Senior Seminar
Assignment #4: Ethics

Ethical Considerations of the Challenger Launch Decision

Overview

In the 1960s, the National Aeronautics and Space Administration (NASA) conceived the idea of a reusable space ship- the space shuttle. The shuttle comprised of a reusable orbiter, a single-use external fuel tank and two reusable solid rocket boosters (SRBs). The expected cost to design and build the shuttle was $6.2 billion. In 1973, Morton Thiokol Corporation won the $800 million contract to create the SRBs [1].

The solid rocket boosters are made of 11 seamless steel sections, joined with tang-and-clevis joints and steel pins. The joint connecting the motor to the solid propellant is sealed with two rubber O-rings. The first O-ring is designed to take the majority of the pressure on the joint; the second O-ring is a backup. A layer of zinc chromate putty lines the O-rings, to act as a thermal and contact barrier be s and the combusting gases within. This zinc chromate putty is the only gas barrier present. The O-ring material is designed to be activated by the pressure of the gas, stretching the putty to retain the seal. If the O-ring material reacts too slowly, "blow-by" can occur, where a gap in the joint allows the ignited gases to escape and destroy the seals. The actual opening of the joints is referred to as "joint rotation" [1].

During the testing phase as well as actual shuttle launches, problems were discovered with the joints. As early as 1977, joint rotation was recorded in the milliseconds after ignition. Thiokol engineers did not think this would cause problems

[1]. They claimed the problem was a "self-limiting phenomenon" and that the O-rings responded correctly after 0.600 seconds. However, engineers from Marshall Space Flight Center, the NASA branch in charge of propulsion, wrote several memos during 1977 – 1978, indicating that the joint seals were unacceptable [2]. These memos were directed to George Hardy, Marshall's Deputy Director of Science and Engineering, but for reasons unknown, were never forwarded to Thiokol [1]. Tests in July 1978 and April 1980 showed the same joint rotation. In 1980, NASA created a committee to evaluate the entire shuttle design. In the committee's report, the SRB joint was classified as "Criticality-1R". This classification meant that the joint contained redundant hardware, but failure of the system would result in destruction of the space shuttle. Since there were over 700 other parts of the shuttle listed as "Criticality-1", this classification was not unusual [3]. Under this hazardous classification, the joints were accepted for flight [1].

One remarkable fact about the O-ring damage is that it was anticipated early on by McDonnell-Douglas Astronautics, a company originally competing for the orbiter contract. The McDonnell-Douglas design included a "burn-though wire" to sense "O-ring leakage" which would trigger a small solid rocket abort motor. This design was several thousand pounds heavier as well as more expensive, and so was rejected despite being safer [4]. Even the O-ring sensor was cut from the final design.

During actual flights of the space shuttle, O-ring damage occurred. Engineers found damage to the O-rings in 14 of the 25 shuttle launches from 1983-1986 and evidence of blow-by in 10 of those flights. In all, there were 7 flights prior to Challenger's destruction which registered an "incident of O-ring thermal distress", meaning excessive blow-by occurred [1]. In 1982, the O-ring seals were re-classified as

Criticality-1, making it a possible single-point failure which could result in loss of the vehicle and crew [4]. On August 20, 1985, Morton Thiokol created a task force to evaluate the O-rings. One of the members of this task force was Roger Boisjoly, an engineer who had evaluated O-ring damage on prior shuttle missions. The worst case of blow-by that Boisjoly had investigated was on the shuttle flight 51C from January 14, 1985. The ambient temperature this day was the lowest yet recorded for a flight. Boisjoly found blow-by on two different joints and damage to both the primary and secondary O-rings. His hypothesis was that the O-rings were less resilient at lower temperature, causing them to react slowly and allowing for blow-by [1].

Prior to each shuttle launch, NASA officials at Johnson and Kennedy Space Centers and Marshall Space Flight Center held a Level I Flight Readiness Review (FRR) teleconference. The purpose of this review was to guarantee that a shuttle mission was ready for flight. Responsibility for the propulsion system belonged to Marshall Space Flight Center. During Challenger's FRR on January 15, 1986, engineers from Marshall declared that there were "no major problems of issues" regarding the SRBs. There was discussion of possible weather problems at this review, but only to the extent of concern over the unusually high amount of rain Florida had been receiving (the shuttle cannot launch or land in rain) [5].

On January 16-17, Morton Thiokol sought approval from Marshall Space Flight Center to completely redesign the O-ring seals [6]. On January 25, NASA hosted a Launch-minus One Day Flight Readiness Review. The Marshall managers reaffirmed that the propulsion, including the Solid Rocket Boosters, was ready and problem-free. They said nothing about the pending redesign of the O-rings.

The Challenger mission had originally been planned for launch in July 1985, but was postponed multiple times to January 26, 1986, mainly due to rescheduling of the Columbia mission launching just a week before Challenger. Certain vital "spare" parts had to be cannibalized from Columbia and installed on Challenger before a launch was possible [7]. A bad weather forecast delayed the launch again until January 27, and excessively high crosswinds on the 27th caused a scrub (cancellation after countdown has started), which pushed the launch further back to January 28. The evening of the 27th, Thiokol called a teleconference with NASA personnel at Kennedy and Marshall Space Centers to discuss concerns about low forecast temperatures for the launch. Boisjoly presented the O-ring data from the task force, and Thiokol recommended that the launch not proceed until the O-rings were at least 53°F, the temperature at which flight 51C had launched [1]. Management from Marshall questioned the logic of Thiokol's engineers, declaring the data to be inconclusive. George Hardy (Marshall's deputy director for science and engineering) declared that he was "appalled" at the recommendation not to launch, but did not want to fly without Thiokol's approval [8]. Thiokol asked for a break in which to discuss the problem amongst its own managers. Despite fervent objections from Boisjoly and other engineers, Thiokol finally declared after the break that the data was, indeed, inconclusive and that launch was acceptable, despite low temperature concerns [1, 8].

NASA was under constant pressure to launch as soon as possible – there were 11 flights scheduled for 1986, and each delay cascaded down the line to affect other flights. If Challenger was launched by the 28th, the following mission could still by launched by

March 6, a mission which was in competition with Soviet missions to survey Halley's Comet [9].

Overnight temperatures had been in the low twenties, and an ice inspection team was sent to the launch pad to determine when enough ice had melted to recommend launch. The ice team found icicles up to 18 inches long coating the launch pad. One member of the ice team measured the aft section of the right-hand SRB at only 8°F [10]. There is a shuttle ambient temperature launch constraint of 31°F, due to the use of water in aspects of the launching sequence, but this is only ambient temperature [11]. There is no constraint on actual hardware temperature for launch. Early in the morning, Rockwell International, the manufacturer of the orbiter, recommended against launching due to the ice buildup. The ice team continued to clear ice, as the day warmed and ice melted. After calculating that the ice would no longer be a danger to the shuttle, NASA administrators cleared the launch. The final decision fell to Jesse Moore, the Associate Administrator for Space Flight. No mention of the possible problems caused by the cold and ice, nor Morton Thiokol's concerns about the O-rings ever reached him. Having heard no objections, he announced the launch just after 11:25 am [12]. The Challenger was finally launched at 11:38 am, EST, with an ambient temperature of 36° F [1].

Upon launch, catastrophe occurred [13]. Immediately after SRB ignition, the O-ring in the aft field joint of the right-hand SRB failed to seal. Both the primary and secondary seals were vaporized at a single point. Photographs show black puffs of smoke from the right-hand SRB. Before the escaping gases could ignite, however, aluminum oxides from the burnt propellant sealed the leak. Fifty-nine seconds into launch, Challenger passed through the most violent wind shear ever encountered by a shuttle. The fragile oxide seal shattered under the pressure and allowed flaming gas out. The flame was directed downward at a stabilizing strut, burning through it and then the exposed Main External Tank. The tank began leaking fuel, which also ignited in the air at the lower end of the tank. Freed from its lower struts, the SRB swiveled toward the main tank, rupturing it and setting fire to hundreds of tons of propellant. The breakup of the engines burned through the right wing section of the orbiter before separating into pieces. The orbiter, suddenly in a free-fall and subject to 20-G forces, broke into its pieces: wings, payload bay, crew compartment [13]. Everything fell into the ocean.

In the aftermath, the Rogers Commission was formed to determine the cause of the accident and recommend changes for the future. The commission determined that the faulty O-ring design was indeed the cause of failure, but that the contributing cause was the faulty decision-making process and poor communication amongst NASA and its affiliates [14]. The commission set forth 9 recommendations, including a redesign of the SRB seals, the creation of a Safety Organization, a demand for improved communications, and the development of abort/escape measures for the crew [15].

Virtue Ethics

Analyzing a decision from a Virtue Ethics point of view offers a very subjective way of looking at a situation. Classical Virtue Ethics are defined by Aristotle [16]. Happiness or "human flourishing" is promoted directly by Virtue. Aristotle's defined Virtues are: Perseverance, the ability to act despite a difficult or lengthy task; Courage, the ability to act against one's fears; Compassion, the ability to respond to others' suffering in a way that seeks to alleviate it; and Self-love, the ability to do whatever promotes one's own genuine flourishing. Practical wisdom derives from the application of these virtues. Virtue Ethics does not analyze with regard to action – it does not tell a person what to do, just what is of good character.

It would be easy in retrospect to declare that all people involved in the decision to launch the Challenger were un-virtuous, as their decision clearly did not promote human flourishing. But that is only the result, the *action* derived from the decision. Virtue Ethics instead seeks to evaluate only the persons involved and the virtues they display. This analysis will also take note of which virtues should have been heeded, or that which made the parties involved un-virtuous.

Roger Boisjoly

Starting at the bottom of NASA's management chain-of-command, Roger Boisjoly was one of the engineers at Morton Thiokol Corporation assigned to the task force to evaluate the O-ring performance [1]. He found that the O-rings did not seal properly and attempted to communicate his concerns to his superiors. He sent several memos and reports to his superiors throughout 1985, which were apparently ignored. He was present during the January 27th Thiokol teleconference with Marshall management, and repeatedly tried to make clear the problems at low temperatures. Even having the meeting was courageous – Marshall did not want to hear reasons why the shuttle should not be launched. At one point in the teleconference, Marshall's SRB Project Manager Larry Mulloy declared "My God, Thiokol, when do you want me to launch? Next April?" [8]. It took courage to admit that the O-rings were a possibly fatal flaw.

During the break with Thiokol management, Boisjoly and another engineer desperately tried to convince their superiors to stick with the original recommendation against launch. The managers ignored them, even when Boisjoly physically intervened, grabbing relevant photos and shoving them at the managers. Eventually, when Boisjoly realized that they were not going to listen, he gave up and allowed Thiokol to sanction the launch. Boisjoly showed perseverance in this case, as he repeatedly tried to communicate the issue, but he didn't persevere enough. It came out later that the Thiokol management was under the impression that the O-rings could erode up to one-third of their diameter and still be safe [8]. Had Boisjoly continued to try and explain the situation, he may have dislodged this notion. Another virtue could account for his lack of perseverance. Continuing to badger his managers could have jeopardized his job. The virtue of self-love promotes one's own flourishing. Maintaining a job would allow Boisjoly to flourish, but since "human flourishing" is closely tied to happiness, the question arises of whether or not Boisjoly could be happy in his job had stayed quiet about the problem. Self-love can go both ways. It seems that in this case, Boisjoly eventually found he would be happier with himself by reporting to the authorities.

In the wake of the disaster, Roger Boisjoly testified before the Rogers Commission with his knowledge of the O-rings and management's erroneous decision [17]. After the testimony, he experienced a "hostile work environment" at Morton Thiokol, eventually taking extended sick leave, then long-term disability for two years, and finally resigning [1]. Boisjoly did the virtuous, courageous thing by "blowing the whistle" on Thiokol, and sacrificed his job as a result. It can also be interpreted that Boisjoly felt compassion for the lost astronauts, their families, and the shocked American public. He sought to relieve their suffering by bringing forth as much of the truth as he could contribute.

Thiokol Management

Just above Boisjoly on the chain-of-command were the senior managers of Morton Thiokol. They seem to have displayed little to no virtues at all, beyond perhaps the self-love exhibited in keeping their jobs and Morton Thiokol's contract with NASA. The virtues they should have exhibited are all too clear.

"confess" would be better in formal paper

Thiokol's management did not have the courage to "fess up" to the company's mistakes. During that teleconference, the virtuous thing would have been to persevere, to stick with the original recommendation not to launch. This also would have shown compassion toward Roger Boisjoly and the other engineers, since they were clearly concerned and upset about the potential danger and kept re-iterating the problem.

Marshall Management

Further up the line is Marshall Space Flight Center and its managers. Within Marshall occurred one of the major communication breakdowns of the entire system. The Marshall Space Flight Center was headed by William Lucas. Lucas ruled Marshall with an iron fist, determined that Marshall not be at fault for anything wrong with the shuttle missions. An anonymous letter received by the Rogers Commission sums up the problem with the communication system:

> "It has been apparent for some time that the Flight Readiness Review process developed by Lucas and other senior NASA managers simply was not doing the job. It was not determining flight readiness. Rather, it established a political situation within NASA in which no center could come to a review and say that it was 'not ready.' To do so would invite the question '…why are you not doing your job? It is your job to be ready.'… Lucas made it known that, under no circumstances, is the Marshall Center to be the cause for delaying a launch…" [18]

To overcome the political situation mentioned, someone at Marshall needed to have courage to stand up to Lucas and also to admit a problem to the Flight Readiness Review. Lucas himself could have had the courage to recommend a postponement, flying in the face of NASA's frantic rush to fly missions as quickly as possible. This lack of brave people helped created the alarming lack of communication which was eventually listed as a secondary cause of the disaster by the Rogers Commission. Lucas had been informed directly of Thiokol's concerns about the cold, but didn't report this to the administrators at NASA, simply because that was not the organizational structure. Lucas did not report to them. If he had showed compassion instead, he might have been worried about this potentially disastrous problem, and made sure that the higher-ups were aware of it.

NASA Administrators

The actual decision of whether or not to allow the Challenger to launch was in the hands of Jesse Moore, NASA's Associate Administrator for Space Flight. He was advised by Arnold Aldrich, director of the National Space Transportation System. Moore was apparently never notified of the flight safety problems provoked by the unusual cold, nor had he heard of Morton Thiokol's concerns from the teleconference the evening before. The only virtue he might have displayed was perseverance- the will to carry on the space program as scheduled.

Aldrich, however, possessed some of the information about the possible problems and yet managed to recommend a launch to Moore anyway [12]. Aldrich had heard from Rockwell, manufactures of the orbiter, that the ice on the launch pad and extremely cold ambient temperature could be a hazard to the orbiter when the ice broke during launch. Though there were quick calculations which hypothesized that the ice would not contact the orbiter, it seems that Aldrich's decision to recommend a launch was largely fueled by perseverance. The space program needed to launch the Challenger on the 28th to keep on schedule for the rest of the year. Multiple problems with the launch preceding Challenger had harried the administrators and staff of NASA, and Challenger had been delayed multiple times. The desire to persevere and overcome the obstacles presented by the weather may have provoked Aldrich to cut safety corners. From Aldrich's view, "human thriving" could best be achieved through continued shuttle missions carried out in a timely manner.

Conclusion

It is clear from this analysis that the only person of any particular virtue in this disaster was Robert Boisjoly. It is probably this reason why the general public regarded him as a hero amongst a corrupt bureaucracy. He is the only person who knew about the problem and came close to doing everything he could to stop it from happening. He exhibited perseverance, courage, compassion, and self-love, combining them all to display wisdom in the face of unethical decisions by others.

The virtuousness of others involved is more tenuous. From Aristotle's original Virtues, it seems that perseverance actually leans in favor of the decision to go ahead with the launch. The problems of the shuttle and the demanding flight schedule certainly provided sufficient difficulties to overcome. In the aftereffect, this perseverance did not result in the desired "human flourishing"- lives were lost, and any further benefit derived by mankind from the space program was delayed considerably.

This example reveals a flaw of Virtue Ethics, in that it declares what qualities displayed by people are "Virtuous", but gives no indication as to what actions ought to result from these virtues. Actions must result from each individual's interpretation of the virtues and how they apply. Virtue as a general concept can be defined as qualities which are admired by others. As these qualities change drastically from culture to culture, the analysis of virtue becomes an incredibly subjective venture. In the modern world, virtue cannot be summed up by Aristotle's list of perseverance, courage, compassion and self-love. Perhaps this is why the practice of Virtue Ethics is fading into the background.

Utilitarian Analysis

Utilitarianism offers a very logical way of looking at the Challenger Disaster and determining what steps, if any, should have been taken to prevent the disaster. Simply put, Utilitarianism (also called Cost-Benefit Analysis) is the ethical theory that encourages decisions which produce the greatest good for the greatest number. This concept requires the definition of a measurable good, called "utility". Happiness is worth positive utility, while suffering is worth negative utility. Accordingly, we should all make decisions based on what will make many people happy and few people unhappy. In this analysis, we'll do our best to enumerate all the harms and benefits resulting from the different decisions NASA could have made in the Challenger project.

Decision 1: Ignore Warnings and Launch

We begin with this scenario because we want to emphasize that this analysis is not meant to operate with perfect hindsight. Obviously we all wish we could go back and undo the launch, as the death of the entire crew was the ultimate utilitarian negative times seven. However without knowledge of the future the situation becomes harder to avoid. The probability of disaster is important. For example, we don't all stay indoors all day for fear of being struck by lightning, but we may take shelter during a thunderstorm. NASA likewise did not believe deaths were likely in the shuttle launch. Still, counting all of the potential positives and negatives of deciding to launch could have illuminated a different path for NASA's decision makers, causing them to re-evaluate their concept of "acceptable risk."

Nearly all of the potential harms from deciding to launch the shuttle are wrapped up in the small probability of the shuttle crashing. Predictable negatives of a crash and the resulting deaths are many. Bereavement at the loss of the crew could spread beyond their friends and immediate family, as the whole event was to be televised. Because of the inclusion of a schoolteacher named Christa McAuliffe, deaths would be civilian and not military. Furthermore, psychological elements like the feeling of helplessness in a space disaster make it more troubling to the conscience than less frequent deadly accidents such as car crashes. Ironically, this mission was meant to show the world that space travel was safe and was becoming increasingly accessible to the public. NASA decision makers should have realized that for psychological reasons the loss of this crew would be more disastrous than an equal number of deaths in its previous missions. If a disaster occurred and the deaths caused a public backlash, NASA could be heavily punished or dismantled entirely.

Also, a lot of valuable technology was at stake. For comparison, today's Space Shuttle Endeavour costs approximately $1.7 billion [19]. It is not the intention of this paper to compare the costs of human lives to a dollar amount, but $1.7 billion is not negligible in a cost-benefit analysis.

There were a few potential positive effects to ignoring the warning. Some money could be saved by avoiding the recurring weather delays. NASA would be able to stop holding its breath and continue working on other projects. The American public would have greater respect for a program that was not flummoxed by a cold spell. The most likely outcome of such a decision would be a successful mission and a job well done by the NASA administrators. Financial benefits to individuals and to the agency seem logical as well.

Nevertheless, the magnitude of the potential negatives tips the scales if there is any significant probability of disaster. The infamy of the incident and its aftermath demonstrate what was at stake if luck happened to not be on NASA's side. Indeed, investigations after the accident determined that even though the O-rings failed the Challenger would have been fine if it had not encountered the strongest wind shear ever experienced by a shuttle. It is possible that the O-ring failure could have been survivable if not for this wind shear [20].

In conclusion, there was a great deal to lose if something went wrong. NASA administrators may have misunderstood the risk of failure as presented by their engineers and, thinking it was minimal, ordered the launch to continue to keep the program from stagnating. If NASA had understood that catastrophic failure was relatively likely, they surely would have realized that the minor benefits associated with a timely launch were overshadowed by the costs of a stroke of bad luck.

Decision 2: Heed Warnings and Postpone Launch

Prior to launching, the engineers worried about launch safety simply because the weather was too cold. Heeding their warnings would mean delaying the shuttle launch until warmer weather. Something as complicated as a shuttle launch is very difficult to plan around the weather, considering all the personnel and equipment that need to be ready to go at launch time. It is undoubtedly frustrating and expensive to have to go through the whole pre-launch process only to be told to pack it up (and be ready the next time you're called.) The frustration of the multiple delays leading up to this Challenger launch could have had a subtle effect on the decision of the NASA administrators to circumvent the warnings and just get the launch out of the way. However, this decision makes no sense from a utilitarian viewpoint. — key pt here: analysis does not allow for delay as excuse for risk.

The benefits of ensuring safety of the shuttle are not so much positive as they are non-negative. Chance of loss of life would be reduced, though it is never possible to eliminate entirely. It's doubtful anyone would gain hero status for announcing that the launch needed to be delayed for a few weeks or months. One distinct positive for NASA would be instilling a sense of confidence in its engineers that their opinions matter, which could help keep the talented individuals from getting frustrated and heading elsewhere. Overall, delaying the launch was the pragmatic but unglamorous option.

Conclusion

fragment

Even a thorough utilitarian analysis is only as good as the information it has to work with. According to Richard Feynman, the engineers estimated the probability of disaster to be about 1 in 100, while the managers seemed to believe it was more like 1 in 100,000 [21]. It is not unfathomable that someone at NASA could have chosen to believe in the lower probability of failure in order to fudge a cost-benefit analysis to avoid scrutiny that would delay the launch.

The result of all this is that the cost-benefit analysis meets a fundamental limitation. It is still vulnerable to bad estimates of risk vs. reward. Thus, even if our present understanding of the incident tells us the risk was high and the scales tipped toward playing it safe, we realize that the same analysis was done back in 1986 with different data, and it ultimately led to a catastrophic loss of property and life.

Rights and Duties

We will now analyze the decisions involved leading up to the launch of the Challenger from a deontological perspective. This is taking a look at the respective rights and correlating duties of all parties involved. First, we will provide a background on deontological ethics and attempt to define the term "rights" as it will be used in this paper. After we have laid that necessary groundwork, we will examine each party involved and attribute the appropriate rights and or duties to them. Then it can be determined what rights or duties may have been violated and what ethical or unethical behavior occurred. Finally, we will conclude based on our analysis and underlying assumptions that the decision to launch made by NASA was either ethical or unethical.

From the standpoint of deontological ethics, it is believed that we as humans have certain rights and therefore duties to uphold the rights of others. We are then obligated to perform these duties irrespective of the consequences. However, what are these rights and duties and how are we to determine them? There are four features traditionally associated with moral rights. First, rights are *natural* in that they are not invented or created by governments. Second, they are *universal* in that they do not change from country to country. Third, they are *equal* in the sense that rights are the same for all people. Fourth, they are *inalienable* which means that I cannot hand over my rights to another person. These are all properties of rights, but we still do not know what constitutes a right. We need some underlying assumptions or rules to base our thinking on. Without first setting out these rules or assumptions, all assigned rights and duties would be completely subjective and unfounded. For this paper, since I am not a philosopher of ethics nor do I have the time to outline an entire ethical framework to work from, I will be using the work of Immanuel Kant and his idea of the "categorical imperative". I chose Kant because he is one of the most famous deontological thinkers, and his theories are still very much used today in modern ethics. Here are the main tenets of his "categorical imperative":

- Act only according to that maxim by which you can also will that it would become a universal law.
- Act in such a way that you always treat humanity, whether in your own person or in the person of any other, never simply as a means, but always at the same time as an end.
- Act as though you were through your maxims a law-making member of a kingdom of ends.

To clarify this a bit, for Kant, we treat people as an end whenever our actions toward someone reflect the inherent value of that person. It is by these rules that I will derive the rights and corresponding duties of the parties involved in the decision making for the challenger launch.

First we will take a look at NASA, or more specifically the MSFC (Marshall Space Flight Center) management. First, we would propose that they have the duty to ensure that the flight is as safe as possible. This is not very hard to prove, as it is clear that the crew has a right to life, and that not ensuring their safety would surely be treating them as a means to an end and not as an end themselves. This would not be treating them in a way as to reflect their inherent value. This same group of people also has the right to know any and all information that could affect their decision. This is the analogous right to the duty of the contracted company, Morton Thiokol Incorporated (MTI), to provide this information. This can also be seen from the perspective of treating people as an end and not a means. If MTI is not providing this information, or giving any purposeful misinformation, then they are effectively treating their customer, NASA, as a means to the end of making money for their company. It also shows the lack of value they place on the crew and whoever's life may be in danger. You may also say that they have the right to decide whether to launch or not, which may be true, however that is really irrelevant to the ethical analysis of this decision because they are already the ones deciding. If we do not assume they have that right, then there is no ethical question. We now move on to MTI.

As explained above, MTI has a duty to provide all information pertinent to the safety of their product to the customer, NASA in this case. Not only this, but they have a duty to uphold their contract, which guaranteed the safe operation of the Solid Rocket Boosters (SRB's). The contract is a promise. To relate this back to Kant, what would happen if everyone were to break his or her promises. The world would probably not be a very functional place. Also, breaking promises is clearly treating someone or some party as a means to an end. This is clearly a duty for MTI. When talking about MTI, we are referring mainly to the decision makers and executives. Therefore, they also have the right to know about any potential dangers or other information affecting their decisions. This goes along with the duty of MTI engineers to provide and alert them to this information. If an engineer withholds this information they are only doing so to look out for themselves and are not valuing the lives of those that may be affected.

The main right held by the crew is the right to life. If people are to be valued and not treated as means, then certainly human life must be of the utmost importance. The crew certainly has the right to life. This right is linked to the duties MTI, NASA, and everyone involved to ensure their safety. The crew may not have any duties that pertain directly to the launch decision in this case. However, they like everyone else involved also have the duty to do everything they can to make the flight safe, and should also voice any concerns that they have.

We now move on to the MTI engineer or employee. Roger Boisjoly will be the representative for this group. He also certainly has the duty that corresponds to the right to life of the crew. That is, the duty to voice his concerns and make sure they are known by management or whoever is making the decisions. Fragment

Though the aim of this paper is not to place blame on a single party, it is necessary to figure out if any party acted unethically to determine whether the decision was ethical or not. In this case, it appears that Roger Boisjoly did fulfill his duty to raise any concerns about the safety of the product to management. He even headed a task force specifically put together to investigate the suspect o-rings. However, he claimed that he never got the real managerial support that the team needed for thorough testing and analysis. He wrote many memos to his superiors voicing his concerns. They were apparently kept very secret however by management. Did MTI fulfill their duty? At first it appears that they did. MTI held a conference with the decision makers at NASA the night before the launch in which they proposed that the launch be delayed again, due mainly to Roger Boisjoly's concerns about the o-rings at the current low ambient temperatures. According to Roger's research on previous launches, at this meeting, MTI recommended that the shuttle not launch at ambient temperatures below 53 °F (12 °C). After Roger had given his presentation of the data and recommendations, Larry Mulloy, the SRB Project manager for NASA began to give his interpretation of the data and stated his opinion that the data was "inconclusive". This act itself may not be unethical, but what follows could be. It is now clear that Larry is of the opinion that the launch should go on as planned. This intimidates the managers at MTI and also may give them excuse enough to overturn their recommendation. Despite repeated attempts by Roger and other MTI engineers and scientists to explain the problem, the MTI managers exclude them and vote within themselves to approve a launch. Here is where some unethical behavior has occurred. MTI managers ignored their duty to ensure safety by excluding their engineers in the vote. This decision seems to be a fairly clear violation of their ethical responsibility and duty to the safety of the crew. Although less obvious, it also may have been unethical for NASA's managers to push the launch decision. Simply stating that the evidence is "inconclusive" does not mean it is safe. It just means that they could not conclude whether it was safe. This also looks to be a violation of NASA's duties to the crew.

In conclusion, breaches of ethical conduct by MTI's managers, and possible by NASA's mangers led to an unethical decision being made. Of course, there is still much subjectivity in the actual rights and duties of each party, but as we see it, in the context of this paper, the decision was unethical and should have been come to differently.

List of Works Cited

[1] G.D. Baura, *Engineering Ethics: An Industrial Perspective*. Burlington, MA: Elsevier Academic Press, 2006, pp. 63-72.

[2] M. McConnell, *Challenger: A Major Malfunction*. Garden City, NY: Doubleday, 1987, pp.118.

[3] McConnell, pp.9.

[4] McConnell, pp.49-50.

[5] McConnell, pp.17-20.

[6] McConnell, pp.112.

[7] McConnell, pp.25.

[8] McConnell, pp.195-200.

[9] McConnell, pp.167.

[10] McConnell, pp.208.

[11] McConnell, pp.136.

[12] McConnell, pp.235.

[13] McConnell, pp.243-244.

[14] *Report of Presidential Commission on the Space Shuttle Challenger Accident*. Washington, D.C., 1986. pp.82.

[15] *Report*, pp. 198-201.

[16] Baura, pp. 12.

[17] *Report*, pp. 88-93.

[18] McConnell, pp.109.

[19] Space Shuttle and International Space Station FAQ. Accessed 14 Nov 2007. http://www.nasa.gov/centers/kennedy/about/information/shuttle_faq.html#1

[20] Rogers Report. http://science.ksc.nasa.gov/shuttle/missions/51-l/docs/rogers-commission/

[21] Appendix F to the Rogers Commission Report on the Space Shuttle Challenger Accident. Available at : http://science.ksc.nasa.gov/shuttle/missions/51-l/docs/rogers-commission/Appendix-F.txt

An excellent & thorough analysis, with in-depth history of ethical theories included.
Some small proofing errors
Evidence of clear effort to be objective to all sides in analysis.

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