From Zero Accidents to Safe Sustainable Production

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The author reflects on his three-decade career in high-hazard industries, combining engineering and social science perspectives to illustrate how his approach to safety has evolved from preventing accidents to building capacity to ensure that 'things' go right in line with the Safety-II philosophy. The author's initial intent to keep systems functioning safely under imperfect conditions has evolved into integrating safety, sustainability and productivity, consistent with the progression of Safety-II toward Synesis. 'Safety is the number one priority' is hyperbole intended to ensure that safety is prioritised against competing considerations, such as productivity. At the same time, if nothing is produced, there can be no resources for safety—nor can there even be a business. Organisations tend to consider these priorities in isolation rather than considering their synergistic or antagonistic relationships. This integrated approach may be new to safety science but is well established in management science. There is a need to bring these two fields together to reflect on how organisations are or should be managed to improve overall business performance. This approach requires building a high level of trust and strong organisational effectiveness, which cannot be achieved by training alone. Executives and managers must face the reality of frontline operations and take bold actions to close uncovered capability and technical gaps.

Keywords: human performance; risk control; sustainability; organisational effectiveness

1. Introduction

With degrees in engineering and social science, I have held executive safety roles with three of the world's largest companies: BP, Anglo American and GSK. As a scholar and practitioner, I strive to implement the latest safety science developments in large manufacturing environments. During my career, my approach to safety has evolved from ‘zero accidents’ to ‘safe, sustainable production’. Not many companies are solely in the business of safety. Most companies must deliver safety, sustainability and productivity for their employees to thrive and their businesses to succeed. This approach is not about a trade-off but about building high-trust and high-performance organisations that deliver safety, sustainability and productivity. This paper summarises my key learning from leading large-scale safety transformations and includes the research literature on each of the points mentioned.

2. Career highlights

I started my operational career in 1993 and held several offshore and onshore operational roles. Like most people working in the oil and gas industry in those days, my focus was on zero accidents and achieving the highest number of days without a lost time injury (LTI). I was shocked when 15 employees died in the Texas City Refinery explosion. I assumed that this kind of accident could never happen in BP. However, most of BP's focus was on personal safety. The safety issues in Texas City were related to process safety and safety culture: two critical aspects of safety that BP did not properly understand at the time. I joined the initial remedial team for Texas City and was responsible for designing and rolling out a global programme to build safety leadership and capability at the sites (Operations Essentials). It was the largest programme of this kind ever rolled out in BP, and its contribution to improving safety was widely acknowledged.

Safety transformation has become my passion ever since, as I can see the positive impact these interventions can have on people's lives. I have been running global safety improvement programmes not only in energy with BP but also in mining with Anglo American and, more recently, in pharma with GSK. I learned that while zero accidents is an admirable goal, but we must recognise the limitations of this approach so that we can address them and create a work environment that is safe, sustainable and productive for all employees.

3. Zero accidents risk and why it can be counterproductive

While zero accidents is an inspiring vision, a problem arises when we turn this vision into a target. I have seen the lengths to which some managers have gone so that an injury was not recordable. This behaviour can indirectly lead to underreporting, which means that some safety issues may not be properly addressed.

Let us take my own experience in the early 2000s when I managed two gas terminals with large inventories of gas and condensate. My focus was on reaching the highest number of days without a LTI. I was spending more time talking to my team about the Dupont STOP Behavioural Safety programme than about process safety and the major hazards that we were managing at the time. This was the way safety performance was measured in those days. I also remember the pressure my team and I experienced when we were getting close to a significant milestone—such as a year without an LTI—and if an injury happened, how much time we would spend arguing about whether it should be recorded as a lost-time injury. Luckily, I did not experience any serious accidents, but in hindsight, I focused too much on personal safety and not enough on process safety.

Sidney Dekker (2021), a prominent critic of the zero accidents approach, has extensively researched this issue. Injured workers, supervisors or even safety managers can feel pressured not to report injuries because it will negatively impact the company's statistics and reputation (Derango, 2013; Frederick and Lessin, 2000; GAO, 2012). A link between a lack of transparency and

employees' ability to speak up on the one hand, and organisational disaster potential on the other, was recently demonstrated (Blanton and Peksen, 2018). The use of injury rates and the rules developed to manage the number of reportable injuries has unsurprisingly generated widespread cynicism among workers (Collins, 2013; Heather and Kearns, 2018; Leplat, 1998; Bieder and Bourrier, 2013).

Furthermore, as the injury rate gets close to zero, the requirements of statistical significance are never met. Deriving trends or changes from this measure is meaningless because of their considerable lack of statistical power. Managers will report a significant reduction in injury rate that actually have no statistical basis. Variations in injury rates from year to year or between companies are completely random and cannot be provably related to a manager's actions or inactions (Muller, 2018). In fact, while not proving a causal relationship, a lack of injuries and incidents in already safe organisations (Amalberti, 2001) has repeatedly been linked with increased risk of process safety disaster and fatalities (Michaels, 2015; Baker 2007, Hopkins, 2010; CSB, 2007; Elkind, Whitford and Burke, 2011). Similarly, the pursuit of ‘zero harm’ has been shown to be correlated with greater rather than smaller company fatality risk (Sheratt and Dainty, 2017).

Pursuing a low injury rate becomes, in Eric Arne Lofquist's words (2010), ‘the art of measuring nothing’. It seduces organisations into what is known as the fundamental regulator paradox: achieving Zero in a dynamic system means that there is no longer any basis on which to correct or regulate the system's behaviour. The organisation is literally ‘going blind’. Finally, the injury rate is a record of injuries and not of incidents. An incident may have significant potential but result in no injury, so high-potential incidents are not captured or investigated and lessons are not learned.

4. The safety culture fallacy and why safety as a value is not enough

Safety culture became very popular in the 2000s, as it gave organisations and leaders something positive to consider rather than focusing on what they wanted to avoid. This focus created a cottage industry of attitude surveys. This approach assumed that values and beliefs are what drive people's behaviours. This approach is only partly true, and several organisations with excellent safety culture survey results have been involved in serious injuries and fatalities.

Let us illustrate why this disconnect exists. It is admirable for managers to tell their team members that safety is a value or the number one priority, but it is not enough. During my career, I have visited some sites where the leadership team kept repeating their commitment to safety. Yet, my site inspection would reveal that some of the equipment and processes were deficient. The employees were not set up for success. There were safety posters everywhere, but for the employees, it was hard to work safely.

People's behaviours are not only driven by their beliefs but also by their context. They do what makes sense to them at the time. We must make sure that employees have the proper equipment and effective processes. We must make sure that we have both safety as a value and effective risk controls in place.

Dekker (2019), in his critical book on the foundation of safety science, summarises the limitations of safety culture. Accident prevention (the title of Heinrich's 1931 book) was organised around what organisations should avoid. Safety culture inverted this approach on the understanding that a good safety culture could prevent accidents. As a result, organisations and leaders started to promote, design or encourage a good safety culture (Pidgeon, 1998). However, Dekker (2019) highlights the key limitation of this approach by asking: 'Is “safety culture” a concept that tries to say so much that it ends up saying very little?' Defining safety culture as 'the way we do things around here' means that there are no boundaries to define, study or change. This ambiguity supports benefits in marketing and convenience while lacking scientific rigour and substance (Cox and Flin, 1998).

Functionalist or quantitative perspectives support the idea that culture is a variable characteristic, a quality that can be measured, managed, changed or manipulated (Haukelid, 2008). Culture surveys are a logical endpoint of the functionalist perspective. The predictive capacity of safety culture, as measured by people's attitudes and beliefs, is not strong at all. Organisations with an effective safety culture have not been proven to generate fewer accidents. In fact, organisations with an effective safety culture have been involved in Serious Incidents and Fatalities (Antonsen, 2009). The results of these surveys form the basis of functionalist safety culture interventions that are meant to generate a sense of commitment and build coherent safety values that in turn shape workers' behaviours. This approach is comparable to behavioural safety initiatives where the workers are problems to be controlled (Hopkins, 2014). Poster campaigns and slogans promoting safety as a value are quickly ignored as fantastical irrelevancies and ill-informed by those who do the organisation's safety-critical work unless these provide clear guidance on actions to increase safety (Lees & Harrison, 2000). In the functionalist perspective, safety is presented as a moral choice—a supposedly 'free' choice—even though it can be in conflict with other stated and unstated organisational goals on production and efficiency or with the design of the equipment that employees must use. In contrast, the interpretivist or qualitative view of safety culture focuses on how workers make sense of their work situation and how they choose between alternative ways of performing work. Culture is seen as a frame of reference for meaning and actions that is consistent with the Safety-II approach advocated by Hollnagel (2014).

5. Human performance and why people are not the problems but the problem solvers

The concept of human performance brought some much-needed fresh thinking to safety by recognising that people are not automatons but are usually able to adapt to unexpected situations and deliver safe production. Sometimes adaption can lead to accidents. Asking people to be careful is not an effective strategy. People make mistakes not by choice, but because it is part of being human. We should not waste our energy asking people to be more careful. Instead, we should design systems that reduce the probability of people making mistakes and, if they do make mistakes, systems that fail safely. Our systems should be resilient, not brittle.

The focus of this approach is about learning and continuously adapting and improving. After the Texas City explosion, BP had a partnership with MIT. We used to send senior operation managers to Boston to learn about safety and operations. The cornerstone of the programme was continuous improvement. I have worked with three global companies and must have visited more than a hundred sites worldwide. The sites with a solid continuous improvement capability always performed better because they kept improving. I am a strong advocate of human performance and continuous improvement, as I have seen the positive impact of these approaches on safety and productivity.

The Human Performance INPO/DOE Handbook (2009) is the reference in this field. This handbook addresses the roles of individuals, leaders and the organisation in improving performance by reducing the probability of human error. Originally, human performance was largely focused on people's errors and violations that adversely affect safety. More recently, there has been a shift in focus toward people's positive contribution to safety, resilience and efficiency. People's ability to adapt is often the reason why systems are successful despite variations and interruptions. People are both the source of some risks and an integral part of identifying and managing all risks. This system approach puts a new perspective on human error: it is not a cause of failure alone but rather the symptom of deeper problems in the system. Most of the time, human error is not random; it is systematically connected to features of people's tools, the tasks they perform and the operating environment in which they work. The foundation of human performance is a set of five principles that represent some basic truth of how humans will perform or will not perform.

The five original human performance principles:
1. People are fallible, and even the best make mistakes.
2. Error-likely situations are predictable, manageable and preventable.
3. Individual behaviour is influenced by organisational processes and values.
4. People achieve high levels of performance based largely on the encouragement and reinforcement received from leaders, peers and subordinates.
5. Events can be avoided by understanding the reasons mistakes occur and applying the lessons learned from past events.

These original principles are still valid but were based on a definition of safety as the absence of accident and injury. They were therefore directed at the workers and focused on preventing adverse outcomes. Todd Conklin (2019) updated the original principles to make them consistent with the new safety philosophy, or ‘safety differently’, while respecting the intent of the original principles.

The five updated human performance principles:
1. Error is normal. Even the best people make mistakes
2. Blames fixes nothing
3. Learning and improving are vital; learning is deliberate
4. Context influences behaviour; systems drive outcomes
5. How you respond to failure matters; how leaders act and respond counts

6. Human performance gap and why human performance is only half the answer

The five principles of human performance are the reference in this field. All these principles are focused on the human, but it is only part of the picture. Todd Conklin, in his session on *Fatality and Catastrophic Loss in Complex Organizational Systems*, targeting the high-risk industries such as drilling contractors, added a sixth one: ‘controls save lives’.

There was a crucial gap in human performance in respect to high-hazard operations. As a process engineer who managed high-hazard operations, I want the operators to be engaged and to adapt. The operators' role is key to safe and efficient operations. At the same time, as a process engineer, my focus is on hazards: their identification, elimination and control. My focus is on making sure that the risk controls are resilient and have the capacity to absorb human errors. Risk controls should not be brittle and should fail safely. There has been extensive research in risk control in process engineering, and we know how to design and maintain resilient risk controls. This knowledge should be leveraged. Many human performance experts are organisational psychologists, so they tend to focus on the operator and the human side. At the same time, 'controls save lives', so human performance should be integrated with risk control or safety engineering to increase its impact.

Conklin (2017) advocates a shift from failure-to-prevent to failure-to-control serious incidents and fatalities. The latter approach focuses on ensuring that effective controls are in place. Conklin recommends asking workers to check for the presence of controls and assessing their effectiveness before starting a task. I have successfully implemented this approach at GSK, and it is an effective way to educate and engage employees while continuously reducing risk.

DOE (2009) developed and began implementing integrated safety management (ISM) in 1996. External organisations also performing high-hazard work, such as commercial nuclear organisations, have gained significant experience in safety management. The ISM core function of 'feedback and improvement' calls for organisations to learn and make changes to improve. The five ISM core functions provide the necessary safety management structure to support high-risk activities. These functions are applied in a continuous cycle with the degree of rigour appropriate to the type of work activity and the hazards involved:

1. Define the scope of work: missions are translated into work
2. Analyse the hazards: hazards associated with the work are identified, analysed and categorised
3. Develop and implement hazard controls
4. Perform work within controls
5. Provide feedback and continuous improvement

The DOE integrated the ISM core functions with human performance principles and methods. Human error can have an adverse effect at each stage of the ISM work cycle, for example:

1. Define work scope: Errors in defining work can lead to mistakes in analysing hazards
2. Analyse hazards: Without the correct hazards identified, errors will be made in identifying adequate controls
3. Develop controls: Without an effective set of controls, minor work errors can lead to significant events
4. Perform work: If the response to the event only focuses on the minor work error, the other contributing errors will not be addressed

Work planning and control processes present key opportunities for enhancement through the application of human performance principles and tools. There is an almost natural integration of the human performance objectives—reducing error and strengthening controls—into the implementation of the ISM core functions. The tools and methods used to reduce human error and strengthen controls support the ISM core functions.

7. Sustainability integration and why sustainability should be built-in as opposed to bolted-on

Until I joined ERM, my focus was more on quality rather than sustainability, in line with pharma's priorities. Most organisations aim to deliver safe, sustainable production but the approach to deliver these integrated goals is still valid. I did my doctoral research on organisational effectiveness in high-hazard environments based on BP case studies (2013), and some of the findings will not come as a surprise:

In 'traditional' organisations, hierarchic and siloed, decisions flow from the top down the frontline. These organisations tend to be very stable, but in a dynamic complex environment they struggle to innovate and deliver high performance. By contrast, in 'agile' organisations that are people-centred and without siloes, decisions are taken at the lowest level and as close as possible to the frontline. These organisations tend to adapt quickly, so in a dynamic complex environment they can innovate and deliver high performance.

Treating sustainability as bolted-on is not going to produce high-performing organisations, but breaking traditional functional boundaries by integrating human performance, risk control and sustainability can deliver high overall business performance. During my time at GSK, I have seen some sites getting close to a safe, quality production vision through integration across disciplines and levels. These teams were highly motivated, thought creatively and delivered excellent performance across the board. When I met and talked to the people, I could feel the excitement; there was something truly special at these sites. Breaking down the barriers between hierarchical levels and the silos between departments are points frequently made in the organisational and sociological literatures and also in the sociological post-mortems of major accidents from Turner (1978) to Vaughan (2016).

Hollnagel, in his book *Synesis: The Unification of Productivity, Quality, Safety and Reliability* (2021), argues that safety is an important issue for many organisations, but not the only one. Quality and productivity are crucial to ensuring the long-term success of the company and investment in new products or services. If nothing is produced, there will be no resources for safety. It is commonly accepted that these issues cannot be considered in isolation. Organisations that nevertheless do so are categorised as pathological or calculative. Organisations that try to take multiple issues into account tend to do so one by one rather than considering them together, as is reflected in the functional structure of many organisations. Each function has its own role, people, resources and competence, and each has a specific focus and performance criteria. Each function has a different focus and works independently of the others: in silos, rather than together. This approach makes it difficult for employees or even departments to share information or knowledge with each other. In the long run it is also impossible to effectively manage an organisation without considering how the various issues relate to each other in either a synergistic or

antagonistic way. Nevertheless, it is typically how organisations are managed. The remedy is simple: consider the issues together, rather than one by one. The question is how this can be done in a practical way. This fragmented approach comes from the well-established tradition of understanding phenomena through decomposition, that is, by taking a complex item and breaking it into its elements in order to divide problems into smaller problems until they are of a magnitude that is thought to be solvable. This approach tends to be used to solve every problem, including the problems of managing an organisation and its performance.

Hollnagel advocates using the functional resonance analysis method (FRAM) as the tool to overcome this traditional fragmented approach and to understand how the different issues are linked, and how they directly and indirectly depend on each other. Levenson (2020) argues FRAM is not suitable for complex, real-time, safety-critical systems or products. There is extensive debate on the suitability of both the FRAM method advocated by Hollnagel and the system-theoretic accident model & processes (STAMP) method advocated by Leveson (2004). Both models have their limitations and can be difficult to implement, so I recommend looking outside the silo of safety science and into the extensive literature of management science on organisational effectiveness, as some of the main objectives of this discipline are breaking the functional silo and creating effective cross-functional organisations.

8. Training is the easy solution but not the effective solution

In the previous sections, I summarised five of the most important things I have learned. However, rushing to develop training courses to cover each of these points as may lead to disappointment with the impact of this training on frontline operations. Transformation is not just about running training courses; the main barriers to organisational improvements have to be considered first. During my career, I have seen site directors who are genuinely committed to safety struggle to create a strong safety culture. I have also seen the personal struggle workers go through while trying to do the best and safest job they can. When the site director did not understand the challenges that frontline employees faced, the organisation was at an impasse. While at BP, my team was able to assist some site directors in understanding the reality of the frontline and then in getting the management team and the frontline employees to effectively work together. As a result, the organisation was able to move forward. It was not an easy exercise and had to be skilfully facilitated to create a mutual understanding and to build trust. However, this practice can dramatically accelerate the organisation's progress.

Hollnagel described this gap of understanding between management and workers in his book *Safety II* (2014). At the ‘sharp end’, we find the people who actually must interact with potentially hazardous processes to do their work. Everyone at the sharp end knows that it is only possible to work by continually adjusting to the situation. In the literature, this is commonly described as 'work-as-done'. From the ‘blunt end’, or the management perspective, there is a tendency to focus on how the work should be done, called 'work-as-imagined'.

At BP, I worked with a 'boutique' management consultancy co-founded by a Harvard Business School Emeritus Professor who is the author, along with two consultants who worked with me at BP, of a 2016 *Harvard Business Review* paper on the need for organisations to go beyond training. The authors talk about ‘the great training robbery’, as $356 billion was spent globally in training in 2015, producing a poor return on investment and little improvement in organisation performance. As a change strategy, training has clearly not succeeded as the work environment or context sets the stage for success or failure. Organisational issues must be addressed first before rolling out training. The idea that organisational factors have a strong impact on individuals' mindsets and behaviour is supported by a number of studies. Edmondson and Williams Woolley (2003) showed that organisations need ‘fertile soil’ in place before the ‘seeds’ of training interventions can grow. Improvements were greater in units that had already developed a ‘psychologically safe’ climate in which employees felt free to voice their concerns. If the system does not change, whatever the training, people will be set up to fail. This study of ‘psychological safety’ has become a popular theme in safety, and ‘people doing what make sense to them at the time based on their context’ is a fundamental aspect of Safety-II. This example also illustrates the synergies between safety science and management science and the link between safety and productivity. The *Harvard Business Review* authors add that HR managers (but their comments are also applicable to EHS managers) can find it difficult to tell senior management the uncomfortable truth: that a failure to execute strategy and change organisational behaviour is rooted not in individuals' deficiencies but, rather, in the behaviours and decisions made by senior management. Those issues or barriers, often unspoken, are called by the authors the ‘silent killers’ that block the systemic changes needed to make training programs effective.

9. Conclusion

Organisations can progress from zero accidents to safe, sustainable production by creating a high-trust, high-performance environment. This is a courageous undertaking requiring leaders who are ready to face the challenges of frontline operations and able to demonstrate care and build trust. These leaders must be ready to support their employees and help them build the leadership and technical skills required to address the challenges so that their employees are equipped to safely and effectively perform their day-to-day tasks. Employees are increasingly keen to play their part in sustainability and need support to take practical steps to reduce the environmental impact of the operations that they are managing. This approach is aimed at improving the overall performance of the organisation and must bring together the best of safety science, organisational development and personal development. Processes are important, but do not inspire or deliver high performance. Knowledge

is not power; action is power, and action is driven by emotion. Safe, sustainable production can only be delivered by creating safe, sustainable passion in our organisations.

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