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Safety barriers: Organizational potential and forces of psychology

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ABSTRACT

Safety barriers are often described as a safety function realized in terms of technical, operational and organizational barrier elements. These elements, in some shape or configuration are established to ensure that the barrier works as intended.

While technical and operational barrier elements appear fairly definable, the organizational barrier element often remains elusive. An appealing solution oriented strategy is probably to urge for a clear-cut categorization of what applies as 'organization'. This tactic may contribute to a tidy method with respect to barrier categorization. However, the question remains whether it is possible or desirable to confine the organizational influences to categorical classifications?

The aim of this paper is to address this question by examining the run-up to the Macondo blowout from a barrier element perspective.

Hopkins' (2012) analysis of the Macondo blowout is applied to identify patterns of organizational impact in three of the pre-blowout defenses: The cement job, the well integrity test, and the kick monitoring.

By re-analyzing Hopkins' study from a barrier element perspective we argue that the organizational impact may morph and change in nature, be contagious and spread across barriers, and travel long distances. The implication is a need to rethink the impact of organizational barrier elements. Part of this rethinking involves acknowledging the impact of psychological mechanisms like consensus-mode decision-making, confirmation bias, normalization of warnings, groupthink as well as social forces of power and persuasion. It is shown how such psychological forces may serve as 'transmitters' of organizational principles, strategies and decisions throughout the barrier system. In turn, this may contribute to risk transfer, and dependence between barriers.

1. Introduction

Safety barriers are part of orthodoxy in safety science and management. Represented by the classic Swiss cheese metaphor, this is the idea of a string of defenses, or barriers – aligned so that if any of the preceding barriers fails, the subsequent defense in line will do its job of preventing the occurrence of hazardous events or limiting their consequences. The safety philosophy forming the basis for barrier management is often denoted 'defense in depth' (Reason, 1997) (referring to the deep layers of defenses or barriers established to prevent harm). Defending 'in depth' may also trigger associations along the lines of 'going deep into the complexities' and so on. In terms of accident causation and explanation, 'further back' is often related issues of organization. Current efforts to understand the organizational impact is a lucid reflection of the acknowledgment that organization matters (see e.g. Weick & Sutcliffe, 2007). Organizational issues may be a forceful contributor to maintain safety; but also in the development of major accidents. Connections between organization and safety are compellingly addressed and revealed in the literature (e.g. Hopkins, 2008; Reason, 1997; Vaughan, 2005).

A barrier is often described by referring to its function. That is, barrier x is established in order to implement function y (e.g. the flare system is installed to relief the process pressure). The barrier function may here be realized and maintained by barrier elements. These barrier elements are typically classified as technical, operational, or organizational. In this approach, a barrier can be defined as '*…technical, operational and organizational elements which are intended individually or collectively to reduce the possibility for a specific error, hazard or accident to occur, or which limit its harm/disadvantages*' (PSA, 2013, page 3).

While technical and operational barrier elements appear fairly definable, the organizational barrier element often remains elusive. An appealing solution oriented strategy is probably to urge for a

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clear-cut categorization of what applies as 'organization'. This tactic may contribute to a tidy method with barrier elements of unambiguous character. But, will a categorical classification of organization solve the challenges related to acknowledging the actual influences on safety? The aim of this article is to address this question by examining the run-up to the Macondo blowout from a barrier element perspective.

2. Conceptual framework

A rendition of Hopkins' (2012) analysis of the Macondo blowout is used as source and conceptual framework.

The following presents selected elements of Hopkins' (2012) analysis of the Macondo accident. This presentation is limited to looking at episodes related to three of the defenses before the blowout: the cement job, the well integrity test, and the kick monitoring.

A simple chronology of the run-up to the Macondo accident: at 5.45 am, 16 h before the blowout, the cement job was declared a success; at 8 pm the well integrity test was affirmed as ok; in the hour before the blowout there were indications that something was wrong. These signals passed unnoticed as no one was monitoring the well; at 9.45 pm drilling mud were churning out – the catastrophe was a fact.

See also the reports from the National Commission to the President (National Commission, 2011a, 2011b as well as Tinmannsvik et al., 2011). Fig. 1 depicts the pre-blowout defenses.

2.1. Cement job

The rig was about to move and begin its next job. In order to leave the well in a safe state, the bottom had to be plugged with cement. This was a case of a 'temporary abandonment' as the well would later be converted to a producing well. This would involve drilling the cement out for oil and gas to flow into the well. The Macondo engineers planned and executed the cement job. And on completion, they declared it a success; a textbook job (Hopkins, 2012). According to Hopkins, this declaration of triumph was based on indications of full returns of fluid and thereby no signs of losses into oil and gas sands. Full returns denote the process when cement is pumped down into position; equal amount of fluid should be coming out on top of the annulus as is going down the casing. This particular well design demanded high pressure on the cement near the well bottom. This increased the possibility of a loss into oil and gas sands. As noted by Hopkins however, this error mode was only one of at least four plausible error modes. The three others were: (i) instable cement (due to the light weight foam cement that was needed in this particular well design); (ii) channeling (i.e. that the cement leaves mud channels behind it during cement placement), (iii) contamination (i.e. that mud is blended into the cement, leaving a less than optimal cement consistency) (Hopkins, 2012).

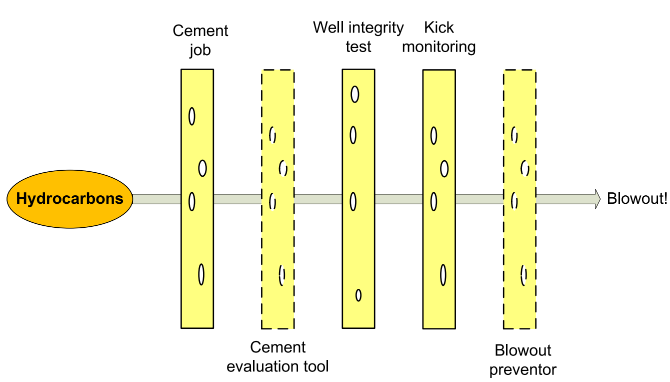

Fig. 1. Pre-blowout defenses in the Macondo accident (based on Fig. 4.1 in Hopkins, 2012, page 54).

Hopkins' point is that a fallacy was made. By concluding that the cement job was successful (due to signs of full returns) the job was affirmed as completed. The declared success rendered the cement evaluation (cement bond log, CBL) unnecessary. The crew that was ready to perform the CBL was brought home by helicopter. By declaring the job a success, corners could be cut by omitting the cement evaluation test, and thereby save money. By the time of the blowout the operation was 38 days delayed and an estimated $58 million above budget (Chief Counsel's Report, National Commission, 2011b). The presumption being, that any needed mitigation regarding cement instability could be done at a later stage. In this way, progression of an already delayed job was ensured. Hopkins (2012) shows how tunnel vision and a consensus mode of operandi contributed to the declaration of a successful cement job.

2.1.1. Tunnel vision engineering

Hopkins argues that the Macondo engineers displayed tunnel vision engineering. Their eyes were fixated on one objective: a well design that was cheaper and would enable easier production when that time came. It was as if peripheral risk awareness was virtually eliminated. Hopkins traces this tunnel vision back to a 'management of change' (MoC) document that had been previously designed to give formal authorization for the well design. Here, the potential of loss of mud into surrounding sands was emphasized specifically. This hazard was in other words primed in the engineers' minds. From the beginning (design approval stage), only one of at least four possible failure modes was addressed (Hopkins, 2012).

2.1.2. Decisions in consensus-mode

Decisions were made in a consensus-mode, effectively made in settings where no one could be held accountable later on. This is according to Hopkins illustrated by (1) decisions that were made in meetings intended to collect information; with the implication of making all – and in effect no one actually responsible; and (2) the management of change documents that were reviewed and approved by a long string of signatures. These signatures often belonged to the same people as those being involved in the plan. In other words, there was no independence, and the system of assurance served only to undermine the process. The MoC process, in reality, was a consensus decision-making process; with the disturbing effect that responsibility was diluted (Hopkins, 2012).

2.2. Well integrity test

Before moving the rig to the next location, the integrity of the well had to be tested (this is part of the temporary abandonment procedure). Removing riser and mud leaves the well underbalanced, meaning that the cement seal must function. In order to test the sealing, a temporary reduction in well pressure is administered. The logic of this test is: a pressure rise indicates that oil and gas flows into the well bottom, meaning that the seal is not working. If the seal does work, the pressure remains steady. The test involves pumping sea water down the drill pipe under high pressure; this, in order to force the mud upwards, thereby creating a water cavity. When the mud level is positioned above the blowout preventer, this is closed with a rubber seal. The cavity (between well bottom and rubber seal) now simulates a situation of no other defense than the cement being in place. Having created this space,