The Challenger Disaster Engineering Ethics Case Study and Technical Report

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Abstract

Regarding the Challenger Disaster from an engineering ethics perspective, this technical report examines the various failure points of the mission that resulted in its unfortunate demise. The cause of the explosion is determined to be the O-rings, while the specifics of preventing their failure is demonstrated to be infeasible. The blame for the disaster then shifts onto the decision to progress during inoperable conditions for these O-rings with the knowledge of their previous failures. The human element is recognized to be the main cause, as communication from management to engineers became ineffective and ignored, and key figures of this disruption are identified with their specific breaches of the code of engineering. Finally, an examination about the consequences of these decisions and the resulting fixes implemented shows the growth caused by the disaster.

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The launch of the shuttle Challenger occurred during the setting glory days of the space race, and was part of a combined effort to bring back public interest towards NASA through the use of the first civilian astronaut. Furthermore, the STS system continually faced pressure as its relatively recent founding required funding for improvement. As a result, the Challenger mission had a burden to progress smoothly and allow recognition to come into NASA, which indirectly resulted in its failure. Shortly after the Challenger launched, the destruction of the solid rocket boosters led to the explosion of the shuttle and the untimely demise of the seven astronauts on board. The Challenger Disaster was a direct result of failure in the O-rings, but more fundamentally revolved around the human element and the unethical decisions made by a pressurized, convoluted, and disconnected chain of command.

The Challenger shuttle’s explosion was a result of the destruction of various fuel tanks as movement and fire from a leaking solid rocket booster tore through the structures. This leak began at a field joint containing an eroded O-ring which did not fully seal the joint due to the failure of the thermal putty (Engineering Ethics, n.d.). These problems were all a result of the inclement weather that had occurred during the night prior to and morning of the launch. Critically, the day of the launch saw the arrival of a cold front with temperatures at 36 degrees or lower (The Accident, n.d.). Initially, this may place the problem on the design of the space shuttle system itself as, had the materials not failed, the shuttle would not have failed. Reporting provided by the Presidential Committee regarding the cause of the accident details that the leak of the solid rocket booster’s gases was the main cause of the larger tank’s collapse, which caused the large explosion (The Cause, n.d.). The cause of the leak was determined, by the Presidential Committee, to be a result of the erosion of O-rings on the solid rocket boosters. Erosion on these seals had been seen as far back as a decade before the launch, and Thiokol even provided steps to prevent failure of the rings through the use of redundant seals, protection of mating surfaces, and providing for proper environments (Presidential Committee). However, only the use of redundant seals could be seen on the day of the launch as protection from the cold weather had not been provided for. While the seals, and the putty that protected them, could have been made more resistant, it was not the critical flaw resulting in the Challenger disaster as it would have required foresight of launch day decisions and a significant deal of effort without much reward due to the inability to easily alter the material properties of the proprietary third-party parts. Rather, the impetus to these direct technical failures was the decision to launch in the inclement and unsafe weather conditions. While the technical faults played a significant role in the disaster, more of the blame resides in the human element that forced the faults’ appearance.

The decision to launch in weather that posed a danger to the O-rings sealing capabilities involved a clash between the management and engineering team of Thiokol. Providing the contractor services for the construction of the solid rocket booster, Thiokol engineers concerned with the low temperatures forecasted on the day of the launch reached out to their connection with the Kennedy center, Mr. McDonald, who then reached out to the vice president of engineering, Mr. Lund (Contributing Causes, n.d.). With research about the concerns taking place through the engineers, a teleconference was setup to request a delay since, as engineer Mr. Boisjoly and Mr. Lund presented, a minimum operating temperature of 53 degrees had been determined (Contributing Causes, n.d.). However, Mr. Mulloy, part of management at the center, pushed against the delay under the rationale that an effective seal would be likely from the incomplete data presented. Breaching the code of ethics, Mr. Mulloy saw the fundamental canon for the safety of the public as beneath the disruption caused by time delays due to the pressure of the situation (Code of Ethics, n.d.). Mr. Hardy, who was also part of management, stated that the engineers’ decision was appalling while Mr. Mulloy had an outburst regarding the postponement of the launch until April due to the engineers (Contributing Causes, n.d.). Offering insight towards the perceptions and unethical priorities of the management, the primary fault in the decision-making process under the control of the management is revealed. As the conference went on, the intractable views of Mr. Mulloy and some others in the management conflicted with the logical trust put on to the engineers and experts by the rest of the management until a caucus was initiated.

Following the stagnation of the discussion, the proposed caucus saw the exclusion of the engineering team in the decisions made as management monopolized the process. Aside from the affiliation some management had with engineering, Mr. Lund represented the primary engineer in the caucus. However, Mr. Lund was told to focus more on the management perspective instead of the engineering perspective during the discussion that followed (Contributing Causes, n.d.). The management was stated to have created an atmosphere where the O-rings had to be proven to fail rather than proven to succeed, which forced Mr. Lund, under his professional rules of practice, to concede as he could not dishonestly guarantee failure of the O-rings (Contributing Causes n.d.). Demonstrating the neglect of the management to prioritize the safety and reliability of the engineered structures, the management clearly worked against the fundamentals of engineering as they reversed the process for decision-making. However, sole blame for this fatal decision cannot be placed solely on the management as the engineers also breached the code of ethics (Code of ethics, n.d.). Mr. Boisjoly and Mr. McDonald both demonstrated their dissatisfaction with the ignorance of the management and the potential harm an improper decision could cause, with Mr. Boisjoly even stating a feeling of defeat (Contributing Cause, n.d.). However, while Mr. McDonald continued to report the negligence to his superiors and sought higher authority, Mr. Boisjoly did not follow through with his professional obligations as an engineer. Management still retains the majority of the fault as they did not actively seek to make their superiors aware of the complaints brought up by Mr. McDonald, since the launch officials stated that they would not have launched had they been aware of the concerns of Thiokol engineers (Contributing Causes, n.d.). The decisions made by the management and the critical flaw to move away from a discussion with the engineers forced a variety of unethical shortcuts and communication gaps to be taken and made, leading to the faulty decision to launch under inoperable conditions.

The Challenger Disaster played a significant role in the public perception of NASA and heavily influenced the capabilities of aerospace endeavors in the following decades. The failure of the O-rings and protective thermal putty due to the environmental conditions subjected to the materials partially brought fault to Thiokol’s construction of the solid rocket boosters. The conditions the seals were subjected to played a greater role than the materials themselves as failures in engineering fundamentals and following of the code of ethics saw a breakdown in communication between qualified engineers and driven management. However, this unfortunate accident also saw the recognition and initiation of fixes through the various areas where problems began and broke down in. Improvements in the O-rings were advanced, as shims decreased gaps, while social reforms, such as improvements in management interactions through accidental damage reporting, helped fear about job security in reporting to authorities under the engineering rules of practice (Engineering Ethics, n.d.). As space missions become more selective and sophisticated in the coming times, the importance of safety and reliability over all will exponentially increase due to the heightened risks of losing resources on costly missions in deeper space. Furthermore, as space becomes more communal, safety in protecting greater numbers of civilians will take on greater importance as well due to the fundamental engineering code of ethics and the reliance on public support. The Challenger Disaster was an unfortunate accident that could have been prevented with improvements in the command structure and communications but provided the stimulus to make crucial changes that necessarily should be safeguarded and remembered.

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