6-2020

Attention, entrainment, and rules in high reliability organizations

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SINGAPORE MANAGEMENT UNIVERSITY
2020

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Submitted to Lee Kong Chian School of Business
in partial fulfilment of the requirements for the
Degree of Doctor of Philosophy in Business (OBHR)

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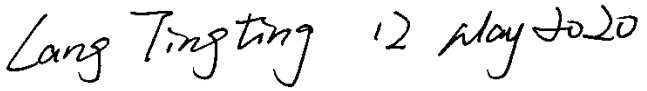
I hereby declare that this PhD dissertation is my original work
and it has been written by me in its entirety.
I have duly acknowledged all the sources of information
which have been used in this dissertation.

This PhD dissertation has also not been submitted for any degree
in any university previously.



Tingting Lang
12 May 2020

Abstract

Chapter 1: How institutions enhance mindfulness: interactions between external regulators and front-line operators around safety rules (with Ravi S. Kudesia and Jochen Reb)

How is it that some organizations can maintain nearly error-free performance, despite trying conditions? Within research on such high-reliability organizations, mindful organizing has been offered as a key explanation. It entails interaction patterns among front-line operators that keep them attentive to potential failures—and relies on them having the expertise and autonomy to address any such failures. In this study, we extend the mindful organizing literature, which emphasizes local interactions among operators, by considering the broader institutional context in which it occurs. Through interview, observational, and archival data of a high-reliability explosive demolitions firm in China, we find that external regulators can crucially enhance the mindful organizing of front-line operators as regulators and operators interact around safety rules. Regulators go beyond the interactions emphasized in institutional theory, whereby regulators help operators internalize the content of rules and follow the rules in practice. Rather, regulator interactions also help ensure the salience of rules, which enriches and distributes operator attention throughout the firm. We also find evidence of regulator learning, as interactions with operators help regulators improve rule content and the techniques by which rules remain salient. These findings expand our understanding of mindful organizing and the interactional dynamics of institutions. They also particularly speak to the debate over whether and how rules can enhance safety. Namely, through distinct practices that impact the content and salience of rules, regulators can increase standardization without diminishing operator autonomy.

Chapter 2: Entrainment and the temporal structuring of attention: insights from a high-reliability explosive demolitions firm (with Ravi S. Kudesia and Jochen Reb)

Attention has always been central to organization theory. What has remained implicit is that attention is a temporal phenomenon. Attention accumulates and dissipates at multiple timescales: it oscillates wavelike within a performance episode, decays gradually over the course of a performance episode, and withdraws in a step-like manner across multiple performance episodes. Organizations attempt to regulate the attention of front-line employees. But to the extent that attention has been examined as a stable phenomenon, rather than a temporal one, metacognitive practices that stabilize attention remain unexamined in organization theory. And to the extent that fluctuations in attention on the front lines generate systemic risks, these unexamined stabilizing practices constitute a core part of organizational reliability. In this case study, we examine a high-reliability explosive demolitions firm. Going beyond past work that identifies best practices shared across organizations, we instead uncover the logic of how several practices are bundled together in a single organization to stabilize front-line attention across these timescales. We uncover distinct bundles of attention regulation practices designed to proactively encourage attention and discourage inattention and to reactively learn from problems, including problems resulting from inattention. We theorize that these practices are bundled according to a logic of entrainment. Practices that proactively regulate the fluctuations of attention over time are mapped onto existing work routines that repeat cyclically across concentrically nested timescales—and reactive practices enhance learning by extracting lessons from mindless behaviors and feeding them back into entrained practice.

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Acknowledgments

First and foremost, I sincerely thank my committee chair Jochen Reb for his years of mentoring, advice, and encouragement. He encourages me to pursue challenging research and always supports me with all the necessary resources. Without his full supports, I wouldn't have completed this dissertation.

Also, I would like to thank Marko Pitesa. He is not only an excellent scholar, but also a helpful friend to doctoral students. From him, I learned how to develop a project from an interesting question, how to generate hypotheses and design empirical studies to test them, and how to write a paper. These skills are important for becoming a qualified scholar. I also appreciate Nina Sirola for her caring and encouragements in many essential moments during my PhD study.

In addition, I thank Ravi Kudesia for all the "talks" and "discussions" during our collaboration process. Thanks for putting me in an equal position when I was still at the early stage of my PhD study. I've learned more from him than what he learned from me. This process encourages me to do more qualitative studies. I also thank my committee member, Thomas Menkhoff, for the helpful comments during the defenses.

Besides my committee members, I would like to thank Roy Chua. He instructed me when I knew little about research. I enjoyed the process of exploring questions in various fields. This process is important for an independent researcher even though it could be painful and sometimes fruitless.

Roger Loh and Gennaro Bernile in the finance department also helped me a lot in my PhD process. Although they did not instruct me directly, they have great influence on my research. More importantly, I've learned to become a strict and creative scholar from their experiences.

I also learn much about the research process from scholars in different fields. Advice from Michael Bashshur, Devasheesh Bhave, Ronald Bledow, Shereen Fatimah, Don Ferrin, Gary Greguras, Filip Lievens, Jared Nai, Michael Shaerer, Hwee Hoon Tan, Kenneth Tai, Abhijeet Vadera, Gokhan Ertug, and Reddi Kotha, is important for improving my work. Further, I appreciate Jason Shaw for his suggestions and supports for my research.

Friends go through the PhD process together with me. I thank Liyao Li, Ke Miao, Liyao Wang, Xin Zheng, Yijie Fei, Shuyu Xue, Tengjian Zou, Lei Zheng, Bin Li, and Yuchuan Liu. We enjoyed the life at SMU together. I also thank Maggie Zhu and Crystal Huang for their friendship and supports. I cherish our time in Singapore.

Finally, I thank Haoyuan Li for his love and support. We learn from each other and enjoy the best time together.

Chapter 1:

How institutions enhance mindfulness: interactions between external regulators and front-line operators around safety rules

Ravi S. Kudesia*, Ting Lang* and Jochen Reb

Abstract

How is it that some organizations can maintain nearly error-free performance, despite trying conditions? Within research on such high-reliability organizations, mindful organizing has been offered as a key explanation. It entails interaction patterns among front-line operators that keep them attentive to potential failures—and relies on them having the expertise and autonomy to address any such failures. In this study, we extend the mindful organizing literature, which emphasizes local interactions among operators, by considering the broader institutional context in which it occurs. Through interview, observational, and archival data of a high-reliability explosive demolitions firm in China, we find that external regulators can crucially enhance the mindful organizing of front-line operators as regulators and operators interact around safety rules. Regulators go beyond the interactions emphasized in institutional theory, whereby regulators help operators internalize the content of rules and follow the rules in practice. Rather, regulator interactions also help ensure the salience of rules, which enriches and distributes operator attention throughout the firm. We also find evidence of regulator learning, as interactions with operators help regulators improve rule content and the techniques by which rules remain salient. These findings expand our understanding of mindful organizing and the interactional dynamics of institutions. They also particularly speak to the debate over whether and how rules can enhance safety. Namely, through distinct practices that impact the content and salience of rules, regulators can increase standardization without diminishing operator autonomy.

The first two authors contributed equally. Correspondence should be addressed to Ravi S. Kudesia (rskudesia@temple.edu). We gratefully acknowledge financial support from the Future Resilient Systems project at the Singapore-ETH Centre, which is funded by the National Research Foundation of Singapore under its Campus for Research Excellence and Technological Enterprise program (FI 370074011).

1. Introduction

As a topic of scholarly inquiry, safety has undergone periodic and substantial shifts in how it is conceptualized (see Hollnagel, 2014). One such shift has been from case studies of safety failures to studies of systems where failures are to be expected, but do not occur. The former approach, as exemplified by Perrow's (1984) influential treatment of the Three Mile Island accident, made a crucial point about how systems are designed: as the activities in a system become more complex and interdependent, the knowledge required to control the system begins to exceed the capacity of any of its regulators, managers, or operators, and the odds of safety failures necessarily increase as a consequence. The latter approach, therefore, has studied *high-reliability organizations*, a subset of complex and interdependent systems that attain nearly failure-free performance despite these trying conditions (LaPorte, 1996).

What became increasingly clear to scholars of high-reliability organizations was that the knowledge required to control such systems indeed cannot be completely encoded in rules formulated by managers or regulators, but that this need not necessarily increase the odds of safety failures. The knowledge required to control systems instead inheres within specific patterns of interactions among front-line operators and a shared concern for reliability that underlies and motivates these interactions (Weick, 1987; Weick, et al., 1999). These patterns of interactions, known as *mindful organizing*, serve a common purpose: they help operators direct their attention toward current activities and the potential failures lurking in them, rather than allowing past successes or previously determined strategies to lull attention away from current activities. These patterns, in turn, rely on operators having the expertise and autonomy to interpret the causes of any lurking failures they notice and address them accordingly (Vogus and Rerup, 2018; Weick and Sutcliffe, 2006). In particular, mindful organizing entails five specific

patterns of interaction in which people demonstrate a *preoccupation* with potential sources of failure, a *reluctance* to accept simplified interpretations of ongoing events, a *sensitivity* to current operations, and, when faced with problems, a *commitment* to resilience and a *deference* to the person with the most relevant expertise, rather than the most power (Weick et al., 1999).

From this perspective, safety is not conceptualized as an abstract system-level outcome (i.e., the absence of major failures), but as a set of concrete interactions that occur at the level of front-line operations (e.g., Hollnagel, 2014; Rochlin, 1999). A key benefit of conceptualizing safety in line with mindful organizing is that practitioners who value safety can more readily influence the patterns of interactions that operators enact during their activities than they can influence the complexity and interdependence of those activities (Perrow, 1984). The complexity and interdependence of operator activities has become less influenceable in part due to external technological advances increasing the complexity of activities (Hollnagel, 2014) and the inability of organizations to buffer their activities from external regulatory influence (Weick et al., 1999). In contrast, the operator interactions that constitute mindful organizing can be enhanced by leader actions (Madsen et al., 2006) and organizational practices like socialization (Weick and Roberts, 1993), training (Vogus and Welbourne, 2003), and technology use (Valorinta, 2009), among others (see Sutcliffe et al., 2016). In this way, mindful organizing may be a particularly promising pathway to safety because practitioners can directly enhance mindful organizing at the level of front-line operators, who are typically closest to any potential lurking failures.

Mindful organizing certainly captures an important aspect of safety. However, the singular focus on social interactions among front-line operators in the relevant research may entail limitations in its explanatory power and recommendations for practitioners. For instance, although these front-line operators will have local expertise, they may lack the broader system-

level understanding to optimally use whatever authority is granted to them (Leveson et al., 2009). Empowering operators in the manner recommended in mindful organizing research could therefore increase the risk of safety failures in some cases, rather than reduce it. Research on mindful organizing can thus be characterized by a degree of "interactional reductionism" (Levinson, 2005), whereby phenomena that are better understood at the system level are reduced to local interactions. Unless the interactions among front-line operators are contextualized more fully within system-level features, the recommendations made in mindful organizing research may be systematically limited in ways that increase the risk of safety failures.

To this end, mindful organizing researchers have recently started to contextualize these front-line interactions through theoretical work. Some have theoretically emphasized interactions between front-line operators and top managers within an organization (Vogus and Rerup, 2018). Others have emphasized how any such interactions occur within the broader organizational context, including the structures that provide people with institutionalized concepts for sensemaking, the resources that enable them to enact routines, and the information flows that guide which routines they enact and which concepts they use to make sense of events (see Kudesia, 2019; Kudesia and Reb, 2018). However, our understanding of how mindful organizing is embedded within broader system-level features still remains exceedingly limited, particularly given the absence of relevant empirical research.

In the present empirical study, we therefore focus simultaneously on global system-level features and local interaction patterns within a high-reliability explosive demolitions firm in China in order to expand the explanatory power of mindful organizing for safety. In particular, we focus not merely on the interactions among front-line operators, but on the interactions between front-line operators and their external regulators, as they occur over time (cf.

Shrivastava et al., 2009). Through an inductive analysis of interview, observational, and archival data, we generate a novel theoretical model that broadens our understanding of mindful organizing by considering interactions between two groups, rather than merely within a single group of front-line operators, and by highlighting how these interactions both draw from and contribute to system-level institutionalization processes (see Figure 2). In particular, we find that four specific types of interactions between external regulators and front-line operators related to safety rules are crucial in enabling and sustaining mindful organizing in ways that, in turn, improve organizational safety. It is, at least partially, through these four interactions that operators and regulators jointly maintain the content and the salience of rules during activities.

A central topic of importance to emerge inductively from our data concerns rules. Rules or formal written-down representations of standard operating procedures, are known to play an important role in safety, albeit a role that remains poorly understood (see Hale and Borys, 2013a, 2013b). On one hand, violations of rules are typically associated with reduced safety (Dekker, 2005; Hopkins, 2011). On the other, operators often report that rules have little to no relevance to their actual activities (Hale and Borys, 2013a, pp. 208–209). People can further violate rules intentionally or unintentionally in ways that enhance or reduce safety, and for varied reasons including that violation has become normalized or that current activities fall outside the scope of the available rules (Reason et al., 1998). All of these complications make the function of rules for safety difficult to understand and in need of further clarification.

One way to help clarify the function of rules for safety is to consider how global system-level features shape local interaction patterns. In one way of thinking, the global system-level features strongly determine local interaction patterns. Dekker (2005), for instance, suggested that institutions can endorse one of two competing approaches to rules—and whichever approach the

institution endorses will shape operator activities. In the first approach, rules are treated as strict bureaucratic controls that institutions encode into operators through socialization and training. Front-line operators thus violate rules at great peril, as rules standardize the knowledge of the experts who formulated them. In the second approach, rules need not be strict and controlling. Instead, properly enacting a rule requires the expertise of operators in their specific contexts (Dreyfus and Dreyfus, 2005). This suggests a need to grant greater autonomy to operators.

In another way of thinking, however, an institution need not exclusively endorse either a standardization approach or an autonomy approach to rules at the global level (Hale and Borys, 2013a). Rather, in line with the principle of loose coupling (Orton and Weick, 1990), an institution can retain aspects of both standardization and autonomy through "flexible rules" (Grote, 2004; Grote et al., 2009). Flexible rules, for instance, are written in a manner that does less to specify the precise actions operators must undertake and does more to emphasize the goals for operators to achieve or the processes by which they can make effective decisions (Hale and Swuste, 1998). As a result, flexible rules can be standardized globally throughout an institution, while still allowing for local autonomy among operators.

But flexible rules cannot be defined merely by their content. An understudied but "crucial" question regarding flexible rules concerns "the process of generating and modifying rules" (Grote et al., 2009, p. 22). Institutions must engage in a process that not only generates safety rules, but also modifies these rules based on feedback from operator activities (cf. Barley and Tolbert, 1997). We can thus reconceptualize mindful organizing on the front lines not as an isolated group activity, but as an important local sensemaking process that draws on, contributes to, and interfaces with the broader system-level process by which institutions manage their safety rules (Kudesia, 2017; Weber and Glynn, 2006).

The present study adopts this reconceptualization of mindful organizing to help clarify the function of rules for safety. In particular, our model addresses the vastly understudied interactions between global and local levels: how institutional and operational actors come to support each other toward mindful organizing and thus safety (Barbour and Gill, 2017; Hale and Borys, 2013b). Our research clarifies how the four specific interactions of encoding, reinforcing, reinstating, and learning that we discover can enhance the management of rules for safety. In so doing, complementing past research that has largely focused on the content of rules, our findings surface the importance of rule salience. Even rules that are well-encoded through training and assessment practices are of little practical value if they are not salient in operators' minds during their everyday activities. We find that regulators engage in a number of specific practices that reinforce and reinstate the salience of safety rules. Our introduction of this distinction between rule content and rule salience further develops the important question of how flexible rules function in practice (Grote et al., 2009) by identifying how salience and content functions of rules enable loose coupling. In particular, regulators can interact with operators in a manner that keeps the goals of rules salient in the minds of operators, which allows regulators to improve the content of the rules as they learn over time. As a result, regulators can modify the rules without undermining their legitimacy in the eyes of the operators (which would entail a dysfunction of excessive autonomy) and without letting safety decay because the regulators are reinforcing rules that contain irrelevant content (which would entail a dysfunction of excessive standardization). Taken in sum, our study thus sheds light on the broader context in which mindful organizing occurs, by considering the interactions around rules between institutional and operational realms.

2. Method

2.1. Study context

Our study concerns interactions between front-line operators and external institutional actors within the explosive demolitions industry. Safety is a serious concern for the explosive demolitions industry given the nontrivial risk of fatality (Chen et al., 2012) and how human errors account for a majority of safety failures (Yin et al., 2017). As such, we purposively sampled from within this industry. Purposive sampling entails the methodological process of selecting a study context where the dynamics of interest are likely to manifest transparently (Patton, 2002).

In particular, operators in our study work for a large Chinese firm, which we refer to by the pseudonym Monkey King Blasting Company (MKBC). Founded in 2007, MKBC operates blasting projects for civil uses in mining and quarrying, as well as other civil engineering uses like dam and road construction. MKBC has earned a "first class" operation certificate from the government for its excellent operational record, which qualifies it as a high-reliability organization within its industry. The explosive demolitions industry is externally regulated by the police, who manage the operation certificates of organizations as well as the licenses of individual operators and maintain an on-site presence where blasting activities are occurring.

During data collection for this study, we recognized that even front-line operators in high-reliability organizations can engage in mindless and unsafe activities for several reasons (e.g., Choudhry and Fang, 2008). But we were surprised to find that these external regulators played an important role in proactively maintaining and reactively restoring mindful organizing, thereby limiting the unsafe activities of operators. Because such interactions between regulators and operators were frequent and revelatory in this context, we chose to explore them in greater

depth as our theoretical contribution for the present study. The focal institutional actors in our study are former operators employed by MKBC who, due to their extensive experience in the industry, have been deputized by the police as on-site regulators for the blasting activities of other firms. Their dual perspective as former operators and current regulators gives them vivid and unique insight into the nature of regulator-operator interactions.

Insert Table 1 about here

2.2. Data collection

We conducted interviews as our primary data source, which we supplemented with observation, informal conversations, and archival data. The data reported in this study include fifteen interviews, selected from a broader data collection based on their relevance to our current research question (see Table 1). We selected these interviews because they contained data about the interactions between regulators and operators from the perspectives of both the operators in the blasting site and their external regulators. The interviews lasted 30 to 90 minutes. They were audiotaped and both transcribed and translated by the author who conducted them, following best practices for cross-cultural qualitative research (Poland, 1995; Xian, 2008). We staggered the interviews over two time periods to allow insights from our first data collection to guide our subsequent data collection, in line with the principle of theoretical sampling (Charmaz, 2006).

We began with phone interviews with the top managers of 4 of the 6 active blasting projects. Because these managers take the lead role of interacting with the police regulators, we felt that they could therefore provide a valuable initial overview. These initial interviews gave us rich insights into the organization's relationship with regulators, how regulatory actions impact

organizational safety, and its various interactions with regulators. To deepen our insight into how interactions with regulators influence organizing at the operational level, one of us travelled to the blasting sites and, once there, carried out a second round of interviews with managers, operators, and regulators on the front-lines. Based on emerging theoretical insights, and in line with the principle of tracer studies (Hornby and Symon, 1994), our interview questions traced the various functions and transformations of safety rules over time to better understand how they were enacted in context. We selected blasting sites for visits that were described by top managers in phone interviews, which allowed us to triangulate across sources in the organizational hierarchy (Lincoln and Guba, 1985). Because top managers interact with city-level police and front-line operators interact with town-level police, over whom city-level police have jurisdiction, our informants collectively cover the spectrum of interactions across different levels of the hierarchy.

These formal interviews were supplemented with observations, informal conversations, and archival data collected at the blasting sites. Specifically, the author attended group field meetings, jotted notes during observations in the blasting sites, had informal conversations with informants during breaks, collected photos and videos to capture important observations, and shadowed a key informant during his everyday activities (Czarniawska-Joerges, 2007; Emerson et al., 2011; Spradley, 1980). Archival data served a complementary function that helped us better understand and contextualize our interviews and observational data. For instance, in explaining how they manage safety concerns, the Guard Man and Site Regulator 2 both showed us physical records they used to document everyday explosive use and operational problems, respectively. We treated copies of these physical records as archival data that enriched our understanding of how safety was managed on the operational level. We also collected archival

data such as organizational brochures and training materials from the CEO's office, as it is the department in charge of collecting and managing firm-level data. Because much of these archival data are confidential, they were used in analysis but are not reproduced here.

2.3. Data analysis

We imported transcribed interviews, field notes, and photos into ATLAS.ti to conduct our data analysis (Friese, 2014). Following an inductive approach to coding, we treated our informants as knowledgeable agents and therefore sought to foreground their interpretations (Gioia et al., 2013; Van Maanen, 1979). Guided by our growing interest in the interactions between operators and regulators, in our first round of coding we sought to describe what regulators do, why the regulators do what they do, how operators react to regulator activities, and how regulator activities affect operations, using in-vivo codes that captured informant language (Charmaz, 2006). For example, we coded "*If the company has even one safety accident, the police will punish us immediately, by degrading the company. Now our company is first class, the highest national class. We would be degraded [to a lower class] if an accident happens. Based on the severity of the accidents, we might even get our blasting certificate cancelled or withdrawn. This would mean that we could never do blasting projects anymore*" (Project Director 1) as "police punish accidents by degrading or withdrawing organizational certificates."

After the first round of descriptive coding, we moved to a second round of coding, in which we identified open codes within the initial codes. The open coding process remained at the level of informant language, but started to identify concepts that could serve as building blocks for a grounded theory (Charmaz, 2006). Examples of open codes include "teaching operation knowledge and procedures," "monitoring operators to conduct tasks by regulations, rules, and procedures," and "stopping wrongdoings." After open coding, when we noticed higher-order

themes starting to emerge, we began axial coding by grouping similar open codes into categories (Charmaz, 2006). For example, the open codes of "teaching operation knowledge and procedures" and "lecturing safety regulations and rules" were grouped into the category of "training rule content," as they showed what content the regulators trained the operators in.

During the axial coding process, we observed that the interactions between regulators and operators influenced one of two aspects of rules—namely, the content of rules (what activities the rules promote or prohibit) and the salience of rules (the extent to which rules are cognitively activated during operations)—and that these interactions proceeded differently across different stages over time. This insight led us to iterate back to the literature (Orton, 1997), seeking insight into the stages across which interactions occur between institutional and operational realms. We found that Barley and Tolbert's (1997) four-stage model helped to explain the interactions between institutional and operational realms present in our data—and, in doing so, highlighted the unique ways in which these interactions relate to mindful organizing. The third, and final, round of selective coding allowed us to arrange our findings into a single theoretical model (Charmaz, 2006), where the interactions between regulators and front-line operators occurred across the four stages identified by Barley and Tolbert. The data structure resulting from our iterative coding process (Gioia et al., 2013) appears in Figure 1, where the stages and regulator-operator interactions are displayed. These themes are subsequently arranged into our full process model in Figure 2 and organized by rule content and rule salience in Table 3.

Insert Figure 1 about here

2.4. Development of theoretical model

To develop our theory, we drew on and extended Barley and Tolbert's (1997) model. Their model was designed to better clarify how features of institutions, such as rules, can both constrain and enable practical human activities, such as operator safety, making it an ideal basis to arrange and organize our findings. Whereas their intent was general, to explain how features of institutions are reproduced or transformed through human activities, our intent here is more specific. Our intent is to understand how the various stages of this process implicate safety—and the specific interactions between actors associated primarily with the institutional realm (the regulators in charge of rules) and actors associated primarily with the operational realm (the blasters whose activities the rules are meant to guide). We use the imagery of rules "circulating" between the institutional and operational realms to capture how these rules are dynamic, active, and negotiated through social interactions rather than existing passively as cognitive knowledge to be passed from one person's mind to another (cf. Gherardi and Nicolini, 2000), although the term "rule management" certainly could apply equally well to our data (Hale and Borys, 2013b).

In line with Barley and Tolbert (1997), we trace four stages of rules circulating between regulators and operators: encoding, enacting, following/violating, and learning (see Figure 2). *Encoding* refers to the first stage in which institutional safety rules are introduced to and internalized within operators, largely by training and certification processes. *Enacting* is the next stage in which operators apply these general rules to their specific current activities. *Following/ violating* refers to the subsequent stage at which the operators, as a result of their actions, either faithfully follow the rule or violate it. Finally, the operator action of rule following or violating can facilitate *learning* within the institutional agents, which, in turn, impacts their subsequent interactions with operators.

In this model of institutional rule circulation, institutional actors perform the encoding and learning stages, whereas operational actors perform the enacting and following/violating stages. We move beyond this model to identify two additional interaction processes, by which institutional actors, the external police regulators in this case, influence how operators use rules—processes that directly map on to the enacting and following/violating stages performed by operational actors. First, whereas institutions are typically seen as only influencing the content of rules through encoding, the on-site external regulators also influence the salience of rules during the enacting stage, through various *reinforcing* interactions that proactively keep operators attentive toward current activities. Second, institutional actors also engage in more reactive *reinstating* interactions that help ensure the integrity of rule content and the constancy of rule salience during the rule following/violating stage. These processes reveal that institutional actors do not merely influence the content of rules, but their salience as well—suggesting that these interactions have greater effects on operator cognition, particularly attention, than has been noted to date.

Insert Figure 2 and Table 3 about here

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3. Presentation of grounded research findings

We now turn to a deeper examination of the four regulator-operator interactions as they occur over the aforementioned stages of rule circulation. For each of these interactions, we provide quotes from our informants in the main text that eloquently describe the interaction and supplementary quotes in Table 2 that offer additional evidence that these interactions are indeed

grounded in our interviews with informants (see Pratt, 2007). In the following section, we detail how these regulator-operator interactions enhance mindful organizing and safety.

Insert Table 2 about here

3.1. Encoding of safety rules

Beginning at the first stage, the first regulator-operator interaction relates to encoding. Encoding entails to the set of interactions through which operators first become exposed to and begin to internalize the content of institutionalized safety rules. Examples of rule content within the explosive demolitions industry include that operators must carry certificates of exam completion with them, follow procedures to properly connect wires, wear electrostatic clothing and not carry cigarettes or cellphones, evacuate from the blasting area behind a prespecified safety diameter before blasting occurs, and that the organization must report the explosives used in each blast by a deadline after use. These safety rules specify both the processes by which operator activities must proceed, if safety is to be maintained, as well as the specific and concrete steps by which these processes are accomplished on the front lines (Hale and Borys, 2013a).

3.1.1. Practices Associated with Encoding

Two specific practices were used to enhance the encoding of rules through regulator-operator interactions: training and assessing. These two practices serve as the initial foundation for operators to competently enact the content of safety rules during their everyday activities.

Training. Regulators formulate the content of the safety rules that operators must know before operating—and training serves as the primary means by which regulators educate the operators on these safety rules. Rather than relegating training to the self-study of individual

blasters, the internal education processes of the various distinct explosive demolition firms, or a third-party contractor, the regulators themselves host a large training to help potential operators encode the rules. As the CTO of MKBC explained, "*the police in our city organize a large blasting operation training every year … It is mandatory. The [operators] must pass this training, which takes 72 hours in total.*"

For all front-line operators, including even the security and guards, the content discussed during training is the requisite first step to entering the blasting industry. Some of this content thus concerns the basic activities of blasting, including "*how to claim and distribute explosives, how to load powder, and how to connect wires*" (Junior Blaster 1). Other content is more advanced and focused on safety as a topic in itself, in which case, experts are brought in to discuss cases where failures occurred. As Project Director 1 explained, "*The police invite experts to give us lectures using cases. The experts teach us cases, tell us about accidents, and show us operation procedures.*"

Assessing. After training the content of the rules, regulators possess the power to issue or withhold a license to any would-be operator (or a renewal to an existing operator) based on their assessment of that person's performance during training. If denied a license, operators are effectively excluded from the industry: "*To work in the blasting sector, we need to obtain a license from police*" (Junior Blaster 1). As a result, assessment of operators' knowledge of the rules is an important step in the process, one that is tightly monitored and controlled. As Site Regulator 2 explained, "*Because the blasting industry is related to civil explosives, the exam is very strict. The questions on each computer are different. It's impossible to cheat.*" The strictness of assessment, with randomized presentation of questions on computers, attests to the dangers of granting licenses to operators with limited or faulty knowledge of safety rules.

3.2. Reinforcing of rule enactment

Whereas the first stage of rule circulation, encoding, occurred within the institutional realm (i.e., police-sponsored training and assessments), the second stage occurs at the operational realm (i.e., where operators enact the rules on the front lines). The second type of regulator-operator interaction, *reinforcing*, occurs here on the front lines, as regulators stationed at active blasting sites proactively ensure that rules are properly enacted through their interactions with operators. On the most basic level, Project Director 1 noted that the on-site regulators ensure that the operators have received training and demonstrated basic competence by "*requiring that all operators have licenses*," as the regulators manually check that "*all people [present at the blasting site] are properly licensed operators.*" But having a license signifying knowledge of the content of rules does not ensure that the rules will be enacted, which is why a need exists for regulators to engage in reinforcing interactions with operators.

3.2.1. Practices Associated with Reinforcing

To ensure that rules are actually being enacted, regulators use two specific practices during their reinforcing interactions with operators: ensuring compliance (increasing the extent to which operators behave in compliance with the rules) and vigilance maintaining (increasing the attentiveness of operators during their everyday activities).

Ensuring compliance. On the front lines, although operators may know the content of the safety rules, they are not uniformly motivated to follow these rules. Despite acknowledging that these safety rules will, in most cases, improve safety, operators note that safety rules also entail tradeoffs with other operational goals, such as productivity. These tradeoffs can limit the degree to which operators actually enact the rule content during their everyday activities. One of the regulators we spoke to was formerly a front-line operator. He described how operators felt

about safety rules: "*To be honest, if we do everything according to the rules, our operations would become very slow. [Following rules] delays progress. Sometimes if we follow rules, our work will be impacted. For example, the rule says that all operators must evacuate outside 200 meters. But it's impossible when operating inside a tunnel. We can only ask the teams following [the blasting team] to go back about 50 meters. [If they evacuated 200 meters like the rule mandates], the progress of the other teams would be delayed*" (Site Regulator 1).

Further, safety rules pertain to different types of operational activities, and thus require some degree of coordination across the various front-line operators. For instance, in a mining blasting project, the safety rules for evacuation are meant to protect the blasting team from injuries. But there are also miners, constructors, and transporters on site, each of whom may be from different organizations. As Site Regulator 2 explained, even if the blasting team follows the relevant safety rule, they have no formal mechanism to ensure that the other teams do so as well: "*Sometimes when asking operators on other teams to evacuate [before the blasting team detonates an explosive], they just want to finish up their tasks, and don't evacuate. This causes the evacuation to be delayed.*"

The presence of on-site regulators helps overcome both of these common reasons why rules are not actually enacted in practice: the tradeoffs between safety and productivity and the inability of any one team to ensure that other teams follow the content of safety rules. We refer to this practice as ensuring compliance, as here the regulators interact with all the operators to ensure behavior is compliant with the rules. Primarily, ensuring compliance takes the form of regulators inspecting the ongoing operator activities. As one of the regulators explained, "*Police come here [to the blasting site] to count: counting the quantity of explosive powder and the number of operators. They also check the operation site, whether there are hidden dangers,*

whether the safety warning zone is [clearly and properly set]" (Site Regulator 1). The Guard Man similarly described the process of checking: "*Police usually check if we work by the rules when operating. For example, the police check whether the blasters wear electrostatic clothing, bring smokes and lighters to the blasting site, bring phones or not, how we set up the safety warning zone, whether we turn on the warning alarm or not before a blast. Also, the police check if each operator is in charge of their own tasks.*" In this way, regulators interact with operators in ways that help proactively ensure that the content of safety rules is enacted, despite any productivity tradeoffs or coordination challenges that accompany multiple teams from different organizations.

As the following conversation reveals, regulators engage in these ensuring compliance interactions with operators specifically with safety in mind:

> Interviewer: "*What do you pay attention to during your daily work?*"
>
> Site Regulator 2: "*Safety! Safety is the most important thing!*"
>
> Interviewer: "*Could you specify what you mean by 'safety'?*"
>
> Site Regulator 2: "*For example, [how operators set up] the safety warning zone when they load powder, [how they] use detonators and explosive powder, and when the blasters are about to blast, all people at the blasting site must be evacuated 200 meters away from blasting zone, where there might be dangers, all people must evacuate, to a safer place, etc.*"

And such interventions lead to concrete improvements in rule enactment:

> Site Regulator 2: "*Now our regulating has become stricter. Our communication [with the operators] works: the [operators] will execute once we tell them to do anything.*"
>
> Interviewer: "*How about the issue of lost explosives?*"

Site Regulator 2: "*Basically there are no lost explosives now. Before they start to work, I told them to claim explosives based on how many they plan to use. The leftover explosives need to be returned to the warehouse. After power loading, all leftover explosives should be returned to the warehouse. So now our regulating is stricter. Normally there is no accident.*"

Vigilance maintaining. In addition to the more direct practice whereby regulators check and inspect operators, the mere presence of on-site regulators has a further indirect effect on the vigilance of operators. Namely, the very presence of regulators at the operational realm enhances operator alertness towards safety in general. The regulators and operators alike that we spoke to consistently suggested—in comparing the frequent supervision of local police in their blasting site relative to other, laxer, blasting sites—that the more often regulators visited the site, the greater the effect it had on maintaining vigilance, ultimately helping to "*prevent accidents*" (Site Regulator 2). The effect was summarized in one particularly revealing conversation:

Interviewer: "*How often do police check the blasting sites?*"

Project Director 1: "*Very frequently! For example, here, the police come to monitor our operations every day.*"

Interviewer: "*Really, local police?*"

Project Director 1: "*Yes. For example, if we plan to blast today, we report to the police that we're going to blast at a certain time, either via WeChat [a messaging program] or just calling them. Then our office needs to send a person to pick the police up and come to our site. Then the police watch over the whole process of blasting.*"

Interviewer: "*So the police are at the site every day.*"

Project Director 1: "*So you see, the supervision of the police here is very strict and*

adequate, in terms of detecting hidden dangers. They did good supervision, helping us to eliminate many hidden dangers. For us, we hope that police are strict in regulating. Why? Because it's beneficial for our own safety."

Interestingly, some informants even suggested that the presence of on-site external regulators offered greater benefit for safety than internal safety processes. As Project Director 1 explained, "*In terms of inspecting the operations, police supervision has better effects than our own*" (Project Director 1). Site Regulator 1, similarly, noted how "*external regulation is the most effective. External supervision is stronger. If there is any accident, the external regulation must have been lax [at that site]*." But it is further likely that the external and internal processes work together, rather than functioning as substitutes. Speaking with the Guard Man, who is the primary person tasked with coordinating with the on-site regulators, he explained the many internal processes he engages in to ensure that rules are followed: "*I'm in charge of coordinating with police at the blasting sites … After I claim the explosives for operators from the warehouse, I transfer the explosives to operators at sites and make records. Then I need to supervise whether every party signed on the records. I need to make sure that every operation is by the rule. [For example,] I need to make sure that the blasters use boxes to store explosives. [I need to check] the distance between detonators and powder. These operations must follow the specific procedures and rules.*" He then went on to explain that the presence of external regulators strengthens his internal safety processes, allowing operators to remain more vigilant.

Interviewer: "*Does the internal [process] become stricter if the external regulation becomes stricter?*"

Guard Man: "*Yes. The external supervision is strict. Our internal [processes] must definitely keep up with their steps. Otherwise, we will be eliminated by the industry.*

Because we can't afford any accident. As our project director said, your performance may be good, like you earn 4 or 5 million for the company today, but your whole work will be in vain once you have a single accident. So, we can't afford any accidents."

3.3. Reinstating after rule violations

The prior stage of rule circulation, reinforcing, describes an ongoing set of regulator-operator interactions, whereby the frequent on-site presence of regulators helps proactively facilitate rule-compliant behavior in operators and maintain their vigilance. During their ongoing interactions, however, regulators might notice violations of rules from operators. Site Regulators notice such rule violations as they "*enter into and get out of the sites together with operators*" (Site Regulator 2). By maintaining a frequent on-site presence, the likelihood of noticing such rule violations substantially increases. As one informant explained, this presence allows them to detect a host of rule violations:

Site Regulator 2: "*Sometimes they [operators in the basting team] violate the rules.*"

Interviewer: "*Could you give some examples of the rule-violating behaviors that you noticed?*"

Site Regulator 2: "*Sometimes when the operators were loading powder, there were still workers at the site who hadn't evacuated. They should cut off the electricity. If not, the detonators might cause premature detonation when loading powder, which might cause accidents. And when distributing explosives, they should've clearly counted the number of explosives, because if they missed counting one detonator while distributing, the detonator might be lost somewhere outside.*"

Upon noticing such rule violations, the external regulators engage in a separate set of reactive social interactions with operators, which we call *reinstating* interactions. These

reinstating interactions differ from reinforcing interactions in that they only occur when regulators notice that operators violate rules. These interactions serve the overall function of addressing the violation both immediately with the offending operator, and more broadly on the front lines.

3.3.1. Practices Associated with Reinstating

In response to rule violations, regulators use three practices during their reinstating interactions with operators: correcting the immediate violation behavior, reasserting the content of the rules, and escalating so that operators more broadly keep the rules salient in their minds.

Correcting. After noticing violations during the front-line operations, regulators quickly react to these problems, intervening to promote problem solving, which we refer to as correcting. For example, Site Regulator 2, who supervises a blasting team, explained how he undertakes correcting actions after noticing operators engage in rule violations:

> "*Sometimes, some operators do a very messy job. The tubes and powders are too messy. If I was operating, I would clean my area after finishing loading powder into one hole, then I would start the next hole. I would put the tubes which I don't use aside. However, some operators work on 20 to 30 holes altogether. And [I saw that] the wires were all mixed on the ground … When I notice that some blasters step over the tubes, I warn them not to step on the tubes, and ask them to check if the tubes were broken. If there are any small holes on the tubes, I ask them to change to new tubes … When we were supervising on the ground, we stop problems once noticing. We have two regulators in this blasting site. We both follow these blasters [around]. When we saw that their tubes were messy, we helped them to clear up…*"
>
> "*When I first came to supervise this team, I noticed that most blasters tied detonators and*

igniters from the forward direction. I told them, 'You should tie from the reverse direction.' But they told me, 'It's okay, as long as the detonator can explode [it doesn't matter how you tie the detonators and igniters]'. Then I explained to them, 'I saw incidents happen twice in your operation … I noticed that there were two holes that didn't explode [because you incorrectly tied detonators and igniters]."

These immediate correcting actions by regulators are helpful for solving problems emerging on site. For instance, speaking about the effectiveness of his correcting actions, Site Regulator 2 explained: "*Now [these violations] have been corrected. They all tie from the reverse direction.*" However, the immediate correcting of a single operator's behavior may not be the only, or most effective, way of ensuring that safety rules are properly followed.

Reasserting. Indeed, some problems might emerge repeatedly across operators on a site. During field observations across blasting sites, and several of our interviews, we found that some problems occur repeatedly over time within a site or across operation sites. For instance, many of our informants also discussed the problem of operators tying wires in the opposite direction (CTO, Site Manager 1, Senior Blaster, Safety Man, Site Manager 2). Another common problem mentioned by several informants was flyrock, where explosions send rocks airborne in ways that can lead to serious injury, particularly if all operators have not evacuated to the proper distance (CTO, Project Director 1, Site Manager 1, Site Regulator 1, Safety Man). In such cases, regulators may adopt more forceful practices when faced with frequent violations of rules, so that these common problems cease. We refer to such practices as reasserting, as these practices help reassert the content of rules that are often violated. One common reasserting action taken by regulators is to force the entire project to pause, require the operation team to solve the problems during the pausing period, and supervise them consistently until the problems are solved. One

informant, Site Regulator 2, told us how regulators take action to reassert the violated rules:

> "*Police notice a problem. They just [ask the company to] stop the project for several days and correct their violations. After correcting, police come to supervise you [the blasting team]. They examine and supervise you to blast. And they check all of your operation records. [After this] they allow you to start the operations again. So, there must be actions to make changes and reforms. Afterward, the operation team conducts blasts for another several times. And police keep coming to supervise these operations [after the correcting] until [they are confident that] you are qualified.*"

Although these reasserting practices are more forceful than the more minor correcting practices, even reasserting may not be sufficient to ensure proper enactment of safety rules.

Escalating. Indeed, one reason why *"external regulation is the most effective"* (Site Regulator 1) is that external regulators possess the power to escalate the repercussions of rule violations in ways that enhance the salience of the rule throughout the entire organization. We refer to these practices as escalating. One escalating practice by which regulators enhance rule salience is to expand the realm of awareness of violations beyond the immediate operators. As our informant, Guard Man, shared with us, "*Police noticed one small problem by one operator. They tended to assume that the entire operation team has such problem. So, [the problem] is exaggerated.*" Escalation, in such cases, is made possible through tactics such as asking the blasting company to "*hold meetings for all operators in the team, let them know about the mistake (one blaster carrying smokes into the blasting site)*" (Guard Man) and "*turn the mistake into a case study and tell it to the whole team*" (Site Regulator 2). By escalating a single violation into a set of meetings or a case study, regulators can dramatically increase the salience of that rule throughout the broader organization.

The more effective tactic to make rules salient on the ground, however, appears to be punishment. As the legitimate external regulator, police have the power to punish violations from operators. Punishments enhance the salience of rules because the severity of the punishments are coupled with the severity of the violation. On the less severe side, the CTO explained, "*police lock the explosives management system if we forget to upload records.*" Even this punishment of locking the explosives management system, however, has organization-wide consequences: "*It's one system for the whole company. You see, there are so many projects in the company. So, if the company's explosives system gets locked, all projects come to a halt, not just one single project*" (Site Regulator 1). This punishment is effective in terms of managing explosives and preventing the loss of explosives, as the operation team now "*doesn't dare forget to report records. As long as we finish the explosives claiming, after the blast per day, we return the left-over explosives to the warehouse, and report how much we used today right away*" (Site Regulator 2).

For more severe accidents, regulators may "*downgrade or withdraw the company's operation certificate*" altogether (Informants: Site Regulator 1, CTO, Project Director 1). As one informant, Project Director 1, told us, "*Police supervision is very strict. If you have any accidents, the police punish you immediately by downgrading your class. For example, now our company is first class, the highest. We could be downgraded [to a lower class], depending on the severity of the accident. Or our operator certificate would be withdrawn, so that we cannot conduct blasting projects in the industry anymore.*" Such punishments escalate the impact of single violations throughout the organization in order to ensure the salience of rules.

3.4. Learning from rule following / violating

The fourth stage of rule circulation, learning, turns from the operational realm back to the institutional realm. Whereas the reinstating behaviors concerned how regulators could respond to

rule violations in ways that impact the operators, the way regulators respond to rule following or rule violations also impacts the regulators as well. To the extent that regulators change their behavior over time based on interactions with operators, this indicates learning, and will have consequences for how the regulators subsequently encode, reinforce, and reinstate rules.

3.4.1. Practices Associated with Learning

Learning occurs in the way that regulators refine the content of their rules and heighten their ability to enhance the salience of rules over time.

Refining. Given that regulator interactions largely function to ensure that operators are following safety rules, both proactively and reactively, it is essential that these rules actually help operators maintain safety. To the extent that operators frequently describe rules as "not always realistic," "too complicated," "sometimes contradictory," or "unworkable in practice" (Hale and Borys, 2013a, p. 208), it becomes clear that regulators do not always formulate useful rules on their own. One important way that regulators formulate more useful rules relevant to front-line operations is through their interactions on the operational realm. These interactions allow them to refine the content of their rules. As one of our informants explained, "*Police may not have much experience in blasting. But they do learn. Otherwise, they would fall behind. Now, police read books on blasting and ask us questions while referring to the books. If we can't answer their questions, they know it immediately. Police are learning every day, particularly about how to regulate. They learn Regulations to Manage Warehouse and Operation Regulations at Sites [two books about regulations in the explosive demolitions industry]. Police learn every day, to inspect problems*" (Site Regulator 2). Such interactions allow the regulators to reconcile the theoretical knowledge contained in their books with the practical knowledge possessed by the operators, and thereby learn how to better regulate the operators. For instance, they become able to design and

enact more comprehensive rules. As the Guard Man explained, "*Before, there were not so many regulations and rules. The control and regulation of explosives was not as strict as it is now. The regulations and rules became more comprehensive as [regulators] went through the accidents.*" This aspect of learning shows how the rule content can improve by becoming more refined and precise through experience conversing with operators and understanding cases of accidents.

Heightening. Similarly, regulators can learn to heighten the salience of rules. As the Guard Man explained, "*They gained experiences from accidents, the lessons of blood. Then the regulations became stricter*" (Guard Man) and "*the regulating here is much stricter than the other places*" (Project Director 1). As various informants explained in relation to reinforcing interactions, the strictness of regulators directly heightens the salience of rules in the cognition of operators. Thus, practices that enhance rule salience are not completely uniform across all the regulators, but these practices instead accumulate based on learning from their own idiosyncratic experience. For instance, one of the informants explained how unique learned practices made the regulations stricter on one site than others: "*Let me tell you something. I've worked in different places. The police here are the only ones I know who ask blasting teams to report storage of explosives at the end of each year. The police in other places are not so strict. For example, during [important dates like] Chinese New Year and national meetings, police at other places would just go to the blasting sites and paste a strip seal on the warehouse. But our police here stop all the blasting projects. They don't seal the warehouse. But they take all explosives away and put them in the main warehouse … So, we [the blasting teams] have nothing to blast! How strict it is!*" (Site Regulator 1). In this way, regulators can also learn how to effectively increase the salience of rules over time, leading to more effective regulating.

4. Implications of rules for mindful organizing and safety

The grounded findings presented in the previous section illustrate how safety rules serve different functions as they circulate back-and-forth from the institutional to the operational realm and afford four distinct stages of regulator-operator interactions. Operator activities are therefore guided by rules, but not entirely governed by them. To even enter the operational realm, both literally through certification checking and more abstractly in terms of their competence, initially operators must learn and follow the rules. But to function effectively as operators, they cannot mindlessly follow the rules because the rules are sometimes irrelevant or unhelpful, leading to necessary violations. But not all violations are of this type. Because of the physical intensity of this work, some violations reflect failures in self-regulation and dangerous shortcuts. This reveals a system in which regulators neither possess the wisdom to craft perfect rules nor do operators possess the expertise and single-minded dedication to safety to not need rules. In the current section, we explore how in such a system, interactions between regulators and operators around these rules can nonetheless enhance mindful organizing and thus safety. Where appropriate, we identify which of the five interaction patterns that collectively constitute mindful organizing (i.e., preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise) are implicated in this rule circulation (Weick et al., 1999).

4.1. How encoding influences mindful organizing and safety

In encoding, the first stage of rule circulation, we see that regulators take an active role of formulating and passing on the content of rules to operators, who take a more passive role of internalizing the rules through training practices and demonstrating competence through assessment practices. Both of these practices, further, occur before operators are licensed to enter active blasting sites and perform any activities on the front lines. Although at this stage of rule

circulation, the rules seem to be used in a rigid, bureaucratic manner (Dekker, 2005), such a use of rules is not necessarily at odds with mindful organizing. To be sure, mindful organizing research emphasizes that organizations should defer to operator expertise, rather than over-specifying their activities (Weick et al., 1999). But its focus on local front-line interactions leaves open the question of where operators gain the requisite expertise in the first place. As recent models suggest, when operators lack expertise, they can best facilitate mindful organizing by internalizing institutional concepts, like rule content (Kudesia, 2019). Junior blasters may lack sufficient personal experience, but they know at minimum the rules to follow from the training. For instance, Junior Blaster 1 recalled how he internalized the rule not to throw detonators to avoid creating sparks. He would "*definitely walk up to the higher channel and pass the detonator to my colleagues [operating in the higher channel]*" because throwing detonators "*is dangerous even in imagination.*" Rules thus serve as an essential artifact that provides operators with an initial conceptual understanding of their activities (Grote et al., 2009). This initial process of internalizing rule content need not be constraining provided that operators continue to refine their understanding of this content as they enact rules during their everyday activities (Dreyfus and Dreyfus, 2005).

One benefit of encoding rule content for mindful organizing is that operators develop a "mental model" of the correct operations, which helps them better identify who possesses the relevant expertise to get tasks done (Weick, 1989; Weick and Roberts, 1993). Encoding rule content thus serves as a precondition to keep the front lines sensitive to operations, in that it helps them create and maintain a current and integrated understanding of how tasks and expertise are distributed across their members (Weick et al., 1999). Rules constitute a baseline model that helps junior operators understand how operations are currently proceeding—and a shared basis

from which senior operators can enrich the understanding of junior operators. As Junior Blaster 1 shared, "*The senior blasters have been working in many different projects before. They saw more and experienced more. And they heard more. So, we [juniors] can ask them.*" In one case, a senior blaster explained how to go beyond the basic rules about powder loading by "*making an interlayer between two layers of powder,*" which can prevent overloading.

Thus, encoding rule content through training and assessment practices need not prohibit necessary flexibility when operators enact the rules on the front lines. These practices can instead form the very basis of shared competence and expertise that make doing so possible. This makes the strictness and highly controlled nature of encoding a likely strength for safety, rather than a danger. In fact, when asked about instances where front-line operators and management lacked agreement about the importance of a lurking failure for safety, Site Regulator 2 emphasized the value of these trainings. He noted how in the three to four years since the police trainings have become stricter, "*operations have become more standardized than before,*" because operators across the organization now have a shared understanding of what constitutes a lurking failure, and how to respond to it.

4.2. How reinforcing influences mindful organizing and safety

Regulator actions, such as those that reinforce rule enactment, are often conceptualized on an abstract level. But, at the front lines, regulators and operators interacted frequently and in very concrete ways that served a reinforcing function for rules. At this second stage of the rule circulation process, it becomes clear that regulators and operators can have different, and even conflicting, priorities (e.g., Bruns, 2009). Whereas regulators are concerned solely with safety, operators must manage the tradeoff between safety and productivity. Operators can further be pressured by clients to sacrifice safety for productivity. A technician described one such situation

which he had encountered just days prior. His operation team wanted to reinforce the blasting site, calling in the next team to perform follow-up tasks (e.g., cleaning residue from the blast, reinforcing the supportive arch around the blasting area) prior to starting the next blast, as stones can come loose during blasting and fall down to cause accidents. The client, however, did not take this potential danger seriously and insisted on proceeding to the next blast without reinforcing the site in order to catch up with the project schedule. As the Technician expected, in the absence of a reinforced arch, stones from the roof of the blasting area fell down, causing a major safety risk.

These concrete differences in priorities on the ground cannot be addressed by the more abstract interactions related to encoding (i.e., training and assessing). Rather, it was the presence of on-site regulators that helped ensure that safety rules were not circumvented in favor of productivity goals, through both direct and indirect means. As the Project Director 1 said, "*In this case [when the client asked the operation team to catch up with project schedule], the police play an essential role [to ensure safety].*" Directly, on-site regulators increase the compliance of operators with the content of rules by strictly checking their activities—and their formal power allows them to ensure compliance across the various teams and organizations in a way that no other actor could, and no amount of abstract training would address. Given that mindful organizing research has seldom explored how multiple operation teams in different organizations work together, these more direct ensuring compliance practices of regulators highlight an important, but understudied, political dimension to mindful organizing and the maintenance of safety on the front lines: sometimes it may require formal power to ensure compliance with safety rules. Otherwise potential failures may be neglected. Maintaining a preoccupation with failure is thus not only a cognitive accomplishment, but a political one as well (Weick et al.,

1999).

Indirectly, the mere presence of on-site regulators served as a visual reminder to keep safety rules salient in the mind of operators. This "priming" effect, whereby concrete cues serve as a reminder of institutionalized rules, also remains a vastly understudied aspect of mindful organizing (see Weber and Glynn, 2006). In the case of the blasters, this priming effect highlights that rules are not just merely content that is encoded in memory and enacted in behavior, as the existing literature largely treats them. Rather, rules also implicate attentional processes of vigilance related to maintaining the salience of rules in the minds of operators. As Site Regulator 1 explained, his presence encourages operators to "*report and solve the problem you discover in your own work*" and keeps individual operators feeling responsible for safety by "*watching themselves.*" Namely, "*the key thing in the company is to ask each worker to watch themselves. Because, if every worker is good in their work, if every worker can watch [take care of] their own problem, there would be no problem.*" In this way, the on-site regulators promote the operation team's preoccupation with failure by encouraging operators to report their problems (Bourrier, 1996; Weick et al., 1999) and their commitment to resilience by encouraging operators to take care of the small problems emerging from their individual work, lest those small problems amplify into large ones (Van Dyck et al., 2005).

Given that the priming effect of social interactions has also not been addressed in the relevant work on vigilance (Grier et al., 2003), the way rule salience is maintained through frequent and strict regulator-operator interactions is an important finding for safety. In sum, by directly reinforcing the content of rules and indirectly reinforcing the salience of rules, regulators can promote mindful organizing in the front-line operators, and thereby enhance safety.

4.3. How reinstating influences mindful organizing and safety

At this third stage of rule circulation, we can see how regulators both act in a manner similar to, and distinct from, that of front-line operators. Through these reactive interactions, the regulators play an "editing" role in mindful organizing that continually reinstates the salience of safety rules in operator activities (Weber and Glynn, 2006). At its least severe, regulators engage in correcting practices that are indistinguishable from how two fellow operators would interact with each other to organize mindfully: engaging in mentoring conversations that help operators better understand and improve their activities (Engemann and Scott, 2018).

But, as violations become increasingly severe, the regulators utilize more of their formal power to reinstate rules, first by pausing ongoing operations to reassert the content of rules, and eventually by escalating the consequences of rule violation beyond the immediate operator to enhance rule salience throughout the organization. However, even these escalation practices are not inconsistent with the principles of mindful organizing. Namely, in mindful organizing, "any failure, regardless of its location, is treated as a window on the reliability of the system as a whole" (Weick et al., 1999, p. 92). Escalating embodies this very principle, as single violations are used to increase the salience of rules across the entire organization through meetings, case studies, and eventually punishments of increasing severity.

These escalating practices from regulators help encourage a preoccupation with failures among operators, such that they treat small failures or near misses as potential indicators of larger threats (LaPorte and Consolini, 1991). The Guard Man described such an example when the police found a blaster who "*took smokes and a lighter with him when he went into the tunnel*." After, the Guard Man convened a meeting with not only the responsible blaster and the leader of that blast site, but with every person working in the site to ensure that they follow the

rules "strictly" once again. As a result, the responsible blaster was named publicly and had to pay a fine and write a letter of self-criticism. The Guard Man explained how the regulators enhance their preoccupation with failures, "*The police noticed a small problem, but they might think the whole project had the same problem, then upgrade the small problem. Actually, it is not wrong that the police make strict requirements and supervision. Because it is the police's job [to ensure safety]. We are working in blasting sector. We need to be responsible for our own safety*."

Interactions with regulators who have the legitimate power to punish rule violations thus encourage operators not merely to follow the rules, but to use small rule violations as a mechanism for enhancing salience of safety throughout the entire firm. In this case, whereas the regulators required reforms and a written notice attesting to these reforms, the firm proactively went several steps further in responding to the violation with the internal site-wide meeting and punishments. What appears essential to the efficacy of such reinforcing regulator-operator interactions is that their forcefulness scales with the severity of the violations to which they respond. Minor violations of rules merit communication, whereas even a single major violation can merit withdrawal of the organization's certificate to operate in the blasting industry.

4.4. How learning influences mindful organizing and safety

At this final stage of rule circulation, we can see that to facilitate mindful organizing, regulators cannot merely impose rules from the institutional realm onto the operational realm in a top-down manner. The rules may be poorly formulated—and encoding and reinforcing poorly formulated rules would erode safety, rather than enhance it. Rather, through social interactions with operators on the front-lines, where rules were followed, violated, or clarified through conversations, regulators learn to improve their rules in a more bottom-up manner. As Site Regulator 1 explained, "*The most important thing is to communicate [with operators]. The*

police cannot 'kill all in one palm' [use one rule for all operations]." Regulators are only capable of learning—that is, modifying rules over time to make them more adaptive—to the extent that they also defer to the expertise of operators (Roberts et al., 1994). The net effect of this learning over time is that the system overall increases its commitment to resilience, in remaining flexible for adapting expertise to changing conditions (Wildavsky, 1991). Unless regulators acknowledge and absorb the expertise elicited by their interactions with operators in the form of learning, the system overall will gradually degrade its resilience in adapting the expertise contained within it.

Although this capacity for regulators learning to improve their rules has been discussed in theoretical terms as a potential contributor to safety (Hale and Borys, 2013b), to our knowledge, it has not yet been observed in an empirical context. This finding, along with the insight that effective reinstating scales the severity of the violation with the severity of the punishment, suggest that part of a mindful organizing system requires not only that the front-line operators bring attention toward current activities and make adjustments to avoid potential lurking failures, but that regulators do the same. For rules to function in a manner that enhances mindful organizing, the regulators who formulate the rules must actively learn from operators.

5. Discussion

How can organizations avoid failures in the face of complexity and interdependence? Past research has found that high-reliability organizations do so through mindful organizing among front-line operators (Weick, 1987; Weick et al., 1999). The present research extends this research by highlighting the importance of the interactions between front-line operators and external regulators. Drawing on recent theories of mindful organizing that seek to unite local

interaction patterns and global system-level features (Kudesia, 2019; Kudesia and Reb, 2018), we show that institutional safety rules of external regulators can actually enhance mindful organizing through four specific types of social interactions—a finding in stark contrast to the common idea that rules are simply bureaucratic tools of control (Dekker, 2005).

Even though the front-line activities of blasters in our study were nowhere near as complex as those in some other high-reliability organizations such as nuclear power plants or aircraft carriers (e.g., Weick et al., 1999), a variety of cognitive and social interaction processes still were implicated in their organizing process. Most tellingly, it was only by tracing the rules across the stages of encoding, enacting, following/violating, and learning, and then further specifying how institutional actors work to reinforce and reinstate the content and salience of rules, and learn along the way, that the full variety of processes was revealed. In this way, our joint examination of local and global aspects of rules approaches a long-held ideal of high-reliability organization research to not take core concepts for granted, but to understand them within their full context (Rochlin, 1999).

As a key takeaway, we identify how each of these four regulator-operator interactions around rules enhance mindful organizing, and thus improve safety.

1. *Encoding*. Rules provide an initial understanding that operators can develop as they gain experience as well as a socially shared understanding that helps them learn from others. Rules also help operators mentally represent the broader operation and thus how their activities interface with the activities of others.

2. *Reinforcing*. Rules carry a weight that allows regulators to directly override goals that compete with safety, such as productivity. This weight also indirectly keeps operators attentive toward their tasks, making them more likely to report and quickly address problems.

3. *Reinstating*. Rules allow regulators to treat small violations as windows into lurking failures in the broader system and encourage operators to do the same within their firm.

4. *Learning*. Rules can be modified to absorb the expertise of operators through their interactions with regulators. Further, these regulator-operator interactions model the type of flexibility that underlies organizational resilience and help enhance it over time.

5.1. Theoretical implications

Although our inductively generated theoretical model (Figure 2) is relatively simple, it nonetheless distills several crucial insights. First, in contrast to common theories that only model institutions as an abstract set of rules that people internalize in a passive manner, we show that institutional rules are taken up in concrete interactions between regulators and front-line operators, such that the rules are used to prime important operational activities and hold people accountable for failures to enact these activities (Weber and Glynn, 2006). Second, and relatedly, these interactions between regulators and operators can increase the salience of rules on the front-lines, essentially serving a function analogous to the interaction patterns that characterize mindful organizing among operators (Weick and Sutcliffe, 2006). These interactions around rule salience, further, have not been as adequately addressed in the safety literature, which has thus far focused more on rule content. Third, we highlight the possibility that institutions, through local interactions with operators, are capable of learning. Although this idea has been noted in theoretical terms (Hale and Borys, 2013b), we show it empirically, and further identify two particular forms of learning. Not only can specific episodes of rule following or violating provide cause for institutional actors to refine rule content, they can also facilitate learning about how to best ensure heightened rule salience.

More broadly, we speak to the debate on how rules influence safety (Dekker, 2005; Grote

et al., 2009; Hale and Borys, 2013a). High-reliability organizations must balance standardization and autonomy, as standardization minimizes lurking failures in the system, whereas autonomy prevents these failures from manifesting. Rules are typically seen as increasing standardization and diminishing autonomy. But rules need not function in this manner. Instead, drawing on the principle of loose coupling (Orton and Weick, 1990), flexible rules have been discussed as a promising way to retain aspects of both standardization and autonomy (Grote et al., 2009). Prior work on flexible rules has considered how specific content of rules may simultaneously promote both standardization and autonomy (Hale and Swuste, 1998). By exploring the understudied processes by which rules are generated and modified through regulator-operator interactions, we identify a further dimension of rules beyond content, namely their salience. Importantly, rule content and rule salience are enhanced by distinct practices (see Table 3).

It is therefore possible that loose coupling of standardization and autonomy can be further achieved by allowing these distinct practices to complement each other. Even if the content of rules is modified over time to address points of irrelevance, rules can still maintain their salience in influencing the vigilance and goals of operators. As a result, regulators can modify the rules without undermining their legitimacy in the eyes of the operators (a dysfunction of excessive autonomy) and without harming safety because they reinforce rules that contain irrelevant content (a dysfunction of excessive standardization). These findings provide new insight into how standardization and autonomy can be loosely coupled through flexible rules. Whereas prior work identifies features of rule content that enhance loose coupling at a single point in time (e.g., whether they emphasize goals to pursue or specify concrete actions), our work focuses on how loose coupling can be dynamically enhanced over time. Rule salience practices can keep safety goals salient at the same time as rule content is adjusted through a distinct set of learning

practices. To the extent that theorists of rules, safety, and high-reliability organizations consider both rule content and rule salience as rules circulate between the institutional and operational realms, we may better understand how loose coupling functions in practice.

5.2. Practical implications

Our study has several practical implications. First, our findings highlight the important role of external regulators in enabling and maintaining mindful organizing for safety. Importantly, our study shows that external regulators' role is not limited to rule content, but also extends to activities that heighten rule salience in situations such as when vigilance has declined. Thus, a focus on both rule content and salience can help guide regulators in the blasting industry and beyond to implement effective regulations (see Table 3). Regulators should be aware that they do not merely help operators encode the rules they devise. They also need to engage in processes of reinforcing and reinstating both rule content and salience, especially when violations occur. Further, regulators should make time to integrate lessons learned to further improve rule content and processes to raise rule salience as needed.

On the other hand, the present findings may help organizations and their operators gain a deeper appreciation of the value of external regulators. While their actions can seem strict and bothersome, when done effectively, they appear crucial for mindful organizing. A better understanding of the role of external regulators may also lead to greater cooperation. Given that our findings emphasize the interaction between regulators and operators, such cooperation can further enhance mindful organizing and improve organizational safety. Indeed, without cooperation, it may be difficult for regulators to conduct effective regulating. Importantly, the specific interaction processes which we found inductively in our data can serve as vivid examples for operators to mirror in their daily work. A deeper understanding from both

regulators and operators is important for practitioners in industries where accidents can have severe consequences. Employee safety will be protected, and even human lives can be saved.

5.3. Strengths, limitations, and future research directions

As with any study, ours has both strengths and limitations. Arguably, the qualitative approach we took is particularly suitable for our interest in inductively addressing how questions and for understanding processes (Pratt, 2007). By shedding light on their interactions, our study provides novel insight into how regulators and operators interact effectively to promote organizational safety. However, although our final theoretical model was derived from empirical data, it is important to keep in mind that the current study is best viewed in the context of theory development, rather than theory testing. As such, scholars and practitioners alike must exercise caution and judgment in transferring the present model to their safety contexts (Firestone, 1993).

In future research, an effort should be made to get more first-hand data from regulators. In our study, we had wide access to operators and other organization members; however, our access was to regulators who were deputized by the police to supervise operations, rather than police officers themselves. While our findings suggest that these regulators play a crucial role in enabling mindful organizing, including a more diverse set of external regulators would go a long way toward testing the robustness of the present model and deepening our understanding of the relation among the organization, its operators, its external regulators, and their safety outcomes.

We should also note that our theorizing concerns how and under what conditions regulators and their safety rules can benefit safety. We do not in any way suggest that regulators necessarily must be beneficial. Rules can be poorly designed, managed by regulators with insufficient expertise, and thereby function to impair safety. It is even possible that some of the regulator practices we identify may hamper, rather than foster, mindful organizing among front-

line operators. We simply did not have data describing any such negative impact. This is likely due to the nature of our high-reliability context, where major accidents seldom occur, providing little empirical possibility for observing whether regulators may play a role in them.

We also focused theoretically on the everyday activities and interactions by which safety is accomplished, rather than the more exceptional circumstances in which accidents occur (see Hollnagel, 2014). Our focus therefore was not on identifying helpful properties of operators, regulators, or rules as independent actors, but on discovering how regulators and operators jointly interacted around rules (Gherardi and Nicolini, 2000; Weber and Glynn, 2006). It is easy to imagine how these interactions are fragile and could become counterproductive in the absence of motivation and goodwill from either regulators or operators. It is also the case that "national, regional, or political cultures" affect how regulators and operators interact around rules (Hale and Borys, 2013a, p. 212). For instance, China has centralized political power in its government, but allows police to regulate operators at more local levels (Blanchard and Shleifer, 2001; Ma and Zhao, 2018). The level of authority that local police possess (e.g., stopping work on an entire blasting site, withdrawing blasting certificates, removing unused explosives) and the flexibility granted to them (e.g., modifying rules with learning over time) seem to be important conditions for such interactions. Future work could shed further light on these observations by comparing regulatory practices across countries (e.g., Bourrier, 2005; Jiao, 2001).

What we suggest is thus that the dynamics whereby rules circulate between regulators and operators have the *potential* to enhance the expertise and attention of operators, as well as the quality of learning that informs the rules formulated by regulators. Given these dynamics, it becomes possible to reconceptualize mindful organizing not as something that happens on the front-lines and which is entirely internal to the organization but instead as emerging from the

alignment between front-line operators and their broader institutional context. Indeed, by integrating the perspectives of both regulators and operators, our findings suggest that mindful organizing is not necessarily contained within a single team, but emerges from interactions between teams (i.e., operators and regulators). This raises the possibility of further research on mindful organizing among multiple parties. This research could examine multiple levels. For example, does the individual-level mindfulness of regulators and operators play a role in attaining collective-level mindful organizing, such as by more effectively carrying out encoding, reinforcing, reinstating, and learning practices? Ideally, such research would study the interactions between regulators and operators over a longer time period to arrive at a fuller picture of their dynamic interplay. Future research could also examine the role of emotions in this process, complementing the more cognition-based view of our current study, as both features certainly play a role (Weick, 1989).

In sum, the present study affirms that mindful organizing is, indeed, an important source of safety in high-reliability organizations. Our findings uniquely illustrate how external parties, such as regulators, can be integral parts of a mindful organizing system. Mindful organizing becomes possible only to the extent that institutions, through regulators, effectively formulate and encode safety rules within operators—and these operators enact these rules, scaffolded by reinforcing and reinstating interactions with regulators, who are themselves willing to learn. Mindful organizing thus cannot be reduced to a set of local interactions. It requires interactions between local and global levels, both within and across teams, to enhance safety.

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Table 1 Data Sources and Informant Descriptions

Informant	1st Round Phone Interview	2nd Round Field Investigating
Regulation		
Site Regulator 1		1 Interview
Site Regulator 2		1 Interview
Operation		
Top management		
Chief Technology Officer (CTO)	2 Interviews	1 Interview
Project Director 1	1 Interview	
Project Director 2		1 Interview and informal conversations
Upper management		
Deputy Project Director 1	1 Interview	1 Interview
Deputy Project Director 2	1 Interview	
Site management		
Site Manager 1		1 Interview and informal conversations
Site Manager 2		1 Interview
Technician		1 Interview
Guard Man		1 Interview and informal conversations
Safety Man		1 Interview and informal conversations
Ground level		
Senior Blaster		1 Interview and informal conversations
Junior Blaster 1		1 Interview and informal conversations
Junior Blaster 2		1 Interview and informal conversations

Table 2 Supporting Data

Theme	Representative Quotations
	Encoding content of rules
Training	"There is a 6-day training for all blasting operators by Police, besides internal trainings by me and CTO." (Deputy Project Director 1) "In the beginning, there was a training for the blasting license... (I attended) a 9-day training by Police." (Junior Blaster 1)
Assessing	"After passing the written test and interview, the blasting operators can renew their license. And the license is renewed every year." (CTO) "We take the computer-based exam. After passing the computer-based exam, there is a simple face-to-face interview. Then we could obtain the license." (Junior Blaster 1)
	Reinforcing content of rules
Ensuring Compliance	"Police coordinate with us, mainly about how we set the safety warnings. And supervise us. They check if the number of detonators and explosive powder is correct (as the record we reported), to see if we hide any explosives by ourselves." (Deputy Project Director 1) "Police check if operators bring smokes and lighters to the blasting sites." (Project Director 1) "Police supervise on-site operations, checking the account books. They keep records of the powder quantity, and the code of each detonator, how many detonators are used today, and the code of each detonator. The police record all of these things. Then they also check the account book to see if there are any discrepancies." (Site Regulator 2)
	Reinforcing salience of rules
Vigilance Maintaining	"Now it has become a rule here. We must call police every time we blast. [The police come for every blast] unless they are too busy to come to the site. For example, they might have to deal with some [legal or criminal] cases. If so, the police will reply and ask us to blast under the condition that safety is ensured. Then we will blast as planned. After blasting, we need to take photos of the site and send them to police [for their records]." (Project Director 1) Interviewer: "Later the police asked you to supervise this blasting team on their behalf, to share their workload?" Site Regulator 1: "Yes, they were quite tired [before assigning us to supervise the site]. This team blasts about three times a day and a single blast lasts about 2 hours, so the police had to remain on-site during the whole process [about 6 hours per day] … So, police assigned us to supervise the site [on their behalf]."

	"We represent the police, to supervise the operations here … If the blasting team supervises themselves, they might not point out the violations timely upon noticing. So police need to supervise the operations. Normally, police should stay and supervise operations at the blasting sites. But police have few people to send to the sites. So they assign us [our blasting company], who have a higher class of operation certificate than the current blasting team to supervise the operations on their behalf." (Site Regulator 2)
	Reinstating content of rules
Correcting	"I stopped the blasters from loading powder. After making sure that everyone was evacuated, I asked them [the blasters] to start blasting." (Site Regulator 2) Interviewer: "Does the client make any inappropriate suggestions, which might violate some operation regulation?" Project Director 1: "Sure. It happens. For the client, the most important thing is productivity, and then safety. Without making progress and ensuring safety, the client cannot make profits. But if the schedule of project is too tight, there will be conflicts between productivity and safety. Sure will there be many conflicts. Under this circumstance, the police play an essential role." Interviewer: "To ensure safety?" Project Director 1: "Exactly."
Reasserting	"They perform surprise checks. They won't tell you when they're coming, to prevent you from taking action beforehand. They will come to check your operations at random intervals, to see if you are still repeating the violations that you did before." (Site Regulator 2)
	Reinstating salience of rules
Escalating	"For small issues, police would ask us to write criticism letter, and pay for fines." (Site Regulator 1) "If detecting who lost the explosives, police would charge criminal detention to the person." (Guard Man)
	Learning content of rules
Refining	"The local police regulate the blasting projects very strictly. For example, we have a strict regulation here called '1322' … It means there must be 1 technician, 3 blasters, 2 safety men, and 2 guard men [under one project]." (Site Regulator 1)
	Learning salience of rules
Heightening	"There were many coal mines in our province. It was so easy to have accidents. Too many. So, now our province is very strict in regulating." (Site Regulator 2) "We're very strict. It's strict here. Much stricter than other places … [There was] an accident happened in a railway project. Tunnel. Railway. Honestly speaking, the reason why that accident happened was that the regulation there was not as strict as [how we're regulating] here." (Site Regulator 1)

Table 3 Regulator-Operator Interactions Enhancing Rule Content and Rule Salience

	Rule Content	**Rule Salience**
Encoding	Training Assessing	
Reinforcing	Ensuring Compliance	Vigilance Maintaining
Reinstating	Correcting Violations Reasserting Content	Escalating
Learning	Refining Content	Heightening

Figure 1 Data Structure

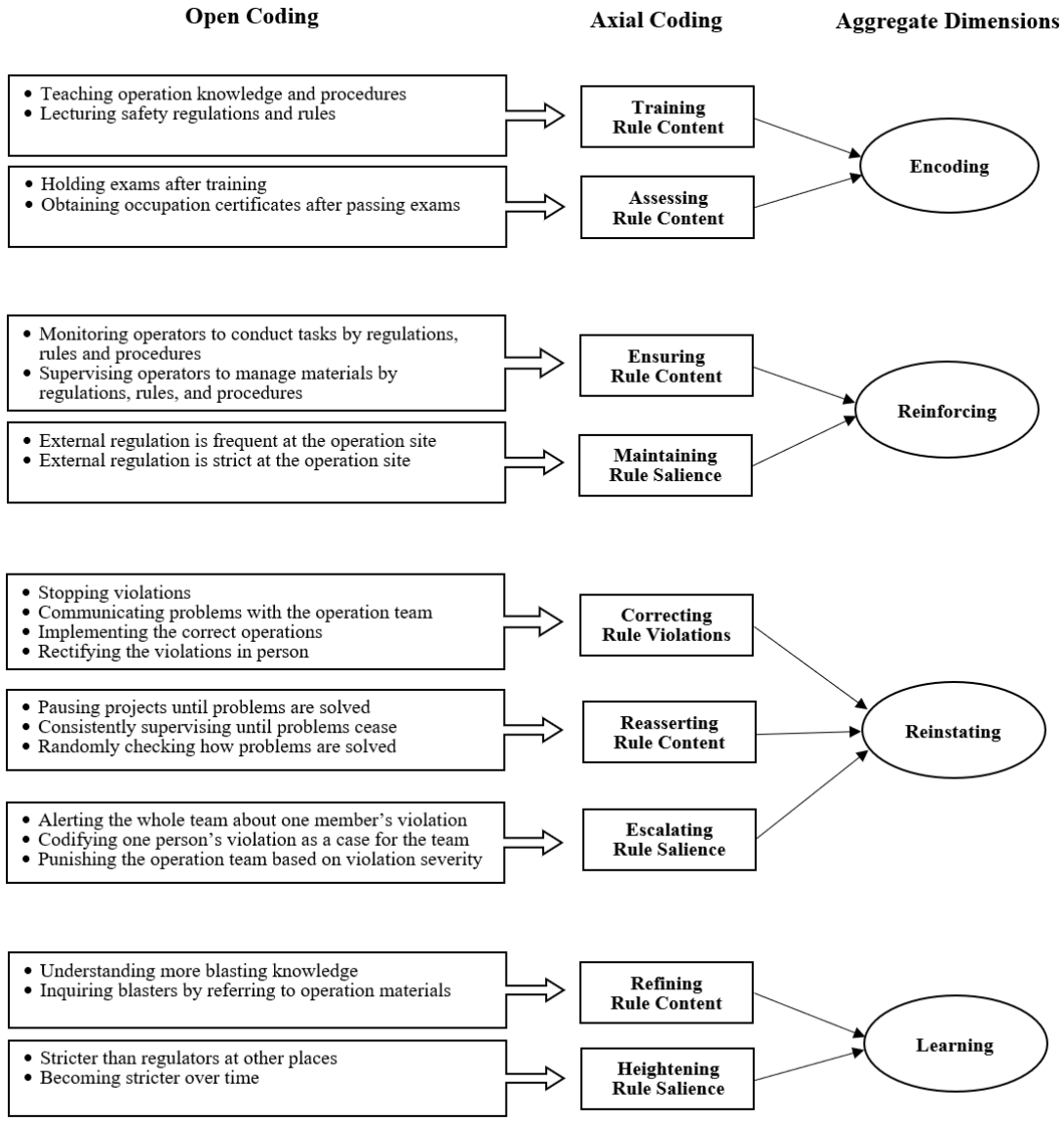
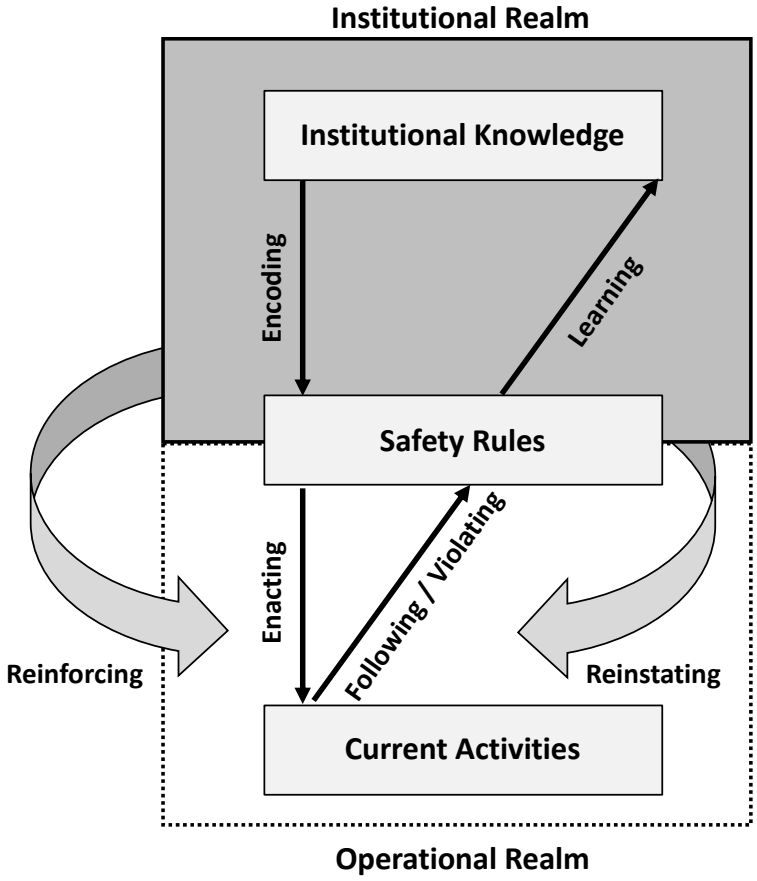


Figure 2 Theoretical Model of Regulator-Operator Interactions



Chapter 2:

Entrainment and the Temporal Structuring of Attention: Insights from a High-Reliability Explosive Demolitions Firm

Ting Lang*, Ravi S. Kudesia*, Jochen Reb

Abstract

Attention has always been central to organization theory. What has remained implicit is that attention is a temporal phenomenon. Attention accumulates and dissipates at multiple timescales: it oscillates wavelike within a performance episode, decays gradually over the course of a performance episode, and withdraws in a step-like manner across multiple performance episodes. Organizations attempt to regulate the attention of front-line employees. But to the extent that attention has been examined as a stable phenomenon, rather than a temporal one, metacognitive practices that stabilize attention remain unexamined in organization theory. And to the extent that fluctuations in attention on the front lines generate systemic risks, these unexamined stabilizing practices constitute a core part of organizational reliability. In this case study, we examine a high-reliability explosive demolitions firm. Going beyond past work that identifies best practices shared across organizations, we instead uncover the logic of how several practices are bundled together in a single organization to stabilize front-line attention across these timescales. We uncover distinct bundles of attention regulation practices designed to proactively encourage attention and discourage inattention and to reactively learn from problems, including problems resulting from inattention. We theorize that these practices are bundled according to a logic of entrainment. Practices that proactively regulate the fluctuations of attention over time are mapped onto existing work routines that repeat cyclically across concentrically nested timescales—and reactive practices enhance learning by extracting lessons from mindless behaviors and feeding them back into entrained practices.

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1. Introduction

Perhaps the foundational idea that distinguished organization theory from its disciplinary antecedents concerns attention (March and Simon, 1958). Rather than being a private, internal psychological process, organization theory recasts attention as a "crucial determinant of human organizing" (Weick, 1969: 38). Organizations rely on attention both for their strategy and operations. Strategic activities typically begin atop the hierarchy, where top managers make plans that influence what people in the organization pay attention to (Ocasio, 2011). But those strategic plans must flow down the hierarchy to operations, which rely both on *what* information front-line employees attend to and *how* attentive they are (Sutcliffe and Christianson, 2011). Reliable organizational performance thus requires metacognitive practices: repeating everyday activities that regulate attention (Kudesia, 2019)—particularly on the frontlines, where the strategic *what* and the operational *how* of attention are integrated into action (Vogus and Rerup, 2018). If attention is well regulated in people across these hierarchical levels of an organization, their actions will interlock into coherent operations that enhance performance in line with the strategy (Weick and Sutcliffe, 2006; Rerup, 2009; Ocasio, Laamanen, and Vaara, 2018). But if attention is poorly regulated, people may overlook threats in the environment, fail to share critical information, form shallow interpretations of events, and thereby act their organizations into crisis (Starbuck and Milliken, 1988; Gersick and Hackman, 1990; Louis and Sutton, 1991).

A class of organizations, known as high-reliability organizations, are thought to exemplify well-regulated attention, particularly on the frontlines (Weick, Sutcliffe, and Obstfeld, 1999). Examples of high-reliability organizations include aircraft carriers, nuclear powerplants, and air traffic control systems. Just one moment of inattention could place the entire organization at risk. But such stark risks seldom manifest into actual crises. That these organizations maintain

reliable performance despite the unrelenting demands on attention makes them theoretically provocative. In these organizations, practices that regulate attention should be both more visible and better refined. If these practices can be identified in high-reliability organizations where they are paramount for safety, organizations that value attention on the frontlines for less stark reasons like innovation, customer service, or risk management could greatly enhance their performance by adopting the practices (Reason, 1997; Roe and Schulman, 2008; Weick and Sutcliffe, 2015).

Given the promise of high-reliability organizations to inform organization theory, in this study, we advance high-reliability research in three ways. First, it remains unclear precisely what process one should use to transfer insights derived from high-reliability organizations to other organizations. The literature on high-reliability organizations has grown by a two-step process. Initially, case studies each identify a handful of best practices, like delegating authority (Bigley and Roberts, 2001), asking reflexive questions (Jordan, 2010), having managers visit operations (Singer and Tucker, 2014), and so on. Then, theoretical work reviews and integrates these many practices into overarching frameworks that can help transfer their insights to other organizations (Weick, Sutcliffe, and Obstfeld, 1999; Wilson et al., 2005; Vogus and Rerup, 2018). This two-step process has generated many valuable insights, but it also excludes a specific type of insight. Namely, some "best practices" may be inherently valuable across all contexts. But it is more likely that organizational reliability depends on the way multiple practices are bundled together within a specific context, such that the value of one practice for performance depends on the presence or absence of other practices (Macduffie, 1995; Delery and Doty, 1996; Ichniowski, Shaw, and Prennushi, 1997). This principle that practices become valuable based on how they are bundled with other practices is known as complementarity (Milgrom and Roberts, 1995). The

logic by which multiple practices are bundled together to produce complementarities can be best examined by in-depth study of a single case in which these practices are jointly enacted, rather than by frameworks that aggregate practices across several distinct cases (Schatzki, 2005; Jarzabkowski et al., 2016). Indeed, critiques of high-reliability research note the need to better explain how multiple practices function interactively, as adopting single practices alone may produce unintended consequences (e.g., (Ramanujam and Goodman, 2003; Leveson et al., 2009; Kudesia and Reb, 2018). What is missing in the literature on high reliability is insight into the underlying logic by which multiple practices are bundled together to produce complementarities.

Second, although attention is critical to high-reliability organizations (Weick and Sutcliffe, 2006), it is seldom lifted from the background to become the focal phenomenon of research (see (Rerup, 2009). Indeed, "few studies have investigated how front-line workers attend to emerging problems or how attention is collectively distributed within teams and organizations" (Sutcliffe and Christianson, 2011: 845). Without in-depth investigation of attention on the frontlines, we lack the set of rich direct observations needed to contextualize the practices meant to regulate it (Bechky, 2006; Watson, 2011). For example, a commonly cited practice in nuclear power plants is changing the layout of forms to prevent people from filling them out mindlessly, with minimal attention (Levinthal and Rerup, 2006). Yet, the primary source material noted that the value of this practice in regulating attention decayed quickly over time (Schulman, 1993). Without more primary empirical research, and the rich direct observations that it entails, we may advocate for certain organizational practices, but without contextualizing the fuller tapestry into which these practices are woven, and through which they become effective (Schatzki, 2005; Nicolini, 2009).

Third, an important part of this tapestry is time. Theories of organization have traditionally assumed stability, rather than change (Tsoukas and Chia, 2002) and seminal work on attention is no exception (e.g., March and Simon, 1958; Ocasio, 1997; Weick, Sutcliffe, and Obstfeld, 1999). But another approach, which remains unexplored in organization theory, actively foregrounds the temporal dynamics of attention (Large and Jones, 1999; Nobre and Coull, 2010; Henry and Herrmann, 2014; Jones, 2019). This approach recasts attention not as a stable capacity, but as a dynamic process. In this process, attention fluctuates rhythmically across timescales that are structured in part by external events. Thus, as the example of changing the forms indicates, if organizations require metacognitive practices to regulate attention on the frontlines, these practices must be bundled using a logic that explicitly accounts for the temporal dynamics of attention. But, to date, the role of time in attention has remained implicit and the metacognitive practices that regulate attention on the frontlines have received little systematic investigation.

To address these three areas, the present case study investigates an explosive demolitions firm, which conducts projects for mining and quarrying as well as for civil engineering uses, like demolishing buildings and blasting tunnels into mountains. Triangulating interviews across the hierarchy with archival data and non-participant observation of active blast sites, we clarify how bundles of practices regulate and stabilize fluctuations of attention among front-line employees. Our study thus extends high-reliability research by (1) conducting an in-depth study of attention on the frontlines of a high-reliability organization, where the strategic what and operational how are integrated into action, and (2) uncovering the logic by which these metacognitive practices are bundled to produce complementarities (3) by theorizing attention as a temporal phenomenon. In doing so, we identify three bundles of practices, which we integrate into a theory of attentional

entrainment. Two bundles proactively regulate fluctuations in frontline attention by encouraging attention and discouraging inattention. These bundles are entrained, that is, mapped onto existing routines that repeat cyclically across multiple timescales, like the shift, blast, workweek, project, and year (Ancona and Chong, 1996; Shipp and Richardson, 2019). The third bundle reactively solves problems ad-hoc, including problems that result from inattention. It enhances learning by extracting lessons from problem solving—and then distributing these lessons throughout the organization by feeding the lessons back into entrained practices that repeat at regular intervals.

2. The temporal dynamics of attention

Although it has not figured prominently into organization theory, the temporal structuring of attention played a critical role in the formative period during which humans first organized work. Tracing work from the earliest agriculturalist societies to modern industrial societies, Bücher's (1899) seminal anthropological study found work to have a temporal structure. The promise of future rewards, he noted, is by itself insufficient to sustain ongoing attention to work, which can be demanding and alienating. To sustain attention, work takes on a temporal structure: repetitive activities of farmers turning hay, blacksmiths striking steel, carpenters chopping wood, and so on produce rhythms that conserve mental and physical energy, connect the activities of people working in proximity to each other, and enable coordination of tasks that require the collective effort of many (see Meyer-Kalkus, 2007; Spittler, 2008; Dobler, 2016). It is of concern to Bücher and others since (e.g., Thompson, 1967; Schafer, 1993; Fuchs, 2018) that work in organizations has increasingly lost its temporal structure, which disciplined attention and made work bearable.

When attention became central to organization theory, however, its temporal dimension and relation to work were largely overlooked. Organization theory instead emphasized two distinct aspects of attention, often in distinct research streams. The first stream emphasizes strategy and treats attention as a *perspective*: a selective top-down focus where *what* information people in the organization pay attention to both shapes and is shaped by its strategy (Ocasio, 2011). Attention is treated as a stable limit in people's information processing capacity (see Porac and Tschang, 2013). The focal puzzle is how organizations can achieve such remarkable outcomes when the people that form organizations can only attend to a limited amount of information at any one point in time (March and Simon, 1958). The solution is for organizations to rely on hierarchy and expertise. Hierarchy provides channels through which procedures and communication flow, so employees ideally only receive information that is relevant to their tasks, which reduces demands on their limited attention (Ocasio, 1997). As employees repeatedly perform their tasks, they also gain expertise. Expertise allows them to act with less need to process information from their environment, which further reduces demands on their attention (Levinthal and Rerup, 2006). Hierarchy and expertise thereby jointly compensate for limits in the attentional perspective of individuals, making the most of the limited amount of information they can focus on at once.

The second stream of research in organization theory emphasizes operations and treats attention as *engagement*: a bottom-up process that shapes *how* attentive people remain over time, particularly in noticing and responding to unexpected information (Sutcliffe and Christianson, 2011). The focal puzzle is how certain organizations can maintain highly reliable performance, despite operating in uncertain and dynamic environments (Weick, Sutcliffe, and Obstfeld, 1999). The solution is to rely on groups of frontline employees to maintain how attentive they remain

through social interactions that raise lurking threats and discuss how to address them (Weick and Sutcliffe, 2006; Vogus and Rerup, 2018). Because their attentiveness and activities are loosely coupled, operators can overcome limitations in any one of their attentiveness through social interactions (Weick, 1989; Farjoun, 2010). Thus, this stream emphasizes the stability of social interactions over time because, as long as these social interactions continue to be enacted, the operators as will maintain attentiveness as a collective (Weick, Sutcliffe, and Obstfeld, 1999).

2.1 Stability and temporality in attention

In this way, attention has largely been examined within organization theory using a language of stability—in terms of stable limits in information processing capacity, stable channels through which information flows, stable accumulations of expertise, stable patterns of social interactions, and so on. Recent theorizing on metacognitive practice, however, provides a basis to reintroduce the temporal dimension into the study of attention and organization (Kudesia, 2019). From a metacognitive practice perspective, attention, expertise, hierarchy, and social interactions are not stable entities in organizations. They are dynamic processes that implicate each other in different ways from one situation to the next. When people have expertise, they know what information to attend to and how to interpret that information (Dreyfus and Dreyfus, 2005). But, it is precisely when expertise breaks down—that is, "when people cannot interpret the meaning of a situation, when they cannot locate a response, or when their actions produce unexpected outcomes"—that people most engage in social interactions, in an attempt to solve problems and restore their grasp of the situation (Kudesia, 2019: 409). And because expertise develops in part based on the information flows people receive from the hierarchy, the quality and extent of expertise is shaped by the very patterns of communication that constitute the hierarchy (Levinthal and March, 1993).

By describing attention as fluctuating temporally—that is, following a "rhythm and pacing" as expertise builds up and breaks down from situation to situation, triggering social interactions on the frontlines and across the hierarchy to help resolve breakdowns—metacognitive practice situates the coupling between attention and work firmly in time (Kudesia, 2019: 411). A major purpose of organization, then, is to regulate the coupling of attention and work. Yet, because expertise, hierarchy, and social interactions are all dynamic processes that fluctuate in tandem with attention, they cannot then be relied on as stable forces that regulate attention. Rather, attention regulation is accomplished by metacognitive practice. Metacognition concerns how people monitor and adjust their attention (Brown, 1987; Nelson, 1996; Fernandez-Duque, Baird, and Posner, 2000), including the extent to which attention remains engaged toward ongoing events and directed by plans received from the hierarchy or expectations derived from personal expertise. Whereas metacognition was initially viewed as an individual psychological process (Flavell, 1979), we show here how repeated everyday organizational practices like pre-shift meetings, role assignments, work inspections, and tracking of work materials can take on a metacognitive function, such that these practices serve to regulate attention in organizations.

Just as metacognition constitutes an executive level of attention that helps regulate the top-down and bottom-up attentional processes in individuals (Fernandez-Duque, Baird, and Posner, 2000; Posner and Rothbart, 2007), so too does metacognitive practice explain how attentional perspective and engagement are regulated in organizations. Top management plans, as described in annual reports, establish a strategy that is taken to represent the perspective of the organization as a whole. And, while it is known that these plans do, in fact, shape what information people in the organization pay attention to (Cho and Hambrick, 2006; Eggers and

Kaplan, 2009), it remains "unanswered" how this actually occurs: namely, how plans are actively maintained over time in the attention of actors throughout the hierarchy in order for the plans become and remain operational (Ocasio, 2011: 1293). Similarly, at the operational level, while social interactions help stabilize attentional engagement, it remains unanswered how these social interactions are themselves made stable if not through the repetition of organizational practices (Wilson et al., 2005; Martínez-Córcoles and Vogus, 2020). Because attention is neither stable nor inertial, but has its own temporal dynamics, it must be continually monitored and regulated. Organizations cannot rely solely on employees to self-regulate their attention, but instead use metacognitive practice. These metacognitive practices neither reduce down to individual psychology nor do they aggregate up to the organization as a whole. They instead concern the processes by which individual attention gets intertwined with everyday organizational activities that repeat over time.

If attention fluctuates over time, then the metacognitive practices that regulate attention must also have a temporal structure—one that intelligently matches the fluctuations of attention to the practices that generate and revise expertise, send and receive information through the hierarchy, and expand or contract the scope of social interactions on the frontlines. For all these practices to function effectively together, and thereby produce complementarities, the temporal structure of metacognitive practice must align with the timescales at which attention must be regulated. This process by which two time-varying processes synchronize is known as entrainment (Ancona and Chong, 1996). Examples of entrainment span from biology—in how the circadian rhythms that govern sleep-wake cycles synchronize with external cycles of sunlight and darkness—to economics, in how the new product development cycle synchronizes with seasonal cycles, such that consumer products are launched during the holiday season (McGrath,

Kelly, and Machatka, 1984; Pérez-Nordtvedt et al., 2008). In these examples, a time-varying process within a person or organization synchronizes with an external cycle based on the presence of pacers like sunlight or holiday sales events—these pacers provide information about what phase the external cycle is currently in, which helps people and organizations align their internal activities with it (Ancona and Chong, 1996). Neuropsychological literatures, particularly those examining attention during meditation (Hasenkamp et al., 2012; Malinowski, 2013) and while listening to music (Large and Jones, 1999; Jones, 2019) have shown that attention fluctuates cyclically and that this cycle can entrain onto external cycles. In the case of music, for instance, attention levels can synchronize with cycles that repeat at timescales including the measure, chorus-verse sequence, and so on.

Despite the neuropsychological research exploring the fluctuation and entrainment dynamics of attention on a micro-level (Henry and Herrmann, 2014), it remains unclear at what timescales employee attention fluctuates in organizations—either in terms of perspective or engagement. Nor is it known how the metacognitive practices responsible for regulating these fluctuations in attention are temporally structured. That is, how these practices are bundled together to produce complementarities by serving as the pacers that synchronize employee attention with broader organizational routines. In sum, we seek to address two primary questions through this research:

> *Research Question 1*: How do metacognitive practices jointly influence and integrate the strategic and operational aspects of employee attention on the frontlines, that is, both *what* information employees attend to (attentional perspective) and *how* attentive they remain over time (attentional engagement)?
>
> *Research Question 2*: What is the logic by which these metacognitive practices are bundled and arrayed over time and across the hierarchy, such that they can optimally regulate and stabilize fluctuations in frontline employee attention?

3. Method

3.1 Industry context

We study a high-reliability organization in the explosive demolitions industry in China, which performs blasting projects for mining, quarrying, and civil engineering uses. In 2016, some 3.54 million tons of explosives were produced in China, of which 22.1% was used for coal mining, 24.9% for metal mining, and 24.9% for nonmetal mining (China Industry Information Network, 2019). Blasting provides material granulation which, given its essential role in mining, makes it a lucrative industry with RMB 251.90 billion ($35.55 billion USD) in 2016 profits. This industry is also incredibly dangerous: from 2001 to 2010, 21 blasting accidents in Chinese coal mines led to 410 deaths (Chen et al., 2012). Analyzing a large dataset of fatal and non-fatal surface mining accidents, Kecojevic and Radomsky (2005) identified misfires, premature blasts, and flyrock (rock that goes airborne after an explosion) as the main accident types. Root cause analyses of these accidents typically implicate human error, which reveals the critical need for attention (Yin et al., 2017). Recent examples illustrate such dangers. On July 22, 2015, blasters were setting wires in preparation for blasting without having first evacuated the other operators. Faulty wiring caused three holes loaded with explosives to detonate unexpectedly, leading to the death of four operators (Safehoo, 2018). On June 21, 2016, a blaster walked into a site where blasting had just completed without careful examination: after a being hit by a falling stone, he died on impact (Tongjiang County People's Government Portal, 2018). In another case, a helper was killed by flyrock, despite standing 150 feet from the blast radius (Bajpayee et al., 2003).

3.2 Organizational context

Following the logic of purposive sampling, we studied an exemplar organization in this industry where practices that enhance reliability will manifest more transparently (Patton, 1990).

We studied CHG Group, a manufacturer of explosive products and equipment.[1] In its initial decades, CHG struggled with reliability. Informants described accidents like gunpowder exploding in the factory (CEO Assistant A), poor safety practices like improper waste disposal and employee multitasking (Office Director), and weak financial performance, with bankruptcy looming (Company Brochure). Some 20 years ago, CHG held a shareholder meeting, elected a new board of directors, and hired a new CEO who proposed and implemented a comprehensive set of rules and regulations, which remain in operation. After this turnaround, CHG has become one of the three largest detonator manufacturers in China with an annual production capacity of 209.50 million detonators. It is now vertically integrated, operating 15 subsidiaries that include manufacturing, marketing, and blasting, to provide a one-stop source for civil blasting services.

We particularly focused on CHG's blasting subsidiary, which we call Monkey King Blasting Company (MKBC). Founded about 10 years ago after CHG's successful turnaround, MKBC has never had a serious accident, reflected in the absence of government sanctions, and has earned a "first class" certificate for operational excellence, qualifying it as a high-reliability organization in its industry. As shown by the chart in Table 1, explosive demolitions require integration across two primary sites: the headquarters where managers and top technicians create plans for blasting projects and the various blast sites where these plans are implemented. Sampling both sites provided insight into the strategic and operational functions of attention in high reliability.

[Insert Table 1 About Here]

[1] All names attached to companies and informants are pseudonyms; all data sources used to support a statement are cited immediately after the statement in parentheses.

3.3 Data collection

As is common for qualitative case studies, data collection occurred iteratively alongside data analysis and consultation with the literature (Orton, 1997). We formed an insider-outsider team (Evered and Louis, 1981; Louis and Bartunek, 1992), in which one of the authors who is a native Chinese speaker and is familiar with the explosive demolitions industry led data collection and provided an insider perspective, while the others who are familiar with high-reliability research and organization theory provided an outside perspective drawing on the relevant literatures. As shown in Table 1, data collection spanned over the course of a year, which allowed us to go back and collect additional data to develop and refine our emerging theorizing (Charmaz, 2006: 102 –108). We collected the three primary types of ethnographic data: multisite non-participant observation of activities occurring both in the headquarters and active blast sites, semi-structured interviews and informal conversations with informants throughout the hierarchy, and archival materials from company and industry sources (Spradley, 1979; Hill, 1993; Lofland et al., 2006).

3.4 Data analysis

Our primary data source is 22 interviews, which lasted between 34 and 90 minutes, and were transcribed and translated by the insider author, following best practices for handling Chinese-to-English data (Xian, 2008).

3.4.1 Practice Theory Approach to Qualitative Methods

It has been increasingly recognized that qualitative methods for researching organizations follow several different approaches in terms of their theoretical assumptions and modes of data collection and analysis (Langley and Abdallah, 2011; Gehman et al., 2018). Best practices for researching organizations are not universal across these approaches and scholars are therefore cautioned against applying standards and techniques from one approach to another (Eisenhardt, Graebner, and Sonenshein, 2016; Pratt, Kaplan, and Whittington, 2019). Qualitative scholars must instead seek consistency within a methodological approach that fits with their theorizing to avoid the internal incoherence that accompanies such "methodological slurring" (Baker, Wuest, and Stern, 1992; Holloway and Todres, 2003; Gurd, 2008; Gehman et al., 2018).

In this study, the theories we draw upon and the research questions that motivate our study are all practice theories. As such, we therefore follow the appropriate standards and techniques (Nicolini, 2009; Jarzabkowski et al., 2016). An important assumption of practice theories is that although individuals are knowledgeable about aspects of their work, much knowledge remains tacit and the actual logic of practice is stored in their repeated everyday activities and the tools, technologies, and social interactions involved in these activities—rather than being something that people can readily articulate (Sandberg and Tsoukas, 2011). Nicolini (2012), for instance, provides the example of a teacher who arranges student desks in a particular manner, with all desks facing the teacher instead of facing each other. This practice—and other related practices like lecturing and raising hands to ask questions—carries a logic that the teacher is the primary source of knowledge, rather than students learning from dialogue with each other. It is not at all clear that a teacher could readily articulate this logic underlying their practice, even though they could describe the details of the practice itself with great richness (e.g., who sets up

the desks, how students tend to participate, what questions tend to get asked) (Jerolmack and Khan, 2014).

For this reason, although interviews are an important data source, the interviews are used to elicit rich and detailed description of everyday activities: enumerating the various practices in a context, which actors are involved in the performance of these practices, how they are concretely carried out, and the intended and actual outcomes of the practices (Jarzabkowski et al., 2016). These activities, when coupled with first-hand observations and archival data, become the focus of theorizing. The purpose of theory is to go "underneath" these everyday activities to uncover the logic of practice—how the various practices function together to accomplish a particular end (Schatzki, 2005; Sandberg and Tsoukas, 2011). This practice approach can be contrasted with an interpretive approach, where interviews are both the source of data and the focus of theorizing because theory is generated by moving inductively "upward" from informant language to more abstract representations of their interpretive schemes (Gioia, Corley, and Hamilton, 2013). Because interpretive research has direct access to its focal phenomena (i.e., the interpretations of informants), its theorizing can be justified based on its grounding in the phenomena. This differs from theorizing such as ours in which "the data we collect are always limited to the surface," like the activities that people perform, and "we have no direct access to the underlying structure of the phenomena we want to explain" (Pentland, 1999: 712). As a result, we focus on developing a rich surface description of the practices and, after tracking their interdependencies, we then apply a logic of abduction, rather than induction. Abduction entails an inference to the best explanation (Dubois and Gadde, 2002; Locke, Golden-Biddle, and Feldman, 2008; Tavory and Timmermans, 2014), in this case, to an explanation of why these practices might exhibit the interdependencies they do, the structure of how they are bundled in

order to produce highly reliable performance. In this abductive process, our analyses necessarily include consideration of how our case surfaces and resolves mysteries in the relevant literatures (Alvesson and Kärreman, 2007; Tsoukas, 2011). The eventual theorizing therefore must be weighed against how it advances theorizing on high-reliability and how plausibly it entails an underlying structure that explains the logic of practice.

In particular, we eschew the grounded theory admonition to "literally ignore the literature" in the initial stages of coding, to ensure "the emergence of categories will not be contaminated" by prior theory (Glaser and Strauss, 1967: 91). We instead actively iterate back-and-forth between the literature (Orton, 1997).

3.4.2 Literature Search

We used criterion sampling based on keyword searches in general management journals publishing work related to "high reliability organization. These journals include Academy of Management Journal, Administrative Science Quarterly, Organization Science, Human Relations, Organization Studies, Journal of Management Studies, Journal of Management, Journal of Organizational Behavior, Management Science, Strategic Management Journal, and Management Learning. After locating papers about practices implemented in organizations to constitute high reliability, we read each paper carefully to identify all the practices. We listed all the practices introduced in past research, including those explicitly mentioned in the paper as practice to constitute high reliability, such as "seeking disparate perspectives" in Barton and Sutcliffe (2009). Also, we included the organizational activities which we found to be related with high reliability, although they were not explicitly mentioned in papers as the practices constituting high reliability. For example, Jordan (2010) described that the organization foster "reflection-in-action" to build high situational awareness through activities such as "teaching

concrete cases" and conducting "interactive on-the-job training". Although Jordan (2010) didn't explicitly mention that the organization achieved high reliability because of these activities, we still consider them as practices constituting high reliability given their effectiveness in training workers about the knowledge and expertise as demanded by their jobs. After listing all the explicit practices constituting high reliability and organizational activities that are related to building high reliability, we compared the existent practices with the practices we found in our dataset. Then we attached the reference for each of our practices that overlaps with the existent practice. Finally, we attached these references to each of the practices in our dataset. Therefore, we not only found references for some of the practices in our dataset to support their effectiveness in constituting high reliability, but also provided an extensive list of novel practices which have not been covered in past research. This provides a bundle of actionable practices and insights for managers and practitioners to build high reliabilities in their organizations.

4. Findings

By way of preview, our grounded findings identify three distinct bundles of practices: the first bundle proactively encourages attention, the second proactively discourages inattention, and the third reactively extracts learning from emerging problems, including problems caused by inattention. After presenting these grounded findings, we introduce a theory of attentional entrainment in organizations. This theory, abstracted from the study data, helps explain the logic underlying these bundles of practices and how they regulate and stabilize attention, leading to high reliability. In it, we find that the first two proactive bundles are entrained: mapped onto existing work routines that repeat cyclically at different concentrically nested timescales. The third reactive bundle is not entrained, as its practices respond ad-hoc to inattention and emerging

problems whenever they occur. But this bundle does feed lessons extracted from problem solving back into entrained practices to distribute learning throughout the organization more widely.

4.1 Bundle one: practices that proactively encourage attention

To proactively maintain attentional perspective—such that front-line employees direct their attention toward relevant information—MKBC arranges three key practices across the temporal stages from planning to execution: (1) planning practices that include the relevant expertise and information from across the hierarchy and even outside firm boundaries at the initial stage of a project, (2) training practices that ensure the plans are clearly communicated and adequately internalized by front-line employees before operations begin, and (3) accessibility practices that ensure managers remain readily available to employees as operations proceed. To proactively maintain attentional engagement—such that frontline employees maintain high levels of ongoing attentiveness to work—MKBC utilizes practices that (4) develop and instill a culture of safety, which makes the importance of high attentional engagement salient and pervasive firm-wide.

4.1.1. Planning Practices that Bring Expertise and Information into the Attentional Perspective

The attentional perspective of organizations—that is, the information that employees are to attend to—is necessarily set atop the hierarchy (March and Simon, 1958; Ocasio, 1997). Top managers have a wider view of strategic issues and demands throughout the organization that front-line employees typically lack (Leveson et al., 2009). Yet, to the extent that planning strictly occurs atop the hierarchy and execution occurs on the frontlines, reliability can be jeopardized. Plans that inform the attentional perspective may be unrealistic or ill-informed by actual ground conditions—and front-line operators who best know ground conditions may be disempowered from adjusting the attentional perspective during execution, because they played no part in the

formulation of plans, or at least face temporal delays in making any such adjustments, as they need to approve adjustments through the hierarchy (Kudesia and Reb, 2018). High reliability thus requires that planning and execution cannot be strictly separated.

MKBC addresses such dangers through practices that take hold as early as the initial stages of planning. The cumulative effect of these planning practices is to ensure that relevant expertise and information from throughout the hierarchy and all sources are included in the plans, so that there is less danger that the managers will promote a maladaptive attentional perspective. The planning practices include three specific activities.

Setting Project Level. At the beginning of any potential project, top managers, particularly the CTO, set the "project level." The project level is based on criteria set by an industry standard for the difficulty and requisite expertise needed for any blasting project and contains four levels ranging from A (the lowest) to D (the highest). These levels are determined both by the general type of project as well as the specific ground conditions at the blasting site. For instance, the Technology Director described how "a typical tunnel blasting project is often at Level B," but that he set a tunnel blasting project at Level C after investigating the site because he noticed "high-voltage power lines and iron towers around the blasting site." He noted that "flyrock produced during blasting might hit the high-voltage power lines" or "the blasting seismic degree might cause damage to iron tower that transmits electricity," which merited a higher project level than is typical for tunnel blasting projects. The project level both implicates and is implicated in two aspects of planning: personnel planning and technique planning. Personnel planning is mainly about selecting operators to be involved in a project and assigning appropriate tasks to each operator. Technique planning is mainly about planning methods for the

blasting operations and how to protect safety during these operations, like deciding the safety distance for blasting.

Participating in Planning. A key consequence of setting a particular project level is that the level (from A to D) directly influences personnel planning: who participates in the project. After top managers set the project level, the CTO explained that they then "select technicians and blasters with operation certificates *higher* than the project level to form a planning team" to ensure that the relevant expertise is brought into the planning process: "If the project is at level C, only operators with certificates higher than level C can join in the planning team" (CTO). This matching of the expertise needed for a project with participation in planning includes actors both internal and external to the organization. For instance, when projects entail unfamiliar situations, MKBC's planning team consults external experts. The CTO described such a case when MKBC was planning the demolition of a chimney. They originally planned to divide the chimney into an upper and lower half and set explosives such that the upper half was demolished first, prior to the bottom half, but that both halves would collapse in the same direction, which is known as "same-direction folding." After external experts from a university noted how same-direction folding had "few successful cases in the whole country and the energy generated while blasting the upper half is very complex: there is no fixed equation to calculate the results," MKBC instead followed an alternate plan that was less risky. As the CTO explained, "I took the experts' advice and adopted a more conservative method … If we adopted [same-direction] folding, we would have to design the time difference between the upper half and lower half [detonations] based on our experiences, as there are few materials for reference … [and] no consensus among experts."

Similarly, MKBC brings in expertise internal to the firm wherever it resides: including at the operational level. Experienced operators on the frontlines also participate in planning to

ensure the consistency between planning and execution. One Senior Blaster shared his experiences of participating in designing blasting plans to ensure the information relevant to their work is included in the formulation of plans.

Senior Blaster	Well, before we make the plan, us blasters and safety men will be present in the site. We do research together, like measuring the distance and proposing blasting methods. For example, if we blast a chimney, we study which direction the chimney should lay down, how to manage the blasting if there is wall and boiler room nearby [the chimney].
Interviewer	So, the blasters would also participate in making plans?
Senior Blaster	Yes. Yes. We participate in the process from plan making and final blasting … We discuss together. And we would use the best, the safest way to blast. Now the safety is Number 1. [We use] the safest way to do the blasting.

Investigating the Site. Another key aspect of planning is designing the safety technique. Setting the project level ensures that the appropriate expertise will be brought in both internally and externally to the organization. But planning cannot be seen as a detached purely strategic activity that occurs at the headquarters, separated from execution on the frontlines. Whereas oftentimes operators report that plans and rules received from management are inappropriate, unrealistic, or have little relevance to their activities (Hale and Borys, 2013), MKBC works to counteract such issues. As a Senior Blaster explained, “It is uncommon that the plan doesn’t fit with the operational circumstances. Because when designing the plan, the designers—like the CTO, technicians, managers, and experienced blasters—all need to investigate the site. They don’t just go to the site one time. They go many times. After deeply understanding the field and its surrounding environment, can they start to make plans” (Senior Blaster). This activity of repeatedly investigating the site during the planning process, the Senior Blaster explained, helps ensure that features like “whether there is a residential building, wall, road, or grassland around the blasting site” is “fully reflected in their plan.” By including such information in the plan, the top managers can become more certain that the attentional perspective they convey will actually work in practice. For instance, during a site investigation, the Technology Director noticed high-

voltage power lines hanging 12–13 meters above the blasting site. As a result, even though flyrock usually will not reach that height, he revised the plan to "reduce the number of blasting holes and the quantity of powder filled in each hole, to minimize the seismic degree of flyrock." He also included two additional safety techniques in the plan: first, making sure "the minimal resistance line" does not face the direction of the hole, which will cause rocks to fly upward and, second, using "blasting covers" by paving a layer of grass on top of the blasting hole, to decrease its upward momentum" (Technology Director).

4.1.2 Instantiation Practices that Carry the Attentional Perspective into Operations

As the planning process draws to a close, the project moves to the execution stage. At this stage, the clarity and detail of plans becomes particularly important: "When the project comes to execution, we should write clearly what safety protection methods would be taken to ensure the execution safety. For example, to prevent flyrock, the safety distance should be designed during planning" (CTO). While the roles and rules for each operator must be specified during planning, they must be continually kept active in the attentional perspective of front-line operators during execution. MKBC relies on three practices to instantiate plans as projects move to execution:

Training. MKBC regularly conducts a comprehensive set of trainings across hierarchical levels. At the higher levels of the hierarchy, the Technology Director explains how "each year, after the Spring Festival and we're starting to work again, there is a one-week internal training in the company … including all the managers … it is me and the CTO leading the training … mainly about the specific operations." Lower down the hierarchy, the technicians take charge of training frontline operators. One technician explained how each month, he conducts trainings for blasters: "I talk about blasting parameters, how to connect wires, how to load powder, and the problems that they might encounter during powder loading. I talk about all these problems to the

blasters … I open a course and lecture them, kind of like communication." These trainings also provide a basis for technicians to refine and clarify techniques. As the technician further noted, "Sometimes they encounter problems that they don't know how to solve. They would give me feedback. I would tell them how to solve the problems. For example, I explain to them how to solve the unexploded blasting [holes] … Sometimes, I also take the experienced blasters to see the site together. Me and the experienced blasters solve the problems together."

Pre-Shift Meetings. Building on the more general blasting knowledge instantiated through trainings, managers use pre-shift meetings as the primary means to ensure operator attention is directed toward project-specific plans, including the relevant rules and roles. These meetings play the critical role of identifying critical aspects of the plan that are relevant for the upcoming performance episode and ensuring people know how the activities they are attending to relate to the activities of other blasters. A site manager from a province we did not visit explained his process, which aligned with our first-hand observations of the pre-shift meeting:

> I need to hold pre-shift meetings everyday with the blasters. No matter how many blasters go to work today, 5 or 6. We all have to take the pre-shift meeting before going to work. I need to explain well the work. For example, we need to load 20 holes today. Blaster, say Wang, is in charge of loading the first 10 holes. Another blaster, say Zhang, is in charge of loading the last 10 holes. I know who is in charge of which holes … the pre-shift meetings have clear task assignments. So, every one's job has clear record. We can track the problem to the person who made it … So, when we start to blast, I would know who load the hole if that hole failed. Then that person needs to take the responsibility.

Mentoring. Finally, even during the actual execution stage, the attentional perspective is maintained through mentorship interactions. The Project Director explained how senior blasters mentor more junior blasters: "Seniors mentor juniors. We have experienced workers. They can mentor the juniors … The company promotes mentorship from the beginning [of a project] … Sometimes, two-to-one [two seniors mentoring one junior] and, perhaps, one-to-two [one senior mentoring two juniors]. This depends on the structure of personnel [i.e., how many seniors and

juniors are at the site].” Invariably, junior blasters lack the expertise to continually apply the right techniques during operations and to faithfully instantiate the plans. Mentoring interactions with senior blasters help to supplement the quality of their attention. A Junior Blaster vividly explained how he supplemented his understanding of operations from senior blasters throughout the course of the execution stage:

Junior Blaster	They [senior blasters] are very experienced. For example, to test how deep the hole is, they [senior blasters] just use a stick and they can estimate how much powder to load into the hole, based on their observation of the rocks. And how to connect wires, in series or in parallel. The senior blasters would teach us these things.
Interviewer	So, you follow them [during operating]?
Junior Blaster	Yes. For example, the seniors would do the complicated jobs, like connecting wires. Then there are some small tasks, like using paste to tie the wires. The seniors would ask us to do the small tasks.

4.1.3 Accessibility Practices that Maintain Attentional Perspective During Operations

Although managers primarily rely on the pre-shift meeting and expertise of senior blasters to maintain attentional perspective during everyday operations, MKBC also employs accessibility practices to keep the full range of expertise available on an ongoing basis. As a Senior Blaster explained, “During open-air blasting, the project director, site manager, technician, safety man, and all blasters have to be in the site together. Everyone from the manager to the blaster has to be present at the site.” It is this physical presence that enables the flow of information and expertise necessary to maintain attentional perspective at the operational level. Yet, a physical presence is not always possible. In such cases, technology plays an important role in accessibility practices. For instance, even when managers leave the site, they always remain accessible by technology: “I never power off the phone. My phone is open 24 hours. The blasters can call me whenever they find any problem” (Site Manager). Technology makes managers accessible for technique consulting, problem solving, or anomaly reporting—all important for operators to maintain the attentional perspective. Similarly, the blasting team uses

an instant message platform to make expertise and information accessible across levels of the organizational hierarchy and across distinct physical site locations. As the Project Director described:

> In the blasting sites, there are 18 tunnels in total. And each two tunnels are over 90 km far away … so it's impossible to gather all the team leaders from 18 tunnels at one place and let them go back to their tunnel after meeting … We create a chat group [on an instant message platform called WeChat], discussing the assignments of the current day, where to claim the explosives, and what happened during the day. We just send messages in the chat group. Everyone in the group can see the messages. And every worker would know what he should do in the current day, where and when to blast. After blasting, the workers report in the chat group, "the blasting was done at when and where." So, I call it as "reporting safety from thousand miles away [in chat group]."

4.1.4 Safety Culture Practices that Enhance Attentional Engagement During Operations

Whereas the prior three practices that enhance attentional perspective—such as by including relevant expertise and information in plans, instantiating the plans within operators as they move to execution, and ensuring relevant expertise and information remains available on an ongoing basis during execution—the fourth practice enhances attentional engagement. Given that blasters know what to pay attention to, these attentional engagement practices address how attentive they remain over time. These attentional engagement practices are therefore not about the directing the location of attention, such as through plans and trainings, but ensuring attention remains at a heightened level. These attentional engagement practices take both a more diffuse form, rooted in artifacts and rituals, and a more concrete form, rooted in social interaction—both of which are a central part of what is generally referred to as safety culture (see (Vogus, Sutcliffe, and Weick, 2010). Because the primary driver of attention in MKBC is safety, rather than innovation or customer service for instance, these practices use the severe safety dangers associated with inattentiveness to enhance ongoing attentional engagement.

Safety Artifacts. At the most diffuse cultural level, MKBC relies on artifacts to maintain ongoing attentional engagement. For instance, slogans with safety warnings are placed

throughout work sites to heighten attentiveness: “You can see logos and warning slogans on each tree when coming inside the company … Did you see the slogans hanging on the trees? You must remember much once you saw one time. They’re very impressive” (Site Supervisor). Whereas some of the slogans are relatively mundane—for instance, one slogan attached to a tree reminds factory workers producing explosives that “dust is very dangerous”—others are drastic and have a marked effect on attention. One such sign reads: “The accident is ‘two change and one belong’—the wife changes marriage, the child changes surname, and the property belongs to another man”. It reminds blasters that even momentary inattention can be fatal, separating them from their wives, children, and property, and replacing them with another man. And to prevent these safety artifacts from losing their potency and becoming passive parts of the background, MKBC conducts exams. These exams ensure that employees remain attentive to the safety slogans and integrate them into their everyday activities. As a Site Supervisor explained, “Safety is often assessed and evaluated. We have a personnel manual in our company. All the safety-warning slogans are included in the manual. Once you remember one slogan, you have safety cognition in your mind. Therefore, we have a higher safety cognition.”

Safety Rituals. Rituals also play an integral role in maintaining attentional engagement. Such rituals can be relatively safety-specific or more generally designed to instill discipline in employees. The most prominent safety-specific ritual is the annual safety month, in which all employees sign a pledge taking a personal responsibility for safety and the organization holds events to promote safety knowledge to all employees. For instance, the organization will send safety brochures to employees and collect safety stories and reflections from them. During safety month, MKBC “establishes a safety group, every year, checking the operations on the ground and conducting safety trainings” (Technician). Beyond the annual safety month, other rituals

help maintain the attentiveness of operators. Managers similarly have operators watch actual videos of accidents from other sites to keep safety on their mind, given that accidents seldom occur at MKBC. One Site Manager explained the profound impact that such videos can have:

> After watching the movies, I learned a lot. I drove fast before. Now I drive slower and I'm more careful while driving … After watching these movies, I feel so cold deep in my heart. The life is so small in front of the safety accident … Asking them [operators] to see the warning movies and get some inspirations in their heart. After getting deeply inspired to care about the safety, the blasters would learn that there must be no incident and would be more careful. Then this changes their habits of violating [safety] regulations psychologically.

More generally, whenever on site, employees always walk in a straight line to emphasize discipline in mind and body: "Our company requires us that we must walk in the straight line if there are three people walking together" (Guard Man), as shown in Figure X. Further discipline-building rituals include military-style training sessions for all employees on site: that last "about half an hour" and include "marching, parade-step, standing at attention, and standing at ease" (Junior Blaster). These discipline-building rituals extend to frontline activities, such as the pre-shift meetings: "When we have meetings, we stand in lines, like in the army. You know, we all walk into the meetings in lines. Very tidy and uniform … All events, no matter what activities we attend, we stand in lines when entering to the meeting place. It is very strict" (Site Supervisor). Such rituals and artifacts draw on the stark safety dangers to instill within MKBC employees the value of ongoing attentiveness at the level of the organizational culture itself. This concern with attentiveness is not limited to any particular activity or project, or accomplished through any specific social interaction, but pervades in a diffuse way that implicates teleology: it communicates the ultimate ends that the organization values (Sandberg and Tsoukas, 2011).

Safety Interactions. Coupled with the diffuse practices that involve artifacts and rituals, MKBC also cultivates a safety culture through discrete and ongoing social interactions. In contrast to the mentoring interactions that maintain the attentional perspective of operators, these

safety interactions use small interactions to ensure that operators maintain their attentiveness over time, rather than letting the potential safety dangers become dull. The purpose of such interactions is less to ensure that attention is directed in line with the proper perspective for a specific activity, but more to ensure that attention remains at high levels in general. The Project Director of a transportation project explained how he treats even little activities, like checking for stones on the road, as an opportunity to keep attentiveness sharp in service of safety:

> I require people working in the site [to check the road]. Even if the production is a little delayed, they should check the road. But some workers think this [not checking the road] is not a problem, because they want to catch up with the production. But I think this is a very serious problem. Because the uneven road breaks one belt. It costs over RMB 4,000 (about $596 USD). It is not easy to earn this RMB 4,000 in the project. So, I require that the drivers have to park well, bend down and pick up the stones if they've seen some, put the stones on the side of the road. Later they do it well [checking road during driving]. But they didn't do it well in the beginning. They didn't think that it was a problem to have a stone on the road. The drivers said that there were all stones in the mountain. But I require them to pat the stones, the sharp stones into the road. Patting the stones into the road, the truck belt won't be broken easily

4.2 Bundle two: organizational practices that proactively target inattention

Beyond encouraging attention, MKBC further engages in two key practices to proactively discourage inattention. To see when attentional perspective is faltering they (1) utilize detection practices, including by pairing operators and including hierarchical work checking routines, and to enhance ongoing attentional engagement, they (2) include unannounced checking from actors up to the top of the hierarchy that are not anticipated and therefore serve as cause to maintain attentiveness. The crucial point here is that although inattention cannot be directly observed, as an internal state, it will produce errors which leave traces that can be detected before they actually culminate in serious accidents.

4.2.1 Detection Practices for Failures in Attentional Perspective

Detection by Pairing. To help detect failures in attentional perspective, where an operator drifts away from implementing plans and procedures or applies inappropriate past

experiences, operators all work in pairs—with a more and less expert member. The CTO explained this pairing practice in detail as a "one-on-one policy", where less experienced blasters are digging holes and loading powder while the more expert operators like technicians or senior blasters are measuring the holes and how much powder is loaded into them: "One blaster loads powder in the front, one follows him and measures [how much powder was loaded into holes]. By doing so, there is no way that the powder loading will not meet the requirement. Otherwise, the blaster might load more powder than required. If so, there would be problems." This pairing practice helps detect problems early on and is essential because of how difficult and dangerous lapses in attentional perspective can be if left unchecked. For instance, without pairing, "the blaster might load 40kg powder, even though he was required to load 30kg. The hole is so deep: it's hard to get the extra 10kg powder out of the hole" (CTO). In this way, pairing brings a greater amount of expertise to bear on operations, helping refine attentional perspective when the past experience of blasters may not be applicable to the current situation: "Speaking from knowledge structure and [expertise] level, blasters only know blasting. Blasters work in the blasting site for a long time and think that they can persist working in their own ways [across different sites]. But technicians work at different angles from the blasters, as do the managers" (Project Director). Pairing helps detect inappropriate use of past expertise.

Detection by Checking. Practices aimed at detection continue even after operators finish their tasks. Operator work go through multiple rounds of hierarchical checking before blasting can begin—starting with the blaster checking his own work and culminating in a final round of checks from the manager. As the Site Manager of a blasting project in another province noted, "After the blaster's self-checking, the project director checks, then the site manager checks again … After the blaster connects wires and checks his work, project director checks, and a manager

on site checks, who could be a technician, safety man, or any manager who's in the blasting site. Only after the manager's checking can blasters prepare to blast." In explaining the value of these checking processes, the Site Manager raises the issue of "fluke mind," which is others at MKBC frequently note as a critical problem. Fluke mind refers to a failure of attentional perspective that has been variously described as "leaving things to chance" (CTO, Site Manager), "intentionally doing less work and thinking that it won't cause any incidents" (Site Manager), and "thinking that skipping some rules will not cause incidents given no accidents happen before" (Site Manager). Despite knowing the proper plans and procedures, operators may nonetheless fail to follow them owing to fatigue or expedience. As the Site Manager explained, checking practices help counter this fluke mind:

Interviewer	The blasters know how many detonators are required, right?
Site Manager	The blasters know it. But in the end, I still have to count the number of detonators. We have planned how many detonators should be used for the holes. For example, these blasting holes need 9 detonators and those blasting holes need 7 detonators. All the holes have a fixed number [of detonators required].
Interviewer	Then why do you still need to check [if blasters know how many detonators are required]?
Site Manager	If I implement a strict and strong supervision and examination, at least the blasters wouldn't have the fluke mind.

The final check by the Site Manager is comprehensive: going through nearly all the steps in the operation from the details of work, like how wires and detonators are connected, to the real-time behavior of operators, such as whether they have evacuated beyond the safety distance, to communicating with clients about technical matters like the size of the seismic center, in order to avoid upsetting any nearby residents with powerful explosions. As the Site Manager explained:

> I need to be more careful. I need to go over again all the works, like where to blast, connecting the detonators, and the warning of security. I use walkie-talkie to command the whole blasting site. [Do you know] how far the safety distance should be? Say 200 meters. Then people [on the other operating team] in the blasting site would confirm with me, telling me that people from their teams are evacuated. Also, I have to communicate with the client, to control the seismic center to

> the minimum, so the residents nearby wouldn't complain. I need to be careful. I need to control well how much powder is loaded and how the detonators are connected. No mistake is allowed.

Detection by Claiming. Beyond what is directly observable through pairing and checking, MKBC also detects failures in attentional perspective through claiming practices. Namely, in concert with organizational rules and government regulations, the Site Manager controls access to explosives and monitors documents that record the number of explosives being used. Because operators may violate regulations, such as by claiming explosives without adequate permissions, or mismanaging explosives, such as by losing them. The technology and documentation around the explosives claiming practices help detect such issues and restore attentional perspective. As an example, the Site Manager explains how he can detect issues through claiming practice:

> The workers can just follow the rules. But I need to control the process. Without my control, what if the drivers go to claim explosives without having the documents permitting them to claim explosives? And [it's possible that] after claiming, drivers may put the explosives at any places. So, my role in this [claiming practice] is to monitor the documents. I give the driver the document permitting him to claim explosives for the current day's blasting demands. After he claims explosives from the warehouse, he would deliver it to the user [operators in the blasting site]. Then the user has to sign [on the document] once receiving the explosives to record how much explosives like electronic detonators are used in the site. We need the signature of both the user and the guard man to record the number of explosives used in the blasting site, and to prevent any loss of explosives.

When explosives are delivered to the blasting site, the Guard Man takes over, monitoring how operators use explosives to detect and prevent any mistakes, such as losing explosives. As the Guard Man noted, "Here in our site, we need to supervise strictly the explosive powder and detonator. For example, one blaster claimed 50 detonators and 10 bags of powder from me. After he put the detonators and powder in the site, he must check and confirm if all detonators had been put in the holes and all powder were loaded to the holes … If one detonator was forgotten on the floor, or if one detonator was forgotten to put into the holes, I must find out who made the mistake." In this way, claiming utilizes formal documents and technology to aid in detection.

4.2.2 Inspection Practices to Enhance Attentional Engagement

Much of the prior detection practices presume that people higher up in the hierarchy have greater expertise and will therefore notice potential issues and help address them. However, just because they are higher in the hierarchy, and perhaps do more supervisory work rather than the more basic tasks, does not mean that their attentional engagement will remain constant. But, as their role in pairing, checking, and claiming has outsized consequences, so too do any lapses in their attentional engagement. In this way, MKBC must ensure the attentional engagement of all actors at the blast sites, from managers to junior blasters.

Regular Inspections. To help manage the issue of lapses in attentional engagement, MKBC has a safety department that will inspect the blast sites in order to ensure that managers as well as operators maintain their attentiveness levels. There is, indeed, a focus on managers during these visits, given their importance to the rest of the practices. The Safety Department exists at MKBC headquarters and examines the blast sites regularly. Beyond checking operations, members of the safety department randomly check the site manager's work like "sitting in the pre-shift meeting" and collect feedback from blasters about the site manager like "talking with blasters over lunch." Although the safety department may not be experts in blasting and are not familiar with the operations in each project, their presence at the site has the effect of enhancing the attentional engagement of managers and blasters. As a Site Supervisor explained:

> If the leaders have [lapses in attention], we are really done for. We have pre-shift meetings every day in the company. The pre-shift meeting is mainly about safety. Sometimes, it doesn't work that we watch ourselves, because we are too familiar with each other. We have been working in the same company for 10 years. So, how does our company solve this problem? Because we couldn't watch well ourselves, our company establishes the department of safety. People from this department come down [to the blast site] to examine regularly, one or two times per week.

Surprise Inspections. Because regular inspections are predictable, operators can anticipate and prepare for them, such as by covering up their mistakes in advance, providing the

potential for regular inspections to become less effective. Regular inspections are therefore supplemented with surprise inspections to ensure that attentional engagement remains high. These surprise inspections include actors from across the hierarchy. For instance, site managers will conduct surprise inspections to ensure operator attentiveness without giving any advance notice. As a Site Manager explained, after conducting the pre-shift meeting, he engages in surprise inspections across various blast sites:

> I just mentioned the pre-shift meeting, which focuses on two things, safety and task assignment. For task assignments, I make a plan that this group of blasters go to load powder in one spot, and another group of blasters go to load powder in another spot. After the task assignment is clear and sent to the blasters, they would know what they should do in the day. Then they would work on their own. After the pre-shift meeting, I may go to the first blasting spot and spend the rest of the day; I may stay in the same blasting spot until the next day; and I may leave to other blasting spots … Perhaps I'm now in this blasting spot but heading to another blasting spot soon later … Also, it is possible that I check all the blasting spots in just one day, or just check one spot one day. Normally, I would examine at least two blasting spots in one day.

Surprise inspections, however, become more influential on attentional engagement when conducted by top managers, and particularly the CTO. If the CTO notices a problem, it will be highlighted across the blasting team and sometimes even the organization. A Site Supervisor recalled such problems, including mismanagement of the ignition machine and improper setting of the safety distance. Although the CTO does address specific aspects of plans and procedures, the presence of the CTO has a major impact on the attentional engagement not only the blasters, but also the senior blasters, technicians, and managers. As the Site Supervisor explained:

> [CTO inspections are] definitely effective. CTO has influence on the team leader. What does he examine? Our operations! He examines me for several times. He comes and says nothing. He gives you power and allows you to work in the way which you believe is right. From powder claiming, powder distributing, operating, blasting, to post-blast examining, you just operate in your own way. He just watches you on the side. Then he would hold a meeting with us after we finish our work. During the meeting, he starts to propose suggestions … After you finish your work, he holds the meeting immediately and proposes suggestions to you. If there is a big mistake, he would hold a safety meeting. We have safety meeting on 5th of each month in the company.

Whereas the presence of the CTO enhances the attentiveness of those on the blast site, the CTO also gains valuable insights through visiting sites and interacting with operators. Because

such surprise inspections provide a view of how activities are actually being performed, they can help the CTO understand the operators' "situations and problems, like problems in management, problems in technique, and problems of each person." These problems are particularly surfaced during casual moments, such as when he eats and chats with operators: "As long as I go down to the blasting sites, I could discover some problems via discussions with operators. Some problems on the ground will be fed back to you … Usually we [CTO and other top managers] go down to the blasting sites to be together with the workers. Then I'll know some situations and get some feedback, via eating and chatting [with operators]. The effect [of such visits] is better." (CTO).

Such detection of problems, whether from practices like inspection or claiming, create the need for the organization to react to the emerging problems in ways that contain them and also create the possibility for learning. This need is met by the third bundle, to which we now turn.

4.3 Bundle three: organizational practices reacting to emerging problems

To react to emerging problems—which can be caused by external circumstances as well as by inattention—MKBC utilizes three key practices that vary in their temporal scope: (1) short-term practices that contain problems by using anticipation of problems and corrections to violations of procedures to repair attentional perspective, (2) short-term practices that restore attentional engagement by reinforcing safety culture, through activities that emphasize the negative consequences of violations and punish them, and (3) long-term practices that extract and distribute learning from ad-hoc problem solving to enrich attentional perspective, using informal discussions for small problems or formal meetings that occur with less frequency but include actors higher up the hierarchy for more severe problems. These practices collectively serve to contain emerging problems and transform them into opportunities for firm learning.

4.3.1 Short-term Practices that Contain Problems by Repairing Attentional Perspective

Anticipating Problems. An integral aspect of maintaining high reliability is that when people notice problems, they act swiftly to communicate and control the problem before it turns into an accident (Engemann and Scott, 2018). The Technology Director offered a clear example of this practice on a day when he noticed that the weather was unusually hot: "Today I called each project to address this problem first. When the explosives-transportation truck arrives at the blasting site, [we must] prevent the warm weather from increasing the temperature inside the truck, resulting in the spontaneous ignition of detonators and powder in it." As a result of his calls to managers across the various blasting sites, each took corrective action: "I called the manager in each site, asking them to hold meetings with safety men and drivers to look for solutions. For example, when the explosives-transportation trucks arrive at the site, they should be parked as far as possible from people, in places avoiding the blazing sun. The second method is to ask safety men and drivers to regularly open the side door of the truck to cool it, every 50 minutes or 1 hour" (Technology Director). As another example, a Project Director noticed that a ground wire of an explosives-transportation truck was broken, which could pose a safety risk by failing to discharge static electricity. He immediately notified the Site Manager about this issue, which was swiftly addressed. By anticipating the consequences of small problems before they grow into serious accidents. Similarly, a Senior Blaster explained how anticipating problems and communicating around them can prevent problems from escalating:

> After loading powder to all the holes, we need to evacuate the blasting site … during evacuation, the technician would ask me "How is the powder loading?" If I feel that one hole is not loaded well, I would tell him, "I think one hole might fail." Then the technician asks me "You feel that one hole would fail?" I say, "Yes, it definitely would fail." … So, when we are evacuating the site, we can check [the failed hole]. Also, after powder loading, we need to connect the detonators. Then we would check the powder loading while connecting the detonators.

As the Project Director of the transportation project explained, by noticing and fixing small problems in an anticipatory manner, larger and more costly accidents can be avoided:

Project Director	Imagine that I'm a driver. I'm catching up with the shifts. I need to finish my quota. If the truck has some small issues, I might not stop and spend time in examining. But if we don't examine the small issues, they might cause big problems.
Interviewer	What kind of issues are small issues?
Project Director	For example, there are 6 screws for one tire. If the driver examines and discovers that one screw is broken, he just needs to strengthen the only one screw. It's just about RMB10 (~$1.50 USD). But if the other 5 [screws] broke together, then we need to replace the whole tire. And incidents might happen. Also, for example, every time when the truck starts, the driver can stop for 1 or 2 minutes and use the small hammer to take an examination [of the tire]. Because the tire might carry some stones. If [drivers] driving with stones in the tire, the tire might be broken…

Correcting and Explaining Violations. Beyond anticipating problems in the site, short-term reactions are also needed when operators violate procedures. Different actors at the blasting site attend to, and enforce procedures around, different aspects of operations. First, because site managers work closely with operators, they can readily notice minor procedure violations and restore the proper attentional perspective. For instance, one Site Manager described how, over the course of several performance episodes, operators can become lax in following basic rules: "… after working as a blaster for a longer time, some blasters just wear the safety hat casually. By the safety rule, blasters have to fasten the strap and then wear the safety hat. The blasters who didn't fasten the strap would say that they've been working in this profession for 30 years and have always been wearing the safety hat without the strap. No incidents ever happened before. Once I notice this kind of careless behavior, I remind them immediately." The technicians take special notice when operators use the wrong tools. One technician explained how he notices and responds to such violations: "If I saw them use ironstone to penetrate the hole, I would definitely lecture them. I ask them to take the ironstone out. Then I ask the blasters to use wood stick. If the wood stick doesn't work, I ask them to install a detonator and explode the blocked powder. And if it doesn't work at all, I would ask them to give up penetrating the hole." The Guard Man most attends to how operators store explosives in the blast site. As an example, if the Guard Man

notices that detonators and explosive powder are put too near each other, he will intervene and ensure that operators put detonators at least 50 meters from powder as regulations dictate.

These occasions to enforce procedures become effective because they are typically coupled with explanations. As the Guard Man explained, “After noticing problems, you correct and solve them. And after solving the problems, you explain to the blasters.” The Technology Director similarly highlighted the importance of explanation during operations, suggesting that it is more effective than learning by books: “For example, when the workers are working, how to control the powder quantity, how to control the power loading, the length of loading, how to make sure the safety distance … Sometimes it is one thing told in the books, but another thing in the site … I would be in the site to do correcting and instructing.” In this way, correcting violations of procedures provides an occasion to explain them and thereby restore attentional perspective.

4.3.2 Short-term Practices that Restore Attentional Engagement by Reinforcing Safety Culture

When operators violate procedures, it is not enough merely to restore the proper attentional perspective by correcting their behavior and explaining the procedure. Violations of procedure can also indicate a failure of attentional engagement, in which operators cease to take the safety dangers seriously enough to motivate sustained and ongoing attentiveness. Managers at MKBC utilize two practices to reinforce safety culture: emphasizing negative consequences of these violations and levying punishments for violations.

Emphasizing Consequences. To help ensure that operators who violate procedures become attentive once again, managers emphasize how their violations ultimately hurt themselves. A Site Manager explains how he makes this point in the context of violations to the

procedure of regular checking of the vehicle: if any problem escalates into an accident, the operator is the key victim.

Site Manager	Supposing that you are a driver, if the truck is broken around 1–2 AM in the night, who is the main victim?
Interviewer	Me
Site Manager	Yes. I, as a team leader, can only tell the operators my requirements, for example, checking the truck regularly both before driving the truck out and after driving the truck back. If my requirement is well-executed among the operators, we can keep the truck back home to do the examination and the truck can go to work after the examination, once we found that the truck has some problems. If my requirement is not well executed among the operators, that is, they didn't check the truck regularly, if the truck is broken while running on the road, happen to be around 2 or 3 AM in the morning, if calling colleagues to help to repair the truck and drive it back to the site, it would take 2 hours. The driver has to stay in the [broken] truck [waiting for helpers] for these 2 hours. But the driver could've gone back home and taken a good sleep if he checks the truck regularly as I require.
Interviewer	So, how do you communicate to the driver?
Site Manager	I would explain to the driver clearly that the ultimate victim is himself.

Site Managers emphasize more severe consequences as well. Making the safety slogan of "two changes and one belong" even more vivid, one Site Manager discusses it when he notices rule violations: "I tell the operators that once an accident happens, it hurts ourselves. Our son will call another man daddy, our wife will sleep with another man, all our savings will go to another man's pocket, and our white-hair parents have to be apart with their black-hair sons … I say these to our operators to [help them] be mindful about safety … I remind them that this job is not only about themselves, it is about the whole family. Letting the blasters have this mentality."

Punishing Violations. Beyond emphasizing these hypothetical consequences, the managers at MKBC also impose very real practical consequences for violations. In particular, they levy a variety of punishments to restore the attentional engagement of blasters. The most commonly levied punishment is to remove blasters from operations and ask them to write a daily "self-criticism letter" in which they reflect on why they made a violation. As the Site Supervisor noted, this process can remove a blaster from operations for some time, "He has to recognize his mistakes. Only when he has a deep understanding of his mistakes, can he come back to work

again. Sometimes, the worker stops one day. Sometimes, several days. He would be stopped [from working] until he recognizes his mistakes." As one Senior Blaster explained from personal experience, he recognized his mistakes deeply after the self-criticism punishment was coupled with a monetary fine when he violated procedures during a visit from the CTO:

> As the old saying goes, "It hurts to cut off the head, it also hurts to fine money." After being fined once, I would definitely know where my problem comes from. Last time when CTO came to examine, I did everything well but had one problem. Us three blasters went inside the tunnel to work. And we left the igniting machine at the tunnel entrance. At last, CTO pointed out that problem. Although our mistake didn't go to the safety meeting, we were criticized. And I wrote a self-criticism letter and got fined RMB200 [~$15 USD] … I wrote a self-criticism letter and handed it to Manager L [pseudonym of a manager]. And Manager L forwarded my letter to CTO … From then on, I remembered my mistake. From then on, I would ask my teammate to carry the igniting machine. I find my own person [to carry the igniting machine]. If he doesn't carry, I would carry [by myself]. [The punishment is] very effective.

4.3.3 Long-term Practices that Distribute Learning from Problem-Solving to Enrich Attentional Perspective

Whereas the short-term reactive practice correct problems, including problems emerging from inattention and violations of procedures, this practice is insufficient to truly maintain high reliability. Instead, the organization needs longer-term practices that extract the learning from such ad-hoc problem-solving activities and distribute this learning throughout the organization more widely. MKBC does so both through informal discussions and through formal scheduled meetings that repeat at varying frequencies. These practices help distribute learnings throughout operators on a project and to actors atop the hierarchy, particularly as problems become severe.

Informal Discussions. Managers may not react immediately to smaller problems. They may instead wait for informal occasions to discuss such problems, as operators are most receptive to feedback in such settings, rather than bringing up the issues in a more formal meeting that occurs regularly, like the pre-shift meeting. As a Site Manager in a province we did not observe noted:

> We don't call it a meeting. We just sit together and discuss. If I say, "Let's have meetings," then it doesn't work. If I say let's talk together, then it works. If I say meeting, often it's just me who is talking. The others keep silent. But if we talk informally, everyone talks, then everybody is active. Once it is active, the works are easier to communicate with. We are more relaxed. We can do everything well. You know, I'm a worker. The blasters are also workers. We don't care so many things like title, position, hierarchy. Then we can communicate everything. If we mind the hierarchy, the blasters wouldn't tell you anything. You know if the blasters can talk to you about things, they are also helping you. If you can't read their mind, the blasters can't read your mind, neither. Then we are just guessing each other's mind … In meetings, people wouldn't communicate. But if we sit down together, we can discuss. We can talk about everything. For example, we are quite happy today. Then we just drink some beer together. Then everything can talk through.

Mangers must make determinations about whether a problem is small enough to address through informal discussions that minimize hierarchical differences, or through more formal meetings that formally identify the operator who made an error and can include actors across the hierarchy, up to and including the CEO. In discussing such determinations, the Site Manager offered a distinction between a situation in which a single operator is responsible for checking the site after a blast and does a careless job, which would merit discussion during a formal meeting, relative to a case where one member of a team of operators does a careless job, which merits an informal discussion during dinner to not be "standing on the shoes of others." One middle ground approach is to use the WeChat group to distribute the learnings from a particular problem they notice. As the Project Director explained, "Technicians and managers may notice that some [past] experiences [being applied by blasters] are not appropriate in certain occasions [i.e., the current project]. Then they would point out the inappropriate experiences and bring them up in the chat group. Then all blasters would pay attention to [the appropriate operations]."

Pre-Shift Meetings. After addressing a more serious problem in the short-term, managers will summarize the problem and any related learning, and feed this content forward into the next pre-shift meeting typically within one day. As the Site Supervisor explained, "The pre-shift meeting is very structured. It solves the problems of yesterday and clarifies the

assignments for today. Then the blasters start the day's work." In this way, the attentional perspective conveyed during the pre-shift meeting is not merely about implementing roles and procedures formulated during the planning stage, but also distributing learning gained from the execution stage. By taking these lessons gained from ad-hoc problem solving and feeding them into the pre-shift meeting, the Site Manager feels more certain that the lessons will shape attentional perspective of the blaster team as a whole, rather than a mere subset thereof. For instance, he describes how explosive materials left behind in one shift is a major potential danger, and this lesson must be distributed to direct the attention of blasters toward issues in the upcoming shift, lest they misuse these materials.

Site Manager	For example, after the blasting, there is no light inside the tunnel. So, we have to use flashlight. There must be more than one blaster going inside the tunnel after the blasting to do the post-blasting check. At least the safety man and one blaster need to go inside. And they must check thoroughly after going inside. For example, if they saw a hole and didn't know if there was powder inside the hole, they must climb to the hole and check with their flashlight, to confirm whether there was power left in the hole.
Interviewer	So, if the blaster didn't check, you would mention this in the team and require people to do the post-blasting check?
Site Manager	Yes. And I must call the name of the blaster who didn't do the post-blasting check. Because this is a very serious problem. If there is detonator or powder left inside the tunnel after blasting and got lost outside [the blasting area], the consequence is hard to imagine [the left powder might be collected by others and used in wrong occasions, causing accident] … The important problems are normally mentioned in the pre-shift meeting. If you just mention it in casual occasions, some members might care, and others might not care. People wouldn't care what you say in informal occasions. If you talk about the problem in formal occasions, they would pay more attention.

The Technology Director of a blasting project at a province we did not observe similarly emphasizes the importance of surfacing problems in front of the whole team during pre-shift meetings. Directing the team's attention to the problem alerts all operators not to make the same mistake and informs them about how to solve such problems in the future. He explains,

> At the everyday pre-shift meetings, we will talk more or less about some problems. Depending on what happening in each day, if some person has a problem, the leader or the person will speak

> it up. This [serves as] a reference to other members in the team. Perhaps only one person encountered the problem, but the others didn't. Speak it up to others. Because the blasting has higher requirement about the workers' operating experiences. If the workers didn't experience such problem, they wouldn't know how to solve it [when they encounter it]. But it is impossible to tell all the problems to the workers, because there are so many problems. You don't know what kind of problems will emerge. Also, if you talk too much [in advance], they couldn't remember all. This [experience] can only accumulate one by one based on the workers' individual experiences.

Problem-Specific Meetings. Beyond relying on the pre-shift meetings, managers will call problem-specific meetings to discuss important incidents and lecture on the lessons learned from the incident. The Project Director of the transportation project, for instance, asked all employees in the project to join a problem-specific meeting after one team's vehicle fell into a hole. During the meeting, the employees became widely aware of the incident and, after studying this case for three days, they refined their attentional perspective for subsequent operations.

For another incident that "an employee broke his legs when dealing with waste tires", the Project Director took it as a case for the whole project. Although this incident happened in May 2015, the project director keeps "talking about this incident during meetings". The project team integrate their learning from that incident in their daily work. As the project director describes, "no matter what we are doing, like maintaining equipment, using crane, lifting things up, or installing things. For example, the engine is broken. We need to use crane to life the engine up. We all need to accept the lessons of that incident. We must make a safety plan [before doing the task]. Leaders, like the team leaders or important operators, must stay in the site to watch how to do the job. [Even for small tasks] like moving tires, we don't just move casually. Because we suffered from the incident.

Triangulation Meetings. Whereas both the pre-shift meetings and the problem-specific meetings function to distribute information and learning throughout the operators, problems also must be communicated up the hierarchy. The time intervals at which such communication occurs

is less frequently. Managers above the level of site manager communicate about problems and learning once a week during weekly safety meetings. Such meetings help to triangulate attention across the various levels of the hierarchy to ensure managers of the organization as a whole have a clear understanding of relevant issues (Rerup, 2009). As the CTO explained,

> The weekly safety meeting is mainly for collecting information from people on the ground. Each attendant talk about the problems they encounter. [Weekly safety meeting] is to collect and analyze problems. What problems could be corrected immediately, what problems need to be reported, what problems are the most important ones, what problems need to be arranged. If the problem needs to be corrected, who will correct, and correct to which level. We will make arrangements for all things described above … The weekly safety meeting is for managers above team leaders to collect problems and make arrangements for problem correcting and solving.

Problems that require the attention of top managers like the CEO are addressed during the monthly safety meeting, which is only attended by managers above the project director level. It is during these meetings that critical problems are addressed and relevant punishments are levied.

> If you made a big mistake, you would be in the safety meeting on 5th of each month. CEO is also in the meeting. During the safety meeting, they would say that some operator in CZ [abbreviation of a city name] made a mistake. For example, the team leader tells the team to work in a wrong way. Director L [pseudonym of project director] would attend that meeting. I can imagine how shamed he must feel. He would not only make changes [to solve the problem], he would also make [punish] you. Definitely. You made the mistake and you made him feel uncomfortable [in the meeting]. He definitely would make changes after coming back [to the blasting site]. Or fining.

During the monthly meetings, one incident happened in one project will be taken as a typical case for all the projects to prevent the same mistake happening in the future. The Project Director who encountered the incident of employee breaking leg when moving waste tires said, "this incident is taken as a typical case in the company. All other projects must take this lesson and not make the same mistake."

The organization makes the best use of incidents happened on the ground as learning materials. For example, Project Director "makes the major incident as a case and lectures it to all employees in the project during general meeting [that all members attend]" while Technique Director "lectures the case of incidents happened last year in the sites" during trainings.

5. Theorizing bundles of attention regulation practices

After presenting the grounded findings; we have a section with the complementarities of the activities within a practice, across practices within a bundle, and then across bundles -- then this goes into the logic of entrainment and learning.

5.1 Complementarities in bundles of practices

Bundles of organizational practices generate complementarities: the value of any one practice depends on the overall configuration of other practices (Macduffie, 1995; Milgrom and Roberts, 1995; Delery and Doty, 1996). As such, any particular activity in the planning, instantiating, accessibility, and safety culture practices cannot be thought of as isolated "best practices," but instead become effective in conjunction with each other. This complementary occurs both with the various activities subsumed by a single practice as well as with activities across practices. For instance, setting the project level during planning determines the extent of expertise brought in (including from outside the organization), but the project level must be determined based on an investigation of the field. The Technology Director described a site investigation of a project that entailed dismantling the foundation of a building: a particularly strong concrete and rebar structure led to the building's foundation being thinly constructed, only 42 centimeters on average, while covering a large area to be blasted only some 11 meters from residential houses. These factors led both to a higher project level and accounting for all these variables prompted him to consult an expert from a university in designing the plan. In this way, the various planning practices work in conjunction with each other. Similarly, it is often the case that top manager attention becomes scarce because of demands from operators for expertise and information (Galbraith, 1974). Why, then, are the accessibility practices not a potential liability for managers? Only because the planning practices incorporate relevant expertise can the plans

be executed without excessive demands for managerial attention: important contingencies that would otherwise require information from managers are accounted for by site investigations.

The three bundles of practices are complementary to each other. First, one bundle of practices is limited and may fail. One of the key activities in Bundle One practices to encourage attention is pre-shift meeting where managers assign tasks for each blaster so that people are clear about what they should focus on. However, this key activity may fail. As described by one blaster, "After a long time [of working in the frontline], we may become numb to the pre-shift meetings…Before I was working in the mines [blasting projects for mining]. There were pre-shift meetings every day. During the pre-shift meeting, people just do whatever they want. They think it [pre-shift meeting] doesn't matter." The failure of pre-shift meeting results in attention failures of both blasters and managers at site such that blasters don't know what to focus on and have a low level of attention during operations, and managers at site exhibit a low level of attention.

So, the organization needs to implement Bundle Two practices during executing for detecting and inspecting attention failures. The detection practices and surprise inspections practices from managers at site help to overcome the attention failures of blasters such that managers at site can notice inattentive behaviors and problems by working together with blasters, checking blasters' operations, and monitoring blasters' work by claiming. In addition, the inspection practices from a higher level of management (Project Director) and a separate department (Safety Department) can solve the attention failures of managers at site.

The Bundle Two practices of detection and inspection not only solve the failures of Bundle One practices, but also lead to the Bundle Three practices of learning. Only after noticing attention failures can the organization enact practices to learn from the attention failures. More

importantly, the learning practices refine the Bundle One practices such as fixing or updating the attentional perspectives. Using the problems analyzed in the meetings, the organization updates the training materials to keep blasters aware of the latest problems by "lecturing the cases of incidents happened last year in the sites" (Technique Director). A more immediate linkage between the learning practices and attention encouraging practices is that the correcting and reinforcing practices provide new attentional perspectives for blasters to maintain high attention in the next round of operating. As recorded in the pre-shift meeting notes on 29 May 2017 by Technique Director, problems noticed in the last shift like "workers in charge of warning are not very responsible and the warning horn's sound is too small" are specifically addressed in the next shift such that "we strengthened the warning, checking multiple times to ensure full evacuation and fixing the horn". Also, emphasizing consequences and punishing violations enhance blasters' level of attentiveness since "reading a self-criticism letter in front of the whole team alerts other blasters not to make the same mistake" (Site Manager).

More broadly speaking, the safety culture practices encourage the executing of all three bundles of practices such that encouraging attention in the organization makes people adopt appropriate practices in different situations. Only "remembering the fear to accident" (Technology Director) and "daring not to be careless" (Site Manager) will people practice these activities to encourage attention, discourage inattention, and learn from attention failures. Without a strong culture in safety, people may not practice the best practices.

5.2 Timescales of attentional fluctuations and the need for many [bundles of] practices

5.2.1 Attention dynamics within a performance episode

The first, most granular, timescale at which attention fluctuates concerns its moment-to-moment oscillations that occur repeatedly within a performance episode. At this *within*

performance episode timescale, people cyclically: begin with top-down focus on task-relevant information and maintaining bottom-up engagement for relevant information, lose their engagement, such that attention decouples from the task and mind wandering begins, after noticing this mind wandering by metacognitive monitoring, people shift their attention back to the task at hand (Hasenkamp et al., 2012; Malinowski, 2013). When attention fails at this within performance episode timescale, blasters drift their attention from the right perspectives, engaging in behaviours like "forgetting to update the data of explosives using which blocks the system of explosives managing" (CTO, Guard) and "forgetting extra explosives in the operation site which may cause explosions when trucks driving by" (Project Director, Site Manager, Guard). Also, blasters fail to monitor their attention failures and bring attention back on track.

[Insert Figure 2 About Here]

The metacognitive practices, particularly the Bundle One practices, regulate blasters' attention fluctuations within a performance episode. Before blasters' performing, the organization implements pre-shift meeting, mentoring, and accessibility practices to make sure that blasters know what they should focus on during the performance. Specifically, blasters get assignments during pre-shift meeting about what they should do during the day, like digging holes and the number of holes. When operating at site, there are senior blasters showing junior blasters who are not familiar with operations about the procedures. For all operators, there are managers working together with them at site and staying contactable for any question which they may have and for any problem which they may need help to solve. One thing worth noticing is that blasters do not fail intentionally at attention fluctuating at the within performance episode timescale but engage in natural attention cycling. Being aware that "no one will be 100% sure that there will be no problem. Even the best blasting expert doesn't dare to [guarantee]" (Site

Supervisor), the organization implements detection practices such that peers and managers can find out operators' attention failures by pairing, checking, and claiming. Lastly, besides the immediate correcting of the attention failures within a performance episode, managers summarize these failures during pre-shift meeting (Site Manager), problem-specific meetings (Project Director), and monthly safety meeting (Top Managers) to prevent the same failures happening again and define new attentional perspectives like introducing new regulations and solutions to solve these failures in the next round of performance.

In the meanwhile, to maintain a high level of attentiveness and address attention failures in engagement within A performance episode, the organization implements safety rituals in meetings, like "singing a revolutionary song in the beginning of the pre-shift meeting" and "standing and walking in straight lines at meetings". During operating, the presence of managers at site primes the engagement of blasters. Knowing that managers are working by their side and checking their works, operators will maintain alertness during performing. More importantly, to cultivate the blasters' awareness and capacity of meta-cognitive controlling, the organization encourages the mindset of "watching yourself" and writes it into the contract to formalize the practice of meta-cognitive controlling. "I have to ensure that no problem happens in my holes [tasks of digging holes]. Within my control, I do my work to the best. I just watch my own work…Each worker takes good care of their own work...This is written in our contract." (Site Supervisor)

5.2.2 Attention dynamics over a performance episode

The second timescale at which attention fluctuates concerns trajectories that occur over the course of a performance episode [the baseline levels of attention also diminish over a performance episode in a quasilinear trajectory]. At this timescale, attention has been found to

decay gradually as people work on a single task for some time—a trajectory first found in critical infrastructure tasks like airport security screening, sonar and radar patrol, industrial quality control, and long-haul transportation driving (Warm, Parasuraman, and Matthews, 2008) and later observed in contexts as varied as court sentencing decisions (Danziger, Levav, and Avnaim-Pesso, 2011), student learning rates (Randles, Harlow, and Inzlicht, 2017), and standardized test performance (Sievertsen, Gino, and Piovesan, 2016). Much of the reason for this gradual decay in attention over a performance episode is an accruing sense of fatigue (Grier et al., 2003; Schmeichel and Baumeister, 2010). But rather than being a flaw, fatigue has an evolutionary basis, in which it conferred adaptive value (Hockey, 2011; Kurzban et al., 2013; Inzlicht, Schmeichel, and Macrae, 2014).

Over a performance episode, feelings of fatigue therefore accumulate and cause people to shift away from the current task and consider other tasks that might provide greater rewards and over a nearer time horizon. Fatigue thus has a "metacognitive function" in that it helps people optimize across tasks (Hockey, 2011: 173). One byproduct of this function is that fatigue can cause people to shift their attention to short-term benefits, which is why fatigue often precedes "a great many varieties" of failures in self-regulation, observed in domains as disparate as education, substance abuse treatment, emotional control, and task performance (Baumeister and Heatherton, 1996: 4). Although fatigue can be overridden with sufficient motivation, doing so is not trivial, as fatigue would offer little evolutionary benefit it was easily overridden (Evans, Boggero, and Segerstrom, 2016; Lian et al., 2017). When attention fails at this over performance episode timescale, the feelings of fatigue motivate blasters to focus on short-term benefits via engaging in behaviours like "intentionally breaking rules and hiding mistakes after breaking rules", "doing a careless job to finish quicker", and "taking short-cuts". Different from the

unintentional attention failures within performance episode, blasters know what they should focus on but are motivated to shift their attention to short-term benefits over performance episode.

To regulate attention fluctuations over a performance episode, the organization implements a different set of practices from those targeting at attention fluctuations within a performance episode. Managers at site check specifically the issues which operators may take short-cut of. For example, both Site Manager and Guard highlight their checking on the use of explosives since operators may lie to managers about the number of detonators they used because they want to skip the step of counting. Besides the specific checking at a regular base, managers at site conduct irregular inspections to overcome the blasters' mindset of "becoming less careful after working at site for a long time" (Site Manager). Upon noticing, blasters' short-cut behaviours like "using iron stones to unblock holes instead of wood sticks" (Technician) and "using stones to fill up holes instead of claiming powder" (Site Supervisor) will be corrected immediately. After correcting these attention failures, managers emphasize the consequences of intentional rule-breaking and mistake-hiding to build blasters' mindset that "their behaviors will only hurt themselves as they are the victims of accidents" (Site Manager). The organization doesn't punish failures stemming from within-performance-episode attention fluctuations. Because these failures are not intentional, and managers can fix them during performing by detection practices. But for the over-performance-episode attention failures motivated by fatigue, the organization needs to implement punishing activities to fix the wrong intentions and cultivate the safety mentality, via practicing "suspension", "fining", "writing self-critique letters", and "reading self-critique letters in front of the whole team".

5.2.3 Attention dynamics across multiple performance episodes

The third timescale at which attention fluctuates concerns trends that occur across multiple performance episodes. At this timescale, attention can withdraw from performance in a step-like manner from one performance episode to the next. As models of learning and expertise suggest, people may begin a task without a clear sense of what information matters, but, over time, they learn to focus more narrowly on a limited subset of valuable information (Dreyfus and Dreyfus, 2005). Such shifts in attention are necessary parts of the skill acquisition process (Anderson, 1982; Kanfer and Ackerman, 1989). But it is often the case that people overlearn from past experience and withdraw their attention more than is helpful (Langer, Blank, and Chanowitz, 1978; Langer and Moldoveanu, 2000). A cause of this issue is that people rely more on their internal past expertise than on the external information available in their current environment (Smith, 2003; Dane, 2010). As a result, they take in less of the available information (Ashforth and Fried, 1988; Louis and Sutton, 1991) and can particularly miss information that conflicts with their expertise (Ohlsson, 2011; Drew, Vo, and Wolfe, 2013). Further complicating matters, the metacognitive processes by which people revise and doubt their expertise tend to be more difficult and less motivating to enact (Chi and Ohlsson, 2005; Yanow, 2015). We represent this timescale in Figure 2 by showing how the baseline level of attention paid to tasks diminishes across multiple performance episodes (represented, for instance, by how the intercept of these lines drops from one performance episode to the next separated by time *t*). When attention fails at this across multiple performance episodes timescale, blasters overly rely on their experiences, "believing that accidents will not happen given that no accidents happened on them before" (CTO, Project Director, Technique Director, Site Manager), "unwilling to change their work habits to fit with the current circumstances" (CTO, Site

Manager, Site Supervisor), and "inventing simpler but less safe ways of operations rather than following the regulations" (Site Manager, Site Supervisor, Technician, Blaster).

The experience-based attention fluctuations across multiple performance episodes relate to the fatigue-based attention fluctuations over performance episode. The reason why blasters' attention fails over performance episode is mainly because they are tired and shift their attention on short-term benefits like finishing job quicker and taking a rest, and partly because they are overconfident in their experiences, believing that taking short-cuts will not cause problems. For example, one Site Manager explains why some managers and blasters do not conduct post-blasting checking. "One reason is that we're so tired after working at site for the whole day. We also believe that we did our job perfectly. There is no need to check again after finishing the blasting. We've been doing post-blasting checking for a long time. We found no problems in previous checks. So, we believe that there won't be problems. So, we do not have to do post-blasting checking every time." The overconfidence in their experiences and complacency in their work limit blasters' attention on their experiences.

To regulate attention fluctuations across multiple performance episodes, the organization implements a set of practices targeting at the experiences of employees in the frontline. First, the organization determines the scope of applying past experiences using planning and training practices. For example, "setting the safety distance at 200 meters" forbids blasters to "blast within 100 meters" although "the safety distance in previous project was 100 meters" (Project Director). Also, the organization builds safety culture via presenting safety artifacts and holding safety rituals to overcome employees' overconfidence in the assumption that "no accidents will happen given that no accidents happened on them before". For instance, watching accident movie reminds people that "accidents always happen" (Site Manager). When blasters become

overconfident and complacent, they treat potential dangers as “small issues” and become slack about their work. As described by one blaster, “it’s okay to ignore the small issues”. But “checking the small issues like tire pressure and screws of trucks can prevent traffic accidents when transporting explosives” (Project Director). So, managers from higher levels address such attention failures during safety interactions. Moreover, although project directors and people from the safety department are often not blasting experts, their presence during inspections is to prime the alertness of front-line people, hence, to prevent them from getting overconfident in their jobs and becoming less attentive, while the inspections of technicians and CTO focus on the specific operations of front-line people to examine whether their experiences and expertise fit with the current operation requirements. Finally, the organization provides multiple expectations to help frontline people understand the limitations of their experiences. For example, managers warn site manager to “fix the broken wires” (Site Manager) and “pay attention on the increasingly hot weather” (Site Manager) when Site Manager doesn’t see the potential dangers of broken wires and hot weather. Managers use the evidence of failure to prove that blasters’ experiences are wrong after their resistance of “changing the way of wiring” as “it always worked before” (Site Manager). Via warning and correcting practices, the organization diversifies the frontline people’s experiences.

Therefore, practices regulate attention fluctuations in three timescales via different processes. Specifically, practices regulate attention fluctuations within a performance episode by defining the attentional perspectives, maintaining a high level of attentiveness, and cultivating the meta-cognitive controlling. Practices regulate attention fluctuations over a performance episode by managing the short-cut behaviors, bringing blasters’ motivation back on safe operations, and building the mentality of safety. Finally, practices regulate attention fluctuations

across multiple performance episodes by defining the scope of applying experiences, overcoming overconfidence and complacency, and diversifying experiences. Understanding the processes how the metacognitive practices regulate attention fluctuations at different timescales is more important than knowing what the practices are. Even replicating the same practices will not produce another high-reliability organization, but understanding the processes helps managers and practitioners to devise practices fit with their own organizations.

5.3 Logic of entrainment in bundles of practices

Drawing on these grounded findings, we suggest that the bundles of practices are arranged according to a logic of entrainment. Entrainment concerns the way that two temporal processes can be mapped onto each other, such as how the circadian rhythms fluctuate in alignment with the 24-hour day, how families of night shift workers change their patterns of meals and leisure to accommodate daytime sleep, or how organizational activities rise and fall with seasonal product launches (Ancona and Chong, 1996; Pérez-Nordtvedt et al., 2008). In the same way, we suggest that fluctuations in employee attention over time are influenced by organizational practices and that these practices are themselves mapped onto existing work routines that repeat across nested time cycles, occurring each shift, blast, week, month, project, and year. Employee mood, sleep, and behaviors are known to be responsive to workplace time-givers like schedules (McGrath and Rotchford, 1983; Shipp and Richardson, 2019). What we theorize is that employee attention is also responsive to workplace time-givers, namely, the practices we have described. But whereas sleep is determined by relatively few time-givers like the daily work schedule and the weekends where work does not occur, attention must be stabilized and regulated by relatively many time-givers, because it fluctuates at multiple distinct timescales, each of which produce different types of mindless behaviors and different risks to

organizational reliability. Rather than trying to develop an entirely separate structure for practices that regulate attention, we theorize that these practices have essentially piggybacked onto existing work routines. The practices can thereby be ensured to be enacted regularly and maintained with relatively little additional effort. We further theorize that the entrainment of attention onto work routines has a logic. For instance, it would be unwise to place a practice that has short-term effects onto a work routine that repeats rather infrequently, like yearly. It would similarly be unwise to place practices that involve top managers onto a frequently repeating work routine, as the use of top management time is costly.

To help unpack the logic of entrainment, we plotted the number of practices that influence attention perspective (what employees attend to) and attention engagement (how attentive they remain) across these nested time cycles and identified where in the hierarchy the actors involved in those practices are located (see Figure 3). For instance, an annual practice in which the CTO trains blasters on the relevant techniques and procedures would involve both the CTO at the top of the hierarchy and the blasters at the bottom of the hierarchy, would occur at the yearly cycle, and would entail an attentional perspective practice as it influences what information blasters attend to. Similarly, a shift-level practice in which groups of blasters assemble and march in military-style lines would occur entirely on the bottom of the hierarchy and would entail an attentional engagement practice, as it influences how attentive the blasters remain over time.

Looking at the Figure 3, we can indeed discern a logic underlying the structure of attention entrainment. For instance, the number of attention practices decreases at higher levels of the hierarchy. These practices at the higher levels of the hierarchy tend to occur over longer duration cycles: each month, project, and year, rather than at the shift, blast, and week level.

These two trends result in a greater density of practices along the diagonal of Figure 3: at increasing levels of hierarchy, practices become fewer, and longer duration. Yet, unlike a correlation matrix, for example, the off-diagonals are not symmetric. While there are no practices for the CTO at short duration cycles, there are practices that involve the blasters at long duration cycles. Perhaps counterintuitively, these longer duration practices at the bottom of the hierarchy involve both attentional perspective and attentional engagement. That the initiation of a new project comes with several attentional perspective practices is straightforward: front-line employees must learn the plans for the new project—and this occasion marks a useful time to go over and refresh the relevant policies and procedures. But why should attentional engagement practices be clustered at the longest duration yearly cycles, when attentiveness would seem to decay at much shorter time cycles? These attentional engagement practices at yearly cycles are precisely the practices that contribute most to a high-reliability culture: memorizing and performing safety slogans and signing a safety oath, for instance. These practices also include the most direct contact with top managers, making them higher in intensity. Thus, these high-intensity but infrequent practices are particularly influential for employees not despite their long duration, but because of it.

We also can see that different locations within the hierarchy involve a different spread of practices over time, which clarifies and aligns with prior theorizing. The narrowest location in the hierarchy is the project director, who is involved mostly in practices that repeat at the project level. In contrast, the site managers interact with the project director, but also are involved in a wide spread of practices across many time cycles. In this way, by studying the logic of practice entrainment, we can identify how communication and procedures flow through the hierarchy (Ocasio, Laamanen, and Vaara, 2018). The middle managers play a crucial but underappreciated

role in high-reliability linking the site of planning at the headquarters and the site of execution on the front-lines (Kudesia and Reb, 2018), without which the activities of the CTO and project director would bear little fruit. The site managers would thus also be expected to have a more vivid understanding of the organization, because they engage in practices that span across all different time scales and are thereby exposed to a wide variety of issues (Rerup, 2009).

[Insert Figure 2 About Here]

6. Discussion

The current research contributes to the literature on attention, practice, and time. First, prior theorizing has made descriptive and prescriptive claims about attention that appear contradictory, like whether employee attention is "scarce" or not (Levinthal and Rerup, 2006; Weick and Sutcliffe, 2006). Such contradictions may only be apparent, as these claims actually refer to different attentional networks, and thus mean different things by scarcity. In one claim, attention is scarce because strategic plans are too complex for any person to attend to all the relevant information at any one point (Levinthal and Rerup, 2006). In the other claim, attention is scarce only to the extent that people cannot maintain a stable level of attentiveness over time, and may therefore miss important information or fall into mindless behaviors (Weick and Sutcliffe, 2006). The former concerns limits in the top-down orienting network at a single point in time, whereas the latter concerns the bottom-up alerting network as it operates across time. Given how central attention is to organization theory, barriers will remain in its capacity to describe organizations and prescribe best practices unless and until greater clarity about the basic properties of employee attention is reached.

Second, the literature on attention shows that attention does not just have the top-down perspective and bottom-up engagement functions, but a third metacognitive executive function through which people monitor and adjust the other attentional functions (Fernandez-Duque, Baird, and Posner, 2000). The existing organizational practices can have metacognitive purposes that have not been clearly articulated so far. For instance, Weick (1979) argued that whereas the espoused purpose of meetings is to plan for the future, the actual purpose is to exchange information that helps them make sense of current events (p. 11). Similarly, a metacognitive practice orientation is one in which repeated everyday activities may function not only to exchange information and negotiate interdependence, but may also serve a metacognitive purpose of revising how and to what attention is paid.

Finally, organization theories have traditionally assumed stability (Tsoukas and Chia, 2002). Recent theorizing on metacognitive practice, however, provides a basis to reintroduce the temporal dimension into the study of attention and organization. From a metacognitive practice perspective, attention and the solutions to regulate attention, including expertise, hierarchy, and social interactions, are not stable entities in organizations. But, to date, the role of time in attention has remained implicit and the metacognitive practices that regulate attention on the frontlines have received little systematic investigations.

The current research conducts in-depth investigations of attention on the frontlines of a high-reliability organization, where the perspective and engagement of attention are integrated into action. This provides rich direct observations needed to theorize attention as a temporal phenomenon, contextualize the organizational practices meant to regulate attention, and uncover the logic by which these practices can serve the metacognitive function to stabilize attention over time. Specifically, we identify three bundles of practices, which we integrate into a theory of

attentional entrainment. Through encouraging attention and discouraging inattention, respectively, the first two bundles of practices proactively regulate attention fluctuations in the frontline. These bundles are mapped onto existing routines that repeat cyclically across multiple timescales in the organization. The third bundle reactively solves problems resulting from attention failures and enhances learning by extracting lessons from problem solving and then distributes these lessons throughout the organization by feeding the lessons back into entrained practices that repeat at regular time cycles.

The current research also advances high-reliability research by clarifying the process one should use to transfer insights derived from high-reliability organizations to other organizations. Through an in-depth case study, we not only provide a list of best practices, but also examine the logic by which bundles of practices work together and contextualize them to regulate attention in organizations. On one hand, practices regulate attention over time by targeting at the attention fluctuations in different timescales. Identifying that attention fluctuates within and over a performance episode and across multiple performance episodes, practices address attention failures in each timescale and stabilize it over time. On the other hand, the practices are bundled together to produce complementarities such that the effect of one practice relies on the presence and absence of other practices. These two principles guide other organizations to use insights derived from the current case study.

The in-depth case study is suitable for studying attention dynamics and the processes how the practices regulate attention fluctuations over time. However, the role of time remains in the theorizing level in the current case study. Future research can take time as a focal phenomenon and use more diverse methods to study it. Also, future research can test other interventions to regulate attention in organizations such as designing novel practices. Moreover, future research

can study the process of designing organizational practices. The current research investigates the existing practices in the high-reliability organization, while future research can examine how the practices are designed and initiate changes in organizations.

7. Conclusion

Attention is a fundamentally temporal process: it occurs in and across time. In this study, we show how a deeper consideration of the various fluctuations in its networks, and their interplay over time, opens up new avenues for organization theory.

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Table 1. Informants and Data Collection Schedule

Data Collection					
	Round 1: 5/2016 (Site Visit)	**Round 2: 9/2016 (Site Visit)**	**Round 3: 4/2017 (Phone Interview)**	**Round 4: 5/2017 (Site Visit)**	**Round 5: 5/2017–3/2020 (Phone Interview)**
CHG Headquarters					
CEO	Unrecorded Interview	Unrecorded Interview		Informal Conversations	Member Check
Director of the CEO Office	Informal Conversations	Informal Conversations		Informal Conversations	Member Check
Director of Technology		Interview			
Director of Human Resources		Interview			
Director of Marketing		Interview			
CEO Senior Assistant	Informal Conversations	Informal Conversations			Member Check
CEO Junior Assistant				Informal Conversations	Member Check
MKBC Headquarters					
CTO		Interview	Interview (x2)	Interview	Member Check
Project Director Transportation Project			Interview		
Project Director Blasting Project				Interview, Informal Conversations	Member Check
Technology Director Blasting Project A			Interview	Interview, Informal Conversations	Member Check
Technology Director Blasting Project B			Interview		
MKBC Blasting Site					
Site Manager (Site 1, 2)				Interview, Informal Conversations	Member Check
Site Supervisor and Senior Blaster (Site 4)				Interview	
Site Supervisor and Senior Blaster (Site 5)				Interview	
Site Manager (Other Blasting Project)				Interview	
Technician (Site 1, 2)				Interview	Member Check
Guard (Site 1, 2)				Interview, Informal Conversations	Member Check
Safety Man (Site 3)				Interview, Informal Conversations	Member Check
Senior Blaster (Site 3)				Interview, Informal Conversations	
Junior Blaster (Site 3)				Interview, Informal Conversations	Member Check
Junior Blaster (Site 3)				Interview, Informal Conversations	Member Check
Blasters (Site 1, 2)				Informal Conversations	

Table 2. Temporal Dimensions of Attention: Three Timescales

	Timescale 1 **Within Performance Episode**	**Timescale 2** **Over Performance Episode**	**Timescale 3** **Across Performance Episodes**
Duration	Frequently within a performance episode	Over the course of a performance episode	Across multiple performance episodes
Functional Form	Wave-like oscillations: attention approximates a sine wave, where people oscillate above and below a baseline level of attention depending on the extent to which their attention is regulated by a metacognitive network. Attention levels dip below baseline when people enter periods of mind wandering and rise above baseline when people regulate attention back to the task at hand. …	Quasilinear trend: beyond the oscillations above and below baseline that occur within a performance episode and are described in Timescale 1, the baseline level of attention itself diminishes over a performance episode in a quasilinear trajectory.	Step-function: beyond the baseline level of attention diminishing over a performance episode described in Timescale 2, the baseline level of attention paid drops across multiple performance episodes, as represented by the intercept of these lines stepping down from one performance episode to the next separated by time *t*.
Attentional Failure	Mind wandering, perceptual decoupling	Mental fatigue, vigilance decrement	Overlearning, mental sets, habituation
Behavioral Failure	Inattentive behavior	Self-regulation failures	Rigid or automatic behavior
Role of Metacognition	Detect mind wandering, return attention back to task	Recognize and repair flagging motivation	Notice expertise breakdowns and increase ability to doubt
Key Literatures	Cognitive neuroscience; mindfulness meditation	Ergonomics and human factors; self-regulation	Learning and expertise; cognitive psychology

Figure 1. Organizational Structure

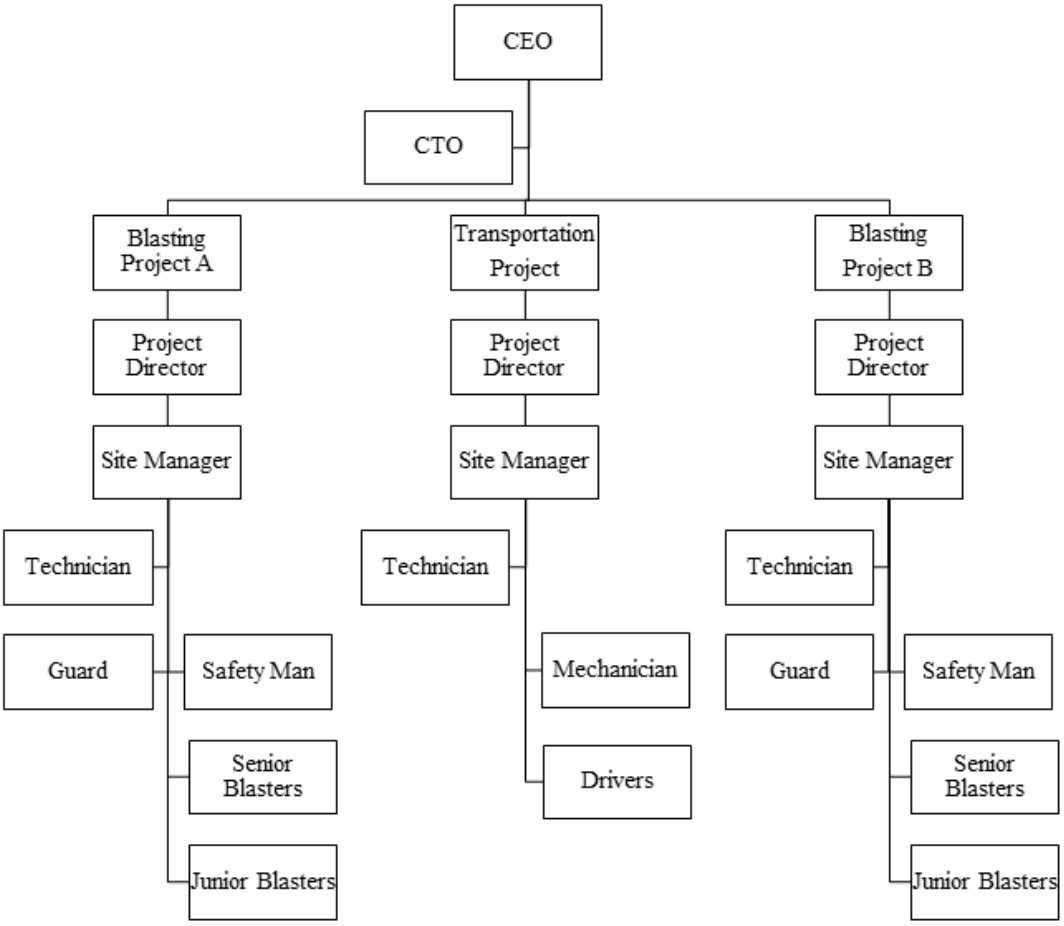

Figure 2. Timescales of Attention Fluctuation and Logic of Entrainment

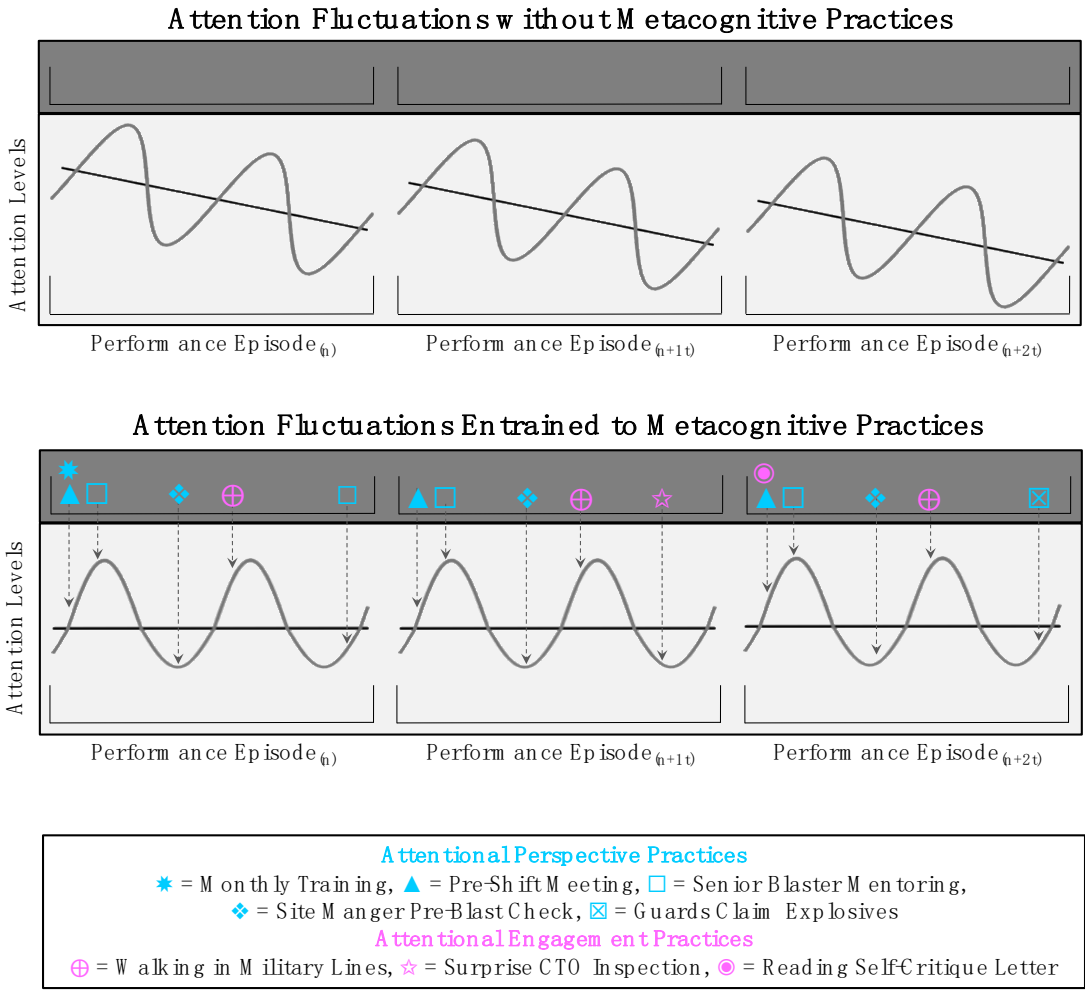

Figure 3. Entrainment Structure of Metacognitive Practices