EXPLORING SYNERGIES BETWEEN THE DESIGN OF PROCEDURES AND THE DEVELOPMENT OF RESILIENCE SKILLS

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Abstract

While it is often taken for granted that gaps in procedures should be filled by well-trained workers, the identification of the most salient gaps and their training implications are not usually made explicit. This paper addresses this problem by introducing a framework for the identification of synergies between the design of procedures and the development of resilience skills (RSs). An instantiation of using the framework in a procedure of administering medications provides insights into its potential for the design of better procedures and training.

1 INTRODUCTION

The use of procedures and scenario-based-training (SBT) are well-known safety management practices in complex socio-technical systems (CSSs). On the one hand, procedures increase predictability and set a basis for the training of routine skills, which should be mastered even by novices. On the other hand, SBT supports the development of skills to deal with the variability that cannot be anticipated by procedures (i.e. resilience skills, RSs), which are usually mastered by experts. RSs are individual and team skills of any type necessary to adjust performance, in order to maintain safe and efficient operations during both expected and unexpected situations (Saurin et al., 2014).

While it is often taken for granted that gaps in procedures should be filled by well-trained workers, the identification of the most salient gaps and their training implications are not usually made explicit. At least four reasons may help to understand this drawback. First, procedure application is not usually viewed as a substantive cognitive activity, but merely as rule-following. In this view, procedures are assumed to be applicable to all circumstances, and thus they are not supposed to have relevant gaps (Dekker, 2003). Second, popular methods for designing procedures originated from manufacturing industries characterized by repetitive tasks, in which motions and times of workers are specified in detail (e.g. Rother and Harris, 2001). Thus, there is a lack of empirically tested methods which fit to the dynamic nature of CSSs. Third, the design of training programs tends to follow the same assumptions and underlying logic of the procedures. Therefore, if procedures imply simple rule-following, training is likely to overvalue the need for following the rules, instead of developing awareness of possible gaps and the need for RSs. Fourth, the lack of concern with systematic ways of analyzing procedures can arise from narrow definitions of what counts as a procedure. Indeed, it is usually assumed that procedures mean action-oriented procedures, which specify in terms of if – then statements how people shall behave (e.g. wearing a seat belt when in a moving car) (Hale and Borys, 2013). This traditional view of procedures tends to be dominant among managers and regulators, and it also envisions procedures as being devised by experts, in advance, away from the time and production pressures of the front lines (Wears and Hunte, 2015).

However, goal-oriented and process-oriented procedures offer alternatives to action-oriented procedures, and these three types may be used in combination. While goal-oriented procedures define only what has to be achieved and not how it must be done, process-oriented procedures define the process by which the person or organization should arrive at the way they will operate – e.g.

requirements to consult with defined people when an emergency situation arises in order to decide how to handle it (Hale and Borys, 2013). This paper partially addresses the aforementioned shortcomings by introducing a framework for the identification of synergies between the design of procedures and the development of RSs. An instantiation of using the framework in a procedure of administering medications provides insight into its potential for the design of better procedures and training.

2 A FRAMEWORK FOR INTEGRATING PROCEDURES AND SBT

The proposed framework for integrating the design of procedures and SBT assumes the preexistence of procedures and training programs in the organization, and therefore it could be better framed as a framework for system redesign. The framework has three stages: (1) the identification of RSs; (2) a content analysis of procedures; and (3) the identification of synergies between procedures and SBT. **Stage (1)** adopts the method proposed by Wachs et al. (2012), which uses techniques associated with cognitive task analysis (Crandall et al., 2006) – e.g. interviews, observations, and analysis of documents such as accident and incident forms. According to Wachs et al. (2012), RSs are used within a context, and therefore it is necessary to identify the work constraints that impact the RSs and the actions for system re-design facilitating their use. Furthermore, RSs are identified and classified across two levels of abstraction. Initially, they are identified at the less abstract level (referred to as examples of RSs), being extracted directly from the transcriptions of the interviews and documents. The search for evidence of RSs in the raw data is guided by identifying events in which workers had to adjust their performance to achieve their goals. While the resilience engineering literature does not define precisely what is meant by "adjusting performance", we propose it involves one or more of the following: (i) the insufficiency or absence of action rules; (ii) improvisation, which is defined by Trotter et al. (2013) as the real-time conception and execution of a novel solution to an event that is beyond the boundaries for which an organization has anticipated or prepared - therefore, improvisation assumes the insufficiency or absence of action rules; and (iii) the isolated existence of performance goals and/or process oriented rules. The second level of classifying RSs, referred to as RSs categories, is defined by labels, for each of which various examples are given. The choice of the labels that designate the categories is based on the assumption that employees should find them meaningful and easy to understand (Wachs et al., 2012).

The work constraints that have an impact on the RSs and that might be integrated into SBT are similarly organized. Extracting these constraints from the raw data is usually straightforward, since they are explicit in the events from which the RSs are extracted. At the less abstract level, constraints that can be incorporated into training scenarios (e.g. failure of certain equipment) are identified. At a more abstract level, labels are created for designating categories encompassing similar constraints (e.g. equipment failure). Concerning the actions for re-designing the system, these are not usually as explicit in the raw data as the work constraints. However, they can be inferred, since they often are the opposite of the constraints. For example, the constraint of equipment failure prompts the identification of maintenance improvement as a re-design measure (Wachs et al., 2012).

Concerning the content analysis of procedures (**stage 2**), it is based on eight criteria (Figure 1) developed from a literature review of types and schools of thought for designing procedures (e.g. Wears and Hunte, 2015; Hale and Borys, 2013; Dekker, 2003). This analysis should be carried out as a teamwork including employees directly involved in the task as well as both training and procedures designers. It is worth noting that although stage 2 stresses the *contents* of procedures, a broader and more effective evaluation should account for the whole process of *managing* procedures, which includes the processes of design and monitoring procedures. Some criteria proposed by Saurin and Sosa (2013) may be useful for this broader evaluation – e.g. procedures should be designed, reviewed and monitored by a team of representatives from all the areas affected by them. As a result of stage 2, gaps and improvement opportunities in the design of both procedures and training are identified. Such gaps and opportunities should be dealt with in **stage (3)**, in which both procedures and training programs should be redesigned to be complementary and aligned to each other, based on a resilience engineering approach.

We also propose that the application of the described method be framed as design science research (DSR), in which all or part of the investigated phenomenon (i.e. procedures and training) may be created as opposed to naturally occurring. The epistemology of DSR stresses knowing through making, and it is solution-focused, rather than problem-focused (Van Aken, 2004). This characteristic fits the nature of the problem addressed in this paper since the view of procedures simply as rule-following is likely to be predominant, in practice, over the view of procedures as substantive cognitive activity. Therefore, the investigation of the alternative view may need an intervention/redesign in the socio-technical system, in order to intentionally create the phenomenon to be investigated. Another characteristic of DSR is that the designed artifact is evaluated according to criteria that are made explicit in the awareness of the problem phase – some criteria may be those presented in Figure 1. Deviations from expectations are noted and must be tentatively explained. The theoretical connections and the research contribution of the solution, as well as its scope of applicability, should be exposed (Kasanen et al., 1993).

Criteria	Implications for the training of RSs
(a) Are the goals of the activity stated in the procedure?	As for the training of RSs, the statement of clear goals is important because it provides a basis for observing how trainees trade-off goals
(b) Are the minimum inputs and preconditions required to start the task stated?	The identification of the inputs and preconditions is crucial for the training of RSs. If these are not available, workers will have to make do using RSs to deal with scarcity of resources
(c) Are the work constraints that can make it difficult to follow the procedure stated?	Work constraints, such as the lack of the minimum inputs to start a task, push performance out of the design envelope, thus increasing the need for RSs
(d) Are there over specifications, or irrelevant specifications, that could be removed from the procedure?	Over specification would be detrimental for the training of RSs, since it would facilitate deviant performance that could be wrongly interpreted as worker´s violation. Furthermore, it would create double-binds for workers – e.g. either following the procedure and be blamed for not deviating when necessary, or not following the procedure and be blamed for deviating. As to irrelevant specifications, these can make the procedure unnecessary long and cumbersome
(e) Are the direct relationships with other procedures mentioned?	These relationships are important for SBT, since the lack of resources for carrying out an interrelated procedure is a work constraint that may demand RSs
(f) Are there examples of under / no specification that should have been specified?	Situations of unnecessary under/no specification possibly mean that RSs have been overused in detriment of routine skills
(g) Do situations identified from (f) have an impact either on safety or efficiency?	Unnecessary under/no specification increases the risk of undesired side-effects arising from the use of RSs
(h) To what extent is it possible and worth specifying the situations identified from (f)?	While some of the unnecessary gaps can be filled using action-oriented rules, others can be suitable for goal-oriented and process-oriented rules, as they rely on RSs to a greater extent. Moreover, the procedure could state the required RSs for steps associated with high variability, especially if there are either safety or efficiency implications

Figure 1. *Criteria for analyzing procedures and implications for the training of RSs*

3 AN EXAMPLE OF APPLYING THE FRAMEWORK

An application of the framework is illustrated by the procedure of giving medications to patients hospitalized in the emergency department (ED) of a University hospital. A case of healthcare was chosen since this environment is well-known for being highly complex, and therefore the limitations of viewing procedures as mere rule-following could be more salient. The data for the identification of RSs (stage 1) were originally collected for identifying RSs of three categories of professionals who worked in the ED (physicians, nurses, and nurses technicians), without emphasizing any particular internal process. Thus, although the data is also of interest for the task of giving medications, some nuances of that task were missed. In all, interviews were made with 20 employees, and about 100 hours of direct observations were carried out in the ED premises. The main results were: the identification of 97 examples of RSs (e.g. run patients in parallel, organize the work area in advance), grouped into 11 categories (e.g. re-plan the sequence of activities); the identification of 13 categories of work constraints that created the need for using the RSs (e.g. high number of patients); and the identification of 15 system re-design measures, which could either facilitate or reduce the need for using RSs.

The content analysis of the procedure (stage 2) was made as a class exercise (i.e. part of a 15h course on resilience engineering given by the first author of this paper) by twenty-five professionals who worked in the hospital; many of them worked in the ED. The professionals worked in groups and they prepared reports with their conclusions from applying the criteria. Figure 2 presents the main insights from stage 2 as well as some examples of synergies between the design of procedures and training, which correspond to **stage 3**.

Criteria	Results of the content analysis
(a) Are the goals of the activity stated in the procedure?	The procedure simply stated that the administration should be "safe and correct". Professionals suggested that the "5 rights" should be explicitly mentioned
(b) Are the minimum inputs and preconditions required to start the task stated?	This information was fragmented over several sections of the procedure, and it focused on the materials for administering medications. Professionals suggested to group the inputs and preconditions into a specific section of the procedure as well as to include new ones
(c) Are the work constraints that can make it difficult to follow the procedure stated?	The procedure took for granted that ideal working conditions would be in place, and thus it did not mention any work constraint. However, data from stage 1 and reports by professionals indicated a number of constraints, such as the lack of prescriptions and high workload. Such work constraints and the RSs they require (e.g. "manage the time with each patient") could be listed in the procedure and included in training sessions
(d) Are there over specifications, or irrelevant specifications, that could be removed from the procedure?	From the view of the professionals, no example of over specification was identified. Nevertheless, professionals identified sentences that were redundant or unnecessary – e.g. "bring the medications to the patient"
(e) Are the direct relationships with other procedures mentioned?	Professionals stressed that other procedures should have been referenced – e.g. the procedure of washing hands. Furthermore, RSs such as "anticipate the need for actions" may be necessary due to relations between procedures
(f) Are there examples of under / no specification that should have been specified?	Professionals indicated a number of unnecessary gaps in the procedure, such as: lack of guidance of how to identify whether the patient is able to swallow the medication; lack of information of where the administration of the medication should be recorded – the procedure only stated the need for the record, but not how to do this
(h) Do situations identified from (f) have an impact either on safety or efficiency?	All cited examples have an impact on patient safety – e.g. to give oral medication to a patient unable to swallow may cause an adverse event; lack of records of administered medications may cause the same medications being administered more times than necessary
(g) To what extent is it possible and worth specifying the situations identified from (f)?	Professionals indicated action and process rules that could fill most gaps – e.g. certain visual cues and questions should be made to the patient, in order to assess their ability to swallow. These cues and questions could be practiced in sessions of SBT

Figure 2. *Content analysis of the procedure for administering medications*

4 CONCLUSIONS

Both procedures and training can support the management of resilience, if designed from a resilience engineering viewpoint. Indeed, procedures too focused on action-rules and the resulting procedural training are of limited usefulness for resilience as they do not account for variability. By contrast, from the resilience engineering view the design of procedures is an opportunity for the design of resilient systems, which recognize that work-as-done in CSSs necessarily relies on RSs to some extent. Although an effective design of procedures must eliminate unnecessary complexity, a portion of complexity is unavoidable. This is not to say that the responsibility for being resilient fully rests on the shoulders of front-line employees. As stressed in stage (1) of the proposed framework, it is necessary to identify the work constraints that create the need for resilience at the front-line and to consider means of reducing these constraints and their impacts. Furthermore, the anticipation of the most salient gaps and the correspondent RSs upfront in the design of procedures is an example of being proactive in work system design.

The framework will be soon tested in a larger healthcare system, comprised by several inter-related procedures that can be simulated using SBT. It is expected that the use of the framework gives rise to a method for the design of innovative procedures conceived from a resilience viewpoint (i.e. resilient procedures). The Functional Resonance Analysis Method (the FRAM) will be used in order to identify the relations between the functions comprised by the procedures, which can provide insights into the design of both procedures and training. The FRAM is also envisioned as a tool for supporting the debriefing stage of SBT, in which trainees discuss the simulation under the instructor´s guidance. Last but not least, a systematic characterization of the complexity of the functions associated with procedures is expected to be useful, since this can shed light on the adequate balance mix of goal, process, and action-oriented rules. In principle, it is assumed that the lower the complexity of the function the greater the emphasis on action-rules.

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