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Complex learning: organizational learning from disasters

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Abstract

This paper examines how organizations and society learn from disasters. While learning can and does take place, the depth of this learning is often superficial. The paper argues that lessons that are more fundamental are learnt with difficulty. In order to examine the aetiology of disasters and organizational learning from them, the paper presents a theoretical framework based on systems theory. Contemporary thought on organizational learning complements this theoretical framework. Two industries, the oil industry and aviation industry, are examined in order to examine different types of learning. Finally, the paper addresses obstacles to learning and the issue of risk migration.

Keywords: Disasters; Double-loop learning; Organizational learning; Systems theory

1. Introduction

Scholars argue that disasters are not events; rather they are social constructions. For example, Dombrowsky (1995) argues that:

Disasters do not cause effects. The effects are what we call disasters (1995, p. 242).

In other words a disaster is an amalgam of the results of an event or series of events, whose impact is disruptive, destructive and/or negative in nature, and whose magnitude is sufficient to be labelled 'disastrous'.

If disasters are amalgams of 'effects', as Dombrowsky suggests, then it is possible that not all of the 'effects' are negative. One positive effect is learning. This paper examines organizational learning in the wake of disasters. The paper argues that organizations, as well as society, do learn from disasters. However, learning tends to

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occur at different levels. While superficial learning is common, more fundamental lessons are harder to learn.

The paper will begin by developing an outline of a theoretical framework for examining and analyzing organizational learning in the wake of disasters. A general sociological disaster theory outlined by Mayntz (1997) is used to put disasters in a broad societal context. Social theory on the aetiology of disasters, or the disaster cycle, complements this broad societal framework. This section is important because it provides a framework, which allows disasters to be analyzed in a systematic manner. In the context of this framework, different types of learning will then be discussed.

This theoretical framework will be applied to two case studies, examining aviation safety and oil spills. The case studies pay special attention to learning processes. Examples of how difficult it is to learn fundamental lessons will highlight the challenges that organizations face in ensuring the future mitigation of analogous disasters.

Finally, conclusions will be presented discussing obstacles to learning from disasters. These obstacles include organizational issues, such as poor safety cultures, and societal issues such as risk migration.

2. Theoretical Framework

In 1997, Mayntz proposed a general sociological disaster theory using a systems model. This model attempts to explain why disasters occur and what they are. There are four main tenants to this model. First, all systems (including societies and their sub-groups, i.e. organizations, settlements, etc.) are prone to internal and external disturbances. Second, systems must react to these disturbances. Third, systems only collapse if precautionary sub-systems cannot cope with these disturbances. Finally, the balance between the requirements and problems the system faces determine precautionary sub-systems. Perrow (1999a) describes the dichotomy that Mayntz establishes between requirements and problems when discussing complex systems, such as aircraft, by arguing that:

> *...in the search for speed, volume, efficiency and the ability to operate in hostile environments, all laudable goals, we have increased the complexity and the coupling of systems unnecessarily and this has reduced their operational reliability, as well as their ability to withstand deliberate attacks or invasions (1999, p. 150).*

In essence, Perrow juxtaposes the requirements of organisations to produce efficiently, quickly and in quantity, with the robustness of the precautionary systems that the organization employs to deal with problems.

Mayntz identifies several types of disturbance that may lead to systems failure. First, chains of misinterpreted and/or unnoticed events, known as incubation chains, may lead to systems breakdown. Second, one element in a widely ramified set of institutions may fail, causing the whole system to fail. The Barings Bank failure

described by Stead and Smallman (1999) fits into this category. In this case, the Singapore futures trading branch of Barings failed, leading to the failure of the whole organization. Finally, due to global changes, which often remain undetected until too late, a disturbance may easily overwhelm systemic coping mechanisms.

Mayntz (1997) identifies three types of possible collapse resulting from the disturbances listed earlier. First, the cessation or ineffectiveness of *restraining mechanisms* that previously prevented the occurrence of specific disruptions may lead to disaster. An example of this type of failure might be the failure of the second hull, on a double-hulled oil tanker, to prevent oil spillage when the tanker runs aground. Second, the failure of *compensating mechanisms* to address the problems faced by the system can also lead to system breakdown. An example of this type of failure might be the failure of an aeroplane's braking system to stop the aeroplane upon landing, which could result in disaster. Finally, *adaptive transformation mechanisms* for disturbances, which may not be restrained or compensated for, fail to cope with the disturbance. This type of systems failure might be seen in the wake of a global market crash in a nation's primary export. The nation is unable to diversify (compensate) for the lost revenues, and does not have the economic power to intervene (restrain) with fiscal aid, through, for example, subsidies. The nation is unable to undergo an adaptive transformation. The result is a socio-economic disaster.

Mayntz's theory presents the idea that disasters occur because societal or systemic coping mechanisms, also known as precautionary mechanisms, are overwhelmed or reach a critical mass. Although Mayntz's paradigm provides a general sociological theory of disasters, it is limited in its depth because it is only a partially developed outline.

However, because this paradigm is an attempt at a broad underlying theory, it lends itself to synthesis with other similar but more specific theories, acting as an umbrella linking them together. One area of research which fits well with Mayntz's framework is research on the disaster cycle or the stages of disaster (Turner, 1978; Shrivastava et al., 1988; Smith, 1990, 1993; Pearson and Clair, 1998; Turner and Pidgeon, 1997; Pearson and Mitroff, 1993).

The disaster cycle describes a series of stages that disasters follow. The disaster cycle allows disasters to be analyzed in a consistent manner. Stead and Smallman (1999) present an overview of the disaster cycle. Their model consists of five stages: pre-conditional, trigger, crisis, recovery and learning, which are described later.

During the pre-conditional stage of the disaster cycle a nominal state of normalcy exists. This normal state has two important associated conditions. First, a set of culturally accepted beliefs about the world and its hazards exists. For example, prior to the Exxon Valdez disaster, it was believed that the navigation and piloting systems for tankers leaving Prince William Sound were adequate (NTSB, 1989). Second, precautionary systems or [as Turner and Pidgeon (1997, p. 70) terms them] 'norms' exist. These 'norms' may be codified in laws, codes of practice, mores and folkways.

During the pre-conditional stage, different authors identify factors, which make systems prone to disaster or crisis. Turner and Pidgeon (1997) identifies incubation chains or series of unnoticed events which contribute to the on-set of disaster. Smith (1990)

identifies managerial behaviour, which creates a crisis-prone organisational environment. Pearson and Mitroff (1993) focus on early warning signs during this stage of the evolution of a disaster. The fundamental characteristic of this stage is that existent precautionary systems are inadequate to deal with the problems the system will face.

At some point an event or trigger signals the on-set of disaster. The trigger or precipitating event brings attention to the problem and transforms general perceptions of the situation. In Turner's model, the precipitating event links the incubation chains in disasters (1997:75).

During the crisis stage people are forced to face the immediate consequences of the event. Planned and ad-hoc responses to the event are initiated (Pearson and Clair, 1998). This period is characterized by attempts to contain the situation and limit damage (Pearson and Mitoff, 1993).

Once the crisis has been brought under control, the recovery period begins in which rescue and salvage operations play an important role (Turner and Pidgeon, 1997, p. 77). Smith (1990) characterizes this stage of the disaster cycle as a crisis of legitimization, where immediate explanations, scapegoats and blame are sought.

Finally, learning takes place in what Turner and Pidgeon (1997) terms 'full cultural readjustment'. This often takes place through some formal process of inquiry or investigation. At the end of this period, precautionary systems or norms are adjusted to fit a new understanding of the world created by the event.

This section presents a framework for analyzing, both why disasters occur and their development over time. Mayntz's framework is presented arguing that disasters occur when precautionary mechanisms are overwhelmed by disturbances of different kinds. The disaster cycle is used to examine the evolution of disasters. The combination of the two components provides a framework for looking at how precautionary systems are overcome, resulting in disaster and how the results of this are dealt with in the post-onset stages of the disaster cycle. The next section of the paper will deal with learning the lessons from disasters.

3. Disasters as heuristics: learning lessons

If lessons can be learnt from a disaster and more importantly the lessons absorbed so as to prevent or mitigate future disasters, then the original disaster will have had a beneficial impact on society. Yet, not all learning is the same. The following section presents various ideas regarding learning the lessons from disasters.

In the context of the theoretical framework presented earlier, learning means the adjustment of coping mechanisms based on a new understanding of the world. This new worldview is a result of the full-cultural adjustment stage of the disaster cycle. Based on this worldview the balance presented both by Mayntz and Perrow between the requirements of a system, i.e. production pressures, and the problems the system may face, i.e. the risk of fire in an oil platform, is adjusted to a newly perceived acceptable level. For this adjustment to be truly effective, it must be based on a valid analysis of the pre-condition stage of the disaster. In other words, lessons learnt need to address the root causes of the disaster, not the superficial causes. When this

occurs it can be said that Argyris' (1982) concept of double-loop learning has been achieved. However, when adaptive and not prescriptive action is taken following a disaster, only single-loop learning can be said to have resulted.

For example, in the wake of the Exxon Valdez oil spill, if a warning buoy were to have been placed above the reef that the tanker hit, to ward off other tankers, single-loop learning would have occurred. This action represents a superficial attempt to prevent the recurrence of the disaster; it does not address the root causes of the oil spill because it only addresses the immediate cause of the oil spill, or the grounding of the Exxon Valdez. For double-loop learning to have occurred, issues such as systematic breaches of safety protocols (like the abandonment of the use of tugs to guide tankers out of Prince William Sound) would have to be addressed.

Superficial learning may also produce higher risks, through the addition of complexity to a system. For example, Perrow suggests that redundant systems increase the complexity of systems and therefore increases the risk of unanticipated failures in the system. The application of additional layers of redundancy in complex systems is a typical single-loop response to a failure.

In order to examine how different types of learning occur two case studies will be used. First, aviation safety has been chosen because the aviation industry is recognised as having improved safety over the years through a process of analysis of accidents and near misses to facilitate the learning process. Second, oil spill disasters in the United States focusing on the Exxon Valdez oil spill are examined. This example has been selected because it has been cited as the principal causal factor in the passage of the Oil Pollution Act of 1990 (Birkland, 1997). Both cases represent areas where double-loop learning at a societal level has taken place.

4. Learning the lessons? — Aircraft disasters

Perrow (1999b) presents a historical analysis of aviation safety in his seminal work 'Normal accidents: living with high-risk technologies'. This analysis asserts that "there are some unique structural conditions in this industry that promote safety" (1999b, p. 123). This case study aims to identify and examine how learning, particularly double-loop learning takes place.

Disasters have been a part of the history of flight since the very beginning. Even one of the first mythical flights ended in disaster. In Greek mythology, we encounter perhaps the first man-made aviation disaster. In order to escape from Crete, where King Minos had imprisoned him, Dædalus built wings of feathers and wax for himself and his son, Icarus. Warning Icarus not to fly too close to the sun, the two took to flight. Icarus, however, did not listen to his father and flew towards the sun. The wax melted and Icarus plummeted to his death (Bulfinch, 1934).

During the early years of aviation, there was a one in eight chance among pilots of dying in flight. After the First World War, the US Air Mail Service was founded. During its 9-year life, 31 of the first 40 pilots died (Perrow, 1999b, p. 125). In 1919, just one year after its founding, the US Air Mail Service faced its first strike over safety. This strike resulted in a safety procedure which forced postal service field

managers to accompany pilots in a circuit of the airfield, if the pilot and field manager disagreed about the risk posed by bad weather. As a result of this and other actions, fatalities were reduced significantly over a 3-year period (Perrow, 1999b, p. 125).

The case of the US Air Mail Service is a good example of the fourth tenant of Mayntz's theoretical perspective: the balance between the problems and requirements of a system determine the precautionary norms of the system. Perrow (1999b) asserts that the US Air Mail Service was risky because there was enormous pressure to deliver on time, no matter how dangerous. This resulted in inevitable accidents. In spite of these accidents, it does seem that lessons were learnt and changes instituted, and therefore double-loop learning was achieved.

Modern day airline travel is very much safer than during the early days of flight. Perrow (1999b) identifies several factors, which have lead to this state. First, while there is a requirement for faster and more efficient travel by plane, it is also a requirement of the system that it be safe. If airline travel were not safe, it would not be a popular mode of transportation. In other words, safety is related to productivity in the airline industry.

Second, at least in the United States, the airline industry operates in an environment conducive to improving safety. The Federal Aviation Administration (FAA), whose mandate is to promote both safety and industry advancement, regulates the industry. The independent National Transportation Safety Board (NTSB) investigates aviation accidents and recommends industry wide changes when necessary. Finally, the Airline Pilots Association (APA), a strong union works to increase safety for its members. These three stakeholders and others interested in airline safety all work towards safer skies. This means that the organizational interests of vested parties, such as aircraft manufacturers, do not dominate (or prevent) the assimilation of lessons learnt from disasters.

Although aircraft safety has increased dramatically over history, the learning process has not been easy. One of the reasons attributed to the increase in airline safety is rapid accumulation of experience (Perrow, 1999b). One only has to read a list of the Top 100 Worst Aviation Disasters (Kilroy and Morrel, 2000) to see that there have been plenty of opportunities to learn.

The following example will look at how lessons were learnt in a specific case, to gain a better understanding of how lessons may be learnt. The McDonnell Douglas DC-10 is an aircraft with a troubled history. AirSafe.Com (2000) lists 15 major DC-10 accidents and disasters in which 1810 people lost their lives. One of these disasters occurred on 25 May 25 1979, when an American Airlines DC-10 crashed killing 273 people (Perrow, 1999b, p. 137). The plane crashed while taking off from Chicago's O'Hare International Airport, due to three factors identified by the NTSB.

The loss of control of the aircraft was caused by the combination of three events: the retraction of the left wing's outboard leading edge slats; the loss of slat disagreement warning system; and the loss of the stall warning systems — all resulting from the separation of the engine pylon assembly (NTSB, quoted in Perrow, 1999b).

This, however, was not the first such accident involving a DC-10. A similar accident took place in Pakistan in 1977. Then again following the American Airlines disaster the same problem cropped up twice more. On 31 January 1981 and on 22

September 1982, DC-10s leaving Washington D.C. and Miami, respectively encountered analogous problems (Perrow, 1999b, pp. 138–139).

Was anything learnt from these near misses and disasters? McDonnell Douglas did install a device to prevent the combination of events, which lead to the disastrous slat retraction responsible for these accidents. The device could be installed in a few hours and cost only a few thousand dollars. Therefore, it would appear that lessons were learned and changes made.

However, it is important to note that it took 5 years, three accidents and a disaster to get the lesson across. Moreover, McDonnell Douglas knew before any of the accidents occurred that this problem existed, though they estimated only a one in one billion chance of it occurring (Perrow, 1999b). Lessons were eventually learnt; however, they were not forthcoming.

Air safety was selected as a case study because it seemed like fertile ground for double-loop learning. The case study shows that although double-loop learning occurs, it is not always achieved easily.

5. Learning the lessons: oil spills

This section of the paper will look at oil spills and oil spill policy in the United States. The work of Birkland (1997) on disasters as focusing events will be presented. Birkland argues that given certain preconditions disasters can act as focusing events, which promote change in policy. In other words, disasters bring attention to themselves and their causes. If the right environment exists, this attention can translate into policy. These preconditions include a policy community, with advocates for change and established power groups. For example, the APA, FAA, NTSB and airline companies represent stakeholders in the airline safety policy forum. When these conditions are present, Birkland argues that disasters can cause shifts in traditional power structures and changes in policy. One example that Birkland employs is that of oil spills in the United States.

On 24 March 1989 at 12.04 a.m., the oil tanker Exxon Valdez ran aground on Bligh Reef, spilling 10.8 million gallons of oil into Prince William Sound, Alaska (Alaska Oil Spill Commission, 1990). Soon thereafter, the Oil Pollution Act of 1990 became legislation, after years of congressional jockeying and deadlock over the issue. Birkland (1997) convincingly links the passage of the Oil Pollution Act of 1990 to the Exxon Valdez disaster.

Several other important changes came in the wake of the Exxon Valdez disaster. The response to the oil spill by Exxon and the Alyeska Pipeline Service (a consortium of seven oil companies responsible for the operation of the oil terminal in Prince William Sound, where the Exxon Valdez loaded its cargo) was not effective. For example, the Alyeska Pipeline Service was required to maintain a spill clean-up barge, to respond to any spill in the area. The barge was not operational when the Exxon Valdez ran aground. The failure of the oil companies to appropriately prepare and plan resulted in a poorly managed response. Browning and Shelter (1992) attribute the lack of readiness to the fact that the oil companies bore sole

responsibility for contingency planning. Since oil companies saw contingency measures as potentially more costly than post-spill litigation and clean up, preparedness measures were inadequate for any major spill.

After the disaster, the responsibility for preparedness and response was widened to include local stakeholders with interest in maintaining adequate precautionary systems to deal with future spills. One example of this is the Regional Citizen's Advisory Council (RCAC), founded to conduct independent research on oil spill prevention and response. The RCAC is funded by the Alyeska Pipeline Service, but maintains fierce independence (Browning and Shelter, 1992). The creation of this independent body, directly addresses Mayntz's and Perrow's dialectic between system requirements (the pressure to produce profit from oil) and systemic problems (the risk of a major oil spill). The creation and maintenance, therefore, of the RCAC represents an incidence of double-loop learning.

The history of oil spills in the USA and the lessons learnt and applied from disasters is similar to the retrofitting of the DC-10 described earlier. The first major oil spill in USA waters to gain widespread attention was the Santa Barbara oil spill of 1969 (Birkland, 1997). Again in 1976, a major oil spill occurred in US waters, this time off the coast of Nantucket Island, where the Argo Merchant ran aground (Birkland, 1997). Although the Argo Merchant spill resulted in some policy action, no consolidated oil spill policy resulted (Birkland, 1997). It was not until the Exxon Valdez spill, 20 years later that erudite policy became law.

6. Conclusions

Both Birkland and Perrow present special circumstances, which have lead to the incorporation of lessons learnt. Both have also shown that achieving double-loop learning is problematic and does not occur easily, due to many obstacles.

Sagan (1993) presents four constraints on organizational learning. First, feedback from the real world is often ambiguous. This allows pre-conceived and convenient positions to be supported through different interpretations of the available information. Second, post-event adjustment often takes place in a highly charged or political environment in which blame is sought. This is a characteristic of the recovery stage of the disaster cycle identified by Smith (1990), which prevents open and objective learning from taking place. Third, faulty reporting from those individuals with vested interests in obscuring the truth prevent objective analysis of the situation. Finally, secrecy, or the failure of internal organizational communication due to restrictions on information flow, prevents learning from taking place.

Within organizations these limitations can be linked with Argyris and Schön's (1974, 1978) concept of Model I behaviour, which is dominant in government, industry and elsewhere in society. Model I behaviour is defensive in nature, results in inefficiency and averts double-loop learning (Bain, 1999). Model I behaviour is governed by four values which include rationality, winning, achievement, and the suppression of negative feelings (Bain, 1999). These four factors in an organizational setting do not permit auto-critical analysis, either at the organizational level or more

generally at the societal level. In systems dominated by Model I behaviour single-loop learning is the only form of learning likely to occur, since addressing the root causes of an event would focus on loss and not gain, and would dwell on the negative past which tends to be suppressed.

Finally, it is possible that the achievement of double-loop learning makes the balance between the requirements of a system and the problem it faces unsustainable. For example, Browning and Shelter (1992) show how the Oil Pollution Act of 1990 led to increased costs for American oil companies. This led these and other companies to increase their international activities in countries with less rigid legal requirements — countries where the lessons of Exxon Valdez had not been learnt. This shift in oil company operations to 'less expensive' countries is a form of risk migration, a concept introduced by Adams (1995). Adams argues that a balance between perceived dangers and potential rewards governs risk decisions. In essence, if the rewards compensate the perceived danger, the risk will be taken. This is a similar concept to that of Mayntz's balance between the requirements and problems a system must deal with in defining the system's precautionary norms.

Adams (1995) contends that when one risk is reduced, others appear in compensation. In a study of speeding motorists, Adams noticed that when a traffic light or stop sign appeared on a road where speeding was problematic, although there was a reduction in speeding on that road, speeding increased on other nearby roads. In other words, the risk migrated to the other roads.

In the case of the Exxon Valdez, lessons were learnt in the context of American society. However, the risk migrated to other countries where the perceived dangers, in fines or loss of revenue for the oil companies, were less.

In this paper it has been shown that learning can take place from disasters. However, achieving a level of learning which addresses the root causes of disasters, is difficult. Model I behaviour, prevalent in society, is not conducive to a productive didactic process. Moreover, when learning does take place, a process of risk migration may offset any gain made through learning.

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Vitae

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