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Communicating Risk: Presentation Matters

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MOST OF THE READERS OF THIS ARTICLE WILL REMEMBER JAN. 28, 1986, even if they don't remember the specific date itself. This was the day that the space shuttle Challenger exploded shortly after liftoff from the Kennedy Space Center in Florida, killing all seven astronauts on board. As a result of this disaster, the American manned space flight program was grounded, and NASA's entire mission was put in jeopardy.

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The cause of this disaster was quickly determined to be the failure of two rubber O-rings in the joint of the solid rocket boosters of the shuttle. The O-rings failed because of the freezing temperatures that existed prior to and at the time of the launch. At these cold temperatures, the rubber O-rings lost their resiliency and failed under the stresses of rocket ignition, allowing hot gases and flames to escape from the side of the rocket. These flames ignited the large fuel tank, which exploded and destroyed the shuttle.

One of the most surprising things about the Challenger disaster is that it was completely avoidable. The engineers who designed and maintained the solid rocket boosters knew that the O-rings would very likely fail at freezing temperatures. They had significant physical and statistical evidence that supported these concerns. They even presented this evidence to NASA officials and had extensive discussions with them the day before the launch. But the NASA officials were unconvinced by the presentation, so the launch proceeded.

The Challenger disaster provides an interesting case study of several facets of risk management. In many ways, the risk management systems functioned as intended. Engineers were aware of the risks posed by freezing temperatures and successfully identified the likely result. Senior management of the organization was made aware of the risk in a timely manner. Yet this did not prevent the Challenger from being launched. In the post mortem analysis of this event, there was much criticism of NASA's decision-making culture. These criticisms tend to place the entire blame for the disaster on the NASA officials who failed to stop the launch. However, in addition to the failure of the final decision, there was also a significant failure in how the risk of O-ring failure was communicated to the decision makers. The lessons of this communication failure are very relevant to risk management professionals in every organization.

THE FAILURE OF PRESENTATION

In his book *Visual Explanations*, Edward Tufte provides a thorough analysis of the 13 pages of information that were given to NASA officials by the engineers.[i] His analysis shows that the information provided and the way it was presented may have left significant doubts in the mind of NASA officials about whether freezing temperatures would result in an O-ring failure.

While the presentation clearly stated that low temperatures would lead to O-ring failure, the data presented did not support these assertions. The documents included several tables describing O-ring damage events that had occurred during previous launches and tests. Surprisingly, very few of these tables actually related temperature to these events. The relationship between temperature and O-ring damage was the key to the entire argument, but the engineers did not present this relationship in their documents. There was plenty of data provided, but little of it directly supported the argument. As Tufte said in his analysis, the engineers "had the correct theory and they were thinking causally, but they were not *displaying* causally." [ii]

One of the key weaknesses in the presentation was that the engineers focused their analysis only on the two launches where the O-ring damage was most severe. The evidence based on these two "blow by" events alone was very inconclusive. The most severe event occurred when the launch temperature was 53 degrees—the coldest launch to date. The engineers tried to extrapolate from that one data point that the O-rings would fail at freezing temperatures.

FOOTNOTES:

[i] Tufte, Edward. 1997. Visual Explanations: Images and Quantities, Evidence and Narrative. Cheshire, Conn.: Graphics Press, pp. 39–53.
[ii] Tufte, pp. 44.

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However, there was another launch with a "blow by" event that had occurred at a launch temperature of 75 degrees. Faced only with these two data points to consider, the evidence seemed contradictory. Instead of supporting the point the engineers were rightfully trying to make, the data the engineers provided suggested that O-ring failure might not have been related to temperature at all.

Tragically, by focusing only on the most severe cases, the engineers discarded information that could have greatly strengthened their case. As Tufte recreated the data tables, he recognized that every launch that had occurred below 65 degrees had experienced some O-ring damage, and the damage became more severe as the temperature decreased. This information could have helped the NASA officials to recognize the cause-effect relationship that O-ring failure was directly related to colder temperature, and that catastrophic O-ring failure was likely to occur at freezing temperatures. Had this information been provided, NASA officials may have made the decision to halt the launch of the Challenger.

LESSONS FOR RISK MANAGEMENT PROFESSIONALS

Ineffective communication about data and statistical evidence may have played a substantial role in failing to prevent the launch of the Challenger. As risk management professionals—particularly *quantitative* risk management professionals—there are important lessons that we can learn from this incident that can improve our competency in risk communication.

This story clearly demonstrates that presentation matters. While the processes that identify and evaluate risks are critical to a successful risk management program, the process of communicating these risks is equally important. This is particularly true in communicating quantitative information. It is essential for risk management professionals to clearly communicate the conclusions of their analyses and to provide support for the decisions they recommend. The following questions motivated by the Challenger example can help us to design more effective risk communications.

1. *Does the presentation provide sufficient information about cause and effect?*
   Inherent in the evaluation of a risk is an assessment of the potential effect from not treating or mitigating the risk. Similarly, an assessment of how the risk treatment will reduce the risk is necessary for decision makers to make an appropriate decision. Information must be presented in a way that enables the decision maker to make the comparison between the cause and the effect.

   However, in some risk management presentations, the cause-effect relationship can be buried in layers of aggregation that make it difficult to discern. For example, in evaluating catastrophe risk, analyses of total potential losses during a year across multiple hazards and multiple events provide an important assessment of the effect of catastrophe risk on the enterprise. However, by summing across all of these occurrences, it may no longer be clear whether the exposure may be driven by one hazard more than another, or by concentrations in one location more than others. Risk management professionals can enhance these presentations by developing ways to describe the cause-effect relationships that underlie the risk exposure.

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FOOTNOTE:

[ii] Tufte, pp. 44.

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2. *Does the presentation provide an appropriate basis of comparison for decision making?*
   Effective quantitative presentations enable the user to make meaningful comparisons to inform their judgment. As Tufte says, "Numbers become evidence by being in relation to."[iii] In designing a presentation, it is essential to consider what information should be provided in order to make these comparisons. Oftentimes this will guide us in choosing an appropriate scale for comparison—such as the axes of a graph—to help facilitate the comparison.

   In risk management applications, we often present data in a form that uses probabilities as a basis of comparison. While probabilities are a natural and often essential element of these presentations, we ought to think carefully about whether other bases of comparison might be more relevant to the decision process. For example, in certain reinsurance decisions, reinsurance attachment points may provide a better basis of comparison than probability thresholds would.

   Carefully evaluating whether probabilities are the most relevant basis is important for at least two reasons. First, it is not natural or intuitive for most people to make comparisons based on probabilities. Secondly, the probabilities resulting from most stochastic analyses are truly only estimates themselves. Particularly in evaluating extreme event risk, the error in estimating the probabilities can exceed the probability estimate itself. So when probabilities do provide an appropriate basis of comparison, it is important for us to communicate clearly and consistently what they mean.

3. *Does the presentation include the right amount of supporting information?*
   Quantitative risk analyses can easily produce volumes of data that can overwhelm the potential user. Therefore it is essential for us to carefully evaluate which information is truly needed to support the decision process. At the same time, we must be careful not to exclude information that can provide meaningful insight to support the conclusions of the analysis. Just as the engineers did by focusing only on the most severe O-ring failures, it is possible for us to focus too much on the most extreme risk events. Such extreme events may have significant uncertainty about their magnitude. Less severe events may provide significant information to guide a risk management decision and reduce the uncertainty about the effects of these decisions.

RISK COMMUNICATION AS A KEY COMPETENCY

The failure of communication that occurred between NASA officials and the engineers is a powerful example that demonstrates the crucial role of effective presentation of quantitative information in risk management. Risk management professionals must develop their ability to communicate risk effectively and support their assessments with meaningful quantitative findings. Risk management professionals who consider risk communication to be a key competency will strengthen this critical link in the risk management process. This in turn will enhance their ability to establish and maintain robust risk management within their organizations. ✦