



Taking responsibility for public safety: How engineers seek to minimise disaster incubation in design of hazardous facilities



Jan Hayes*

Centre for Construction Work Health and Safety Research, School of Property, Construction & Project Management, RMIT University, City Campus, 360 Swanston Street, PO Box 2476, Melbourne, 3001 VIC, Australia

ARTICLE INFO

Article history:

Received 12 May 2014

Received in revised form 5 February 2015

Accepted 20 March 2015

Available online 7 April 2015

Keywords:

Safety in design
Safety imagination
Standards
Professionalism

ABSTRACT

Inquiries into the causes of man-made disasters have shown repeatedly that ongoing safety of workers and the public depends on decisions made, often many years earlier, during the design stage of infrastructure or facility development. The potential for disaster represented by incompatibilities that remain undiscovered between design choices and future operating requirements is a classic example of what Turner calls 'disaster incubation' – where beliefs about control of hazards are at odds with actual events.

This research investigates the motivations and attitudes of people working in a design office environment who determine the form of hazardous facilities such as oil refineries, petrochemical plants and pipelines. It explores particularly the issue of responsibility for public safety. This long-term goal faces serious competition for attention from short-term project priorities of integrity, cost and schedule. Linking requirements for public safety to facility integrity (as is often done in a project environment) is shown to have substantial limitations as a strategy for ensuring the best long term outcomes. As a counter to this, some senior discipline engineers were found to emphasise the real-world potential consequences of their work through use of stories and saw communication of professional values to younger staff as a key aspect of their work. The paper also touches on the perceived role of engineering standards and shows that safety design is seen to go beyond simply compliance.

There has been little social science research in this important area. The paper concludes with areas in which further work would be valuable.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Ongoing public safety around hazardous facilities such as chemical plants and high pressure pipelines depends critically on decisions made, perhaps many years earlier, as the facilities were conceived, designed and constructed. Despite this, little social science research has addressed the way in which safety issues are identified and considered through the course of the project development, from concept selection to operations.

This research focuses specifically on design which is one step in the project development process. Engineering design is a specialist activity which is often undertaken outside the organisation that will ultimately operate the facility. Despite the physical, temporal and organisational separation from facility operations, decisions made during the design of the facilities have the potential to contribute to disaster (and its prevention). The full project development program for a complex plant may

extend over several years with many other specialist contractors involved in the processes and activities that turn the output of the work of the design team (drawings, specifications and other documentary artefacts) into a physical facility that is ready for operation.

Design work appears to be highly structured and controlled with many formal methods in use to address safety such as hazard and operability studies (HAZOP), failure modes and effects analysis (FMEA), reliability analysis and similar. Despite this, design aspects have contributed to many major accidents, including the loss of the space shuttles *Challenger* (Vaughan, 1996) and *Columbia* (Starbuck and Farjoun, 2005), the explosion and fire at Exxon's Longford gas plant (Hopkins, 2000), the Buncefield fire (HSE Major Incident Investigation Board, 2008) and the BP Texas City Refinery fire (Hopkins, 2008). In addition, various process industry studies have shown that design error is a root cause of around half of all accidents (Drogoul et al., 2007; Johnstone et al., 2012; Kinnersley and Roelen, 2007; Taylor, 2007). This record demonstrates that design offices are workplaces that should be of more interest to safety researchers.

* Tel.: +61 419 114 950.

E-mail address: jan.hayes2@rmit.edu.au

In an operational environment, an attitude of mindfulness is important in being aware of the potential for failure (Weick et al., 1999). Being mindful of the potential for disaster is arguably even more difficult in a design office, where the impact of decisions may not be clear for many years and where responsibility for the facilities has long since been transferred to a different organisation. For this research, more than 30 people working on the design of process equipment in five design offices have been interviewed to ascertain how public safety is considered in their work. This paper focuses on the impact of this very long delay before the practical impact of decisions is realised and in particular what this means for design engineers engaged in the work.

Other key results of this research related to conflict, power relationships and organisational structures impacting design teams and their management have been published separately. That work demonstrates the significant extent to which conflict between project goals of cost/schedule and quality/integrity is institutionalised by the way in which design work is organised. Project outcomes are then at least partly determined by the relative power of the various team members, be they design engineers or project managers. Of more interest here, is the way in which design engineers conceptualise their responsibility for long term safety and the extent to which that view is believed to be unique.

Since very little has been published in this area, this qualitative, investigative research simply acts as a starting point for academic endeavours focused on design of hazardous facilities. As such, the article concludes with some ideas for further research to better understand the impact of design office social processes on long-term safety outcomes.

2. Theoretical framework

Organisations that operate complex facilities with the potential for major disaster are driven by a range of business objectives that compete for resources and attention on a day-to-day basis. Safety performance relies on those in critical positions making decisions that balance these competing priorities and, as a result, many safety researchers have focused on decision making processes (Allard-Poesi, 2001; Ball and Ball-King, 2011; Carroll and Johnson, 1990; Cook et al., 2007; Hayes, 2012, 2013; Hopkins, 2011, 2012; Klein, 2009; Roberts et al., 1994; Vaughan, 1996 and many others). In the broadest terms, high reliability theory provides some insights into qualities that promote good decision making by fostering the ‘capacity to discover and manage unexpected events’ (Weick, 1987; Weick and Sutcliffe, 2001). Resilience engineering research focuses on anticipation of problems and the conditions in which people are willing to make ‘sacrifice decisions’, again trading off longer-term production goals in the face of short-term safety imperatives (Hollnagel et al., 2011).

Whilst most research addresses how such choices are best made in operations, decision making in the design of hazardous facilities can also have major safety implications. Despite the potential for similarly disastrous consequences, designers’ work has a different orientation in relation to the hazards that they consider. Designers themselves are in no physical danger and, in the short-term at least, their choices pose no threat to the public. Rather, they need to consider the long-term potential for disaster and may need to sacrifice short-term goals related to cost and schedule of the project on which they are engaged, in order to build in safety for an operation that many not commence for several years but once underway may continue for several decades. Of course not all important decisions in an operational environment have an immediate impact on safety. Reduced levels of maintenance on critical equipment or shift patterns that foster fatigued workers and similar operational issues are potential examples of latent errors (Reason, 1997) and design error can be

conceptualised in the same way. Design is a potential source of fragility or brittleness that may be literally built into a new facility. Nevertheless, the juxtaposition of very long-term safety impacts relative to short-term project goals provides an opportunity to investigate this temporal orientation and its impact on safety decision makers.

Minimising the design contribution to disaster requires the foresight to understand how designed equipment will function in practice. The time during which a design error lies undetected in the system is what Turner and Pidgeon (1997) call the disaster ‘incubation period’. Whilst Turner’s original work in the 1980s was based in analysis of operational issues, Turner and Pidgeon noted in their update to the earlier work on failure of foresight (1997) that further studies on design in the British building industry has demonstrated that these concepts also apply in the design and construction field, particularly when designers have failed to foresee the potential consequences of their chosen design basis. In this way of considering design, a problem arises when there is a deviation between the design assumptions and the operating reality. Whilst some theorists might postulate that the issue is drift by operations away from the design intent, this view does not privilege the designers’ choices in this way.

An important consideration in the design process that has also received some attention in the literature is the attitudes, motivations and behaviours of design engineers. There are four linked areas of inquiry that have particularly informed the present work: safety imagination, professionalism, sensemaking and compliance with standards. These four intersecting theoretical perspectives support inquiry into how responsibility for public safety is conceived, understood and enacted by design engineers.

Design work is quite structured and often time pressured. This raises questions about the extent to which space was available for design engineers to develop and exercise a safety imagination (Pidgeon and O’Leary, 2000). A lack of safety imagination is linked to a psychological rigidity that restricts decision makers in their ability to link their work to the possible consequences. Drawing on culture research, an effective safety culture is seen as promoting a ‘shared care and concern for hazards’ (Turner and Pidgeon, 1997, pg 88). The extent to which design engineers are able to link their work to the long-term consequences in a project environment is one key question underpinning this research.

The second overarching theoretical consideration in this research relates to the professionalism of the design engineers. By this we mean the extent to which engineers identify with a particular professional group (rather than with a particular employer) and the extent to which professional values, rather than organisational imperatives, influence decision making. Various authors (Friedson, 2001; Middlehurst and Kennie, 1997; Sullivan, 2005) describe the strong sense of responsibility held by professionals for the public good. This has a particular resonance for engineers responsible for the design of hazardous facilities when the result of errors could be catastrophic. The way in which design engineers describe both their motivations for choices made and their relationships with professional colleagues (if they indeed see their co-workers in this way) are of particular interest here.

It is one thing to be aware of responsibility for outcomes but another to see where action might be required. The ability to notice important cues about the state of the system from the mass of information available in a busy design office requires more than just technical knowledge. Weick’s work on sensemaking (1995, 2001) is one useful way to think about this issue. In any given situation, it is not possible for an individual to absorb and make sense of every piece of sensory information available. We selectively attend to certain things and ignore others, based on what we understand to be important at the time. Sensemaking theory takes the view that it is the role of leaders to create meaning or

Download English Version:

<https://daneshyari.com/en/article/6975772>

Download Persian Version:

<https://daneshyari.com/article/6975772>

[Daneshyari.com](https://daneshyari.com)