Using Failure Analysis Learning in Business School Instruction

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Abstract

Most university business schools logically use best practices learning so students may learn professional policies and procedures generally accepted by business and industry as being correct and effective. Whether through tradition, historical precedent, or instructor preference, errors and faults in leaders, systems, or products are rarely considered.

Conversely, failure analysis learning is a pedagogical methodology that requires the systematic collection and analysis of information to determine the root causes of a specific failure, and the development and reporting of recommendations to prevent the failure from recurring in the future. Failure analysis learning includes a form of behavioral systems analysis and deals with the unwanted behavior of systems. In most cases, failure analysis learning is composed of five important steps, including data gathering, data analysis, conclusion development, countervailing recommendations, and extrapolation to other circumstances.

What differentiates failure analysis learning from other forms of study is that it is widely inclusive of all facts and speculation related to a failure, systematic in the gathering, measurement, and consideration of this information, and thoroughly prescriptive in reporting proposed actions relative to failure prevention. Failure analysis learning includes forensic inquiry utilizing the collection and analysis of data and the use of rigorous scientific methodologies to determine the root causes of failure, and then the intentional extrapolation of findings to other circumstances through the use of analogy and metaphor. Failure analysis learning is most often focused on aircraft, infrastructure, buildings, vehicles, leadership, equipment, processes, etc. As a minimally-guided learning methodology, failure analysis learning is a pedagogically sound tool through which to impart key business concepts.

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JEL classification: A20, A23, A29

1. Introduction

On a misty-gray March day more than forty years ago, a crude bomb made by separatists exploded in a dustbin in the florist's shop at Las Palmas Airport in the Canary Islands. Incoming aircraft at the busy airport were immediately diverted to the much smaller Los Rodeos Airport at Tenerife. Believing that they would soon

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be cleared for takeoff, airline crews kept passengers on the planes, which were parked wingtip-to-wingtip at the tiny airport. A thick fog soon moved in, frustrating passengers and crews alike. After a two-hour wait, the fog appeared to be clearing, and the aircraft began taxiing so they could depart as soon as the fog dissipated. Tower controllers ordered KLM 4805, a Boeing 747 which held 248 people, to proceed to the end of the runway and to then wait for further instructions. The tower subsequently ordered Pan Am 1736, also a 747 with 335 passengers, to proceed up the same runway and then to turn off on one of the side jet-ways. A moment of confusion occurred when both jets radioed the tower at the same instant, and neither could be heard. Communications were further complicated when the control tower and aircraft used non-standard phraseology in their subsequent communications. Captain Jacob van Zanten in the cockpit of the KLM jet reached down and began to throttle-up his engines to take-off speed. His co-pilot immediately advised him that they had not yet been cleared for takeoff. Captain van Zanten angrily said in Dutch, "We're going," and started the jet rolling down the main runway. Moments later, the pilots in the Pan Am jet were horrified to see the headlights of the KLM jet lumbering at them through the fog. They turned their jet sideways in an effort to exit the runway, but it was too late. The KLM jet sliced through the Pan Am jet above the wing, both jets instantly exploded, and 583 souls perished, making it the world's worst aviation accident.

While corporate best practices are most often utilized to examine and teach business concepts, they often prove insufficient because of accidental or intentional obfuscation. Instead, a systematic review of project and program failures may provide an equally beneficial opportunity to identify and learn the effects of values, cultures, policies, and procedures. The events that led to the horrific crash at Tenerife were complex and sometimes turned on remarkable twists of fate. Unlike stories of success in corporations, this disaster was thoroughly reviewed and documented by numerous investigatory officials. The facts of the Tenerife crash are especially useful for students to consider specific values such as accessibility, self-control, assertiveness, boldness, decisiveness, discipline, experience, loyalty, restraint, and teamwork (Rokeach 1973, 1979). This paper will consider the use of failure analysis learning, or forensic inquiry, utilizing the collection and analysis of data and the use of rigorous scientific methodologies to determine root causes of failure and to posit preventative measures, as a pedagogical tool in teaching critical thinking, analysis, and prediction related to complex systems.

2. Limitations of Success Studies

Although case studies and other forms of "success studies" are an important part of every executive's training, there are notable limitations to these methodologies. For competitive reasons, successful companies rarely spell out details of corporate victories. Conversely, some companies put a positive "spin" on all corporate actions, including successes and failures, to make the company seem more successful. History, including that of corporations and other organizations, is often ultimately written by those who "won," e.g. senior surviving participants. The reasons they ascribe to the success may be incomplete or even intentionally spurious. Heroic accounts that reflect positively on only a few successful corporate leaders often overlook the important efforts of the employees who actually engendered the success. What might have been an exceedingly complex and decades-long effort is often drastically simplified and shortened to fit public relations needs. The corporate success may be logically linked to the wrong inputs and improper or irrelevant metrics may be used to measure the success. As Nonaka (1991) noted, "According to this view, the only useful knowledge is formal and systematic—hard (read: quantifiable) data, codified procedures, universal principles. And the key metrics for measuring the value of new knowledge are similarly hard and quantifiable—increased efficiency, lower costs, improved return on investment" (Nonaka 1991). Business schools almost never consider the key input factors and resultant messy decision-making that made the success a possibility, and corporate obfuscation may make it difficult to recognize values, motives, and analogies. In essence, the "story" of corporate success is usually simplified to an account of a single, bold, short-term decision on the part of one or a few senior leaders. The translation from reality to fairy tale often occurs in less than ten years.

3. Student Affinity for Failure Analysis

Both formal and casual students respond positively to learning through the use of failure analysis. Interestingly, students tend to be skeptical and ascribe simplified reasons to explain success, but are deeply interested and objectively consider the mysteries of failure. There are both cultural and pedagogical reasons for this positive response. The significant real-world loss of life and property that accompanies major failures personalizes the cases and captures the attention of students. Students are painfully aware of dear friends lost in auto accidents and note entire television networks based upon court cases and engineering failures. Students are confronted with possible failure events to analyze every day in the media. Current media portrayals of crime scene analysis and other forensic actions have also increased student interest in failure analysis. So interested are young people in puzzling through failures that they have voluntarily submitted more than 25,000 screenplays to the website of one crime scene investigation television program.

Because failure events often have or may involve significant numbers of people, governmental agencies and specialized non-profit organizations often conduct very thorough and public investigations of the event, and finally, publish their findings to the public in an effort to thwart reoccurrence in the future. True historical examples of failure events open for analysis include the sinking of the Lusitania, the crashes of the space shuttles and Concorde supersonic transport, the Boston Molasses Disaster, the Triangle Shirtwaist Factory fire, and the disasters in Bhopal, Chernobyl, and New Orleans. Students embrace the complexity of failures and typically prosecute a vigorous gathering and assessment of the case facts using cross-disciplinary knowledge, incisive logic, and available investigative tools. They demonstrate an interest in the causal relationships between discrete facts and concentrate on the possibility of human error and linkage between multiple issues contributing to system failure. By methodically following the scientific process when examining a systemic failure, students may ultimately draw informed conclusions, translate their findings into analogy and metaphor, and extrapolate their learning to other business or life circumstances.

4. Description of Failure Analysis Learning

Failure analysis is the systematic collection and analysis of information to determine the root causes of a specific failure and the development and reporting of recommendations to prevent the failure from recurring in the future. It is a form of behavioral systems analysis and deals with the unwanted behavior of systems that prove dangerous, ineffective, or inefficient. What differentiates failure analysis learning from other forms of study is that it is widely inclusive of all facts and speculation related to a failure, systematic in the gathering, measurement, and consideration of this information, and thoroughly prescriptive in reporting proposed actions relative to failure prevention. While the public is most often aware of failure analysis regarding aircraft and infrastructure such as bridges and buildings, failure analysis is routinely applied to virtually all events that are perceived to pose a danger to the health, safety, or property of the public. Failure analysis learning is formalized standard operating procedure for many governmental organizations: "On a larger scale, the U.S. Army is known for conducting After-Action Reviews that enable participants to analyze, discuss, and learn from both the successes and failures of a variety of military initiatives" (Edmondson and Cannon 2005).

Failure analysis learning is highly systematic in nature. Analysis techniques have been developed to enhance the validity of failure analysis research reports. One of the most comprehensive of these techniques is named "Why-Because Analysis" (WBA). It is an especially rigorous technique used to analyze the behavior of complex technical and socio-technical systems, primarily transportation systems (air, rail, and sea). The "Why-Because Analysis" is a direct descendant of philosopher David Hume (1770's) and the work of David Lewis in the mid-1970's. During a rigorous failure analysis, a detailed "Why-Because Graph" is developed which shows all causal relationships between events and states of behavior being considered. A completed WB-Graph is the primary output of the Why-Because Analysis. The systematic and comprehensive nature of the Why-Because Analysis encourages the inclusion of causal relationships often missed by other analysis systems: "Aircraft accidents are amongst the most carefully researched failures in all of engineering… While looking carefully at recent accident reports involving complex and often computerized aircraft, we found what appeared to us to be reasoning discrepancies: significant causal factors described in the body of the report did not appear in the final list of causes ('probable cause' and 'contributing factors'). Simple logic mistakes appear to have been made. We thus developed the WB-graph method " (Gerdsmeier et al., 1997).

Failure analysis learning is typically composed of five steps:

- **Data Gathering** – Upon the occurrence of a failure, a systematic forensic process is initiated to gather all facts and speculation that might ultimately contribute to a better understanding of the failure. Objectivity and thoroughness are essential.
- **Data Analysis** – When all information related to the failure is gathered, a comprehensive history of the failure is reconstructed and validated for consistency and plausibility.
- **Conclusion Development** – If all relevant data has been gathered and appropriate review and analysis of that information completed, specific conclusions regarding the causation (often termed "root cause analysis" - RCA) and sequence of contributory factors may be ascertained.
- **Countervailing Recommendations** – In some instances, recommendations must be promoted to prevent the occurrence of similar incidents in the future.
- **Extrapolate To Other Circumstances** – Utilizing the analysis and recommendations of a completed failure analysis, students consider how the findings might be applied to both similar and substantially different circumstances.

In business schools, the true value of failure analysis learning is the opportunity to apply the findings from an analysis of a specific failure to possible failures in similar objects or processes, but also to consider how those findings might align with circumstances totally different from the original study. For example, there may be important similarities between the decision-making processes of a pilot guiding a crippled aircraft toward a safe landing and a CEO directing her wounded corporation back toward economic viability. One method for extrapolating useful concepts from failure analysis to divergent circumstances is through the use of metaphor: "One kind of figurative language that is especially important is metaphor. By 'metaphor,' I don't just mean a grammatical structure or allegorical expression. Rather, metaphor is a distinctive method of perception. It is a way for individuals grounded in different contexts and with different experiences to understand something intuitively through the use of imagination and symbols without the need for analysis or generalization. Through metaphors, people put together what they know in new ways and begin to express what they know but cannot yet say. As such, metaphor is highly effective in fostering a direct commitment to the creative process in the early stages of knowledge creation" (Nonaka 1991).

5. Pedagogical Attributes of Instruction Via Failure Learning

Students serve as interlocutors in discussions of specific failure: "The learning that is potentially available may not be realized unless thoughtful analysis and discussion of failure occur…This analysis can only be effective if people speak up openly about what they know and if others listen, enabling a new understanding of what happened to emerge in the assembled group" (Edmondson and Cannon, 2005).

As they apply the scientific method to failure analysis, students are often able to utilize problem-solving and critical analysis skills they already possess. As Ladkin noted, “We must think about the system we have, and we must attempt to assess what could happen and what could not, and if necessary reconfigure the system or its environment of operation or both in order to change what we believe to be the behavioral possibilities. An accident is a concrete, irrefutable example of system and environment behavior. It is thus a guide to the possibilities. By comparing what we think we knew about the system with what we know from a detailed investigation of the accident, we may be able to correct and improve our reasoning about and our knowledge of possible system behavior” (2000). Although they may require guidance in rendering theories or principles from failure analysis, they are interested in finding worthwhile meaning in project results. One area that often requires additional guidance is defining the relationship between failure analysis outcomes, legacy organizational values, corporate culture, and codified policies and procedures.

Why is student interest in failure analysis important to learning outcomes? Kuhn posited, “Motivation resides not within the individual but in the interaction between individual and subject matter…It is students themselves, in the end, not teachers, he says, who decide what students will learn. A teacher cannot change a student’s belief system or way of thinking unless the student wishes it to be changed. Hence, it is essential that we attend to what students think they are doing at school – what sense the endeavor makes to them” (Kuhn 2007).

The use of failure analysis learning provides an important middle ground to resolve the serious ongoing debate regarding the level of guidance required for student learning. The debate is succinctly described by Kirschner et al., (2006): “A worked example constitutes the epitome of strongly guided instruction, whereas discovering the solution to a problem in an information-rich environment similarly constitutes the epitome of minimally-guided discovery learning.” Kirschner et al. (2006) vehemently debunked minimally guided instruction: “We have known at least since Peterson and Peterson (1959) that almost all information stored in working memory and not rehearsed is lost within 30 seconds and have known at least since Miller (1956) that the capacity of working memory is limited to only a very small number of elements. That number is about seven according to Miller, but may be as low as four, plus or minus one (see, e.g., Cowan, 2001). Furthermore, when processing rather than merely storing information, it may be reasonable to conjecture that the number of items that can be processed may only be two or three, depending on the nature of the processing required. The interactions between working memory and long-term memory may be even more important than the processing limitations, however (Sweller, 2003, 2004). The limitations of working memory only apply to new, yet-to-be-learned information that has not been stored in long-term memory. New information such as new combinations of numbers or letters can only be stored for brief periods with severe limitations on the amount of such information that can be dealt with… The consequences of requiring novice learners to search for problem solutions using a limited working memory or the mechanisms by which unguided or minimally guided instruction might facilitate change in long-term memory appear to be routinely ignored.”

Others advocate the use of minimally-guided learning: "Well-controlled experimental studies have shown that students' learning is enhanced when they have identified a question or a problem to address (Capon & Kuhn, 2004; Kuhn & Dean, 2005)". Even those who deride minimally-guided instruction, however, find it acceptable if there is guided linkage between activities held in short-term memory (failure analysis) and concepts held in long-term memory (analogy, metaphor, values). As Kirschner, et al. (2006) noted, "In contrast when dealing with previously learned information stored in long-term memory, these limitations disappear. In the sense that information can be brought back from long-term memory to working memory over indefinite periods of time, the temporal limits of working memory become irrelevant." Minimally-guided failure analysis learning that links failure analysis with underlying concepts and theoretical constructs provide that important middle ground to satisfy both pedagogical philosophies. As Kuhn (2007) said, "How do such questions get answered? In the words of White and Frederiksen (2005), '... students need to develop explicit cognitive models of capabilities needed for an inquiry. Such models help students learn how to do inquiry, as well as to understand its nature and purpose' (p. 212)."

6. Contemporary Resistance to Failure Learning in Organizations

At this time, business schools rarely utilize failure analysis learning: "It hardly needs to be said that organizations cannot learn from failures if people do not discuss and analyze them. Yet this remains an important insight. The learning that is potentially available may not be realized unless thoughtful analysis and discussion of failure occur." (Edmondson and Cannon, 2005) Why aren't failures analyzed and learned from? Edmondson and Cannon noted, "Social systems tend to discourage this kind of analysis. First, individuals experience negative emotions when examining their own failures, and this can chip away at self-confidence and self-esteem. Most people prefer to put past mistakes behind them rather than revisit and unpack them for greater understanding… Second, conducting an analysis of a failure requires a spirit of inquiry and openness, patience, and a tolerance for ambiguity. However, most managers admire and are rewarded for decisiveness, efficiency, and action rather than for deep reflection and painstaking analysis" (2005). Even hospitals are often immune from the diagnostic power of failure analysis: "Whether medical errors or simply problems in the work process, few hospital organizations dig deeply enough to understand and capture the potential learning from failures. Processes, resources, and incentives to bring multiple perspectives and multiple minds together to carefully analyze what went wrong and how to prevent the occurrence of similar failures in the future are lacking in most organizations" (Edmondson and Cannon 2005). In addition, corporations that succeed through the use of failure analysis view it as a competitive advantage and do not willingly proffer explanations to the public. Without question, corporations need graduates with the experience and desire to positively analyze organizational shortcomings.

7. Importance of Failure Analysis Learning To Corporations

Corporations desperately need the knowledge that is provided through systematic internal and external failure analysis. Historian Steven Johnson noted, “The history of being spectacularly right has a shadow history lurking behind it: a much longer history of being spectacularly wrong, again and again” (Johnson 2011). Schwartz (2004) similarly opined, “Failure is the rule rather than the exception, and every failure contains information… Perseverance must be accompanied by the embrace of failure. Failure is what moves you forward. Listen to failure.” Successful leaders fully embrace learning from failure: “Leaders are great learners, and they regard mistakes as learning opportunities, not the end of the world. And this attitude is true not just for themselves, but also for their constituents. In fact, because they appreciate that mistakes are an essential part of the learning process, leaders develop their constituents’ capabilities by helping them break out of old patterns of thinking” (Kouzes and Posner 2011). Moreover, “Leaders view some project failures as inevitable and unavoidable and ensure that competent people taking intelligent risks are not punished when things don’t pan out. After all, the enemy of growth is often not bad decisions but no decisions at all” (Liedtka et al., 2009). This type of learning must be formalized throughout the organization. As Nonaka (1991) noted, “In an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge. When markets shift, technologies proliferate, competitors multiply, and products become obsolete almost overnight, successful companies are those that consistently create new knowledge, disseminate it widely throughout the organization, and quickly embody it in new technologies and products. These activities define the “knowledge-creating” company, whose sole business is continuous innovation.” Disciplined thinking gained through failure analysis learning is translatable to the corporate environment and encourages an important shift from analysis based on emotion and political expediency to analysis based on fact and logic. Corporations that routinely use failure analysis tend to utilize appropriate metrics, are able to disassemble complex failures and identify causal factors, and to initiate and promote changes in policies and procedures to eliminate recurrence of failure. Failure analysis should be routinized into the formal decision-making process of the organization: “One way to become more methodical is to look closely at the features of the reasoning as practiced, identify general principles, justify these principles, and build them into a formal logic” (Ladkin 2000). As Nonaka has said of successful corporations, “Making personal knowledge available to others is the central activity of the knowledge-creating company. It takes place continuously and at all levels of the organization” (1991).

8. Conclusion

Although corporate best practices are often used to examine and teach key business concepts, they often prove insufficient because of an incomplete or intentionally wrong examination of the facts supporting the success. Through the systematic review of project and program failures, like the horrendous crash of airliners at Tenerife, the Canary Islands in 1977, students may gain a remarkably beneficial opportunity to identify and learn important business concepts. After all, “Companies don’t need more risk takers; they need people who understand how to de-risk big aspirations” (Hamel 2002). Failure analysis learning includes forensic inquiry utilizing the collection and analysis of data and the use of rigorous scientific methodologies to determine the root causes of failure, and then the intentional extrapolation of findings to other circumstances through the use of analogy and metaphor. As a minimally-guided learning methodology, failure analysis learning is a pedagogically sound tool through which to impart key business concepts.

Reference

Edmondson, A. & Cannon, M. (2005). “The Hard Work of Failure Analysis,” *Harvard Business School Working Knowledge*, available at: http://hbswk.hbs.edu /item/4959.html, (accessed 28 December 2017).

Gerdsmeier, T., Hohl, M., Ladkin, P. & Loer, K. (1997), “How Aircraft Crash: Accident Reports and Causal Explanation,” *Networks and Distributed Systems*, available at: http://www.rvs. uni-bielefeld.de/publications/ Journalism /ForMag.html, (accessed 28 December 2017).

Hamel, G. (2002). *Leading the revolution*. New York: Plume.

Johnson, S. (2011). *Where Good Ideas Come From*. New York: Riverbend Books.

Kirschner, P., Sweller, J. & Clark, R. (2006), “Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching.” *Educational Psychologist*, 41(2), pp. 75–86.

Kouzes, J. & Posner, B. (2011), *Credibility.* San Francisco: Jossey-Bass.

Kuhn, D. (2007), “Is Direct Instruction an Answer to the Right Question?”, *Educational Psychologist*, *42*(2), pp. 109–113.

Ladkin, P. (2000), “Causal Reasoning About Aircraft Accidents,” in Koornneef, F. & van der Meulen, M. (Ed.), Computer Safety, Reliability and Security: 19th International Conference, SAFECOMP 2000, Rotterdam, The Netherlands, number 1943 in Lecture Notes in Computer Science, Springer-Verlag, Berlin, pp. 344-360.

Liedtka, J., Rosen, R., Wiltbank, R. (2009). *The Catalyst*. New York: Crown Business.

Nonaka, I. (1991), “The Knowledge-Creating Company,” *Harvard Business Review*, Vol. 69, Issue 6, pp. 96 – 104.

Rokeach, M. (1973). *The Nature of Human Values*. New York: The Free Press.

Rokeach, M. (1979), *Understanding Human Values.* New York: The Free Press.

Schwartz, E. (2004). *Juice: The Creative Fuel That Drives World-Class Inventors.* Boston: Harvard, Business School Press.