Roger Boisjoly and the Challenger Disaster: The Ethical Dimensions

Russell P. Boisjoly
Ellen Foster Curtis
Eugene Mellican

ABSTRACT. This case study focuses on Roger Boisjoly's attempt to prevent the launch of the Challenger and subsequent quest to set the record straight despite negative consequences. Boisjoly's experiences before and after the Challenger disaster raise numerous ethical issues that are integral to any explanation of the disaster and applicable to other management situations. Underlying all these issues, however, is the problematic relationship between individual and organizational responsibility. In analyzing this fundamental issue, this paper has two objectives: first, to demonstrate the extent to which the ethical ambiguity that permeates the relationship between individual and organizational responsibility contributed to the Challenger disaster; second, to reclaim the meaning and importance of individual responsibility within the diluting context of large organizations.

Introduction

On January 28, 1986, the space shuttle Challenger exploded 73 seconds into its flight, killing the seven astronauts aboard. As the nation mourned the tragic loss of the crew members, the Rogers Commission was formed to investigate the causes of the disaster. The Commission concluded that the explosion occurred due to seal failure in one of the solid rocket booster joints. Testimony given by Roger Boisjoly, Senior Scientist and acknowledged rocket seal expert, indicated that top management at NASA and Morton Thiokol had been aware of problems with the O-ring seals, but agreed to launch against the recommendation of Boisjoly and other engineers. Boisjoly had alerted management to problems with the O-rings as early as January, 1985, yet several shuttle launches prior to the Challenger had been approved without correcting the hazards. This suggests that the management practice of NASA and Morton Thiokol had created an environment which altered the framework for decision making, leading to a breakdown in communication between technical experts and their supervisors, and top level management, and to the acceptance of risks that both organizations had historically viewed as unacceptable. With human lives and the national interest at stake, serious ethical concerns are embedded in this dramatic change in management practice.

In fact, one of the most important aspects of the Challenger disaster – both in terms of the causal sequence that led to it and the lessons to be learned from it – is its ethical dimension. Ethical issues are woven throughout the tangled web of decisions, events, practices, and organizational structures that resulted in the loss of the Challenger and its seven astronauts. Therefore, an ethical analysis of this tragedy is essential for a full understanding of the event itself and for the implications it has for any endeavor where public policy, corporate practice, and individual decisions intersect.

The significance of an ethical analysis of the Challenger disaster is indicated by the fact that it

Russell P. Boisjoly is Associate Professor and Chairperson, Department of Finance at the University of Lowell where he specializes in Corporate Finance. His research focuses on applications of finance to regulated firms, especially in trucking and electric utility industries. He has published a number of articles on capital structure, mergers, bankruptcy prediction, and ethics.

Ellen Foster Curtis is Associate Professor of Management at the University of Lowell where she specializes in Business Policy, Corporate Social Responsibility, and Transportation. Her research focuses on labor relations, impacts of transportation deregulation, and ethical issues in business. She has published a number of articles on these topics, labor relations in the transportation industries, and ethics.

Eugene Mellican is Chairperson of the Philosophy Department at the University of Lowell. He describes himself as "a student of philosophy concentrating on issues in applied ethics."

immediately presents one of the most urgent, but difficult, issues in the examination of corporate and individual behavior today, i.e., whether existing ethical theories adequately address the problems posed by new technologies, new forms of organization, and evolving social systems. At the heart of this issue is the concept of responsibility. No ethical concept has been more affected by the impact of these changing realities. Modern technology has so transformed the context and scale of human action that not only do the traditional parameters of responsibility seem inadequate to contain the full range of human acts and their consequences, but even more fundamentally, it is no longer the individual that is the primary locus of power and responsibility, but public and private institutions. Thus, it would seem, it is no longer the character and virtues of individuals that determine the standards of moral conduct, it is the policies and structures of the institutional settings within which they live and work.

Many moral conflicts facing individuals within institutional settings do arise from matters pertaining to organizational structures or questions of public policy. As such, they are resolvable only at a level above the responsibilities of the individual. Therefore, some writers argue that the ethical responsibilities of the engineer or manager in a large corporation have as much to do with the organization as with the individual. Instead of expecting individual engineers or managers to be moral heroes, emphasis should be on the creation of organizational structures conducive to ethical behavior among all agents under their aegis. It would be futile to attempt to establish a sense of ethical responsibility in engineers and management personnel and ignore the fact that such persons work within a socio-technical environment which increasingly undermines the notion of individual, responsible moral agency (Boling and Dempsey, 1981; DeGeorge, 1981).

Yet, others argue that precisely because of these organizational realities individual accountability must be re-emphasized to counteract the diffusion of responsibility within large organizations and to prevent its evasion under the rubric of collective responsibility. Undoubtedly institutions do take on a kind of collective life of their own, but they do not exist, or act, independently of the individuals that constitute them, whatever the theoretical and practical complexities of delineating the precise relationships involved. Far from diminishing individuals' obligations, the reality of organizational life increases them because the consequences of decisions and acts are extended and amplified through the reach and power of that reality. Since there are pervasive and inexorable connections between ethical standards and behavior of individuals within an organization and its structure and operation, "the sensitizing of professionals to ethical considerations should be increased so that institutional structures will reflect enhanced ethical sensitivities as trained professionals move up the organizational ladder to positions of leadership" (Mankin, 1981, p. 17).

By reason of the courageous activities and testimony of individuals like Roger Boisjoly, the Challenger disaster provides a fascinating illustration of the dynamic tension between organizational and individual responsibility. By focusing on this central issue, this article seeks to accomplish two objectives: first, to demonstrate the extent to which the Challenger disaster not only gives concrete expression to the ethical ambiguity that permeates the relationship between organizational and individual responsibility, but also, in fact, is a result of it; second, to reclaim the meaning and importance of individual responsibility within the diluting context of large organizations.

In meeting these objectives, the article is divided into two parts: a case study of Roger Boisjoly's efforts to galvanize management support for effectively correcting the high risk O-ring problems, his attempt to prevent the launch, the scenario which resulted in the launch decision, and Boisjoly's quest to set the record straight despite enormous personal and professional consequences; and an ethical analysis of these events.

Preview for disaster

On January 24, 1985, Roger Boisjoly, Senior Scientist at Morton Thiokol, watched the launch of Flight 51-C of the space shuttle program. He was at Cape Canaveral to inspect the solid rocket boosters from Flight 51-C following their recovery in the Atlantic Ocean and to conduct a training session at Kennedy Space Center (KSC) on the proper methods of inspecting the booster joints. While watching the launch, he noted that the temperature that day was much cooler than recorded at other launches, but was still much warmer than the 18 degree temperature encountered three days earlier when he arrived in Orlando. The unseasonably cold weather of the past several days had produced the worst citrus crop failures in Florida history.

When he inspected the solid rocket boosters several days later, Boisjoly discovered evidence that the primary O-ring seals on two field joints had been compromised by hot combustion gases (i.e., hot gas blow-by had occurred) which had also eroded part of the primary O-ring. This was the first time that a primary seal on a field joint had been penetrated. When he discovered the large amount of blackened grease between the primary and secondary seals, his concern heightened. The blackened grease was discovered over 80 degree and 110 degree arcs, respectively, on two of the seals, with the larger arc indicating greater hot gas blow-by. Post-flight calculations indicated that the ambient temperature of the field joints at launch time was 53 degrees. This evidence, coupled with his recollection of the low temperature the day of the launch and the citrus crop damage caused by the cold spell, led to his conclusion that the severe hot gas blow-by may have been caused by, and related to, low temperature. After reporting these findings to his superiors, Boisjoly presented them to engineers and management at NASA's Marshall Space Flight Center (MSFC). As a result of his presentation at MSFC, Roger Boisjoly was asked to participate in the Flight Readiness Review (FRR) on February 12, 1985 for Flight 51-E which was scheduled for launch in April, 1985. This FRR represents the first association of low temperature with blow-by on a field joint, a condition that was considered an "acceptable risk" by Larry Mulloy, NASA's Manager for the Booster Project, and other NASA officials.

Roger Boisjoly had twenty-five years of experience as an engineer in the aerospace industry. Among his many notable assignments were the performance of stress and deflection analysis on the flight control equipment of the Advanced Minuteman Missile at Autonetics, and serving as a lead engineer on the lunar module of Apollo at Hamilton Standard. He moved to Utah in 1980 to take a position in the Applied Mechanics Department as a Staff Engineer at the Wasatch Division of Morton Thiokol. He was considered the leading expert in the United States on O-rings and rocket joint seals and received plaudits for his work on the joint seal problems from Joe C. Kilminster, Vice President of Space Booster Programs, Morton Thiokol (Kilminster, July, 1985). His commitment to the company and the community was further demonstrated by his service as Mayor of Willard, Utah from 1982 to 1983.

The tough questioning he received at the February 12th FRR convinced Boisjoly of the need for further evidence linking low temperature and hot gas blow-by. He worked closely with Arnie Thompson, Supervisor of Rocket Motor Cases, who conducted subscale laboratory tests in March, 1985, to further test the effects of temperature on O-ring resiliency. The bench tests that were performed provided powerful evidence to support Boisjoly's and Thompson's theory: Low temperatures greatly and adversely affected the ability of O-rings to create a seal on solid rocket booster joints. If the temperature was too low (and they did not know what the threshold temperature would be), it was possible that neither the primary or secondary O-rings would seal!

One month later the post-flight inspection of Flight 51-B revealed that the primary seal of a booster nozzle joint did not make contact during its two minute flight. If this damage had occurred in a field joint, the secondary O-ring may have failed to seal, causing the loss of the flight. As a result, Boisjoly and his colleagues became increasingly concerned about shuttle safety. This evidence from the inspection of Flight 51-B was presented at the FRR for Flight 51-F on July 1, 1985; the key engineers and managers at NASA and Morton Thiokol were now aware of the critical O-ring problems and the influence of low temperature on the performance of the joint seals.

During July, 1985, Boisjoly and his associates voiced their desire to devote more effort and resources to solving the problems of O-ring erosion. In his activity reports dated July 22 and 29, 1985, Boisjoly expressed considerable frustration with the lack of progress in this area, despite the fact that a Seal Erosion Task Force had been informally appointed on July 19th. Finally, Boisjoly wrote the following memo, labelled "Company Private", to R. K. (Bob) Lund, Vice President of Engineering for Morton Thiokol, to express the extreme urgency of his concerns. Here are some excerpts from that memo:

> This letter is written to insure that management is fully aware of the seriousness of the current O-ring erosion problem . . . The mistakenly accepted position on the joint problem was to fly without fear of failure . . . is now drastically changed as a result of the SRM 16A nozzle joint erosion which eroded a secondary O-ring with the primary O-ring never sealing. If the same scenario should occur in a field joint (and it could), then it is a jump ball as to the success or failure of the joint . . . The result would be a catastrophe of the highest order – loss of human life . . .
>
> It is my honest and real fear that if we do not take immediate action to dedicate a team to solve the problem, with the field joint having the number one priority, then we stand in jeopardy of losing a flight along with all the launch pad facilities (Boisjoly, July, 1985a).

On August 20, 1985, R. K. Lund formally announced the formation of the Seal Erosion Task Team. The team consisted of only five full-time engineers from the 2500 employed by Morton Thiokol on the Space Shuttle Program. The events of the next five months would demonstrate that management had not provided the resources necessary to carry out the enormous task of solving the seal erosion problem.

On October 3, 1985, the Seal Erosion Task Force met with Joe Kilminster to discuss the problems they were having in gaining organizational support necessary to solve the O-ring problems. Boisjoly later stated that Kilminster summarized the meeting as a "good bullshit session". Once again frustrated by bureaucratic inertia, Boisjoly wrote in his activity report dated October 4th:

> . . . NASA is sending an engineering representative to stay with us starting Oct. 14th. We feel that this is a direct result of their feeling that we (MTI) are not responding quickly enough to the seal problem . . . upper management apparently feels that the SRM program is ours for sure and the customer be damned (Boisjoly, October, 1985b).

Boisjoly was not alone in his expression of frustration. Bob Ebeling, Department Manager, Solid Rocket Motor Igniter and Final Assembly, and a member of the Seal Erosion Task Force, wrote in a memo to Allan McDonald, Manager of the Solid Rocket Motor Project, "HELP! The seal task force is constantly being delayed by every possible means . . . We wish we could get action by verbal request, but such is not the case. This is a red flag" (McConnell, 1987).

At the Society of Automotive Engineers (SAE) conference on October 7, 1985, Boisjoly presented a six-page overview of the joints and the seal configuration to approximately 130 technical experts in hope of soliciting suggestions for remedying the O-ring problems. Although MSFC had requested the presentation, NASA gave strict instructions not to express the critical urgency of fixing the joints, but merely to ask for suggestions for improvement. Although no help was forthcoming, the conference was a milestone in that it was the first time that NASA allowed information on the O-ring difficulties to be expressed in a public forum. That NASA also recognized that the O-ring problems were not receiving appropriate attention and manpower considerations from Morton Thiokol management is further evidenced by Boisjoly's October 24 log entry, ". . . Jerry Peoples (NASA) has informed his people that our group needs more authority and people to do the job. Jim Smith (NASA) will corner Al McDonald today to attempt to implement this direction."

The October 30 launch of Flight 61-A of the Challenger provided the most convincing, and yet to some the most contestable, evidence to date that low temperature was directly related to hot gas blow-by. The left booster experienced hot gas blow-by in the center and aft field joints without any seal erosion. The ambient temperature of the field joints was estimated to be 75 degrees at launch time based on post-flight calculations. Inspection of the booster joints revealed that the blow-by was less severe than that found on Flight 51-C because the seal grease was a grayish black color, rather than the jet black hue of Flight 51-C. The evidence was now consistent with the bench tests for joint resiliency conducted in March. That is, at 75 degrees the O-ring lost contact with its sealing surface for 2.4 seconds, whereas at 50 degrees the O-ring lost contact for 10 minutes. The actual flight data revealed greater hot gas blow-by for the O-rings on Flight 51-C which had an ambient temperature of 53 degrees than for Flight 61-A which had an ambient temperature of 75 degrees. Those who rejected this line of reasoning concluded that temperature must be irrelevant since hot gas blow-by had occurred even at room temperature (75 degrees). This difference in interpretation would receive further attention on January 27, 1986.

During the next two and one-half months, little progress was made in obtaining a solution to the O-ring problems. Roger Boisjoly made the following entry into his log on January 13, 1986, "O-ring resiliency tests that were requested on September 24, 1985 are now scheduled for January 15, 1986."

The day before the disaster

At 10 a.m. on January 27, 1986, Arnie Thompson received a phone call from Boyd Brinton, Thiokol's Manager of Project Engineering at MSFC, relaying the concerns of NASA's Larry Wear, also at MSFC, about the 18 degree temperature forecast for the launch of Flight 51-L, the Challenger, scheduled for the next day. This phone call precipitated a series of meetings within Morton Thiokol, at the Marshall Space Flight Center; and at the Kennedy Space Center that culminated in a three-way telecon involving three teams of engineers and managers, that began at 8:15 p.m. E.S.T.

Joe Kilminster, Vice President, Space Booster Programs, of Morton Thiokol began the telecon by turning the presentation of the engineering charts over to Roger Boisjoly and Arnie Thompson. They presented thirteen charts which resulted in a recommendation against the launch of the Challenger. Boisjoly demonstrated their concerns with the performance of the O-rings in the field joints during the initial phases of Challenger's flight with charts showing the effects of primary O-ring erosion, and its timing, on the ability to maintain a reliable secondary seal. The tremendous pressure and release of power from the rocket boosters create rotation in the joint such that the metal moves away from the O-rings so that they cannot maintain contact with the metal surfaces. If, at the same time, erosion occurs in the primary O-ring for any reason, then there is a reduced probability of maintaining a secondary seal. It is highly probable that as the ambient temperature drops, the primary O-ring will not seat that there will be hot gas blow-by and erosion of the primary O-ring; and that a catastrophe will occur when the secondary O-ring fails to seal.

Bob Lund presented the final chart that included the Morton Thiokol recommendations that the ambient temperature including wind must be such that the seal temperature would be greater than 53 degrees to proceed with the launch. Since the overnight low was predicted to be 18 degrees, Bob Lund recommended against launch on January 28, 1986 or until the seal temperature exceeded 53 degrees.

NASA's Larry Mulloy bypassed Bob Lund and directly asked Joe Kilminster for his reaction. Kilminster stated that he supported the position of his engineers and he would not recommend launch below 53 degrees.

George Hardy, Deputy Director of Science and Engineering at MSFC, said he was "appalled at that recommendation", according to Allan McDonald's testimony before the Rogers Commission. Nevertheless, Hardy would not recommend to launch if the contractor was against it. After Hardy's reaction, Stanley Reinartz, Manager of Shuttle Project Office at MSFC, objected by pointing out that the solid rocket motors were qualified to operate between 40 and 90 degrees Fahrenheit.

Larry Mulloy, citing the data from Fight 61-A which indicated to him that temperature was not a factor, strenuously objected to Morton Thiokol's recommendation. He suggested that Thiokol was attempting to establish new Launch Commit Criteria at 53 degrees and that they couldn't do that the night before a launch. In exasperation Mulloy asked, "My God, Thiokol, when do you want me to launch? Next April?" (McConnell, 1987). Although other NASA officials also objected to the association of temperature with O-ring erosion and hot gas blow-by, Roger Boisjoly was able to hold his ground and demonstrate with the use of his charts and pictures that there was indeed a relationship: The lower the temperature the higher the probability of erosion and blow-by and the greater the likelihood of an accident. Finally, Joe Kilminster asked for a five minute caucus off-net.

According to Boisjoly's testimony before the Rogers Commission, Jerry Mason, Senior Vice President of Wasatch Operations, began the caucus by saying that "a management decision was necessary". Sensing that an attempt would be made to overturn the no-launch decision, Boisjoly and Thompson attempted to re-review the material previously presented to NASA for the executives in the room. Thompson took a pad of paper and tried to sketch out the problem with the joint, while Boisjoly laid out the photos of the compromised joints from Flights 51-C and 61-A. When they became convinced that no one was listening, they ceased their efforts. As Boisjoly would later testify, "There was not one positive pro-launch statement ever made by anybody" (Report of the Presidential Commission, 1986, IV, p. 792, hereafter abbreviated as R.C.).

According to Boisjoly, after he and Thompson made their last attempts to stop the launch, Jerry Mason asked rhetorically, "Am I the only one who wants to fly?" Mason turned to Bob Lund and asked him to "take off his engineering hat and put on his management hat". The four managers held a brief discussion and voted unanimously to recommend Challenger's launch.

Exhibit I shows the revised recommendations that were presented that evening by Joe Kilminster after the caucus to support management's decision to launch. Only one of the rationales presented that evening supported the launch (demonstrated erosion sealing threshold is three times greater than 0.038" erosion experienced on SRM-15). Even so, the issue at hand was sealability at low temperature, not erosion. While one other rationale could be considered a neutral statement of engineering fact (O-ring pressure leak check places secondary seal in outboard position which minimizes sealing time), the other seven rationales are negative, anti-launch, statements. After hearing Kilminster's presentation, which was accepted without a single probing question, George Hardy asked him to sign the chart and telefax it to Kennedy Space Center and Marshall Space Flight Center. At 11 p.m. E.S.T. the teleconference ended.

Aside from the four senior Morton Thiokol executives present at the teleconference, all others were excluded from the final decision. The process represented a radical shift from previous NASA policy. Until that moment, the burden of proof had always been on the engineers to prove beyond a doubt that it was safe to launch. NASA, with their objections to the original Thiokol recommendation against the launch, and Mason, with his request for a "management decision", shifted the burden of proof

EXHIBIT I

MTI assessment of temperature concern on SRM-25 (51L) launch

- CALCULATIONS SHOW THAT SRM-25 O-RINGS WILL BE 20° COLDER THAN SRM-15 O-RINGS
- TEMPERATURE DATA NOT CONCLUSIVE ON PREDICTING PRIMARY O-RING BLOW-BY
- ENGINEERING ASSESSMENT IS THAT:
  - COLDER O-RINGS WILL HAVE INCREASED EFFECTIVE DUROMETER ("HARDER")
- "HARDER" O-RINGS WILL TAKE LONGER TO "SEAT"
    - MORE GAS MAY PASS PRIMARY O-RING BEFORE THE PRIMARY SEAL SEATS (RELATIVE TO SRM-15)
  - DEMONSTRATED SEALING THRESHOLD IS 3 TIMES GREATER THAN 0.038" EROSION EXPERIENCED ON SRM-15
  - IF THE PRIMARY SEAL DOES NOT SEAT, THE SECONDARY SEAL WILL SEAT
    - PRESSURE WILL GET TO SECONDARY SEAL BEFORE THE METAL PARTS ROTATE
      - O-RING PRESSURE LEAK CHECK PLACES SECONDARY SEAL IN OUTBOARD POSITION WHICH MINIMIZES SEALING TIME
- MTI RECOMMENDS STS-51L LAUNCH PROCEED ON 28 JANUARY 1986
    - SRM-25 WILL NOT BE SIGNIFICANTLY DIFFERENT FROM SRM-15

Joe C. Kilminster, Vice President Space Booster Programs.

in the opposite direction. Morton Thiokol was expected to prove that launching Challenger would not be safe (R.C., IV, p. 793).

The change in the decision so deeply upset Boisjoly that he returned to his office and made the following journal entry:

> I sincerely hope this launch does not result in a catastrophe. I personally do not agree with some of the statements made in Joe Kilminster's written summary stating that SRM-25 is okay to fly (Boisjoly, 1987).

The disaster and its aftermath

On January 28, 1986, a reluctant Roger Boisjoly watched the launch of the Challenger. As the vehicle cleared the tower, Bob Ebeling whispered, "we've just dodged a bullet." (The engineers who opposed the launch assumed that O-ring failure would result in an explosion almost immediately after engine ignition.) To continue in Boisjoly's words, "At approximately T + 60 seconds Bob told me he had just completed a prayer of thanks to the Lord for a successful launch. Just thirteen seconds later we both saw the horror of the destruction as the vehicle exploded" (Boisjoly, 1987).

Morton Thiokol formed a failure investigation team on January 31, 1986 to study the Challenger explosion. Roger Boisjoly and Arnie Thompson were part of the team that was sent to MSFC in Huntsville, Alabama. Boisjoly's first inkling of a division between himself and management came on February 13 when he was informed at the last minute that he was to testify before the Rogers Commission the next day. He had very little time to prepare for his testimony. Five days later, two Commission members held a closed session with Kilminster, Boisjoly, and Thompson. During the interview Boisjoly gave his memos and activity reports to the Commissioners. After that meeting, Kilminster chastised Thompson and Boisjoly for correcting his interpretation of the technical data. Their response was that they would continue to correct his version if it was technically incorrect.

Boisjoly's February 25th testimony before the Commission, rebutting the general manager's statement that the initial decision against the launch was not unanimous, drove a wedge further between him and Morton Thiokol management. Boisjoly was flown to MSFC before he could hear the NASA testimony about the pre-flight telecon. The next day, he was removed from the failure investigation team and returned to Utah.

Beginning in April, Boisjoly began to believe that for the previous month he had been used solely for public relations purposes. Although given the title of Seal Coordinator for the redesign effort, he was isolated from NASA and the seal redesign effort. His design information had been changed without his knowledge and presented without his feedback. On May 1, 1986, in a briefing preceding closed sessions before the Rogers Commission, Ed Garrison, President of Aerospace Operations for Morton Thiokol, chastised Boisjoly for "airing the company's dirty laundry" with the memos he had given the Commission. The next day, Boisjoly testified about the change in his job assignment. Commission Chairman Rogers criticized Thiokol management, ". . . if it appears that you're punishing the two people or at least two of the people who are right about the decision and objected to the launch which ultimately resulted in criticism of Thiokol and then they're demoted or feel that they are being retaliated against, that is a very serious matter. It would seem to me, just speaking for myself, they should be promoted, not demoted or pushed aside" (R.C., V, p. 1586).

Boisjoly now sensed a major rift developing within the corporation. Some co-workers perceived that his testimony was damaging the company image. In an effort to clear the air, he and McDonald requested a private meeting with the company's three top executives, which was held on May 16, 1986. According to Boisjoly, management was unreceptive throughout the meeting. The CEO told McDonald and Boisjoly that the company "was doing just fine until Al and I testified about our job reassignments" (Boisjoly, 1987). McDonald and Boisjoly were nominally restored to their former assignments, but Boisjoly's position became untenable as time passed. On July 21, 1986, Roger Boisjoly requested an extended sick leave from Morton Thiokol.

Ethical analysis

It is clear from this case study that Roger Boisjoly's experiences before and after the Challenger disaster raise numerous ethical questions that are integral to any explanation of the disaster and applicable to other management situations, especially those involving highly complex technologies. The difficulties and uncertainties involved in the management of these technologies exacerbate the kind of bureaucratic syndromes that generate ethical conflicts in the first place. In fact, Boisjoly's experiences could well serve as a paradigmatic case study for such ethical problems, ranging from accountability to corporate loyalty and whistleblowing. Underlying all these issues, however, is the problematic relationship between individual and organizational responsibility. Boisjoly's experiences graphically portray the tensions inherent in this relationship in a manner that discloses its importance in the causal sequence leading to the Challenger disaster. The following analysis explicates this and the implications it has for other organizational settings.

By focusing on the problematic relationship between individual and organizational responsibility, this analysis reveals that the organizational structure governing the space shuttle program became the locus of responsibility in such a way that not only did it undermine the responsibilities of individual decision makers within the process, but it also became a means of avoiding real, effective responsibility throughout the entire management system. The first clue to this was clearly articulated as early as 1973 by the board of inquiry that was formed to investigate the accident which occurred during the launch of Skylab 1:

> The management system developed by NASA for manned space flight places large emphasis on rigor, detail, and thoroughness. In hand with this emphasis comes formalism, extensive documentation, and visibility in detail to senior management. While nearly perfect, such a system can submerge the concerned individual and depress the role of the intuitive engineer or analyst. It may not allow full play for the intuitive judgment or past experience of the individual. An emphasis on management systems can, in itself, serve to separate the people engaged in the program from the real world of hardware (Quoted in Christiansen, 1987, p. 23).

To examine this prescient statement in ethical terms is to see at another level the serious consequences inherent in the situation it describes. For example, it points to a dual meaning of responsibility. One meaning emphasizes carrying out an authoritatively prescribed review process, while the second stresses the cognitive independence and input of every individual down the entire chain of authority. The first sense of responsibility shifts the ethical center of gravity precipitously away from individual moral agency onto the review process in such a way that what was originally set up to guarantee flight readiness with the professional and personal integrity of the responsible individuals, instead becomes a means of evading personal responsibility for decisions made in the review process.

A crucial, and telling, example of this involves the important question asked by the Rogers Commission as to why the concerns raised by the Morton Thiokol engineers about the effects of cold weather on the O-rings during the teleconference the night before the launch were not passed up from Level III to Levels II or I in the preflight review process. The NASA launch procedure clearly demands that decisions and objections methodically follow a prescribed path up all levels. Yet, Lawrence Mulloy, operating at Level III as the Solid Rocket Booster Project Manager at MSFC, did not transmit the Morton Thiokol concerns upward (through his immediate superior, Stanley Reinartz) to Level II. When asked by Chairman Rogers to explain why, Mr. Mulloy testified:

> At that time, and I still consider today, that was a Level III issue, Level III being a SRB element or an external tank element or Space Shuttle main engine element or an Orbiter. There was no violation of Launch Commit Criteria. There was no waiver required in my judgment at that time and still today (R.C., I, p. 98).

In examining this response in terms of shifting responsibility onto the review process itself, there are two things that are particularly striking in Mr. Mulloy's statement. The first is his emphasis that this was a "Level III issue." In a formal sense, Mr. Mulloy is correct. However, those on Level III also had the authority — and, one would think, especially in this instance given the heated discussion on the effects of cold on the O-rings, the motivation — to pass objections and concerns on to Levels II and I. But here the second important point in Mr. Mulloy's testimony comes into play when he states, "there was no violation of Launch Commit Criteria." In other words, since there was no Launch Commit Criteria for joint temperature, concerns about joint temperature did not officially fall under the purview of the review process. Therefore, the ultimate justification for Mr. Mulloy's position rests on the formal process itself. He was just following the rules by staying within the already established scope of the review process.

This underscores the moral imperative executives must exercise by creating and maintaining organizational systems that do not separate the authority of decision makers from the responsibility they bear for decisions, or insulate them from the consequences of their actions or omissions.

Certainly, there can be no more vivid example than the shuttle program to verify that, in fact, "an emphasis on management systems can, in itself, serve to separate the people engaged in the program from the real world of hardware." Time and time again the lack of communication that lay at the heart of the Rogers Commission finding that "there was a serious flaw in the decision making process leading up to the launch of flight 51-L" (R.C., I, p. 104) was explained by the NASA officials or managers at Morton Thiokol with such statements as, "that is not my reporting channel," or "he is not in the launch decision chain," or "I didn't meet with Mr. Boisjoly, I met with Don Ketner, who is the task team leader" (R.C., IV, p. 821, testimony of Mr. Lund). Even those managers who had direct responsibility for line engineers and workmen depended on formalized memo writing procedures for communication to the point that some "never talked to them directly" (Feynman, 1988, p. 33).

Within the atmosphere of such an ambiguity of responsibility, when a life threatening conflict arose within the management system and individuals (such as Roger Boisjoly and his engineering associates at Morton Thiokol) tried to reassert the full weight of their individual judgments and attendant responsibilities, the very purpose of the flight readiness review process, i.e., to arrive at the "technical" truth of the situation, which includes the recognition of the uncertainties involved as much as the findings, became subverted into an adversary confrontation in which "adversary" truth, with its suppression of uncertainties, became operative (Wilmotte, 1970).

What is particularly significant in this radical transformation of the review process, in which the Morton Thiokol engineers were forced into "the position of having to prove that it was unsafe instead of the other way around" (R.C., IV, p. 822; see also p. 793), is that what made the suppression of technical uncertainties possible is precisely that mode of thinking which, in being challenged by independent professional judgments, gave rise to the adversarial setting in the first place: groupthink. No more accurate description for what transpired the night before the launch of the Challenger can be given than the definition of groupthink as:

> . . . a mode of thinking that people engage in when they are deeply involved in a cohesive in-group, when the members' strivings for unanimity override their motivation to realistically appraise alternative courses of action. . . . Groupthink refers to the deterioration of mental efficiency, reality testing, and moral judgment that results from in-group pressures (Janis, 1972, p. 9).

From this perspective, the full import of Mr. Mason's telling Mr. Lund to "take off his engineering hat and put on his management hat" is revealed. He did not want another technical, reality-based judgment of an independent professional engineer. As he had already implied when he opened the caucus by stating "a management decision was necessary," he wanted a group decision, specifically one that would, in the words of the Rogers Commission, "accommodate a major customer" (R.C., I, p. 104). With a group decision the objections of the engineers could be mitigated, the risks shared, fears allayed, and the attendant responsibility diffused.[1]

This analysis is not meant to imply that groupthink was a pervasive or continuous mode of thinking at either NASA or Morton Thiokol. What is suggested is a causal relationship between this instance of groupthink and the ambiguity of responsibility found within the space shuttle program. Whenever a management system, such as NASA's generates "a mindset of 'collective responsibility' " by leading "individuals to defer to the anonymity of the process and not focus closely enough on their individual responsibilities in the decision chain," (N.R.C. Report, 1988, p. 68) and there is a confluence of the kind of pressures that came to bear on the decision making process the night before the launch, the conditions are in place for groupthink to prevail.

A disturbing feature of so many of the analyses and commentaries on the Challenger disaster is the reinforcement, and implicit acceptance, of this shift away from individual moral agency with an almost exclusive focus on the flaws in the management system, organizational structures and/or decision making process. Beginning with the findings of the Rogers Commission investigation, one could practically conclude that no one had any responsibility whatsoever for the disaster. The Commission concluded that "there was a serious flaw in the decision making process leading up to the launch of flight 51-L. A well structured and managed system emphasizing safety would have flagged the rising doubts about the Solid Rocket Booster joint seal." Then the Commission report immediately states, "Had these matters been clearly stated and emphasized in the flight readiness process in terms reflecting the views of most of the Thiokol engineers and at least some of the Marshall engineers, it seems likely that the launch of 51-L might not have occurred when it did" (R.C., I, p. 104). But the gathering and passing on of such information was the responsibility of specifically designated individuals, known by name and position in the highly structured review process. Throughout this process there had been required "a series of formal, legally binding certifications, the equivalent of airworthiness inspections in the aviation industry. In effect the myriad contractor and NASA personnel involved were guaranteeing Challenger's flight readiness with their professional and personal integrity" (McConnell, 1987, p. 17).

When the Commission states in its next finding that "waiving of launch constraints appears to have been at the expense of flight safety," the immediate and obvious question would seem to be: Who approved the waivers and assumed this enormous risk? And why? This is a serious matter! A launch constraint is only issued because there is a safety problem serious enough to justify a decision not to launch. However, the Commission again deflects the problem onto the system by stating, "There was no system which made it imperative that launch constraints and waivers of launch constraints be considered by all levels of management" (R.C., 1986, I, p. 104).

There are two puzzling aspects to this Commission finding. First, the formal system already contained the requirement that project offices inform at least Level II of launch constraints. The Commission addressed the explicit violation of this requirement in the case of a July 1985 launch constraint that had been imposed on the Solid Rocket Booster because of O-ring erosion on the nozzle:

> NASA Levels I and II apparently did not realize Marshall had assigned a launch constraint within the Problem Assessment System. This communication failure was contrary to the requirement, contained in the NASA Problem Reporting and Corrective Action Requirements System, that launch constraints were to be taken to Level II (R.C., 1986, I, pp. 138—139; see also p. 159).

Second, the Commission clearly established that the individual at Marshall who both imposed and waived the launch constraint was Lawrence Mulloy, SRB Project Manager. Then why blame the management system, especially in such a crucial area as that of launch constraints, when procedures of that system were not followed? Is that approach going to increase the accountability of individuals within the system for future Flights?

Even such an independent minded and probing Commission member as Richard Feynman, in an interview a year after the disaster, agreed with the avoidance of determining individual accountability for specific actions and decisions. He is quoted as saying, "I don't think it's correct to try to find out which particular guy happened to do what particular thing. It's the question of how the atmosphere could get to such a circumstance that such things were possible without anybody catching on." Yet, at the same time Feynman admitted that he was not confident that any restructuring of the management system will ensure that the kinds of problems that resulted in the Challenger disaster — "danger signs not seen and warnings not heeded" — do not recur. He said, "I'm really not sure that any kind of simple mechanism can cure stupidity and dullness. You can make up all the rules about how things should be, and they'll go wrong if the spirit is different, if the attitudes are different over time and as personnel change" (Chandler, 1987, p. 50).

The approach of the Rogers Commission and that of most of the analyses of the Challenger disaster is consistent with the growing tendency to deny any specific responsibility to individual persons within corporate or other institutional settings when things go wrong. Although there are obviously many social changes in modern life that justify the shift in focus from individuals to organizational structures as bearers of responsibility, this shift is reinforced and exaggerated by the way people think about and accept those changes. One of the most pernicious problems of modern times is the almost universally held belief that the individual is powerless, especially within the context of large organizations where one may perceive oneself, and be viewed, as a very small, and replaceable, cog. It is in the very nature of this situation that repsonsibility may seem to become so diffused that no one person IS responsible. As the National Research Council committee, in following up on the Rogers Commission, concluded about the space shuttle program:

> Given the pervasive reliance on teams and boards to consider the key questions affecting safety, 'group democracy' can easily prevail . . . in the end all decisions become collective ones . . . (N.R.C. Report, pp. 68 and 70).

The problem with this emphasis on management systems and collective responsibility is that it fosters a vicious circle that further and further erodes and obscures individual responsibility. This leads to a paradoxical – and untenable – situation (such as in the space shuttle program) in which decisions are made and actions are performed by individuals or groups of individuals but not attributed to them. It thus reinforces the tendency to avoid accountability for what anyone does by attributing the consequences to the organization or decision making process. Again, shared, rather than individual, risk-taking and responsibility become operative. The end result can be a cancerous attitude that so permeates an organization or management system that it metastasizes into decisions and acts of life-threatening irresponsibility.

In sharp contrast to this prevalent emphasis on organizational structures, one of the most fascinating aspects of the extensive and exhaustive investigations into the Challenger disaster is that they provide a rare opportunity to re-affirm the sense and importance of individual responsibility. With the inside look into the space shuttle program these investigations detail, one can identify many instances where personal responsibility, carefully interpreted, can properly be imputed to NASA officials and to its contractors. By so doing, one can preserve, if only in a fragmentary way, the essentials of the traditional concept of individual responsibility within the diluting context of organizational life. This effort is intended to make explicit the kind of causal links that are operative between the actions of individuals and the structures of organizations.

The criteria commonly employed for holding individuals responsible for an outcome are two: (1) their acts or omissions are in some way a cause of it; and (2) these acts or omissions are not done in ignorance or under coercion (Thompson, 1987, p. 47). Although there are difficult theoretical and practical questions associated with both criteria, especially within organizational settings, nevertheless, even a general application of them to the sequence of events leading up to the Challenger disaster reveals those places where the principle of individual responsibility must be factored in if our understanding of it is to be complete, its lessons learned, and its repetition avoided.

The Rogers Commission has been criticized – and rightly so – for looking at the disaster "from the bottom up but not from the top down," with the result that it gives a clearer picture of what transpired at the lower levels of the Challenger's flight review process than at its upper levels (Cook, 1986). Nevertheless, in doing so, the Commission report provides powerful testimony that however elaborately structured and far reaching an undertaking such as the space shuttle program may be, individuals at the bottom of the organizational structure can still play a crucial, if not deciding, role in the outcome. For in the final analysis, whatever the defects in the Challenger's launch decision chain were that kept the upper levels from being duly informed about the objections of the engineers at Morton Thiokol, the fact remains that the strenuous objections of these engineers so forced the decision process at their level that the four middle managers at Morton Thiokol had the full responsibility for the launch in their hands. This is made clear in the startling testimony of Mr. Mason, when Chairman Rogers asked him: "Did you realize, and particularly in view of Mr. Hardy's (Deputy Director of Science and Engineering at MSFC) point that they wouldn't launch unless you agreed, did you fully realize that in effect, you were making a decision to launch, you and your colleagues?" Mr. Mason replied, "Yes, sir" (R.C., 1986, IV, p. 770).

If these four men had just said no, the launch of the Challenger would not have taken place the next day. Could there have been any doubt about what was at stake in their decision, or about the degree of risk involved? Not in view of the follow up testimony of Brian Russell, another Thiokol engineer present at the teleconference. Mr. Russell was asked by Mr. Acheson to give his recollection of the thought process followed in his mind "in the change of position between the view presented in the telecon that Thiokol was opposed to the launch, and the subsequent conclusion of the caucus within the company" (R.C., 1986, IV, p. 821). In the course of his response, Mr. Russell stated:

> But I felt in my mind that once we had done our very best to explain why we were concerned, and we meaning those in the camp who really felt strongly about the recommendation of 53 degrees, the decision was to be made, and a poll was then taken. And I remember distinctly at the time wondering whether I would have the courage, if asked, and I thought I might be, what I would do and whether I would be alone. I didn't think I would be alone, but I was wondering if I would have the courage, I remember that distinctly, to stand up and say no . . . I was nervous . . . there was a nervousness there that we were increasing the risk, and I believe all of us knew that if it were increased to the level of O-ring burnthrough, what the consequences would be. And I don't think there's any question in anyone's mind about that (R.C., 1986, IV, pp. 822–823).

Some pertinent observations that have direct implications for managers in any organization must be made about where the principle of individual responsibility intersects with the structural flaws and organizational deterioration that have been attributed such a prominent role in the Challenger disaster. While it is on the basis of these flaws that the Rogers Commission absolved NASA officials of any direct responsibility for the disaster, it must nevertheless be pointed out that such officials "act in the context of a continuing institution, not an isolated incident, and they or other officials therefore may be culpable for creating the structural faults of the organization, or for neglecting to notice them, or for making inadequate efforts to correct them" (Thompson, 1987, p. 46). While it is true that attributing responsibility demands precision in determining the consequences of acts as much as in identifying the agents, this specificity of outcomes "does not preclude responsibility for patterns of decision and decision making" (Thompson, 1987, p. 48). Therefore, among the outcomes for which managers are held responsible, the continuing practices, standards, and structures of their organizations should be included.

Of all the descriptions of the flaws, break downs, and deterioration of NASA's managerial system, none point to any failures that fall outside the well-documented pathologies of bureaucratic behavior (e.g., lack of communication, distortion of information as it passes up the hierarchy, jealousy of existing lines of authority, bias in favor of the status quo, bureaucratic turf protection, power games, inclination to view the public interest through the distorted lens of vested interests, the "think positive" or "can-do" syndrome), and, as such, they can be anticipated. That bureaucratic routines "have a life of their own, often roaming beyond their original purpose, is a fact of organizational behavior that officials should be expected to appreciate. The more the consequences of a decision fit such bureaucratic patterns, the less an official can plausibly invoke the excuse from ignorance" (Thompson, 1987, p. 61).

So much has been made of NASA's top officials not being fully informed of the extent of the problems with the O-rings, and specifically of the Thiokol engineers' objections to the Challenger launch in cold weather, that an analysis of the disaster in *Fortune* magazine had as its title, "NASA's Challenge: Ending Isolation at the Top" (Brody, 1986). The actual extent of their isolation has been questioned, and even the Rogers Commission is not consistent on this issue. In its findings for Chapter V, the Commission states, "A well structured and managed system emphasizing safety would have flagged the rising doubts about the Solid Rocket Booster joint seal." Nevertheless, it concludes in the next chapter that "the O-ring erosion history presented to Level I at NASA Headquarters in August 1985 was sufficiently detailed to require corrective action prior to the next flight" (R.C., 1986, I, pp. 104 and 148).

Whatever the extent of their ignorance, an important principle comes into play in determining the degree of individual responsibility. It is implied in Richard Feynman's position where he drew the line in not ascribing accountability for the Challenger disaster to specific individuals. Referring to Jesse Moore, Associate Administrator for Space Flight, the Level I manager with whom final approval for launch rested, Feynman maintained, "the guy at the top never should have an excuse that nobody told him. It seemed to he me ought to go out and find out what's going on" (Chandler, 1987, p. 50). The moral principle underlying Feynman's position here and which must be considered in tracing the boundaries of individual responsibility *vis-à-vis* the question of ignorance is the principle of "indirect responsibility".

As applied to the issue of ignorance, this principle confronts anyone in an organization with the inherent expectations of his or her position of power and level of expertise. The contours of indirect responsibility follow in the wake of these expectations because the standards against which to measure a claim of ignorance are precisely the standards of a given position and requisite knowledge. Therefore, to reject an excuse from ignorance it is sufficient to say: You are indirectly responsible for what has transpired because, given your position and professional experience, if you didn't know, you should have (Rosenblatt, 1983).

Although this principle operates in a gray area where the difference between indirect responsibility and pardonable ignorance can be marginal, a tragic, complex event like the Challenger disaster demands its application. Like the law, ethical thought must not be willing to accept ignorance as a sufficient excuse when it can be reasonably established that those in the causal sequence or in positions of authority should have known, or found out before acting or rendering decisions. This is especially true for managers who become instruments of their own ignorance whenever they prevent the free and complete flow of information to themselves, either directly by their acts, or indirectly through the subtle messages they convey to their subordinates, in their management style, or by the organizational climate they help create (Thompson, 1987, pp. 60–61).

Although fragmentary and tentative in its formulation, this set of considerations points toward the conclusion that however complex and sophisticated an organization may be, and no matter how large and remote the institutional network needed to manage it may be, an active and creative tension of responsibility must be maintained at every level of the operation. Given the size and complexity of such endeavors, the only way to ensure that tension of attentive and effective responsibility is to give the primacy of responsibility to that ultimate principle of all moral conduct: the human individual — even if this does necessitate, in too many instances under present circumstances, that individuals such as Roger Boisjoly, when they attempt to exercise their responsibility, must step forward as moral heroes. In so doing, these individuals do not just bear witness to the desperate need for a system of full accountability in the face of the immense power and reach of modern technology and institutions. They also give expression to the very essence of what constitutes the moral life. As Roger Boisjoly has stated in reflecting on his own experience, "I have been asked by some if I would testify again if I knew in advance of the potential consequences to me and my career. My answer is always an immediate 'yes'. I couldn't live with any self-respect if I tailored my actions based upon the personal consequences . . ." (Boisjoly, 1987).

Note

[1] A contrasting interpretation of the meeting the night before the launch given by Howard Schwartz, is that NASA began to view itself as the ideal organization that did not make mistakes. According to Schwartz, "The organization ideal is an image of perfection. It is, so to speak, an idea of God. God does not make mistakes. Having adopted the idea of NASA as the organization ideal it follows that the individual will believe that, if NASA has made a decision, that decision will be correct" (Schwartz, 1987).

In his testimony before the Rogers Commission, Roger Boisjoly indicated the extent to which NASA procedure had changed: "This was a meeting (the night before the launch) where the determination was to launch, and it was up to us to prove beyond the shadow of a doubt that it was not safe to do so. This is the total reverse to what the position usually is in a preflight conversation or a flight readiness review" (Boisjoly, 1986).

As Schwartz indicates: "If it was a human decision, engineering standards of risk should prevail in determining whether it is safe to launch. On the other hand, if the decision was a NASA decision, it is simply safe to launch, since NASA does not make mistakes" (Schwartz, 1987).

References

Boisjoly, Roger M.: 1985a, Applied Mechanics Memorandum to Robert K. Lund, Vice President, Engineering, Wasatch Division, Morton Thiokol, Inc., July 31.

Boisjoly, Roger M.: 1985b, Activity Report, SRM Seal Erosion Task Team Status, October 4.

Boisjoly, Roger M.: 1987, Ethical Decisions: Morton Thiokol and the Shuttle Disaster. Speech given at Massachusetts Institute of Technology, January 7.

Boling, T. Edwin and Dempsey, John: 1981, 'Ethical dilemmas in government: Designing an organizational response', *Public Personnel Management Journal* **10**, 11–18.

Brody, Michael: 1986, 'NASA's challenge: Ending isolation at the top', *Fortune* **113** (May 12), pp. 26–32.

Chandler, David: 1987, 'Astronauts gain clout in "revitalized" NASA', *Boston Globe* **1** (January 26), 50.

Christiansen, Donald: 1987, 'A system gone awry', *IEEE Spectrum* **24** (3), 23.

Cook, Richard C.: 1986, 'The Rogers commission failed', *The Washington Monthly* **18** (9), 13–21.

DeGeorge, Richard T.: 1981, 'Ethical responsibilities of engineers in large organizations: The Pinto Case', *Business and Professional Ethics Journal* **1**, 1–14.

Feynman, Richard P.: 1988, 'An outsider's view of the Challenger inquiry', *Physics Today* **41** (2), 26–37.

Janis, Irving L.: 1972, *Victims of Groupthink*, Boston, MA: Houghton Mifflin Company.

Kilminster, J. C.: 1985, Memorandum (E000-FY86-003) to Robert Lund, Vice President, Engineering, Wasatch Division, Morton Thiokol, Inc., July 5.

McConnell, Malcolm: 1987, *Challenger, A Major Malfunction: A True Story of Politics, Greed, and the Wrong Stuff*, Garden City, N.J.: Doubleday and Company, Inc.

Mankin, Hart T.: 1981, 'Commentary on "Ethical responsibilities of engineers in large organizations: The Pinto Case" ', *Business and Professional Ethics Journal* **1**, 15–17.

National Research Council: 1988, *Post-Challenger Evaluation of Space Shuttle Risk Assessment and Management*, Washington, D.C.: National Academy Press.

Report of the Presidential Commission on the Space Shuttle Challenger Accident: 1986, Washington, D.C.: U.S. Government Printing Office.

Rosenblatt, Roger: 1983, 'The commission report: The law of the mind', *Time* **126** (February 21), 39–40.

Schwartz, Howard S.: 1987, 'On the psychodynamics of organizational disaster: The case of the Space Shuttle Challenger', *The Columbia Journal of World Business*, Spring.

Thompson, Dennis F.: 1987, *Political Ethics and Public Office*, Cambridge, MA: Harvard University Press.

Wilmotte, Raymond M.: 1970, 'Engineering truth in competitive environments', *IEEE Spectrum* **7** (5), 45–49.

College of Management Science,
University of Lowell,
Lowell, MA 01854, U.S.A.