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Downgrading Complexity in the *Exxon Valdez* Crisis: Using Information as a Risk Mitigation Tool in Complex Adaptive Systems

Abstract: In a high-stakes crisis environment, trial and error can be too costly an approach. The Exxon Valdez oil spill provides an example of how complex adaptive systems can have simple, preventable problems and complex, unpredictable problems can come together with disastrous consequences. Not every possible contingency can be accounted for. However, research and experience can be applied to mitigate these types of risks by using information to reduce or “downgrade” the complexity of the contributing situations. The Cynefin contexts of complexity can be used to assess problems when they arise. Downgrading the level of complexity for a given problem can turn formerly complex or complicated situations into simple ones that require less knowledge and resources to resolve and can reduce the risk of failure. The possibility and consequences of failure may remain, but downgraded complexity can reduce the likelihood of this failure and make problems more manageable when they do occur.

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Introduction

The *Exxon Valdez* oil spill caused devastation to the communities, businesses, and environment in the area surrounding the Prince William Sound. While numerous competing factors contributed to the disaster, the potential for an oil spill was one that could have been foreseen by the community. The disaster was far from the first major oil spill to occur, and considerable experience and research was already available on how best to both prevent spills and mitigate their damages when they do occur. However, decision makers failed to effectively harness that information in a way that could have prevented or mitigated the devastation. In order to better prepare to respond to high stakes crises in a complex adaptive system, stakeholders must strive both independently and collectively to use information as a tool to downgrade the complexity of potential crises. Finding existing information through experience, creating new information through research and innovation, and employing the information to downgrade complexity can make mitigate damages in high stakes scenarios by making crises less likely and more manageable.

This paper will examine the circumstances surrounding the *Exxon Valdez* oil spill and begin to break the events down into their individual parts. From there, it will consider the levels of complexity in issues and how they apply to the oil spill. The balance of the paper will assert the possibility of downgrading complexity through the use of information, while examining the challenges, benefits and risks of doing so.

Background

On March 24th, 1989, the supertanker *Exxon Valdez* struck the Bligh Reef in Prince William Sound, off the coast of Alaska. An estimated 11 million barrels of oil spilled out of the ship, causing tremendous lasting environmental damage to the region (Bowen & Power, 1993, p. 97). The tragedy of these events is exacerbated by the fact that they could have been avoided. Kelso & Brown (1991) point to a list of reasons why the spill should never have happened, based on existing precautions and the favourable conditions. The *Exxon Valdez* “was a relatively new super tanker that struck a clearly marked reef miles outside the tanker lanes, within radar and radio range of Valdez” (p. 15).

Exxon Valdez Tanker. Retrieved from Pearlstein (2008).

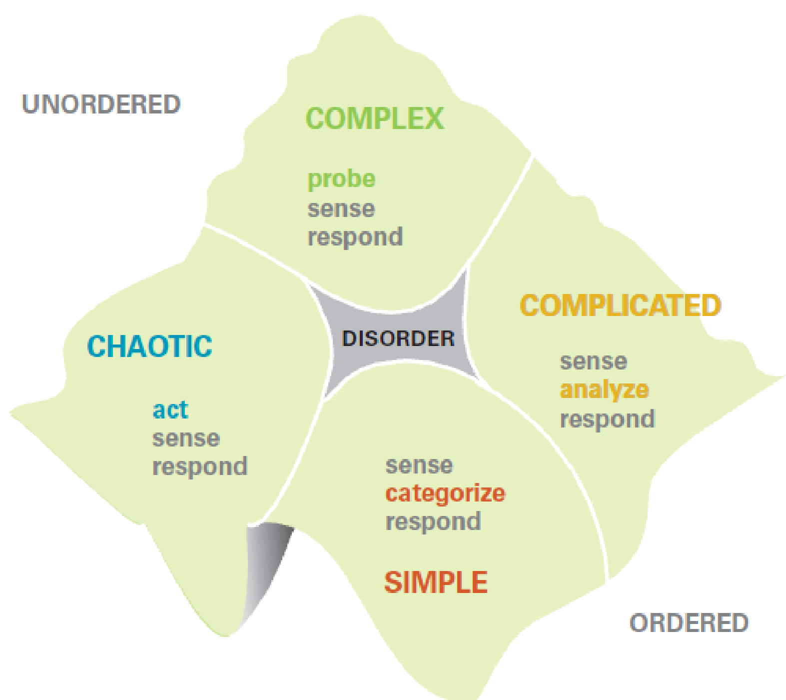
No single event caused the crisis of the *Exxon Valdez*. Rather, it was the culmination of a number of smaller factors interacting with one another. Complacency and confidence in the system meant that decision makers failed to adequately consider variables such as human error, durability of tanker construction, and tanker safety rules (Kelso & Brown, 1991, p. 15-6). Coast Guard Vice-Admiral Clyde Robbins demonstrated this problem well when, upon hearing that the *Exxon Valdez* had struck the reef, he stated “That’s impossible. We have the perfect system,” (Bowen & Power, 1993, p. 100). Similarly, no group was single-handedly capable of resolving the crisis. Multiple levels of government, business, regional organizations and local citizens all played their own respective roles in responding to the oil spill. The complexities of these relationships were demonstrated shortly after the crisis, when stakeholders from Exxon, Alyeska, the state of Alaska, and the Coast guard were reluctant to begin cleanup out of fear of accepting legal liability as a result (Bowen & Power, 1993, p. 101). This eventually forced other actors, such as local fisherman, to come together and initiate their own response effort (Kelso & Brown, 1991, p. 14).

This large group of independent actors, with their divergent interests, found themselves dealing with a crisis in the context of a complex adaptive system. This system is defined by its numerous interacting elements and stakeholders; the potential for small actions to produce disproportionately large consequences; the ability for solutions to arise naturally through emergence; and difficulties predicting future events due to constantly changing circumstances (Snowden & Boone, 2007, p. 71). Stakeholders must be able to react to recognize and adapt quickly to constantly changing circumstances.

Any efforts to mitigate or eliminate oil spills must consider the issue both in a response capacity to mitigate damages and in a prevention capacity to prevent such occurrences altogether. Since the potential for devastating environmental damage from oil spills is so high even when there is an effective response, prevention should be the primary objective. However, both prevention and mitigation are necessary components of a strategy to approach crises, respond to them, and minimize the possibility of them occurring in the future.

Identifying Complexity

The Cynefin framework was designed to help managers identify the context of the issues that they face based on their level of complexity. The framework divides issues into five contexts: simple, complicated, complex, chaotic and disorder (Snowden & Boone, 2007, p. 70). Identifying the context of an issue can help decision makers to identify the best plan of action, avoid pitfalls, and make better decisions.



Cynefin framework. Retrieved from Snowden & Boone (2007).

Simple issues live up to their name in most respects, featuring minimal complexity and limited risks in finding the appropriate solution. Since simple issues have established procedures or experience to guide individuals to a solution, the issue can be dealt with "by the book". Snowden and Boone (2007) argue that such issues are often accompanied by a "self-evident and undisputed solution" (p. 70). Simple issues can become more challenging if complacency sets in and prevents individuals from taking the appropriate action. Some of the causes of the *Exxon Valdez* crisis, such as striking "a clearly marked reef miles outside the tanker lanes" (Kelso & Brown, 1991, p. 15), were simple issues governed by existing rules and procedures, and could easily have been prevented. Solutions themselves can also get in the way when they fail to be sufficiently dynamic to address the changing nature of complex adaptive systems. Past experiences and rules on best practices should not stifle creativity, nor should they prevent decision makers from employing the most effective approach to resolve the issue.

Complicated issues are similar to simple ones in that both have a clear answer. However, in complicated issues, that answer requires a great deal more expertise; the answer will not be immediately recognizable and there may be more than one solution to the problem. Decision makers require the support of an expert in the relevant field in order to determine the appropriate solution. One such issue that was approached proactively was the need for tankers to have double hulls (Kelso & Brown, 1991, p. 15). There was sufficient knowledge available for a solution, or at least a way to mitigate risk, within the expert community. Unfortunately for the Prince William Sound, this was a long-term solution and did not come into effect until after the *Exxon Valdez* had already done its damage.

Once issues reach the complex level, serious difficulties begin to arise. The benefits of expert advice remain from the complicated model, but in the complex context, there is no single right answer. Complex issues are characterized by unpredictability and uncertainty as to the consequences of a given action, and the experts may well disagree on how best to resolve the issue. In these areas, innovation is needed to suit the circumstances in question. One of the major debates in the aftermath of the *Exxon Valdez* spill was determining how extensively to clean the beaches, and the appropriate techniques to employ (Harrald, Marcus & Wallace, 1990, p. 25). Too little effort would leave the toxic oil on the beach to further disrupt local wildlife, while too much would cause additional damage to the entire local food chain by affecting micro-organisms in the area. In order to tackle complex issues, decision makers need to encourage discussion and experimentation to develop creative and effective solutions. Mistakes become far more likely, but it is necessary to work with the available information, identify patterns, and make the best decisions possible under the given circumstances.

Chaotic issues are mercifully rare. When they occur, these issues lack any sort of cause and effect relationships at all, which creates a tense and turbulent environment. In this context, the appropriate course is to act decisively in order to impose some semblance of order. Once achieved, this order facilitates the search for an appropriate solution. While more recent oil spills like the *Exxon Valdez* certainly have their complexities, they were insufficiently complex in their time to meet this standard of a chaotic issue. Early oil spills such as the *Torrey Canyon* in 1967, which was one of the world's first major oil spills (Harrald, Marcus & Wallace, 1990, p. 15), would be more akin to a chaotic situation due to considerably less familiarity with the variables involved in countering a spill. At the time, the unfamiliarity with oil spills meant that existing maritime response organizations were simply unable to handle the crisis (Harrald, Marcus & Wallace, 1990, p. 15). For the *Exxon Valdez*, given the crisis management expectations on the company, the knowledge of past experiences and the otherwise favourable conditions, there was no excuse for the spill to become a chaotic issue.

Cases of disorder, the final context, can be difficult to recognize. In order to approach such issues, the problem must often be broken down into smaller pieces before each can be considered within its own context. From there, these smaller issues are considered under whichever is appropriate out of the remaining four classifications.

Downgrading Complexity

Changes in circumstances produce new information over time through experience and innovation. If this information is appropriately considered and employed, it can reduce the complexity of new issues when they arise. Complicated issues can be made simple through training or emergency procedures. Complex issues become complicated when reflection and research demonstrate the best approach. Chaotic issues that have occurred in a similar way before can be shifted down by contingency plans to become complex ones, where only the differences remain at issue. This notion of downgrading issue contexts is based primarily on the spread of information in an effective and appropriate manner. This involves first taking the time to research circumstances to generate the information, and then employing it practice through the creation of new regulations, procedures, and contingency plans.

Technological development has been a driver of access to information and diversification of skill sets. Computers, once largely restricted to being scientific tools, are now a common household appliance and their various uses are increasingly in the realm of common knowledge. Furthermore, the Internet has created an enormous wealth of information that is easily accessible throughout the developed world, and expanding into the developing world. Sheer technological power combined with user interface development has made tasks that once required extensive technical skills accessible to the general public. Information is no longer restricted to those who have shelves of books on a given topic, but available on a limitless range of topics to anyone with an Internet connection and a device that can use it. Telecommunications developments have allowed individuals to be reachable at any place or time.

The impact of these developments in the context of issue complexity is that the potential for downgrading complexity is greater than ever. As experience and research into new fields expands the wealth of human knowledge, problems that were once overwhelming or inconceivable have become part of contingency planning. Maritime response organizations may have been woefully unprepared for the *Torrey Canyon* oil spill, but numerous deliberations have been made since the accident, leaving teams much better equipped to tackle such an incident in the future (BBC News, 2007, March 19). Regulation has become even tighter and more comprehensive in the decades following the *Exxon Valdez* spill (Kelso & Brown, 1991, p. 15). This new information makes what was once a highly complex issue, with uncertainty as to the proper approach, into a complicated one, with crisis management experts prepared to jump into action if another such issue arises. Preventative measures and technologies designed to prevent crises, such as sonar and maps detailing unsafe maritime areas, are developed, become more readily available, and continue to improve over time. Not all creative new ideas require advanced technological development: one new idea that arose from oil spill clean-up in Australia was the notion of knitting sweaters for penguins, whose natural oil is diminished by the contamination. The sweaters keep the penguins warm until their natural oil recovers, and prevents them from swallowing the toxic oil while preening themselves (BBC News, 2007, February 16). As time goes on, experience, innovation and creative new ideas will continue to add to the resources at the disposal of decision makers and facilitate further downgrading of complexity

Fashion Penguins. Retrieved from *BoatOfFury* (2008, October 21)

There are two ways for information to filter into risk mitigation strategies, the first of which is a natural process achieved through emergence. As one of the primary characteristics of complex adaptive systems, emergence allows groups and individuals to respond to changing circumstances in a manner that contributes to the best interests of the system as a whole

(Porter & Córdoba, 2009, p. 338). This is often achieved through incentive and deterrence. For example, businesses involved in oil transportation were able to see the legal costs and the public relations nightmare that Exxon incurred in the aftermath of the spill. When functioning properly, emergence would cause companies to react by improving their own procedures and contingency plans to mitigate the risk. Some contemporary approaches also suggest that public concerns are already inexorably tied to the objectives of organizations through a stakeholder approach. This helps businesses, for example, to meet their corporate social responsibilities (Hearit, 1995, p. 3). Furthermore, this model is easier to achieve than any artificially organized approach due to the automatically coordinated nature of a self-organizing system.

The self-organization model does, however, have its limitations. First, there is significant evidence to suggest that organizations will stick to current routines and practices unless there is an external shock or crisis to elicit change (Tyre, Perlow, Staudenmayer, & Wasson, 1996, p. 3). This limits the ability of foresight to stimulate proactive effort. Even if the information is available and the will to act is present, an internal cost-benefit analysis may reveal in some cases that it is more efficient to save money and risk an accident than to absorb the cost of safer practices. For example, Alyeska as well as federal and state agencies rejected potential safety measures such as a comprehensive radar system prior to the *Exxon Valdez* crisis (Bowen & Power, 1993, p. 100). This can cause significant problems when companies fail to take into account externalities or the greater societal cost that will be incurred if an accident does occur. Exxon certainly placed significant funds towards legal and clean-up costs in the aftermath of the accident. However, the oil spill had farther-reaching consequences, such as its crippling impact on the local economy and regional biodiversity, which would not have fit as easily into Exxon's internal calculations. Hearit (1995) argues that there is a trade off for companies between meeting the needs of stakeholders, and meeting the needs of shareholders. As such, "[corporations] cannot always be accountable to both managerial and social interests" (p. 3). It is in circumstances like this, when the stakes are high yet not adequately taken into account, that the self-organization approach fails to achieve the desired outcome.

When the system fails to provide a solution naturally, one must be imposed. This generally requires government intervention, which is the second way for information to enter into risk management strategies. This can be a challenging task; complex adaptive systems do not lend themselves well to top-down strategies due to their unpredictable and uncontrollable nature (Porter & Córdoba, 2009, p. 338). Since government intervention is unlikely to present a comprehensive solution, government can instead hone in on much more specific concepts. In focusing their efforts, policy makers can employ regulatory and incentive-based instruments to mitigate risk by changing one small part of the system. One example of this approach would be legislation introduced after the crisis that requires companies to phase in double hulls for tankers (Kelso & Brown, 1991, p. 15). In this way, government forces companies to internalize the externality and take responsibility for the costs of mitigating the environmental risks.

Like the emergence approach, government intervention has its challenges. In addition to requiring greater effort, intervention may not result in an effective solution if policy makers fail to acquire sufficient information to make the right changes. Government action can have negative unintended consequences; overregulation, for example, can hurt companies or even drive them out of business. As such, government must act cautiously and target only areas where emergence fails to adequately create a natural response. Furthermore, government is not necessarily going to produce results any faster than emergence would in the absence of intervention. To continue the double hulls example, the notion had already been proposed before the crisis occurred in 1989 (Kelso & Brown, 1991, p. 15). In high stakes circumstances, governments must act quickly to overcome the shortcomings of emergence before serious and potentially irreparable damage is done. Time remains the key variable in both of these problems. It falls to policy makers to find a balance between having sufficient time to weigh their decisions and acting decisively enough to prevent crises from occurring.

Though there are considerable benefits in terms of risk mitigation through emergence or government intervention, issues that have been downgraded pose some risk themselves. One important example is that shift in responsibility for expertise and creative thinking can cause an information overload. Preventing overload requires a combination of approaches to ensure the right people know the right things at the right time. The captain of an oil tanker, for example, may not need to know all of the details involved in designing a double-hull tanker, even if it is a key component of risk mitigation for oil spills. However, if the captain of the *Exxon Valdez* had been more familiar with management systems that strengthen accountability, or with drug and alcohol monitoring (Kelso & Brown, 1991, p. 15), the oil spill may not have occurred at all. In addition to categorizing information, this example also demonstrates the benefits of consolidating information. In this case, knowledge would be concentrated in the captain; other information may be better suited to a safety officer. Another option would be to have the information available, though perhaps not memorized. This is a useful practice for more complex circumstances, provided the information can be effectively disseminated during a time of crisis. Finally, this ties in with the need to prioritize certain categories of information over others, which requires an effective balance of the probability of a risk with the seriousness of its impact. Airlines demonstrate their approach to this balance by choosing to begin every flight with an explanation of the emergency procedures. While the likelihood of a plane crash is extremely low and frequent fliers will hear the information multiple times, airlines (or perhaps their regulators) have decided that the risks associated with a crash warrant placing a higher priority on the information.

Another risk associated with downgrading issue contexts is complacency; individuals may not give appropriate consideration to low probability risks. This certainly contributed to the *Exxon Valdez* crisis, when reports supported a solid safety record by saying that large spills are unlikely to occur more than once every 241 years (Bowen & Power, 1993, p. 100). Downgrading complexity will not impact the consequences of a given scenario; rather, the benefits are focused on facilitating better management of the issue. If an issue is feared for its complexity and dangerous for its high stakes nature and the issue ceases to be complex, it may no longer elicit the same concern. Stressing the seriousness of situations where the risk is realized can be one effective approach to this issue; the *Exxon Valdez* provides a fitting horror story as an example. Kelso and Brown (1991) recommend accountability measures that can consider and attempt to account for human error as the best approach (p. 15).

With that said, the challenge of complacency that results from downgrading is not otherwise considerably divergent from those of any other simple issue. In fact, beyond information overload, the risks associated with downgrading are largely comparable to those of other issues at a comparable level of complexity. In a high stakes, complex adaptive system, these risks would likely be less of a threat than their more complicated alternatives. Furthermore, there is nothing preventing decision makers from employing experiences related to other levels of complexity in their decisions; an issue may now be defined as simple, but that does not preclude consultation within an expert in a related field. As long as the inherent risks of emergence, government intervention, and information overload are taken into account, downgrading the complexity of issues serves as a tool for mitigating risk and reducing chaos.

Conclusion

The challenges involved in working within complex adaptive systems to mitigate risk are considerable and should not be understated. However, when the stakes are so high that failure can cause extensive and irreparable damage, the effort is worthwhile. Downgrading complexity provides an opportunity to use a resource that is already available, information, and use it to prevent the occurrence of undesirable and sometimes devastating consequences. However, the Cynefin framework demonstrates that while an issue may be “simple”, that does not mean it involves no risk. Downgraded issues still bear both the risks associated with their new level of complexity and comparable consequences of failure if those risks are not adequately managed.

The ability to downgrade complexity should not be construed as a mechanism to eliminate complexity altogether. As time goes on, new and unexpected crises will inevitably occur and decision makers must be prepared to tackle issues at any level of complexity if and when they arise. Downgrading simply allows people to learn from the experiences of others to prevent the same mistakes from occurring again and to use research and innovation to prevent other mistakes from ever occurring at all. In a complex adaptive system, all of the stakeholders involved must be prepared to act decisively and effectively in order to best prevent a catastrophic outcome. Downgrading complexity can help to simply this task. As time goes on and the wealth of information and knowledge increases, downgrading can continue to mitigate risks such that impossible challenges yesterday can have clearly defined solutions tomorrow.

The losses suffered as a result of the *Exxon Valdez* crisis need not be in vain if the lessons drawn from it can help prevent another disaster like it from happening again.

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