers from accurately and transparently reporting safety violations. Since railroad technicians, engineers, and middle managers would simply have to shoulder the blame for the issue, it was beneficial for them to suppress the information. It is clear that the lack of a strong "safety culture" contributed not only to the Amtrak Cascades derailment in 2017 but also to the many other accidents that have occurred. If employees at Amtrak were able to bring up safety issues without fear of punishment, then workers at the company could work together to address and resolve them.

Potentially, the issues that led to this particular derailment could have been properly solved way before the incident occurred.

I have shown that prioritizing advancement and deadlines can be dangerous in the passenger locomotive industry because it directly makes passenger safety less important. Proponents of the other side may argue that is important to mention how development in technology can eventually lead to improved safety measures and devices that protect passengers. However, this view fails to acknowledge that Amtrak and other similar organizations may take a very long time to develop improved safety technology through innovation due to limited funding and profits.

Political Pressure. Like many other issues, politics have played an impactful role in the rules and regulations the United States Government and other regulatory bodies require for both passenger and freight train travel. More specifically, political affiliations and lobbying contributed to the failure of the technology by influencing high-level decision-makers to not prioritize passenger safety.

For more than 50 years, the NTSB has been advocating for the aforementioned PTC system. The US Congress eventually mandated PTC in 2008 and required that all major rail lines implement this technology by the end of 2015. However, both the passenger and freight industries spent millions of dollars lobbying to delay this deadline. They argued that the technology they were being required to implement was not fully developed and would require more time to fully flesh out. Additionally, commuter rail lines that are publicly funded reasoned that they could not meet the costs. These efforts were ultimately successful as the deadline was pushed to 2020. Furthermore, many financial contributions to individual members in the 2015-16 campaign cycle were made by organizations affiliated with the railroad industry after the delay was put in place (Rogin, 2016). Without lobbying and the political power that the rail industry possesses, the PTC requirements most likely would've been in place by the end of 2015. This device could have directly prevented the train derailment, which occurred in late 2017.

The Association of American Railroads (AAR) is a powerful lobbying group that represents major railroad companies such as Amtrak and Norfolk Southern. Therefore, their interests usually align with saving costs for these companies. Many of the nation's rail lines still rely on braking systems that are decades old. Luckily, electronically controlled pneumatic (ECP) brakes are an advanced and modern option that allows all cars to brake at once using an electronic signal. The FRA has been consistently recommending a switch to ECP braking and even published a technical report that details the improved safety of these braking mechanisms. However, the powerful AAR was able to pressure President Donald Trump into repealing an act that required newer and safer electronic braking systems in 2015 (Rock & Burns, 2023). Without this political pressure, it is possible that the act would have resulted in the Amtrak Cascades passenger train having higher quality brakes that could have prevented the accident.

Finally, President Donald Trump's relationships with the locomotive industry played an important role in disregarding passenger safety during his tenure in the Oval Office. An important example of this comes from his decision to not require more standardized two-person crews in locomotive cabs (Mikulka, 2017). Even with PTC, having more people in the locomotive lab would establish a sense of security and would reduce mistakes made by the employees. However, his affiliations with AAR leaders and others lead him to act against this proposal. If it was a requirement for the Amtrak Cascades passenger train to have more crewmates, it is possible that someone would have been able to slow down the train even though the original engineer did not. Trump also canceled regulations that would have required train operators to be tested for conditions like sleep apnea. Additionally, the regulation of rail wear and rail failure are important conditions that political affiliations that have also played a role in. Normally, these appear from the fatigue of alternating stresses created by the passage of trains. However, AAR lobbyists have claimed that they are unaware of limits on rail wear and have downplayed the issue in general (Mikulka, 2017). The AAR has continued to push for self-regulation of rail wear and track maintenance. If Amtrak was also relying on self-regulation for the quality of their tracks, they would not be as strict or regulated as an impartial third party. This would've led to issues within the tracks that also eventually could've caused the accident.

Conclusion

In this paper, I have used the sociotechnical framework of ANT to discuss how negligence from various organizations, societal pressure, and political affiliations worked in conjunction with known technical and non-technical actors to contribute to the Amtrak Cascades passenger train derailment in Dupont, Washington on December 18, 2017. Analyzing the lack of safety regulations, insufficient training procedures, minimal oversight, and disregard for mitigation strategies make it clear that the involved organizations showed true negligence and an absence of foresight. Furthermore, the perceived lack of railroad development and the desire to prioritize advancement caused passenger safety to decrease in importance. This attitude led to decisions by the FRA, Amtrak, and others that put passengers on the Amtrak Cascades passenger train in danger. Political loyalties and powerful lobbying organizations such as the AAR have convinced the US government to not implement certain effective safeguards, which potentially changed the outcome of the derailment.

By following this approach to the train derailment incident, readers will have a more comprehensive understanding of the factors that went into play. Considering the various actors that were mentioned, in addition to technical and human errors, paints a much clearer picture of the interconnections that are vital to the performance of the action. Lastly, this also explains how the failure of one actor is directly connected to the other actors in the network.

With this new understanding, engineers will have a refined understanding of the importance of organizational culture and having well-defined roles and responsibilities. These measures would hopefully be able to reduce the number of similar incidents in the future.

Word Count: 3,099

References

3 dead, scores injured after Amtrak train plunges off bridge onto I-5. (2017). https://komonews.com/news/local/derailed-train-falls-off-bridge-onto-i-5-lanes-south-of-tacoma

Badugu, S., & Movva, A. (2013). Positive Train Control. *International Journal of Emerging Technology and Advanced Engineering*.

Callon, M. (2001). Actor Network Theory. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 62–66). Pergamon. https://doi.org/10.1016/B0-08-043076-7/03168-5

Crawford, H. (2020, September 28). *Actor-Network Theory*. https://oxfordre.com/literature/display/10.1093/acrefore/9780190201098.001.0001/acrefore-9780190201098-e-965

Dwiartama, A., & Rosin, C. (2014). Exploring agency beyond humans: The compatibility of Actor-Network Theory (ANT) and resilience thinking. *Ecology and Society*, *19*(3). https://doi.org/10.5751/ES-06805-190328

Liu, X., Saat, M. R., & Barkan, C. P. L. (2012). Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates. *Transportation Research Record*, *2289*(1), 154–163. https://doi.org/10.3141/2289-20

Mikulka, J. (2017, December 29). Trump and the Rail Industry Had a Great First Year Together. *DeSmog*. https://www.desmog.com/2017/12/29/trump-rail-industry-year-performance-based-regulation/

National Transportation Safety Board. (2019). *Railroad Accident Report Amtrak Passenger Train 501 Derailment DuPont, Washington December 18, 2017*.

Reinach, S., & Viale, A. (2006). Application of a human error framework to conduct train accident/incident investigations. *Accident Analysis & Prevention*, *38*(2), 396–406. https://doi.org/10.1016/j.aap.2005.10.013

Rock, J., & Burns, R. (2023, February 10). *There Will Be More Derailments*. The Lever. https://www.levernews.com/there-will-be-more-derailments/

Rogin, A. (2016, October 5). *How Congress and Lobbyists Helped Delay Passenger Train Safety Measures—ABC News*. https://abcnews.go.com/Politics/congress-lobbyists-helped-delay-passenger-train-safety-measures/story?id=42554562

Shiga, J. (2007). Translations: Artifacts from an Actor-Network Perspective. *Artifact*, *1*(1), 40–55. https://doi.org/10.1080/17493460600658318

Silverman, S. (2017, November 21). *To improve safety, significant cultural change is needed at Amtrak*. The Business Journals. https://www.bizjournals.com/bizjournals/how-to/growth-strategies/2017/11/to-improve-safety-significant-cultural-change-is.html

Yglesias, M. (2015, June 12). *The real reason American passenger trains are so bad*. Vox. https://www.vox.com/2015/6/12/8764819/why-american-trains-are-bad