The Intangible-tangible Dilemma

Abstract: Safety is much talked about but mostly in general. Safety is in practice defined by its **absence** rather than by its **presence**. Safety is also assumed to be the outcome of an intangible safety culture. This raises two serious problems. First, whether it actually is possible to manage the absence of something? And second, how can an intangible safety culture determine tangible safety performance? Despite the obvious practical significance of these problems and 40 years of R&D, neither problem has received sufficient attention let alone been solved. The second problem has two popular candidate solutions, but this paper will argue that neither works in theory nor in practice. The only real solution is to define safety by its presence rather than its absence, and to replace the intangible by the tangible. In both cases resilience engineering offers valuable assistance.

Keywords: safety culture tangible intangible safety systemic potentials; safety culture ladder; decremental safety; Safety-I; decremental safety; Safety-II; incremental safety; resilience engineering;

Introduction

So much has by now been written about safety culture, that even an AI endowed search engine cannot count the number of books, but a feeble human guess is several hundred, to say nothing of surely thousands of papers and probably an even larger number of conference presentations. Few of these efforts have, however, addressed the critical issue that safety culture is an intangible that is claimed to account for and regulate tangible human performance in general and "safety performance" in particular. This paper aims to put that right. By doing so it also identifies a devastating weakness of safety culture.

***Safety Culture*.**

Safety culture, became part of the safety legacy when the International Nuclear Safety Advisory Group (INSAG) of the International Atomic Energy Agency (IAEA) in 1986 published a Summary Report, Safety Series No.75 (INSAG-1), from the Post-Accident Review Meeting on the Chernobyl Accident and further expanded this in a report on Basic Safety Principles for Nuclear Power Plants, Safety Series No.75 (INSAG-3), issued in 1988.The commonly used definition of safety culture is, however, from INSAG-4, which defined safety culture as:

> "that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority (nuclear plant) safety issues receive the attention warranted by their Significance" (INSAG-4, 1986, p.5). *This is known in philosophy as an analytic proposition, that is true solely by virtue of its meaning, even in the absence of empirical evidence. It is a relation of ideas rather than matters of fact.*

A second problem with the INSAG definition is that safety culture is defined with reference to safety issues and therefore is recursive. But safety as such is neither discussed nor defined in the INSAG-4 report. That is hardly surprising because the term safety is used so frequently that few find it necessary to define it. It is truly a social construct (Searle, 1995 and (Rochlin, 1999)). The definition was also produced by members of INSAG, the International Nuclear *Safety* Advisory Group, and members of the INSAG being the *de facto* safety experts, would presumably never ask each other for a definition of safety.

A third problem is that safety culture is a **contrafactual conditional**. A contrafactual conditional, is a factor or a condition, whose presence presumably might have prevented an unexpected and unacceptable outcome (such as an accident) that already has occurred. Commonly used examples other than safety culture are just culture, communication, leadership and situation awareness (the mother of all contrafactual conditionals). Counterfactual conditionals are the favourite of self-anointed experts who in the aftermath of major calamities find it difficult or impossible not to impose their wisdom and insights on others.

Worse than these misgivings is that only relatively few readers seem to have noticed an important comment tucked away on page 1 of the INSAG-4 report.

"The definition relates Safety Culture to personal attitudes and habits of thought and to the style (*sic*!) of organizations. ***A second proposition then follows***, *namely that such matters are generally intangible; that nevertheless such qualities lead to tangible manifestations*; ***and that a principal requirement is the development of means to use the tangible manifestations to test what is underlying***." (INSAG-4, 1986, p. 1, emphasis added).

(The word tangible comes from Latin, where *tangere* means to touch as we know it from the word tangent. Intangible therefore designates something that cannot be touched, and which has no physical presence, such as a social construct, (Rochlin, 1999) and (Searle, 1995). The tangible-intangible dilemma is not isolated to safety culture. Rochlin defined safety as a dynamic intersubjectively constructed ***belief*** in the possibility of continued operational safety, rather than avoidance of risk or management of error. While (Searle, 1995) defined it as an idea that has been created and accepted by people in a community. The quality of being intangible is similar to the proposition by Scottish philosopher David Hume that while causes and effects are physical, and observable, causality itself is metaphysical, and therefore not observable (Hume, 2000; org. 1739)).

The Second Proposition

The second INSAG proposition mentioned above creates a fundamental dilemma for the use of safety culture, because introducing safety culture as an hypothetical intervening variable that determines the quality of human performance as far as safety is concerned, willy-nilly requires acceptance of the unproven hypothesis that something intangible (safety culture) can be used to affect or regulate something tangible (safety performance) with the aim usually is to decrease the **absence** of safety, by controlling human performance in safety critical work, as Behavior-Based Safety (BBS) also tries in a completely different way, (Geller, 2005)). There is obviously a practical need to be able to control the tangible, although this is usually done in the negative or decremental sense aiming either to **avoid** unexpected and unacceptable outcomes due to so-called unsafe behaviours (errors deviations, violations and general non-compliance, all defined and determined in *hindsight* after an unexpected and unacceptable outcome has occurred). But a more important practical need is to be able to control the tangible in a positive or incremental sense in order to increase the **presence** of safety, and ensure that expected and acceptable outcomes happen reliably so that work goes well since companies and businesses need that to sustain their existence. This second INSAG-4 proposition is relevant for all kinds of collective activity, the production of goods as well as the provision of services. These needs underline the importance of how or whether we can use an intangible safety culture to determine tangible performance in a controlled manner.

The Paradoxes Of Reason

The paradoxes of Reason do not refer to some fundamental problem of human reasoning, in the same way as the paradoxes of Russell and Zeno. In this case Reason is the surname of Professor James Reason, who described four safety paradoxes in an eponymous paper (Reason, 2000, p. 1). The four paradoxes are:

1. That safety is defined and measured more by its absence than its presence.
2. That defences, barriers and safeguards not only protect a system, they can also cause its catastrophic breakdown. (This is nearly a paraphrase of "the ironies of automation" by (Bainbridge,1983), discussed anew by (Hollnagel & Dekker, 2025).
3. Many organisations seek to limit the variability of human action, primarily to minimise error, but it is this same variability – in the form of timely adjustments to unexpected events – that maintains safety in a dynamic and changing world. (This third paradox predates the main ideas of both resilience engineering (Hollnagel, Woods & Leveson, 2006) and safety differently (Dekker, 2015)
4. That an unquestioned belief in the attainability of absolute safety (such as the Zero Accident Vision (ZAV) (Zwetsloot et al., 2013; Björnberg, et al., 2019), can seriously impede the achievement of realisable safety goals, while a preoccupation with failure can lead to high reliability. This is a quiet warning against the Zero Accident Vision, advocating the need to understand what happens when work occasionally does not go well.

The first paradox has had a large effect on safety practices. But it hides a fifth paradox which Professor Reason apparently missed. The fifth paradox is that, since we do not know what the **presence** of safety is, except as a reduced number of unexpected and unacceptable outcomes, it is impossible directly to **increase the presence of safety**. The only available option is to **reduce the absence of safety,** and this is what most safety management methods try to do as best they can.

The Intangible-tangible Dilemma

The second proposition from the INSAG-4 report defines what must rightly be called **an intangible-tangible dilemma**. As long as that dilemma exists safety culture will remain an appealing, but useless social construct. Yet to resolve the dilemma requires clearly articulated theories about safety as well as safety culture, but despite 40 years of intensive research and countless books and papers, we are no wiser now than when the INSAG-4 report was published in 1986. Neither has the intractable-tractable dilemma received even a small fraction of the attention and efforts that have been lavished on safety culture itself, and few seem to realise that safety culture cannot be a practical tool until the intractable-tractable dilemma has been resolved. Since this has not yet happened the only reasonable response would be to stop the use of safety culture as a *panacea,* altogether. But this leaves us at the mercy of the *psychological anxiety* humans experience when confronted with something new and unfamiliar. Apart from reducing, but not quite quelling this psychological *anxiety s*afety culture has never served any practical purpose it has neither reduced the number of unexpected and unacceptable outcomes which is the legacy definition of safety also called Safety-I (Hollnagel, 2014) now renamed decremental safety nor increased the number of expected and acceptable outcomes which as Safety-II was the logically alternative to safety-I, now called incremental safety (Hollnagel, 2026) and (Hollnagel & Slater, 2025).

The Need Of Safety Culture

In view of the widespread interest in safety culture it is reasonable to ask why safety culture was introduced in the first place. It is characteristic of scientific progress that the conceptual repertoire from time to time must be enriched with new concepts in order to explain hitherto unsolved problems.

Metal Fatique

The best example of that in relation to safety is the use of metal fatigue as a technical cause of accidents. The de Havilland DH106 Comet was a four-engine narrow body aircraft developed and manufactured by de Havilland in the United Kingdom. During its first year of operation (1949) three Comet aircraft were lost in highly publicised accidents after suffering catastrophic mid-flight mishaps. The cause was determined to be the weakening of metal parts due to repeated cyclical movement such as bending or twisting. Since then the technology has improved to the extent that metal fatigue has disappeared from sight. Metal fatigue was not a novelty in 1949, it had been known since 1839, in the French mining industry, but obviously not by British engineers.

The Higgs Boson

Another example, completely unrelated to safety, is provided by physics where strong theories such as the Standard Model of particle physics predict and require specific elementary particles, most famously the Higgs boson proposed by Peter Higgs, Francois Englert, and others in 1964, and confirmed to exist by experiments using the Large Hadron Collider (LHC) in 2012. Higgs and Englert shared the Nobel prize in physics in 2013. A similar inference in cosmology is dark matter, a mysterious form of matter that supposedly makes up altogether 85% of the known universe although it has not yet been found, perhaps because it by definition conveniently is invisible.

Psychological Anxiety

In the case of safety culture there are first of all no compelling physical manifestations, such as crashed airliners that require safety culture as a cause, nor are there any strong theories about human or organisational behaviour that predicts the existence of safety culture, although it would be nice if there were. There are actually no articulated theories about safety culture or human behaviour at all, let alone theories about safety itself (Hollnagel, 2013). Safety like dark matter is practically invisible, perhaps because it as noted by (Reason, 2000, p.1) is ”defined and measured more by its absence than by its presence”. Safety culture is not a physical phenomenon, but a social construct. It represents a set of ideas shared by a number of people, based on a collaborative consensus rather than observations of a physical reality. The need for a safety culture is neither physical, nor theoretical. It is psychological. The psychological need of safety culture is captured by the following quote from the great German philosopher, Friedrich Wilhelm Nietzsche (1844-1900), who with impressive insight wrote:

> "To trace something unfamiliar back to something familiar is at once a relief, a comfort and a Satisfaction, while it also produces a feeling of power. The unfamiliar involves danger, anxiety and care -the fundamental instinct is to get rid of these painful circumstances. **First principle - any explanation is better than none at all.**" (Nietzsche (1997, org. 1887, Chapter 5, emphasis added).
>
> A much earlier recognition of the same phenomenon, but without Nietzsche's strong and clear conclusion is found in the writings of the muslim scholar (Ibn Ḥazm al-Andalusi (994-1064) who explained all man's activities and emotions as stemming from anxiety and the attempts to dispel it. (Laylah, 1998., p. 114). Offering safety culture may rightly be seen as an attempt to dispel anxiety. Nietzsche and Ibn Hazm basically came to the same conclusion, even though they were separated by a Millenium, and also expressed themselves differently.

This profound recognition, that I, Ibn Hazm's original work notwithstanding will call the *Nietzschean anxiety*, is a strong involuntary and uncontrollable human reaction to unexplainable occurrences, such as the organisational accidents that began in the 1970s, Perrow's seminal book from 1984 on normal accidents was an early recognition of these, calling them "normal accidents" was an appealing label but not quite an explanation. The frequency and seriousness of such organisational accidents grew during this period (the names are well-known, and practically a safety litany [Flixborough (1974), Three Mile Island (1979), Bhopal (1984), Challenger and Chernobyl, both in 1986, the Herald of Free Enterprise in 1987) and the King's Cross Underground fire also in 1987.] In no case was there a proximate active failure that by itself could explain the accident, instead investigations uncovered long-standing (latent) systemic pathogens that inexplicably combined to become part of an accident. These organisational accidents marked a change in preferred explanations from proximal monocausal to distal multicausal, at the transition from the second age of human factors to the third age of safety management, cf. Figure 1 and Table 1.

Figure 1: Characteristics of the three ages of safety (from Hale & Hovden, 1998).

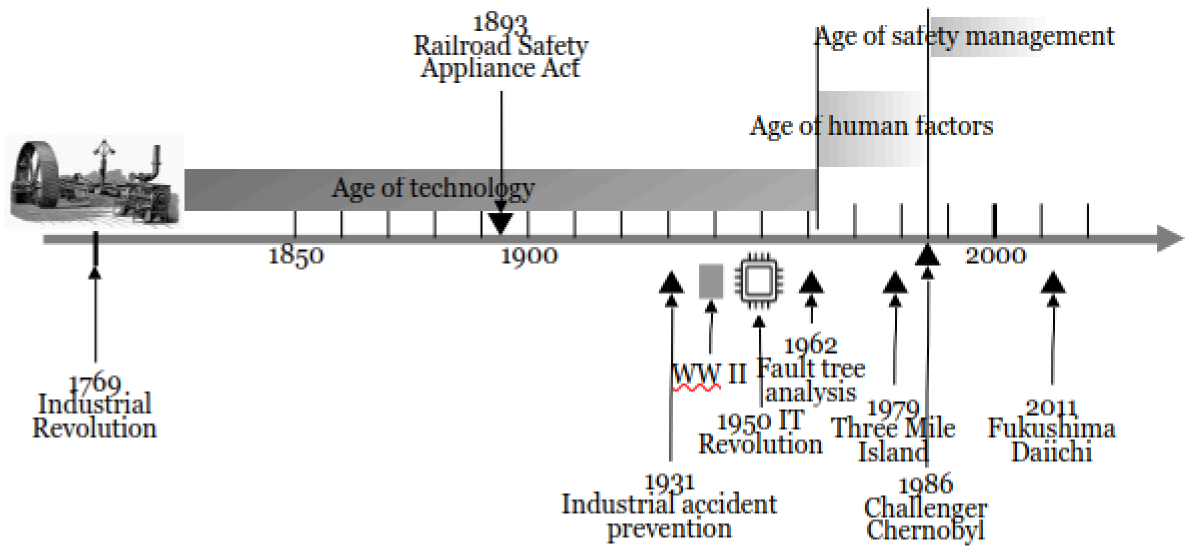


Table 1: Characteristics of the three ages of safety (from Hale & Hovden, 1998).			
Age of safety thinking	Typical (default) cause	Typical (default) response	Assumed mode of causality
Technology	Failure of technology	Replace, repair and improve	Linear, Proximal Monocausal
Human factors	Human factor “human error”	Blame, train, design, automate	Linear, Proximal Monocausal
safety management	Organisational failure	Audits, standardisation regulation, compliance	Linear, Distal multicausal

Humans have presumably tried to make sense of the world they live in and of what happens around them from the beginning of language and thought, and definitely when the first societies appeared. Trying to make sense of what happens or what is observed, is the basic reaction to the *Nietzschean anxiety*. Even today the ways we reason about what happens around us rely on principles established thousands of years ago.

Atomistic Thinking

Atomistic thinking refers to the Greek philosophy of atomism and to the intellectual tradition of decomposition, which in combination with linear cause effect thinking has had a devastating influence on accident investigation practices, and essentially shaped the current safety legacy.

Physical Atomism: The atomic theory of Leucippus (480 – c. 420 BCE) and Democritus c. 460 – c. 370 BCE) is an important intellectual foundation of our societies and civilisation. It makes obvious sense in the physical world that everything is divisible until you reach the smallest part or item humans presumably early on realised that physical objects, such as a piece of rock could be broken down into steadily smaller parts, even with primitive tools and methods. And it became self-evident the moment people started to build artefacts, such as ploughs, wheeled carriages, clockworks and houses. People have always been intuitive natural scientists.

Metaphysical Atomism

Atomism was applied not only to the material physical world where it made obvious sense, but it was inevitably carried over to the metaphysical or incorporeal world, where it gave rise tothe notion of **causality:** the assumption that everything has a cause, and that we therefore can continue to reason backward until we find the first cause in a series of causes and consequences (Even Aristotle had a theory of causation, which distinguished between four causes: material, formal, efficient, and final, but had no special category for the first cause). The idea that it is possible to reason backwards until the first cause is reached, is most famous in *the cosmological argument* by Saint Thomas of Aquinas (1225-1274) who used it to prove the existence of God (faith was apparently insufficient for Saint Thomas). The parallel in accident investigations is the traditional domino model (Heinrich, 1931), and the belief that there is a first or root cause, corresponding to the first domino piece that falls Heinrich called the first piece for ancestry and social environment (perhaps a rudimentary version of safety culture?) Although Heinrich did not use the term root cause directly, he strongly implied it by proposing ten axioms of industrial safety, of which the first states that:

“The occurrence of an injury invariably results from a completed sequence of factors - the last one of these being the accident itself. The accident in turn is **invariably caused** or permitted directly by the unsafe act of a person and/or a mechanical or physical hazard.” (Heinrich, 1959, p. 13 emphasis added).

In our time root cause thinking has moved from theology to physics and is now applied to the indivisible atom itself which according to current knowledge (known as the Standard Model) is made up of submicroscopic particles that interact and combine to produce ourselves as well as everything around us. But it is still assumed that there are some truly indivisible particles, without any measurable internal structure, according to the Standard Model there are twelve fermions plus four bosons, (the photon, the gluon, the neutral weak boson, and the long elusive Higgs boson). The opposite of root cause reasoning is teleology, where phenomena are explained in terms of the purpose they serve rather than of the cause by which they arise (Rosenblueth, Wiener & Bigelow (1943). Metaphysical atomism is also enshrined in the Cartesian principle of reductionism formulated by French philosopher Rene Descartes (1596-1650).

Error Atoms

The persistence of atomism over millenia is illustrated by the surprising suggestion of error atoms and error molecules by Alan Hobbs, who wrote:

> ”In most well-defended systems more than one unsafe act must occur before a hazardous situation will result. A useful metaphor is to consider individual errors as *atoms* that pose the greatest dangers when they combine to form *error molecules*. Yet relatively little attention has been given to how errors combine to create hazards or reduce system reliability” (Hobbs, 2003, p. 2)

Hobbs here expressed that a single action or a single tangible cause, calledan error atom, often is insufficient to be socially acceptable as **the** cause an accident (error atoms represent the proximal monocausal accident reasoning that prevailed in the first and second ages of safety, Table 1). This way of reasoning is obsolete today and was obsolete even in 2003. Hobbs also argued that several such individual actions and conditions that occurred together might be seen as an error molecule and as such be socially acceptable to explain how a more complex accident could happen (this represents the distal multicausal accident reasoning that became prevalent during the third age of safety), and which is very much in line with the epidemiological accident thinking represented by Reason’s well-known Swiss cheese model (Reason, Hollnagel & Paries, 2006). Hobbs, however, failed to explain how error atoms could coalesce to become molecules, whether these hypothetical molecules were stable or unstable, and whether they could combine to become stable error crystals, or perhaps even error diamonds.

Causality.

The other critical principle is the assumption of causality. This also has ancient roots, and can be traced back to the causality assumption of the pre-Socratic philosopher Leucippus: ”nothing happens in vain (which means that nothing happens by itself without a cause), but everything happens from (= for) a reason and of necessity”.The principle of **inferred causation**, meaning the belief that every effect has an identifiable cause made it reasonable for Babylonian king Hammurabi to incorporate a provision in his code of laws in the second millennium BCE ordering the punishment of the mason if the house he built fell down and killed the owner (Hale & Hovden, 1998, p. 129). This kind of simple-minded reasoning is an essential part of the safety legacy we rely on today 4,000 years later. The absurdity of the principle that we can reason backward step by step is convincingly illustrated by the cosmological argument, by Saint Thomas of Aquinas (c. 1225-1274), who used it to prove the existence of God. He began by the fact that we exist (St Thomas in the 13th century and we in the 21st), and that something therefore must have caused our existence, by repeating this reasoning, he inevitably arrived at the first efficient cause which for Saint Thomas was God. And since God, by definition is eternal, the backward reasoning must stop there. When Aristotle made the same exercise, well before Christianity the result was called the Unmoved Mover. (Interestingly according to Aristotelian thought, an accident is a property of a thing which is not essential to its nature). It is highly questionable whether it makes sense to repeat the exercise of St. Thomas today, and indeed whether anyone would accept that it proves the existence of God. Blaise Pascal (1623-1662) used a completely different approach in his wager (Table 1) to decide whether or not to believe in God (Hacking, 2007). Since we cannot calculate or even estimate the probability of the alternatives, they have both been assigned the default value of p=0.5. Pascal’s conclusion was that any person who prefers infinite reward over infinite punishment should choose to believe in God, although that does not prove that God exists, only that it is more reasonable to believe that God exists, than the opposite.

Table 1: Pascal's wager			
Alternatives	God exists (p=0.5)	God does not exist (p=0.5)	Expected value
Believe in God	Infinite reward	Finite outcome	Infinitely good
Do not believe in God	Infinite punishment	Finite outcome	Infinitely bad

In current secular thinking the beginning is the Big Bang, but this only explains the existence of the physical universe, not our existence as members of *homo sapiens*, one possible explanation of life as we know it is the *panspermia theory*, which places the origin of life somewhere else, and therefore does not explain anything at all. The same kind of backward causal reasoning is also present in Charles Darwin's theory of evolution, which includes the concept of a Last Common Universal Ancestor, or (LUCA). According to fossils found in Pilbara, Eastern Australia The LUCA was probably a bacterium that existed 3.5 billion years ago, and not a hominid. Cosmology has also proposed a hypothetical particle called the *inflaton*, which appeared – seemingly out of nowhere? – when the Big Bang developed out of the initial singularity an estimated 13.787±0.02 billion years ago. Since this hypothetical inflaton later conveniently disappeared and since the singularity does not exist any longer, there is no need to worry that this will ever happen again. In relation to safety the simple-minded backward reasoning became institutionalised as Root Cause Analysis (RCA), which has many devoted adherents. RCA is a popular, but fatally oversimplified principle that guides reasoning backward from an outcome to determine the cause. But if step by step reasoning is a valid way to find the cause of an outcome, it ought also work in the forward direction. Yet everyone from bitter experience knows that causality does not work in the opposite direction, and that it is impossible to reason step-by-step from the present about how to arrive at a future goal . Life would be much easier if that was the case, for politicians as well as the rest of us, But the world and societies we live in are far too complex and unpredictable for that to be possible. Winston Churchill many years admitted that:

> "A politician needs the ability to foretell what is going to happen tomorrow, next week, next month, and next year. And to have the ability afterwards to explain why it didn't happen." (Halle, 1987, p. 30),

These obvious problems did not prevent the Institute for Healthcare Improvement (IHI) from promoting the idea of a Success Cause Analysis (SCA) (Parkash et al., 2024). This has oddly enough, but predictably(?) never become very popular. The strong belief in rigid determinism was also held by the great French mathematician Pierre-Simon, Marquis de Laplace, who wrote:

> "We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes." (de Laplace (1820, p. iv).

A far less rigid view of causality is presented by (Suppes, 1979)

The Hidden Premises.

The practical use of safety culture at present rests on two hidden premises. The first premise is that safety culture is a necessary and sufficient condition for the "safe performance" that reliably leads to expected and acceptable outcomes. But this raises the question of how "safe performance" is defined. From a decremental safety perspective, safe performance means there are as few unexpected and unacceptable outcomes as possible, achieved by reducing the absence of safety. An accident is an unexpected event with serious unacceptable consequences, while an incident is an unexpected event with less serious unacceptable consequences. From an incremental safety perspective (Hollnagel, 2026), the aim is instead to have as many expected and acceptable outcomes as possible, achieved by increasing the

presence of safety. The concept of an accident thus has no role in an incremental safety culture. The safety legacy offers little if any terminology or methodology for acceptable outcomes that are the opposite of accidents and incidents, except composite terms such as complete and partial successes.

Safety Culture Maturity

The quality of tangible performance is often explained by the maturity of an intangible safety culture, following a suggestion by (Lawrie, Parker & Hudson, 2006), which unfortunately was a misinterpretation of Ron Westrum's proposal of three organizational culture types (pathological, bureaucratic, generative) (Westrum, 1996) seen in Table 2. Westrum, however, intended these to describe *organisational climate* rather than *organisational culture*. The second premise is that the quality of performance is a function of the quality of safety culture. This immediately raises the questions of how the quality of an intangible safety culture can be defined, how it can be assessed in practice, and how it can possibly be improved. Two widely known frameworks have been proposed to do just that: The EHS Safety Culture Ladder and the DuPont-Bradley Postulate, both described in the following.

Table 2: Westrum's (1996) Tree types of organizational climate (Westrum,1996)

Table 2: Westrum's (1996) Tree types of organizational climate.		
Pathological	Bureaucratic	Generative
Information is hidden Messengers are "shot" Responsibilities are shirked Bridging is discouraged Failure is covered up New ideas are crushed	Information may be ignored Messengers are tolerated Responsibility is compartmented Bridging allowed but discouraged Organisation is just and merciful New ideas create problems	Information is actively sought Messengers are trained Responsibilities are shared Bridging is rewarded Failure causes inquiry New ideas are welcomed

The EHS Safety Culture Ladder

(Lawrie, Parker & Hudson, 2006) proposed the EHS Safety Culture Ladder as a framework for the development of organisational safety culture by adding two types to the three that Westrum originally had suggested, but also changed the name of the second climate type from bureaucratic to either reactive or proactive(Lawrie, Parker & Hudson, 2006) do not explain exactly which. leading to the five levels seen in Table 2, leading to the five levels shown in Table 3, and Figure 1. The lowest and the highest levels retain their names (pathological and generative, respectively, but (Lawrie, Parker & Hudson, 2006) do not explain whether the middle level, bureaucratic in Table 2, corresponds to proactive or reactive in Table 3. A consensus somehow developed that the quality of a safety culture could be expressed by the maturity of that culture. To which (Lawrie, Parker & Hudson, 2006) wisely added

> “The framework of safety culture maturity requires further research attention to ensure its appropriateness and sound theoretical basis.”

They, unfortunately, failed to follow their own advice, nor has anyone else tried to later. The intractable Safety culture maturity is therefore still without a sound theoretical basis, it is a *terra incognita*, which is deplorable given the importance of role safety culture in contemporary safety management. The definitions provided in Table 3, characterise each level so it in principle is recognisable, but not so precisely that it can be used reliably to determine how mature an organisation’s safety culture is. In order to manage a change or a safety culture journey toward greater maturity, it is essential to know how the current position can unequivocally be determined at any time. That is regrettably the case for neither the EHS Safety Culture Ladder, nor the DuPont-Bradley Postulate. Since the intention is that safety culture matures, corresponding to moving to a higher step on the ladder it also requires that the means by which this change or movement can take place are defined in operational terms. The EHS Safety Culture Ladder unfortunately fails to do that. A cheese, even a hard Emmentaler with holes, will mature if just left alone. But that is not the case for a safety culture, which actually deteriorates if left unattended.

Table 3: The five levels of safety culture (Lawrie, Parker &Hudson, 2006)		
Level of safety culture	Characteristic	Typical response to incidents/accidents
Generative	Safe behaviour is fully integrated in everything the organisations does.	Thorough reappraisal of safety management policies and practices.
Proactive	We work on the problems that we still find.	Joint incident investigation.
Reactive	Safety is important, we do much every time we have an accident.	Perfunctory investigation.
Pathological	The organisation cares more about not being caught than about safety.	No investigation.

Journey To Maturity

Safety culture is the hypothetical intractable that supposedly determines the required tractable performance that is necessary and sufficient to ensure as many expected and acceptable outcomes as possible (corresponding to an incremental safety view) and, conversely, as few unexpected and unacceptable outcomes as possible (corresponding to a decremental safety view).

The question is whether there is a sensible metric for safety culture, assuming that it is possible to measure or gauge something intractable in the first place, so that a higher value of said metric corresponds to a more mature safety culture, hence improved performance in relation to safety critical issues. Neither the EHS Culture Ladder nor the DuPont-Bradley postulate, offer a practical candidate metric. The EHS Culture Ladder names five steps and the affordance of a ladder is that it can be used to reach a higher position, which culturally is assumed to be better than a lower. This is, however, of little use since the EHS Culture Ladder does not provide a reliable way to determine at which step you are, nor how to move up one step. The Dupont-Bradley postulate includes four named stages [reactive, dependent, independent, and interdependent], but again no way to determine at which stage a system is. The idea that safety, or rather safety thinking, progresses through a number of stages is also present in (Hale & Hovden, 1998) Figure 1 and (Table 2). Although the development described by (Hale & Hovden, 1998) is historical rather than parametric.

Three Types Of Knowledge

It is quite common to use a travel or journey metaphor to describe management and change. We talk about keeping or improving our position, of getting closer to or reach a target, and even of *roadmaps* for change. The metaphor is convenient since it clearly is essential to be able to control how something moves and changes position, whether it is physical or metaphysical and whether the subject is tangible or intangible. The metaphor is also useful because it points to the need for three different types of knowledge.

- It is necessary at all times to know what the current **position** is.
- It is equally necessary to know what the **goal** or **target** is.
- It is finally necessary to know the **means**, i.e., to know what can be done in order to reduce the distance between the current position and the goal.

The journey metaphor is certainly appropriate for tangible matters because it is easy to describe movements in a physical or material sense. It is, however, less appropriate for intangible matters, even though it remains widely used.

First type of knowledge - Position: Where You Are at the moment

Before beginning to make a change it is obviously necessary to establish where you are, your initial position, regardless of whether the change is a movement in physical space or movement in a more abstract space. In conventional or legacy safety management the position often represents a condition or a state that you want to avoid or get away from, for instance, an unacceptable number of unexpected and unacceptable outcomes. The problem is that if you just want to get **away from** a current position, then it matters little in which direction you move. Conversely if you want to **get to** a specific position, there is only one direction that will do. Safety is usually represented by the consequences of its **absence**, such as the number of unexpected and unacceptable outcomes (accidents, Lost Time Injury, delays, etc.), rather than by the consequences of its **presence**, e.g., Reason 2000, p.1). Knowing the position at two different points in time is also necessary in order to determine whether a change has taken place, whether it has the proper magnitude and goes in the intended direction. Knowing the position is also necessary to determine whether you have reached the goal, and how large the remaining distance is.

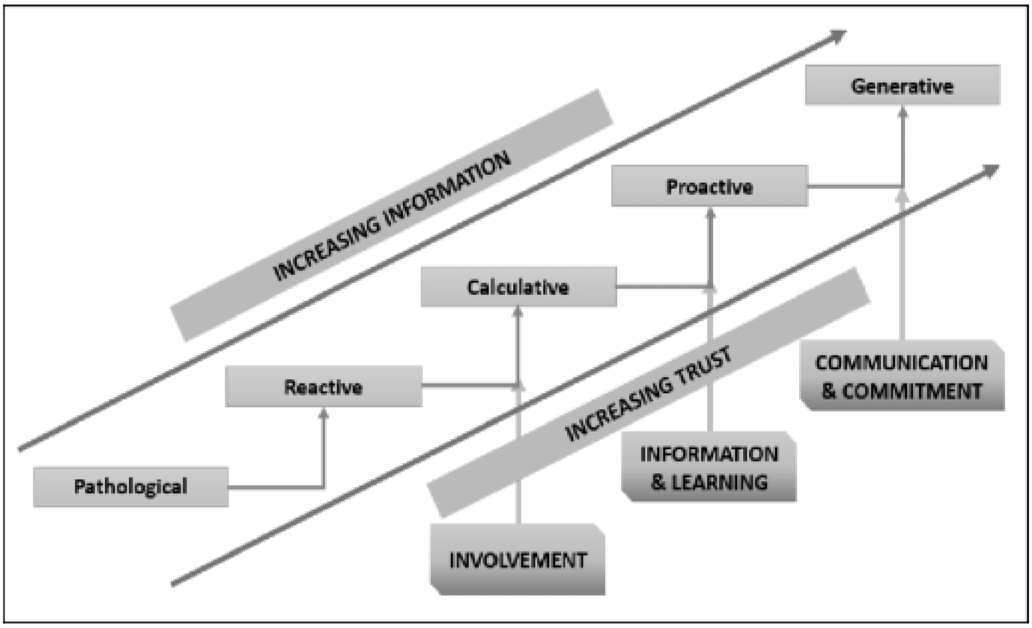
Second type of knowledge -Goal: Where You Would Like To End

In order to know whether the change is going in the right direction – and whether it happens at the proper rate – it is necessary to know what the goal or target is, i.e., to know where you would like to end. Knowing where you want to end is also necessary in order to determine whether and when the change or movement has been completed. The goal should therefore be described in practical or operational terms, preferably absolute and concrete rather than relative. While this is straightforward in the case of tangible systems and material processes (such as the production of goods, or driving a vehicle) it is less easy in the case of intangible systems and more abstract movements such as a higher level of safety or an improved safety culture / learning culture / reporting culture, etc.

Third type of knowledge - The Means

The third type of knowledge is about the effective means – how to make the change, how to move from the current position and towards the goal. In the case of tangible systems – riding a bicycle driving a car sailing a boat, the production and transmission of information, energy, or materials – we usually know how to make the change because the process being managed takes place in or by a physical system that has been designed and provided with the necessary means of measurement and control. But few such means exist in the case of changes that refer to intangible systems, to concepts or to abstractions. What means are at disposal to change safety? To change quality? To improve precision or minimise delays? To change a culture? The list could go on.

Figure 1: The safety culture journey Orlando, Lima & Abreu (2019) (creative commons attribution 4.0 International



The DuPont-Bradley Postulate

The EHS Safety Culture Ladder was not the only attempt to explain how safety culture maturity could work in practice. The other proposal is commonly known as the DuPont-Bradley curve, but since the attractive looking curve is wishful thinking, it will here be referred to as the *DuPont-Bradley Postulate*.

The DuPont-Bradley curve (Figure 2) illustrates an imagined gradual improvement of safety, measured by a smaller number of occupational accidents (hence safety by its **absence**, as (Reason, 2000, p. 1) pointed out, and this is, of course, what management desires.

The smooth curve is, unfortunately, *a manager's wet dream* with neither data or theory to support it. In the 1990s, Ed Woolard the CEO of DuPont chartered a so-called DuPont Discovery Team to develop a system that would bring sustainable and lasting improvements to organisational safety (unsurprisingly defined with zero accidents as the ideal). The best known outcome of that team was the Bradley Curve (proposed in 1994 and named after one of the team members: Vernon Bradley (sometimes wrongly called Berlin Bradley, who was Manager of a DuPont plant in Canada). **The DuPont-Bradley curve is thus a result of a management edict rather than of Research**. (The names of the four stages [reactive, dependent, independent, and interdependent] appear to be borrowed by Mr. Bradley from (Covey, 1989) who himself apparently was inspired by the famous Swiss developmental psychologist Jean Piaget's description of children's cognitive development, (hence completely unrelated to safety.) The curve is only possible if it is supported by a method that independently produces a reliable reduction of occupational accidents. The DuPont Discovery Team unfortunately never offered that. Such a method did not exist in the 1990s and does not exist today either. If wishes were horses, beggars would ride, and occupational accident rates would be under steady control.

Empirical support for the Bradley curve is unthinkable because continuous measurements of occupational accident rates are unaffordable and therefore practically impossible. In the best cases an occupational accident rate may be available weekly, monthly, or quarterly, but most likely just once a year as part of an annual report. A proper rendering of the Bradley curve should therefore be a staggered graph or a histogram rather than a smooth curve. The DuPont-Bradley Postulate does not include a method that will bring sustainable and lasting improvement in organisational safety, but only the imagined outcomes should such a method ever be specified and realised. The DuPont-Bradley curve often appears in promotional materials from companies that either claim they use it or audaciously offer to teach others how to do so, but although there are several scientific papers that refer to it there are none that either analyse or support it. The common renderings of the DuPont-Bradley curve curve include an irregular, and presumably *ordinal* scale called Self Assessment, showing 12 positions but with no explanation of what self assessment means, nor how the positions can be determined. Unlike the DuPont-Bradlery postulate the EHS Safety Culture Ladder proposes that safety culture maturity can be improved by means of the *hearts and minds method*, that originally was developed to help people stop smoking[1] (Prochaska & DiClemente, (1983), although it has never been proven to work. (It really ought to be called the *minds and hearts method*, since we know that it is what the mind thinks that determines what the heart feels, and not the other way around, as Aristotle and the ancient philosophers mistakenly believed).

Making The Safety Journey

Once the underlying model of the five levels, that became the HSE Culture Ladder (Hudson, 2007, p. 703), had been established, the question arose of how changes could be made, how a safety culture could mature by moving up another step on the ladder. The ladder analogy implies both that progress is going up the ladder, while deterioration is moving down the ladder, although few intend to do that intentionally. Progress according to the DuPont-Bradley Postulate is likewise a move to the right through the four stages. This unfortunately clashes with our cultural stereotype that the leftmost position is the best. The HSE Safety Culture ladder unfortunately does not explain how an upward movement can take place nor does the DuPont-Bradley Postulate describe how the rightward movement can take place. In the Domino model Newton's laws at least explain how a domino piece will fall, when hit by a neighbouring piece. Although this strictly speaking does not explain how causality works. Yet nothing comparably concrete exists for the HSE Culture Ladder. An important question is therefore how changes are to be made. Everyone surely wants to make progress and increase safety culture maturity. Progress requires dedicated work, while deterioration seems to take place spontaneously, as a form of cultural entropy, perhaps? It is also important that any change must be made gradually as in an incremental safety culture (Hollnagel, 2026). Large changes are likely to disrupt smooth work practices that have been established and calibrated over a long time. (It is unwise to contemplate large changes to established work routines and patterns neither a huge jump from the bottom (pathological) to the top (generative). and no sensible manager would want the opposite to happen. The question is how smaller controlled changes should best be done. Hudson (2007, p. 704) noted:

> "But it was clear that simply pointing out which direction to go would not be enough to actually induce progress up that ladder, for that some way of creating lasting change was necessary. The next stage in the project therefore required the development of a process model that defined how people could be brought to change and, it was felt, it would be best if this change was what people wanted, not one that they felt had to take place because they are told to".

Hudson elegantly avoided the need to develop a solution by simply adopting the so-called transtheoretical model of (Prochaska and DiClemente, 1983 and Prochaska et al., 1998) Figure 3. (The transtheoretical model of change, is so named because it is not based on a specific articulated theory of how changes can be made but rather is a hodgepodge of different theories from psychotherapy.)

The transtheoretical model was originally developed to tailor interventions to an individual's readiness to change for a wide variety of behaviours and specifically to help smokers stop smoking, this work became the basis of the so-called *hearts and minds behavioural safety toolkit* (van der Graaf & Hudson, 2002). Improving safety culture is, however, fundamentally different from giving up an undesirable personal habit, such as smoking, and postulating that it can be expressed in terms of individual changes contradicts that a culture by definition is a collective and not an individual phenomenon. So even contemplating a transtheoretical model with all that it represents is a self-contradiction. To assume that being unsafe (or rather being perceived as unsafe by others) is an undesirable individual habit, not only denigrates people but also flies in the face of everything we know about how human performance depends on the social and physical context (Schein, 1992). It is ludicrous to assume that so-called unsafe behaviour is the result of an individual choice, and

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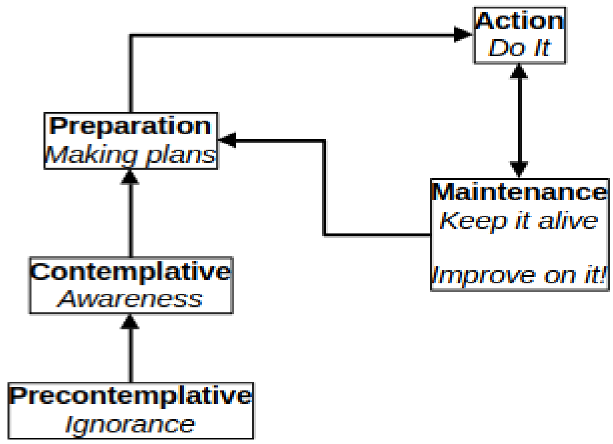
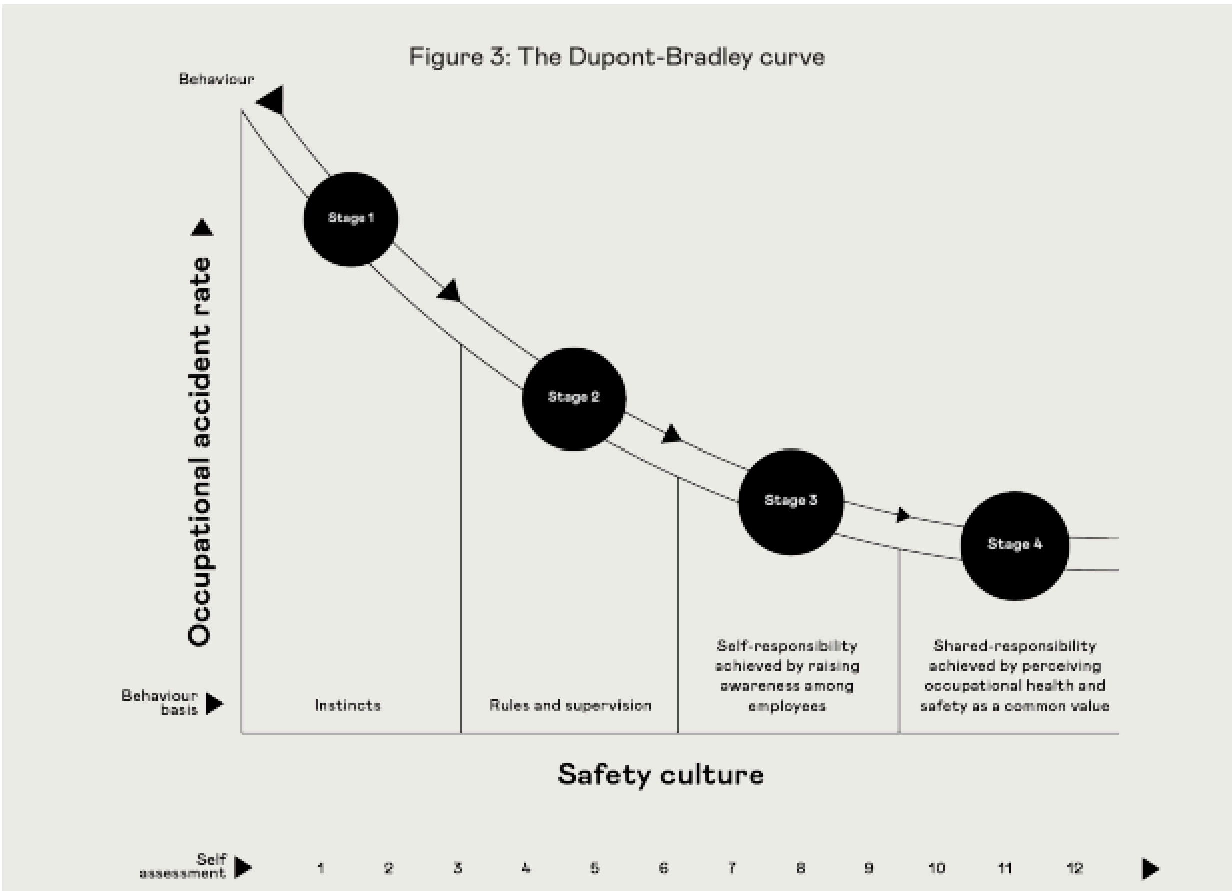
[1]

therefore that it can be changed by revising or improving a person's mindset by.The popular definition of safety culture is "the way **we** do things around here" and not "the way **I** do things around here" Hudson's efforts and ambitions notwithstanding **Safety culture is still in desperate need of an adequate process model,** for which Systemic Potentials Management, described below, so far is the only articulated contender.

Figure 3: The transtheoretical change model *(*Hudson, 2007), p. 4).



Insert Figure 3: The DuPont-Bradley curve from (Hollnagel & Slater, 2025) about here



Resolving The Dilemma

There is fortunately a very simple way to resolve the intangible-tangible dilemma. Namely to replace the intangible with something tangible. Here the obvious candidate is resilience. Safety Whereas safety paradoxically defined and measured more by its absence than its presence (Reason, 2000, p. 1). resilience is defined and can be measured by its presence. Resilience was initially defined as "the intrinsic ability of an organisation (system) to maintain or regain a dynamically stable state, which allows it to continue operations after a major mishap and/or in the presence of a continuous stress" (Hollnagel, 2006). This definition reflected the safety legacy bias of contrasting two states: one of stable functioning and one where the system for some reasons has broken down. Following the safety legacy, the definition was also limited to consider situations of threat, risk or stress. Indeed, for many years resilience in yet another was defined in a juxtaposition as the antidote to brittleness. By the 2008, the definition had become:

"A system's performance is resilient when it can function as required under expected and unexpected conditions alike." (Hollnagel, 2008).

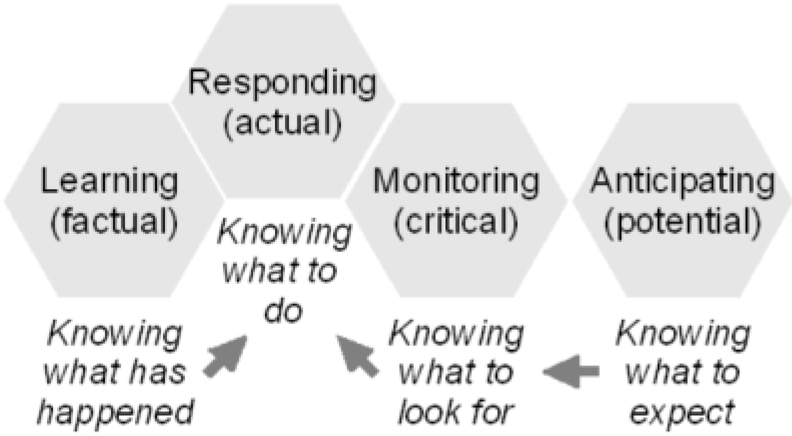
Having a tangible-tangible relation as the basis for efforts to improve safety in the sense of increasing the number of expected and acceptable outcomes, instead of an intangible-tangible relation, renders the dilemma obsolete. The solution is not to make a wholesale substitution of safety by resilience, hence offers resilience, or resilient, culture rather than a safety culture, because simply replacing one term by another would be meaningless. The solution is to be more concrete about what is meant by the tangible safety performance that is the coveted goal. Safety science has so far been unable to do that except by introducing apparent solutions like the EHS Safety Culture Ladder and the DuPont-Bradley postulate

The four systemic potentials

Resilience engineering makes clear that to get as many expected and acceptable outcomes as possible requires the ability to **respond** to what actually happens, to **monitor** what could be critical in the near term – and that is practically a precondition for being able to respond, to **learn** from what factually has happened in order to weed out ineffective responses and strengthen effective responses – always responding in the same way is inadvisable unless conditions of work never change or vary, and finally to **anticipate** so you can prepare yourself for what potentially may happen further ahead. This quadruple was first introduced in (Hollnagel, 2008, p x-xi), and then called *four main abilities* but were later renamed *the four cornerstones of resilience engineering* (Hollnagel, 2009) and, to make the confusion complete, renamed again to become *the four systemic potentials* (Hollnagel, Licu & Leonhardt, 2021) and (Hollnagel, 2025)) The preferred term is now the four systemic potentials. The four abilities, cornerstones, or potentials can be seen in Figure 6. If the meaning of safe performance, that there are as many expected and acceptable outcomes as possible is defined in terms of the four potentials, the need for something intangible like safety culture completely disappears, and the dilemma no longer exists, provided it is possible to manage or regulate the four systemic potentials. The details of how to do that have been described in (Hollnagel, Licu & Leonhardt, 2021) and (Hollnagel, 2025) and are summarised in the rest of this paper.

Incremental safety culture is a real and workable solution, because the four potentials are tangible, they are not social constructs, but operationally well-defined and can also be systematically and reliably assessed. The general problem is that most of the concepts rely in the efforts to improve the safety of how our systems and organisations work, such as safety, trust, risk, and leadership are social constructs According to Gene. And according to (Searle, 1995), In all the other cases there is also a need to do something concrete and tangible in the reality in which systems and organisations exist and operate, which inevitably invokes the dilemma. Safety culture is intangible, and to make matters worse, so are the stages or steps through which a safety culture is supposed to mature. The same goes for the EHS Safety Culture Ladder and for the Bradley curve. But not for the ISC-SPM.

Figure 6: The four potentials needed by an incremental safety culture



The transtheoretical model of change in Figure 3 represents stages of an individual's mind or different mindsets, but not stages of a safety culture. It is therefore not a model of safety culture, since safety culture cannot be reduced either to an individual or a collective mindset. Developing or maturing a safety culture must address the shared basic assumptions and espoused values and this cannot be replaced by individual characteristics, attitudes, and mindsets. Group think is neither the sum, nor the average of how a set of individuals think or of their readiness to behave safely.

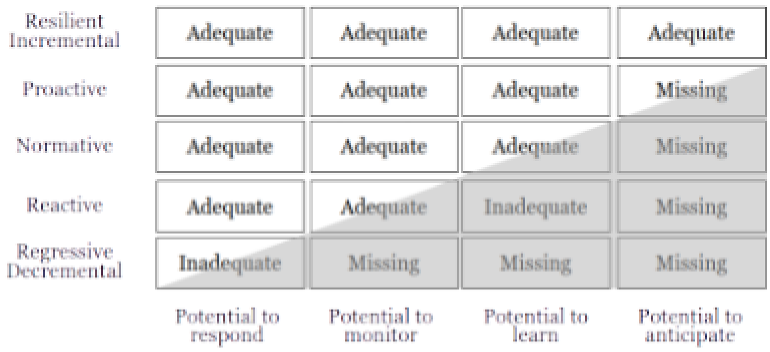
The four systemic potentials provide a straightforward way to characterise different stages of the capability for resilient performance as an alternative to levels of safety culture maturity. It stands to reason that it is better if all four potentials are adequate than if only some of them are. This leads to the characterisation in Table 4. The contents of Table 4 are also rendered graphically in Figure 4. The names of the five stages or levels have obvious allusions to the terminology of the EHS Safety Culture Ladder. The worst and the best stages or levels represent a decremental and incremental safety culture, respectively, as defined in (Hollnagel, 2026).Table 4 clearly illustrates how progress can be made from a Regressive, decremental safety culture to a resilient incremental safety culture simply by improving the four potentials in the twenty step sequence implied by Table 4, and Figure 5. Although the path is just indicated here by the arrow symbols the complete path is easy to figure out, depending on what the organisation's definition of adequate is, and that must obviously differ among organisations, the potentials are addressed and improved one by one in the order implied by Table 4. Knowing how to do that is provided by the means. It is explained in detail in (Hollnagel, 2026).The progression toward an incremental safety culture retains the traditional affordance that a move upward represents an improvement, and unlike the EHS Safety Culture Ladder and the DuPont-Bradley postulate the current level can easily be identified by a systematic assessment of the potentials.

Table 4 Twenty necessary and sufficient steps to an incremental safety culture.

Stage or level	Potential to respond	Potential to monitor	Potential to lean	Potential to anticipate
Resilient, incremental safety	Adequate (17) →	Adequate (18) →	Adequate (19) →	Adequate (20)
Proactive	Adequate (13) →	Adequate (14) →	Adequate (15) →	Missing (16) ↰
Normative	Adequate (9) →	Adequate (10) →	Inadequate (11)	Missing (12) ↰
Reactive	Adequate (5) →	Adequate (6) →	Missing (7) →	Missing (8) ↰
Regressive, decremental safety	Inadequate (1) →	Missing (2) →	Missing (3) →	Missing (4) ↰

(The numbers indicate the order in which the potentials should be addressed and improved)

Figure 5: Incremental Safety Culture progression by the systemic potentials.



In terms of the three types of knowledge required to manage a change, the four systemic potentials provide all three. The position is determined simply by repeatedly and regularly assessing each potential, provided criteria for adequate and inadequate have been carefully defined. As Figure 5 suggests this may be represented by converting the assessment outcomes to values on a Likert-type scale. The goal is defined by describing the “ideal” outcome of an assessment (Figure 5). And the means are simply the ways in which the potentials can be improved based on their assessment, The overall principle of the means is illustrated by Figure 5. Progress does not depend on changing the minds and hearts of people working at the sharp end, but on concrete actions and interventions based on the assessments of the potentials, described below and detailed in (Hollnagel, Licu & Leonhardt, 2021) and (Hollnagel, 2025)

The EHS Safety Culture Ladder and the Bradley postulate fully demonstrated that it is futile to ask wholesale questions about something intangible, such as “how mature is the safety culture”. It is, of course equally futile to ask wholesale questions about any of the four potentials, such as “how good is our potential to respond?” And it is not necessary to do so, because each potential can be described by a number of facets. (Table 4), which then provides the basis for four sets of generic questions leading to a set of tailored questions for each potential. The facets for the potential to respond can be seen in Figure 4 This also shows how the results of assessing the facets can be shown as a radar profile, Figure 4 shows one assessment compared to the ideal or goal values for the potential in question. The radar profile is clearly a very effective way to illustrate changes over time. The facets of all four potentials are described in separate tables, which for reasons of space are not included here, but can be found in the freely available White Paper (Hollnagel, Licu & Leonhardt, 2021) or in (Hollnagel, 2025).

Assessing the four systemic potentials

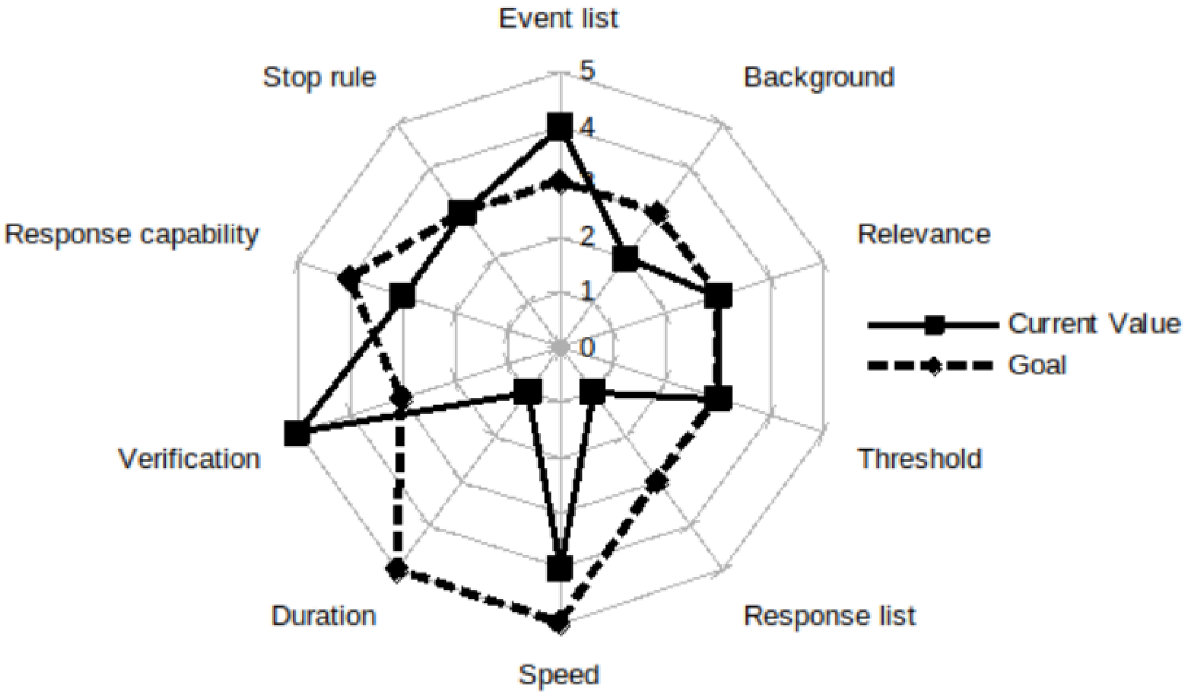
Just as for safety culture the status, value or level of the four potentials cannot be measured directly. It is, however, possible to propose good proxy measures, the facets mentioned above and to assess these systematically. The four potentials can in this way be assessed by means of four sets of questions that are answered by the people who actually carry out the work, and therefore have first hand experience with regard to how well a company is able to respond, monitor, learn and anticipate.

Developing relevant questions

It is inadvisable to have complete ready-made sets of questions (because all organisations are and must be unique). The sets of genetic questions that the method provides (Hollnagel, Licu & Leonhardt, 2021) and (Hollnagel, 2025) are not intended to be used as ready-made questions, but instead to be the reference for developing sets of questions that are tailored to a specific organisation or purpose. It is quite possible to use the four systemic potentials as proxy measures.

A first suggestion might be to assess the level of each potential as such, similar to assessing the level of safety culture, etc. But it is as pointless to ask questions about the level of a potential as it is to ask questions about the “level of resilience” or“level of safety (culture)”. Questions such as “how high is the potential for monitoring” or “how large is your potential for learning”, may well elicit an answer but since an answer cannot be meaningful if the question is not,an answer will in this example most certainly not be one that can be easily used to develop a relevant response. Each potential can, however, be described by means of a number of more specific facets or functions that are common to many types of activity and domains. So instead of assessing each potential as a self-contained element, the potentials can effectively be assessed in terms of the several facets that each represents. The facets in turn provide the basis for specific questions leading to a set of generic questions for each potential. The facets for the potential to respond can be seen in Figure 5 (the names of the radar chart axes), and are also listed in Table 5. For a group of people with knowledge of and experience from what the organisation in question does, it will not be difficult to propose similar sets of generic issues for the other three potentials It may be a good idea to appoint a group of experts to do this,and also to manage the practical application of the systemic potentials, provided this does not become a new incremental safety silo in the organisation.

Insert Figure 6: Radar profile for the potential to respond about here



The generic sets of questions must be developed into a set of tailored questions for each domain and type of basic. Doing that is in itself a valuable exercise to get any safety discussion back on track and each tailored question must meet the following criteria.

- Questions must be **specific** in the sense that they address issues that are important for a concrete organisation.
- Questions must also be **diagnostic** and point to details of a potential that are meaningful to assess.
- And questions must finally be **formative** – in the sense that the answers (directly or indirectly) can be used to make decisions about how best to improve a potential. In this way the answers are helpful to develop the proper means to move forward. Another way of conveying the meaning of formative is *the golden rule* that a question should never be asked unless it is clear **why** the answer is needed and **how** the answer will be used.

Table 5: Detailed facets for the potential to respond	
Name of facet	Specification and explanation
Event list	What are the events for which the system has a prepared response?
Background	How were these events selected (tradition, regulator requirements, design basis, experience, expertise, risk assessment, industry standard, etc.?
Relevance	When was the list created? How often is it revised? On which basis is it revised? Who is responsible for maintaining the list?
Threshold	When is a response activated? What is the triggering criterion or threshold? Is the criterion absolute or does it depend on internal / external factors? Is there a trade-off between safety and productivity?
Response list	How was the specific type of response decided? How was it ascertained that it is adequate? (Empirically, or based on analyses or models?)
Speed	How fast is full response capability available? How fast can an effective response be implemented?
Duration	For how long can a fully effective response be sustained? What is the minimum acceptable response level and how long can it be sustained?
Stop rule	What is the criterion for returning to a “normal” state?
Response capability	How many resources are allocated to the response readiness (people, materials)? How many are exclusive for this response? Who is responsible for maintaining the response capability?
Verification	How is the readiness to respond maintained? How and when is the readiness to respond verified?

Conclusion

Safety culture is indisputably a central concept of the safety legacy and in current safety management efforts. Safety culture is widely considered a solution, although it in reality rather is a problem disguised as a solution (Hollnagel & Slater, 2025). The main problems are that neither safety, nor culture are well-defined. They are both social constructs, but used so frequently by practically everyone that no one bothers to ask for definitions. The usefulness of safety culture is constrained by the intangible-tangible dilemma discussed here. The INSAG-4 report that introduced safety culture to the safety community, did make clear ”that a principal requirement is the development of means to use the tangible manifestations to test what is underlying.” Yet despite 40 years of intensive research, no such means have yet been identified or defined. Without them safety culture cannot become a practically useful tool, but mainly serves to quell the seemingly inexorable *Nietzschean anxiety*. While that may give us peace of mind, it does not actually make our systems any safer. Safety culture, as described by the INSAG-4 report, was always an indirect way of controlling performance whether to reduce the number of unexpected and unacceptable outcomes, hence reduce the absence of safety or to increase the number of expected and acceptable outcomes, hence increase the presence of safety. Safety culture as commonly pursued has an insufficiently developed theoretical basis, here identified as the intractable-tractable dilemma. In contrast to that, resilience engineering, and especially the systemic potentials that constitute the foundation of an incremental safety culture, make it possible directly to improve and regulate the potentials needed for (safe) performance that increases the number of expected and acceptable outcomes, thereby rendering both safety culture and the intangible-tangible dilemma unnecessary.

Safety culture plays an important role in contemporary safety management. An inescapable consequence of that is the need of a solution or method by which safety culture can be managed. This paper has examined two complicated solutions, the EHS Safety Culture Ladder and the DuPont-Bradley Postulate, neither of which actually provide the needed solution, mainly because they both fail to provide the three types of knowledge required by change management, knowledge about the position, the goal, and the means. On top of that the EHS Safety Culture Ladder treats safety culture as an individual disposition rather than as the collective phenomenon it is. And the DuPont-Bradley Postulate is completely atheoretical. Since neither of these complicated solutions are effective,It stands to reason that no single factor solution, such as commitment, employee empowerment, or **leadership** will be so either.

Table 4: Lists of facets for the four systemic potentials			
Potential to respond (details provided in Table 5)	Potential to monitor	Potential to learn	Potential to anticipate
Event list	Indicator list	Selection criteria	Expertise
Background	Relevance	Learning basis	Frequency
Relevance	Indicator type	Classification	Communication
Threshold	Validity	Formalisation	Strategy
Response list	Delay	Training	Model
Speed	Measurement type	Learning style	Time horizon
Duration	Measurement frequency	Resources	Acceptability of risks
Stop rule	Analysis / interpretation	Delay	Aetiology
Response capability		Learning target	
Verification of response(is it the correct response?)		Confirmation, verification and maintenance of what has been learnt.	

In the intangible-tangible dilemma the tangible represents what people do. What people do is physical and can be observed. The intangible is what hypothetically makes people act in certain ways. The intangible is, according to David Hume, metaphysical, and can therefore not be observed. It is nevertheless assumed there is a causal relation between the intangible (people's mindset or their safety culture) and the tangible (what they do and how they do it). Psychologists have studied this relation since the beginning of psychology as a science in 1879 when Wilhelm Wundt, opened the first laboratory ever to be exclusively devoted to psychological studies at the University of Leipzig, but it is fair to say that this relation remains to be fully articulated. Major contributions have been realistic descriptions of how people make decisions, which offer three main types, people's decisions can be recognition-primed (Klein, 1993) made by means of satisficing (March & Simon, 1958; Simon, 1947); although people mostly just try to muddle through (Lindblom, 1959). (Braithwaite, Hollnagel & Hunte, 2021).

Conclusions

Safety culture is an intangible social construct, "a dynamic intersubjectively constructed belief in the possibility of continued operational safety" as described by (Rochlin, 1999, p. 1549). Safety culture has never actually served any practical purpose; it has neither reduced the number of unexpected and unacceptable outcomes, nor increased the number of expected and acceptable outcomes. The main demonstrable effect has been to quell the Nietzschean anxiety in the wake of unfamiliar and unexpected events. Safety culture is in many ways the equivalent of snake oil for industrial safety.

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