

Managing Worst Cases¹

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Worst case analyses are an increasingly normal feature of organizational operations. Such analyses happen with computer networks where complicated algorithms are used to map possibilities of system failure; it happens in industrial plants where engineers and scientists try to map the complex systems they construct; it happens in the business world where billions of dollars and jobs can evaporate if projections of the future are wrong; it happens in the command and control of nuclear weapons where it must serve as a proxy for experience about total catastrophe.

It is important to understand what “worst case” means, why worst case analyses are increasingly prominent, and what the consequences are of approaching problems in such terms. Yet for all its present and expanding empirical importance, social science has little or nothing to say about the various forms of worst case thinking and analysis. What follows is an initial foray into some of the issues involved in analyzing worst cases.

Public designations of the worst

From the start we must distinguish between planning for a worst case and designating something a worst case. Planning for a worst case is future oriented. Designating a worst case is past oriented. Both orientations are sense-making activities, but of different things. Planning for worst cases involves mapping out failures of system elements; that which is being made sense of is the complexity of a socio-technical system. Designating something a worst case is the post-hoc application of a label; that which is being made sense of is an event that’s already caused harm. Most of what I have to say concerning *planning* for worst cases is about organizations; most of what I have to say concerning *designating* a worst case is about the public.

How can we tell if something is a worst case? Worst cases generate awe, capturing people’s imaginations with images and fears of overwhelming loss and destruction. But what makes something overwhelming? Often an accident or disaster is judged a worst case if it takes many lives, or more lives compared to previous, similar accidents or disasters.

Consider the Tunguska case.

In 1908, about 7:00 in the morning a meteorite (most likely, scientists still aren’t sure) exploded some 3 to 5 miles over Siberia, near the Tunguska river. The object was probably 200 to 300 feet wide. Trees were incinerated within a 9 mile

¹ For helpful comments I thank Steve Kroll-Smith, Lynne Moulton, Charles Perrow, Patricia Roos, Diane Vaughan.

radius and were knocked down within a 25 miles radius. The Tunguska Event, as it is known, was 15 times more powerful than the explosion over Hiroshima. Shock waves circled the globe twice. The explosion was bright enough to read newspapers in the middle of the night—in *Britain*.

The Tunguska event took few if any lives but imagine what would happen if a huge meteorite hit Manhattan. Although highly unlikely, this possibility isn't entirely fantastic. If a Tunguska-sized object crashed into Manhattan millions of people would be obliterated. Survivors would likely say that having so many die at once made it the worst disaster that ever happened.

<http://leeclarke.com/images/manhattan.jpg>

Artist's rendition of Manhattan after being hit by a Tunguska sized object

Or consider the Hindenburg. Listen to radio broadcaster Herb Morrison, who witnessed the crash on 6 May 1937:

The ship is riding majestically toward us, like some great feather...There are a number of important persons that's on board...It's practically standing still now. They've dropped ropes out of the nose of the ship and they've been taken ahold of down below by a number of men. It's starting to rain again. The rain had slacked up a little bit. The fast (?) motors of the ship are holding it uh just enough to keep it from...It burst into flames. It's burst into flames and it's falling, it's crashing...Get out of the way, get out of the way...Get this Scotty, get this Scotty...It's fire and it's crashing. It's crashing terrible. Ooh my, get out of the way, please...it's burning, bursting into flames. And it's falling on the mooring mast and all the folks...this is terrible, this is one of the worst catastrophes in the world...four or five hundred feet into the sky.. it's a terrific crash ladies and gentlemen...Oh, the humanity and all the passengers screaming around here...I can't talk ladies and gentlemen. Honest, it's just laying there a mass of smoking wreckage and everybody can't hardly breathe...I'm going to step inside where I *cannot* see it...²

You watch the video, or listen to the broadcast, and Morrison's voice is initially smooth and admiring as the giant Nazi dirigible, resplendent technological marvel, floats down to Lakehurst, New Jersey. But then with a flash the airship catches fire and its aft drops fast. Morrison is shocked, and his voice starts to crack, giving us some glimpse into the terror that must have touched the souls of the hundreds of spectators in attendance. "This is one of the worst catastrophes in the world..." said Morrison, and it really does look like one. It must have felt, smelled, like doomsday, a worst-case come alive.

And yet while the Hindenburg crash was dramatic, the carnage was slight. Only 36 people died (one was on the ground); there were 97 aboard. The Challenger space shuttle accidents is an even more extreme example. While that event was seen widely as a worst case, only seven lives were lost.

² You can listen to the whole broadcast here: <http://leeclarke.com/sound/Hindenburg.wav>. The filesize is 2.4 megabytes.

A high fatality rate sometimes does qualify an event as a worst case.³ But that's not always enough. Thousands of people can die in a single flood in the third world and the event will hardly be noticed in the United States. But if twenty Americans drown after a hurricane it becomes a catastrophe of major proportions. This observation suggests not only that people tend to care more about people like themselves but also that there's an unavoidably social element to designating something a worst case.

Put differently, accidents and disasters are most likely to be judged worst cases if they are defined as rare and overwhelmingly destructive. That's why the Hindenburg crash looks so horrendous: a burning behemoth that no one can do anything about. This observation raises a question that I have not been able to resolve: whether there is in fact something to investigate over and above the uncontrollable accidents and events that I analyzed in *Mission Improbable*.

Organizational planning for worst cases

However untoward events come to be judged worst cases, it is organizations that are our main concern here. There is good reason for that. The potential for catastrophic failure is greater now than in the past, a potential wrought largely by organizations. There is some irony in that because it is to organizations that we must turn for effective response to catastrophic potential. Organizations bring massive dangers. But when hazards turn into disasters, organizations are the most effective tool available to mitigate the consequences.

The drive to use worst case analysis in organizations is particularly strong, because societal expectations are such that leaders and experts *should* be in command. The key idea in doing a worst case analysis is that one *can* find the most dangerous path. When organizations try to find the worst case path they attempt to model the timing and configuration of what can be very fast moving and chaotic events. As they do such modeling, they create ideal typical constructions of how systems work and don't work. Those constructions are then sometimes believed within organizations as accurate representations of reality; as well, they are sometimes projected to various audiences as promises of competence, control, and expertise. Constructing such analyses can have a range of consequences.

One outcome of such modeling is that managers get it right, increasing their understanding of how their systems work. A widely touted consequence of the extensive planning that went into preparations for the Y2K rollover is that organizations realized previously hidden interdependencies in their systems. It is fair to say, indeed, that Y2K preparations helped organizations to learn about systems of systems. All that preparation, and learning, accounts for a large part of why we didn't see important failures on 1 January 2000.

Formal worst case analyses can also facilitate organizational learning by forcing managers to imagine possibilities that might not otherwise have occurred to them. This is a key function of the error reporting system in American air traffic control, wherein pilots can report anonymously any event they consider dangerous. One of the acknowledged results of the system is that exaggerated

³ Airbus is creating planes that will carry 555 passengers. When the first one goes down I suspect we'll all agree when someone calls it a worst case.

events are sometimes reported. Those exaggerations are seen as sources of information about potential worst cases.

But there is a darker side to worst case thinking in organizations. A worst case analysis can be used as a tool to justify dangerous technologies and activities. Some systems are so complex that no one really understands all the pathways of possible interactions in them. Comprehending how elements affect each other can be especially hard when systems start to fail. But organizations can use a worst case analysis to “show” that all dangers have been fully considered and planned for. Sometimes such claims are cynical public relations efforts; sometimes they are proffered in earnest.

When they are proffered in earnest, worst case analyses can lead organizations to think that they really have considered all pathways to disaster, lulling them into a false sense of security. That false sense of security can in turn help to create the very breakdown that the organizations were planning against. US Army fighter pilots shot down 26 “friendlies” in northern Iraq in 1994. Those pilots were confident that their plans and training prepared them for all possible contingencies. That confidence prevented them from second, or third, guessing their decision to shoot.⁴

A false sense of security can also lead organizations, mostly unwittingly, to mislead the publics they’re trying to serve because managers use the analysis as a basis to make promises that can’t be kept. It can also lead to diminished public safety. For example, for several years after the Alaska pipeline opened, each tanker was escorted out of Prince William Sound with a tug. But in what Freudenburg (1992) calls “the atrophy of vigilance,” Alyeska abandoned the escort service, interpreting the absence of a tanker accident as evidence that the service was no longer needed.⁵ Before the disaster the oil industry figured that worst cases were covered and promised as much to Alaskans, indeed to all Americans. When the Exxon spill made clear that such was not the case, and that in fact the industry’s plans were fantasy documents, any extant institutional trust was severely threatened.

Worst case analyses can protect organizations in a different way too. When something really bad happens, organizations can claim they did all that was humanly possible to prepare for it. This will be one result of the EPA’s present program to require chemical companies to create worst case scenarios for the communities in which they’re located.

Thinking about and planning for the worst, then, is multifaceted. It can work in a logical way, as a map constructed to discover how systems work, and how they can fail. But worst case analysis can work in other ways too. Those other ways have more political uses, in the sense that worst cases analyses become tools to use in power struggles and conflicts of interest. These distinctly social aspects of worst case planning have been neglected in scholarship on accidents and disasters.

⁴ *Friendly Fire: The Accidental Shootdown of U.S. Black Hawks over Northern Iraq*, by Scott A. Snook. Princeton: Princeton University Press, 2000.

⁵ The service was reinstated after the spill.

A case of planning for the worst

The Environmental Protection Agency, following a mandate from the Clean Air Act, started a process in 1996 that requires industrial facilities that hold or produce toxic chemicals to create “worst case scenarios.” These scenarios, in one form or another, will be made available to local citizens. This is quite unprecedented. At the very least, the program itself is a crude indicator of how important such scenarios are becoming in our lives. Note that the chemical industry has persuaded the EPA that the worst case scenarios can’t go on the Internet without controlling access in some way. The curious reasoning is that terrorists would then have easy access to dangerous information, which is worse than building dangerous things. It is almost as if there is no danger if there are no terrorists.

The mission of the United States’ Program Manger for Chemical Demilitarization “is to safely and effectively dispose of all U.S. chemical warfare materiel while ensuring maximum protection of the public, the workers and the environment.”⁶ Those are serious goals, demanding the very best we have to offer: money, expertise, communications, high technology, training, and personnel. Most of all, the position demands good planning.

The US Army oversees 9 facilities that are destroying (or will destroy) chemical weapons. One facility is on Johnston Island; the others are in Alabama, Kentucky, Utah, Maryland, Indiana, Arkansas, Colorado, and Oregon.⁷ The disposal of America’s chemical arsenal was mandated by Congress in 1985. The Army has roughly 30,000 tons of materiel to dispose of, and they hope to get rid of it all by 2007. There is some urgency to the mandate because some of the containers are 40 years old and their integrity is declining. Storing the materials becomes increasingly difficult and expensive. The kinds of material to be destroyed include VX, phosgene, Sarin, chlorine, various mustard gasses. Almost all of the Army’s arsenal is colorless, odorless, and can incapacitate people in “seconds to minutes.”

<http://leeclarke.com/images/canisters.jpg>

Canisters/projectiles holding chemical weapons

The destruction plant in Oregon is called the Umatilla Chemical Disposal Facility and is currently under construction. It is also becoming a site of major political conflict because some people are questioning whether the Army can be trusted to handle the site safely. People have heightened risk perceptions, as some might put it, because of some events that have happened in Utah.

About 12 miles south of Tooele, Utah is another chemical weapons destruction facility. It is, says the Army, “the first full-scale facility in the continental United States built to destroy chemical weapons and agent.” Tooele holds 45% of the United States’ stockpile of chemical weapons (about 14 tons). Reading through their material, denizens are assured that any risk is under control. One reason for

⁶ <http://www-pmcd.apgea.army.mil/graphical/tour.html>

⁷ <http://www-pmcd.apgea.army.mil/graphical/CSDP/SL/index.html>. Note that the Army readily lists the location of these facilities, though the EPA and the chemical industry think that revealing the location of non-weapons chemical facilities is too dangerous.

that is that the facility is overprotected. There's a caption beside the picture of some otherwise bland looking pipes that reads:

Extra protection: Carbon filter banks ensure that no agent is released through the stack⁸

<http://leeclarke.com/images/greypipes.jpg>

In May 2000 some agent was released through the stack. The “agent” was Sarin nerve gas which “inhibits nerve conduction” in “seconds to minutes.” It was Sarin that Shoko Asahara terrorists released in Tokyo subways in 1995, killing 12 and injuring over 5,000. The Tooele accident itself was a system accident, in Perrow’s sense of the term. Several failing subsystems interacted in unexpected ways, baffling operators who ignored alarms. All of that was exacerbated by a common intra-group conflict: the failure began on the afternoon shift, which left the problem for the night shift to deal with. That led to a cascade of failures, which eventually led to something the Army said could not happen—the release of nerve gas to the atmosphere.

The Army has steadfastly promised that there is no risk to workers or the public. Army officials have also said that if any problem *were* to occur their contingency plans would kick in to contain any damage. These are classic signs of over-promising and symbolic planning, as I detail in *Mission Improbable*. After the Sarin leak at Tooele the Army and the state of Utah responded as organizations typically respond. First came the assurance from Utah’s Division of Solid and Hazardous Waste that there was “no health threat to workers or the off-post community.”⁹ “Computer analysis indicated that there were no potential health effects to any human who was further than eight feet from the common stack,” said the Army’s report.¹⁰ Next came the independent studies. The Army, concluding that “human error” and “equipment malfunction” were to blame, then instituted a raft of technical fixes that will undoubtedly ensure that this particular accident will never happen again. The Army made 29 recommendations in its report, most having to do with engineering issues but also recommending, again typically, better training for operators, more experience for operators, clearer instructions, better procedures, and better communication.

As noted, officials promised that the Sarin leak would never happen again. That’s probably true.

But here’s a list of other leaks at Tooele:

May 2 – Sarin

May 4 – Sarin

June 12 – mustard gas

July 3 – mustard gas

July 11 – mustard gas

Luckily, in every case, says the Army, “There was no danger to the surrounding communities or to the environment.”¹¹

⁸ <http://www.eq.state.ut.us/eqshw/cds/TPictHP1.htm>

⁹ See the “completed investigation letter” at

<http://www.eq.state.ut.us/eqshw/cds/AgentReleaseReport.HTM>

¹⁰ http://www.eq.state.ut.us/eqshw/cds/TOCDF_ARR/ArmyReport/MainReport.pdf

¹¹ <http://www-pmcd.apgea.army.mil/text/CSDP/IP/PR/index.html>

Were the accidents at Tooele worst cases? The one on May 20—the one that’s generated the most concern—was a worst case in the sense that there were several unexpected failures that resulted in a release that the Army said could not happen. That is to say, the operators did not have control of their dangerous system.

But the May 20 accident was clearly not a worst case in the sense of being a threat to the public. And yet I’m not sure there’s much solace to be taken from that fact. There’s reason for skepticism, because the managers have responded in the usual fashion to questions about their abilities to control everything they claim they can control. After researchers at the University of Arizona conducted a risk perception study of people in 10 states, discovering fairly widespread distrust of the Army, the Army said:

Based on information needs identified in this survey, we will expand and coordinate our activities to ensure that information regarding [the program] reaches the public so that they can feel more secure with their level of protection and their knowledge of what to do in an emergency.

What is typical about the Army’s response is the presumption that the only problem with the public’s assessments is a lack of information. If only the public knew what the experts know, goes the argument, it would trust the Army when told that safety is guaranteed and that the worse possible failure has been considered and is under control.

Experience with other cases in which managers over-promised suggests that leaders in Oregon are setting themselves up for trouble. Over-promising safety and coverage of every important contingency can lead to institutional complacency and public distrust. Organizations sometimes make excessive claims, and then can’t live up to their promises. Publics are often baffled and angered when organizations seem incapable of adequate response. When the often substantial gaps between what organizations *say they can do* and what they *can actually do* become public, institutional legitimacy is threatened and the probability of popular distrust increases.

I have called this situation one of *social liquefaction*. Liquefaction is when the ground becomes highly fluid in an earthquake; it usually happens on landfill or where the water-table is high, and the soil can become so saturated with water that it becomes unstable. The result can be catastrophic if buildings or other life-supporting structures are built on it. Social liquefaction happens when organizations and their leaders can’t live up to their claims, promises, or plans. The bonds of institutional trust between people and organizations are often quite tenuous, easily broken by the slightest act of misfeasance, malfeasance, or recreancy. When the inevitable accident (even catastrophe) happens, risk managers rarely volunteer their responsibility for the damage or recognize that difficult to measure things might suffer. More common are public relations campaigns, marked by clichés (“life is a risk”) and denunciations (“chicken little was scared too”). People know public relations campaigns have more to do with selling products than communication, and salespeople do not command high levels of trust.

Thus I expect that examining “worst cases” and the social construction of worst case scenarios will lead to issues of institutional legitimacy and trust. Such a focus will urge an emphasis on how organizations try to position themselves in political struggles so that their own definitions of “the worst” prevail, and so that responsibility for losing control, and causing damage, is diffused. The issue of

worst cases affords a new opportunity to explore the power of organizations, and of managers, in modern society.