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Responding to project uncertainty: Evidence for high reliability practices in large-scale safety–critical projects

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Abstract

In large-scale safety–critical projects unforeseen events and uncertainties must be carefully managed to safeguard the integrity of the end product and deliver projects to time and cost. Based on 47 'vignettes' of uncertainty across projects in two safety–critical sectors, this study provides an empirical examination of whether practices consistent with theories of high reliability organising are adopted by project managers as a response to project uncertainty. Our findings are that confronting uncertainties in safety–critical projects do involve many high reliability practices. Respondents expressed a sense of balancing competing demands, and provided evidence of learning, acting mindfully, avoiding over-rigid processes, and of upholding constructive tensions, conceptual slack and close interdisciplinary working.

However these practices are often fragile in nature and dependent on key individuals. There are also differences between the two sectors studied, with more widespread evidence of high reliability project organising in civil nuclear than in aerospace projects.

Keywords: Projects; High reliability organising; Safety-critical; Uncertainty

1. Introduction

Designing the next generation civil airliners, constructing new nuclear power plants and safely decommissioning former civil nuclear assets are all large-scale safety–critical projects that must be completed in a safe, yet timely manner. However, the uncertainties in these projects are numerous and non-trivial in nature. For example, what is the condition of the radioactive waste that needs to be removed from a decades old storage pond; or what are the performance trade-offs and design implications in bringing ever lighter and more fuel efficient aircraft into service? Barton et al. (2015) argue that performance in these uncertain contexts is "*a situation specific accomplishment that involves managing contradictions and interruptions*" (Barton et al., 2015, p. 75) and that high reliability theory provides a theoretical framework for how this may be achieved. To date, however, most research into high reliability organisations has focused on high hazard *operations* (cf. La Porte, 1988; Mannarelli et al., 1996; Roberts and Bea, 2001; Rochlin et al., 1987; Roe and Schulman, 2008; Schulman, 1993) and there is little prior work on high reliability organising in the *project* context. Saunders (2015) argued that safety–critical projects – like operations – are complex, highly consequential, and under tremendous pressure to deliver safe outcomes. However, there remain a number of key differences between operations and projects, including the non-routine and temporary nature of project work and the strong change mandate that drives many projects (Reich et al., 2013; Turner and Mueller, 2003; Williams, 2009). Safety–critical projects also typically progress at a more measured pace, are more loosely coupled and less highly dynamic than an active operational context such as the real-time operating environment of a nuclear power plant.

The study reported on here extends the application of high reliability theory into the domain of the safety–critical project

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and provides the first empirical evidence for practices associated with high reliability organising in safety–critical *projects* as a response to project uncertainty. We draw on 47 retrospective accounts (vignettes) of project uncertainty from project management practitioners on nine safety–critical projects to investigate the following research question:

> "How does the manner in which project management practitioners respond to uncertain situations compare with the principles of an ideal-type high-reliability organisation?"

Our contribution to theory is twofold. First, we empirically examine whether practices consistent with high reliability organising are adopted by project management practitioners in safety–critical projects in response to uncertain situations. Secondly, we provide the first empirical testing of earlier work by (Saunders, 2015), who posited the principles of an ideal-type high-reliability organisation and the notion of high reliability project organising. This approach is consistent with Reich et al.'s (2013) call for project management research not to reinvent theory, but rather use extant theories from the wider domain of organisational theory as a lens through which to view projects.

Lastly, we did not investigate any causal relationships between evidence for high reliability practices and eventual project outcomes as the nine case-study projects in this study were each at very different stages of their lifecycle, and none were yet complete. One other hypothesis raised by this study is whether interviewing the same respondents at a different (later) point in their projects' lifecycle would yield different results. And, if there is a difference in results, is this a function of the project's lifecycle stage and fact that uncertainty typically decreases as the project proceeds (Winch, 2010), or of the additional experience gained by the respondent during the intervening time. Investigating this hypothesis also lies outside the scope of this paper.

The remainder of the paper proceeds as follows; first, the literature on high reliability organising is discussed and the principles of an ideal-type high-reliability organisation presented. Subsequent sections describe the study design, the findings and explore their implications for both theory and practice.

2. The theoretical context

The aim of early research on high reliability organisations (HROs) was to explore how three specific organisations (a nuclear power plant, the US air traffic control network and US navy aircraft carriers (La Porte, 1988; Rochlin et al., 1987; Schulman, 1993) appeared to violate the principles of normal accident theory (Perrow, 1984) – the commonly accepted theory of accidents at the time – and managed to maintain safe and reliable operations, while often operating under considerable time pressure in high-risk environments (Rochlin, 2011). The researchers identified several common features in the three organisations including the high prioritisation of safety, decentralised decision making within a strong management hierarchy, the presence of organisational and technical redundancy and powerful cultures of learning, openness and accountability (Roberts and Bea, 2001). They argued that high reliability organisations are not error free, but rather remain obsessive about the potential causes of failure and are quick to respond to any errors that do occur (Weick et al., 1999; Weick and Sutcliffe, 2007).

Since the late 1980s, HRO research has proliferated, leading to an extensive body of work – largely case study based – but latterly attempting to position HROs within the wider domain of organisational theory (cf. Boin and van Eeten, 2013; Klein et al., 1995; Mannarelli et al., 1996; Myers, 2005; Ruchlin, 2004). As HRO research has evolved, some of its early assumptions have also been revised. For example, early studies viewed HROs as closed systems immune from external influences and with the total elimination of errors as the overriding organisational goal. Gradually researchers acknowledged that HROs are in fact open systems; subject to the pressures of "*aggressive knowledge watchers*" (La Porte, 1996, p. 64) such as regulators and the wider public. HRO's organisational objectives may also be more nuanced; safety is no longer the single overriding concern, with reliability of service and profitability attaining greater significance (Perin, 2005; Rochlin, 1993). Researchers also accept that in complex, highly interdependent systems errors are inevitable (Perrow, 1984; Rijpma, 1997) but what matters is how resilient the organisation is in predicting, handling and recovering from these errors (Hollnagel et al., 2006).

There are a number of ongoing criticisms of theories of high reliability organising which merit attention. First, there has been a long-running debate between both normal accident theory and high reliability theory as rival explanations of safe performance in safety–critical environments (cf. (Hopkins, 2014; Leveson et al., 2009; Rijpma, 1997). Normal Accident Theory contends that the highly-complex and tightly intercoupled nature of complex socio-technological industrial systems such as nuclear power plants, makes accidents inevitable and to be expected. Sagan (1993) argues that NAT takes a pessimistic view; asserting that accidents are inevitable and that adding redundancy to systems can actually increase the interactive complexity that can lead to accidents. In contrast, high reliability organising is more optimistic, implying that accidents can be avoided through effective organisational structures and management, and that redundancy provides the organisational slack to foster safe operation. Secondly, there is an ongoing discussion over whether high reliability theory is still relevant in lower hazard sectors, such as construction or healthcare, where reliability is a relative rather than an absolute requirement (cf. Olde Scholtenhuis and Doree, 2013). The third point of contention is whether theories of high reliability organising are at all empirically testable; if HROs cannot be identified a priori, then it is impossible to assess whether they actually possess the defining characteristics of HROs (Hopkins, 2014).

Despite these unresolved questions, researchers have widened the application of high reliability theory to several other highly complex and consequential operational environments - for instance: healthcare (Chassin and Loeb, 2013; Ruchlin,