The Rule of Three: Situation Awareness in Hazardous Situations

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Abstract

The criteria for making Go - No Go decisions are often conservative because the decision rule (i.e. to stop flying helicopters, to go around with a tanker, to shut down a platform or halt concurrent operations) does not take the *interaction* of multiple factors into account. All of the situations and events leading to an incident are sub-standard, but taken in isolation none of them usually appear dangerous enough to warrant halting operations and taking stock. Accidents rarely happen because of a single catastrophic failure, except when that failure is at the end of a chain of non-catastrophic failures and organisational oversights. Go - No Go decisions are hard to make, especially when situations have been deteriorating slowly, and a clear decision rule can help. The Rule of Three is proposed as a way of combining information to make operational decisions in order to maximize opertunities and minimize regrets..

Introduction

Accidents don't just happen. Rather than having just one cause, it takes a great many factors, often in excess of 50, to lead to an accident[1]. Analyses of accidents, both within the Shell Group and outside, show how accidents all too often happen because of combinations of relatively trivial events and situations[2]. While any one particular accident can be avoided by stopping any one of those causes, most accidents happen in the middle of situations which, afterwards, people see as "an accident in the making". Fixing one potential cause out of 50 may stop *that* accident, but with 49 other factors still around we may find ourselves in a state of permanent near-miss, what we might call Living on the Edge. The Rule of Three is proposed as a way of finding out just how close we are to the edge and helping us decide what to do, whether to stop operations or manage the risks down to manageable proportions.
The main factors causing accidents are increasingly the result of the human factor, especially as we obtain more control over the technical causes[2,3]. As technical safety and integrity is assured, we are left with finding ways of providing the same assurance with people as we have with equipment. While the absolute number of accidents will fall as technical controls take effect, the remaining accidents will become increasingly bizarre as human ingenuity is left to test what someone has regarded as foolproof.
One reason why people create problems is because they often fail to understand how small problems, that no one would regard as particularly dangerous, may interact to become big ones, that suddenly threaten life or limb. Immediate operating conditions can become such that simple everyday *errors,* such as turning the wrong control handle or forgetting a part of a check sequence, can become suddenly dangerous, as when someone who is bending the rules fails to tell his colleagues. Violations interact with errors to create novel and dangerous situations out of the blue[4]. The Tripod concept of Error Enforcing Conditions was set up to highlight how some working conditions make the occurrence of errors much more likely[5].
Incidents at the Edge. An analysis of a helicopter accident in the North Sea[6] found that there were no specific reasons, in advance, why the pilots could have reasonably stopped flying. The weather was marginal, but within 'acceptable limits'; the pilots were close to the limit of their allowable flying hours, and would have exceeded them on the final leg, but they were still within limits at the time of the accident; the operational requirements were not impossible, but were changed many times in the course of the mission. The accident, in which 13 people died, was in hindsight almost inevitable.
In oil tanker operations, one of the most sensitive undertaken by Oil and Gas companies in today's environmentally-sensitive climate, a similar picture arises. When a vessel is approaching an unknown harbour in poor weather, having taken on board a pilot whom the master may not trust entirely, where the draft of the vessel and the available clearance may not leave a large margin, it might be more sensible to stand off and wait for daylight than press on under the burden of a tight sailing schedule. A grounding and a major pollution threat would, again, make it seem obvious in hindsight that caution is the only sensible course. Nevertheless such incidents still occur, unfortunately frequently, even after the a number of major shipping accidents have highlighted how vulnerable organisations are to such disasters.
Learning from Hindsight. The problem is: How can we acquire the benefits of hindsight, and prevent such accidents, without unnecessarily curtailing operations by excessive caution? The issue appears not to be one associated with individual limits on permissible operations, but rather on the way in which the sum total of marginal conditions can be computed in such a way that safe and sensible decisions are made, whether it be to carry on or to stop. Go - No Go decisions which can lead to shutdown are easily influenced by production pressures, on the one hand, and the belief of those involved that things will be all right as long as they, personally, are running the operation (although they may recognise that others might well be less fortunate). The kind of decision that is required is, also, almost always made under conditions of haste, pressure and expectation, exactly the conditions that are less than ideal for making such decisions[7].
This paper proposes a way of combining information to help in making safe decisions called the *Rule of Three*. Because much of the necessary information can be collected and judgements made in advance, outside of the pressure of immediate circumstances, decisions can be made and, possibly more important, safe conditions can be managed, without losing sight of overall goals of an

operation. This should be applicable to a wide range of operations where critical shutdown or go-around decisions need to be made, and such decisions are often being made under conditions that are not ideal for taking rational decisions.

The Rule of Three

The proposal is that there are, for any operation requiring potential shut-down or No Go decisions, a number of factors that complicate matters. External factors such as the weather, or internal factors such as the experience of those involved, may not be enough to trip a *stop* decision. Many of these marginal conditions may not appear in a direct causal analysis of an accident. Nevertheless such marginal conditions as bad weather or operators' inexperience may be enough to make the sudden appearance of errors much more likely or make recovery from errors less likely. When there are enough of such complicating factors, a sensible manager calls a halt, or changes the conditions to bring the situation back from 'The Edge'. The proposal is that three marginal conditions should be considered as equivalent to a single exceeded limit when deciding to halt operations. This is equivalent to the three strikes rule in baseball, although the metaphor used here is based on the traffic light, where going through an orange or amber light may still be acceptable, but it is close to going through a red light.

Threshold Setting. One approach to the problem of setting appropriate Go - No Go thresholds is to be conservative in defining the point at which an operation has to be halted. A maximum permissable wind speed for a given make of helicopter might have been defined by the manufacturer as 55 knots, but may be reduced to 52 knots, not because this is a better upper limit, but because such wind speeds are often accompanied by other weather problems, such as gusts and poor visibility. This approach, that is conservative, may be understood in terms of compensatory decision-making; Go - No Go thresholds are adjusted downwards to compensate for other factors that are not otherwise included in the strict set of thresholds defined.

An alternative approach recognises that there is often a range of conditions, from perfectly normal up to unacceptable. In such an approach values exceeding an absolute safety threshold can be represented by *red*, the ideal operating environment by *green* and marginal situations can be designated as *orange*. The red threshold can now be set in terms of absolute requirements, such as might be determined by the laws of aerodynamics in the case of a helicopter's maximum permissable wind-speed for take-off. The compensating factors are now handled distinctly (gusting, visibility, icing etc.), each with its own red threshold. At the same time it is possible to identify less stringent thresholds, beyond which one would proceed with caution. These can be defined as the orange thresholds. Experienced operators and managers can discuss and set the orange thresholds in the calm of the office and with the benefit of their experience. *Orange* thresholds can continue to be reviewed and altered as more experience is gained, whereas *red* thresholds are much more likely to remain fixed. In the past the thresholds that are applied in practice form a heterogeneous mix of what are here distinguished into red and orange thresholds.

The Decision Rule. Too many factors in the 'orange' distract and influence decision makers and stress the system's defensive barriers. The Rule of Three uses both *red-orange* and *green-orange* thresholds, with a summation rule that three *orange* factors is equivalent to a single *red*. At this point operations should be stopped or, possibly better, delayed until a number of the factors in the orange have been managed back down to the green. For instance, an operation about to be carried out in bad weather, performed with inadequate planning ("Go out there and fix it") and with an inexperienced crew, rates as three oranges and should not proceed. Nothing can be done about the weather, but if the planning is improved, or the experience level of the crew is brought up to the necessary level, then the number of oranges reduces to two or one, and the operation can proceed. The Rule of Three allows direct assessment of the *total* situation, into which people may inadvertently find themselves, framed in terms of the factors which increase the permeability of the barriers to accidents.

Number of Critical Dimensions	**Action** ***Go or Nogo***
All Green	Proceed normally
One Orange	Proceed normally
Two Oranges	Proceed with caution
Three Oranges	Halt operation Reduce problems
One Red	Halt operation

Table I. *The Rule decision criteria framed in terms of Reds and oranges*.

Dimensions and Sub-dimensions. The rule is applied using a number of major dimensions, such as Weather, Experience of Crew/operators, Commercial Setting, quality of plan etc. (See Table II), each of which can be subdivided into a small number of sub-dimensions. If more than one sub-dimension goes Orange, then we can mark the major dimension as Orange. If any sub-dimension goes Red then the major dimension is immediately Red. The Rule of Three states that if there is a single Red Dimension, or Three

Orange Dimensions, then operations should be halted (i.e. three strikes). Three or more Oranges represents an accident in the making, where hindsight would say, "we should have stopped earlier".

Major Dimension	Sub-dimensions
Weather	Rain Wind Lightning
Experience of crew	Individuals in training Percentage with 5+ years competence
Commercial Setting	Profit push Deadline approach
Sort term variation	Day/night Shift change
Equipment	Fit for purpose Recently maintained
Task	Novel Unpractised Difficult
Planning	Change of Plan Change of plan timing

Table II. *Possible Major and sub-dimensions. The particular thresholds for any operation should be filled in by those with local experience.*

Calibrating Thresholds. Once such a set of dimensions and associated thresholds has been defined for a specific operation, there are two ways to proceed. One would involve collecting data systematically about incidents, normal conditions, acceptable shut-downs and unacceptable missed opportunities, followed by a formal optimisation of the settings. This rigorous approach can not always be applied because there may not be enough decisions made, capable of evaluation afterwards, in a reasonable time period. A more informal approach would involve renegotiating the thresholds from time to time on the basis of continued experience.
In each case (See Figure 1) we wish to continually minimise the amount we would *regret* if we either had an accident or, out of unreasonable fear, stopped operating too early. As the thresholds are directly associated with the line between regret and no-regret, we can consider using the Rule of Three in a continuous way, aiming to minimise regret, *converting hindsight into foresight*.

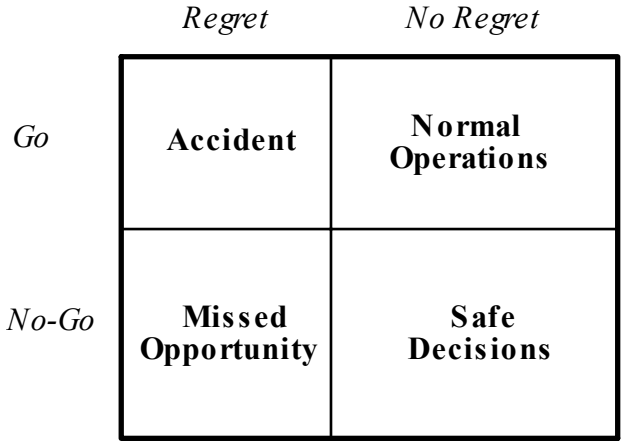

Figure 1 *The dimensions for calibrating the rule of Three*

Relationship with Tripod: Weakened Barriers

In terms of the Tripod Model of accident causation[2,7,8] the accident process gathers momentum when situations arise which lead to the final barriers becoming less effective, and thus easier to pass. Ideally one hopes to have removed all the latent failures in an operation, in practice some will always remain. The full set of preconditions to an incident include many factors out of an individual's

direct control, such as the weather or the time of day, and others which people quickly grow accustomed to, such as high levels of work pressure or unusual operating requirements. Finally there are factors, such as time on shift and time of day, or remaining fuel, that deteriorate inexorably and, at some point, become unacceptable, but prior to that have already become a matter of concern. Because most systems fail to acknowledge the creeping effect of deteriorating conditions, the Rule of Three provides a way of bringing their potential into the decision process without, necessarily, immediately leading to a halt of the operation.

In Tripod theory[5], when a triggering event happens, it is up to the barriers to avert damage; when and while those barriers are temporarily weakened, an incident becomes much more likely. People who are insufficiently aware of how close they are to the edge are those most likely to short-circuit established procedures or actively remove existing defences. The Rule of Three is intended to be a way of combating such problems by providing a framework which improves situation awareness.

Situation Awareness. The best and most experienced managers recognise the situations they find themselves in. Less experienced or effective managers often concentrate upon the most obvious problems. Fighter pilots and top-level team sportsmen show similar abilities to understand the *whole* situation and profit from it, lesser pilots get shot down, lesser sportsmen lose. The Rule of Three, in practice, is intended to provide and support *situation awareness*, to support the risk management process by reminding those involved of how deep in trouble they are and just how close to the edge they may have come [9]. Armed with such knowledge it is easier to decide whether to halt operations or, minimally, which factors need to be managed down to return to safe operating conditions.

One significant factor in many accident scenarios is the creeping acceptance of a situation that has slowly deteriorated. The fact that people habituate to initially unacceptable conditions means that they often lose sight of which conditions have become too serious to ignore. The use in the Rule of Three of a set of predetermined dimensions and associated sub-dimensions helps the decision-maker to reconsider the sum total of conditions. The specific nature of the rule means that attention has to be directed to the total set of dimensions, rather than being captured by what appears to be most important at the time.

Applications.

Possible application areas for the Rule, within the Exploration and Production setting, include aircraft operations and platform shutdowns. Other areas include oil tanker (VLCC) and coal mine operations. The time to apply such a rule can be before starting, on shift handover, or at critical periods such as prior to coming into harbour in a tanker.

The list is short enough to function like the sort of checklist that is common in the aviation industry, where safety standards are of the highest. In the aviation industry one of the indications of the existence of a safety culture is the disciplined way in which such checklists are gone through every time, regardless of how unnecessary it might seem. Such a level of commitment is what can ensure that problems are not simply accepted and lived with, that everyone is aware of exactly what the situation really is.

Conclusion

The Rule of Three is a decision-making rule intended to upgrade the quality of decision-making. Within Shell companies it is accepted as providing valuable insights, but it has still to be turned into an effective and working tool. Such a tool has the potential to be developed further in concrete settings where it is applicable, but has yet to mature into a calibrated tool . One always hopes to make critical decisions with all the best people available and under ideal conditions, in practice this is not always possible. The Rule of Three is intended to access the benefits of the best managers' past experience, set into a simple rule-of-thumb tool that can aid the less experienced *before* situations turn nasty.

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