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MSC.1/Circ.1609
14 June 2019

**GUIDELINES FOR THE STANDARDIZATION OF
USER INTERFACE DESIGN FOR NAVIGATION EQUIPMENT**

- 1 The Maritime Safety Committee (MSC), at its 101st session (5 to 14 June 2019), approved the *Guidelines for the standardization of user interface design for navigation equipment*, as set out in the annex, prepared by the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR), at its sixth session (16 to 25 January 2019).
- 2 MSC 95 instructed the NCSR Sub-Committee to develop guidelines on standardized modes of operation that would make a substantial contribution to enhance the safety and efficiency of marine navigation through the development of improved, harmonized and user-friendly bridge design.
- 3 The aim of these Guidelines is to promote standardization of user interfaces to help meet user needs. Improved standardization of the user interface and information used by seafarers to monitor, manage and perform navigational tasks will enhance situation awareness and improve safety of navigation.
- 4 These Guidelines apply to Integrated Navigation Systems (INS), Electronic Chart Display and Information Systems (ECDIS) and radar equipment, and they may be applied to other electronic navigation equipment, where applicable, to improve standardization and usability.
- 5 Member States and international organizations are invited to bring the Guidelines to the attention of all parties concerned.

ANNEX

GUIDELINES FOR THE STANDARDIZATION OF USER INTERFACE DESIGN FOR NAVIGATION EQUIPMENT

Introduction

1 These Guidelines apply to Integrated Navigation Systems (INS), Electronic Chart Display and Information Systems (ECDIS) and radar equipment. They may also be applied to other electronic navigation equipment, and navigation sensors, where applicable, to improve standardization and usability. The aim of the Guidelines is to promote standardization of user interfaces to help meet user needs. The Guidelines have been developed in close collaboration with an international association of equipment manufacturers to ensure its efficient implementation. The Guidelines also aim to leave room for future innovation and development while still addressing the primary user need for standardization and usability.

2 Improved standardization of the user interface and information used by seafarers to monitor, manage and perform navigational tasks will enhance situation awareness and safe and effective navigation.

Scope

3 These Guidelines stem from a compelling user need for greater standardization to enhance usability across navigation equipment and systems. Significant variation between systems and equipment produced by different manufacturers has led to inconsistency in the way essential information is presented, understood and used to perform key navigation safety functions. Improved standardization of navigation systems will provide users with more timely access to essential information and functions that support safe navigation.

4 While the operation of navigation equipment requires specialist training and familiarization, variations across different manufacturers' equipment for mandatory functions should be minimal. The application of these standardization principles enables users to locate and understand important information quickly and enhance all levels of situation awareness, such as perception, comprehension and projection of situation that will assist in the seafarer's decision-making process.

5 These Guidelines have been informed by research into human factors, cognitive science and human-centred design (HCD) as the findings stemming from this research have been seen to be advantageous and should be considered as part of system design (background information can be found in appendix 1). This is largely due to HCD affording users quicker and more efficient understanding and familiarization of new technology. Well conducted HCD can also result in error-tolerant systems that can reduce the complexity of tasks while increasing task support.

6 The standardization design principles for electronic navigation equipment are addressed within these Guidelines. The design principles have been applied in the development of the technical content provided in the appendices to these Guidelines. The appendices include:

- .1 default and user settings;
- .2 standardized terminology, abbreviations and icons for commonly-used functions (Hot Keys) and groups of functions (Shortcuts);

- .3 logical grouping of related information; and
- .4 access requirements for essential information and functions.

7 There are a number of IMO instruments and other international standards that deal with system design and information portrayal. These Guidelines build on such standards. A list of relevant references used and/or consulted during the drafting of these Guidelines is provided in paragraph 21.

Definitions

8 This section provides definitions relevant to these Guidelines.

- .1 **Standardization design principles:** a set of general rules that encapsulate human abilities, characteristics and limitations to the design of a ship navigational user interface.
- .2 **Standardization:** in the context of these Guidelines, means the achievement of the optimum degree of order in the user interfaces provided by different equipment manufacturers for essential navigation functions and information. The optimum degree of order is that required for safe and efficient navigation, and to minimize the variation and complexity of navigation equipment for the user.
- .3 **User interface:** all components of an interactive system (software and hardware) that provide information and controls for the user to accomplish specific tasks using the interactive system.
- .4 **Testing:** testing to be carried out by system designers and/or manufacturers to ensure compliance with these Guidelines.

User needs

9 These Guidelines have been developed for the equipment manufacturer but are driven by the needs of seafarers. They are focused on standardization of user interfaces provided for INS, ECDIS, radar and other relevant equipment where applicable, whether the equipment is stand alone or part of a mixed/integrated solution.

10 Large variations in the user interfaces of electronic equipment can significantly inhibit an operator's effectiveness in performing navigational tasks. Where there is significant variation in buttons, icons, actions, workflows, processes, units of measure or location of information, there is a commensurate increase in the time required for equipment familiarization and the risk of operational error, particularly in challenging navigational situations. Users need to be better able to accumulate knowledge, skills and experience of using essential functions, which can be transferred between the systems and equipment of different manufacturers. To achieve this, essential functions and information needs to be located in consistent locations, be of a similar size, recognizable by location, colour and shape. Units of measurement should also be consistent.

11 Feedback from users and research indicates that users benefit from standardization, which provides for effectiveness, efficiency and satisfaction for the user, and supports overall system safety. This provides the navigation equipment user with an opportunity to transfer skills gained through experience between systems and equipment. Deck officers surveyed on

the usefulness of standardization stated that they believed it was a necessary safety measure especially when applied to navigational equipment.

Standardization design principles

12 User feedback and testing have been used to develop a set of design principles, adapted from commonly recognized user interface design heuristics. These principles align with the navigation equipment users' need for greater standardization. They could be applied to future design processes for electronic navigation equipment and to test conformance with these Guidelines.

13 Vast amounts of information is made available to the user of electronic navigation equipment. To a large extent, the safe navigation of a ship depends on a user's ability to identify, understand and interpret essential information, in order to perform navigation functions. Good decision-making depends on the effective and efficient use of essential information from across different pieces of equipment. Different manufacturers often produce these different pieces of equipment. The use of standardization design principles across key systems and equipment will improve design consistency, reduce head down time, increase situation awareness, and provide users with more time to look out, evaluate situations and monitor a ship's safe navigation.

14 Users generally follow a common, but often undocumented, workflow for the functions associated with their role. Standardization of information and the way it is presented makes this task easier. As an example, the standardization of essential information for navigational tasks means that the user can easily comprehend information across different navigation systems and equipment. Greater usability can reduce the workload and simplify the process, which increases efficiency and effectiveness.

15 The following principles were applied when designing the appendices to these Guidelines:

- .1 Consistency has been identified as the most significant standardization design principle. The use of consistency throughout the design process increases usability. The findings of user feedback and system testing can be used to identify areas where further consistency can enhance standardization:
 - .1 Standard vocabulary – which should be in accordance with the STCW Code, and appropriate IMO Model Courses terminology. Consistency in naming, in conjunction with (2), (3) and (4) (see below), will aid search and identification. The naming protocol should be based on the needs of seafarers. Functions related to mandatory tasks should follow a standardized naming convention whereby the function name is shared between systems (e.g. starboard and port, not right and left).
 - .2 Standard symbols and icons – Many function-related icons vary across different navigation equipment and between manufacturers. Appendix 2 provides information on icons, symbols and abbreviations that require standardization. Consistency enables recognition and detectability across the user interfaces of different navigation systems.

- .3 Patterns, grouping – Humans react positively to patterns and logical groups of items, and use categories to search for individual bits of information. User testing can identify groupings and patterns of information that should be prioritized for consistency. Patterns incorporate the way in which someone uses information and the types of information that are grouped together.
- .4 Standard location – The search for information when monitoring can be greatly improved through the use of consistent location, which when coupled with consistent grouping greatly speeds up searches and contributes to recognition. User testing can identify high frequency use areas that may be places and locations on a display screen requiring standardization. Colocation of related essential information is beneficial.
- .2 Recognition – Using location and grouping for consistency provides for recognition. Human perception and search works faster with cues than complete recall, especially when aided by consistency. The user must recognize where information is or how to perform a process. In performing functions, the user should not need to recall where something is located or the process for doing something. This is the ability for the user to recognize an event, process or information flow rather than recall the detail of how to get to that point. This is integral to usability.
- .3 Frequency of use – Sorting, grouping and locating of information according to frequency of use increases efficiency. This principle requires that the user can access those tasks that they frequently use. It includes the application of "hot keys", and single operator actions.
- .4 Visibility of system status – The integration of humans and technology to support the ability to work as a team relies on their being able to identify system status. System status provides confidence in the validity of information, and the performance of navigation equipment and sensors. Knowing the system status includes visibility of "processing" information and the correct functioning of system sensors to illustrate degraded information.
- .5 Projection to the real world – There are two elements to projecting to the real world.
 - .1 Whenever possible use images or wording that is contextually related to the task. This is applicable to the interaction with the user interface, for example when increasing a number, twist a dial and show increase as "up".
 - .2 Geolocation of information to provide a linkage, or correlation, between the user, electronic equipment and the real world relative to the ship promotes correlation of information. When combined with recognition, the user intuitively links displayed information with physical reality. In other words, what appears on the visual displays in terms of location and information is in accord with the seafarer's understanding of where they are.

- .6 Prevent errors, emergency exit – Continuous testing during development will identify possible error paths that can be removed. Users should be aware of how to navigate back to the start of a process and also be aware of where they are in that process. The user should always be able to see navigation critical information even if layers of information are interlaid with the ENC/radar.
- .7 Help functions – Design help functions embedded within systems to be logical, task focused, user friendly, easily accessed and understandable. For example, where a user puts the cursor or marker on a specific icon, the meaning of the icon may be automatically displayed to help the user. To assist and help the user, technologies such as interactive learning of a task and use of videos could be implemented into the system.

User interface design standardization for navigation equipment maintenance

16 Equipment standards inevitably evolve to give improved functionality and safety, led by a mixture of regulatory, commercial and user requirements. Fundamental changes to requirements can be prompted by new developments in affordable technology. Ever-evolving practices to achieve better human cognition should play a major part in equipment changes. All are assisted by the continuing rise in affordable computing power and sophisticated software development. This evolution is a primary reason behind differences in the user interfaces of equipment fitted to different ships – bridge equipment typically has a very long in-use life and so newer and older equipment can become quite different to use.

17 Such continuing evolution of concepts and technology makes it inevitable that the requirements of the Guidelines will also need to evolve:

- .1 to allow users to have ready and common access to new sources and types of data and to assimilate them into the total navigational situation; and
- .2 to incorporate improving concepts for the human assimilation and integration of all data.

18 The implication is that systems compliant with the Guidelines need to have their software readily and safely updateable, in accordance with the *Procedures for updating shipborne navigation and communication equipment* (MSC.1/Circ.1389).

Conformance

19 Conformance with appendices 2 to 5 of these Guidelines satisfies the requirements for meeting the standardization design principles and human-centred design. User feedback testing is recommended to confirm conformance with these Guidelines.

20 Conformance with appendices 2 to 5 of these Guidelines is demonstrated by meeting the applicable requirements of the *Performance standard for the presentation of navigation-related information on shipborne navigational displays* (resolution MSC.191(79)) and IEC 62288.

Relevant references

21 References used or consulted in the drafting of these Guidelines are as follows:

IMO references:

- .1 Resolution MSC.191(79), as amended – *Performance standards for the presentation of navigation-related information on shipborne navigational displays*
- .2 Resolution MSC.192(79) – *Adoption of the revised performance standards for radar equipment*
- .3 Resolution MSC.232(82) – *Adoption of the revised performance standards for Electronic Chart Display and Information Systems (ECDIS)*
- .4 Resolution MSC.252(83) – *Adoption of the revised performance standards for Integrated Navigation Systems (INS)*
- .5 Resolution MSC.302(87) – *Adoption of performance standards for bridge alert management*
- .6 MSC/Circ.982 – *Guidelines on ergonomic criteria for bridge equipment and layout*
- .7 MSC.1/Circ.1389 – *Procedures for updating shipborne navigation and communication equipment*
- .8 MSC.1/Circ.1512 – *Guideline on Software Quality Assurance and Human-Centred Design for e-navigation*
- .9 MSC.1/Circ.1575 – *Guidelines for Shipborne Position, Navigation and Timing (PNT) data processing*
- .10 MSC.1/Circ.1593 – *Interim guidelines for the harmonized display of navigation information received via communication equipment*
- .11 SN.1/Circ.243/Rev.2 – *Guidelines for the presentation of navigational-related symbols, terms and abbreviations*
- .12 SN.1/Circ.265 – *Guidelines on the application of SOLAS regulation V/15 to INS, IBS and bridge design*

ISO/IEC standards:

- .13 ISO 9241-110:2006 Ergonomics of human-system interaction – Part 110: Dialogue principles
- .14 ISO 8468:2007 Ships and marine technology – Ship's bridge layout and associated equipment – Requirements and guidelines
- .15 ISO 9241-210:2010 Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems

- .16 ISO 20282:2006 Ease of operation of everyday products – Part 1: Design requirements for context of use and user characteristics
- .17 ISO/TS 20282-2:2013 Usability of consumer products and products for public use – Part 2: Summative test method
- .18 IEC 61174:2015 Maritime navigation and radiocommunication equipment and systems – ECDIS
- .19 IEC 61924-2:2012 Maritime navigation and radiocommunication equipment and systems – INS
- .20 IEC 62388:2013 Maritime navigation and radiocommunication equipment and systems – Radar
- .21 IEC 62288: 2014 Maritime navigation and radiocommunication equipment and systems – Presentation of navigation-related information on shipborne navigational displays
- .22 IEC 61174:2015 Maritime navigation and radiocommunication equipment and systems – Electronic chart display and information (ECDIS)
- .23 IEC 60945:2002 Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results
- .24 ISO/IEC 25010:2011 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – System and software quality models
- .25 ISO/IEC 25060:2010 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Common Industry Format (CIF) for Usability – General framework for usability-related information
- .26 ISO/IEC 25062:2006 Software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Common Industry Format (CIF) for Usability test reports
- .27 ISO/IEC 25063:2014 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Common Industry Format (CIF) for Usability: Context of use description
- .28 ISO/IEC 25064:2013 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Common Industry Format (CIF) for Usability: User needs report
- .29 ISO/IEC 25066:2016 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Common Industry Format (CIF) for Usability – Evaluation Report

- .30 ISO/IEC Guide 2:2004 Standardization and related activities –
General vocabulary

IHO documents:

- .31 IHO S-52 Edition 6.1.1, June 2015, Specification for chart content
and display aspects of ECDIS

APPENDIX 1

INFORMATIVE APPENDIX ON HUMAN FACTORS RESEARCH SUPPORTING STANDARDIZATION DESIGN PRINCIPLES

Introduction

1 This appendix supports the *Guidelines for the standardization of user interface design for navigation equipment* by explaining the application of human factors and cognitive science during the design of navigation systems. This appendix also provides relevant information on human factors and human error and how they relate to system design. It also discusses human factors research relating to icons and display design, the presentation and processing of information and their effect on decision-making, the effects automation can have on human performance, and how a ship's systems, information displays and the human element form a distributed cognition team.

Human factors research

2 Display technology has markedly changed and improved, providing an operator with an array of multimedia formats for the presentation of information. The effective design of new types of work systems has required the application of knowledge regarding human information processing capabilities. This knowledge requirement has created a greater emphasis on the issues relating to human cognition, leading to an increased application of cognitive sciences, cognitive psychology and other discipline knowledge to the design of work environments.

3 Adding to the original complexity of this domain is the fact that most complex systems have multiple actors with multiple information requirements (e.g. a master, pilot, OOW, helmsman and look-out on the bridge of a ship entering a busy port).

4 Well-designed displays should provide support to the front-end of decision processes (e.g. to an operator attending to and evaluating whether a cue or piece of information is significant and salient, the operator then formulating a diagnosis and assessing the situation).¹ Therefore, the proximity of objects on a display screen becomes important to effective front-end decision-making. Display principles such as proximity and emergent features help ensure that sources of information that need to be integrated for the purposes of diagnosing a problem are displayed simultaneously (not sequentially) to ensure rapid processing with minimal effort.²

5 Well-designed systems have the propensity to support effective back-end decision-making as well. Decision processes from the back-end of the decision cycle concern the culmination in a final decision given information processing and the response to the situation presented. Examples of back-end processes can include retrieving an appropriate course of action from memory, locating a prescribed response in the appropriate manual or procedures, adapting a known response to the specific demands of the current situation, mentally simulating a possible response, planning a sequence of actions or evaluating alternatives.³

¹ Mosier, K.L., and Fischer, U.M. (2010). Judgment and decision making by individuals and teams: Issues, models, and applications. *Reviews of Human Factors and Ergonomics*, 6, pp.198-256.

² Wickens, C.D., and Carswell, C.M. (1995). The proximity compatibility principle: Its psychological foundation and relevance to display design. *Human Factors*, 37, pp.473-494.

³ Mosier & Fischer (2010) p.202.

6 From a human-centred perspective, one of standardization's principal benefits, if designed and implemented properly, is in the reduction of the user's physical and mental workload. Reduction in mental workload has been identified as beneficial in areas such as decision choice (e.g. high-risk decision-making under conditions of uncertainty in unfamiliar situations), and information acquisition and analysis (e.g. the cost of scanning a cluttered display for information or mentally adding two numbers).

Icon usability

7 A great deal of research has been conducted to identify the factors that are important in determining the usability of icons. An examination⁴ of icon recognition tasks identified the following effects:

- .1 The extent to which an icon depicts a real-life object as opposed to a more abstract representation denotes its concreteness. Although a very important usability trait for when an icon is unfamiliar, concreteness effects diminish over time as an operator gains experience. Therefore, an icon should be designed to be as concrete as possible to provide heightened usability for novice operators. Usability testing is very important for determining the transferability of these types of icons.
- .2 An icon's level of detail or intricacy is defined as its visual complexity. A seafarer will be able to infer meaning from an icon more quickly if it depicts a real-life object in detail. This is due to the seafarer's understanding of the object via their pre-existing knowledge. Increased detail in icons also increases visual search times, even following considerable training. Icons should represent, as far as practical, the real-life object while taking into account that less detailed icons decrease visual search times. Icons should be designed to look like the objects, processes, or operations they represent, by use of literal, functional or operational representations.
- .3 How close the relationship is between the icon and its meaning is termed its semantic distance. Semantic distance has been shown to be an important determinant of novel icon usability.
- .4 A user's level of experience with the object depicted and the icon itself denotes its familiarity. Familiarity is as important an effect on icon usability as semantic distance but has been found to be longer lasting, due mainly to an individual's experience level with an object coming via access to long-term memory.

Information location

8 Good display design follows the principles that provide for global or holistic information processing. This type of processing reduces the attentional demand on the individual because it is preattentive (e.g. organized into objects or groups of objects) and automatic. This lowering of attentional demand (and therefore the lowering of fatigue-inducing attentional effort) will occur under two conditions. First, Gestalt principles, such as proximity and symmetry, and other attention principles, such as redundancy (e.g. knowing where one item is will lead the operator to look for a similar or related item in the same location) should be used to produce groupings of display icons and readout information (e.g. course, heading, speed, etc.). Second, the organization formed by the spatial proximity of differing elements on a navigation display

⁴ Isherwood, S.J., McDougall, S.J.P., and Curry, M.B. (2007). Icon identification in context: The changing role of icon characteristics with user experience. *Human Factors*, 49, pp.465-476.

must be compatible with the physical entities they represent, and the seafarer's mental representation of those entities.⁵

9 For example, the essential information available to the navigator from an ECDIS display should be easily accessed, easily cognitively processed and expected. Then, it can be combined with what is observed out of the bridge window, the environmental conditions and other available information, to build a mental model of where the ship is and where it is heading – in other words, the navigator's situation awareness. By applying proven display design principles to the proximity, redundancy and grouping of icons and information readouts on the ECDIS or radar equipment display, their mental model, and thus their situation awareness, will be enhanced.

10 When the seafarer needs to take information from two or more information sources but they are required to be mapped onto a single task, the information needs to be mentally integrated.

11 The designer has several ways to manipulate display proximity to help this cognitive activity take place. Display proximity can be improved by placing readouts closer to each other on the screen and thus reducing cognitive effort in the act of integration. This same effect can be achieved through using similar-coloured objects, cognitively linking two objects by drawing a line between them or abutting two objects.

12 Research has shown that the closer the proximity of two objects in a display, the better the seafarer's performance in integrating the information provided by the two objects. However, there will also be a higher likelihood that performance will be disrupted on a focused attention task. If a seafarer needs to focus on a readout in a display and another readout or object is too close, it can act as a distractor and slow their information processing. This has been identified as a property of display clutter and this type of minimal separation or partial masking of one item over another has been seen to be a design issue.⁶

Distributed cognition

13 The function of display icons and information is to enhance team situation awareness. A navigator will use the physical world, the ship's systems and members of the bridge team as sources of information and as extensions of their own knowledge and reasoning systems. They can operate as a type of distributed intelligence where much of their intelligent behaviour results through the interaction of cognitive processes with bridge systems and the environment outside the bridge window. Researchers have found that cognition may not necessarily be confined to an individual's grey matter.⁷

⁵ Wickens, C.D., Hollands, J.G., Banbury, S, and Parasuraman, R. (2013). *Engineering psychology and human performance, 4th Edition*. Abingdon, UK: Routledge.

⁶ Wickens and Carswell, (1995).

⁷ Norman, D.A. (1993). *Things that make us smart, defending human attributes in the age of the machine*. New York: Basic Books; Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA: MIT Press.

14 The information and knowledge required to complete tasks is available in the systems, resources, environment and other individuals they have at their disposal – whether these artefacts are collocated, transmitted via voice/text or viewed on a high definition display. When a seafarer's intellect is tightly coupled to their windows on the world (e.g. their displays, their automation, the symbols and icons that access the information they require and the bridge window), decision-making and action can take place within the context established by the physical environment, where the structures put in place can often take some of the memory and computational burden off the human.

Projection to the real world

15 Sound navigational principles have been built on using a chart oriented to North up. Information processing research and literature related to chart orientation has shown that a seafarer may find navigational performance improvements by using a chart which is oriented to the direction of travel (e.g. Heading or Course up). When a frame of reference is not aligned (i.e. what is seen out the window is not a direct representation of what they see on the chart – such as, they are heading south using a North-up chart), the seafarer will need to mentally transform their frame of reference. Research indicates that this requires cognitive processing and an increase in mental workload, which may increase the likelihood of errors. Thus, a frame of reference transformation from true to relative reference of a situation can have an impact on human performance.

16 If the chart is an electronic display and can automatically rotate in the direction of travel (e.g. "track up" or "heading up"), mental rotation effort is minimized because text and symbols will rotate too, however, three other human performance costs may be encountered:

- .1 It becomes more difficult for a user to build a mental model (or an "understanding") of the environment. Research has shown people are less able to reconstruct the environment after having operated with a rotating chart.
- .2 There are substantial individual differences in mental rotation ability. Some people will have no difficulty navigating with a north-up chart, with minimal human performance costs in maintaining an awareness of the greater spatial environment.
- .3 When communication is required between operators (e.g. between ships, and ship to shore, such as VTS) who may not share the same momentary frames, world referenced (exocentric or north-south-east-west) language is more universal and less ambiguous than relative referenced (port, starboard, ahead and astern) information. It is for these reasons that electronic charts with a fixed north-up orientation mode are included as a standard.⁸

17 The ability to orient to head or course up provides a benefit to navigation in some situations (i.e. operating at high speeds or in littoral waters), but primacy of a North-up chart orientation is in keeping with the fundamental principles of navigation. Future research in this area is required to ascertain whether training in the use of head up/course up charts in conjunction with North-up charts can provide improved navigational performance.

⁸ Wickens, et al. (2013).

Human factors methods for engineering and design

18 Navigational operators, who are the main users of navigational equipment, should find that their displays provide a natural and intuitive interface between the equipment, the tasks they need to perform and themselves. There are many comprehensive methods for measuring and evaluating the cognitive, ergonomic and organizational elements of system design and manufacture. Research into such areas as human capabilities and limitations, human-machine interaction, teamwork, interface design and organizational design spanning back over many decades has provided the evidence for the validity of these methods and they continue to be used widely. Evaluating new interface designs using the methods outlined in human factors references⁹ and ergonomic standards,¹⁰ in conjunction with the guidance of a human factors/ergonomic expert/practitioner, is recommended.

⁹ Stanton, N.A. et al. (2005). *Human Factors and Ergonomic methods*. London: Taylor and Francis. Stanton, N.A. et al. (2005). *Human Factors methods: A practical guide for engineering and design*. Farnham, Surrey: Ashgate Publishing.

¹⁰ For example: ISO 9241-5:1998 Ergonomic requirements for office work with visual display terminals (VDTs) – Part 5: Workstation layout and postural requirements. ISO 10075-1:2017 Ergonomic principles related to mental workload - Part 1: General issues and concepts, terms and definitions. ISO 10075-2:1996 Ergonomic principles related to mental workload – Part 2: Design principles. ISO 10075-3:2004 Ergonomic principles related to mental workload – Part 3: Principles and requirements concerning methods for measuring and assessing mental workload.

APPENDIX 2

NAVIGATION-RELATED TERMINOLOGY AND ICONS OF FUNCTIONS (HOT KEYS AND SHORTCUTS)

Introduction

1 This appendix identifies commonly-used functions on navigation equipment and for each function specifies the associated terminology, abbreviation and (where appropriate) icons. These terms, abbreviations and icons, if available, are recommended to be used for the display of navigation-related information, to promote consistency of presentation across navigational equipment.

2 Where icons, terms and/or abbreviations are used, they must meet the requirements of this appendix. Where a standard term, abbreviation, or icon is not available, another icon, term or abbreviation may be used, but these should not conflict with those listed in the appendix.

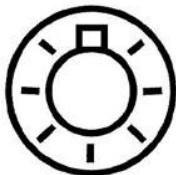
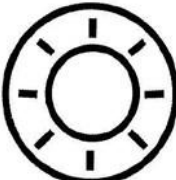
3 The icons specified may indicate a status, may execute a specific function (hot key), or may provide access to a group of related functions (shortcut).

4 Only the shape of the icon is specified; this appendix does not specify a colour scheme for icons, except for the icons depicted in colour in table 2 which should follow the IHO colour scheme or similar.

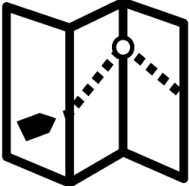
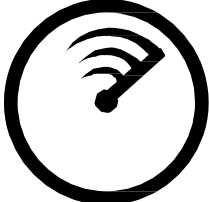


5 Where appropriate and practical, a brief explanation of the purpose of an icon should be easily obtainable by the user. This functionality should be able to be turned off easily by the user.

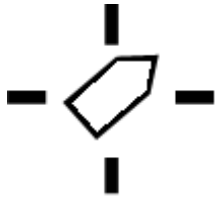
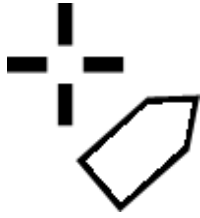
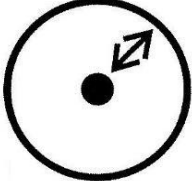
Icons and terminology for functions (hot keys)




Table 1: General navigation functions


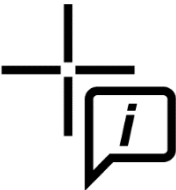

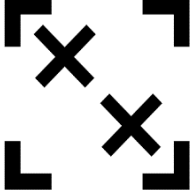

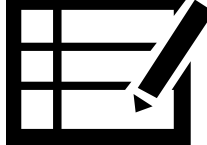
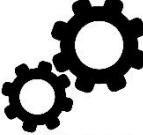
Explanation	Term	Abbreviation	Icon (hot key)
To set panel illumination	Panel illumination	PANEL	 11
To set display brilliance	Display brilliance	BRILL	 11




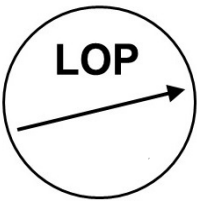

¹¹ The circles around the *Panel illumination* and *Display brilliance* icons are optional.

Explanation	Term	Abbreviation	Icon (hot key)
To select ECDIS mode (for multifunction displays)	ECDIS	ECDIS	
To select radar mode (for multifunction displays)	Radar	RADAR	
To select Conning display or to select "navigation control data" task of the INS (for multifunction displays)	Conning	CONN	
To select CAM-HMI as defined in Bridge Alert Management (BAM) (for example as required by INS)	CAM-HMI	CAM	
To select North Up display	North Up	N UP	N UP
To select Head Up display	Head Up	H UP	H UP
To select Course Up display	Course Up	C UP	C UP

Explanation	Term	Abbreviation	Icon (hot key)
To select True Motion mode	True Motion	TM	TM
To select Relative Motion mode	Relative Motion	RM	RM
To select ship centred Mode	Centred	CENT	
To select ship off centred Mode	Off centred	OFF CENT	
To perform True Motion reset	TM reset	TM RESET	TM RESET
To select range	Range	RANGE	
To perform range up (Radar) or to zoom in (ECDIS)	Up/In	+	+


















Explanation	Term	Abbreviation	Icon (hot key)
To perform range down (Radar) or to zoom out (ECDIS)	Down/Out	-	
To identify the "heading line" off position	Heading Line Off	HL OFF	
To toggle Range Rings on and off	Range Rings	RR	
To set Variable Range Marker	Variable Range Marker	VRM	<p style="text-align: center;">VRM</p>
To set Electronic Bearing Line	Electronic Bearing Line	EBL	<p style="text-align: center;">EBL</p>
To control simultaneous measurement of range and bearing	Electronic Range and Bearing Line	ERBL	<p style="text-align: center;">ERBL</p>
To perform Target Acquire	Acquire	ACQ	<p style="text-align: center;">ACQ</p>

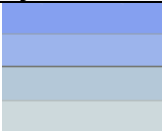
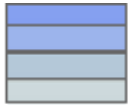













Explanation	Term	Abbreviation	Icon (hot key)
To perform selection (for example, target or chart object)	Select	SEL	
To call up the information associated with an object by cursor selection on its symbol	Info report	INFO REPORT	
To perform target cancellation	Cancel	CNCL	
To perform cancellation of all targets	Cancel all	CNCL ALL	
To acknowledge an alert	Acknowledge	ACK	ACK
To temporarily silence alerts	Silence	SLNC	
To record or log an event or occurrence	Record Event	REC EVENT	
Select default settings	Default settings	DFLT SET	 DFLT

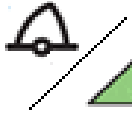











Explanation	Term	Abbreviation	Icon (hot key)
Select user settings	Select user settings	USR SET	
Save user settings	Save user settings	SAVE USR	
To select standard display for chart symbol	Standard Display	STND DISP	<p>STND DISP</p>
To execute Trial Manoeuvre	Trial manoeuvre	TRIAL	<p>TRIAL</p>
To toggle Day/Night/Dusk mode	Day / Night	DAY / NT	
To plot own ship position manually	Line of Position	LOP	
To toggle True/Relative Vector mode	True/Relative Vector	T/R VECT	<p>TRUE REL</p> 

Explanation	Term	Abbreviation	Icon (hot key)
Toggle On/Off AIS	Automatic Identification System contacts on/off	AIS	AIS
To "status and data display" tasks of the INS	Status and Data	STAT DISP	STAT DISP

Table 2: Control of chart display functions

Explanation	Term	Abbreviation	Hydrographic symbol	Icon (hot key)
To show accuracy related symbols	Accuracy	CATZOC		
Selector for viewing group layer	All isolated dangers	ISODNG		
	Archipelagic sea lanes	ASL		
	Boundaries and limits	BNDLIM		BND LIM
	Buoys, beacons, aids to navigation	ATON		
	Cautionary notes	CTNNTE		
Chart boundary shown	Chart boundary	CHTBND		
Selector for viewing group layer	Chart scale boundaries	CHTSCA		
To show contour labels	Contour label	CNTLBL		
Deep contour	Deep contour	DEEPCNT		DEEP CNT
Selector for viewing group layer	Display base	DISPBASE		DISP BASE

Explanation	Term	Abbreviation	Hydrographic symbol	Icon (hot key)
Use four shades	Four shades	4SHADE		
Selector for full light sector lines	Full light lines	FULLSEC		
Show date dependent object	Highlight date dependent	DATEDEP		
Show symbol for INFORM and NINFOM	Highlight info	INFHLT		
Show symbol for TXTDSC, NTXDS and PICREP	Highlight document	DOCHLT		DOC HLT
Selector for viewing group layer	Important text	IMPTXT		IMP TXT
	Other text	OTHTXT		OTH TXT
	Magnetic variation	MAGVAR		
	Miscellaneous	MISC		MISC
Show national language NOBJNM, text group 2	National language	NATLANG		
Selection for point object style	Paper chart symbols	PAPERSYM		

Explanation	Term	Abbreviation	Hydrographic symbol	Icon (hot key)
	Simplified symbols	SIMPSYM		
Selection for line style	Plain boundaries	PLNBND		
	Symbolized boundaries	SYMBND		
Selector for viewing group layer	Prohibited and restricted areas	PRBAREA		
Selector for viewing group layer	Drying line	DRYLNE		DRY LNE
To select safety contour	Safety contour	SF CNT		SAFE CNT
Shallow contour	Shallow contour	SHAL CNT		SHAL CNT
Depths in safety area shown, soundings in safe area shown	Safe depths shown	SF DPTH SHOW		DPTH SHWN
To select safety depth	Safety depth	SF DPTH		SAFE DPTH
To turn SCAMIN off	Scale min	SCAMIN		SCA MIN
Selector for viewing group layer	Seabed	SEABED		SEA BED
To show shallow pattern	Shallow pattern	SHALPAT		














Explanation	Term	Abbreviation	Hydrographic symbol	Icon (hot key)
To show isolated dangers in shallow waters	Shallow water dangers	SHALDNG		
Selector for viewing group layer	Ships' routeing systems and ferry routes	ROUTEING		
	Spot soundings	SPOTSND	1g	1g
	Submarine cables and pipelines	SUBCAB		
	Tidal	TIDAL		
	Two shades	2SHADE		
Selector for displaying unknown objects	Unknown	UNKNOWN		
To highlight objects which have undergone modification	Update review	UPD REV		UPD REV

Table 3: Control of chart functionality


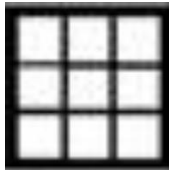
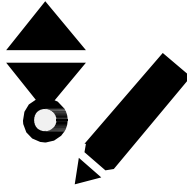



Explanation	Term	Abbreviation	Icon (hot key)
To select a date or date range for displaying all chart objects active at that date and time	Dated Objects	DATE OBJ	
To toggle latitude/longitude grid	Grid	GRID	
To perform manual update	Manual update	MAN UPD	
To toggle radar overlay	Radar overlay	RADAR OVR	

Table 4: Database functions

Function*	Term	Abbreviation	Icon (Hot Key)
To import ENC	Import Chart	IMPORT CHT	Not applicable
To review ENC updates	Update review	UPD REV	Not applicable
To view ENC update summary report	Update summary	UPD SUM	Not applicable
To view graphical index of ENC charts	Graphical index	GRAPH INDX	Not applicable
To view ENC update log	Update log	UPD LOG	Not applicable
To view ENC Update Status Report	ENC Update Status Report	ENC UPD STATUS	Not applicable
To view ENC Management Report	ENC Management Report	ENC MGMT REP	Not applicable









* Some of these functions may also apply to RNC.


Table 5: Route plan and monitoring functions

Function	Term	Abbreviation	Icon (Hot Key)
To export route plan	Export Route	ROUTE EXP	
To import route plan	Import Route	ROUTE IMP	
To set own-ship look ahead	Own ship look-ahead	LOOK AHEAD	Not applicable

Icons and terminology for groups of functions (shortcuts)

Table 6: Groups of functions

Group of functions	Term	Abbreviation	Icon (shortcut)
To set collision avoidance limits and other target-related parameters (including CPA, TCPA, etc.)	Target settings	TGT SET	 TGT
To set radar controls (including tunings, anti-clutter, etc.)	Radar settings	RADAR SET	 RADAR
To set chart related limits and other chart-related parameters (including safety contour, safety depth, areas with special conditions, own ship check area, etc.)	Chart safety settings	CHT SF SET	 CHART
To set trial manoeuvre parameters	Trial Settings	TRIAL SET	 TRIAL
To add or remove information from the ECDIS display	Chart display settings	CHT DISP SET	
To provide additional mariner's information	User Chart	USR CHT	 USER
To access route plan functionality	Route plan	ROUTE PLAN	 PLAN
To access route monitoring functionality	Route monitoring	ROUTE MON	 MONIT

Group of functions	Term	Abbreviation	Icon (shortcut)
To access management chart database	Chart management	CHT MGMT	CHT MGMT
To access alert setting management	Alert Setting	ALERT SET	 ALERT

APPENDIX 3

LOGICAL GROUPING OF INFORMATION

Introduction

1 This appendix defines groups of related navigational information that should be displayed together on the user interface, to enable the user to quickly locate and react to essential navigation information, if available on the screen. This appendix applies to radar equipment, ECDIS and minimum INS functions as defined in resolution MSC.252(83). It may be applied to other electronic navigation equipment and navigation sensors where applicable, to improve standardization and usability.

2 This appendix does not specify where the groups of information should appear on the screen, or the order in which the individual information elements should be grouped. The groups of related navigational information presented on the user interface are not limited to the information listed in this appendix. They may be extended by associated information. These groupings apply to both mandatory and non-mandatory information.

Groups of information

Ownship

HDG: <value> <unit> | <sensor source/ status>
COG: <value> <unit> | <sensor source/ status>
SOG: <value> <unit> | <sensor source/ status>
STW: <value> <unit> | <sensor source/ status>
Position (Optional) <LAT value> | <LON value> | <Sensor source and status>

Date and Time

<Date> | <Time> | <time reference>
<Date> | <Time> | <UTC>

Target Information

Target Number/ Identifier <1234>
Target Name <Alphanumeric>
COG: <value> <unit>
SOG: <value> <unit>
STW: <value> <unit> >
Closest Point of Approach (CPA): <value> <unit>
Time to Closest Point of Approach (TCPA): <value> <unit>
Bearing from Ownship: <value> <unit>
Range from Ownship: <value> <unit>

Measurement Info

EBL bearing: <value><unit>
VRM range: <value><unit> >

Route

Route Name: <RTE Name>
Next Waypoint Number/ Name: <WPT name>
Distance to "TO-WPT": <value> <unit>
Bearing to "TO-WPT": <value> <unit>
Time to go to "TO-WPT": <value> <unit>
Estimate time of arrival: <value> <unit> <time reference>
Next course: <value> <unit>
Current Cross Track Distance: PORT <value> <unit> Or STBD <value> <unit>
Cross track Limit Current Leg: PORT <value> <unit> STBD <value> <unit>

Cursor Location

Position <LAT value> | <LON value>
Bearing from Ownship: <value> <unit>
Range from Ownship: <value> <unit>

APPENDIX 4

LIST OF FUNCTIONS THAT MUST BE ACCESSIBLE BY SINGLE OR SIMPLE OPERATOR ACTION

Introduction

1 Where the equipment provides the functions listed in the tables below, access should be as defined as in the tables. A requirement for information to be presented on single operator action may alternatively be met by a permanent indication.

- .1 **Single operator action** is defined as "A procedure achieved by no more than one hard-key or soft-key action, excluding any necessary cursor movements, or voice actuation using programmed codes."
- .2 **Simple operator action** is defined as "A procedure achieved by no more than two hard-key or soft-key actions, excluding any necessary cursor movements, or voice actuation using programmed codes."

(Both definitions taken from resolution MSC.252(83)).

2 Care will need to be taken when adding single and simple operator action buttons to displays. The manufacturer/operator should consider keeping the display area clear of clutter for the main function of the equipment as much as possible for user operability. It may be more useful to contain shortcut buttons under one setting menu rather than add many icons to the desktop.

Table 1: Access to existing functions already defined
(IEC 62388:2012, IEC 62288:2014, IEC 61174:2015)

Function	Equipment	Access
Select ECDIS standard display	ECDIS	Single operator action
Remove radar (image and tracked target), AIS and other target information overlaid over the ENC chart	ECDIS	Single operator action
Select route monitoring display covering own ship's position	ECDIS	Single operator action
Select default ECDIS settings	ECDIS	Single operator action followed by an action to confirm the selection
Select AIS target information	Radar/ECDIS	Simple operator action
Remove chart data	Radar	Single operator action
Reset VRM origin to CCRP	Radar/ECDIS	Simple operator action
Reset EBL origin to CCRP	Radar/ECDIS	Simple operator action
Reset ERBL origin to CCRP	Radar	Simple operator action
Reset parallel index line to own ship's heading	Radar	Simple operator action

Function	Equipment	Access
Remove user defined maps	Radar	Simple operator action
Select default radar settings	Radar	Single operator action followed by an action to confirm the selection
Select presentation mode (radar, chart and other navigation information)	Radar/ECDIS	Simple operator action
Remove AIS Area Notice	Radar/ECDIS	Simple operator action
Remove additional information, including information for route planning, route monitoring, information overlays and supplementary navigation tasks	Radar/ECDIS	Simple operator action

3 The inclusion of non-mandatory functions in the table below does not make such functions "mandatory". Where the below functions are included within navigation equipment, manufacturers are requested to comply with the criteria listed in the table below.

Table 2: Access to additional functions

Function	Equipment	Access
Set panel illumination	Radar/ECDIS	Simple operator action
Set display brilliance / toggle Day/Night mode	Radar/ECDIS	Simple operator action
Select ECDIS mode	INS/Radar/ECDIS	Simple operator action
Select radar mode	INS/Radar/ECDIS	Simple operator action
Select Conning display mode	INS	Simple operator action
Select CAM-HMI as defined in Bridge Alert Management (BAM) (for example as required by INS)	INS	Simple operator action
Select North Up display	Radar/ECDIS	Simple operator action
Select ship's Head Up display	Radar/ECDIS	Simple operator action
Select ship's Course Up display	Radar/ECDIS	Simple operator action
Select True Motion mode	Radar	Simple operator action
Select Relative Motion mode	Radar	Simple operator action
Select Ship centred mode	Radar/ECDIS	Simple operator action
Select Ship off centred mode	Radar/ECDIS	Simple operator action
Perform True Motion reset	Radar/ECDIS	Simple operator action
Select range	Radar/ECDIS	Simple operator action
Perform Range up	Radar/ECDIS	Simple operator action

Function	Equipment	Access
Perform Range down	Radar/ECDIS	Single operator action
Temporarily suppress the "heading line"	Radar	Single operator action
Toggle Range Rings on and off	Radar/ECDIS	Simple operator action
Start Variable Range Marker adjustment	Radar/ECDIS	Simple operator action
Start Electronic Bearing Line adjustment	Radar/ECDIS	Simple operator action
Start Electronic Range and Bearing Line adjustment	Radar/ECDIS	Simple operator action
Perform Target Acquire	Radar	Simple operator action
Select tracked target	Radar/ECDIS	Simple operator action
Call up the information associated with an object by cursor pick on its symbol	ECDIS	Simple operator action
All AIS targets to Sleep Mode	Radar/ECDIS	Simple operator action
Acknowledge an alert	Radar/ECDIS	Single operator action
Silence alerts	Radar/ECDIS	Single operator action

Group of functions	Term	Abbreviation
Record an event	ECDIS	Simple operator action
Set Trial Manoeuvre on	Radar	Simple operator action
Select True Vector	Radar	Single operator action
Select Relative Vector	Radar	Single operator action
Select True Trail	Radar	Simple operator action
Select Relative Trail	Radar	Simple operator action
Select CATZOC	INS/ECDIS	Single operator action
View ECDIS software version	ECDIS	Simple operator action
View ENC information	ECDIS	Simple operator action

APPENDIX 5

DEFAULT AND USER SETTINGS

User settings

1 A facility should be provided to store and recall user-specific settings to suit the conditions at hand. At least two such configurations should be available to be stored for recall. Selection for recalling a stored configuration should be followed by an action to confirm the selection.

Default settings

2 A facility should be provided to apply a set of default settings to return the equipment to a known default state. The default settings are intended to provide a basic and minimal mode of operation for the system or equipment that can be built upon by the user.

3 Default settings are not intended to provide a redundant setting in the event of an equipment failure or loss of input.

ECDIS default settings

4 The table below lists the default settings for ECDIS.

Table 1: ECDIS settings configured in response to "Default" selection

Function	Setting
Display category	ECDIS Standard display
Selected sea area	Around own ship with appropriate off-set
Range/Scale	3 NM
Orientation	True motion, north up
Geodetic datum, if selectable	WGS84
Manual updates	If applied, i.e. displayed if available
Mariner's notes	If applied, i.e. displayed if available
Selected route	Last selected route, including route parameters
Past track	On
Past track length, if selectable	Remain unchanged
Past track time-labels	Off, 30 min
Look-ahead time	6 min
Menu or edit windows that overlap chart or route monitor data	Minimized or stacked to provide focus on chart and own ship location

Function	Setting
Position data source	GNSS, sensor to remain unchanged if previously in use
Safety contour	Remain unchanged
Planned safety depth	Remain unchanged
Planned cross track limit	Remain unchanged
Graphical indication of crossing safety contour during route planning, if selection provided	On
Graphical indication of prohibited areas, areas with special conditions and navigational hazards during route planning, if selection provided	On
User-specified distance to prohibited areas, areas with special conditions and navigational hazards, when planning	Remain unchanged
Graphical indication of crossing safety contour during route monitoring, if selection provided	On
Graphical indication of prohibited areas and areas with special conditions during route monitoring, if selection provided	On
Graphical indication of navigational hazards during route monitoring, if selection provided	On
Object highlight, selected object, track display from log	Cleared from display
Cursor pick	Closed
Any additional window (dual view, 3D, tides, etc.)	Closed
Any additional information layer, proprietary layer (weather, tides, Additional Military Layer (AML), etc.)	Cleared from display
Chart update, chart information exchange	Aborted
Colour differentiation test diagrams	Closed
Update review	Off
Chart 1	Closed
Units	m, NM, kn
Crossing a navigational hazard in route monitoring mode	Alert priority set as caution
Vector time (length)	6 min
Vector mode	True

Function	Setting
Vector stabilization	Ground
Collision warnings, if provided	On (limits, CPA = 2 NM; TCPA = 12 min)
Radar and AIS target association, if provided	On
Radar and AIS target association priority	AIS
AIS target filtering, if provided	Target range = 6 NM Target CPA = 4 NM Target TCPA = 24 min Target display = On Sleeping target display = Off AtoN display = On SART display = On Repeated target display = Off
AIS true target outline	Off
Display of radar image overlay, if provided	Off
Display of radar tracked targets, if provided	On
Display of AIS reported targets, if provided	On
Target past positions, if provided	Off
Target trails, if provided	Off
Lost target warning, if provided	Off
AIS interrogation, if provided	Off
Own ship true outline	On, unless the resultant outline would be smaller than 6 mm on the screen
LOP source indication	Off
User selected time for warning escalation	60 s
Suppression of indication of user selected MSI messages based on first character of NAVTEX code field, if provided	Remain unchanged
Suppression of indication of user selected MSI messages based on time and distance from own ship, monitored route or planned route, if provided	No
Brightness and contrast controls, if software controlled	Calibrated setting

Radar default settings

5 The table below lists the default settings for radar.

Table 2: Radar control settings configured in response to "Default" selection

Function	Setting
Band	Remain unchanged
Gain and anti-clutter functions (Sea, Rain)	Radar gain automatically optimized, where provided. Anti-sea and anti-rain clutter manual controls set "as is" or set to "zero" if such functionality exists.
Tuning	Automatically optimized where provided, otherwise remain as is
Range	6 NM
Fixed range rings	Off
VRMs	On
EBLs	On
Parallel index lines	Remain unchanged
Orientation Mode	North Up
Presentation Mode	True Motion
Vector mode	Relative
Vector time	6 min
Stabilization Sea/Ground	Sea
Off-Centre	Off-Centre, with appropriate look ahead
Target trails	On
Past positions	Off
Radar target tracking	Continued
Automatic radar target acquisition	Off
Graphical AIS reported target display	On
Radar and AIS target fusion	Association on, priority AIS
Operational alerts (except collision warnings)	On
Collision warnings	On (limits CPA 2 NM; TCPA 12 min)
Display of maps, navigation lines and routes	Last setting
Display of charts	Off