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Abstract. A central facet of resilience engineering involves adaptation which involves making temporal adjustments by responding, monitoring, anticipation and learning from disturbances continuous stressors. This ability to adapt is inherent in the actions which manifest as behaviors in individuals and teams. In the main, the response is generally in response is to regular and irregular threats such that work continues to operate as normal. Invariably, these adaptations also require trade-offs and sacrifices being made at a number of levels. However, there is little published research that seeks to explain how such adaptations actually occur in construction works. It has been suggested that resilience manifests as episodic adaptations which comprise of 'cluster of potentially dispersed activities,' and which can be observed as 'pockets of order' and analyzed through the response-execution-leverage (REL) model. It is our contention that these adaptations can be understood in normal construction work by observing how workers react to respond threats. This paper, based on an analysis of observations as part of a broader PhD research project examining resilience engineering in the Victorian construction industry, explores three episodes of such adaptations and analyses them using the REL model.

1 INTRODUCTION

While there is no uniform definition of Resilience engineering (RE), it has been suggested to be closely linked with adaptation (Chialastri & Pozzi, 2008), hence has been associated with the has adaptive age of safety management (Borys, Else, & Leggett, 2009). Such adaptations involve temporal adjustments made by people in these organisations as they respond, monitor, anticipate and learn from disturbances and/or continuous stressors (Hollnagel, 2009). According to McDonald (2006) this ability to adapt is inherent in the actions which manifest as behaviours at team (as well as individual and organizational) levels and involve response to regular, irregular, and to some extent (Westrum, 2006), even unexampled threats (Epstein, 2008) such that work continues to operate as normal. Invariably, these adaptations also require those operating at the sharp and blunt end of risks to make trade-offs and sacrifices in favour of safety over production (Cook & Nemeth, 2006).

In the case of normal, everyday work, such sacrifices and trade-offs form part of the way operators deal with regular threats in the construction industry. These occur at micro-levels; however, there is little published research that explains how such adaptations actually occur in construction sites. This paper seeks to make a small a contribution by exploring these facets of RE. It is based on an analysis of observations made as part of a recent doctoral research project completed through the Victorian Institute of Occupational Safety and Health at the University of Ballarat, Australia.

The reminder of the paper is organized as follows. First, the construction industry as a context for RE research is introduced. Next, we propose episodic adaptations as a means of exploring resilient behaviour at team level. This is followed by a close examination of three construction activities involving (i) roof plumbing and tiling, and (ii) excavation and drains on domestic construction sites. How the teams doing these activities are explored by analysing the way they responded a regular threat, changing weather conditions.

2 SAFETY AND COMPLEXITY OF THE CONSTRUCTION INDUSTRY

On a global level, the construction industry is one of the most dangerous for workers as evidenced by the high number of injuries and fatalities. In the UK, one third of all work-related fatalities occur in construction; workers are six times more likely to be killed than employees in other sectors (Health and Safety Executive, 2003),with the industry incurring the largest number of fatalities and major injuries compared to other industries (Health and Safety Executive, 2012). In Australia at least one construction worker continues to die every fortnight (Fisher, 2008), with the industry experiencing a fatality rate of 5.6 fatalities per 100 000 employees, which is more than twice compared to other industries such as manufacturing (Australian Safety and Compensation Council, 2010).

There are a number of aspects of construction that sets it apart from other industries such as manufacturing. For example, construction work can be dispersed physically over several, sometimes distant, locations, with each site representing 'mobile factories' (Bakri, Zin, Misnan, & Mohammed, 2006). Upon completion of each project the 'factory' is disassembled and relocated to the site of a new or different project. However, the conditions at the new site might be completely different from the earlier site (Bakri et al., 2006). The construction working environments can also be very dynamic with frequent rotations of work teams, changing weather conditions, and a high proportion of unskilled, temporary and transient workers. As every construction site progresses, new hazards and risks may also develop. Outdoor operations, working at heights and sophisticated plant and machinery add to the risks faced by construction employees (Choudhry & Fang, 2008). The nature of the work, poor attitudes and behaviors, unsafe work practices, ignorance, pressure from budget cuts and time restraints can compound health and safety risks (Choudhry & Fang, 2008; Holmes, Lingard, Yesilyurt, & De Munk, 1999). Combined, these factors make construction a complex industry to work in (Choudhry & Fang, 2008; Howell, Ballard, Abdelhamid, & Mitropoulos, 2002).

One consequence of this is that improving safety in construction work can be more difficult than in a manufacturing facility . Existing contemporary approaches may not be sufficient in driving safety improvements beyond what has already been achieved. This makes it an ideal candidate for RE (Pillay, Borys, & Else, 2011; Schafer, Abdelhamid, Mitropoulos, & Mrozowski, 2009). In RE, narrowing the 'gap between work as imagined and work as performed' requires making a number of different types of trade-offs (Hofman & Woods, 2011).

2.1 Episodic Adaptations

It has been suggested that resilience manifests as episodic adaptations (Grøtan, 2011; Grøtan, Størseth, Rø, & Skjerve, 2008). Such adaptations can be observed as 'pockets of order' and analyzed through the response-execution-leverage (REL) model. Recently authors such as Furniss, Back, and Blanford (2011) used case studies to observe a series of episodic adaptations in an Oncology Day Care Unit to understand the strategies that people adopted to balance risk and efficiency. The researchers concentrated on six episodes to explore resilient behaviors in normal work settings in the healthcare industry. It is our contention that these adaptations can be explored in construction settings by observing and anlysing how workers react to regular threats such as changing weather conditions.

3 RESEARCH FINDINGS

The paper is based on the results of observations conducted as part of research study aimed at exploring RE through the prescription and of safe work method statements in the Victorian construction industry. The aim of this research was to gain an understanding of the whether safe work method statements impede or enhance RE as a health and safety management strategy. Data for this study was collected in two domestic and one commercial construction sites through a series of one-to-one and focus group interviews held with sixty-four participants, documents and a series of observations.

This paper is limited to an analysis of three observations, two involving working at heights and one involving excavation and drains.

3.1 Episode 1 : Roof Plumbing on a Medium-Density Housing Project

The first activity involved roof plumbing on a medium-density housing project. Similar to most works in the construction industry, this work was outsourced to a subcontracted team of four people, one of who was a manager, an experienced tradesman and two apprentices. Over the course of two hours the researcher spent on the site, some slight changes in weather conditions were observed. There was a breeze, followed by a slight drizzle, with the wind picking up speed. Apart from a cursory glance at the sky, the team continued working work continued without a break. However, on an adjacent sit where similar woks were going on involving a different set of workers and unrelated to this research site, I observed the three people who had started the job stopped when the wind picked up speed.

It was noted that the Safe work method statement (SWMS) and Job safety analysis (JSA) used on our research site work did not mention changes in weather conditions as a potential hazard. Discussions with the team of roof plumbers revealed that such threats were basically treated as part of the norm, it was something they had learnt to continue working with; the threats were not high enough to put them in any form of harm. Because they were experienced plumbers, they relied on their experience to decide if and when the job had to be abandoned.

3.2 Episode 2 : Roof Tiling on a Medium-Density Housing Project

The second activity involved roof tiling on a medium-density housing. During the course of our observations different degrees of changes in wind and rainy were experienced over the two days this work was done. On the first day there were slight drizzles and light breezes, with increasing speeds over the course of the day. Similar to the roof plumbers observed in Episode 1, the roof tilers did no more than give a cursory look at skies, and continued their work, even when the wind had picked up speed. However, as the wind picked up speed, the team broke up early for 'smoko,' which also meant they left the site at around 2.00 p.m. (as opposed to 3.00 p.m. which was the norm).

However, on the second day it was windier, and wetter because of the rain that had fallen the previous night. As we joined the team at around 7.00 a.m., we observed this team were still on the ground. From the discussions they had another two days of work on that particular building, and were waiting for the weather to become better. The JSAs used for this job were also examined, and it was noted that 'wet weather, slippery top' and 'falling from height' had been added in black ink. The two partners indicated they would not normally add this on the JSA but had been advised to do so by the contract supervisor the previous evening, because of the 'OHS stuff that is going one.' They also provided that they would generally monitor the change in conditions and decide on the day if it was safe to work. Moreover, instead of relying on the JSA/SWMS they would use their previous experience to decide if it was safe to continue working.

3.3 Episode 3 : Excavation and Drains on Domestic Housing Project

The third activity involved excavation and drains (plumbing) on a single storey housing construction. This work was done by a team of two people; an experienced drainer who was also doubled as an excavator operator, and an apprentice drainer. What challenged use was that fact that the apprentice stayed within an arm's reach of the bucket during the course of the excavation activity, literally 'close to the edge' where he could have been knocked out cold (if not dead) were the bucket to strike him. This practice of 'working in close vicinity of a mobile plant goes against the guidelines for doing such work safely. Excluding workers from areas of an excavator by bunting or fencing, a clearance of at least 0.5 metres between the any operating part of an excavator and persons, a high level of visibility and safe means of signalling between the excavator operator and any persons nearby are minimum requirements (Safe Work Australia, 2012). However, on this occasion, visibility and hand signalling between the two were used which, at least in my view, were largely used for controlling the risks in this context. In this instant there was a regular threat, in the form of the apprentice working in close vicinity of the excavator where he would have been subjected to series injuries from being stuck by the bucket or crushed by the excavator. However, the two workers continued work as normal by taking things in their stride (Cook & Nemeth, 2006). There were also decisions made, subtly, not to follow the typical 'rules' associated with mobile plant-pedestrian segregation. These rules, to this team at least, were deemed to be part of the 'low-order' goals according to the goal-means hierarchy; whilst completing the excavations and drains in a timely manner (i.e. production) was more necessary to achieve the higher-order goals of production.

This team's response to changing weather conditions was also observed. About an hour into work the winds picking speed, followed by darkening of the skies. The workers glanced at these changing conditions, but continued working, with a subtle increase in pace. At the sign of the first drizzle the excavator operator signalled 'thumbs down', a cue that resulted in his colleague starting to collect the boxes of PVA glues, joints and tapes for the job and moving it inside their ute. Within less than twenty minutes it started pouring heavily, causing the workers to stop work and move to safety.

4 DISCUSSION AND ANALYSIS

The response repertoire in the above three activities can be suggested to represent to forms of episodic adaptation in the form of small pockets of order (Grøtan, 2011; Grøtan et al., 2008). This adaptation can be analysed through the response-execution-leverage (REL) model (Grotan, 2011). By subtly paying attention to the changing weather conditions (*entry point*) the three teams developed an anticipation of the risks; this targeted their *risk understanding*. The teams responded in an organised sequence, first by continuing to work and taking things in their stride (Cook & Nemeth, 2006), and later by stopping altogether to think of a new strategy when the weather worsened; this acted as the *release chain*. By stopping work altogether the teams responded to the changing degree of threats they faced.

At a minimum, these examples are illustrative of episodic adaptations that can occur in the construction industry, and demonstrated a form of resilience with production being sacrificed in favour of safety.

The three episodes can also be analyzed using the four cornerstones of RE suggested by Hollnagel (2009). By paying attention to changing weather conditions, the teams were able to *monitor* and remained *aware* of the changing nature of threats posed by increasing wind conditions and rainfall. They *responded* in one of two ways, by continuing to work or abandoning work altogether. By choosing to continue working In one case the team improvised on the job by including 'wet weather, slippery top' and 'falling from height' in their job safety analysis forms; in some ways this was about *learning from success*, because there had been no incident yet the team chose to take on board the learnings from the previous day.

The episodes also reveal different degrees of sacrifices being made on the construction sites, either for or against safety. In the first episode, subcontractors on our research site continued with their roof plumbing works by continuing to work when there was a slight drizzle, while on an adjacent site work stopped altogether. It could be suggested that there was some tendency on our research site to *sacrifice safety* in favour of production, while the adjacent site *sacrificed production* in favour of safety. Similar types of sacrifices were also made by the excavation and drains crew when they continued to use the mobile plant for excavating without the necessary level of segregation, and when choosing to abandon work when the site was impacted by rain.

5 CONCLUSION

The types of episodes that were observed and analyzed above represent those that are part of everyday work in the industry. In the domestic and/or medium density construction trade-offs and adaptations such as the ones we observed are made regularly as part of normal work. Such trade-offs, in the form of episodic adaptations, could increase or decrease the gap between work as imagined and work as performed. Depending on whether they are aimed at sacrificing safety or production, and could therefore enhance or hinder RE as a safety management strategy in construction settings. This paper makes a small contribution to the RE literature by providing empirical evidence of the utility of the REL model for understanding episodic adaptations, by providing empirical evidence of how subcontracted construction workers make trade-offs amidst a regular, everyday threat in the form changing weather conditions, as part of their normal work.

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REFERENCES

Australian Safety and Compensation Council. (2010). Construction Safety Data Sheet. Retrieved from http://www.safeworkaustralia.gov.au/NR/rdonlyres/E491F016-E62A-4A52-B1FC

Bakri, A., Zin, M., Misnan, M. S., & Mohammed, A. H. (2006). *Occupational Safety and*

Health (OSH) Management Systems: Towards Development of Safety and Health Culture. Paper presented at the 6th Asia-Pacific Structural Engineering and Construction Conference (ASPEC 2005), Kuala Lumpur, Malaysia.

Borys, D. M., Else, D., & Leggett, S. (2009). The Fifth age of Safety: the Adaptive age. *J Health & Safety Research & Practice, 1*(1), 19-27.

Chialastri, A., & Pozzi, S. (2008). Resilience in the Aviation System. In M. D. Harrison & M. A. Sujan (Eds.), *Computer Safety, Reliability, and Security* (pp. 86-98). Berlin: Springer-Verlag.

Choudhry, R. M., & Fang, D. (2008). Why Operatives Engage in Unsafe Work Behavior: Investigating Factors on Construction Sites. *Safety Science, 46*(4), 566-584.

Cook, R. I., & Nemeth, C. P. (2006). Taking Things in one's Stride: Cognitive Features of two Resilient Performances. In E. Hollnagel, D. D. Woods & N. G. Leveson (Eds.), *Resilience Engineering Concepts and precepts* (pp. 205-221). Aldershot: Ashgate.

Epstein, S. (2008). Unexampled Events, Resilience and PRA. In E. Hollnagel, C. P. Nemeth & S. W. A. Dekker (Eds.), *Resilience Engineering Perspectives Volume 1: Remaining Sensitive to the Possibility of Failure* (pp. 49-62). Aldershot: Ashgate.

Fisher, T. (2008). Building a Safety Culture. *Address to the australian institute of building 'construct' conference,* 22 February , Sofitel Hotel, Gold Coast, Queensland.

Furniss, D., Back, J., & Blanford, A. (2011). *Unwritten Rules for Safety and Performance in an Oncology Day Care Unit: Testing the Resilience Markers Framework.* Paper presented at the Fourth Resilience Engineering Symposium, 8-10 June, Sophia-Antipolis, France.

Grøtan, T. O. (2011). *The Stratified and Dialectical Anatomy of Organizational Resilience.* Paper presented at the 4th Resilience Engineering Symposium, 8-10 June, Sophia-Antipolis, France.

Grøtan, T. O., Størseth, F., Rø, M. H., & Skjerve, A. B. (2008). *Resilience, Adaptation and Improvisation–Increasing Resilience by Organising for Successful Improvisation*. Paper presented at the SecondResilience Engineering Symposium, 8-10 November, Antibes-Juan-les-Pins, France.

Health and Safety Executive. (2003). Causal Factors in Construction Accidents *Research Report 156*: Loughbrough University.

Health and Safety Executive. (2012). *Construction Work Related Injuries and ill Health*. London: Health and Safety Executive Retrieved from http://www.hse.gov.uk/statistics/industry/construction/index.htm.

Hofman, R. R., & Woods, D. D. (2011). *Simon's Slice: Five Fundamental Tradeoffs that Bound the Performance of Human Work Systems.* Paper presented at the 10th international conference on naturalistic decision making (NDM 2011), Orlando, FL.

Hollnagel, E. (2009). The Four Cornerstones of Resilience Engineering. In C. P. Nemeth, E. Hollnagel & S. W. A. Dekker (Eds.), *Resilience Engineering Perspectives,*

Volume 2: Preparation and Restoration (pp. 117-133). Surrey: Ashgate.
Holmes, N., Lingard, H., Yesilyurt, Z., & De Munk, F. (1999). An exploratory study of meanings of risk control for long termand acute effect occupational health and safety risks in small business construction firm. *Journal of Safety Research, 30*(4), 251-261.
Howell, G. A., Ballard, G., Abdelhamid, T. S., & Mitropoulos, P. (2002). *Working Near the Edge: a new Approach to Construction Safety.* Paper presented at the 10th Annual Conference of the International Group for Lean Construction Safety Quality and the Environment, 10 August, Granado, Brazil.
McDonald, N. (2006). Organisational Resilience and Industrial Risk. In E. Hollnagel, D. D. Woods & N. G. Leveson (Eds.), *Resilience Engineering Concepts and Precepts* (pp. 155-180). Aldershot: Ashgate Publishing Limited.
Pillay, M., Borys, D., & Else, D. (2011). *Exploring Safe Work Method Statements in the Australian Construction Industry: A Prospective Study in Resilience Engineering.* Paper presented at the Fourth Resilience Engineering Symposium, Sophia-Antipolis, France.
Safe Work Australia. (2012). *Code of Practice: Construction Work*. Canberra: Safe Work Australia.
Schafer, D., Abdelhamid, T. S., Mitropoulos, P., & Mrozowski, T. (2009). *Resilience Engineering: A New Approach for Safety Management.* Paper presented at the Construction Research Congress 2009: Building a Sustainable Future, April 5-7, Seattle, USA.
Westrum, R. (2006). A Typology of Resilience Situations. In E. Hollnagel, D. D. Woods & N. G. Leveson (Eds.), *Resilience Engineering Concepts and Precepts* (pp. 55-65). Aldershot: Ashgate.