may discharge an employee at any time and for virtually any reason. Court decisions, such as this one, have held that the traditional doctrine must be modified if there is an important interest at stake. Precisely how far the public policy exception extends is still being formulated by the courts, but it includes such things as a refusal to break the law (such as in the Lorenz case), performing an important public obligation (e.g., jury duty), exercising a clear legal right (e.g., exercising free speech or applying for unemployment compensation), and protecting the public from a clear threat to health and safety. In general, the public policy exception has not been invoked to protect an employee when there is a mere difference in judgment with the employer.[28] The courts have also given more weight to the codes of administrative and judicial bodies, such as state regulatory boards, than to the codes promulgated by professional societies.[29]

In addition to the judicial modification of at-will employment, dissenting employees have also received some statutory protection, primarily through whistleblower laws. The first such state law was passed in Michigan in 1981. If the employee is unfairly disciplined for reporting an alleged violation of federal, state, or local law to public authorities, the employee can be awarded back pay, reinstatement to the job, costs of litigation, and attorney's fees. The employer can also be fined up to $500.[30] New Jersey's Conscientious Employee Protection Act forbids termination for conduct undertaken for the sake of compliance with "a clear mandate of public policy concerning the public health, safety, or welfare."[31] Many cases in the area of what might very generally be called "employee rights" involve nonprofessional employees, but our special interest is professional employees, especially engineers. Many of the cases, like the Lorenz case, involve a conflict between professional employees and managers. In fact, most of the classic cases in engineering ethics involve conflicts between engineers and managers.

4.8 ROGER BOISJOLY AND THE *CHALLENGER* DISASTER

Two events in the professional life of engineer Roger Boisjoly, both related to the 1986 *Challenger* disaster, illustrate several themes in this chapter. One of these events is the teleconference between Morton Thiokol and NASA the night before the launch of the *Challenger*. This dramatic event illustrates the conflict between engineers and management in decision-making. The second experience is Boisjoly's testimony before the Presidential Commission on the Space Shuttle *Challenger* Accident. Boisjoly's testimony raises the issue of whistleblowing and the extent of the legitimacy of loyalty of an engineer to the organization in which he or she is employed.

Proper Management and Engineering Decisions

Robert Lund, vice president of engineering at Morton Thiokol, was both an engineer and a manager. In the teleconference on the evening before the fateful launch, he, in concert with other engineers, had recommended against launch. The recommendation was based on a judgment that the primary and secondary O-rings might not seal properly at the low temperatures at which the vehicle would be launched. NASA officials expressed dismay at the no-launch recommendation, and Thiokol executives requested an interruption in the teleconference to reassess their decision. During the 30-minute interruption, Jerald Mason, senior vice president of Morton Thiokol, turned to Lund and told him to take off his engineering hat and put on his management hat. Afterward, Lund reversed his no-launch recommendation.

BOX 4.7 Engineering Hat

In the *Challenger* disaster, Robert Lund was told to take off his engineering hat and put on his management hat. This brought about the last-minute reversal of a long-standing policy, requiring the burden of proof to rest with anyone recommending a no-launch rather than a launch decision. This was a serious threat to the integrity of the engineering obligation to protect human life.

In admonishing Lund to take off his engineering hat and put on his management hat, Mason was saying that the launch decision should be a management decision (Box 4.7). Testifying before the Rogers Commission, which investigated the *Challenger* accident, Mason gave two reasons for this belief. First, the engineers were not unanimous: "[W]ell, at this point it was clear to me we were not going to get a unanimous decision."[32] If engineers disagreed, then there was presumably not a clear violation of the technical or ethical standards of engineers; thus, it could be argued that neither requirement of the PMD was being violated.

There are reasons to doubt the factual accuracy of Mason's claim, however. In his account of the events surrounding the *Challenger* given at the Massachusetts Institute of Technology (MIT) in 1987, Roger Boisjoly reported that Mason asked the Morton Thiokol engineers if he was "the only one who wanted to fly."[33] This would suggest that Mason did not have evidence at this point that other engineers supported the launch. Whatever validity Mason could give to his argument that some engineers supported the launch (and therefore that the opposition of the engineers to the launch was not unanimous) was apparently based on conversations with individual engineers after the teleconference. Nevertheless, Mason may be correct in maintaining that there was some difference of opinion among those most qualified to render judgment, even if this information was not confirmed until after the event. If engineers disagreed about the technical issues, then the engineering considerations were perhaps not as compelling as they would have been if the engineers had been unanimous.

Mason's second reason was that no numbers could be assigned to the time required for the O-rings to seal at various temperatures:

> *Dr. Keel:* Since Mr. Lund was your vice president of engineering and since he presented the charts and the recommendations not to launch outside of your experience base—that is, below a temperature of 53 degrees for the O-rings—in the previous 8:45 Eastern Standard Time teleconference, what did you have in mind when you asked him to take off his engineering hat and put on his management hat?
>
> *Mr. Mason:* I had in mind the fact that we had identified that we could not quantify the movement of that, the time for movement of the primary [O-ring]. We didn't have the data to do that, and therefore it was going to take a judgment rather than a precise engineering calculation, in order to conclude what we needed to conclude.[34]

This might also be a reason for holding that the decision to launch did not violate criterion 2 of the PMD and did not clearly satisfy criterion 1 of the PED. However, the fact that no calculations could be made to determine the time it would take the O-rings to seal at various temperatures does not necessarily justify the conclusion that a management decision should be made. Surely the fact that failure of the O-rings to

seal could destroy the *Challenger* implies that the engineering considerations were of paramount importance even if they could not be adequately qualified. The engineer's concern for safety is still relevant.

Nevertheless, Mason's comment may make a valid observation. Given that engineers generally prefer to make judgments on the basis of quantitative calculations, they may well have been uncomfortable with the fact that there were no precise numbers for the degree of degradation of the O-rings at lower temperatures. As a result, the engineering judgment did not have the same degree of decisiveness that it would have had otherwise. All that Roger Boisjoly could argue was that the degree of degradation seemed to be correlated with temperature, and even the data he used to back up this claim were limited.

Mason's arguments, taken together, might be seen as an attempt to meet criterion 2 of the PMD. If the decision to recommend launch is not a clear violation of engineering practice, then an engineer would not violate his technical practices by recommending launch. Thus, Mason's argument could be seen as a claim that the decision whether to launch was at the very least not a paradigm instance of a PED. A paradigm PED would be one in which (among other things) the experts clearly agree and there are quantitative measures that unambiguously point to one option rather than another. Thus, the recommendation to launch was at the very least not a paradigm case of a violation of technical engineering practices.

Mason might also have argued that criterion 1 of the PMD was satisfied. A renewed contract with NASA was not assured, and failure to recommend launch might have been the decisive factor that persuaded NASA officials not to renew the contract with Morton Thiokol. Thus, the well-being of the company might have been substantially harmed by a no-launch recommendation.

Despite these arguments, we believe that the launch decision was properly an engineering decision, even though it perhaps was not a paradigm case of such a decision.

First, criterion 1 of the PMD was not as compelling a consideration as Mason may have supposed. There was no evidence that a no-launch decision would threaten the survival of Morton Thiokol, or even that it would in any fundamental way jeopardize Thiokol's well-being. In any case, engineering considerations should have had priority.

Second, criterion 2 of the PED was relevant because the decision to launch violated the engineer's propensity to modify or change criteria only in small increments. The temperature on the launch day was more than 20 degrees below that of any previous launch day. This was an enormous change, which should have given an engineer good reason to object to the launch.

Third, criterion 1 of the PED was relevant. Even though the quantitative data were limited and clearly did not give conclusive evidence that there would be a disaster, the data did seem to point in that direction so that the engineering need for quantitative measures was satisfied to some extent. Engineers, furthermore, are alert to the fact that composites, such as the ones the O-rings are made of, are temperature sensitive and that one could reasonably expect substantially lower temperatures to produce substantially greater blow-by problems.

Fourth, criterion 2 of the PED was also relevant because life was at stake. Engineers are obligated by their codes of ethics to be unusually cautious when the health and safety of the public are involved. This should be particularly important when those at risk do not give informed consent to special dangers. This was the case with the

astronauts, who did not have any knowledge of the problems with the O-rings. The importance of the safety issue was further highlighted because of the violation of the practice of requiring the burden of proof to be borne by anyone advocating a launch decision rather than a no-launch decision. In testimony before the Rogers Commission, Robert Lund recounts this all-important shift in the burden of proof:

Chairman Rogers: How do you explain the fact that you seemed to change your mind when you changed your hat?

Mr. Lund: I guess we have got to go back a little further in the conversations than that. We have dealt with Marshall for a long time and have always been in the position of defending our position to make sure that we were ready to fly, and I guess I didn't realize until after that meeting and after several days that we had absolutely changed our position from what we had before. But that evening I guess I had never had those kinds of things come from the people at Marshall that we had to prove to them that we weren't ready.... And so we got ourselves in the thought process that we were trying to find some way to prove to them it wouldn't work, and we were unable to do that. We couldn't prove absolutely that the motor wouldn't work.

Chairman Rogers: In other words, you honestly believed that you had a duty to prove that it would not work?

Mr. Lund: Well that is kind of the mode we got ourselves into that evening. It seems like we have always been in the opposite mode. I should have detected that, but I did not, but the roles kind of switched.[35]

This last-minute reversal of a long-standing policy, requiring the burden of proof to rest with anyone recommending a no-launch rather than a launch decision, was a serious threat to the integrity of the engineering obligation to protect human life.

Although hindsight no doubt benefits our judgment, it does seem that the decision whether to recommend launch was properly an engineering decision rather than a management decision, even though it may not have been a paradigm case of a PED. There is insufficient reason to believe that the case diverged so much from the paradigm engineering decision that management considerations should have been allowed to override the engineering constraints. Engineers, not managers, should have had the final say on whether to launch. Or, if the person making the recommendation wore both an engineering hat and a management hat—as Robert Lund did—he should have kept his engineering hat on when he made the decision. The distinction between paradigmatic engineering and management decisions and the attendant methodology developed here help to confirm this conclusion.

Whistleblowing and Organizational Loyalty

Boisjoly's attempt in the teleconference to stop the launch was probably not an instance of whistleblowing. It certainly was not an instance of external whistleblowing because Boisjoly made no attempt to alert the public or officials outside Thiokol and NASA. His actions on the night before the launch were probably not even internal whistleblowing because (1) they did not involve revealing information that was not known (rather, they made arguments about the information already available) and (2) he did not go out of approved channels. His testimony before the Rogers Commission, however, might be considered a case of whistleblowing because it did