Document Usability

Core Body of Knowledge for the Generalist OHS Professional

Second Edition, 2019

12.3.2

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Bibliography

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Document Usability

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Klaus Hofer began his working life as a nurse working in Australia and Canada. Following a an incident involving a medical error his personal mission became to understand the science behind human behaviour that determined how people interpret and act on workplace documentation such as procedures. This mission led him to undergraduate studies in experimental and behavioural psychology and graduate studies in cognitive and neuro-psychology. Working as a research associate for 13 years at the Nestlé Research Centre in Lausanne he applied existing cognition science to deduce lessons for document usability. These lessons were then tested throughout Nestlé's production sites globally and subsequently developed into a course on applied psychology for technical communication. This work formed the foundation for the development of *Usability Mapping*®. In later years Klaus has focused his work on the oil and gas industry as a high risk industry and where he has continued to refine the principles and application of *Usability Mapping*®.

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Core Body of Knowledge for the Generalist OHS Professional

Document Usability

Abstract

While being low on the hierarchy of risk controls, procedures and other safety-related documentation are a vital element in occupational health and safety (OHS) hazard management and OHS management systems. Usability or UX engineering as applied to safety-related documentation is a relatively new concept. However it is built on a significant science background that draws on psychology and neuroscience. This chapter identifies a need for a different approach to the development and design of safety-related documentation. It introduces the science behind the usability of documentation. Emphasising that designing safety documentation for usability (UX engineering) is a skill and that the OHS Body of Knowledge cannot teach a skill, the chapter outlines how the science is applied to the design and content of procedures providing some illustrative examples. The chapter concludes with the implications for OHS practice.

Keywords

usability, UX, usability engineering, document, procedure, *Usability Mapping*, safety, OHS, PQA

Contextual reading

Readers should refer to *OHS Body of Knowledge* 1.2 Contents for a full list of chapters and authors and 1.3 Synopsis of the OHS Body of Knowledge. Chapter 2, Introduction, describes the background and development process while Chapter 3, The OHS Professional, provides context by describing the role and professional environment.

Terminology

Depending on the jurisdiction and the organisation, Australian terminology refers to 'Occupational Health and Safety' (OHS), 'Occupational Safety and Health' (OSH) or 'Work Health and Safety' (WHS). In line with international practice, this publication uses OHS with the exception of specific reference to the Australian Work Health and Safety (WHS) Act and related legislation.

Editorial note

This chapter discusses the cognitive science that underpins document usability. It also links the cognitive science to a process developed by the company *Communications and Training International* (Cat-i) called *Usability Mapping*®. It is not the practice of the OHS Body of Knowledge to present corporatised processes. However, on examining the background to *Usability Mapping*® and the science and evidenced-based approach it was considered that this knowledge was important to OHS professional practice. We thank Klaus Hofer and his team at Cat-i for sharing their knowledge that has gone into developing *Usability Mapping*®. As acknowledgement of source references is a key element of professional practice it is important that *Usability Mapping*® is acknowledged as the source of the specific formats and application details by OHS professionals as appropriate.

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1 Introduction

The concept of 'safety clutter' is receiving considerable attention in the occupational health and safety (OHS) community. Introduced by Rae, Provan and colleagues (Rae, Provan, Weber & Dekker, 2018) safety clutter is defined as "the accumulation of safety procedures, documents, roles and activities that are performed in the name of safety, but do not contribute to the safety of operations" (p. 1). Two of the reasons given for the development of safety clutter is that a response to accidents is usually to add more safety activity; and as the volume of safety activity is seen as a proxy for the physical safety in an organisation there is a reluctance to take anything away. These two factors create a 'ratchet effect' where the volume of safety work increases with little or no improvement in safety. (Rae, et al., 2018)

Rae and his colleagues list four reasons why safety clutter is a problem. Safety clutter:

- Damages employee ownership of safety
- Is bad for adaptability
- Erodes trust
- Creates an unnecessary trade-off between safety and productivity.

A further issue created by safety clutter, not listed by Rae et al., is that by creating an illusion of safety it actually increases risk as it inhibits the implementation of effective controls.

This chapter focuses on one aspect of safety clutter – documentation and particularly procedures. Procedures are used to direct and control work and are integral to the management of occupational health and safety (OHS). They may be part of OHS management systems, work permits, checklists, standards, high risk protocols and golden/cardinal rules. However, rules and procedures are a topic of debate within OHS professional and academic communities. They are often seen to:

- Be used as a tool to manage worker behavior rather than create safety
- Not reflect the reality of how the work is done
- Be restrictive, not allowing for the dynamic nature of the work, and so add to the risk
- Focus on the administrative aspects of OHS related to legislative compliance and so create 'safety clutter'
- Be documented and structured in a way that is not conducive to worker comprehension. (Provan & Rae, 2020)

Accepting that, while being low on the hierarchy of controls, procedures play a vital role in OHS risk reduction, Provan and Rae (2020) propose that these issues can be minimised by focusing on:

- Understanding the reality of work as done and what is required for it to be executed
- Collaboratively developing rules/procedures as resources to support work
- Integrating rules/procedures as part of an overall safe system of work
- Learning about work variability and instances of non-compliance to improve rules/procedures
- Removing obsolete rules/procedures from the organisation. (Provan & Rae, 2020, p. 20.)

Having done the background work of understanding the reality of the work and defining the purpose of the procedures (see Provan & Rae, 2020, pp. 4-8) the challenge is to specify and present the procedure in a way that enables comprehension and usability by those whose work is the subject of the procedure. While the development of procedures is often delegated to administrative personnel, there is a science behind the writing of procedures which, if not understood and followed, can lead to non-compliance and even catastrophic outcomes.

The science behind writing procedures is Usability. The concept of Usability, UX or Usability Engineering originated in the 1980s and draws on the theories of computer science and psychology to improve the usability of interactive systems (Interaction Design Foundation, n.d.). It is usually associated with computer systems but may be applied to other interactive systems including documentation. *Usability Mapping* is usability engineering applied to documentation.[1] As with usability engineering, *Usability Mapping* applies the science of human cognitive behaviour to documentation.

Usability Mapping is a skill. Skills are based on knowledge. Learning a skill requires practice. The OHS Body of Knowledge cannot teach a skill. Rather, the objective of this chapter is to

- Create awareness of the need to UX safety-critical OHS documentation and
- Outline the underpinning knowledge.

Thus, this chapter makes a contribution to reducing safety clutter, making OHS-related documentation more usable and so improving workplace safety and health.[2]

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[1] *Usability Mapping* is a registered trade mark. See https://usabilitymapping.com.

[2] For information on *Usability Mapping* workshops see AIHS Events (www.aihs.org.au) or Usability Mapping(https://usabilitymapping.com/).

The chapter begins by making the case for a different approach to safety-related documentation before giving a brief overview of the development of *Usability Mapping.* It then reviews the types of OHS-related documentation before exploring the science behind UX and how it informs the principles of *Usability Mapping*. Section 6 applies the cognitive principles described previously to outline the process of *Usability Mapping*. The chapter concludes with some implications for OHS practice and a summary.

2 The need for a different approach

While low on the hierarchy of control,[3] it is generally accepted that correctly developed and implemented standards and procedures are essential risk management tools. Lack of compliance with, or misunderstanding of procedures can lead to reduced performance, quality issues, injury and death.

ABC News 22nd July, 2020

Failure to follow safety warnings led to fatal Rotorlift helicopter crash at Hobart Airport, ATSB finds

A helicopter crash at Hobart Airport three years ago that killed one pilot and seriously injured another was caused by a failure to follow safety warnings in the helicopter's flight manual, an investigation has found.

The report said the trainee pilot was in control of the … helicopter when [the instructor] announced a simulated hydraulic failure and pushed a switch to cut off the hydraulic system. The helicopter entered a high hover with a cross wind, before it veered to the left, rolled and hit the ground.

The manufacturer's flight manual warns that to safely practise the procedures the helicopter should make a shallow approach into a headwind and avoid hovering. ATSB director of transport safety … said entering a high hover with a crosswind made the helicopter uncontrollable.

"The … flight manual notes that without hydraulics the helicopter is subject the rapid changes in control direction" [Director of transport safety] said. "Compliance with the …flight manual requirements following a real or simulated hydraulic failure ensures that the helicopter remains controllable during all phases of flight."

…

The ATSP reviewed 34 investigations of accidents involving hydraulic systems in the same model of helicopter and found that even very experienced pilots often suffered rapid, catastrophic loss of control.

* The pilot instructor had more than 35 years' experience in the aviation industry.

(Beavis,. 2020)

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[3] See *OHS BoK* 34.1 Prevention and Intervention.

This investigation report raises a number of questions about procedures and their interpretation and application, often by experienced operators. The key to understanding such issues is to realise that users of procedures are not readers, they are users, and user behaviour is different to reader behaviour. Trained writers know how to make text read well, but a users' priority is usability, not readability. Procedures and other safety-related documentation must be developed for usability rather than to be read. In other words, they must be usability engineered.

Usability is about engineering content rather than writing content. Approaches to development of organisational documentation are commonly based on the principles of technical writing. Usability takes a different approach. Table 1 outlines reasons why standard approaches to technical writing are not suitable for safety-critical documentation.

Table 1: Reasons why technical writing is inappropriate for safety-related documentation

Technical writing principle	Reason why technical writing principles are not appropriate
"Know your audience."	Not a precise description. Who is the audience? How can the document writer know the audience and write content to suit them all?
"Put yourself in the shoes of the user."	Too many shoe sizes (many users). Users at the moment in time live out a unique experience that the writer cannot experience.
"Think about how you would feel if you were the user"	Writers may understand the user but cannot feel the user's emotions and it is the user's emotions that drive behaviour. User emotions or experience may override instructions especially in the case of an unexpected consequence.
Format designed for 'attractive' appearance.	A user's visual field narrows under stressful conditions and so they may miss important cues.
Writing that is 'clear and concise'	Difficult to define what is 'clear and concise'. Complex documents force users into content analysis behaviour which increases the risk of comprehension error and cognitive overload.
No emphasis on measurable language.	If language is not measurable then compliance cannot be assessed. Measurable language may not be a pretty read, but it works, and in safety precision matters.

3 Historical perspective

While the concept of usability, UX and usability engineering are reasonably recent having originated in the 1980s, the science behind usability has been developing for over 100 years.

The science informing usability comes from the disciplines of psychology and medicine and can be considered in two eras. The first era gave us insights into memory, perception and how the brain processes language. The second era provided an understanding of motivation, reading and comprehension. The researchers and their key areas of research for each era are shown in Figures 1 and 2. Each era is represented as a circle with the areas of research being a segment of the circle to show that it is the synthesis of the research that provides the basis for usability. The two eras also overlap with the second building on the first. Research on cognition and psycholinguistics continues with increasing complexity and sophistication but it is these early researchers who provided the basis for document usability.

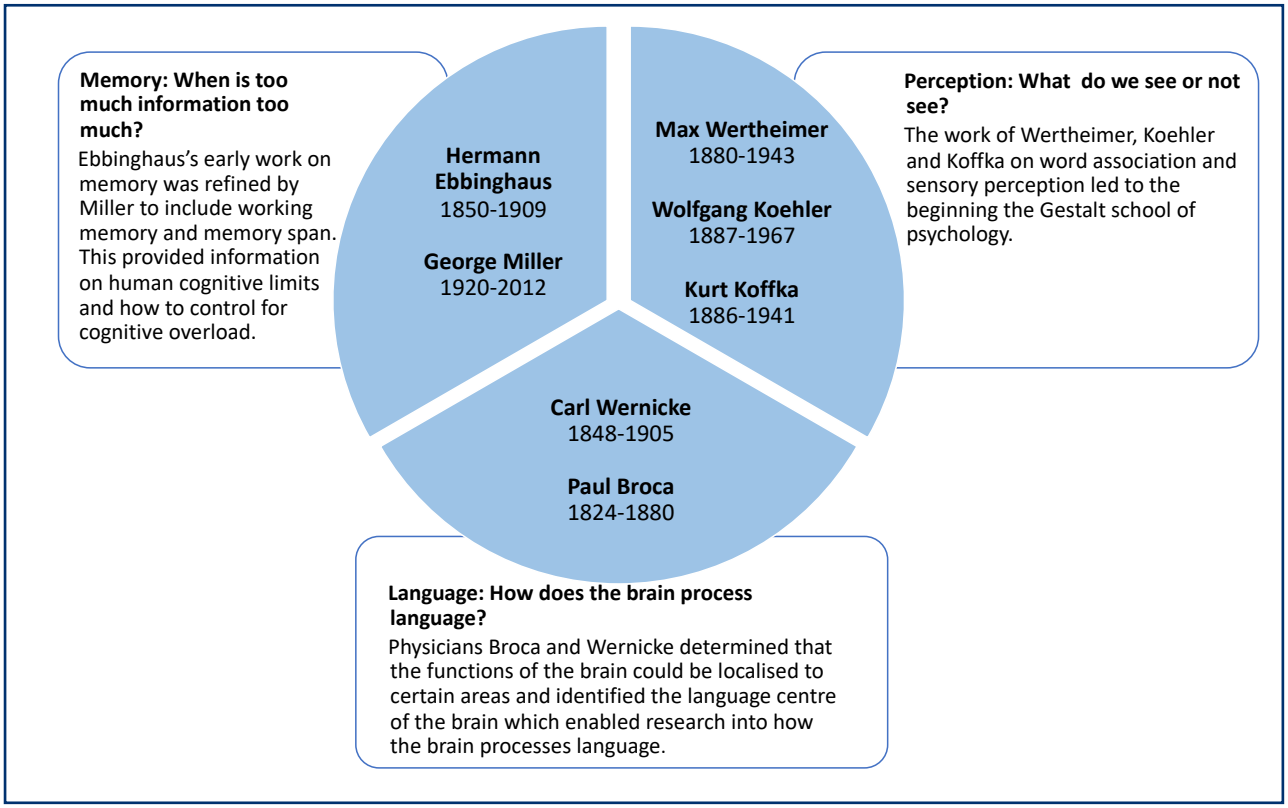

Figure 1: Era 1 in cognition science: Memory, perception and language

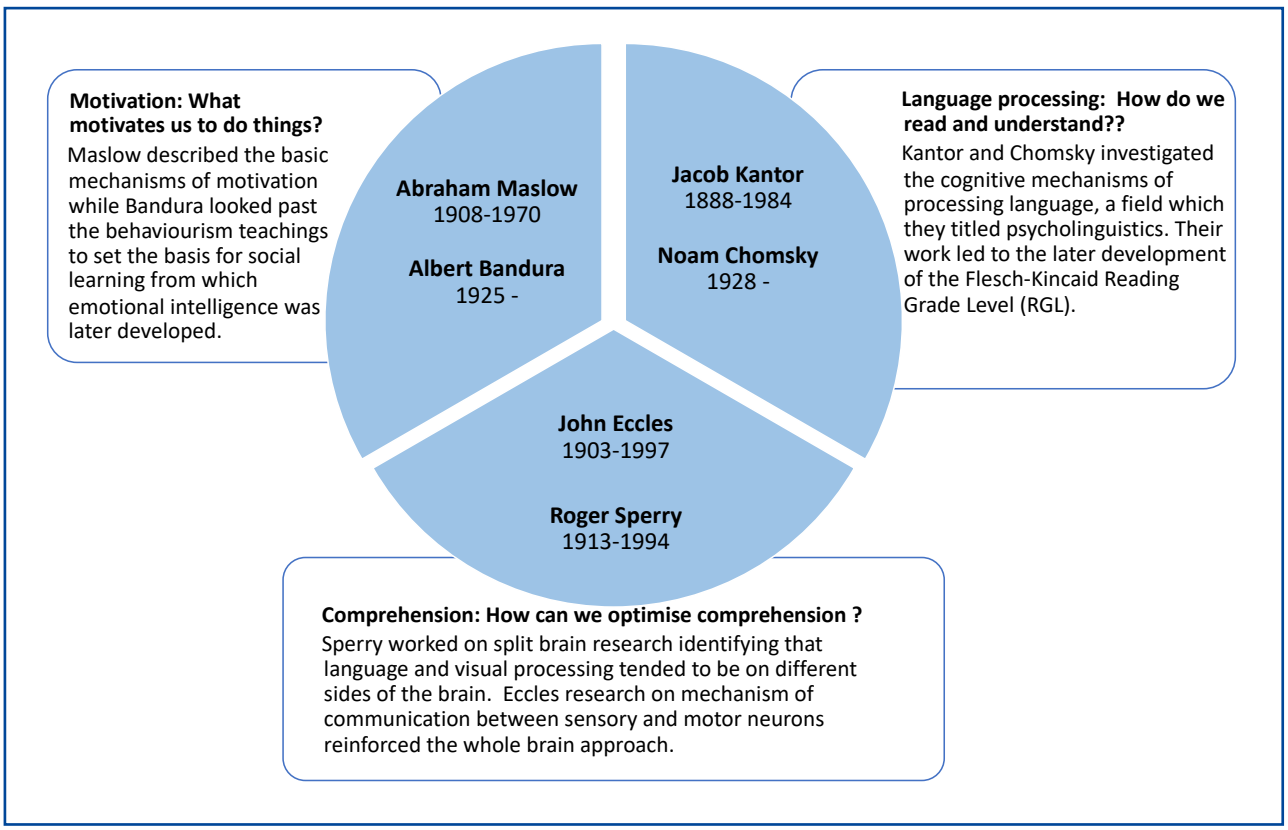

Figure 2: Era 2 in cognition science: Motivation, reading and comprehension

This science was quickly picked up by the marketing and advertising industry where improved sales curves demonstrated that the science worked. However, industry more generally has been slow to accept it and it is given little attention in safety.

4 Types of documentation

There is a hierarchy of safety documentation:

1. *Policies:* are corporate guiding values that drive everything else.
2. *Standards:* describe what must be done for regulatory compliance.
3. *Processes:* or workflows, describe how something works.
4. *Procedures:* describe what to do.
5. *Guidelines:* describe non-mandatory recommendations and best practice.
6. *Manuals, handbooks, training materials, user guides, etc:* give more general information.

This OHS document hierarchy is described in Figure 3.

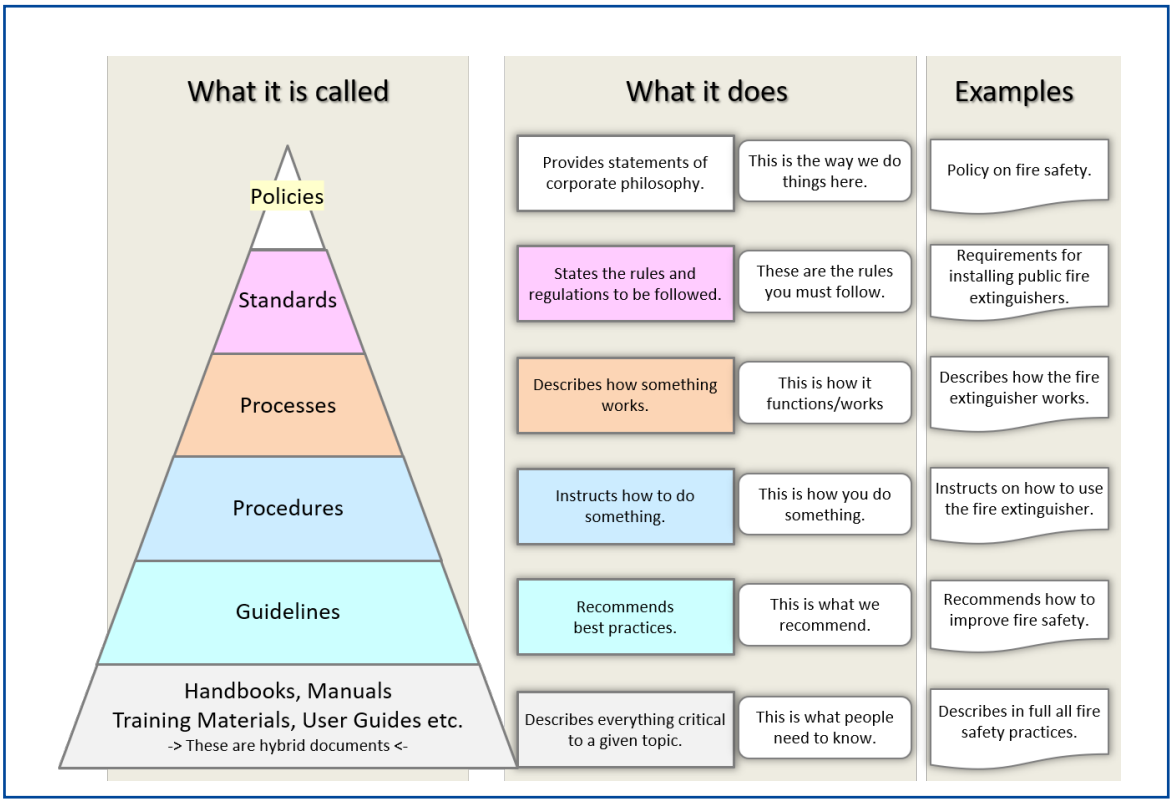

Figure 3: A basic OHS document hierarchy

Problems in locating the documentation, their interpretation and application arise when the content is not true to the title of the document or when the content of different types of document are blended in a single document.

Document types are unique in purpose, They must be clearly identifiable and its content limited to the purpose. This requires organisational, and content discipline. The first five of these document types are the core document types and must be strictly governed for format, style and content – they need to be usability mapped. Whilst considering the range of OHS documentation, this chapter focuses on the usability of procedures.

Usability Mapping of documents is required when it is important to:

- Minimise risk of misunderstanding (content errors)
- Enable navigation (as opposed to searching) specific parts of documents.

Usability Mapping should be applied to documents such as:

Rules: to enable compliance
Directions: to enable finding something
Guidance: to enable choosing best practice
Instructions: to enable performing a set of sequential steps.

Usability Mapping is not appropriate for narrative documents especially those where stimulation of emotion is important for comprehension. Such documents include articles, discussions, case studies, criticisms or feedback, praise or success stories.

5 Science informing practice

The most important reason for ensuring usability of OHS documentation is to minimise performance errors for safety-critical actions. Designing documentation for usability requires an understanding of human behaviour. This can be achieved by drawing on the science of cognition to inform layout, style and content with the objective of:

- Reducing comprehension errors
- Reducing performance errors
- Increasing safety.

5.1 Key document usability principles

Table 1 lists the reasons why technical writing is not appropriate for safety-related documentation. Table 2 outlines the UX approach describing how it addresses the deficiencies of standard technical writing approaches. These UX approaches are discussed in subsequent sections.

Table 2: UX approaches that address deficiencies in technical writing

Technical Writing principle	UX approach	Section
"Know your audience." "Put yourself in the shoes of the user."	Create an artificial but representative user persona.	6.2
"Think about how you would feel if you were the user."	Manage known user emotions (psychological set) • The need to act • A fear of failure • A sense of urgency • A constant awareness of time.	6.3

Technical Writing principle	UX approach	Section
Format designed for 'attractive' appearance.	Use a layout that matches user needs driven patterns. • Matches user eye-tracking patterns • Reflects parallel construction ○ Follows human cognitive pattern of: Promise -> Question -> Answer.	5.2.1 5.2.2 5.2.3
Writing that is 'clear and concise.'	Writing: • Controls for reading grade levels. • Includes navigation and cognitive links	5.3.1 5.3.2 5.3.3
No emphasis on measurable language.	Language: • Describes measurable outcomes • Uses mainly present tense and active voice • Uses positive rather than negative statements. • States observable and verifiable actions and criteria.	6.3

May add to safety clutter.	Document scope and content:
	• Defined by:
	  ○ Use case
	  ○ UX persona
	• Limited to essential requirements as defined by:
	  ○ Use case
	  ○ UX persona
	  ○ Foundation block.
		6.1
		6.2

5.2 General format

Two elements of cognition science inform the *Usability Mapping* layout.

- Eye-tracking patterns
- Gestalt design principles.

In addition to the Gestalt principles, the basic psychological principle of operant behaviour-reward inform the segmentation of procedural documents.

5.2.1 Eye-tracking patterns

Analysis of eye-tracking patterns has been used in medical research since the 1970s. Interest in eye-tracking patterns and attention of the user's focus increased with the advent of website design and is now a cornerstone of communication science.

Eye-tracking analysis reveals that users don't read each word line by line – they scan. This scanning is actually a sequence of jumps and stops. For English language speakers the jumpy scanning patterns fall into one of two patterns – the Z-pattern and the F-pattern.

The *F-pattern* is most commonly followed by users in scanning blocks of text and when users are under stress. They:

- First read in a horizontal direction across the upper part of the content area (top bar of the F)
- Then they scan down the left-hand side looking for points of interest in a paragraph's initial sentences (vertical bar of the F)
- If they find something interesting they read a line across (second horizontal bar, usually shorter than the first)
- They finally scan the content's left side in a vertical movement. (Babich, 2017a)

Z-pattern scanning occurs more often when documents are not text-heavy such as where there are diagrams or graphics with some text. As with F-scanning, the user's eye traces out the letter Z. The user:

- Scans from top left to top right
- Then diagonally down to the left side of the page
- Lastly back to the right again.(Babich, 2017b)

When a person's eyes track they cannot scan smoothly but do so in a rapid sequence of jumps (saccades) and stops (fixations). Areas where many fixations are bundled are called 'heat zones' and can be represented on 'heat maps'. The heat maps in Figure 4 were recorded to confirm that user eye tracking applies to user documentation.

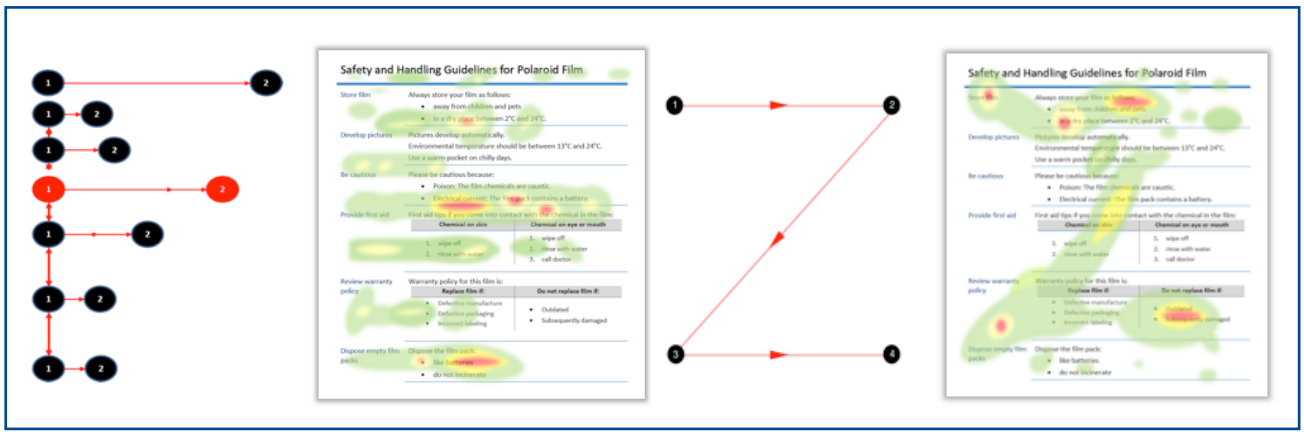

Figure 4: Eye-tracking heat maps for classic F and Z patterns

5.2.2 Gestalt design principles

The human eye and brain perceive a unified shape in a different way to the way that they perceive individual parts of shapes. Gestalt[4] principles are laws or rules that describe how the mind processes what the eye sees. The Gestalt principles were first devised in the 1920s by German psychologists who aimed to understand how humans typically gain meaningful perceptions from the chaotic stimuli around them. They identified a set of laws or principles which address the natural compulsion of humans to find order in disorder. The Gestalt principles are important in OHS documentation as they reduce the 'processing' time and energy required by users and so help in reducing performance errors.

There are more than ten overlapping Gestalt principles with six being of particular importance in informing the layout of safety documentation. (Table 3.)

Table 3: Summary of Gestalt principles important in developing OHS documentation

Gestalt principle	Explanation	Cognitive load reduced by:
Figure/ground	The eye isolates shapes from the background. How the eye separates figures from the background is influenced by size, colour, contrast and texture.	Ensuring appropriate use of white background, contrasting text colour and limited shading.
Similarity	The eye tends to build a relationship between similar elements such as shapes, colours and size in a design.	Using basic elements such as parallel construction to create similarity.
Closure	The eye prefers to see complete shapes. When there is missing information in an image the eye ignores the missing information and fills in the gaps with lines, colour or patterns from the surrounding area to complete the image.	Including closing or summary statements to confirm earlier content.
Proximity	Simple shapes arranged together can create a more complex image.	White space and paragraph spacing can be used to build relationships between different elements.
Continuation	The human eye follows paths, lines and curves of a design and prefers to see continuous flow of visual elements rather than separated objects.	Continuation may be created by a series of numbered steps or arrows on a flow chart.
Connectedness	Elements that are connected to each other using colours, lines, frames or other shapes are perceived as a single unit when compared with other elements that are not linked in the same way.	Elements can be linked using bullets or numbering systems.

Summarised from Soegaard, 2019; 2020a; 2020b.

[4] *Gestalt* is German for 'unified whole'.

5.2.3 The PQA zones

The *Usability Mapping* approach to safety-related documents presents the document in three content panels – the PQA zones. (Figure 5)

> The P or *Predictor Zone* is the title of the document. It offers a promise to the user as to what is coming. It should motivate the reader and suppress stress as it indicates the purpose of the document.
>
> The Q or *Query Zone* gives margin titles that are queries that a user might ask related to the promise or predictor.
>
> The A or *Answer Zone* provides answers to the queries set up in the margin titles.

The PQA format draws on the science of eye-tracking and some of the Gestalt principles such as figure/ground, similarity and continuation.

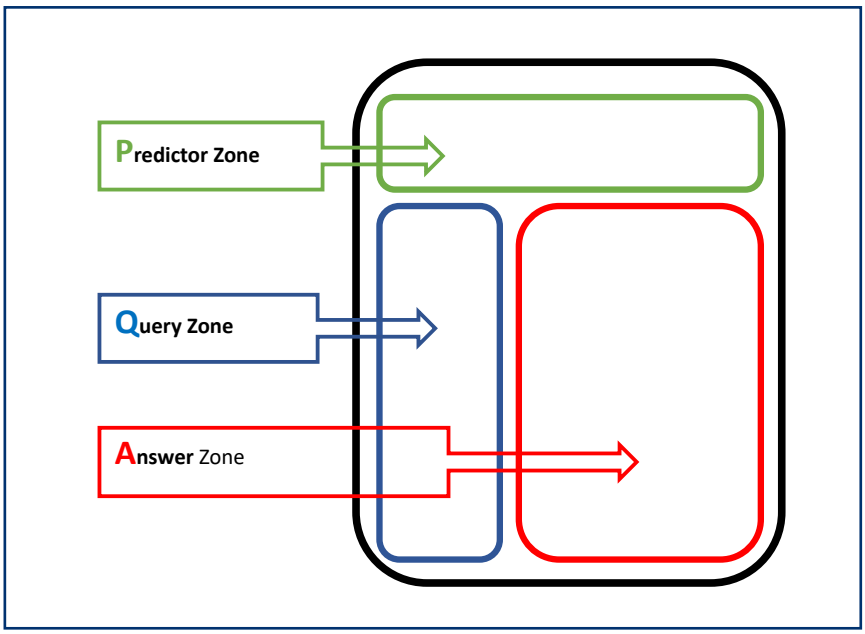

Figure 5: PQA Zones

5.3 Content

Cognitive principles also inform the population of the PQA zones with content. The objective in developing the content of a procedure is to minimise the cognitive load on the user. This is achieved by limiting the content in the answer block to strictly satisfy the query cue from the query block. The answer must then be limited to the specified reading grade and reading ease. Strategic notation and chunking techniques that align with parallel construction (law of similarity) enable easy navigation behaviours by the user of the document instead of forcing search behaviours.

5.3.1 Reading grade and reading ease

Converting information to text is a coding process. Comprehending written text is the result of a complex decoding process to enable the reader to construct a mental model of the situation described in the text. To do this the reader has to apply significant cognitive processing. (Perfetti, Van Dyke & Hart, 2001.) Comprehending complex text requires readers to move into analytical mode, requiring even more cognitive effort. *Users* of safety-related documentation should not be required to analyse as this increases the likelihood of comprehension errors.

Two measures are used to assess readability of text – reading grade and reading ease.

> *Reading grade level (RGL)*: is a measure of comprehension. The Flesch-Kincaid Reading Grade measure is considered the most robust measure for technical documents.
>
> *Reading Ease (FRES):* developed by Rudolf Flesch is a more refined analysis particularly valuable for analysing standards, policies and handbooks.

Table 4 describes the application of reading grade levels and readability, highlighting the impact on cognitive processing such that the reader is in analysis, reading or user mode. A maximum Reading Grade Level of 9 (preferably 8) and a reading ease of more than 50 are the standard for safety-critical documentation. Emergency procedures and procedures for use in a high stress environment should have a Reading Grade Level of 8 or lower and a reading level of more than 50. (See highlighted area in Table 4.).

Table 4: Recommended application of reading grade level and reading ease measures

	Usability and readability	RGL	FRES	Environment	Recommended Use
Analyse	Only suitable for specialists who need to reflect, contemplate and conceptualise.	16 15 14 13	<50	High concentration and focus on document. Low stress. Decoding forces careful analytical behaviours.	Academic text books, engineering control narratives.
Read	The highest level for reading comprehension regardless of education	12		High concentration and focus on document. Low stress. Analysis behaviour is not forced.	Interesting books, magazines, technical descriptions, business reports.
UX User	All user documents should score in this range or lower	11 10		High concentration and focus on document and environment.	Maximum for policies, standards, processes and guidelines.

	Usability and readability	RGL	FRES	Environment	Recommended Use
	US Defence and NATO requirement for operating procedures.	9	>50	Controlled or routine stress environment. Trained individuals performing a complex procedure.	Maximum for SOPs, procedures and work instructions.
		8	>70	High stress environment.	
		7			Emergency procedures.
		6	>80	Potential panic environment	

While a range of online tools are available for analysing documents for Reading Grade Level and reading ease[5] only those tools that apply the Flesch Kincaid formula should be used for assessing Reading Grade Level for safety-related documentation.

Reading Grade Level can be reduced and reading ease increased by:

- Using shorter sentences
- Unpacking lists to dot points
- Arranging numbers in tables
- Editing out 'boxed-in' statements (i.e. where there are two or more commas in a sentence)
- Applying *Usability Mapping* PQA format and following *Usability Mapping* rules.

5.3.2 Notation and chunking

Managing Reading Grade Level and reading ease significantly reduces the cognitive effort by users and so increases the usability and reduces the likelihood of errors in performance. Two further strategies are useful in reducing cognitive overload of users: notation and chunking.

[5] See for example see https://readabilityformulas.com/free-readability-formula-tests.php (free) or https://readable.com (fees apply). See also for Microsoft Word – Word Options > Proofing > When correcting spelling and grammar on Word > Show readability statistics.

Notation

Notation reduces cognitive load by organising the content. Notation also assists in document navigation. (See section 5.3.3.) Notation may be of five types:

Collective notation: uses bullet points for lists of items.

Sequential notation: (1, 2, 3, 4, …) is used for sequential items.

Alphabetical notation: (a, b, c, …) is used when collective lists may require cross-referencing.

Legal notation:(1, 1.1, 1.1.1 …) is used when cross referencing to other documents may be required.

Roman numerals: (I, II, III, IV, … i, ii, iii …) (upper and lower case) should be avoided but if used should not exceed the numeral XII (12).

Chunking

Chunking is the re-coding of smaller units of information into larger familiar units. Chunking has been found to reduce the cognitive load where the content of the chunks is similar (Thalmann, Souza, & Oberauer, 2019). The chunking rule for readers is usually given as 5-7-9 or 7+2 or–2. However for *users* the chunking rule is modified to 5-6-8 or 6+2 or -1. This means that any bullet list should never exceed more than 8 items and be preferably 6 or less. If the list has more than 6-8 items then the list should be chunked into groups of similar items.

When chunking information it is important to consider the primary and recency effect on short-term memory. When reading or learning people tend to remember:

- That which comes first the best: primacy effect
- That which comes last second best: recency effect
- That which is in the middle least well. (Sousa, 2016.)

5.3.3 Navigating not searching

Users need to be able to navigate documents rather than spend cognitive effort on searching for hints or patterns in text. The importance of navigation becomes apparent when considering the psychological set of the user – perception of time, sense of urgency, need to act and fear of failure.

Search behaviour is scanning around in the hope of finding a hint as to where to go next. Navigation behaviour is tracking known hints. Navigation behaviour is only possible if these hints are embedded in the document.

Navigation is aided by the cognitive strategies of notation and chunking as discussed in the previous section and also parallel construction of the document (which reflects the Gestalt principle of similarity). (See section 5.2.2.). *Usability Mapping* also employs the cognitive strategies of echo statements and cognitive links (C-links).

Echo statements create cognitive redundancy and strengthen user confidence and reduce the risk of misunderstanding. They are the first text that appears in the Answer block.

Cognitive links are the strategic repetition of key words. Four types of cognitive or c-links are important in *Usability Mapping*:

> *Question-Answer (Q-A) cognitive link*: is the repetition of a key word in the question (margin title) and the answer part. The C-link in the answer part is embedded in the echo statement.
>
> *Walking cognitive link:* connects process or procedural steps. Each subsequent step contains a key word from the previous step.
>
> *Closing cognitive link*: is nested into a closure statement at the end of a segment and at the end of a process or procedure. It nests key words from the title (promise) into the closure statement. A closure statement is required whenever a document describes something that has a beginning or an end such as in a procedure or process.

These cognitive aids are illustrated in Figure 6A, B and C. A fourth C-link is *Navigating cognitive link*s which are used in introductions, overviews and summaries and relate to tables of contents (Figure 7).

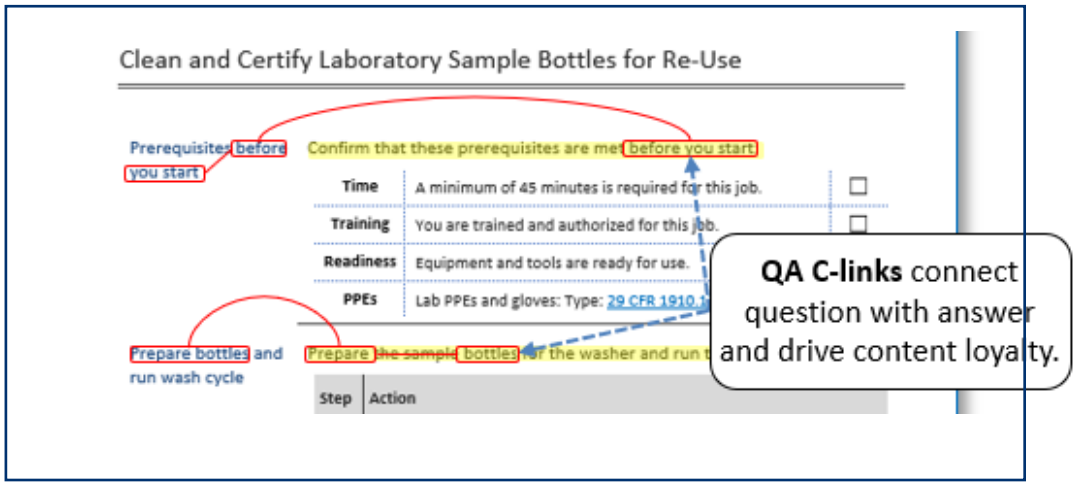

Figure 6A: Cognitive navigation aid – Echo statement with QA C-link

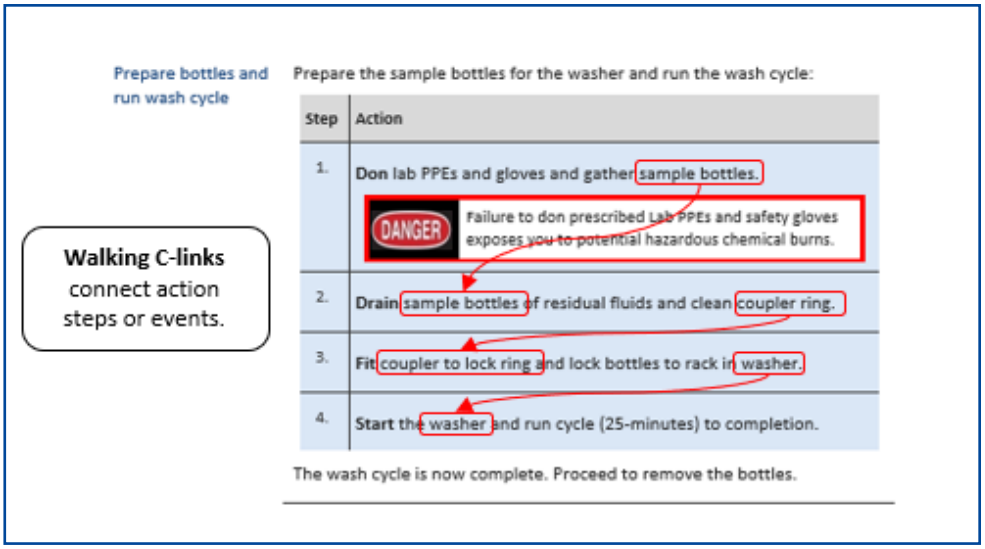

Figure 6B: Cognitive navigation aid – Walking C-link

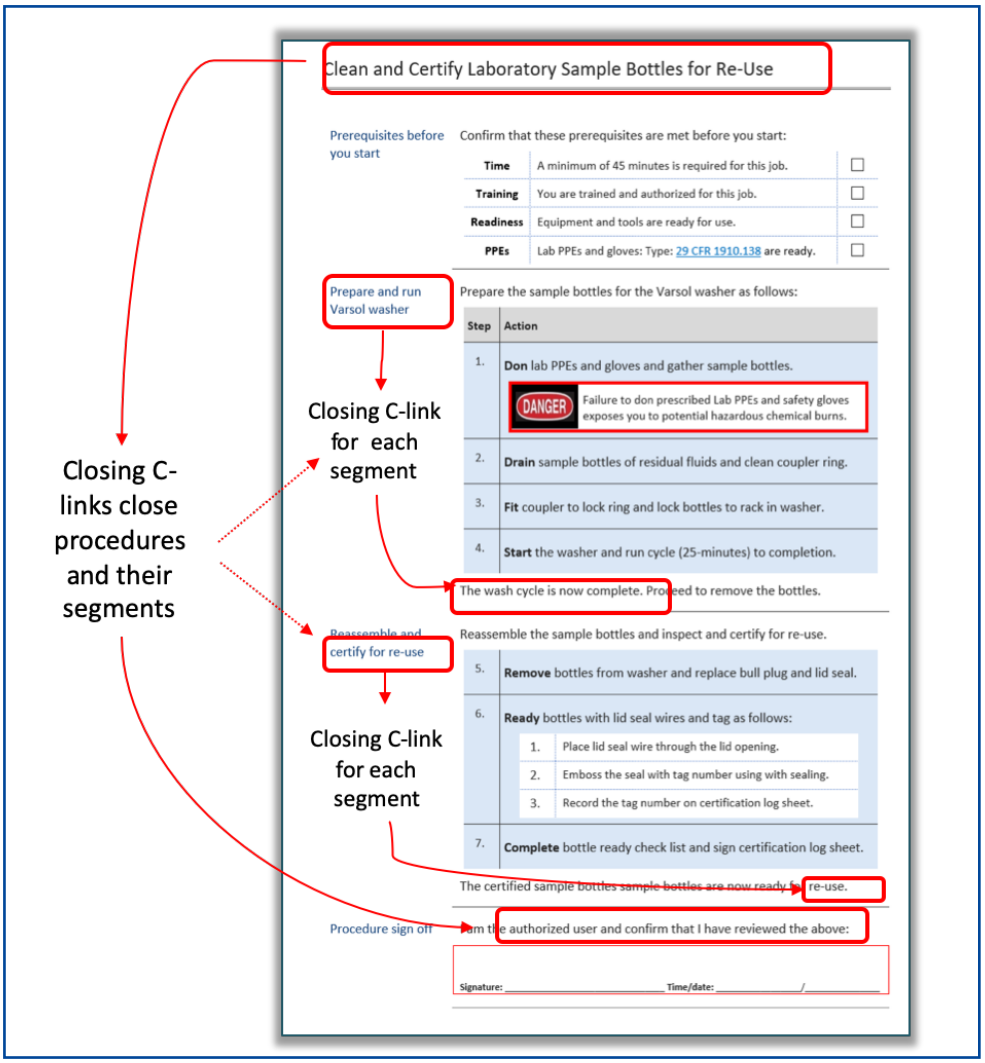

Figure 6C: Cognitive navigation aid – Closing C-link

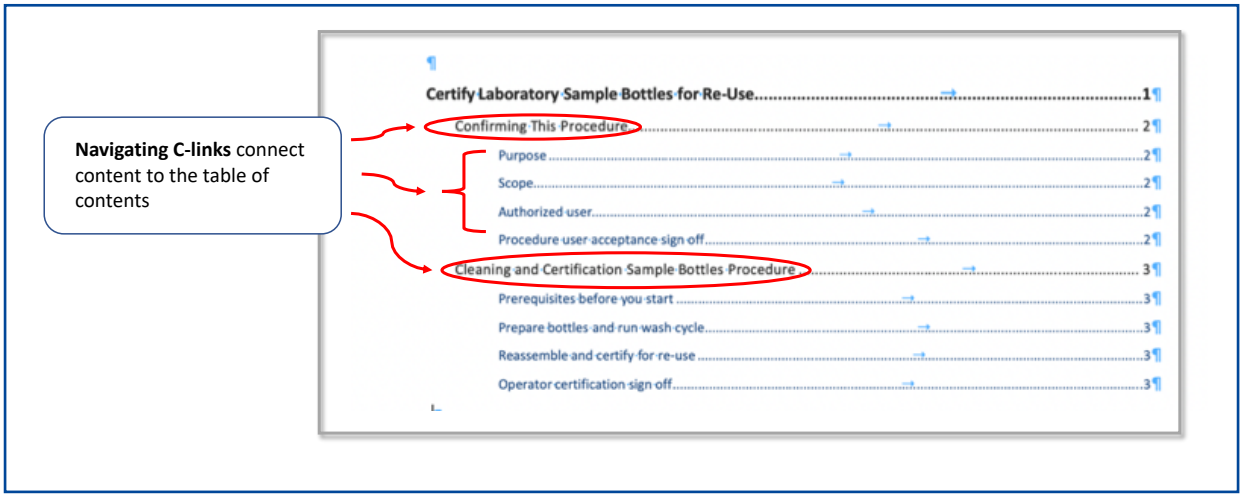

Figure 7: Navigating cognitive links

5.3.4 Motivation and reward

Procedures drive behaviours. Human behaviour is the result of complex neurological and psychological interactions. Taking a simplistic approach and applying it to users of safety-related documentation, for a user to take action as part of a procedure:

- The procedure must gain the attention of the user
- The user needs to retain or remember the required action(s)
- The user must be able to reproduce the behaviour
- The user needs to be motivated to perform the behaviour.[6]

The preceding sub-sections addressing the design of the PQA format, reading grade, notation and chunking, navigation and C-links are all directed to achieving the first three requirements for action: attention, retention and reproduction. To understand the fourth requirement of motivation we can look to Maslow's hierarchy of needs. Again, applying a simplified approach to the motivations of users of safety-related documentation, they are motivated by, in order of priority:

- Safety needs
- Social belonging
- Self-esteem.

These needs, particularly social belonging and self-esteem, can be met by building 'rewards' into the procedure. These rewards come in the form of completion statements at the end of each segment in the answer zone and at the end of the procedure which act as behavioural

[6] Drawing on Albert Bandura's Social Learning Theory (SLT). McLeod, 2016.)

reinforcers. The signoff signature at the end of a procedure confirms that the promise in the title (predictor zone) is kept and acts as a reward. (Figure 8.)

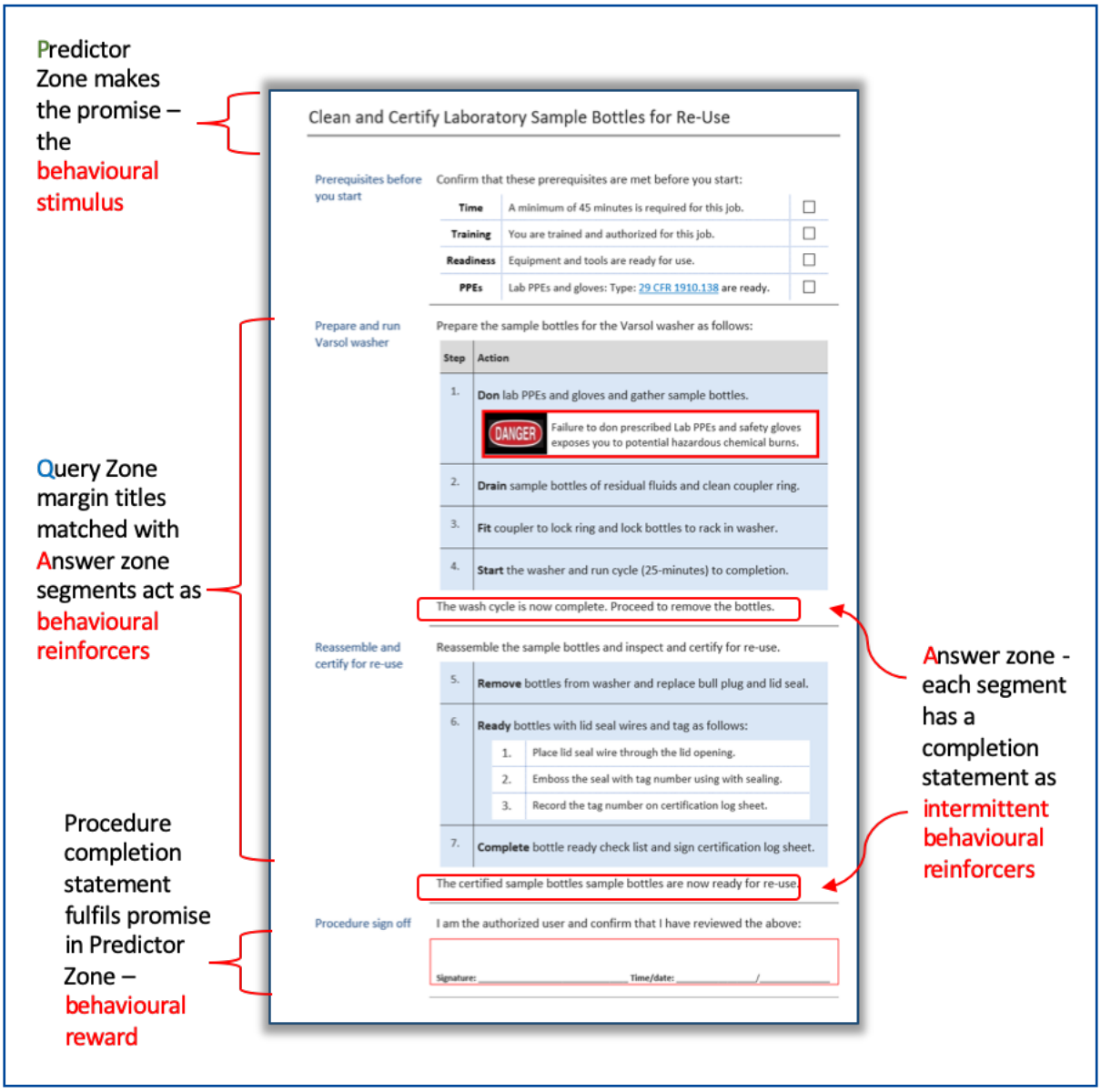

Figure 8: Behavioural reinforcers and rewards

5.3.5 The Answer Zone

The Gestalt principles (section 5.2.2) together with the cognitive strategies of notation, chunking, echo statements and C-links inform the design of the Answer Zone. The answer zone comprises segments that correspond to the margin title in the query zone. Each segment starts with an echo statement that reflects the margin query. The segment may then list actions or other requirements. Actions are referred to as the 'motion zone' where an operator's hands are in motion. This is a high risk part of the procedure and is often shaded. Each segment includes a closing statement. Figure 9 outlines how these come together in a procedure.

Completing the procedure with a sign-off reflects the Gestalt principle of closure.

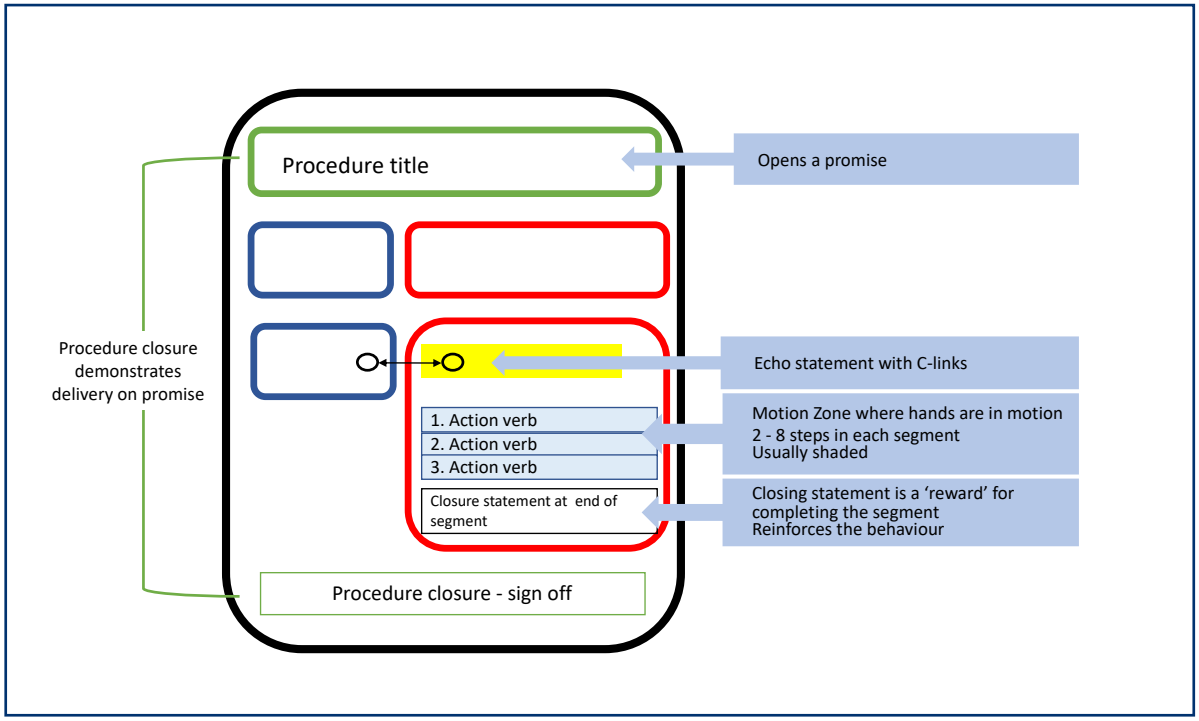

Figure 9: Cognitive linking for the Answer-Zone

6 Applying Usability to developing OHS documentation

As discussed in section 1, safety-critical documentation must be user engineered. User engineering requires knowledge of cognition science. Rarely is this knowledge held by the users of procedures or subject matter experts. Similarly knowledge of the work and the task is rarely held by the UX engineer writing the document. The document writer must engage with the users and subject matter experts to observe the work and also test the documents with the users. However, it is the responsibility of the document writer (the UX engineer) to ensure usability. This requires that the principles of cognition science outlined in section 5 are incorporated into the document. This can be done by *Usability Mapping* the document.

This section outlines the key steps in *Usability Mapping* of a document and gives an example of the outcome. As noted in section 1, *Usability Mapping* is a skill and developing such a skill requires hands-on practice. This section gives an overview of what a UX engineered, *Usability Mapped* procedure might look like. The examples are given for illustration purposes only and should not be taken as models of best practice.

OHS documentation cannot be UX engineered or *Usability Mapped* without first defining the rationale for a document – a UX use case. Once the use case is defined, the document 'specification' – the UX foundation block is developed. The document can then be written applying the *Usability Mapping* principles. Before being operationalised, the document is validated to ensure usability.

6.1 Rationale for document

The discussion on safety clutter in section 1 identified that creation or maintenance of safety-related documentation is not always accompanied by a clear justification for the document. A corollary to this is that for each document developed there should be a clear description of:

- Why the document is needed
- How it will be used
- How it adds value – a UX Use Case.

A UX use case describes the scenario or conditions where the document is needed and so focuses the document. They provide information for:

- A rationale for spending time and money to produce the document

- Verifying the usability of the complete content of the document
- Eliminating unnecessary content if a verifiable use case for the document cannot be provided.

Use cases are used to verify the usability of the content in imagined user scenarios. If usability cannot be imagined the document is not likely to be needed and cannot be usability engineered.

Use cases should be validated with users and stakeholders prior to developing the document. Inclusion of scenarios that are borderline out-of-scope assist in defining the limits of the document. Whilst a UX use case is essential for the development of a document, it does not form part of the document.

(Example) UX Use case for Bottle cleaning and certification procedure

- A laboratory technician is requested to test a larger than usual batch to QA Product prior to being loaded into rail cars to go to market. Half way through working through the batch the assistant notices that there will be a shortage of certified sample bottles to meet the requirement. 40 contaminated bottles are in the “used” bottle rack. The technician asks the assistant to take the current procedure and work out a solution.
- While working through the cleaning and certification procedure to get the sample bottles ready for re-use, the operator notices that there is a tear in the safety gloves. To replace the gloves the operator needs to know exactly which type of gloves are required.
- A hectic production run requires more testing than usual creating a bottleneck in available sample bottles. An qualified operator needs to be identified that is allowed to do the job.
- Laboratory technician has spare time. To plan ahead the technician decides to catch up on certifying sample bottles. The technician reviews the procedure and notices that an authorisation is required before starting.

6.2 Document ‘specification’

6.2.1 The UX persona

The many users of safety-related documentation will have different feelings and emotions. It is the emotions that impact behaviour and so safety. The document writer cannot understand the range of emotions that a user might experience. The UX engineer manages this dilemma by creating an artificial but representative user persona (the UX persona) and managing the emotions that a user is known to experience. Faced with a procedure it is recognised that a user will experience:

- A need to act
- A fear of failure
- A sense of urgency
- A perception of time.

This is termed the 'psychological set' and the procedure has to be written to take account of these known user emotions.

6.2.2 The UX foundation block

In the same way that a specification is developed for the design of an item of plant or criteria specified for purchasing, a specification is required for the development of OHS documentation. This specification sets the limits or goals of the document and in UX practice this is the UX Foundation Block which specifies the: purpose; scope and intended user. (Table 5.).

Table 5: Outline of UX foundation block

Specification questions		UX Foundation Block	
Why is this document required?	What is the problem to be solved?	**Purpose**	This is why the document is needed
What is the range and limits of the document?	Where and where not can it be used?	**Scope**	This is where the document is used
Who can use the document?	What observed skills, demonstrated knowledge or certifications are required?	**Intended user (UX persona)**	This is who is authorised to use the document
		Authorised User Sign-Off (as appropriate)	Confirms that only qualified personnel perform task. Allows anyone who is unsure about their qualification or authority to refuse job.

(Example) UX Foundation block for Bottle cleaning and certification procedure

Certify Laboratory Sample Bottles for Re-Use

Predicts what this procedure delivers

Purpose

The purpose of this procedure is to assure XXX-OIL laboratories are provided with regulatory compliant and certified sampling bottles.

This procedure controls the required steps for sample bottles to be:

- Compliant with ISO 17025
- Tested and fully functional
- Certified for re-use.

Why we have this procedure

Scope

This scope of this procedure applies to XXX-OIL Laboratories only.

In scope	Only XXX-OIL laboratories under the governance of ABC Oil Association.
Out of scope	Any other XXX-OIL laboratories not under the governance of the ABC Oil s Association

Both in-scope and out-of-scope required to set limits

Authorised user

Authorized users are XXX-OIL laboratory technicians who are:

- Trained and tested in the ISO 17025 requirements
- Certified by XXX-OIL to perform this procedure
- Authorized by the individual laboratory manager who will be using these sample bottles.

Defines who can use the procedure in measurable terms.
Do NOT use generic, inclusive terms

Procedure user acceptance sign off

I am the authorised user and confirm that I have reviewed the above:

Signature: _____ **Time/date:** _____/_____

May not be required in all procedures

6.3 Document development

Once the use case is developed and the foundation block written, the cognitive principles described in section 5 can be applied to developing the content.

In addition to the actions required for the task most procedure documents will require a prerequisite section. Prerequisites address the requirements for the task to commence including:

- Allowance for the minimum time required for the procedure to be undertaken (which if undertaken in a shorter time would impact on safety, quality or other operational factors)
- Training and authorisation requirements of operators
- Readiness state and availability of required equipment
- Required personal protective equipment (PPE)

Figure 10 gives an annotated example of a procedure which incorporates the usability features explained through sections 5 and 6:

- F patterns for eye tracking
- Gestalt principles
    - Figure/ground (appropriate use of white background, contrasting text colour, limited shading
    - Similarity (parallel construction)
    - Closure (summary statements and closing statement to confirm earlier content)
    - Proximity (white space and paragraph spacing used to build relationships between different elements
    - Continuation (created by numbered steps)
    - Connectedness (using bullets or numbers
- Behaviour and rewards theory
- Reading grade and reading ease
- Notation (sequential)
- Chunking (limited to 6+2-1)
- Echo statements with QA – C-link
- Walking cognitive links
- Closing statements and links.

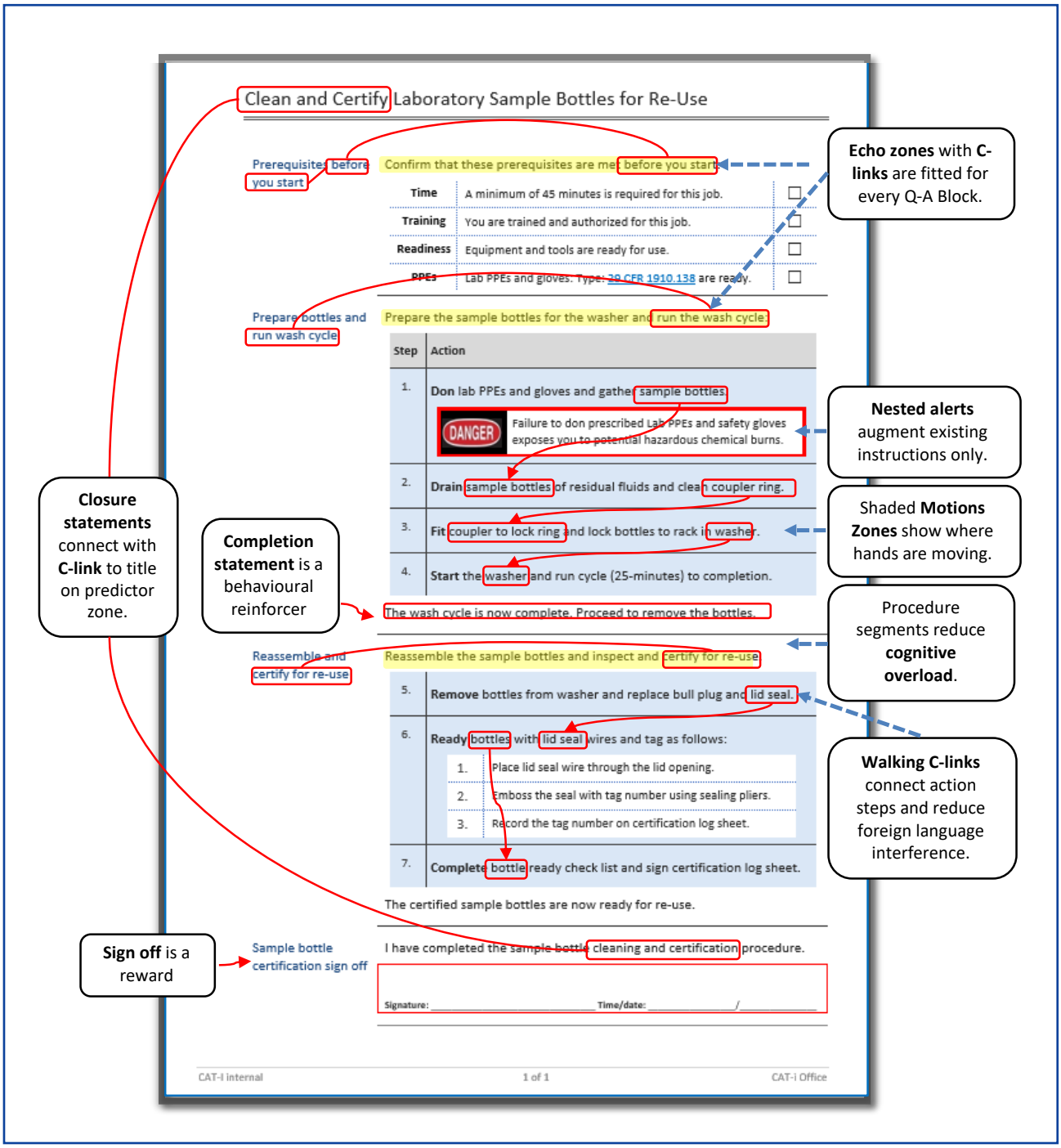

Figure 10: Annotated example of procedure showing key cognitive devices.

Some further suggestions for document usability illustrated in Figure 10 are:

Nested alerts: augment a procedure step so they follow a procedure step, not precede the step. A procedure should be written to be safe without the inclusion of any nested alert.

Nested alerts may be notes, cautions or warnings.

NOTE: Addresses best practices, alternative options or points to supporting materials.	Does not contain: • Procedural steps • Safety advice
CAUTION: Addresses possible procedure failure or equipment damage. Does not point to support documentation.	Does not contain: • Procedural steps • Cross-references to other documents
WARNING: Addresses possible injury or personal harm. Does not point to support documentation.	Does not contain: • Procedural steps • Cross-references to other documents

Graphics: should be simple line drawings. Photographs should never be used in procedures as they present too much detail and so create confusion. Like alerts, graphics augment a procedure so they follow a procedure step.

Fonts:

- Serif fonts are easier to read on paper than online. Sans serif fonts are easier to read online than on paper. Calibri font suits both online and on paper
- 11pt is a good font size but most 10pt fonts are also easily readable
- Bold type should only be used for single words
- Capitilisation should only be used for the start of sentences or start of titles or names, never for full words, sentences or paragraphs. Capitalisation reduces readability
- Right justification should not be used as it has a negative effect on readability.

Descriptions:

- Descriptions of sensory perceptions (e.g. smell) should be supported by a metaphor
- Descriptions of physical objects should be supported graphically or by graphical text.

Grammar:

- Present tense is typically used in procedures however precautions or prerequisite sections that list conditions that have to be met before starting may be in past tense
- Active voice (command language) is used for actions; passive voice may be used in introductory or preparatory sections
- Positive statements about what is needed to be done are stronger than

negative statements on what should not be done.

Some general rules for the PQA zone content are given in Figure 11.

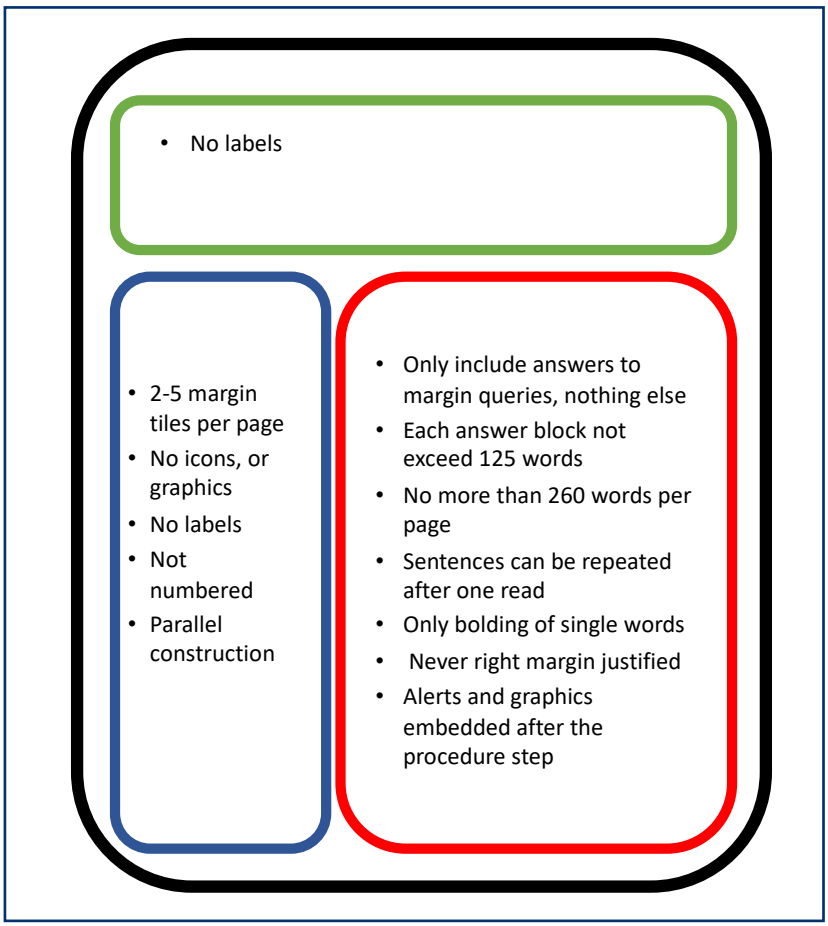

Figure 11: Rules for formatting within PQA zones

Appendix 2 is a 'clean' version of the example document used for illustration through this chapter.

6.4 Document validation

Documents should be validated to:

- Confirm compliance with usability principles
- Confirm application in the work environment.

A *Usability Mapping* audit sheet is included in Appendix 1 for reference. OHS professionals or organisations may wish to compile their own document usability audit sheet to suit their organisational requirements.

Before being operationalised it is important that any procedure is tested in the work environment and work context. This is not about consultation or 'proof reading' by operators, supervisors or subject matter experts. (They are unlikely to understand UX principles.) It is about asking the normal users of the procedure document to follow the procedure as it is written while being observed by other users, supervisors and subject matter experts to confirm that the procedure addresses all the required elements and steps.

7 Implications for OHS practice

Writing OHS and safety-critical documents, or mentoring others to do so is a key role of OHS professionals. OHS professionals who have read the OHS Body of Knowledge chapter on *Rules and Procedures* (Provan & Rae, 2020) will be aware of the concept of 'safety clutter' and associated issues in managing OHS. Having read this chapter, OHS professionals will be aware of another aspect of 'safety clutter' – that of procedures and other safety-related documentation that is not designed for usability. Such documentation requires significant cognitive load by the user which can negatively impact OHS and operational performance and potentially have catastrophic outcomes.

OHS professionals should critically review the documentation they or their organisation generate. Focusing on safety-critical documents they may examine ways in which the documents can be improved by applying UX principles.

In reviewing safety-critical documentation OHS professionals should:

- Recognise that an existing document cannot be 'rewritten' for usability but has to be UX engineered based on a use case with a foundation block specifying the criteria for the document
- Engage with users and subject matter specialists to collect information for the use case and the foundation block. At this time it is important to also collect information on the content requirements for the document

- Apply the insights from the cognitive principles and *Usability Mapping* formats and examples outlined in this chapter to inform the development of procedures and other safety-related documentation in their organisation
- Recognise that UX engineering is a skill and take steps to develop their UX skills as they see fit.

8 Summary

Whilst the issues of safety clutter are being recognised within the OHS profession, this chapter addresses the largely unrecognised knowledge and skill of usability engineering (UX) of documentation. Usability of safety-related documentation is vital in optimising effectiveness of OHS practice.

The chapter begins by defining a hierarchy of safety-related documentation and emphasising the importance of 'loyalty' to the document type to avoid confusion and misinterpretation. The need for a different approach is identified by drawing out the reasons why the usual approaches to technical writing are inappropriate for safety-critical documentation. While the concepts of usability and UX have a relatively recent history the strength of the approach is highlighted by referring to key researchers and their work on memory, perception and language and the later work on motivation, reading and comprehension.

The science behind usability is introduced and linked to the design of procedural and other documentation focusing on:

- Recognising the psychological set of the user who experiences: a need to act; a fear of failure; a sense of urgency; and an awareness of time
- Employing a layout that matches user eye tracking patterns, Gestalt design principles and the psychology of reward-driven behaviour
- Developing content that takes account of reading difficulty and employs cognitive devices to manage user cognitive load and follows guidelines for use of graphics, grammar, voice and tense to further reduce cognitive load.

An annotated example of a procedure is provided to illustrate the application of usability to the development of a procedure.

The chapter concludes with some implications for OHS practice emphasising that UX engineering of safety-related documentation is a skill. While the chapter outlines the knowledge underpinning usability OHS professionals should consider strategies for developing their skill in UX engineering of safety-related documentation.

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Appendix 1: Document usability audit checklist

CAT-i AUDIT_REPORT Usability Mapping OHS Documents.xlsx 2020-09-21

UX Usability Audit Report

title: _____

number: _____

Pass	Comments required for
Repair	Repair and Fail
Fail	
n/a	date:

Audit item ID		Description	Comments if required
1 UX Goal Posts	1.1	Purpose statement justifies the document (why/because) and C-links to TOC.	
	1.2	Scope: Measurably states the document's coverage and limitations.	
	1.3	Document User (UX persona) is measurably identified (user profile).	
2 Titles	2.1	All Titles contains predictor characteristics - no generic titles - scan TOC.	
	2.2	Title length does not contain a line break. Scan TOC for this audit.	
	2.3	Topic title (UMAP Title) predicts the content (makes a promise).	
	2.4	Margin titles evoke a question relating to the U-Map promise.	
	2.5	Margin titles do not narrate or describe.	
	2.6	Margin titles are never notated.	
3 Sentences	3.1	Sentence length - content is repeatable after one reading.	
	3.2	Sentences do not narrate a list (> than 2 items).	
	3.3	Sentences do not narrate tables (relational information or comparisons).	
	3.4	Sentences do not contain more than one comma (general guideline).	
	3.5	Descriptions of sensory perceptions are supported with a metaphor.	
	3.6	Descriptions of physical objects are supported graphically (or graphical text).	
4 Notation	4.1	Sequential notation (1. 2. 3. etc.) is used for sequential items only.	
	4.2	Legal notation is correctly applied and limited to the third level.	
	4.3	Bullets are applied to lists of items only and are chunked if required.	
	4.4	Bullets are not used to notate paragraphs.	
	4.5	Roman numerals (upper/lower case) used correctly and do not exceed 12.	
	4.6	All items, (bullets, steps or requirements) are chunked using the 6+2-1 rule.	
5 C-links	5.1	Question-Answer constructs contain echo statement with cognitive links.	
	5.2	Closure statements contain cognitive links from the relevant title.	
	5.3	Process steps contain walking cognitive links.	
6 Design	6.1	Left Margins (query zone) contains only words - no icons or nested statements.	
	6.2	White space is used optimally (Figure/Ground ratio).	
	6.3	Q-A blocks are separated by a separator line.	
	6.4	Parallel construction is maintained throughout. (Law of similarity).	
	6.5	Steps in a procedure nest "reinforcers" after no more than 8 steps.	
	6.6	"page cont'd" connectors are used if one topic title covers more than a page.	
	6.7	PQA Maps contain at least two and no more than five margin titles.	
	6.8	Chunking rule is applied to everything including document structure.	
7 Fonts	7.1	Right or full margin justification is never used.	
	7.2	Line length not too long or too short (text nested in tables).	
	7.3	Document contains no more than three fonts (not counting nested alerts).	
8 Alerts	8.1	"Notes" augment existing content and point to best practices.	
	8.2	"Cautions" augment existing content and point to technical failures.	
	8.3	"Warnings" augment existing content and point to personal hazards.	
9 RGL	9.1	Flesch Kincaid RGL for procedures is equal to or less than 9.	
	9.2	FRES (Flesch Reading Ease Score) equal or greater than 45.	

Auditor: _____ 1 of 1 for internal use only

Appendix 2: Example UX procedure

This procedure has been used as an example in the chapter. It is provided for discussion purposes only and should not be considered an operational example. It also provides an opportunity for confirming the knowledge developed through the chapter by identifying and annotating the following features:

- Design reflecting F pattern for eye tracking
- Gestalt principles
    - Figure/ground (appropriate use of white background, contrasting text colour, limited shading
    - Similarity (parallel construction)
    - Closure (summary statements and closing statement to confirm earlier content)
    - Proximity (white space and paragraph spacing used to build relationships between different elements)
    - Continuation (created by numbered steps)
    - Connectedness (using bullets or numbers)
- Notation
- Chunking (limited to 6+2-1) dot points or steps
- Echo statements with QA – C-link
- Walking cognitive links
- Closing statements and links
- Navigating cognitive links
- Use of nested alerts
- Use of shading where an operator's hands are moving.

Certify Laboratory Sample Bottles for Re-Use

Doc Type:	SOP	**Controlled document by:**	XXX-OIL LAB
Owner:	XXX-OIL Lab Safety	**Expiry date:**	Dec 31, 2022
Doc Number:	15-000XXXOILLAB0009	**Risk Rank:**	Rank 4

Confirming This Procedure

Purpose

The purpose of this procedure is to assure XXX-OIL laboratories are provided with regulatory compliant and certified sampling bottles.

This procedure controls the required steps for sample bottles to be:

- Compliant with ISO 17025
- Tested and fully functional
- Certified for re-use.

Scope

This scope of this procedure applies to XXX-OIL Laboratories only.

In scope	Only XXX-OIL laboratories under the governance of ABC Oil Association.
Out of scope	Any other XXX-OIL laboratories not under the governance of the ABC Oil Association.

Authorised user

Authorised users are XXX-OIL laboratory technicians who are:

- Trained and tested in the ISO 17025 requirements
- Certified by XXX-OIL to perform this procedure
- Authorised by the individual laboratory manager who will be using these sample bottles.

Procedure user acceptance sign off

I am the authorised user and confirm that I have reviewed the above:

Signature: _____**Time/date:** ___/____/__

Cleaning and Certification Sample Bottles Procedure

Prerequisites before you start

Confirm that these prerequisites are met before you start:

Time	A minimum of 45 minutes is required for this job.	☐
Training	You are trained and authorized for this job.	☐
Readiness	Equipment and tools are ready for use.	☐
PPEs	Lab PPEs and gloves: Type: 29 CFR 1910.138 are ready.	☐

Prepare bottles and run wash cycle

Prepare the sample bottles for the washer and run the wash cycle:

Step	Action
1.	**Don** lab PPEs and safety gloves and gather sample bottles. DANGER Failure to don prescribed Lab PPEs and safety gloves exposes you to potential chemical burns.
2.	**Drain** sample bottles of residual fluids and clean coupler ring.
3.	**Fit** coupler to lock ring and lock bottles to rack in washer.
4.	**Start** the washer and run cycle (25-minutes) to completion.

The wash cycle is now complete. Proceed to remove the bottles.

Reassemble and certify for re-use

Reassemble the sample bottles and inspect and certify for re-use.

5.	**Remove** bottles from washer and replace bull plug and lid seal.
6.	**Ready** bottles with lid seal wires and tag as follows: 1. Place lid seal wire through the lid opening. 2. Emboss the seal with tag number using sealing pliers. 3. Record the tag number on certification log sheet.
7.	**Complete** bottle ready check list and sign certification log sheet.

The certified sample bottles are now ready for re-use.

Operator certification sign off

I have completed the sample bottle cleaning and certification procedure.

Signature: _____ **Time/date:** _____/_____