After the Dust Settles…

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1. Introduction

After the dust settles and the reporters go home the various investigative groups selected to study the Gulf oil spill will still be under way. Their final reports are likely to be sprinkled with such phrases as "riser and Blow Out Preventer (BOP) package," drilling system, well casing, plumes, methane gas, cement seal, "top kill," well design, acoustic switch, "dead man" switch, etc. Yet every major disaster that has been subject to investigation includes often blatant, sometime subtle, people, organizational, and systemic issues. These issues are, anyway, as important as the technical issues. Technical problems are caused by people, organizations, and systems of organizations operating together. This paper examines the people, organizational, and systems issues identified in a number of catastrophic accident investigations. We suggest that since there is similarity across incidents in the kinds of issues uncovered, these be the first "people" issues to examine in any investigation of the Gulf oil spill. We first look at the Clapham Junction and Piper Alpha disasters because they happened the same year and represent two very different industries. We then take a look at the Columbia space shuttle accident. The official report of this accident is often cited as the example of how accident investigations should be carried out. Finally, we examine the 2005 Texas City BP refinery accident based on three investigations. Again, all three investigations find more similarities than differences in cause, and many of these causes are similar to those found in the first three examinations. Based on these examinations we suggest issues that should not be forgotten in any of the Gulf oil spill investigations.

2. Similar Malfunctions Are Repeated – In Different Industries

Across industries mega-crises appear to have similar etiologies. For example, two accidents, both of which happened in 1988 look similar from a people or management perspective. On July 6th the North Sea Oil and gas production platform, Piper Alpha, blew up. One hundred sixty seven people lost their lives. Although all evidence was lost the investigation pieced together how it may have happened. The Cullen report[1] concluded that a condensate leak resulting from maintenance work caused the accident. The report indicated that management implemented inadequate maintenance and safety procedures. On December 12th the driver of British Railway's train from Basingstoke to Waterloo came to a signal that abruptly turned red. He stopped and phoned this information into the signalman. He was told to proceed and just as he hung up the phone he was hit from behind. Then there was a side on collision with an empty train leaving Clapham Junction caused by the wreckage of the first collision. Thirty five people were killed and another sixty nine were seriously injured. One cause of the accident was incorrect wiring work. The accident report[2] cited management's failure to consider signaling as a major safety issue.

Looking more closely at these two accidents we find more similarities. The maintenance work that led to the condensate leak was probably done incorrectly. Occidental Petroleum, which owned

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Piper Alpha, used a permit to work system. This "is a formal written system which is used to control certain types of work which are potentially dangerous." [3] To maintain safety it is essential that the operating staff work exactly to the written procedure. Many errors were found in the permit to work process. For example, often several jobs were done on one permit. Designated Authorities and Performing Authorities were supposed to act as checks and balances on one another. Appropriate supervision might have reduced or eliminated such behaviors. Occidental provided no formal training on how to operate the permit to work system.[ii] The report offered 106 recommendations, only two of which were concerned with management.

The Clapham Junction inquiry finds that the faulty wiring was done by a workman who had been making the same errors for most of his working life. The workman joined the company in 1972 and had very little to no training on wiring the signals. Had he received appropriate supervision he might have had such training. The supervisor also failed to check the quality of the workman's work, thus eliminating a check and balance. In addition the Testing and Commissioning person failed to carry out a wire count or insure that someone else carried this out. Thus, "what had originally been a perfectly reasonable system directed toward the safety of the railway and based sensibly on a three-level system of installer, supervisor, and tester, degenerated into a series of individual errors at those three levels of staffing…" [4] The report made ninety-three recommendations. Of these twenty-six were concerned with management.

These are not the only similarities between the two incidents. These examples illustrate that organizational processes that resulted in catastrophic accidents in two very different industries were similar.

3. The Columbia Space Shuttle

The National Aeronautic and Space Administration's (NASA) investigation of the Columbia space shuttle accident, which happened in 2003, is often mentioned as the quintessential accident investigation. While the report devotes one chapter to the technical failures involved, it devotes three chapters (out of eleven) to cultural, decision making, and organizational failures that ultimately lead to the accident. That report might well serve as a model for investigations of the current BP gulf oil spill, as it did for the U.S. Chemical Safety Board's (CSB) investigation of the Texas City BP tragedy (to which we will return). This accident happened because the insulating foam separated from the external tank left bipod. The accident killed the seven astronauts aboard. While the two previously cited reports give lip service to systemic issues associated with the accident this report is clearer about embedding the accident within a systemic framework:

> "Standing alone the components may be well understood and have failure modes that can be anticipated. Yet when these components are integrated into a larger system, unanticipated interactions can occur that lead to catastrophic outcomes. The risk of these complex systems is increased when they are produced and operated by complex organizations that also break down in unanticipated ways.
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> In our view, the NASA organizational culture had as much to do with this accident as the foam."[5]

[ii] This investigation also pointed out that the inherent nature of the permit to work system in place at Occidental may itself have contributed to the accident.

A number of organizational political and behavioral processes were involved in the failure. The first point made is about cost reductions that caused NASA to downsize the shuttle work force, outsource many of its program responsibilities (including safety), and consider eventual privatization of the shuttle program. NASA also viewed the shuttle not as a developmental but as an operational vehicle. It points to indecision in the White House and Congress as a basic source of these behaviors. It also points out that:

> "By the eve of the Columbia accident, institutional practices that were in effect at the time of the Challenger accident – such as inadequate concern over deviations from expected performance, a silent safety program, and schedule pressure – had returned to NASA."[6]

In 2002 a review of the U.S. aerospace sector pointed out that because of lack of top level commitment a sense of lethargy had set in at NASA.[7] In addition, in 1992 the White House appointed Daniel Goldin as the NASA administrator. Goldin initiated a torrent of changes, not evolutionary changes but radical and discontinuous changes. In 1996 the Johnson Space Center was selected as the lead center for the space shuttle program, thus returning the space program to the flawed structure in place prior to the Challenger accident.

The NASA report devotes an entire chapter to flawed decision making at NASA. It points out the foam loss was a characteristic of previous shuttle flights. NASA came to see this as inevitable and, as Diane Vaughan points out, came to accept the "normalization of deviance."[8] In other words, over time NASA managers became conditioned to not regard foam loss as a safety-of-flight concern. A number of people on the ground were concerned about potential foam loss when Columbia was launched. No one asked for external pictures to be taken, though this was entirely possible to do. At the time there was tremendous pressure to get on with the schedule and the launch of STS-120, which was to occur on February 19, 2004. A reason for this is that the launch of STS-120 would complete the U.S. obligation to the space station. An example of the time pressure NASA placed on itself was that every NASA space flight manager was mailed a computer screen saver with a clock on it counting down to February 19, 2004. The chapter concludes by discussing decision-making flaws which include a flawed analysis by an inexperienced team, shuttle program management's low level of concern, a lack of clear communication, a lack of effective leadership, and the failure of safety's role. It makes a number of recommendations about each of these.

The report also devotes an entire chapter to organizational causes of the accident. The chapter begins with the following account:

> "Many accident investigations make the same mistake in defining causes. They identify the widget that broke or malfunctioned, then locate the person most closely connected with the technical failure: the engineer who miscalculated an analysis, the operator who missed signals or pulled the wrong switches, the supervisor who failed to listen, or the manager who made bad decisions. When causal chains are limited to technical flaws and individual failures, the ensuing responses aimed at preventing a similar event in the future are equally limited: they aim to fix the technical problems and replace or retrain the individual responsible. Such corrections lead to a misguided and potentially disastrous belief that the underlying problem has been solved."[9]

In addition to the cultural issues previously described, the report found that the original compromises required to gain approval for the shuttle program in the first place: subsequent years of resource constraints, reliance on past success as a substitute for sound engineering practices, organizational barriers to effective communication of critical safety information and stifled professional differences of opinion, lack of integrated management across program elements , frequent restructuring to achieve cost reduction goals, and the evolution of an informal chain of command contributed to the accident. After a number of close calls NASA chartered an Independent Assessment Team[10] to examine shuttle sub system and maintenance problems. That team was quite critical of NASA and noted that the organization was transitioning to a "slimmed down," contractor-run organization. The team also noted that NASA was using previous success as a justification for accepting increased risk. The shuttle program's ability to manage risk was eroded by: (a) the desire to reduce costs, (b) the size and complexity of the program and NASA/contractor relationships demanded better communication; (c) the NASA's safety and mission assurance organizations were not sufficiently independent of one another, and (d) the workforce was receiving conflicting messages due to emphasis on achieving staff and cost reductions and pressures placed on increasing scheduled flights. In great part this was due to Administrator Goldin's "faster, better, cheaper" doctrine of the 1990s.

The board turned to contemporary organization theory on accidents and risk to help it understand how to develop a more thorough understanding of accident causes and risk. Specifically they turned to high reliability, normal accident, and organization theory.[11] The Board found that neither high reliability nor normal accident theory were entirely appropriate for understanding the accident, but that insights from each figured prominently in its deliberations. From the smorgasbord of conceptual ideas in the literature[12, 13] the Board selected the following:

- Commitment to a safety culture. NASA's safety culture had become reactive, complacent, and dominated by unjustified optimism.
- Ability to operate in both centralized and decentralized manner. NASA did not have centralization where it was needed or decentralization where it was needed.
- Importance of communication. At every juncture of STS-107 the shuttle program's structure and processes, and therefore the managers in charge resisted new information.
- Avoiding oversimplification. The accident is an unfortunate example of how NASA's strong cultural bias and its optimistic organizational thinking undermined effective decision making.
- Conditioned by success. Even though it was clear from launch videos that that the foam had struck the orbiter in a way never seen before the space shuttle program managers weren't unduly alarmed.
- Significance of redundancy. The space program compromised the many redundant checks and balances that should identify and correct small errors.

All in all, the Board focused on a number of organizational processes that impacted the accident. And it suggests that NASA was warned repeatedly about these deficiencies. While it mentions the importance of NASA's larger environment, it doesn't examine this environment in any depth. The NASA report makes twenty-nine recommendations and six of them are specifically directed to management issues.

4. BP's Oil Refinery at Texas City

More official and quasi official data exist about this accident than about the previously discussed accidents. The U.S. Chemical Safety and Hazards Board (CSB) commissioned a report,[14] BP commissioned a report[15] also known as the Baker Report, and at least one book has been written about it.[16]

> "On March 23, 2005 at 1:20 PM the BP Texas City Refinery suffered one of the worst industrial disasters in recent U.S. history. Explosions and fires killed fifteen people and injured another one hundred eighty, alarmed the community, and resulted in financial losses exceeding $1.5 billion. The incident occurred during the startup of an isomerization (ISOM) unit when a raffinate splitter tower was overfilled; pressure relief devices opened, resulting in a flammable liquid geyser from the blowdown stack that was not equipped with a flare. The release of flammables led to an explosion and fire. All the fatalities occurred in or near office trailers located close to the blowdown drum. A shelter-in-place order was issued that required 43,000 people to remain indoors. Houses were damaged as far as three-quarters of a mile from the refinery." [14]

Industrial Accidents Versus Process Safety

As pointed out in the U.S. Chemical Safety and Hazards Board (CSB) report[17] and by Hopkins[16] the usual organizational approach to thinking about safety is to examine classical industrial accidents; trips, slips and falls, and to account safety as the number of these that happen in any given time frame. These individually based data points have nothing to do with the huge systemic accidents we see in growing numbers. The classical way of thinking about accidents is evidenced in the Texas City disaster. An interesting facet of that accident is that shortly before the explosion a meeting was held in the control room which included about twenty people. The reason for the meeting was to celebrate safety! A thirty-five day maintenance shutdown of two other process units at Texas City was just completed without a single recordable injury and with only two first aid treatments. All three publications discuss BPs failure to consider these major catastrophes as process safety catastrophes. From the CEO downward BP looked at individual indicators (trips, slips, and falls) as precursors to catastrophic outcomes. A number of company personnel statements indicated that Lord Browne (BP's CEO at the time) was uninterested in safety.

Problems Across BP

According to both the CSB and Baker commission reports the Texas City disaster was caused by organizational and safety issues at all levels of BP. Warning signs of imminent disaster had been around for years. The extent of serious safety deficiencies was revealed in the months after the accident by two further incidents. One, a pipe failure, caused $30 million in damage and the other resulted in a $2 million property loss.[18]

From the top down the BP Board did not provide effective oversight of BP's safety, culture, and major accident prevention programs. Cost cutting, failure to invest, and production pressures characterized BP's executive manager's behaviors. Fatigue, poor communication, and lack of training characterized Texas City's employees. On the day of the accident many start-up deviations occurred. Many aspects of the work environment encouraged such deviations, such as the fact that the start-up procedures were not regularly updated. Operators were allowed to make procedural changes without proper management of change (MOC) analysis. BP had replaced classroom training with some computer training. However, computer training doesn't necessarily allow the trainee to have to think through problems. It is more appropriate to memorization. BP did not offer its rig employees simulation training. Simulation training is the appropriate form of training to give people practice with thinking through problems. The start-up procedure lacked sufficient instruction to the board operator for a safe and successful start up the unit.

BP has a MOC plan. Supposedly all new and ongoing procedures are subject to MOC analysis. Not only does it appear that start up changes were not subject to MOC analysis, it also appears that corporate changes (such as tightening budgets, reduced staffing, etc.) were not subject to MOC analysis.

What BP Was Doing About Process Safety

In 2001 and 2002 the author of this paper and a colleague (with a background in maritime engineering and the oil industry) worked with BP's refinery Business Unit Leaders (BULs) on a project to inject into BP's refinery operations high reliability organizational (HRO) processes. "Simply stated an [sic] HRO is an organization which conducts relatively error free operations over a long period of time (and) makes consistently good decisions resulting in high quality and reliable operations." [19] The project included a presentation in London to BP's BULs. Following a definition of an HRO the audience was provided with a list of keys to success for one HRO, the U.S. Navy's carrier aviation program. This list included: (a) building relatively flat hierarchies during flight operations, (b) constant and relentless training, (c) the challenge to constantly improve resulting in an active learning organization, and (d) constant communication. The presentation then compared HROs and low reliability organizations (LROs). HROs are preoccupied with failure, reluctant to simplify interpretations, sensitive to operations, committed to resilience, have under specified structures, and highly developed cognitive infrastructures. LROs focus on success, have under developed cognitive infrastructures, focus on efficiency, are inefficient learners, lack diversity, reject early signs of deterioration, and conduct briefings; and convince no one. Finally the audience was told implementation is not simple or easy, and more often than not it is done poorly.

> According to Hopkins[20]:
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> "…HROs "organize themselves in such a way that they are better able to notice the unexpected in the making and halt its development (Weick and Sutcliffe, 2001, p. 3)." This is first and foremost a statement about organizations and organizational practices, not about the mindset of individuals. In other words, if an organization is to become an HRO, the first thing its most senior people must do is to put the organizational structure in place that will enable it to see and respond to the unexpected. These structures include reporting systems, auditing systems, training systems, maintenance systems, and so on – all of which have resource implications….
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> If we now talk about introducing an HRO culture, HRO theory tells us that we are talking about modifying organizational practices, not just the mindsets of individuals. Introducing an HRO culture starts with organizational change."

BP's *Refining and Pipelines Leadership Fieldbook* set out some of the HRO organization theory and includes much of what was in the London presentation. It also provides a toolkit of games, exercises, and quizzes aimed at educating frontline workers to think differently. An educational program is insufficient by itself to move an organization toward being a HRO. A different set of organizational practices with regard to structuring, maintenance, training, etc. are required. BP put no resources into changing organizational practices. The HRO programs were refinery responsibilities and thus funding for them had to come out of refinery budgets. In addition culture change begins at the top and we have seen that Lord Browne was felt to have little interest in safety.[16] Finally, the first HRO "cheerleader" was quickly promoted to vice president, and the second HRO manager also stayed in the job a short time.[15]

All Reports Focus on Some Aspect of Management

Both the CSB and Baker reports focused on culture as the prevailing problem. Hopkins focused on organizational structure, leadership, blindness to risk, failure to learn, and other factors as major precursors. BP's organization is decentralized so that the refineries themselves make decisions about how they do business. Hopkins argues that this strategy fails to allow plant managers to gain from the learning from incidents that top management might have sequestered in its memory.

The CSB report includes thirteen chapters, only two of which do not address some management issue. It makes 14 recommendations to various organizations. The organizations are the American Petroleum Institute (API) and the United Steelworkers International Union (USW) (two recommendations), Occupational Safety and Health Administration (OSHA) (two recommendations), BP's Board of Directors (three recommendations), BP's Texas City refinery (seven recommendations), and the United Steelworkers International Union and Local 13-1 (one recommendation). The Baker report has seven chapters, all of which address some aspect of management. The report makes ten recommendations – all to BP.

The Wider Context

Andrew Hopkins[16] reminds us that the wider context of the Texas City accident is worth thinking about because it demonstrates that Texas City's problems were part of a broader pattern. In 2000 BP's Grangemouth Complex located on the south bank of the Firth of Forth (20 miles from Edinborough) was the only BP site to include all three of its major business steams – exploration, oil, and chemicals.[iii] In 2000, over a two week period, three potentially life-threatening accidents happened at Grangemouth. The first was a power distribution failure, the second a medium pressure steam line rupture, and the third was a major leak from a processing unit which ignited causing a large fire. The Health and Safety Executive's (HSE) investigation noted that there were "a number of weaknesses in the safety management system on site over a period of time." [22] The HSE also identified common themes[23] over all three incidents:

- BP Group Policies set high expectations but these were not consistently achieved because of organizational and cultural reasons.
- BP Group and Complex Management did not detect and intervene early enough on deteriorating performance.
- BP failed to achieve the operational control and maintenance of process and systems required by law.

[iii] The Grangemouth Complex was sold to INEOS in 2005.

At the end of 2005 BPs partially completed deep water production platform in the Gulf of Mexico, Thunder Horse, suffered a structural collapse and tipped sideways. The cause of the accident was insufficient engineering caused by the company's desire to cut costs. In March 2006, oil was discovered leaking from BP's pipeline in Alaska. The cause of the leak was corrosion.

BP's problems were not limited to its oil business. In 2003 the company was fined for manipulating the US stock market and it admitted to manipulating the North American propane market in 2004.[16]

5. The Next Go Around

The next "go around" in studying catastrophic accidents will be in the reports of the many Gulf oil spill accident investigation commissions and committees. As we see, the more recent of the past reports pay increasing amounts to organizational processes. Slips, trips, and falls are bad metrics to use if an organization is interested in avoiding catastrophic outcomes.

All the past accident reports note that cost cutting lack of training, poor communication, poor supervision, and fatigue were contributors to the accidents. All of these behaviors fall under the umbrella organizational process – culture, which the NASA report adds to the mix. Failures in these areas should be examined in the most current catastrophe. Drivers of those failures need to be identified. Investigators need to know what to look for and how. Engineers are not trained to examine these issues in situ.

The NASA Columbia report adds an issue that was not examined prior to Challenger and appears not only with Challenger but with Columbia. That is a reliance on past success as a substitute for sound engineering practices. This is an outgrowth of a "not on my watch" or "not in my backyard (NIMBY) management philosophy. The NASA report also commented on confusion at NASA caused by Congressional and White House activities. Almost any message sent to NASA from these organizations is set up to be the wrong message.

Only infrequently do investigations examine infrastructure issues. Note that neither the Cullen report nor the Hidden Report did so. NASA alludes to problems of structure and the Texas City investigations strongly suggest that BP's structure contributed to errors.

The NASA report, the CSB Report, and Hopkins all draw to some degree on high reliability organization theory. A number of organizations are trying to implement high reliability processes to increase safety performance. HRO theory offers a set of conceptualizations and a way for both practitioners and investigators to organize material about management processes.

One thing none of these reports do every well is examine constituencies and their relationships to each other and with the focal organization. The CSB makes recommendations to constituents but they rather come out of the blue. It is often said that Wall Street guides the behavior of energy companies, but constituencies also guide the behavior of other kinds of organizations. These constituencies should be examined in detail; if for no other reason than the academic literature on crises is beginning to look at interdependencies among organizations with different goals from the focal organization.

In the BP Gulf case it is clear that one stakeholder, the Minerals Management Service (MMS), may have had questionable relationships with BP. Any investigation can't afford to neglect the interdependence across the two organizations. The September 10, 2008, *New York Times* makes a strong statement about allegations against MMS, "including… financial self dealing, accepting gifts from oil companies, cocaine use, and sexual misconduct." [24] *The Washington Post* published similar allegations the next day. BP has relationships with many other organizations from contractors to environmental groups. Some of these need to be considered in examining the etiologies of the Gulf oil spill.

This paper makes the case that the industrial accident approach to understanding disaster is inappropriate. It further states that such disasters are contributed to by human and organizational behavior. It sets out some of these behaviors found at the heart of previous disasters and argues that these processes should be examined in the Gulf Oil spill. Finally it argues that interdependencies across organizations also need to be considered in such situations.

6. Acronyms

Table 5.1 – Acronyms.

Term	Definition
API	American Petroleum Institute
BOP	Blowout Preventer
BUL	Business Unit Leader
CSB	U.S. Chemical Safety Board
HRO	High Reliability Organization
HSE	Health and Safety Executive, U.K.
ISOM	Isomerization Unit
LRO	Low Reliability Organization
MOC	Management of Change
MMS	Minerals Management Service
NASA	National Aeronautic and Space Administration
NIMBY	Not In My Backyard
OSHA	Occupational Safety and Health Administration
OTS	Operational Condition Safety
USW	United Steelworkers International Union

7. References

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