The Actors Involved in the Takata Airbag Rupture Incident

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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.

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Introduction

In recent years, automotive safety systems, such as airbags, have been among one of the automotive industry's fast-growing sectors. Airbags have made driving substantially safer since their introduction in the late 1960s (Date, 2017; Nayak et al., 2013). They are used to cushion the driver and passengers during a collision to reduce bodily injuries and increase survival chances. The technology involved in the manufacturing and the interworking of airbags is complex. Also, airbag technology has been undergoing continual evolution in terms of design, material, and performance (Nayak et al., 2013). Airbags work when the car's sensors detect a crash; the airbag's mechanism triggers a chemical reaction by igniting a solid chunk of propellant. This thermal reaction makes the chemical expand as a gas quickly and inflates the bag, and vents on the back of the airbag prevent the whole thing from being blown to bits. All this happens quicker than the blink of an eye, roughly 100-200 milliseconds (LaFrance, 2015).

In 2001, Takata Corporation, one of the largest suppliers of car brands' safety systems, designed a much cheaper automotive airbag by using a new and cheaper propellant called ammonium nitrate (LaFrance, 2015). After becoming integrated into dozens of car brands vehicles, accident reports started to occur where their airbags would explode when deployed. Researchers concluded the cause was due to the new propellant, which they found to be a dangerously volatile compound when exposed to high temperature and moisture (Tabuchi, 2016b). This explosion shoots pieces of metal shrapnel at drivers and passengers, posing a potentially disastrous outcome from a supposedly life-saving device (Hankel, 2015). To date, this incident has led to more than 19 deaths and more than 400 hundred people injured in the United States alone, and NHTSA reports at least 27 deaths worldwide (Consumer Reports,

2021). With political and media pressure, the company had to initiate recalls for tens of thousands of United States domestic and international vehicles.

However, while it is true that the new propellant did play a role in the airbag systems failure, it was not the only actor; there were also other actors like Takata employees and automakers who also played roles in conjunction with the propellant. If we continue to think that the only cause was the propellant and do not include Takata employees and automakers that play privative roles; then we will not have a complete and new understanding of the various actors and power relationships among them that contribute to network failures.

In fact, to effectively increase human safety in car design and manufacturing, we should look more into the social-technical relationship. I argue that there are also actors like Takata employees and automakers responsible for this network failure in addition to the propellant. In what follows, I will begin mapping the network, and then I will discuss the contributions of Takata employees and automakers in particular that lead to the collapse of the airbag safety system. I will also use the science, technology, and society (STS) framework of actor-network theory (ANT) to analyze how the human and non-human factors contributed to the network failure. My study will examine government and court case reports about parties involved in the airbag explosion in order to support my argument. In doing this analyzes, I will dissect how Takata employees knew the dangers of using the propellent and tried to cover up the issues. In addition, how automakers were prioritized profit over human safety in selecting Takata as the sole supplier for their manufacturing and over-trusting the supplier's data.

Background

Takata Corporation is a Japanese company found in 1933 as a textile manufacturer but quickly developed an expertise in manufacturing parachuting systems for the Japanese military

(Baheti et al., 2019). After partnering with Japanese manufacturers, Takata supplied its first seat belt for vehicular installation in 1960 in which would be a turning point for the company as an automotive supplier (Baheti et al., 2019). This initial foray into vehicular safety would be a turning point for the company. The organization would create several innovations and firsts in the industry. This change, in turn, made them a supplier of parts to nearly every giant automaker in the world; Takata would rely on airbag systems for more than a third of its revenues (Baheti et al., 2019). Starting in 2008, the recall of vehicles linked with defective airbags occurred in the United States of America. Takata airbag defects resulted in more than tens of millions of vehicle recall between dozen vehicle brands (such as Toyota, Honda, etc.), which was the largest auto recall in history (Chen, 2019; Consumer Reports, 2021). On May 18, 2015, Takata admitted that there were security risks in their airbags but refused to release the problem detail about airbag defects (Chen, 2019).

Literature Review

While several scholars have researched the Takata airbag defect through a technical lens by examining the individual component of the airbag system, scholars have not adequately considered the actors responsible that lead to this airbag explosion incident.

In *A Ticking Time Bomb*, the author explained how the air bag's inflator was the cause of the defect, which can rupture due to sensitivity to humidity. According to the author, in March 2012, a woman rear-ended a car and had to be taken to a local hospital to have pieces of metal removed from her chest; a year later, she received a recall notice for her vehicle that was involved in the crash, indicating that the vehicle's airbag was defective (Gaskill, 2016). At the time of the accident, no one believed the airbag could cause her injuries. The author explains that it was not until 2015 that Takata admitted the widespread danger of its airbags exploding and

sending metal shrapnel flying at passengers. As the recalls continued to expand, the U.S. National Highway Traffic and Safety Administration (NHTSA) conducted studies. After uncovering the nature of the defect, they came to the same conclusion that propellant is temperature and humidity sensitivity (Gaskill, 2016). The author continues into the cause of the instability. In 1998, Takata engineers met to review whether they should try using ammonium nitrate, a cheaper compound but less stable. In fact, a former Takata propellant engineer said during the meeting, "If we go forward with this, somebody will be killed (Gaskill, 2016)." The author states that three independent investigations found ammonium nitrate propellant to be the root cause of Takata's airbag defects: "Without an additive to prevent moisture absorption, the compound degrades after years of exposure to humid air and temperature fluctuations" (Gaskill, 2016). Thus, this damage can cause the propellant to explode too forcefully and spray metal shards. The author finishes the article by explaining why the time to resolve the exploding airbags takes a long time. Gaskill explains three reasons why replacing the defective airbags is a slow process it includes: "their designs are unique to each car model, the extensive testing process to get approved by regulators like the NHTSA, and that companies are not only having to make replacement parts, but they must make airbags for all the new cars, too" (Gaskill, 2016).

In *Honda Motor Company: Communication and the Takata Airbag Crisis*, the article analysis Takata airbag explosion affect one of the automakers, Honda, and the backlash they face due to Takata using unstable propellant. The authors begin the article by giving some background and details about the organization in play like Honda, Takata, and NHTSA. Then the authors explain how airbag is supposed to work and deployment. The authors mention how at the early stage of Takata airbag development, they used an explosive compound called sodium azide (Baheti et al., 2019). Although stable and safe once installed, it is highly volatile and toxic during

manufacturing, so bad that if ignited can trigger asthma attacks. The authors explain that all these problems create multiple safety issues, and to solve these problems, Takata began searching for alternatives. They discovered a breakthrough with tetrazoles (Baheti et al., 2019). However, this propellant did not last long, and a couple of years later, Takata developed the ammonium nitrate inflator. According to reports, "this breakthrough allowed them to make the smallest, lightest inflator on the market and improve manufacturing safety" (Baheti et al., 2019). The authors then start to examine the issues that begin to expand with Takata's new airbags and highlight some of the accident reports about exploding airbags. Finally, the authors conclude with the congressional involvement and recall of Takata airbags due to their dangerous propellant. The authors state that one of the senior vice presidents for Global Quality Assurance at Takata testified that the "root cause of the exploding inflators was unknown, but it likely involved a combination of three factors. One the age of the unit, two persistent exposure over an extended period to conditions of high absolute humidity, and three potential production issues" with the inflator (Baheti et al., 2019). Also, how Honda was put in charge of communicating the recalls and took a hit to their reputation.

While it is true that the Takata and their decision to use the ammonium nitrate as the propellent contributed to the problem that caused the airbag to rupture unexpectedly; what these analyses overlook is that there were other actors, mainly Takata engineers and automakers, that also played a critical role that contributed the airbag system to fail. This paper will use ANT to provide detailed evidence and cast a broader net for other actors that played a role in the system's failure and ultimately lead to humans being killed or severely injured.

Conceptual Framework

My analysis for Takata airbag defects and network failure will draw on the STS concept of ANT because it allows the heterogeneous components and connections of this field to be isolated and critiqued. The basic ideas that ANT studies how network builders assemble networks of human and non-human actors to accomplish a goal or solve a problem. ANT allows me to investigate and theorize about how networks come into being, to trace what associations exist, how they move, how actors are enrolled into a network, and how network achieve temporary stability (or conversely, why some new connections may form networks are unstable) (Cresswell et al., 2010). The aim is to gain detailed insights into how social effects such as power come into being. As Crawford explains, ANT "redefines actors not so much as willful or intentional agents but instead as an entity," both "human or non-human" actors "that in some way influences or perturbs the activity of a techno-society system" (Crawford, 2020). ANT assumes that if any actor is removed from or added to the network, as is the case for introducing technology into an organization, then the functioning of the whole network will be affected (Cresswell et al., 2010).

In the analysis that follows, I begin by analyzing the power dynamics among human and non-human actors associated together in a network designed to accomplish a particular goal that failed to meet parameters and contributed to the network's failure.

Analysis

Network Formation

Reconstruction of the Takata airbag actor-network will provide the necessary framework for the critical analysis to follow. First, let me start by briefly mapping the network by first identifying the network builder who is Takata, with the network goal of engineering and manufacturing a vehicle airbag that; when an accident occurs, will deploy to save the lives of

humans and reduce serious injuries (Etienne, 2020). Next is to define the heterogeneous actors – human or non-human – that are present within the network that includes: Takata engineers, Takata executives who engineer the airbags, and automakers who installed them in their vehicles (Tabuchi, 2014; Tabuchi & Boudette, 2017). These human actors that I have identified contributed to the network's failure by: (i) Takata engineers who are responsible for choosing dangerous propellant and manipulating testing data; (ii) Takata executives who were placing profits over human life in approving the use of the cheaper propellant; (iii) automakers who agree to use the airbags and continued using after reports of accidents.

Takata Engineers

Firstly, I will discuss how Takata engineers contributed to the network failure. My first claim is that Takata was investigated on the fact that it controlled the data test and removed bad data to make reports of products look qualified (Chen, 2019; MacDuffie & Dasher, n.d.). Honda's audit of Takata airbags suggested that Takata engineers removed some test results to artificially reduce the variability in air-bag inflator performance. In an interview with Brain O'Neil, a former Insurance Institute for Highway Safety president said that "we have found examples of what I would call 'selective editing,' where they (Takata) have left out results not because they were bad results, but because the results that remained were better" (Bloomberg, 2016). For example, Takata changed the data so they meet the customer requirement for a safety factor of 1.5 presented in Figure 1. This misrepresentation with data suggests that Takata engineers wanted to keep selling their airbags to automakers and have job security. Secondly,

	US		Japan
Note: Both the US and Japan data in this report has been sorted in decending order of magnitude.	60.25		59.20
	59.04		58.00
	58.72		58.00
	58.63		57.80
	58.17		57.20
	56.99		56.20
	55.62		54.80
	54.99		54.70
	54.12		54.20
	54.07		53.60
	53.91		53.50
	53.29		53.40
	52.83		52.90
	52.54		52.40
	52.30		52.30
	51.93		52.20
	51.60		51.90
	51.16		51.70
	50.97		51.70
	49.27		50.70
average	54.52		54.32
std dev	3.16		2.56
+3 sigma	63.99		61.99
Burst Pressure	94.00		94.00
Safety Factor	1.47		1.52

Figure 1 – Takata Airbag Test Data. Left: United States testing data and Right: Takata testing data (Nelson, n.d.)

Takata described that the defects occurred in the specific event, which was not a wide problem, and then tried to announce that they have improved them and ensure safe and quality of products. However, the deaths and injuries still occurred due to defects. In fact, Takata's internal file indicated engineers have been recording problems about airbags (Chen, 2019). In 2004, an engineering manager at Takata's Armada, Michigan Plant wrote regarding a specific model of the inflator, "IF we continue to humor them by sending them DV/ PV [Design Validation/Process Validation] data so they can 'selectively modify' however they see fit, the data reported to our Asian Customers will always be suspect compared with what we will have on file here" (Nelson, n.d.). This evidence communicates that Takata engineers knew the dangers associated with their airbags, but since they had a stake in this network, the company would collapse if the airbag fails.

Takata Executives

Another actor who contributes to the network failure was Takata executives. They claimed not to be aware of the harm of producing inadequate airbags and agreed on it (Chen, 2019). A director within Takata's global inflator/propellant organization raised ethical concerns to a senior vice president, failing to address the concerns. More than four years after the first recall of Takata airbags, the director was asked in March 2013 to present information to an automaker about the range of vehicles affected by a recall. In his notes, which Committee minority staff reviewed, the director wrote, "I told the group that it seemed clear to me that the information used to set the range of the recall was, in one case, technically unsupportable, and in the other case, a likely misrepresentation of the production records." Later in his notes, he explained, "The basis for limiting the 2002 recall population is false. It is a blatant misrepresentation of the production records" and "will either generate unnecessary recall

population or fail to recall a product that is suspect," which he deemed a potential "violation of our moral obligation to protect the public" (Nelson, n.d.). The director's comments suggest that Takata as a business might only concentrate on earning benefits from the auto airbag business. As a result, there was fraud from Takata towards other brands and customers. (Chen, 2019)

I would also argue that Takata's poor manufacturing and quality management controls contributed danger to the network and has been questioned for other incidents. In 2003, Hiroshi Shimizu, Senior Vice President for Global Quality Assurance, Takata Corporation, testified that it was a manufacturing process problem that caused an airbag rupture in a similar incident in Switzerland. Furthermore, he continues that they did identify two manufacturing process problems related to this incident; "first an operator apparently put too many wafers in the inflator, and second, a height-check device designed to verify that the proper quantity of wafers had been put in the inflator was not properly functioning, resulting in the possibility that the device may have failed to detect an overload" (*Takata Airbag Ruptures and Recalls*, 2014). This evidence shows Takata quality issues way before the significant number of incident reports that initiated the airbag recall. However, Takata did not take time to thoroughly investigate the incident and just classify it under a technical defect.

In 2016 an independent Takata Corporation quality assurance panel conducted a study to evaluate Takata's current practices to ensure that product quality, which is an indispensable component of product safety, is at the forefront of all facets of Takata's operations so that consumers safety is paramount. The panel concluded from its review that Takata must make significant improvements across the quality spectrum and, in particular, in three broad areas: "(1) addressing quality-related concerns; (2) ensuring quality in Takata's design and manufacturing processes; and (3) promoting quality through improved management practices" (Skinner et al.,

2016) and again, showing that Takata management did not promote the best engineering practices. Other reports also reported sub-standard chemical handling procedures to mis-manufactured and poorly designed canisters that increased propellant exposure to moisture. (*Takata Whistleblower Says Air Bag Warning Was "Ethical Duty,"* 2018). Therefore, from Takata's manufacturing and quality process, some gaps could have contributed to Takata not identifying that their airbag network was destabilizing from within the company.

Automakers

Now let's look at the automakers and how that contributed to the failure of the network. I argue that automakers play a role in prioritizing profits to over-trusting Takata and not performing testing to ensure safety devices like the airbag were working effectively. One example I want to look at is an event in the late 1990s when General Motors (G.M.) got an unexpected and enticing offer from a Japanese supply, Takata, who said they had designed a much cheaper automotive airbag (Tabuchi, 2016b). G.M. tuned to their airbag supplier, which at the time was the Swedish-American company Autoliv and asked them to match the cheaper design or risk losing the automaker's business, according to Linda Rink, who was a senior scientist at Autoliv assigned to the G.M. account at the time (Tabuchi, 2016b). However, when Autoliv's scientists studied the Takata airbag, they found that it relied on a dangerously volatile compound in its inflater, the ammonium nitrate which I explained in the literature review section of this paper. Thus, one of Autoliv's chemists, Robert Taylor, said, "No, we can not do it," which led G.M. to drop the Autoliv account and partner with Takata as the sole supplier for their airbag systems (Tabuchi, 2016b). This decision by G.M. suggests that they were on the quest for savings of just a few dollars per airbag, which comprised a critical safety device, resulting in passenger deaths and injuries. In fact, Linda Rink's team got told that the Takata inflaters were as

much as 30 percent cheaper per module. In addition, relevant departments and other auto brands such as Honda, Toyota, Nissan, Subaru, and Mitsubishi also contributed to the network failure. These brands did not taking to the extra step to ensure the safety of Takata airbags (Chen, 2019). They also ignored the problems; the first report of the airbag defect happened in 2000. However, it was not until 2008 that the airbag recall started, an eight-year difference between this and the first complaint (*Takata Expected to Pay $1 Billion in U.S. Settlement*, n.d.). From these evidence reports, they might not always use goodwill to be the motivation of solving problems because if they always used goodwill, these brands and departments would focus on each possible problem and solve them until obtaining reliable safety reports or early recalling.

Another example was in 2016, according to a Senate Commerce Committee report, at least four automakers (Toyota, Volkswagen, Fiat Chrysler, and Mitsubishi) continued to sell new vehicles with defective Takata airbags (Tabuchi, 2016a). In addition, automakers were not required to tell buyers of the new cars about the problems with the airbags, which just adds more fuel to the fire and puts more humans in danger (Tabuchi, 2016a). Again, automakers did not want to fall out from a recall and use profits to fix customers' vehicles.

Despite the evidence provided above that see automakers as a contributor to the failing network. There are others who see automakers as the victims of Takata's missteps and argue why are they must be held responsible for the cost of replacing the potentially deadly airbag (Tabuchi, 2016a). While these are solid and reasonable arguments, automakers have the utmost duty to ensure that vehicles leaving their doors intended to put human life and safety above all else can perform to the best of their abilities.

Conclusion

In this paper, I have used the socio-technical concept of ANT to systematically compile and deconstruct the Takata airbag defect actor-network to identify the root source that led to the airbag safety system's failure and cause harm to humans. By analyzing the actor's relationship within the network, it is evident that Takata employees knew the dangers related to the new propellant and tried to cover up the safety risk. In addition, automakers took the cheaper route without doing extra quality assurance to ensure passengers were being kept safe. With this newfound knowledge available, we can better see where the problem arises during vehicle design and manufacturing, leading to injuries to humans and introducing countless recalls in the automotive industry. The analysis also shows whether actual individuals could be held responsible for the airbag system's failure instead of organizations, like Takata alone. This incident gives a warning to other industries in the automotive sector that if they do not account for all actors in their network, that network is prone to destabilization and could ultimately collapse. Another option is for automakers and suppliers to integrate more of their quality managers into the product development process.

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