



The Human – Procedure Interface

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Operations and maintenance procedures are used in the industry as a key tool in prevention of accidents and incidents, and are necessary for standardization and safe performance of tasks. Whether in hard copy or electronic format, procedure documents allow operators and maintenance crafts to focus attention on task performance instead of trying to recall the steps, which may be complex, difficult and not often performed. Additionally, procedures that are taken to the field to be checked off during work and signed at task completion are an invaluable knowledge management and accountability resource.

Given their obvious value, the interface between the human user and the procedure document is rarely considered. Occasionally there is some discussion of procedure “best practices,” but the focus is usually limited to policy issues such as the types of procedures to be developed and how reviews should be completed.

The purpose of this paper is to derive the best practices for the actual procedure document using psychological research about human thought processes. The goal is to use the research to build recommendations for procedure documents that will result in optimal usability in the field.

A Note About Use

In order for usability to become a factor, procedures must actually be used. Despite policies, companies often find in incident investigations and root cause analysis that procedures were not used. Without both policy and a culture for the expectation of use and accountability for lack of use, it is doubtful that this trend will change.

In addition, procedures must be accessible in order to be used. Knowledge and document management policies and work practices must result in it being as quick and easy to find, access and print controlled procedure copies as it is to pull tattered, outdated copies from lockers or desks. Not only must procedures be accessible, operators and maintenance crafts must know how to access them. This means ensuring that operators and crafts have completed document management training that has been demonstrated to be successful, resulting in student access that is the same or faster than pulling a copy from a file cabinet.

Finally, use requires that employees know how to use the procedures once they are in hand. Again, this requires proven, successful training that includes the procedures that are available, as well as the method of use (i.e., sections, sign offs, reporting mistakes, etc.).

Procedures and the Brain

It is well documented that people have a limited pool of attention (Kahneman, 1973). We are unable to reliably perform multiple tasks that require higher-level processing (i.e., reading comprehension, decision making, choosing among responses, retrieving information from memory). The result of attempting to perform competing, high-level tasks is either slowing in responses on both tasks or on errors in performance (Pashler, 1994).

When using procedures, the operator or maintenance craft is attempting to split attention between the written procedure and the task at hand. Therefore, a primary goal when developing procedures should be to reduce the cognitive load associated with the procedure as much as possible, allowing the majority of attention to be focused on accurate task performance. The recommendations below are all focused on ways to reduce the cognitive load associated with procedure use.

1. Use checklists for each task step.

Psychologists have long referred to the “rule of 7 ± 2 ” to define how many separate items people can simultaneously hold in memory. More current research shows that the capacity of short-term memory may be even more limited to three to five items (Cowan, 2001).

In order to prevent errors due to skipping or repeating tasks steps, procedures should contain some method for users to track items that they have completed. A simple check off for each task step is sufficient to free operators and crafts from having to remember completed items, and allow them to focus more attention on tasks currently being performed.

2. Use simple, common words and syntax.

Procedures should be written using the shortest, simplest words possible to aid in comprehension and memory during task performance (Baddeley, Thompson & Buchanan, 1975, Neveh-Benjamin & Ayers, 1986, Schweickert & Boruff, 1986). Additionally, simple syntax (i.e., verb + predicate) are read more quickly and require less cognitive capacity than complex syntax (i.e., compound sentence) (Britton et al. 1982, Inhoff and Fleming, 1989).

Because task steps are commands, the subject is implied as the procedure user and can be inferred. So task steps can be written in verb + predicate format. To the extent possible, simple words should be substituted for more complex terms, and procedure writers shouldn't introduce new concepts or ideas.

3. Use all capital letters for task step verbs.

McAteer (1992) states that “Emphasizing words within a text to signal information focus—and using different kinds of typeface emphasis to do so—is a good and economical strategy for getting intended meaning across.” One easy way to draw attention to a word is to print it in all capital letters. Readers tend to interpret the use of all capital letters as emphasizing that particular word (McAteer, 1992). That may be due to the fact that words in all capitals are read more slowly (Tinker and Paterson, 1942) than those in all lowercase or mixed case.

Formatting the verb in a procedure task step in all capital letters guarantees that the user focuses on the action to be completed. This helps to ensure that the procedure user comprehends the task step prior to performance.

4. Use red – sparingly.

Sixty-four percent of color receptor cells (cones) in the human eye are designed to respond to the color red (Hecht, 1998). It may be that humans have evolved more red cones because red in the natural world is often a sign of threat (Elliott & Aarts, 2011). Research shows that human performance changes in the presence of red, with an increase in the speed and force of motor movements (Elliott & Aarts, 2011).

In procedures, red can be used to call the attention of the procedure user to hazards or threats. But red should be used sparingly and only for the most important (critical, catastrophic, likely) things. Otherwise, there will be loss of reaction due to habituation or inability to contrast the important items with those of lesser importance.

5. Train prior to procedure use.

Several studies have documented that knowledge of word meanings results in improved reading speed and comprehension (Beck, Perfetti and McKeown, 1982; Nation, 2001, Read, 2000). When readers are exposed to new concepts, their reading speed slows significantly (Petros, et al., 1990). From this research, the conclusion can be drawn that operators and maintenance crafts should complete training to learn the fundamentals of equipment and systems operations prior to learning written procedures.

Additionally, because practice has been shown to result in a reduction of the attention resources required for performance (Spelke, Hirst, and Neisser, 1976), procedures should not only be introduced during training, but employees should also be allowed to practice performing the procedure. If operational conditions prohibit actual procedure performance, trainees can simulate or walk through the procedure steps as part of training.

Summary

The research literature on reading comprehension and memory is broad and far reaching. The recommendations contained in this paper represent only a fraction of the data available. Additional best practices for procedures can certainly be derived by applying the principles introduced here: reduced cognitive load, linguistic simplicity, reduced need for recall from memory, writing for emphasis, and practice prior to performance.

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