Design Guidance Exploration

Alert Symbol Design

Wednesday, 21 May 2008
Version 2.0.0.0

Prepared by
Microsoft

Microsoft

PREFACE

Documents replaced by this document

Document Title	Version
None	

Documents to be read in conjunction with this document

Document Title	Version
Design Guidance Exploration – Icons and Symbology	1.0.0.0

TABLE OF CONTENTS

1 Executive Summary

1.1 Scope

This document explores a framework for describing alert symbols, reviewing existing symbols, and making initial recommendations on the design of alert symbols.

It has been developed prior to a review of the specific needs of clinical applications and their developers, and may change following such an investigation. The contents of this document should therefore be viewed as early exploration of a complex user interface area of concern and is for community preview and consultation.

1.2 Classification

Alert symbols are classified by:

- Intensity (whether they must be obeyed, or merely offer advice / alerts)
- Polarity (whether they recommend, or deprecate, a course of action)

This classification allows four classes of alert symbol to be identified:

- Prohibitions
- Mandatory actions
- Warnings
- Suggested actions

1.3 Visual Syntax

A study of the structure of signs shows that the graphical element associated with an alert is a ‘container’ surrounding a symbol or icon.

1.4 Warning Signs in Use

A review of alert symbols shows a very wide range in use. Some alert symbols are used in contradictory cases. Symbols adhering to International Organization for Standardization (ISO) standards are, however, among the most commonly used.

Analysis of these symbols shows that combinations of their shape and tone determine their meaning. Colour is used to enhance their meaning.

1.5 Principles and Recommendations

From a study of the literature surrounding this field, a number of principles of good symbol systems have been developed:

- Prohibitions and mandatory actions are at the top of the intensity scale. They have equal intensity – the reader is obliged to obey the message. Therefore, intensity should be represented separately to polarity (positive / negative)
- The system should have clear rules for setting the number of levels of intensity below this maximum
- The system should be able to incorporate alert signs into a more complex message structure

A review of how signs are interpreted by readers (see APPENDIX A), has lead to a number of additional rules for good symbol design:

- Signs should rely on codes which are shared by the recipients
- Signs should be based on codes which are already widely understood and repeated, rather than seeking to create new codes
- Sign systems should be as simple as possible to ensure ease of learning
- Signs should be easily distinguishable by target users in the media in which they are displayed
- Signs should be easily distinguishable without relying on colour alone to convey their meaning

Upon applying these principles to the observations made, it is recommended that the following symbols are used:

Figure 1: Recommended Symbols

Suggested Action

A symbol for suggested action or information, for example, the speech bubble, does not fit strongly into the proposed framework and, therefore, has not been included in this guidance as a formal recommendation. Further investigation needs to be undertaken to establish its suitability.

2 Introduction

2.1 Overview

Within the user interface, alert symbols are used to influence users' behaviour by indicating where problems (or opportunities) may lie, and what actions either should or should not be attempted.

Alert symbols are important in providing cues to users for changes in their behaviour. Alert symbols that are misinterpreted by users (for instance, suggestions that are taken to be requirements) may cause users to suspend their better judgement and endanger patient safety.

Alert symbols that are deployed inconsistently may cause users to lose confidence in the system and ignore potentially important information. Again, this could put patient safety at risk.

It is important, therefore, that developers have at their disposal a set of symbols that are unambiguous and can be deployed in a consistent manner.

2.2 Scope of Alert Symbols

Symbology is the study, interpretation and use of symbols. The scope of this design exploration and early design guidelines is to:

- Establish a detailed understanding of both online and offline symbols that may be encountered by clinical audiences
- Understand the fundamental language of symbols
- Determine the role that symbols should play in the overall application framework, and understand how other application elements, such as menus and buttons, are used in conjunction with symbols to provide a comprehensive set of actions, tools, and features that comprise a graphical user interface
- Develop a set of rules for the design, making use of symbols which enhance the speed and accuracy with which information is conveyed, in a manner which end users find acceptable

2.3 Current Focus of this Document

The current focus of this work is to:

- Formulate a framework that provides guidance for symbol construction, use and interpretation
- Identify trends in alert symbols in various environments, using this framework
- Propose principles for the design and use of alert symbols
- Apply these principles to the trends to develop recommendations for alert symbol construction
- Identify future research requirements for symbols in general, and alert symbols in particular

The current research focus does not include:

- Symbols that represent specific items within the clinical environment (such as people, places, equipment, actions or concepts)
- The application of icons and symbols (representing controls and concepts within software)
- An understanding of how the target audience interprets symbols
- An understanding of the individual needs of developers of specific clinical applications, who are designing or deploying alert symbols

- Understanding how the clinical environment affects the interpretation of symbols
- User research, or research into artefacts, within the clinical environment, such as physical alerts, notices and forms
- Text accompanying alerts and warnings, and informational text

2.4 Considerations and Assumptions

2.4.1 Considerations

Patient Safety

Patient safety is the primary concern of this work. Alerts must be clear, accurate, unambiguous, and timely. Clinicians need to be able to interpret and act upon alerts with minimal delay, in an adaptive unconscious manner. Non-verbal communication is at the heart of the principals stated here.

Existing Clinical Applications

More research needs to be done to understand how alerts are currently used in clinical applications. The contextual use needs to be determined, and an understanding of 'if' and 'when' processes should be interrupted using alerts.

2.4.2 Assumptions

- Clinical alerts can be split into the four main classifications of alert (that is, Prohibitions, Mandatory actions, Warnings and Suggested actions)
- The four categories (listed above) broadly cover all clinical alert types
- Clinical software alert symbols must be internationally relevant
- Our recommendations do not conflict with current best practice within the healthcare industry

2.5 Methodology

In developing the recommendations within this document, the following steps were followed:

- Review of research performed relating to the classification, interpretation and design of symbols in general, and symbols in user interfaces in particular. This involved:
  - A review of texts on semiotics (the study of signs and symbols and their meanings)
  - A review of books and papers on the use of signs and symbols within user interfaces
  - A review of books and papers on warning signs and symbols
  - A review of standards and guidelines on warning signs and symbols
- Development of a framework for describing alert symbols, and identifying their distinguishing features, using the research specified above. This involved:
  - Determining the scope of alert symbols
  - Identifying the key characteristics of alert symbols and using these to develop groups and shared dimensions
  - Developing a system for describing the components of signs and symbols
  - Identifying the components of signs and symbols that are unique to alerts, and the shared characteristics of those components

- Identifying rules and guidelines for the design of good signs and symbols

- Review of existing symbols:
  - Identifying alert symbols used in a variety of environments, and deconstructing these into their component parts
  - Identifying patterns and inconsistencies within the available signs
  - Showing how the rules specified in section 1.5 can be applied to existing symbols, in order to make recommendations on the design of alert signs

3 CLASSIFICATION

3.1 Alert Signs

Alert signs can be classified according to two criteria:

- What is the polarity of the alert sign? Is the alert sign a 'negative' (trying to prevent the reader from doing something) or a 'positive' (trying to encourage the reader to do something)?
- What is the intensity of the alert sign (from low intensity to high intensity)?

The zones within this framework are:

- Prohibitions (negative, maximum intensity)
- Mandatory actions (positive, maximum intensity)
- Warnings (negative, mid intensity)
- Suggestions (positive, mid intensity)
- Safe conditions (positive, minimum intensity)

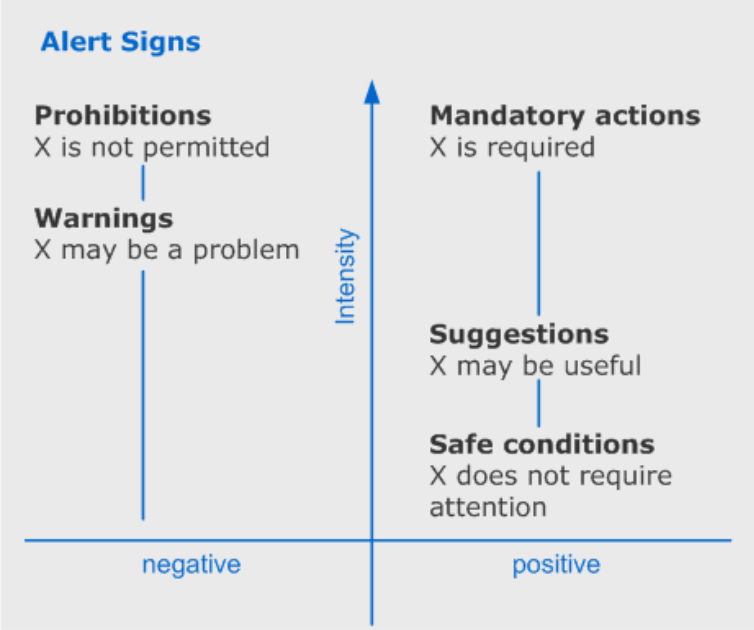


Figure 2: Framework for Classification of Alert Signs

In Figure 2 above, 'X' is any item, data or action. 'X' may equally refer to something from the clinical domain (for example, a drug) or the system domain (for example, a disk drive).

The scale of increasing intensity, from zero to maximum, describes the importance of the alert sign within the context of the thing to which it is referring. As intensity increases, so does the likelihood that the interface will limit the users' freedom of action.

The power of this framework is its simplicity – it helps to avoid unnecessary categories of alert, and it helps to determine what is and is not an alert.

3.1.1 Examples of Messages within the Scope of the Framework

It is helpful, when considering this framework, to have some examples that illustrate how alerts can be classified.

- 'Requests for information' are a form of positive alert. 'Omitted' information alerts are a form of negative alert. This framework could be used to identify fields in a form where a user is required to fill in information (mandatory action). If the user attempts to submit the form without completing these fields, their status would change to 'warning' (meaning 'these fields may be causing you a problem')
- The framework covers conditional alerts. These are instructions about what readers should do under specified circumstances (for example, ‘If patient develops headaches then administer aspirin.’). Conditional statements are multi-part: a condition and a response. There are two types of alert here: a warning and a mandatory/prohibited/suggested response. The trigger here is the warning ('if X…' or 'X may require your attention') – and it is the warning that should be displayed
- The framework includes 'limits'. These are a form of prohibition (for example ,'Do not exceed specified dose')
- The lowest level of alert (‘positive, zero intensity’) is simply a display of the state of a system. Examples of system state include ‘whether or not an action has been initiated’, ‘preferences’ and ‘to what level a thermostat has been set’.

The lowest level of alert – display of the state of a system, is not included in this study. This is because it is not considered to be an alert, merely ‘direct information’. Achieving a specific system state, or attempting to change the system state may *trigger* a higher level of alert (for instance ‘are you sure you want to empty the wastebasket?’), but the system state (‘wastebasket contains some items [but you don’t need to do anything about them for the system to continue to operate properly]’) and the alert (‘you will lose data by emptying the wastebasket’) are not the same thing.

3.1.2 Messages Outside of the Scope of the Framework

- There is no alert sign for 'negative, minimum intensity' – this would imply a problem that did not require attention. It is possible to imagine such conditions (for example, a piece of unused equipment is broken). However, it is impossible to distinguish these examples from warnings in any practical circumstance (for example, if the reader is interested in the status of the unused equipment, he should be warned that it is broken – so a warning is required here).

3.2 Requirements for Systems of Alert Signs

The framework identifies some important requirements that must be addressed by an alert sign system:

- Intensity should be represented separately to polarity (positive / negative)
- Prohibitions and mandatory actions are at the top of the intensity scale. They have equal intensity – the reader is obliged to obey the message
- The system should have clear rules for setting the number of levels of intensity below this maximum
- The system should be able to incorporate alert signs into a more complex message structure

4 VISUAL SYNTAX

Alert signs are composed of a number of elements. However, many of these elements are *supplementary* to the alert symbol – they provide context or add detail.

The dialogue box in Figure 3 shows how the sign can be broken down into component parts. Detailed definitions are available in APPENDIX A.

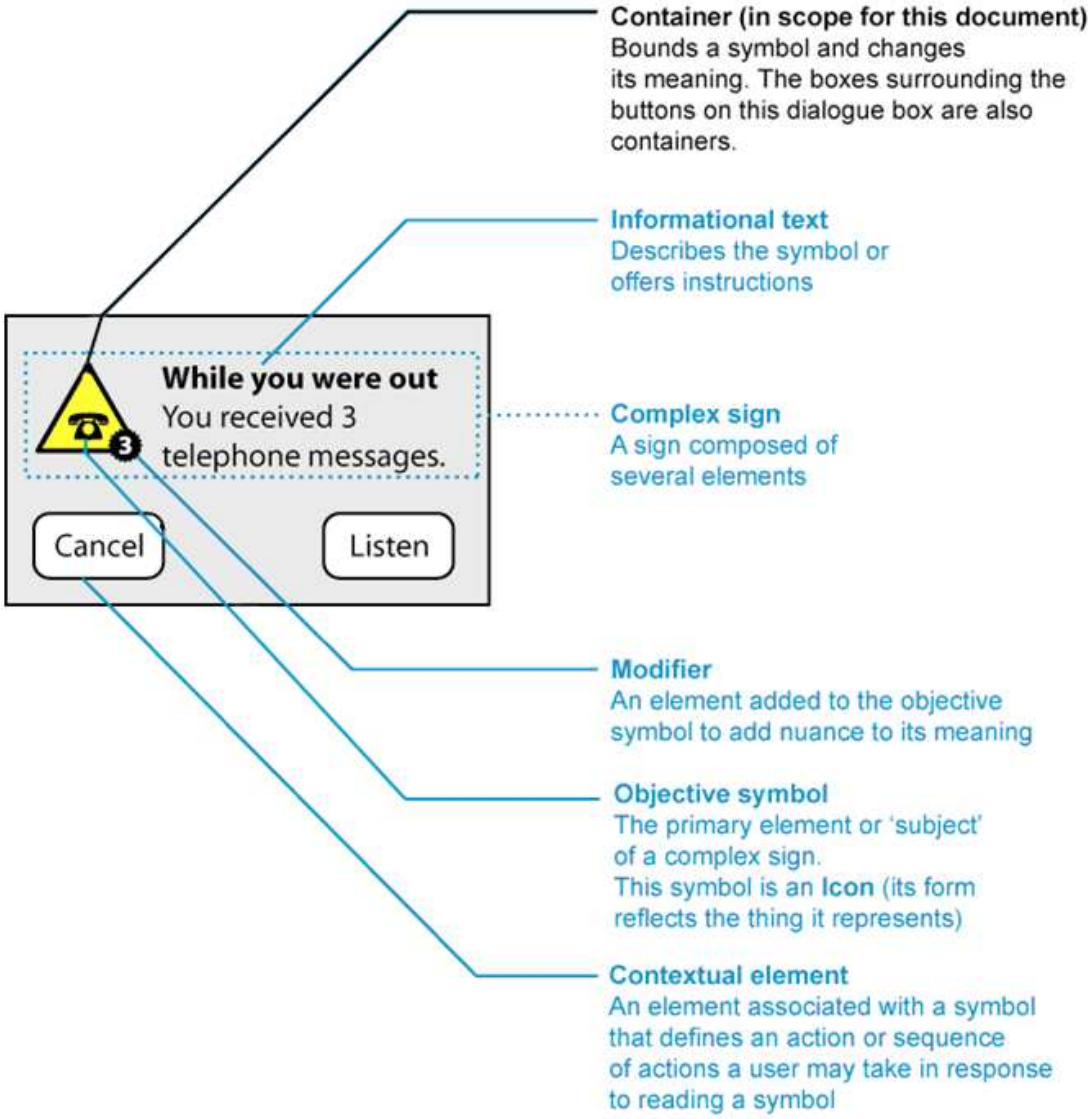


Figure 3: Elements of an Alert Sign

This breakdown shows that the primary elements of an alert symbol are the container, which is a combination of shape, tones and colours. Different alert symbols use unique combinations of shapes, and colours to express their meaning.

Therefore, there is a syntax of shapes and colours which can be used to express an alert.

5 Warning Signs in use

5.1 Observations

5.1.1 Syntax

- The circle is used in prohibitions and mandatory signs – it represents the 'most intense' level of signs
  - Intensely negative signs are light circles (with a thick dark border)
  - Intensely positive signs are dark circles (sometimes a thin light border is applied to make the sign stand out from its background)
- Colour is used to emphasise the difference between positive and negative signs, often by using a red border for prohibition and a blue fill for mandatory
- The strike-through on the prohibition sign is additional emphasis. The cross usually falls from left to right – but can fall from right to left if this helps make the sign clearer. A double strike-through is not necessary
- Limits are a special case of prohibition. They are very rare in the signs that were studied – though they did occur in road signs (speed limits and rights of way). Here the prohibition sign, without a strikethrough was used
- Warnings are most frequently represented by triangles. Often different colours are used to distinguish these from prohibitions
- Suggestions do not occur very frequently, except in interactive environments. The speech bubble is sometimes used, although sometimes no container is used at all
- The safe condition is expressed primarily by an absence of containers
- Colours are chosen to be accessible – circumstance (red – prohibition, blue – mandatory, yellow – warning, white – suggested action/information)

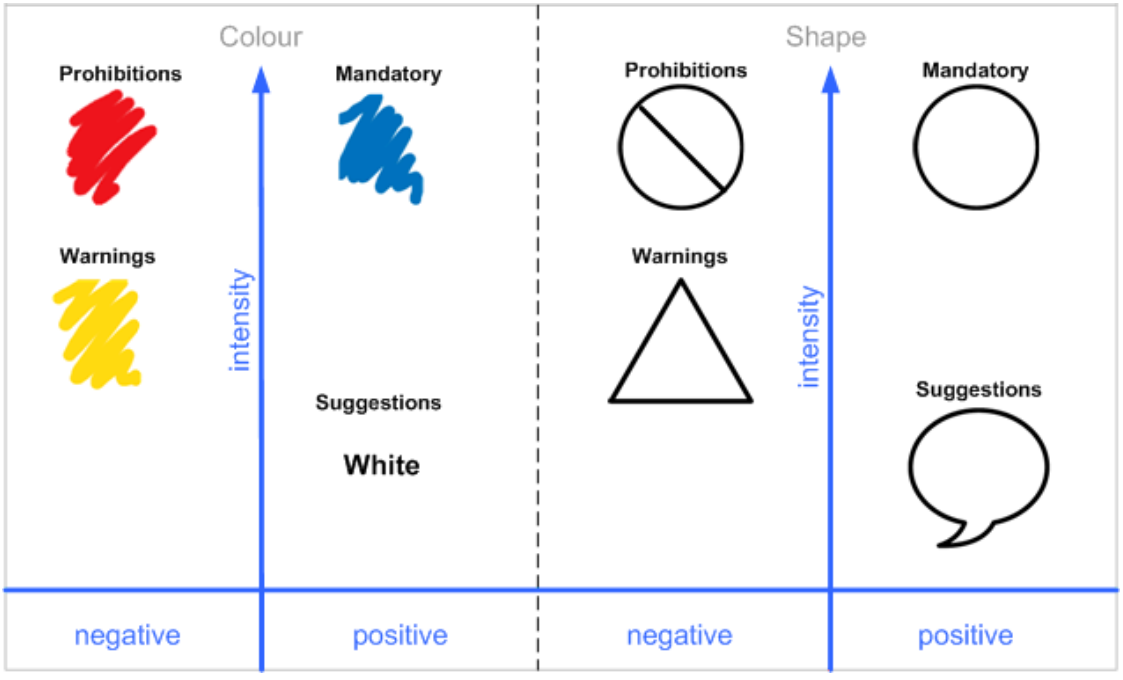


Figure 4: Alert Syntax

6 RECOMMENDATIONS AND PRINCIPLES

6.1 Rules for Symbol Design

The framework outlined in this guidance has led to the identification of a number of rules for good symbol design:

- Intensity should be represented separately to polarity (positive / negative)
- Prohibitions and mandatory actions are at the top of the intensity scale. They have equal intensity – the reader is obliged to obey the message
- The system should have clear rules for setting the number of levels of intensity below this maximum
- The system should be able to incorporate alert signs into a more complex message structure

A review of how signs are interpreted by readers (see APPENDIX C), has led to a number of the identification of additional rules for good symbol design:

- Signs should rely on codes which are shared by the recipients
- Signs should be based on codes which are already widely understood and repeated, rather than seek to create new codes
- Sign systems should be as simple as possible to ensure ease of learning
- Signs should be easily distinguishable by target users in the media in which they are displayed
- Signs should be easily distinguishable without relying on colour alone to convey their meaning

6.1.1 When to use Symbols

APPENDIX C also discusses when symbols should be used:

If the target audience is familiar with the symbols employed, then symbols can be used to:

- Represent items in the interface that would otherwise take many words to describe
- Draw attention to information (for instance in warnings)
- Communicate to people who may not be able to communicate in written language
- Speed the communication of frequently repeated or important information

7 Current Alert Symbol Recommendations

This section recommends the standard for displaying alert and warning symbols within clinical applications.

> **Note**
>
> In line with the previously mentioned finding (see section 2.4.2), that alert symbols in safety critical environments should be based on internationally understood standards, a unique set of alert symbols has not been identified.

In the software world there is poor conformance to guidelines and, where these exist, they borrow heavily from real world standards. In the real world, there is a strong stream of conformance to robust, internationally accepted standards for alert symbols within safety critical environments (such as the European Union (EU) Directive 92/58/EEC **{R1}**, and American National Standards Institute (ANSI) Z535) **{R2}**.

7.1 Symbol Construction Recommendations

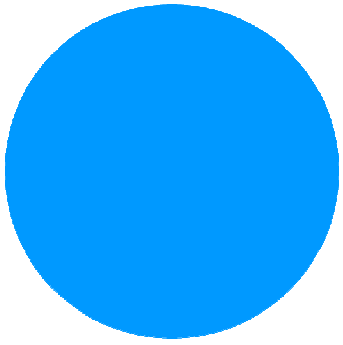
When making recommendations for alert symbols, all valid shape, colour and modifier combinations were considered. For each of these valid symbols, the attributes were compared against meaning, usage, international recognition and supporting standards. The recommendations are based on the strongest combination of these factors present for any given symbol.

Three symbol configuration recommendations, based on research undertaken and the prevalence of certain symbol compositions, are given:

- Mandatory actions
- Prohibitive actions
- Warnings

The symbol for suggested action or information (speech bubble) does not fit strongly into the framework outlined in this guidance and, therefore, has not been included as a formal recommendation, since further investigation needs to be undertaken to establish its suitability.

7.2 Mandatory Action Symbol



7.2.1 Format

Clinical applications should display mandatory actions as:

- Symbol Shape is a circle
- Symbol Colour is Blue (Red-Green-Blue (RGB) value to be specified)
- Symbol Size is (to be specified)

- Icon Colour is (to be specified)
- Icon Size is (to be specified)

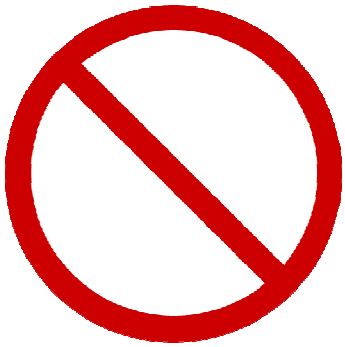
7.2.2 Recommendation Rationale

- This mandatory symbol configuration is used in international safety signage to indicate a mandatory instruction. It has the strongest combination of meaning, usage, international recognition and supporting standards
- The shape, a circle, signifies the most intense level of alert sign. The colour, blue, determines the polarity of the sign, signifying the sign as positive, mandatory action
- As shown in the observations diagram this shape and colour combination is consistently used (by 10 out of the 17 references) to denote a mandatory action
- This shape and colour combination is sighted in the EU Directive 92/58/EEC **{R1}** as the mandatory action symbol which must be used by all twenty five member states
- The harmonisation of the ISO 38643 standard **{R3}** and the ANSI Z535 standard **{R2}** states mandatory action symbols be displayed as a blue circle
- The sign is visually distinct from the other signs due to colour (no conflicts for colour-blindness)
- The sign is visually distinct from the other signs due to tone (works on black and white monitors / printouts and mono-chromatic colour blindness)
- The sign does not rely on colour alone to convey its meaning

7.2.3 Key References

- EU Directive 92/58/EEC **{R1}**
- ANSI (American National Standards Institute) Z535.1-4: Safety Color Code, 1991; Environmental and Facility Safety Signs, 1991; Criteria for Safety Symbols, 1991; Product Safety Signs and Labels, 1991 **{R2}**
- Health and Safety Executive (HSE) Regulations 1996 **{R4}**
- British Standard Institute: BS 5378-2:1980: Safety signs and colours. Specification for colormetric and photometric properties of materials **{R5}**
- International Organization for Standardization: ISO 7010:2003: Graphical symbols – Safety colours and safety signs – Safety signs used in workplaces and public areas **{R6}**
- International Organization for Standardization: ISO 3864-1: 2002: Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs in workplaces and public areas **{R7}**
- International Organization for Standardization: ISO 3864-3:2006: Graphical symbols – Safety colours and safety signs – Part 3: Design principles for graphical symbols for use in safety signs **{R3}**
- International Organization for Standardization: ISO 17631:2002: Ships and marine technology – Shipboard plans for fire protection, life-saving appliances and means of escape **{R8}**
- The Highway Code (Driving Skills), Driving Standards Agency **{R9}**
- Traffic Signs Regulations and General Directions 2002: Statutory Instrument 2002 No. 3113 **{R10}**

7.3 Prohibited Action Symbol



7.3.1 Format

Clinical applications should display mandatory actions as:

- Symbol Shape is a circle
- Symbol Colour is white
- Symbol Border and Diagonal line is red (RGB value to be specified)
- Symbol Size is (to be specified)
- Icon Colour is (to be specified)
- Icon Size is (to be specified)

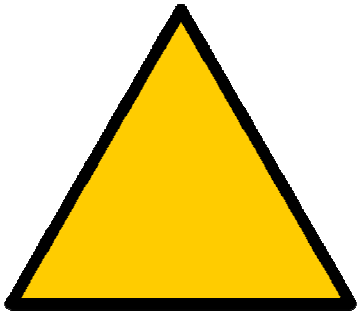
7.3.2 Recommendation Rationale

- This prohibition symbol configuration is used in international safety signage to indicate a prohibitive instruction. It has the strongest combination of meaning, usage, international recognition and supporting standards
- The shape, a circle, signifies the most intense level of alert sign. The colour, red, determines the polarity of the sign, signifying the sign as a negative, prohibited action
- As shown in the observations diagram, this shape and colour combination is consistently used (by 10 out of the 17 references) to denote a prohibited action
- This shape and colour combination is cited in the EU Directive 92/58/EEC **{R1}** as the prohibited action symbol which must be used by all twenty five member states
- The harmonisation of the ISO 3864-3:2006 standard **{R3}** and the ANSI Z535.1-4 standards **{R2}** states that prohibited action symbols be displayed as a white circle with a red border, and diagonal line running from the top left to the bottom right of the circle
- The sign is visually distinct from the other signs due to the border and diagonal line colour (no conflicts for colour-blindness)
- The sign is visually distinct from the other signs due to tone (works on black and white monitors / print-outs and mono-chromatic colour blindness)
- The sign does not rely on colour alone to convey its meaning

7.3.3 Key References

- European Union Directive 92/58/EEC **{R1}**
- ANSI (American National Standards Institute) Z535.1-4: Safety Color Code, 1991; Environmental and Facility Safety Signs, 1991; Criteria for Safety Symbols, 1991; Product Safety Signs and Labels, 1991 **{R2}**
- Health and Safety Executive (HSE) Regulations 1996 **{R4}**
- British Standard Institute: BS 5378-2:1980: Safety signs and colours. Specification for colormetric and photometric properties of materials **{R5}**
- International Organization for Standardization: ISO 7010:2003: Graphical symbols – Safety colours and safety signs – Safety signs used in workplaces and public areas **{R6}**
- International Organization for Standardization: ISO 3864-1: 2002: Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs in workplaces and public areas **{R7}**
- International Organization for Standardization: ISO 3864-3:2006: Graphical symbols – Safety colours and safety signs – Part 3: Design principles for graphical symbols for use in safety signs **{R3}**
- International Organization for Standardization: ISO 17631:2002: Ships and marine technology – Shipboard plans for fire protection, life-saving appliances and means of escape **{R8}**
- The Highway Code (Driving Skills), Driving Standards Agency **{R9}**
- Traffic Signs Regulations and General Directions 2002: Statutory Instrument 2002 No. 3113 **{R10}**

7.4 Warning Symbol



7.4.1 Format

Clinical applications should display warnings as:

- Symbol Shape is a triangle
- Symbol Colour is Yellow (RGB value to be specified)
- Border Colour is black (RGB value 0,0,0)
- Symbol Size is (to be specified)
- Icon Colour is (to be specified)
- Icon Size is (to be specified)

7.4.2 Recommendation Rationale

- This symbol configuration is used in international safety signage to indicate a warning. It has the strongest combination of meaning, usage, international recognition and supporting standards
- The shape, a triangle, signifies a medium intensity level of alert sign. The colour, yellow, determines the polarity of the sign, signifying the sign as negative warning
- As shown in the observations diagram this shape and colour combination is consistently used (by 10 out of the 17 references) to denote a mandatory action
- This shape and colour combination is sighted in the EU Directive 92/58/EEC **{R1}** as the warning symbol which must be used by all twenty five member states
- The harmonisation of the ISO 3864-3:2006 standard **{R3}** and the ANSI Z535.1-4 standard **{R2}** states warning symbols be displayed as a yellow triangle
- The sign is visually distinct from the other signs in this set due to colour (no conflicts for colour-blindness)
- Does not rely on colour alone to convey its meaning

7.4.3 Key References

- European Union Directive 92/58/EEC **{R1}**
- ANSI (American National Standards Institute) Z535.1-4: Safety Color Code, 1991; Environmental and Facility Safety Signs, 1991; Criteria for Safety Symbols, 1991; Product Safety Signs and Labels, 1991 **{R2}**
- Health and Safety Executive (HSE) Regulations 1996 **{R4}**
- British Standard Institute: BS 5378-2:1980: Safety signs and colours. Specification for colormetric and photometric properties of materials **{R5}**
- International Organization for Standardization: ISO 7010:2003: Graphical symbols – Safety colours and safety signs – Safety signs used in workplaces and public areas **{R6}**
- International Organization for Standardization: ISO 3864-1: 2002: Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs in workplaces and public areas **{R7}**
- International Organization for Standardization: ISO 3864-3:2006: Graphical symbols – Safety colours and safety signs – Part 3: Design principles for graphical symbols for use in safety signs **{R3}**
- International Organization for Standardization: ISO 17631:2002: Ships and marine technology – Shipboard plans for fire protection, life-saving appliances and means of escape **{R8}**
- The Highway Code (Driving Skills), Driving Standards Agency **{R9}**
- Traffic Signs Regulations and General Directions 2002: Statutory Instrument 2002 No. 3113 **{R10}**
- Microsoft Windows Vista User Experience Guidelines (last updated August 28, 2007) **{R11}**

7.4.4 Other Candidates Considered

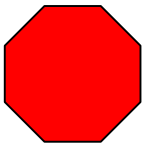
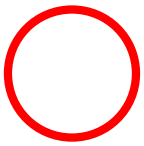
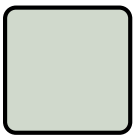
Alert Symbol Type	Candidates	Dismissal Rationale
Warning		This symbol is used in international road signs to denote a warning, however it has no other context of use. Although its shape is similar to Chemical Hazard Warning signs, it is not used to present the same complex meaning.
Mandatory Action		Although the octagonal STOP sign is unique, it represents only one specific meaning. If used at low resolution or small size, it might be mistaken for a circular shape. This sign could also be considered a prohibitive symbol in terms of classification. This symbol is only cited in Road Traffic regulations.
Prohibitive Action		Although this symbol configuration is very similar to the one recommended, without the crucial diagonal line modifier, its meaning is somewhat diluted and may even make it ambiguous in some cases. This symbol is only cited in Road Traffic regulations.
Information		Real world information is presented in a rectangular container. This shape is problematic in the real world as it is used to contain the information icon (as a logogram), directional information, explanatory text and modifier text, mandatory signs, and prohibitive signs. This shape is problematic in the software world as it is used to contain application icons in toolbars and it bounds alert messages.

Table 1: Alert Symbol Candidates

7.5 Summary

- The three categories of alerts symbols were split by the intensity of their meaning and the polarity between their positive and negative message
- Alert symbols used in the non-clinical, off-line world have strong supporting international standards and are used extensively across industries
- Alert symbols in the software world borrow heavily from real world examples, however there is little adherence to the few guidelines that exist for software alerts
- Combinations of colour and shape have significant meaning for alert symbols in safety critical environments and are supported by international standards
- The recommendations given in this guidance for key alert symbol classifications are based on the framework that was developed from research and analysis
- The context of alert symbols is derived from additional elements in an alert, such as icons, text and other modifiers
- Research performed to date has not included a detailed review of symbols in use in clinical applications. Future rounds of research will cover this area

8 Accessibility Considerations

The following considerations for accessibility should be applied to any implementation of alerts and icons:

- Appropriate text equivalents for all images must be provided, for example by the use of 'alt text' in Web applications. The text should be functional and not a literal description of the design of the image. For icons, the text should provide the function of the icon (for example, 'save' not 'disk'). For alerts, the text should describe the detail of the alert (for example, 'warning: above recommended dosage' not 'red…')
- Colour must not be the only way of differentiating between symbols
- Flashing in the 2-59 Hertz (Hz) range must be avoided
- Alerts and icons (and their equivalent text) should be used consistently across the whole application

9 Next Steps

9.1 Key Activities

- Understand the effect of clinical environments on the interpretation of alert symbols
- Understand how end users interpret alert symbols
- Establish rules for when an item is a critical alert and when it is a warning
- Begin research on application icons
- Begin research on buttons
- Begin research on clinical icons within alert symbols
- Research standards and guidelines for application icons
- Review icons currently used in clinical applications
- Build detailed clinical scenarios for hypothesis testing
- Explore clinical environment (detailed in section 9.2 below)

9.2 User Research

Some broad secondary research has been conducted into cultural observations, ISO standards and software platform guidelines. Of these areas, the greatest degree of confusion and non-conformity regarding the implementation of alerts and the use of icons is to be found in the software platform guidelines. For this reason it is necessary to conduct more extensive user research, especially within the clinical environment, to establish how users interpret icons and how alerts might best be constructed to support their working practices and ensure safety without being over intrusive or cumbersome.

9.2.1 Primary Research

- Observational research
- Research within clinical environments
- How clinicians currently use notes to attract attention or denote importance
- Research within other non-clinical environments where safety is an important factor, for example, the power industry, airlines, armed forces, car manufacturers (designing safety warning features in vehicles)
- Interview-based research
- Interview people who train for safety
- Interview clinicians in a safety critical environment or process
- Interview people who teach clinicians

9.2.2 Cultural Research

- Studying alerts and icons in different software environments, for example, in games where there is high emotional engagement (including the perception of danger) and a lot of instructions to follow
- Warnings, icons and information architecture on packaging and labels (for example, non-prescription drug packaging, online health sites for special groups, such as diabetics)

9.2.3 Confirmation Research

- Survey-based research directed at specific clinician groups (helps to support primary research findings)
- Survey questionnaire for symbols and icons
- Building journals of daily interaction with warnings in clinical environment
- Informal usability testing on early paper prototypes

10 Document Information

10.1 Terms and Abbreviations

Abbreviation	Definition
ANSI	American National Standards Institute
BS	British Standards
BSI	British Standards Institute
EEC	European Economic Centre
EU	European Union
HSE	Health and Safety Executive
Hz	Hertz
ISO	International Organization for Standardization
NCEC	National Chemical Emergency Centre
RGB	Red-Green-Blue
SP2	Service Pack 2

Table 2: Terms and Abbreviations

10.2 Definitions

Term	Definition
Current best practice	Current best practice is used rather than best practice, as over time best practice guidance may change or be revised due to changes to products, changes in technology, or simply the additional field deployment experience that comes over time.

Table 3: Definitions

10.3 Nomenclature

This section shows how to interpret the different styles used in this document to denote various types of information.

10.3.1 Body Text

Text	Style
Code	`Monospace`
Script	
Other markup languages	
Interface dialog names	**Bold**
Field names	
Controls	
Folder names	Title Case
File names	

Table 4: Body Text Styles

10.3.2 Cross References

Reference	Style
Current document – sections	Section number only
Current document – figures/tables	Caption number only
Other project documents	*Italics* and possibly a footnote
Publicly available documents	*Italics* with a footnote
External Web-based content	*Italics* and a hyperlinked footnote

Table 5: Cross Reference Styles

10.4 References

Reference	Document	Version
R1.	European Union Directive 92/58/EEC	
R2.	ANSI (American National Standards Institute) Z535.1-4: Safety Color Code, 1991; Environmental and Facility Safety Signs, 1991; Criteria for Safety Symbols, 1991; Product Safety Signs and Labels, 1991	
R3.	International Organization for Standardization: ISO 3864-3:2006: Graphical symbols – Safety colours and safety signs – Part 3: Design principles for graphical symbols for use in safety signs	
R4.	Health and Safety Executive (HSE) Regulations 1996	
R5.	British Standard Institute: BS 5378-2:1980: Safety signs and colours. Specification for colormetric and photometric properties of materials	
R6.	International Organization for Standardization: ISO 7010:2003: Graphical symbols – Safety colours and safety signs – Safety signs used in workplaces and public areas	
R7.	International Organization for Standardization: ISO 3864-1: 2002: Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs in workplaces and public areas	
R8.	International Organization for Standardization: ISO 17631:2002: Ships and marine technology – Shipboard plans for fire protection, life-saving appliances and means of escape	
R9.	The Highway Code (Driving Skills), Driving Standards Agency	
R10.	Traffic Signs Regulations and General Directions 2002: Statutory Instrument 2002 No. 3113	
R11.	Microsoft Windows Vista User Experience Guidelines (last updated August 28, 2007)	
R12.	CCMS – Communication, Cultural and Media Studies http://www.cultsock.ndirect.co.uk/MUHome/cshtml/index.html	
R13.	Emergency Action Codes (Hazchem Codes), National Chemical Emergency Centre (NCEC) http://the-ncec.com/hazchem/	
R14.	Manual on Uniform Traffic Control Devices, US Department of Transportation – Federal Highway Administration http://mutcd.fhwa.dot.gov/ser-shs_millennium_eng.htm	

Table 6: References

APPENDIX A DEFINITIONS

In common parlance, words such as 'sign', 'symbol' and 'icon' are used interchangeably. For clarity, and for correct application of the framework identified in this guidance, user interface designers must adhere to careful definitions of these terms.

This document uses the following definitions from the field of semiotics (CCMS – Communication, Cultural and Media Studies)[1].

Sign

A 'sign' is a meaningful unit which is interpreted as 'standing for' something other than itself. Examples of signs are written words, images, sounds, acts or objects.

Symbol

A symbol is a sign whose meaning comes from an agreement between the people using it.

For example:

- A red traffic light means 'stop'
- A circle with a vertical line at the top means 'on/off'

Symbols are purely arbitrary – to be correctly interpreted by users, symbols must follow conventions and rules that are accepted and understood by the reader. This is an important point crucial to understanding how to develop signs (see 'How signs are read', below).

Code

A code is a convention for communication. For instance, the Roman alphabet is a code.

Icon

An icon is a sign whose form reflects the thing that it signifies.

For example:

- An image of a CD on a computer screen (representing a real CD in the computer's CD-ROM drive)
- An image of a person in a wheelchair (representing disabled people in general)
- The word 'splash' (which sounds like the thing it describes)

By definition, icons represent things that have a form.

[1] CCMS – Communication, Cultural and Media Studies **{R12}**: http://www.cultsock.ndirect.co.uk/MUHome/cshtml/index.html

Complex Signs

Complex signs are signs which are comprised of other signs. Figure 5 displays an example of this.

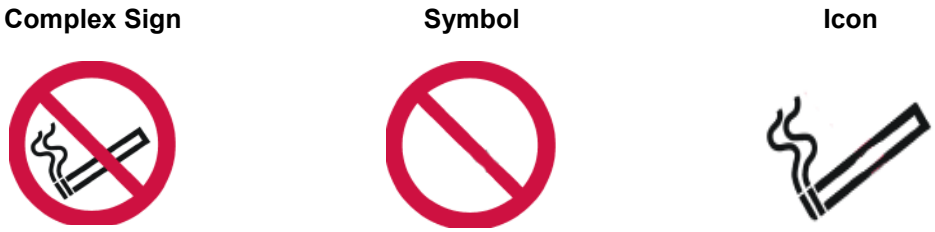


Figure 5: Components of a Complex Sign

Complex Sign Elements

Clinical application developers will need to describe specific types of signs, namely alert signs that are used within the applications. This guidance proposes new definitions of elements of complex signs.

These are:

- The objective symbol
- The container
- The modifier
- Informational text
- Contextual elements

> **Note**
>
> These definitions are specific to this document and will be reviewed if future research identifies a classification scheme that is already in common use.

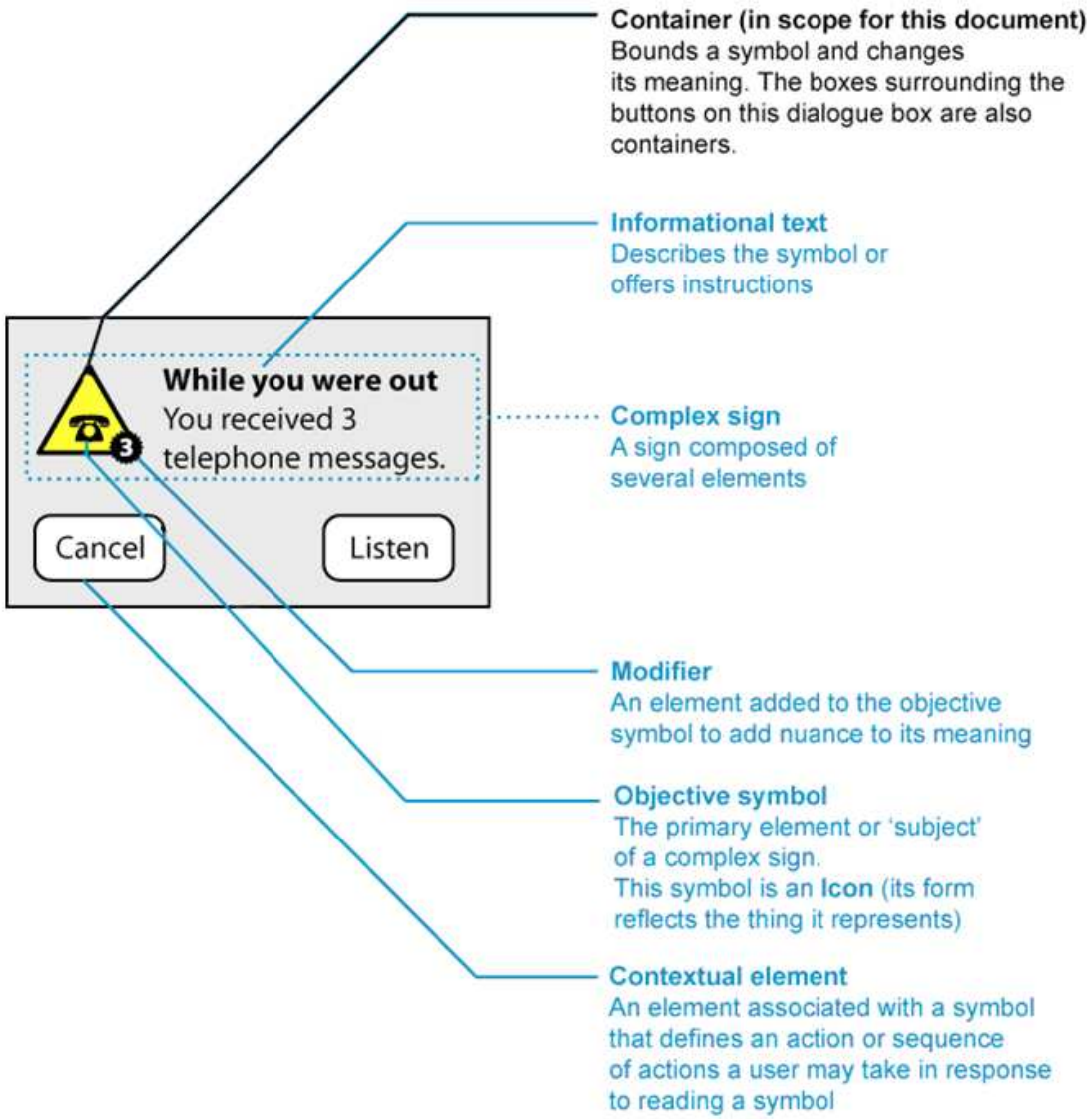


Figure 6: Illustration of the Components of a Complex Sign

Objective Symbol

The objective symbol is the primary element of the sign. It is usually placed at the centre of the sign. It is the 'subject' of the sign. In Figure 6, the telephone icon is displayed as the objective symbol.

Container

A container is a shape that bounds or overlays the objective symbol. The container should be used to change its meaning.

For example:

- A circle with a line through it, overlaying an icon of a cigarette ('no smoking')
- An image of a 'button' surrounding a magnifying glass icon (a 'zoom' control in a software interface)

In Figure 6, the yellow triangle is a container. The button outlines placed around the words 'Cancel' and 'Listen' are also containers.

Modifiers

A modifier is a minor element (icon, number or text) which should be combined with a major icon. The minor element should be used to modify or nuance the icon's meaning.

For example:

- A list of times underneath a 'No Parking' sign which describe when it is illegal to park
- An icon of a folder with an icon of a picture frame within it, used to represent 'folder for pictures'

In Figure 6, the '3' symbol is a modifier.

Informational Text

Informational text is a message that should be placed next to the symbol and is used to describe the symbol's meaning, offer instructions, or explain the purpose of the symbol.

Informational text is different from modifying text. For instance a 'No Parking' symbol may be accompanied by a list of times (which modify its meaning) and the words 'no parking' (which repeat the symbol's meaning). In this instance, the times are modifiers and the words 'no parking' are informational text.

In Figure 6, the message 'While you were out you received 3 telephone messages,' is the informational text.

Contextual Elements

Contextual elements are the surrounding and context in which a symbol will be displayed. These determine the actions the user may perform in response to interpreting the icon.

For instance, a symbol may be displayed in the context of (next to) a checkbox. The context modifies the users' interpretation of the symbol (as an option).

In Figure 6, the dialogue box and buttons are contextual elements in relation to the telephone icon.

APPENDIX B ALERTS AND INTERACTIONS

The classification of alert signs (Figure 2) can be used as a template for other interface elements – for instance, interactions.

A short discussion of inactivity cues is included because, although it is out of the scope of this document, interactivity cues are also containers and are, in this sense, related to alert cues.

Interactivity Cues

Interactive elements can be classified according to two criteria:

- Is the element 'information' ('click to find out more detail') or an action ('click to execute')?
- What is the state or intensity of the interactivity cue?

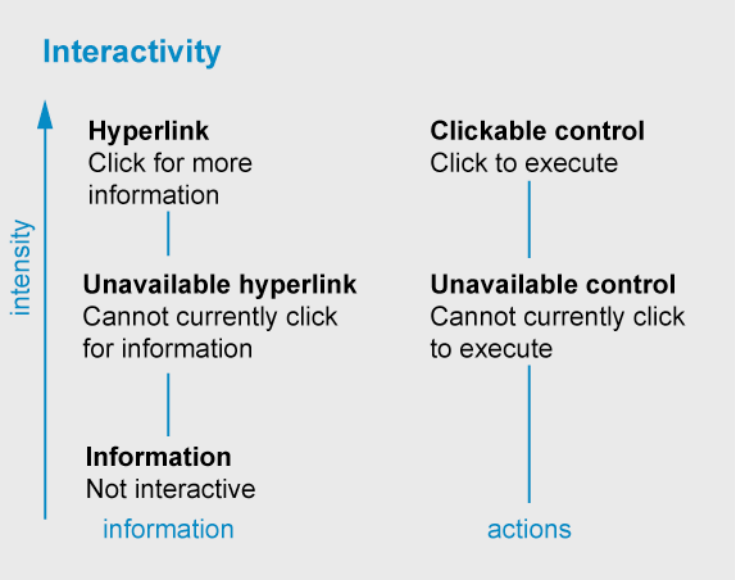


Figure 7: Classification of Interactive Elements

Again, this simple framework allows many items to be classified. For instance, checkboxes are interface elements that are always 'clickable'. Hyperlinks may be disabled or enabled. Buttons may be clickable or currently unavailable.

What is interesting is that alert signs are a form of information. They may be clickable or not. So a 'safe condition' symbol may also be a non-interactive piece of information (for example, an indicator of temperature) or an interactive piece of information (an 'all clear' summary icon leading to a page detailing a patient's vital signs).

APPENDIX C RULES FOR SYMBOL DESIGN

In the language of semiotics, signs are written by a 'sender' in order to convey information to a 'receiver'.

Rule 1: Understanding a Sign

To be easily and accurately understood, signs should rely on codes that are shared by the recipients.

The first principle of semiotics is the 'arbitrariness of the sign' – the idea that there is no *inherent* reason for a sign to mean something.

For instance, there is no particular reason why the word 'sister' should mean a female sibling, other than convention. A sender may choose another word (such as 'egg' or 'brother') to carry the meaning 'a female sibling'. The only reason that 'sister' is a good choice is because English speakers tend to agree that 'sister' means 'a female sibling'.

This is the case for all signs – the arrows, shapes and diagrams people see around them only mean something because they have learned a 'code' that is shared with the people who wrote the signs.

- The value of a sign depends on the ease and accuracy with which the recipient decodes it
- The author of a sign has no control over how it is interpreted

Rule 2 and 3: Learning the Meaning of a Sign

Signs should be based on codes which are already widely understood and repeated – rather than seek to create new codes.

Sign systems should be as simple as possible to ensure the ease of learning.

Learned behaviour has a tendency to break down during the early stages of learning and under stressful conditions. This needs to be taken into account when designing signs for a safety critical environment.

It is clear that signs that are entirely new will have to be learned by all readers.

Furthermore, it is axiomatic that simple subject matter (subject matter with few elements, few rules and few exceptions) is easier to learn than complex subject matter.

Rule 4 and 5: Legibility and Accessibility

Signs should be easily distinguishable by target users in the media in which they are displayed.

Further releases will attempt to determine specific values to accompany Rule 4.

Signs may also be seen by readers with defective colour vision, or by readers using equipment with defective colour reproduction.

Signs should be easily distinguishable without relying on colour alone to convey their meaning.

Signs within the clinical application may be displayed on computer / television screens, as well as other media. This will constrain the legibility of the signs – for instance, due to low resolution of the computer screens.

It is clear from Rule 4 and Rule 5, safety-critical signs will have to rely on a combination of colours, shapes and words to accurately convey their meaning.

When to Use Symbols

If the target audience is familiar with the symbols employed, then symbols can be used to:

- Represent items in the interface that would otherwise take many words to describe
- Draw attention to information (for instance in warnings)
- Communicate to people who may not be able to communicate in written language
- Speed the communication of frequently repeated or important information

Features of Alert Symbols

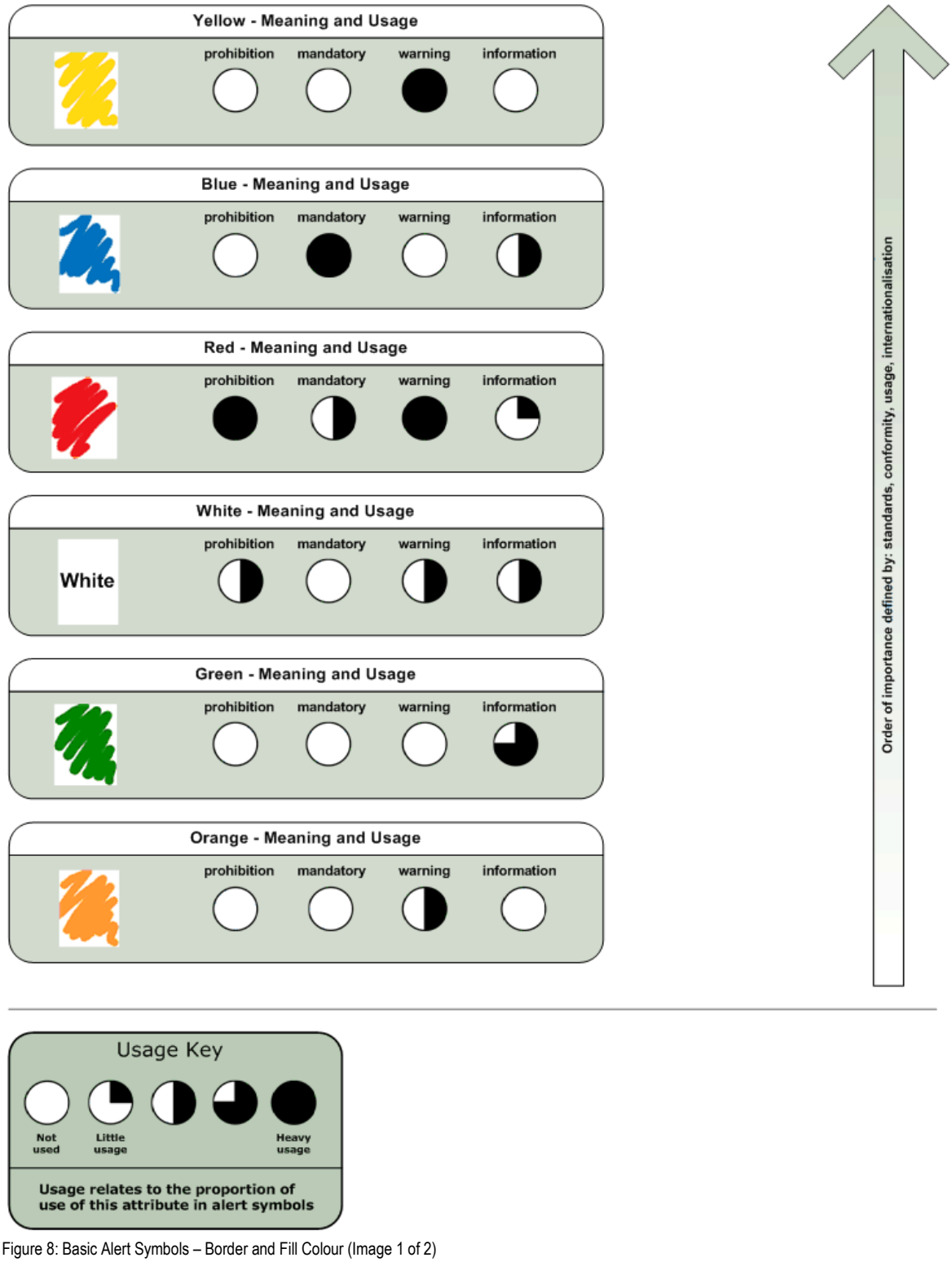


Figure 8: Basic Alert Symbols – Border and Fill Colour (Image 1 of 2)

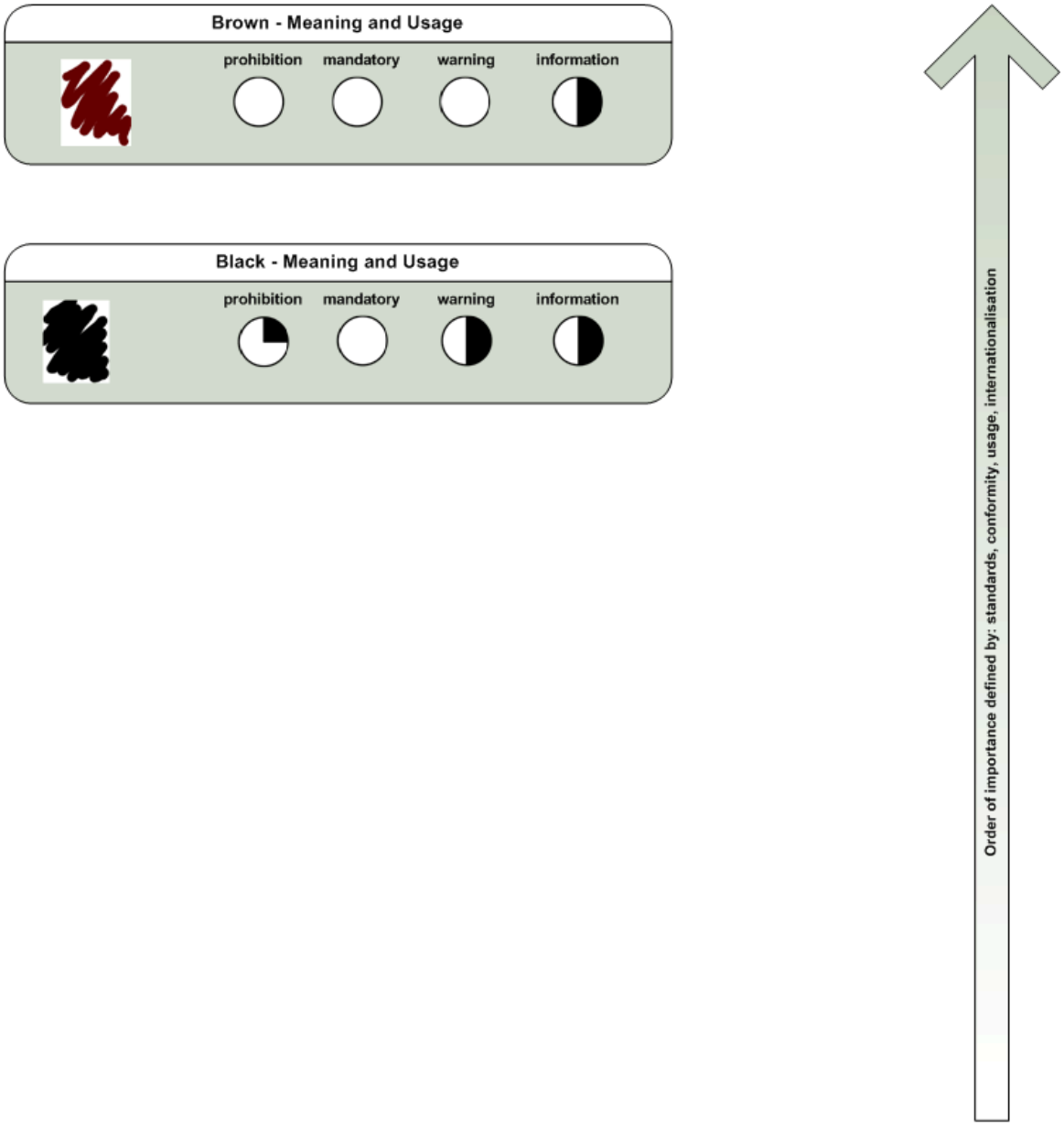


Figure 9: Basic Alert Symbols – Border and Fill Colour (Image 2 of 2)

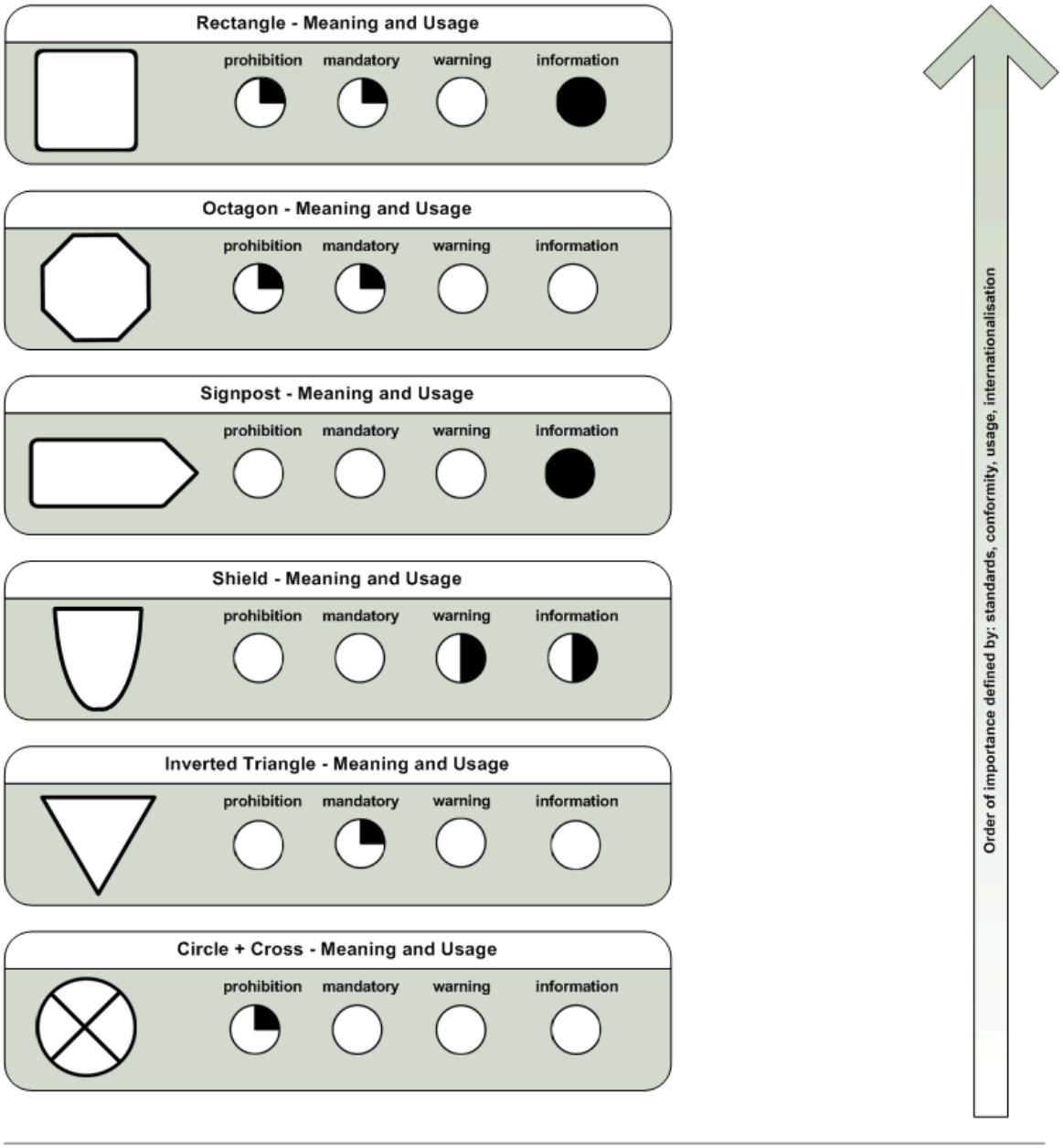


Figure 10: Basic Alert Symbols – Containers (Image 1 of 2)

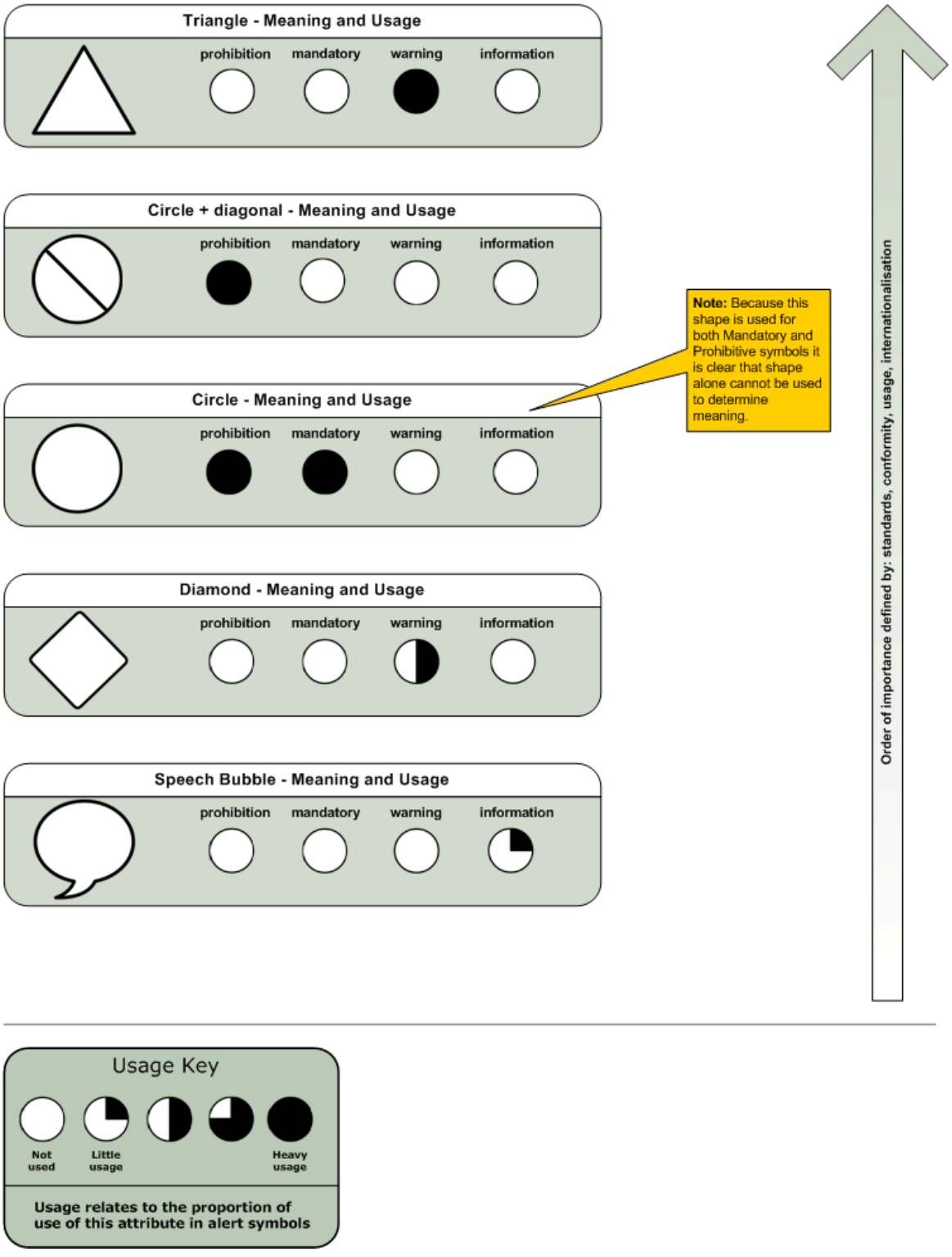
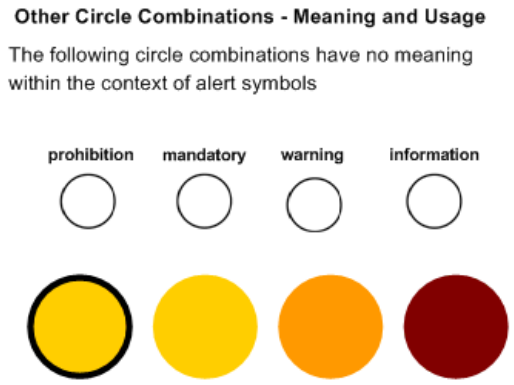


Figure 11: Basic Alert Symbols – Containers (Image 2 of 2)



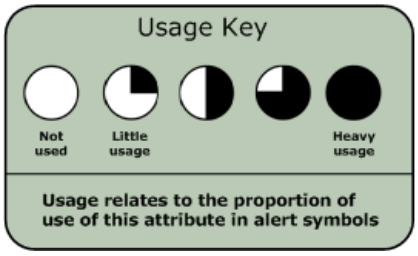


Figure 12: Basic Alert Symbols – Colour Combinations (Image 1 of 3)

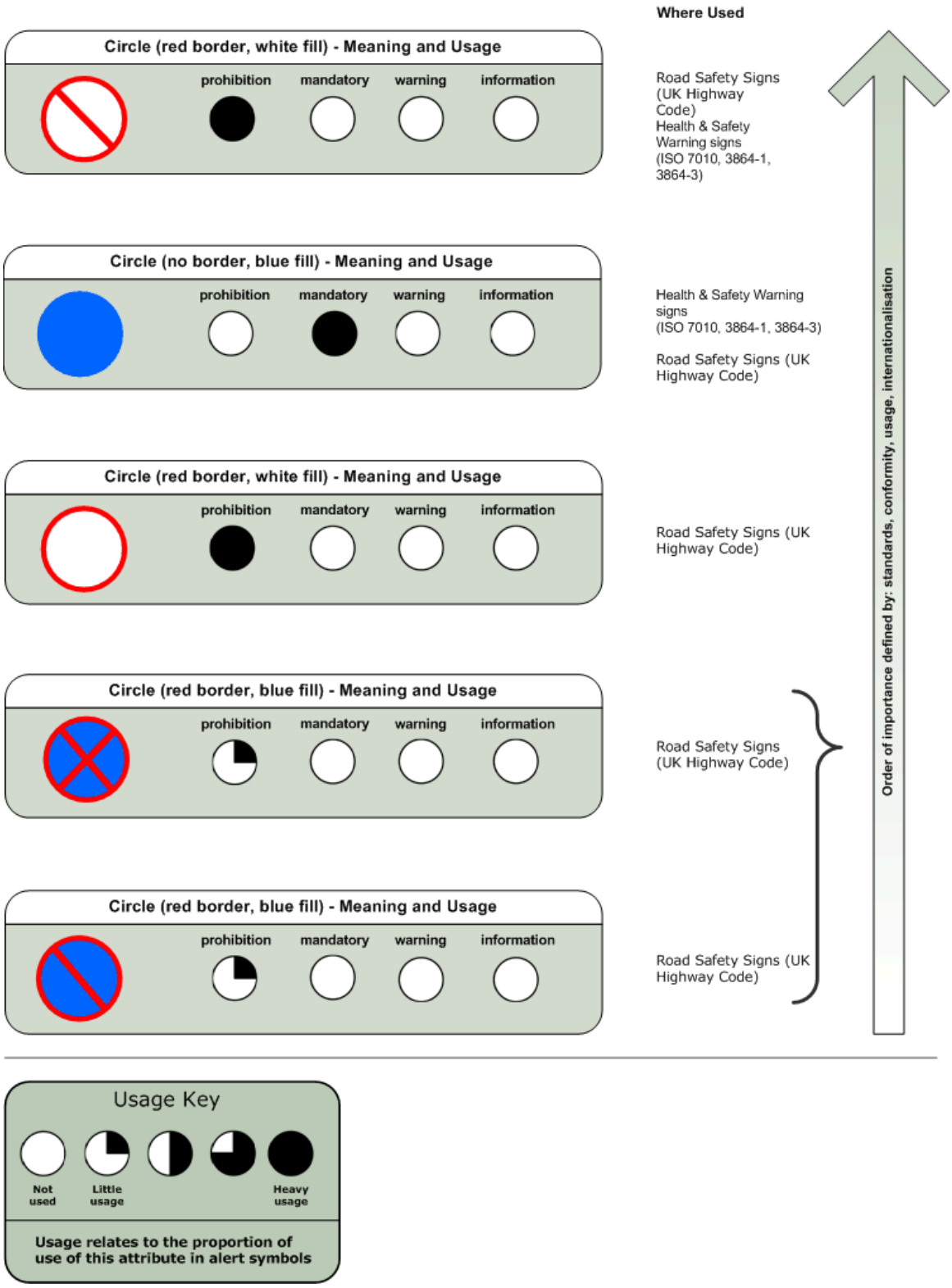


Figure 13: Basic Alert Symbols – Colour Combinations (Image 2 of 3)

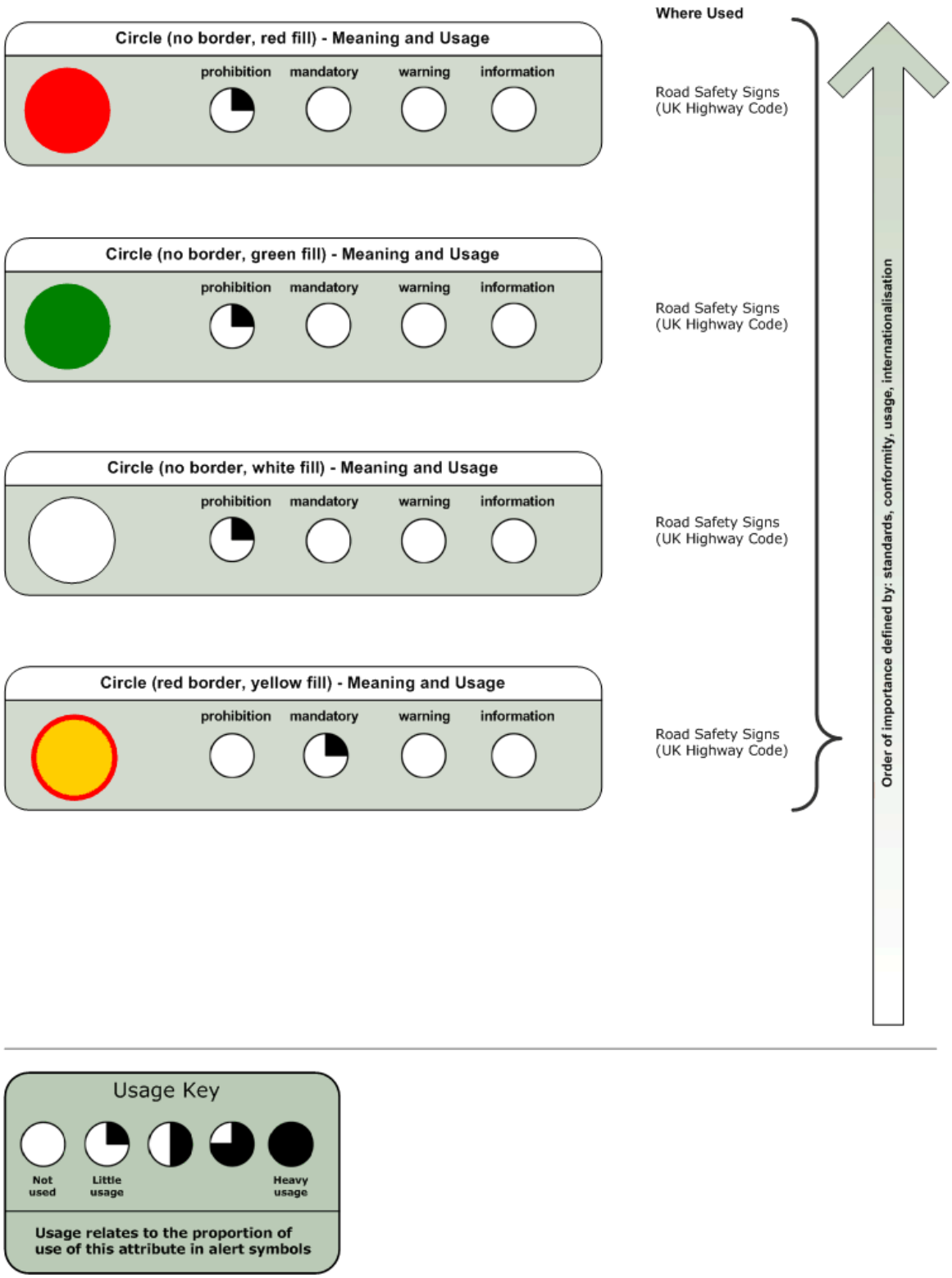


Figure 14: Basic Alert Symbols – Colour Combinations (Image.3 of 3)

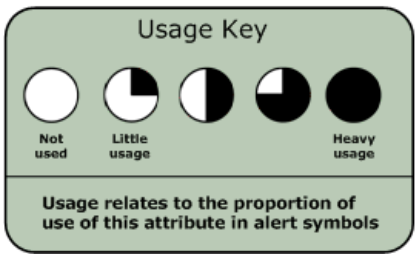


Figure 15: Basic Alert Shapes – Reconstruction

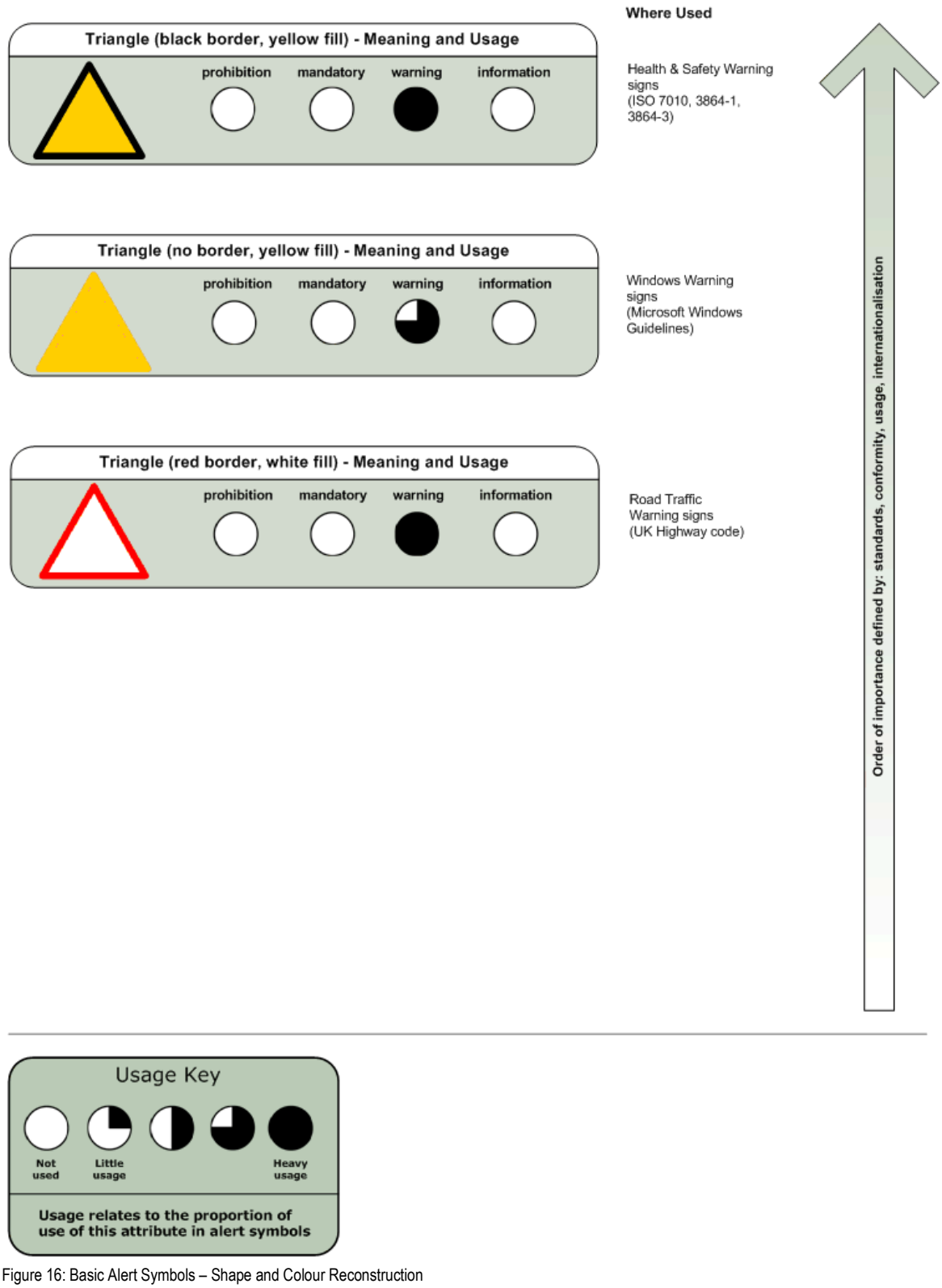
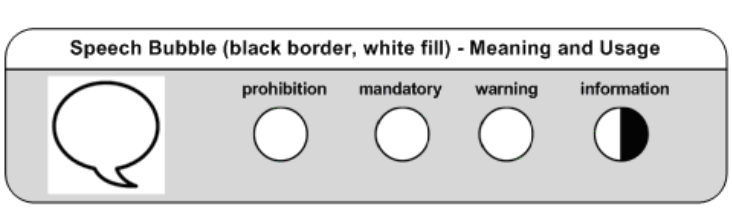


Figure 16: Basic Alert Symbols – Shape and Colour Reconstruction

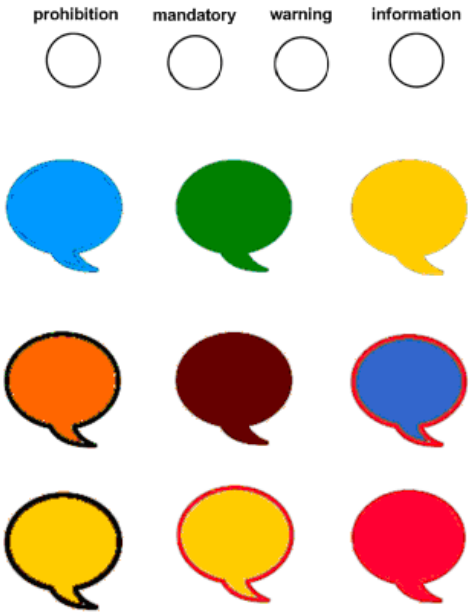


Where Used

Microsoft Windows
Alert messages

Other Speech bubble Combinations - Meaning and Usage

The following speech bubble combinations have no meaning within the context of alert symbols



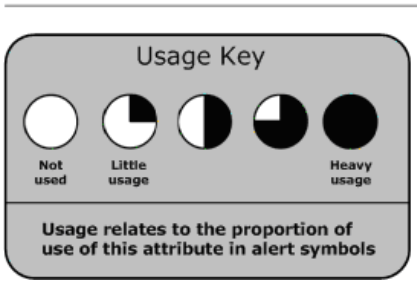


Figure 17: Basic Alert Shapes – Reconstruction (Image 1 of 3)

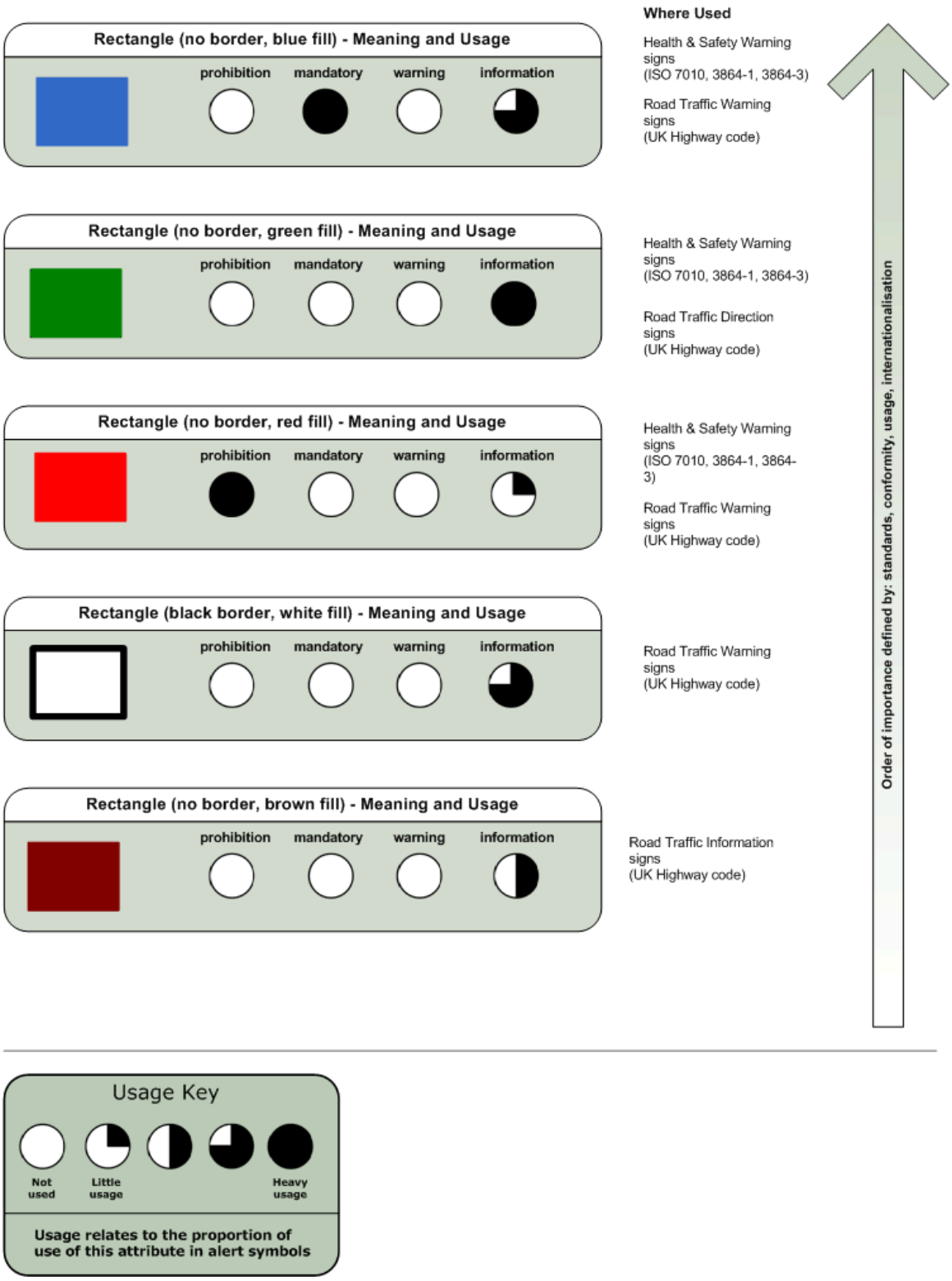
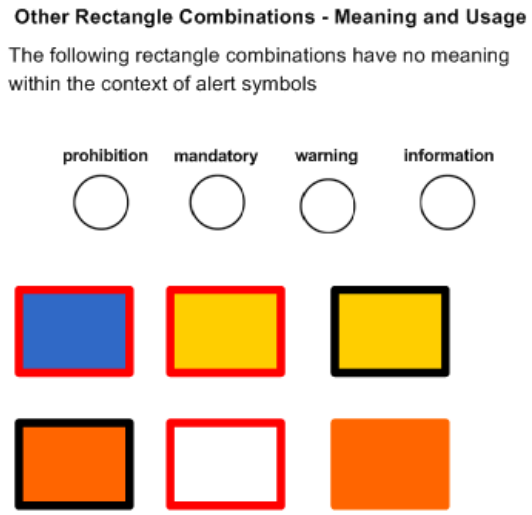


Figure 18: Basic Alert Shapes – Reconstruction (Image 2 of 3)



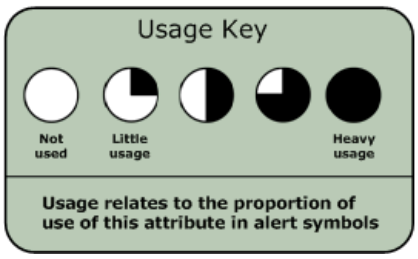
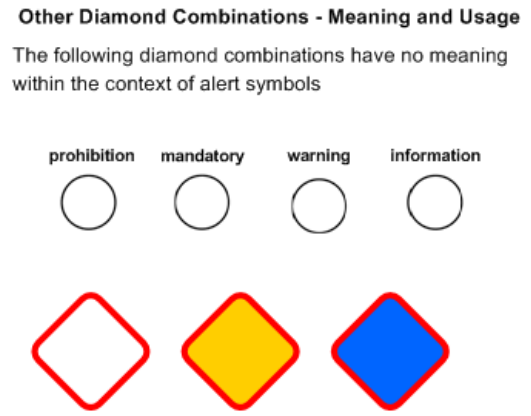


Figure 19: Basic Alert Shapes – Reconstruction (Image 3 of 3)



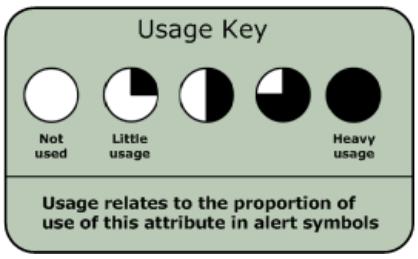


Figure 20: Basic Alert Symbols –Colour Combinations (Image 1 of 5)

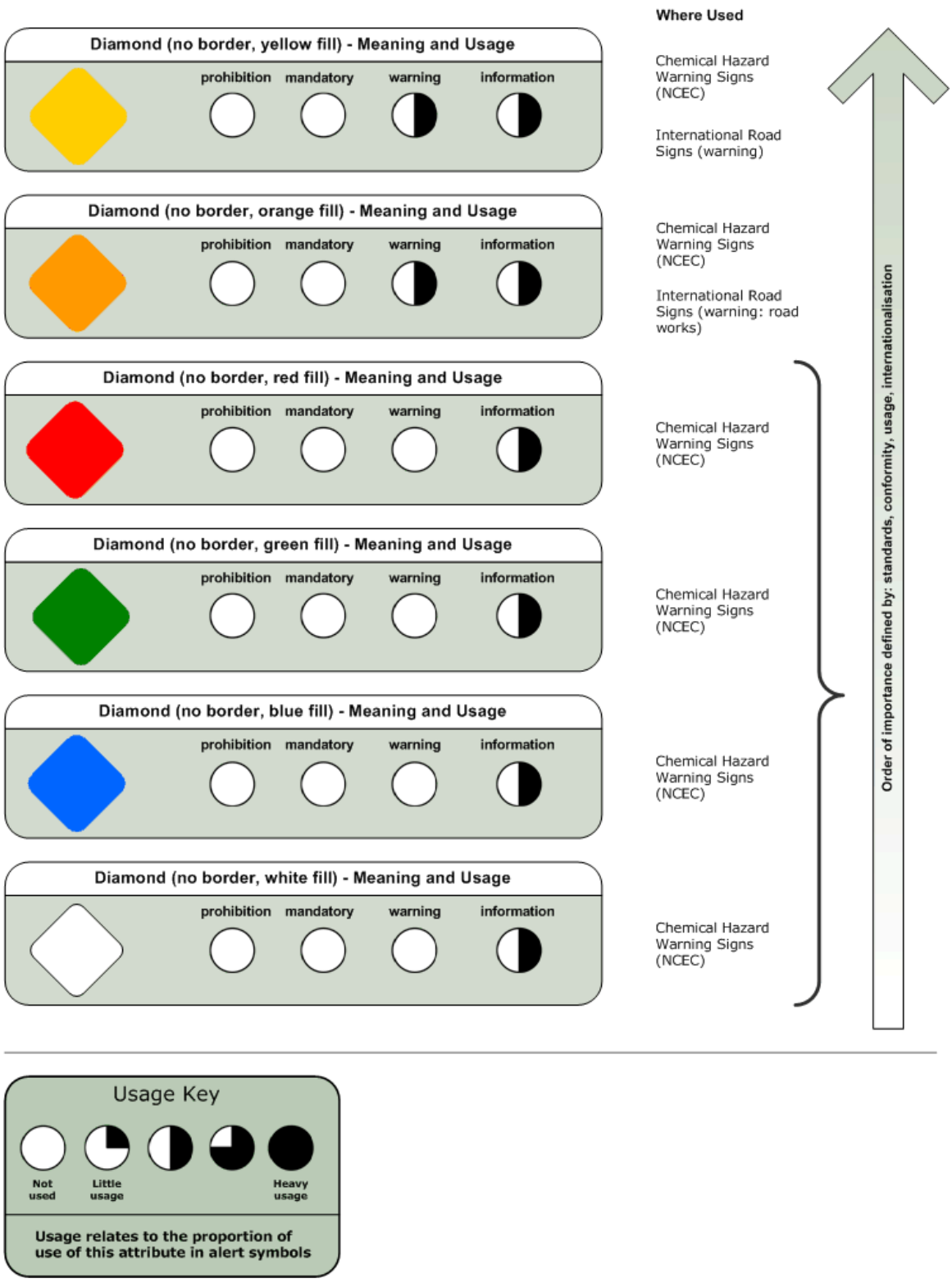
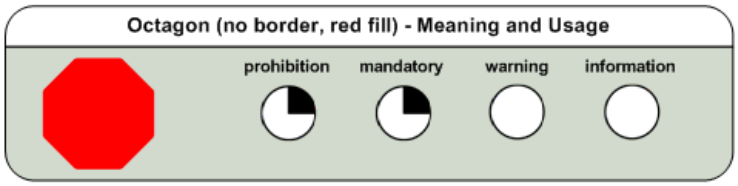


Figure 21: Basic Alert Symbols – Colour Combinations (Image 2 of 5)

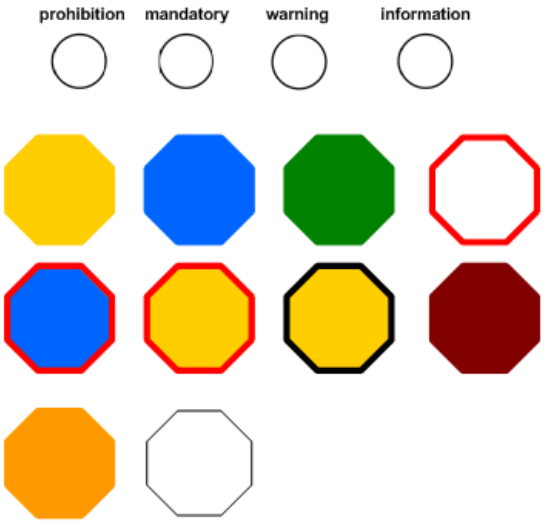


Where Used

Road Safety Signs
(UK Highway Code)

Other Octagon Combinations - Meaning and Usage

The following octagon combinations have no meaning within the context of alert symbols



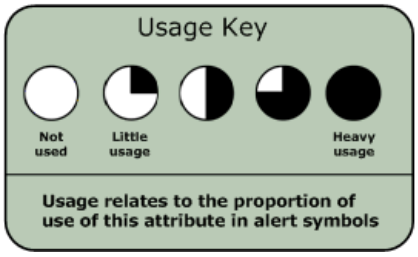


Figure 22: Basic Alert Symbols – Colour Combinations (Image 3 of 5)

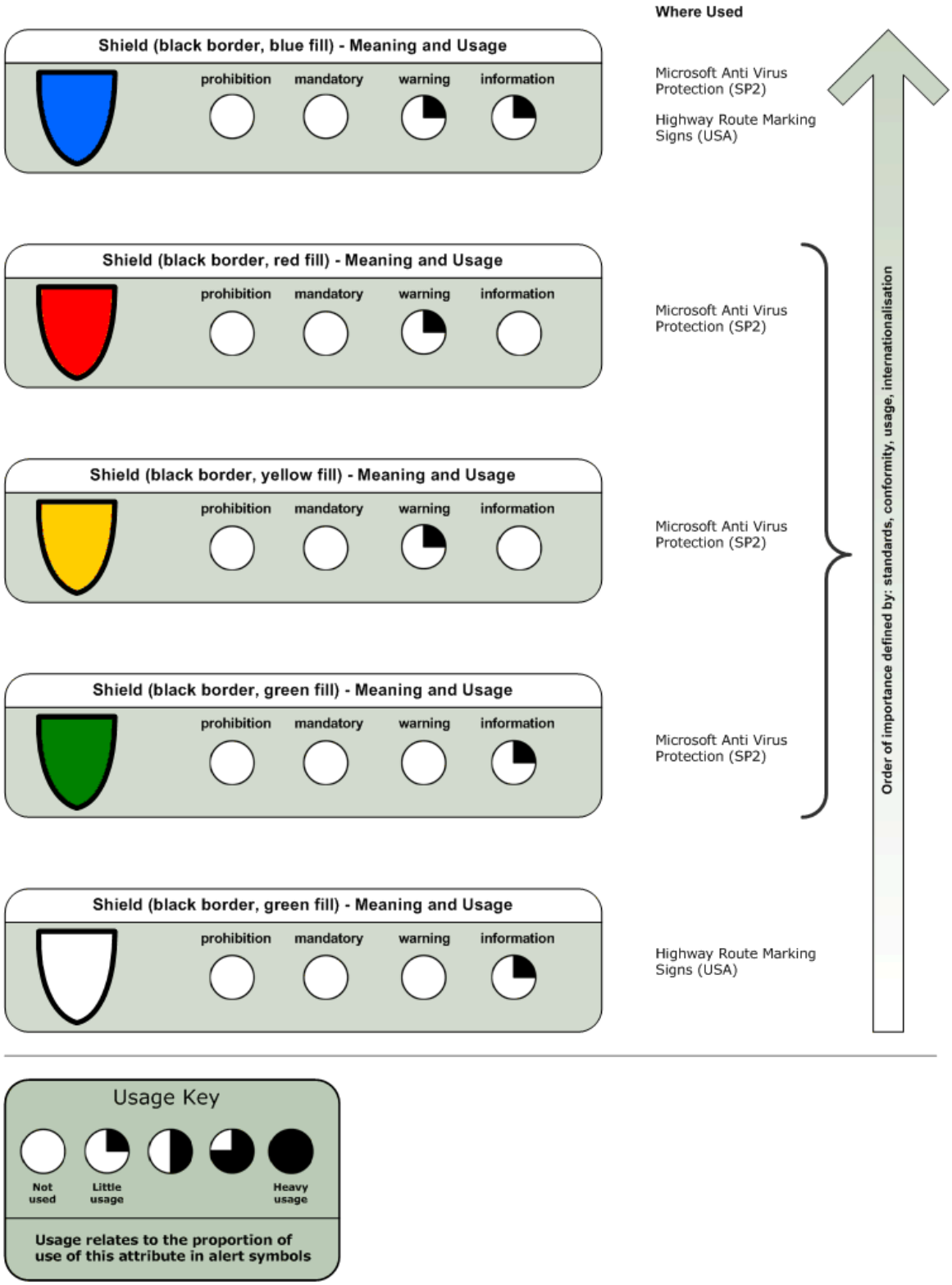
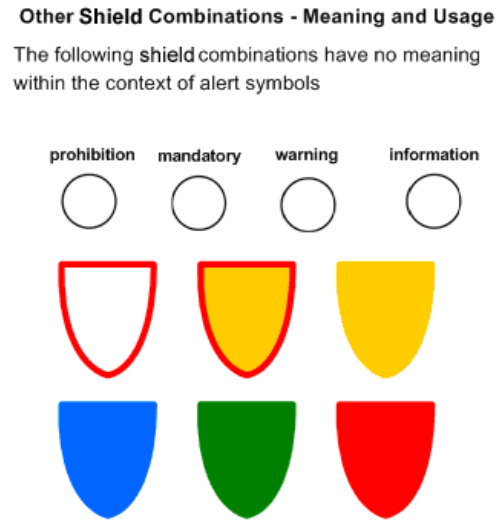


Figure 23: Basic Alert Symbols – Colour Combinations (Image 4 of 5)



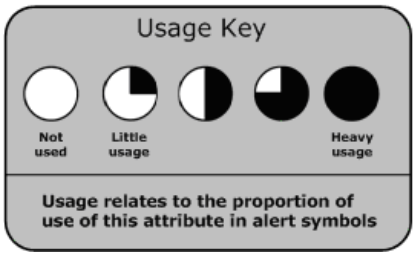


Figure 24: Basic Alert Symbols – Colour Combinations (Image 5 of 5)