Challenger and the Social Contingency of Meaning: Two Lessons for the Technical Communication Classroom

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In my technical writing class, I examine two "meanings" from the *Challenger* disaster to illustrate the social contingency of meaning even in science and technology. These instances are the "anomalous" charring of the O-rings and the reconceptualized assumption of flightworthiness the night before the launch. The social contingency of these meanings shows that the "object" of technical communication is not the material object as a pre-existent isolate but in its social interpretation, significance, and meaning. Ultimately, technical communication is about people communicating about and to the interests of other people.

The *Challenger* disaster was both a terrible tragedy and a vivid personal event in the life of most Americans. Any lessons drawn from this disaster for the technical communication classroom naturally provide both a tie to the emotionally powerful personal experiences of the audience and a real illustration of the grave consequences of failed human communication. The purpose of this paper is pedagogical, presenting one way I have discussed this disaster in my technical communication classes, highlighting the social contingency of meaning. By focusing on *Challenger*, the discussion of the sociology of knowledge, a topic that seems almost required in the contemporary technical communication classroom, can be moved from abstraction to vivid, personal reality. I will begin by reviewing other articles and explaining the need for a very general observation, then review critiques of positivistic attitudes toward language, and finally discuss my classroom presentation of an authoritative narrative of two crucial aspects of the disaster, emphasizing that the meaning of knowledge is contingent on social assumptions, conceptualizations, and construction.

My primary purpose is to convince those technical communication students holding positivistic preconceptions about technical communication (especially those from the sciences and engineering) of the sociology of knowledge and meaning in the hope of preventing similar disasters in the future. Such residues of positivism impede our students' appreciation of the generative, social power of their writing. These fundamentally disempowering notions, characterized by the window pane or conduit theories of language, assume that the objects of technical communications are "out there" already, existing in some absolute sense prior to and separate from social constructions, negotiations, and interests. These misconceptions also make the epistemological mistake of assuming that the thing-in-itself can be known unequivocally. I examine the *Challenger* disaster not in its particular causes but as an illustration of a very general phenomenon: communication is not the simple reflection of a pre-existent reality but the social, creative, interested, and often unwittingly formation of meaning. In a separate article, I explore related lessons drawn from the official investigations of the disaster (Dombrowski, "Lessons"; see also, Dombrowski, "People").

Other authors have explored the theoretical and empirical aspects of the social construction of scientific knowledge in other areas. Debra Journet, for example, reviews several major compendiums of instances. Still others have examined the particulars of this disaster. The Presidential commission and the Congressional committee present a complex history of events and causes. Dorothy Winsor shows instances of interpreting from different perspectives and the difficulty of accepting "bad news" ("Communication Failures"). Winsor also shows how the very questions asked in investigation guide the formation of our understanding and how rhetoric can facilitate the communicative tasks of engineers and managers ("Construction of Knowledge"). Roger Pace has examined the group differentiation process as it affected the decision to launch. Dennis Gouran, Randy Hirokawa, and Amy Martz present a social psychological perspective based on the commission's finding that the procedural system itself was sound. Carl Herndl, Barbara Fennell, and Carolyn Miller present a rhetorical and argumentative perspective concluding that it is difficult to neatly define the "discourse communities" in this event. Relatedly, James Zappen points out the complexity and methodological contingency of "discourse community."

These other authors have struggled to explain and interpret incidents relating to the disaster in order to prevent similar disasters in the future. They have identified various loci of responsibility, causality, and intervention ranging from personal judgment (Dombrowski, "People") to hierarchical organization (Winsor, "Communication Failures"). These explorations, however valuable in themselves, collectively yield a morass of competing explanations. For example, Zappen suggests that there are several understandings of what constitutes a "discourse community." As another example, Winsor suggests the hierarchical nature of the NASA contributed to failed communication ("Communication Failures") while, on the other hand, Charles Perrow states that complex, high-risk technologies such as the Shuttle *require* an authoritarian and hierarchical organization. Rather than attempt to sort out this morass, for instructional purposes I focus only on the general phenomenon of the social contingency of the meaning of knowledge. The simple but vital awareness that data do not speak for themselves and that the meaning of a "fact" is contingent on many social factors rather than compelled by its own autonomous authority is perhaps the most general and least equivocal pedagogical lesson to be drawn from the disaster.

Additionally, in the same context, I discuss in class the various articles written about the disaster, which in themselves also demonstrate the indefiniteness and the social contingency of meaning. None of these authors completely agrees either as to interpretation or as to prevention, yet they are all examining the same protracted, complex event. The data, we might say, remain constant while what they signify or mean is practically an independent variable.

Winsor's thorough, thoughtful exploration of the social construction of knowledge relating to *Challenger* ("Construction of Knowledge") is a good illustration of the difficulty of searching for definite explanations for the disaster. After reviewing various articles and then exploring in her own earlier article the difficulties in defining "sound" versus "erroneous" knowledge after-the-fact, she concludes that different initial questions are called for, yet offers no definite answer to these questions. This is not to derogate Winsor's article but only to illustrate the great difficulty attending trying to pinpoint convincingly specific causes, responsibilities, and explanations. Therefore, I settle in my own classes for indicating the general phenomenon of social contingency in its manifold complexity rather than pointing out the complex organizational, political, ethical, and rhetorical ramifications of this phenomenon. I conclude by indicating that there are no easy answers or quick, sure solutions for situations such as this, stressing that indeed it can be a profoundly serious mistake to expect definite, positive answers.

Positivism and Rhetoric

Many theorists of technical communication have pointed out that the view of knowledge and meaning that seems to underlie both early treatments of technical communication and many of our students' naive perceptions of technical communication is largely positivistic. Michael Halloran and Merrill Whitburn trace the excessive concern with material objects, referentiality, and spare language to both ancient rhetoricians and early modern science. Such critics point out that language never does, even in the most rigorously technical of technical communications, act as a simple window pane. Language never presents a referent without distortion, or more correctly, without interpretation. Furthermore, the priority (in the sense of already-existent) of the referent implied in such a view is, as Kenneth Burke and social constructionists have pointed out, a misconception. As Burke put it poetically, ". . . And how things are / And how we say things are / Are one" (56). Both Halloran and Miller encourage us to be less suspicious of language than positivists have been, to see language as an inseparable ally, or at least as a neutral, rather than as an enemy. More importantly, they have illuminated the vital connection between language and our scientific and technological culture. Indeed, the entire topic of social constructionism, associated with critics including Peter Berger and Thomas Luckmann, Clifford Geertz, Karina Knorr-Cetina, Bruno Latour, Charles Bazerman, Greg Myers, and Karen LeFevre, is based on this same essentially antipositivistic understanding of knowledge and meaning.

In the classroom, I synthesize from two key incidents attending the disaster a narrow but far-reaching general lesson for the technical communication classroom: the "objects" of our communications are oftentimes not material objects and raw data but the socially contingent meanings, interpretations, and significances attached to material objects. I do this by presenting summary histories of the development of the interpretive meaning of the charring of the O-rings and the meaning of "flightworthiness" regarding recommendations for launch. I reinforce this lesson through the fact of the multiplicity of articles on *Challenger* with their various understandings of construction, explanation, and intervention. As pointed out earlier, rather than explore the specific social forces at work or weigh the relative impacts of them (a formidable and inconclusive task), I settle for demonstrating the general phenomenon of social contingency. Furthermore, rather than use "social construction," which suggests active, conscious deliberations, I use "social contingency," which includes unwitting and passive considerations as well.

Charring of the O-ring Seals

The first incident I discuss in class is the charring of the O-ring seals beginning several years before the disaster. I proceed by presenting a summary narrative of the history of O-ring charring and the meaning attributed to it gleaned from the evidence, testimony, and findings of both the Presidential commission and the Congressional committee. The basic information has not been seriously challenged though others have, not surprisingly, offered differing interpretations of this material.

I begin with the following brief historical and technical overview. The Solid Rocket Booster, two of which are attached to the shuttle and its fuel tank like two enormous Fourth-of-July skyrockets, is a huge structure. It is so large that it could not be fabricated as a single structure by technology circa 1970. It had to be fabricated as several segments that were bolted together to form an entire booster. The seal between these massive segments was of vital importance. If any of the hot, explosively pressurized exhaust gases vented through the side of the booster rather than through the nozzle, the gases would immediately erode an increasingly large hole like water through a hole in a dike. The importance of the seal called for it to be redundant, meaning that a double seal had to be used—if one failed, there was the other to ensure safety. The seals were rather simple and surprisingly fragile rubber O-rings. They were separated from the hot exhaust gases by a generous glob of putty that was to perfect the sealing and protect the O-rings from being burned and made inoperative. That is, neither O-ring was expected to ever come in contact with hot exhaust gases because such exposure would immediately threaten the loss of the seal, the integrity of the booster, and so the entire vehicle and crew.

The boosters, due to their high initial cost and basic simplicity, were to be re-used over the course of several Shuttle missions. After completing their pyrotechnic boost of the main vehicle, they were disengaged at high altitude and parachuted to fall in the ocean. They were then recovered and recharged for another flight. From the earliest Shuttle missions, however, it was apparent that something was wrong. Examination of the spent boosters revealed that the O-rings frequently were charred to varying degrees, some almost half-way through. Keep in mind that the O-rings were intended never to be exposed to exhaust gases in any way at any time. Thus, this charring was at first said to be "anomalous"; that is, it was not supposed to happen.

The earliest observations of charring were noted with alarm and reported to higher authorities because the seals were not operating as expected and because sound sealing was vital to the safety of the flight. For a variety of reasons beyond the scope of this paper, these alarms were noted but little was done to change the design of the seal system or to curtail flights until the problem was corrected. Instead, procedures were instituted to apply more putty, install the O-rings more carefully, and test more scrupulously the seating of the O-rings. To the credit of Morton Thiokol Industries (MTI) and the National Aeronautics and Space Administration (NASA), some organizational steps were taken to begin a long-range, more substantial remedy. However, as investigating committee documents clearly reveal, this task force was "hog-tied by paperwork" and continually "delayed" (United States, *Investigation* 57; United States, *Report* 252, 253). Its efforts came to little as increasingly vocal and urgent warnings apparently went unheeded or were reconceptualized and dismissed.

The instructive aspect of this charring episode is that social factors (economic, historical, political, professional, organizational, and rhetorical concerns) had a powerful effect on how this anomaly was perceived and what was to be done in light of that perception. Indeed, whether the charring was construed as "anomalous" or not was socially determined, as we will see, this despite seemingly obvious indicators of danger.

As flight after flight was launched and successfully recovered even though some charring of some O-rings occurred, these flights were taken as a sort of evidence that charring should be understood in a new light. The very success of these flights was taken to demonstrate that exposure of the O-rings to the exhaust gases was not a serious concern and could and should be tolerated. The Congressional report points out seven instances of "poor technical decisions" leading to the disaster, one of which is "Mr. Mulloy's description of joint failures as being within 'their experience base.' In other words, if it broke before and the size of the recent break was no bigger than those before, then there was no problem. Even when the erosion surpassed all previous experience, NASA then went on and expanded its 'experience base' " (United States, *Investigation* 50). That is, the successful completion of the mission was taken as *prima facie* evidence that exposure and charring should be tolerated. Thus what was never to happen came to be permissible, even being taken as an indication of safety rather than danger.

The Congressional committee report is especially enlightening on this matter, tracing the introduction of "acceptable erosion," "allowable erosion," and "acceptable risk" into discussions of the charring (United States, *Investigation* 53, 55, 56). "But rather than identify this condition as a joint that didn't seal, that is, a joint that had already failed, NASA elected to regard a certain degree of erosion or blow-by as 'acceptable' " (62). As time went on, therefore, the increasing number of unanticipated events came to be viewed with decreasing concern. Thus, the anomalous was no longer considered anomalous because it happened all the time, and what was cause for alarm became grounds for reassurance. It was as though black became white.

The Congressional committee is also clear in finding that the information available before launch was not equivocal and should have prevented launch. "The joint seal problem was recognized by engineers in both NASA and Morton Thiokol in sufficient time to have been corrected by redesigning and manufacturing new joints before the accident on January 28, 1986 (United States, *Investigation* 50). More pointedly, "The question remains: Should the engineering concerns, as expressed in the pre-launch teleconference [the L-1 conference the night before the launch in which flightworthiness was discussed in relation to seal erosion history], been sufficient to stop the launch? The Committee concludes that the answer is yes" (71). The lesson to be drawn from this reversal of meaning is that data are not the clear, absolute, pre-existent entities that a positivistic pre-conception would suggest. Instead the meaning of data is understood and defined in light of many other social considerations, some of which are necessary and appropriate (such as the replicability of the scientific method) and some of which clearly are neither. Expecting the data to speak for themselves, to tell their own story as though from their own autonomous authority, is to disregard the social contingency of knowledge and meaning.

Flightworthiness

The second episode has to do with the teleconference the night before the launch (called the L-1 meeting) between NASA managers and MTI managers and engineers. During this teleconference, management and engineers at MTI strenuously expressed their grave reservations about the safety of the flight on the basis of the charring of the O-ring seals (some engineers refusing to buy into the reconceptualization of the anomaly). The engineering group at MTI was "very adamant about their concerns . . . because we were way below our data base and we were way below what we qualified for" (United States, *Report* 86-89). The response of management to this expression of reservations at such a late date was to say that they were "appalled" (Hardy at Marshall SFC) because such reservations called up the possibility of postponing the already long-postponed flight for another three months at least. MTI management acted by calling for an off-line caucus in which they discussed among themselves the seriousness of these reports, the implications, the responsibility and authority involved, and the actions to be taken. Management (Mason) told engineers that what was needed was a "management" decision rather than an engineering decision, which ultimately had the effect of overriding the objections of the engineers.

Management at MTI and NASA questioned engineers further, pressing them to prove that their reservations involved certain peril to the mission. Thus began the second major reconceptualization. Management's questioning (which could be construed as browbeating, considering the power and status differential) expressed a complete change in perspective and assumption. Engineers found themselves in the situation of being asked by management to prove absolutely and certainly that the *Challenger* flight would end in disaster. This they could not do, especially in light of previous successful missions in which some charring had occurred. More specifically, engineers were totally thrown into confusion and frustration by the change of assumption and conceptualization. The standard perspective for these discussions with management was that engineers were called on to prove that the vehicle *would* fly safely, working to refute the sort of devil's advocate approach by management that assumed that it *would not* fly. This standard assumption prudently leaves the engineers with the burden of proof; without convincing proof, the flight is scrubbed.

At the *Challenger* L-1 meeting, however, there occurred an absolutely vital flip-flop of assumption and burden of proof. When engineers could not prove that *Challenger would not* certainly go up in flames, management took their implicit assumption that *Challenger* would fly as thus confirmed and unqualified.

Lund testified to the Presidential commission: "We . . . have always been in the position of defending our position to make sure that we were ready to fly. . . . I didn't realize until after that meeting and after several days that we had absolutely changed our position from what we had been before. . . . 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 that it wouldn't work, and we were unable to do that. We couldn't prove absolutely that that motor wouldn't work. . . . It seems like we have always been in the opposite mode" (United States, *Report* 94). Boisjoly, an engineer at MTI, later summed up the alteration of assumptions succinctly: "This was a meeting where the determination was to launch, and it was up to us to prove beyond a shadow of a doubt that it was not safe to do so. This is in total reverse to what the position usually is in a preflight conversation or flight readiness review. It is usually exactly opposite to that" (93).

Nevertheless, and to their credit, MTI engineers continued to vociferously object to approving the launch. But in the face of an adamant management and an argumentative perspective that was not only unusual but which opposed accepted good practice in astronautical engineering, the engineers gave up. As Boisjoly testified to the Presidential commission: "And we were attempting to go back and re-review and try to make clear what we were trying to get across, and we couldn't understand why it was going to be reversed. So we spoke out and tried to explain once again the effects of low temperature. Arnie [Thompson] . . . tried to sketch out once again what his concern was with the joint, and when he realized he wasn't getting through, he just stopped. I tried one more time with the photos. . . . I also stopped when it was apparent that I couldn't get anybody to listen" (United States, *Report* 92). In this case, the all-important meaning to be attached to an event (the engineers' unwillingness to recommend the launch and the charring history itself) was pre-determined by NASA management. Further objecting by MTI engineers did not fit this prior conceptualization and so was discounted by management or not even recognized: "nobody said a word" (92).

Bringing the discussion of this episode to a close, I point out the interrelation of the interpretation of O-ring erosion history and the reversal of the assumption of unflightworthiness. I quote from the Presidential report where Boisjoly is queried by Feynman about the L-1 conference regarding his inability to *prove* unflightworthiness.

Feynman: I take it you were trying to find proof that the seal would fail?

Boisjoly: Yes.

Feynman: And of course, you didn't, you couldn't, because five of them didn't, and if you had proved that they would have all failed, you would have found yourself incorrect because five of them didn't fail.
Boisjoly: That is right. (United States, *Report* 93)

When the assumption was changed to having to prove that *Challenger* would *not* fly, engineers could not prove this with certainty because five earlier flights had returned safely with charring. This reinforces the crucial importance of the conceptualization of O-ring erosion. This episode shows that prior conceptualizations can work both to alter drastically the meaning of evidence and even to refuse to recognize conflicting evidence. The crucial question of whether the shuttle was flightworthy or not at a given time was ultimately answered less by hard data or even by the interpretation advanced by engineers but more by the conceptualization advanced by another, more powerful social group.

Lessons for Technical Communication

What do these two episodes suggest for the technical communication classroom? They raise the question, what is technical communication about? Is it, as some students with positivistic preconceptions believe, only about objects and data, the artifacts of technology? The lesson of these two episodes answers, No. It is clear that the object, in the case of the O-ring and its physical condition, was not in itself the crucial factor in the communications. That charring occurred is indisputable but also, in a way, trivial. Rather, what is important and problematic and what gave purpose to communications was the interpretation or meaning of this charring and what should be done in light of it. Does the charring mean we should postpone the launch or should we not? In this case, the attendant assumptions and interests were absolutely vital to defining the substantive content and purpose of technical communication about the charring.

In the case of the L-1 meeting, the social construction imposed on the interaction by management (from their position of greater authority and power) completely undid the conventional assumptions of engineers regarding good engineering practice. The reversal of argumentative assumption in effect reinterpreted the positivistic data about the charring by casting it in completely different light, yielding conclusions unexpected by engineers. Perhaps equally importantly, this extraordinary conceptual reversal undid any force to the engineers' argument to the point that there was nothing possible for them to say. It also undid the lives of seven people.

The lessons of the *Challenger* disaster are simple, powerful yet at the same time difficult to grasp fully. The thing, the charred seal, is itself of little interest or even meaning in itself for technical communication. Only when we begin to grapple with such questions as—what does this mean? how is it to be interpreted? and what are we to do in light of this?—does a valid rhetorical object emerge for technical communication. This is true for practically all technical reports in that a purpose statement casts the content report in a light of on-going social, organizational, professional, and discourse community concerns while the summary section and conclusions and recommendations section cast the raw material of the report in interpretations and applications, for example, constructions, along the line of social interests broadly defined

Others on Social Construction of Meaning

LeFevre's comments on writing are particularly germane regarding the social contingency of meaning. She explains that invention in writing is an inherently social act, an essentially "communitarian" endeavor. The sociality of invention stands in opposition to some prevailing assumptions about writing that seem particularly prevalent in the technical communication classroom. Among these are the assumption is that "knowledge is represented in language rather than constituted by it" and that " 'hard' knowledge is mechanistically gained by the accumulation of objective facts" (135). As the *Challenger* examples show, knowledge is instead constituted in such communication acts as the reconceptualization of assumptions and accumulated evidence. In this case the increasing accumulation of evidence was counterproductive of safety because of the reconceptualization of "anomalous" or the reconceptualization of "flightworthiness" imposed on the evidence as an *a priori*. LeFevre argues that "We should seek . . . to persuade those who write about science and technology—and their employers—that writing and language are closely connected with invention or innovation, that they do much more than merely transmit work that has already been completed" (135).

The epistemological indeterminacy of such "things" as the charring of an O-ring should not be surprising. Paul Feyerabend and others interested in the sociology of science have pointed out that all knowledge, including scientific and technological knowledge, is sociologically contingent, being based on a tradition or context of consensus, semantics, and even cognition. Feyerabend emphasizes that even in the most supposedly objectivist science, physics, knowledge is socially contingent in many ways. He also explains that the assumption of fundamental indeterminacy and the toleration of alternative construals are the *sine qua non* of a growing, vibrant science. He says, "Science is an essentially anarchic enterprise: theoretical anarchism is more humanitarian and more likely to encourage progress than its law-and-order alternative" [which will tolerate only a single interpretation]

(5). This amounts to saying that the epistemological condition in which the O-ring charring could be construed either as a cause for alarm or as a cause for assurance is fundamentally inescapable and a basic feature of the advancement of knowledge. This is not to say, however, that the inclination to make safety the paramount concern should not be over-riding in the minds of those construing the "thing."

David Dobrin holds similar views. Dobrin points out the vital importance of alternity in human communication, explaining that the degree of alternity and flexibility is in a way a distinction between literary expressions and technical expressions (at least those from the window pane perspective). He also points out that too often the technical communicator feels "dominated" and "subjugated" in the face of technology (245). He argues that instead the communicator, by virtue of knowing so much more than most readers about what he or she writes, actually makes *de facto* policy and thus actually has substantial power. He also explains that the communicator stands in a unique relation, straddling the otherwise separated groups of technicians and users, and so performs a valuable social function.

Miller critiques the window pane view of language in technology and science as being suspicious of language while at the same time fostering a socially invidious impersonalness. When science and technology insist on privileging atomistic knowledge about content and objects, they disempower those not participating in that privilege. Miller argues instead that "reality cannot be separated from our knowledge of it; knowledge cannot be separated from the knower; the knower cannot be separated from a community. . . . Science, then, is not concerned directly with material things, but with these human constructions, with symbols and arguments" (615-16). Miller advocates a humanistic education for technical communicators. "To write, to engage in any communication, is to participate in a community; to write well is to understand the conditions of one's own participation—the concepts, values, traditions, and style which permit identification with that community and determine the success or failure of communication" (616). This communitarian awareness includes recognition of the fundamental interpretative indeterminacy and social contingency of a great deal of technical knowledge.

LeFevre, Feyerabend, Dobrin, and Miller all agree that the positivistic, window pane assumption that the objective, material world is absolute and amenable to unisignatory expression in an ideally referential way is fundamentally invalid. It is therefore incumbent on teachers of technical communication to point out both the social contingency of the meaning of "things" and the social responsibility that this contingency entails.

Conclusion

The two aspects of the *Challenger* disaster that I have discussed vividly demonstrate the powerful social contingency of meaning. The raw evidence, having little meaning in itself, has importance contingent on social assumptions, conceptualizations, and constructions. In the first instance, what is meant by "anomalous" and what are the conditions under which anomalousness is to be attached to an observation was instrumental in reconceptualizing a grave danger into an assurance of safety. In the second instance, the subtle reconceptualization of the assumption regarding flightworthiness, do we assume that *Challenger* will fly or do we assume that it will not, was crucial in defining the light in which engineers' data were seen, in turn directing the course of the decision to launch or not. The outcome we all know.

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