The Great Swindles, Scams and Myths
in Safety

White Paper by **Corrie Pitzer**

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Safety performance in many companies and even industries has stalled in the last decade. Accidents rates are at a "plateau" and yet, serious accidents and fatality rates are not. In more dramatic cases, such as in the BP Texas Refinery disaster, organizations that have "exemplary" safety statistics, suddenly have a catastrophic or multi-fatality event occurring. Classic examples are the Piper Alpha disaster and NASA's Challenger and Columbia disasters, the BP's Deepwater Horizon Rig disaster in the Gulf of Mexico. Looking into the causes of these accidents provides an insight into the events and deficiencies that led up to the accident, but what are the common features in the organization's mindset, or its culture? What characterizes these organizations' decision-making, their approach to safety and to risk and are there features that can be delineated? The research and review presented in this paper covers a period since 1995, which started in the Australian resource industry and since then covered international events. The features of these organizations are summarized as the seven deadly delusions of near zero organizations (NZO) that suffered unexpected disasters, based on extensive research by the author.

More recently, the massive West Fertilizer plant explosion in Texas, and the Train Disaster in Lac-Mégantic, Quebec, Canada underlined the same trends. Organizations may experience calamities not because they are bad, or unsafe, but because they have become "cult-like."

Introduction

The train disaster of 6 July 2013, in the small town of Lac-Mégantic in Quebec, Canada, in which 47 people were killed, had many strange pre-cursors...so-called "black swan" events that have occurred in many different industries.

Black swan events are so rare, that there is almost zero chance that they will ever occur again, but they are so calamitous that the responses to these are emotional and irrational, (but necessary) and in those responses, the seeds for other, different black swan events are put into place.

It is not what we don't do, or do wrong, that causes modern disasters, it is what we do. The same things in the culture that make us successful, may also cause the disasters. We slowly, incrementally and insidiously 'float' into disaster.

One such Black Swan event: The Piper Alpha Oil Rig disaster, killing 167 men in the North Sea on the 6 September 1988, was one of the most pivotal events in safety around the world. It changed the thinking and focus of governments, whole industries and led to numerous books and papers. It resulted in new legislation, textbooks and a critical self-examination by the oil and gas industry.

In short, an explosion and fire occurred when a pipe started leaking gas and ignited. A temporary flange, with no safety valve, was used to block off this pipe during a maintenance operation the previous shift. The permit to advise operators not to start the pumps on this line was misplaced and lost. Several deficiencies, problems and system failures coincided. A key factor was that the water deluge system was inoperable at the time and failed to extinguish the large fire that erupted, followed by an even larger gas explosion. The accommodation unit, situated on top of the oil rig, was the main "killing field" – most men gathered here to await instructions (which never came) and they died here from smoke inhalation.

The line of events and the associated system failures are all very relevant in the analysis of the accident, and provide the only insight into what caused the accident. But much "further back", inside the organization's culture, lay more dark matter. The first inclination is to ask what was "deficient" in the culture. Did they not care enough about safety, or about their people? Did they have a culture where production decisions were more important than safety considerations? Did they 'coerce' supervisors and employees to ignore safety precautions or did they just "fly by the seat of their pants"?

Not surprisingly, it is very difficult to identify the true nature of the culture in that business because in such an aftermath of death and destruction, no one dares to say that the safety culture was a positive one, focused and caring or that the company was doing well in safety or that this was only a freak accident. Indeed, there were many deficiencies in the organization's systems and procedures, such as the permit to work system.

But there are some niggling questions: How was it then that the Piper Alpha Oil Rig was actually considered one of the company's most productive and safest oil rigs in the North Sea? How could this rig win a safety competition, 6 months before the disaster, with the deficient permit-to-work system named as its most outstanding successful system, which played a key role in the sequence of events of the day. It wasn't a poor audit. All systems in safety are like that: operating 'perfectly' when audited, but 'normally deviated' in practice…

More tellingly, why did the manager of this rig, when he was questioned about why he did not know about all the deficiencies that were so readily uncovered in the inquiry, say: "I knew everything was all right, because I never got a report that anything was wrong" *(Brian Appleton presentation, video recording).*

This is a strong indication of a delusion. The manager clearly was deluded that his rig was safe, sound and well managed. This is a manager who expressed his confidence, based on the lack of reports to him about problems.

But what is wrong with that? Isn't this what all managers, everywhere, do, managing by exception? It is clearly impossible to manage and know of every detail in the business, every step of the way. Any manager will tell you that you have to rely on reports, and you have to trust the people who work for you. In fact, this is the 'right way' to manage the business! It allows you to make fast decisions and to expedite work – it is an integral part of the success of the business, which is now fingered as a cause of the failure!

And what if your workers don't trust you? What if they 'feel' that if they report deficiencies to you that they will become the targets of being 'shot as the messenger'? Or even more subtly, what if workers feel that they dare not, or do not want to disturb the 'peace' in a company that is clearly doing well on safety,

with no incidents, many accolades, lots of vision statements and goals about accident-free performance, and celebrations of these milestones.

The culture in such an organization is not deficient or 'faulty' in the traditional sense of the word. It is 'deluded'.

A series of such delusions have been identified in the research of the author, starting with a paper in 1997 about the incidence of mine disasters in Australia. Peculiarly, the disasters in that industry, during that period, (1980 - 1999) tended to be at mine sites that could hardly be described as deficient in their management of safety. They were operated by mining corporations, that had a tremendous and sincere focus on safety, and, in some cases, that could be described as the 'best in the business'.

Indeed, one such mine was Northparkes gold and copper mine, in New South Wales, Australia, then owned and operated by North Mining, a mining corporation that was for many years regarded as a leader in safety in the resources industry in Australia.

On the afternoon of the day shift on 24 November 1999, four men were killed at the Northparkes E26 Lift One underground mine as a result of a massive collapse of rock and the subsequent devastating air blast. While the inquiries into this accident focused mainly on the risks and technicalities associated with so-called block cave mining, there was a unique opportunity, unreported until now, to also study the safety culture and systems of that mine.

At that time, the resources industry of Australia operated an industry award system called the Minex Awards. This award was given annually to the best mine in Australia from a safety perspective, and the strength of it was that it was only given after a very rigorous audit and analysis of the participating mines' safety systems, culture and performance by a visiting team of trained evaluators. An iterative process ensured that the top award would only be given to a truly deserving mine. Northparkes Mine was a participant in this award process, and was given a "high commendation" by the Minex panel, prior to the disaster. The author was a member of the evaluation team in 1999, and had first-hand insight into the quality and design of Northparkes safety management systems and culture.

Another unique opportunity presented itself: In 1999, the Australian Minerals Council commissioned an industry-wide safety culture survey, with 42 participating mines and plants selected from all the mining locations, types of mining and commodities. Coincidently, Northparkes Mine was also a participant in this survey and analysis. The author's company, SAFEmap, was responsible for the survey and subsequent report (see www.safemap.com).

It can be stated, unequivocally, that Northparkes was a top performing mine in safety. The survey of safety culture had placed it as the third highest in the rank of 'positive responses' by employees and the safety culture, in several respects, was unequalled. This company's response levels are still of the highest ever recorded in the SAFEmap database of more than 200 companies and more than 100 000 employees – one of the largest in the world. The Minex panel gave the mine a 'High Commendation' in the awards process that same year, and 4 months later, the disaster occurred and suddenly, the search was on for what the company did wrong, or did not do at all. Now, they were a 'broken' company...

It is suggested that mine management was not 'deficient', it was simply too good for its own good! Their huge focus on safety, the achievement of lofty goals and celebration of safety successes led to a "mindset" that they were leaders in safety, protected by an extraordinary safety system and that their safety incident figures indicated a truly world-class safety performance.

It led them into the trap of the seven deadly delusions…

The evolution of these delusions is not a linear process, of A to B, to C. The analogy of a whirlpool might illustrate the process. At the surface, and near the edge, the slow swirl of water appears normal and mundane. All pools where water collects may show the same appearance. As the movement gathers momentum, it increasingly becomes powerful and erratic, and draws, randomly, more debris towards the center, which collides and bounces unpredictably. The typical organization shows the same patterns of movement and may continue to swirl with no negative effects...until a random event triggers a series of random connections, nodes and ripple effects – and a powerful collision results.

Organizations and managers have long been the victims of myths and delusions, and so has the science of safety. Many slogans and mantras abound in the safety profession, and large 'industries' evolved around those. Myths such as "human error is the root cause of accidents" and "all hazards can be controlled" have long been part of the foundational concepts of safety management.

In 1996, the author started with a research program for the NSW Minerals Council and presented a paper at its annual safety conference, tiled: The Myths of Safety, in which it compared the events of the Challenger Disaster, Piper Alpha disaster in the North Sea, and the Moura Coal mine disaster in Australia. Since 2006, the paper was presented at several international conferences, and since 2008, renamed the "Delusions of Safety", following the terminology of Philip Rosenzweig in his book, "The Halo Effect, and the eight other delusions that deceive managers".

1. The delusion of linear causation

A key aspect of modern risk management approaches is that risk has a certain 'probability' (likelihood or chance) and if the risk is analyzed, its probability can be identified and cautionary actions taken. However, unlike the risk insurance industry, there is little objective, hard data available about events in near zero organizations. There simply isn't enough data to achieve the goal of risk quantification, and risk assessments often become a subjective guess, often by unqualified people who have a vested interest in a certain guess and are easily manipulated for "organizational politics". It creates the delusions that risks are quantified, which was exactly what happened with the O-rings on the Challenger Space Shuttle.

The delusion of linear causation is further entrenched by elegant accident causation models, created by Heinrich (Dominoes) and Reason (Swiss cheese) creating the impression that accidents have rather simple, linear traces of failures in defenses that allow accidents to occur...with the further delusion that strengthening defenses, (or cheese layers/dominoes) will prevent the linear causes of accidents. It could not be further away from the reality of failures. The complex and chaotic nature of risks, the randomness of these 'trickles' of failures is impossible to predict, yet very simple to review in hindsight.

This delusion can also be named the delusion of predictability... that all events could have and should have been foreseen. The common term: "an accident waiting to happen", is all too common. In hindsight, the investigation becomes condescending, and the operators of the business have no defense, because the dead bodies make it indefensible. Those operators dare not divulge that the 'signs' of accidents were always there. There are many complex factors in the business that they don't control and that they cannot control, other than to shut that business down. And the business right next door cringes; because they know that that disaster could have been theirs.

In safety, we simply don't have, or we don't employ, advanced techniques of risk scanning, of analyzing virtual risks. The analytical methodologies with which we look at accidents can have only outcome: it was a series of easily identifiable errors and failures. In some ways we are cheating by starting at the cheese and work our way back into the maize. But if we had to start at the 'beginning' of the maize, and not knowing where the cheese was, the analyses could've delivered a very different outcome, many dead ends and many failed attempts.

We apply risk management techniques still based on the Taylorist models of management, over 100 years old, in the modern complex adaptive systems that our organizations have become. As an analogy: we use management techniques originally designed to build Model T Fords, to put Space Shuttles into space.

2. The delusion of compliance

James Reason (2001) published an insightful article in which he made the controversial statement: "following safety procedures has killed people" and he cites examples such as the Piper Alpha disaster as just one such case, where the workers who strictly followed the safety procedure were the ones killed in the fire, while those who jumped into the sea, against procedures, survived. This doesn't imply that safety procedures are wrong and shouldn't be adhered to, but it does mean that human beings in a high-risk work environment should firstly apply their risk skills and risk judgment. It becomes very evident that humans, while complying, become less responsive to the threats, or signals of such threats, in their environments. The classic lack of attention of a pedestrian at a crosswalk un-

derscores this. There are several other influences at play in this delusion. The reliance on procedures and rules in the workplace readily becomes cult-like and workers are increasingly confident that the safety system is reliable and 'trustworthy' and therefore show less and less inclination to deviate from company directives, even if the actual situation of impending risks may dictate otherwise. Organizations also act in the same way, as if walking in a crosswalk, when they believe that their safety system audits show impeccable results, their commitment to safety is clear and unequivocal and their measured performance proves it.

3. The delusion of consistency

Human beings learn to deal with risks though a complex process of cognitive adaptation, often developing an intuition and competence that defies reasoned thinking. This 'capability' allows them to deal with risk in a highly variable fashion, a readiness for any/many possibilities. But then our risk control logic says we should limit all variability and create consistency and compliance in the workplace. Workplaces are becoming increasingly regulated by vast numbers of rules, controls and legislation, with the natural increase in perceptions of predictability and harmonization of work practices.

This logic seems flawed, and contrary to the 'natural state' of any high risk and complex systems, where risks dynamically and systems adapt to interventions. It is also deluded to think that we can impose consistency because of the sheer, inherent, chaotic nature of organizations. The power and benefits of human performance variability and responsiveness increasingly becomes lost.

4. The delusion of (risk) control

The delusion of risk control is the most persuasive and the most 'attractive' one.

In the safety profession, we create a myriad of rules and procedures that are supposed to defend us and create controls in the workplace. These are the very basis of most legislation and are often supplemented by the management of an enterprise. Many organizations have very comprehensive safety management systems in place, either based on a commercially available package, or they deploy their internally developed

and audited systems. Organizations that had disasters such as BP, Union Carbide, Occidental Petroleum, NASA, all had this focus on risk control, not unlike the focus of other "non-disaster" organizations such as Shell, Dow Chemicals, Chevron, and Aerospatial etc. All have very well developed systems and they operate sophisticated auditing of compliance.

A key element of all of these systems is a clear and unabated focus: to control risks in the work place. While these systems are largely successful, they eventually become a complexity of their own. Layer upon layer of risk controls actually create behavioral responses that expose the organization in unpredictable ways. The organization doesn't and cannot cater for the risks that 'migrate', for new risks created by the risk controls themselves, or for the natural response of humans and organizations, to adjust their risk thermostats accordingly. This "risk homeostasis" occurs when the more we perceive risks as being controlled, the more we increase our risk propensities, because we believe we are so safe…

5. The delusion of human error

The delusion of human error is closely linked with the stereotypes about humans that the safety profession holds, and also linked to the delusions discussed above. One of the long-standing 'axioms' in behavioral safety is that the majority of accidents are because of human error, and that behavioral observations will eliminate this.

This linear approach wholly underestimates the complex interactions between humans and their dynamically changing environments. It also completely misses the point that human actions are only the visible sharp end of the many safety management systems that actually 'create' and induce human error. It also misses the point that human error is a misnomer.… The notion of human error is so entrenched in the literature of safety, that it is almost incomprehensible to argue that it doesn't exist, or that it doesn't cause accidents, or that human error itself is a symptom of a system.

But human error is inevitable; it is part of the human condition and in fact a very necessary part of our survival as a human race. A human race that is completely situational aware, vigilant and focused on all, even minute risks in their environments, one hundred percent of the time, 27/4, will not survive mental breakdowns. (See footnote[1] below)

Safety has a focus on behavior and 'behavior change' entrenched in its paradigms, and yet, behaviorism is a psychology that has been outdated for 50 years and disproven time and again to be too narrow a paradigm to describe human nature, The world has moved on, and safety science has stayed behind.

Human error, is at its core, cognitive and largely unintentional. How then can attempts at behavioral management have any effect, which fundamentally assumes that risk-taking is intentional?

6. The delusion of quantification

The saying: "lies, damn lies and statistics" is a famous one in the world of business research and reporting, but nowhere is it as damaging as in the world of safety statistics.

There is a significant demand for improving safety performance, as measured by graphs and statistics – resulting in all kinds of 'treatments' of the data. Workers are quickly 'rehabilitated' to return to work before a certain cut-off period, incidents are "argued away" as not work-related or large incentives often drive reductions in the rate of accident reporting. Not only is the data unreliable, it is also invalid: The reality is that the small number of incidents, at the top of the triangle, simply cannot be a measure of 'safety'. In every organization, many millions of activities take place every day, every minute, and if only one of those activities fail, or ten, the statistical insignificance is the same. One person (or 100!) selected out of the almost 300 million in the USA is not a valid example of all Americans, or the 'average' American…

Yet the safety profession thrives on measurement, and it may well be the primal cause of calamities…leading into the killer delusion of invulnerability.

A further very entrenched delusion in the safety profession is that minor accident ratios are predictive of serious events. The

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[1] Who noticed the previous sentence showed 27/4 and not 24/7? A human error that most readers WILL make. If this error occurred in random circumstances associated with others triggers and nodes and collusions in a complex, risky environment, does it make sense to want to retrain the reader/worker in literacy skills?

(Frank Bird) ratio triangles continue to pervade the thinking of safety professionals, and they chase after the reporting of small incidents or near miss events, in the mistaken belief that trends in these will allow them to prevent serious ones. While there may be, or certainly is, value in learning from these failures in the organization, the patterns and trends are false and misleading. We gain no insight into catastrophic system failure from the frequency of soft muscle injury or infractions of personal protection usage!

The most damaging delusion is the obsession of the industry with the notion of zero (accidents/incidents or harm), which triggers a number of failures in the organization. The focus on zero triggers a failure in creating a just culture, because a 'zero tolerance' approach soon follows. Normal deviations and variability in system performance are viewed as 'abnormal', and treated as such. Under those circumstances, the trajectory towards zero incidents suppresses information about mistakes, risks and potential problems – and triggers the ultimate 'failure' of "risk secrecy". Many, even most disasters in organizations were preceded by excellent safety performances, and an obsession with safety metrics. And therein lies the ultimate harm. The focus on accident numbers is inherently flawed, for the following reasoning…

To achieve the ultimate: Zero Fatalities, we need to achieve zero's in all of the "contributing" factors and causes, such as mistakes, system failures, deviations, human errors, hazards and even risks. Eventually, a nirvana of perfection is pursued - a condition that only exists as a figment of our imagination. The laws of nature militate against order, which will always naturally decay... (The Second Law of Thermodynamics states "in all energy exchanges, if no energy enters or leaves the system, the potential energy of the state will always be less than that of the initial state." This is also commonly referred to as entropy.)

In practical terms, to achieve a reduction in zero incidents/mishaps/accidents, you need a reduction (eventually to zero) of 'near misses'. However, we need to encourage the reporting of near misses so that we can identify and eliminate the risk!! This "Catch-22" results in a process of "elimination through non-reporting." At best, this is self-defeating; at worst it is fatal!

The 'target zero' philosophy also sends an extremely deluded message to all in the organization: that the 'safety journey will one day end in a decisive victory. It is a false victory. In the end, safety metrics become the goal itself, and this distorted focus will eventually kill the business.

A case in point: It is quite possible to achieve a "zero fatality" goal, and a worthy one too. In North America alone, over 30 000 people are killed in traffic accidents per year. Simply change the speed limit on all roads, everywhere, to 5 miles per hour…

7. The delusion of invulnerability

Like the Titanic, the delusion of invulnerability is the most deadly of them all. It pervades the minds of individual workers, supervisors and managers and eventually becomes ingrained in the culture of the organization. It is caused by three factors or 'conditions' in the organization: high levels of perceived safety protection, systems and programs, low levels of incidents occurring (near zero) and the increasing trend of workers (and supervisors and managers) to hide risk-taking, risks and potential safety problems from the critical eyes of managers and safety professionals. This is largely a result of a well-intentioned, but poorly deployed, focus on zero – a number chased by all, mystified by gurus and used as a large stick against all "heathens".

Almost all organizations that suffered dramatic disasters appeared to have had commendable safety performance records.

Apart from the fact that these figures and statistics are unreliable, invalid and even fudged, the actual or real decrease in incidents is also creating a reduction in the organization's ability to maintain a state of risk readiness: the signals are fewer and fewer and weaker and weaker – and therein lies the ultimate dilemma. The safety profession relies on these signals because its whole science is created around finding error and failure and analyzing them and eliminating them. It has very few predictive or progressive methods and it has little understanding of statistical analysis of the 'small kind' – it uses statistical techniques such as moving averages and frequency rates to make predictions that are wholly inadequate for the kind of weak data sets it has.

The safety profession cultivated and "cult"-ivated the vision of zero incidents/accidents/harm and still crucifies the heathens that question it. And it knows less and less of what it doesn't

know. While zero is the only moral target for any company, the answer of safety lies beyond the numbers, certainly not in the 'absence of accidents'.

The delusion of invulnerability is often incorrectly described as 'complacency' and there are large armies of consultants who peddle their solutions to this 'evil' in the organization, or in the workers. Training programs masquerading as behavioral science have us believe that our problem is simply the workers who fail to "keep their minds on the jobs", or who "are rushing", or who display poor attitudes (of complacency). We declare "war against human error" (an actual title of a recent presentation at a safety conference!) and we plug holes in the Swiss cheese layers, etc.

And as we achieve the targeted reduction in the 'numbers', we confidently conclude that we have won the war, or are very, very near to the victory, but in actual fact we have set ourselves up for the moment when all things evil come together, when a simple mishap links up with another and another, and an explosion, or a fire, or chemical reaction results in the deaths of many…

That is the inevitable conclusion of the delusion of invulnerability, but only if it actually happens. Most organizations, for many years, may be harboring the same delusions, but escape the calamity, not by design, but by sheer coincidence and good fortune.

One of Albert Einstein's most meaningful quotes rings true here: *"The world we have created is a product of our thinking; it cannot be changed without changing our thinking."*

(The 'zero harm' discourse introduces the biggest force of destruction into the organization, namely "fear" – and it is perhaps Target Zero's most damaging consequence. The length to which organizations will go to achieve the required performance numbers is astounding. For example, some construction companies are known to hide (very) serious accidents routinely from their clients out of fear of losing work contracts, and ordinary workers hide injuries to escape being scapegoated a few days out from another "zero days" milestone. (The author has previously encountered an extreme case in a particular construction company. The company jet would be used to transport the bodies of deceased contracted workers from a building site

to their country of origin, where they are reported as a fatality on another work site of that sub-contractor, allowing the main company to then gleefully report "another year with out a fatality at any of our sites".) Of course, not all companies engage in such extreme behaviours, but most still do it for lesser injuries - the process is the same.)

Leading safety into the future…

The 7 delusions each give rise to a new reality for managing safety into the next decades to come. In these new realities, the safety profession disappears, just like the quality control profession disappeared - because it became fully integrated, into basic operational processes. It is time to abandon the "behavioral era" of safety and to embrace the new era of resilience engineering. The safety professional has a new role: that of a resilience engineer - to increase the *effectiveness* of the organization.

1. The delusion of *linear causation* should be replaced by a reality of *multiplicity.*

In the old model, the organization is seen in a simplistic way… as a technical system in which any event has a cause, and every cause has another cause, until you find the root cause. Our analysis processes are all based on the original Domino models of Heinrich, and even though we have smarter Swiss Cheese ones – they are still linear. The original root cause is the need for the organization to take risks, because without doing so, the organization will not exist, nor succeed. We cannot eliminate the root cause of accidents!

Complexity refers to the fundamental paradigm of organizations as complex socio-technical systems, with interactive layers, coupled processes and complex goals. Organizational structures are flexible, intertwined and dynamic. In this reality, the traditional safety approaches and tools are invalid, inadequate and ineffective. Existing safety techniques of accident analysis should be reconsidered, and new ones found that are able to capture this reality of multiple and dynamic causation.

2. The delusion of *compliance* should be replaced by the reality of *agility.*

Flexibility of operational systems ensures the ability to quickly respond to changes and to maximize profitability or effective-

ness. Directly contrary to this is the rigidity of the safety/risk management systems that are currently deployed, coupled with legislative requirements that demand compliance at all levels. Particularly because of legal considerations, organizations have become cult-like in the culture of compliance. These cultures don't allow for innovation, flexibility or adaptation, and in fact, destroy it.

In the new reality, safety approaches allow front line employees the latitude to make crucial decisions and responses at the point of risk, even allowing them to bend safety rules where employees judge this to be safer. Safety systems are adapted to the operational realities, instead of operations adapting to safety systems. Of course, this will require extremely high levels of skills and competencies in employees and extremely high levels of trust at all levels.

3. The delusion of _consistency_ should be replaced by the reality of _adaptation._

Consistency is the foundation of all organizations, because it delivers a predictable range of controlled operation, and variation is the enemy of safety, efficiency and of quality. But the range has become too narrow in the near zero organization. With this myopic focus on safety deviations and shortfalls, the absence of variability has defeated innovation. The organization has lost its innate capability to renew processes and to push them to the next level. The safety profession was too successful.

In the new reality of variability, innovation is the new focus. The prevention of accidents is no longer based on the hierarchy of risk controls, but on the capacity to change and innovate fundamental processes, and to solve risk at the source. In this reality, operational systems are dynamically changing and responding to risk. There are no bolted-on safety regulations for each task, because each becomes inherently safe and efficient through adaptive innovation.

4. The delusion of _risk control (simplicity)_ should be replaced by the reality of _complexity._

The "control of risk" is hardly questioned. The "science" of risk management enjoys growth and self-confidence in the safety era, because it promises to identify, evaluate and mitigate risks - an irresistible lure for the safety profession. In an immature

work environment, with high levels of risk and accidents, the science can probably deliver good outcomes. But in a mature environment, at near zero levels of safety performance, the existence of risk is not obvious anymore, because previously the occurrence of accidents "identified" the risks. But the absence of accidents should not be taken as an indication of the presence of safety.

The new risk system has a human risk control hierarchy, long before it contemplates its engineering controls, such as elimination or substitution, or its administrative controls. Humans have several options in controlling or responding to the risks, such as proceeding with caution, reviewing tasks, changing methods, incorporating assistance, seeking expertise, elevating decisions to the supervisor, etc. - as the risk levels increase. The new risk management is focusing on risk resilience in response to uncertainty - learning, responding, monitoring and anticipating. All in real time.

5. The delusion of _human error_ should be replaced by the reality of _competence._

Human error continues to be targeted as the (root) cause of problems in safety and humans still seen as the weak link in the safety chain. Programs to change behaviors, to overcome complacency and to improve attitudes abound, accompanied by a huge consultant industry.

In this new reality of competence, humans are seen as the strongest link, where people are trusted, skilled and enabled to make decisions, to take risks competently and to contribute to the effectiveness of the business. The new safety system actually relies on the human capabilities, not mitigating or engineering them out. Humans have immense capabilities such as risk intuition, sixth senses, lighting-fast responses and smart heuristics, which are all dumbed down by the modern safety system.

6. The delusion of _quantification_ should be replaced by the reality of _variability._

The notion of randomness in safety science is controversial, even unacceptable. The science is riddled with myths, such as all accidents are preventable, safety is no accident, no hazard is uncontrollable, etc. They all make emotional sense, but can be challenged at a rational level. Randomness is a key aspect

of life, risk and accidents. It delivers both good and bad outcomes, and is increasing in its magnitude, or "contribution" to events.

Dealing with systematically occurring risks (if that is the paradigm) in a systematic way seems to make sense, but in this new reality, risks are random, and the "treatment" must be random too. Reward systems should be for effort and for random effort - and no rewarding of safety results as measured by KPI's. Traditional safety KPIs are invalid and unreliable, increasingly fudged to obtain targets, and should be abolished in favor of measurements of impact, such as perception and culture measurement, deployment effectiveness and for levels of quality and depth of controls.

7. The delusion of _invincibility_ should be replace by the reality of "_resilience._"

The delusion of invincibility is directly correlated with increasing success in safety improvement. The near zero organization has only few reminders (accidents) of its vulnerability and believes, rightly so if traditional measures are to be believed, in its own capabilities, systems and defenses. It has increasing evidence of this as accidents rates decrease, and the number of days between accidents extends further and further. Our risk systems focus on predictability and control and the increasing controls reduce the number of incidents which shed light on potential system failures. Although it is impossible to predict "a black swan" it is possible to prepare for it. The absence of reminders of vulnerability hinders our willingness to prepare and shifts our entire business further towards the edge.

Our ability to suppress volatility, inconsistencies and uncertainty has created system atrophy…it still looks like a system but it will not have the innate flexibility to respond when adversity strikes. And when control is lost, coincidence becomes a killer…

In the new reality of anti-fragility, (from Nassim Taleb) the organization develops a capacity to grow from disorder and failures, to 'know' what to look for and to accept error as positive uncertainty. It is the difference of accepting/living with 50 car accidents at 1 km/h each, instead of one car accident at 50 km/h. The net statistical impact on the organization is the same - it can recover and grow and learn from the small incidences, but will perish from the one big catastrophe.

Antifragility doesn't mean the organization is able to withstand or avoid adversity, it means it becomes better as a result of it. The key is to ensure that the "adversity" is small, limited and readily identified.

The problem is that the above 'car crash problem' doesn't allow avoiding both. Avoiding the smaller incidents develops creeping atrophy, opening the door for the big one. We must have the small ones, in order to preempt and avoid the big ones.

If we are successfully avoiding the small one's – the focus of current safety paradigms - we _will_ have the big one…unless we are 'lucky', and we should not want to take that gamble.

Conclusion

Organizations are currently functioning at an 'optimal' level, given modern constraints and limitations. In the figure below, we are probably functioning at the A-intersect. At the C-intersect we will be taking too much risk and killing people, at the B-intersect we are taking too few risks and will go out of business.

Our focus, as safety professionals, should be to move our organizations from the A-intersect, to the D-intersect – higher up the performance _and_ risk curves. This will of course be a challenging concept for most safety professionals, whose entire raison d'etre is to keep the organization at the lowest risk level possible, and to push the organization further back towards the B-intersect/lowest risk.

It is for this reason that the fundamentals of the safety profession will need to be reviewed, challenged and redefined. A profession with 'safety' at its heart cannot be expected to be something else, and will therefore always be in conflict with any attempt to move the organization in a different direction. Therefore, 'safety' will need to be replaced by something else, and that something else could be the concept of 'resilience'.

In the organizational context this could be defined as the department of resilience engineering, whose focus is to create abilities in the organization so that it can be:

- **Knowing what to *do***, that is, how to respond to regular and irregular disruptions and disturbances either by implementing a prepared set of responses or by adjusting normal functioning.

- **Knowing what to look for**, that is, how to *monitor* that which is or can become a threat in the near term. The monitoring must cover both that which happens in the environment and that which happens in the system itself, that is, its own performance.

- **Knowing what to *expect***, that is, how to anticipate developments, threats, and opportunities further into the future, such as potential changes, disruptions, pressures, and their consequences.

- **Knowing what has happened**, that is, how to learn from experience, in particular how to learn the right lessons from the right experience – successes as well as failures.

This will require a vastly different approach to risk management, namely to develop capacities in the organization to take risk competently, as against avoiding risk effectively. This is a very different notion to traditional 'safety' management. The organization should look like this:

- **Variable work practices**, developed through local experimentation to be optimal.

- **Distribution of decision-making authority**, to the actors in the local circumstances.

- **Technology that enables people**, as against restraining or disabling them.

- **Operational procedures** with safety completely integrated/invisible.

- **Random and dynamic risk interventions**, as against structured, reactive safety interventions.

This is the challenge of the future of safety management…

Figure 1: Based on Rasmussen, in "Resilience Engineering" (Hollnagel et al)