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The Idea to Develop Standard Icons to Control ECDIS Functions as Part of S-Mode Proposal in the Implementation Process of the IMO

A. WEINTRIT
GDYNIA MARITIME UNIVERSITY, Jana Pawla II 3, 81-345 Gdynia, Poland
EMAIL: weintrit@am.gdynia.pl

ABSTRACT

This paper presents the consequences resulting from the guidelines on the display of navigation-related information elaborated by the IMO, related to ECDIS, as part of S-Mode proposal in the implementation process of e-Navigation concept. The idea to develop standard icons to control the chart display functions in ECDIS is discussed. The use of these icons will ensure that navigation information presented on ECDIS screen will be displayed in a harmonized manner on the ships' navigational bridge. Today many function-related icons vary across different electronic chart systems and between producers. The paper provides information on icons, symbols and abbreviations that required standardization. It was necessary to develop standard icons whose consistency will allow easy and intuitive use of user interfaces of different navigation systems.

KEYWORDS: e-Navigation, IMO, ECDIS, S-Mode, Standard Icons, Safety at Sea

1. Introduction

Over the past two years the International Maritime Organization (IMO) has been intensively working on the development of guidelines on standard modes of operation, S-Mode. Guidance on the standardization of design for navigation and communication systems, encompassing displays, interfaces, and functionalities able to provide the bridge team and the pilot with timely access to most important information for the conduct of navigation throughout the voyage, from berth to berth. S-Mode aims to reduce variation in navigation systems and equipment through the standardization of some aspects of the user interfaces [22].

The Author, as a chairman of the Poland Branch of the Nautical Institute and a member of the IMO expert group, who was working on this guide, will try to describe the current state of work, previous and final arrangements. The guidance is underpinned by user needs and is focused on standardization of the functions of electronic navigation equipment. When applied in the design process, the guideline aims to enhance the safe and effective navigation of SOLAS ships and reduce the need for familiarisation with various types of electronic navigation systems.

At the 6th session of IMO's Navigation Communications and Search and Rescue subcommittee in January 2019 has completed works on a guideline on S-Mode which will now be sent to the next meeting of the IMO's Maritime Safety Committee for approval. The guideline has a new name, "Guidelines for the standardization of user interface design for navigation equipment". No doubt it will still be informally known as S-Mode. If you are interested in the particular results you can find they in the IMO document NCSR 6 WP.4 [4], or eventually in the NCSR final report to the MSC [3].

2. Human Factors Research Supporting Standardization Design Principles

2.1 Human factors research

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. 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).

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) [10]. 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 [23].

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 [10].

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).

2.2 Icon usability

A great deal of research has been conducted to identify the factors that are important in determining the usability of icons. An examination of icon recognition tasks identified the following effects [2, 5]:

- 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.
- 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 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.
- 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.
- 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.

2.3 Information location

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 of perception, 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 must be compatible with the physical entities they represent, and the seafarer's mental representation of those entities [24]. 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.

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. 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. 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 [23].

2.4 Projection to the real world

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 [1, 11]. 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.

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

- 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.
- 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.
- 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 [24].

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 [19].

2.5 Human factors methods for engineering and design

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 references [16 – 18] and ergonomic standards [6 – 9], in conjunction with the guidance of a human factors/ergonomic expert/practitioner, is recommended.

3. Standard Mode

3.1 Introduction

The concept of Standard Mode has been proposed under the agenda of the IMO e-Navigation initiative. At MSC 95, IMO recently identified that the 'Guidelines on standardized modes of operation (S-Mode)' are a priority and need to be established by 2019. The Nautical Institute as initiator and main author of this idea was calling on the maritime community to have a say in its development [12-16].

There are almost fifty ECDIS manufacturers, many of which offer more than one model, and some of the key operational features differ widely from one producer to another. The IMO's e-Navigation project aims to ensure seafarers are provided with the information they need for safe and efficient navigation, and this includes the development of an "S mode" or standard mode of operation for navigation displays across all producers. Considerable variations in the way different producers display navigation systems have been a cause for concern for several years, prompting calls for a default setting across all models. The Nautical Institute strongly supports the introduction of a S-Mode, or Standard setting on all systems. The adoption of S-Mode would reduce the risk of confusion when a navigator is faced with a system that he is unfamiliar with.

3.2 S-Mode: feedback needed

Seafarers are very traditional community. They often and passionately remind us to keep things simple, make best use of standardisation and to put a high priority on education and training (MET). Armed with this advice, efforts continue to work with all stakeholders in the industry to represent the professional views of seafarers, towards developing a future navigation system to improve safety and efficiency.

These discussions bring us back to a recurring theme from the series of integrated bridge systems (IBS) conferences held in the beginning of this century. There the debate often centred on the need and advantages of standardised controls and presentation, and the advantages and need for the producers to drive innovation. One of main outcome from these conferences was the desire for an IMO approved default setting that could be triggered by a single button. Although the navigator-display interface is only one aspect of e-Navigation, it is an essential one. This general concept has now evolved into what could be called the 'S-Mode' of operation.

It is recognised that there is a vital need to embrace new technology and for producers to be able to innovate with the expectation that if they get it right, they will be rewarded with sales of their products. Recent innovations include the chart radar; new technology (NT) nonmagnetron radar, AIS, LRIT, PNT; and ECDIS, to name just a few. Significant innovations from the past have included electronic position fixing systems (EPFS), NAVTEX, the gyro compass, autopilot, log and even the chronometer in its day. Standardisation of professional displays on the navigation bridge would simplify training and ensure that pilots and seafarers could be instantly familiar with the operation of such equipment when joining a vessel and therefore be better placed to concentrate on making relevant, correct decisions. The question therefore is how to balance these two important objectives.

The concept of S-Mode builds on the concept of a default setting by being a 'default mode'. This mode is made possible by the increasing use of multi-function displays (MFDs) where radar overlay, charts, position information etc. are inputs that can be arranged or re-arranged in standard form on a display.

S-Mode would require all navigation displays, regardless of producer, to have a clearly identified button that, when pressed, brings the display into a standard format with a standard menu/control system, standard interface (keyboard/trackball/ joystick etc.) and basic features. For example, there may have to be a tactical display for near-time decisions (collision, and/or hazard avoidance) and a complementary display for voyage planning. At the press of a button the tactical display might revert to a 6-mile range radar view with targets showing relative vectors; and perhaps hazardous depth contours shown from vector chart data, such as used on a chart radar. This view would be standardised and familiar to all pilots and seafarers and then could be manipulated through a standard menu system for a limited, although adequate, functionality. The benefits to this would be that [12]:

- Training for S-Mode could be standardised throughout the world.
- Any mariner or pilot would be comfortable reverting to S-Mode and be competent in using the system's layout and functionality, regardless of producer.
- Companies (Ship-owners) or Masters could impose S-Mode only use by crews until such time that they have proven they are competent to use further functionality that may have been provided by individual producer.
- S-Mode could also be used at times when the bridge team is made up of multiple persons who need to share a common display for decision making.

With the performance of S-Mode secured and strictly governed by the IMO, producers would be able to develop further functionality that they could market to shipowners as a 'value added' feature. If, in time, these new innovative features proved to be popular and effective, they could then be brought into S-Mode in a controlled way by the IMO.

At a basic level, some vessels might opt to only have S-Mode functionality installed: however there may be other vessels which by the nature of their trade or quality of their training can take advantage of new and innovative features that would be developed by the industry.

3.3 The Nautical Institute initiative to make S-Mode reality

With almost fifty different producers of ECDIS alone now operating in the market, it remains difficult for mariners who may have just joined a ship to become familiar with even the key features. Not being familiar, particularly in darkness or during stressful situations such as busy ports, can be dangerous. No mariner wants to feel unprepared to use systems to make critical decisions.

The Nautical Institute says that in order to know how to minimise the risk, one thing is to make sure you are familiar with all the key tasks that will be required – and get someone to show you if you are unsure about any of them [12–16].

It should be explained that Nautical Institute's proposal on S-Mode involves the following three features:

- A default display presented at the press of a button;
- A standard menu structure on this display, where all essential tasks could be operated in the same way across all producers;
- A standard interface device (mouse, trackpad, joystick, etc.).

He further mentions The Nautical Institute insists that the S-Mode guidelines should have the widest possible input from the estimated 400,000 navigating officers in the global fleet. This feedback should then result in a small number of possible solutions that will then be thoroughly tested in simulation for effectiveness before a final decision is made. It is also important that any solution should be future-proofed (perhaps through software updates), so that S-Mode evolves with time and technology to remain effective.

3.4 Industry at odds over Standard Mode for ECDIS

It was a milestone in the era of digital disruption; the International Maritime Organization (IMO) mandating the use of electronic chart display and information systems (ECDIS) made centuries-old paper charts traditionally used for navigating the high seas swiftly redundant. This regulatory catalyst sparked the perfect storm of competition-driven innovation and fast-paced advances in ECDIS technology, which resulted in a wide range of products able to cater for individual ship needs becoming available to owners Wide-ranging options from a variety of producers may be a favourable scenario for the shipowner making ECDIS investment decisions, but it exacerbates the increasingly problematic scenario of seafarer unfamiliarity when faced with differing equipment from ship to ship [19].

As was mentioned above there are almost fifty ECDIS producers, many of which offer more than one ECDIS model, each with different features. So seafarers increasingly find themselves facing a bewildering array of ECDIS models. For the seafarer, flipping between models, proficiently familiarising themselves with the key operational features when moving from one ship to another is a difficult task.

Familiarity with an ECDIS is key to its proficient use in critical decision making. Therefore, the debate around the importance of standardisation and the possible development of a standard mode of operation, or 'S-Mode', for navigation equipment has landed firmly in discussions at IMO headquarters.

The year 2008 was pivotal in the journey towards S-Mode. It was during this year that The Nautical Institute and the International Federation of Ship Masters' Associations (IFSMA) proposed, in a joint submission to the IMO, the development of an S-Mode for navigation displays. At MSC 95 in 2015, the IMO identified that the development of guidelines on S-Mode was imperative, citing the development of S-Mode as one of its top six priorities under its four-year work programme on practical solutions to implement e-Navigation [20, 21]. Fast forward to 2018 and the S-Mode development wheels were still in motion. The next milestone was at the beginning of 2019, when a set of guidelines describing a standardised mode of operation and display for all navigational equipment was submitted and preliminary adopted.

4. Guidelines for the standardization of user interface design for navigation equipment

4.1 Introduction

The guidelines apply to Integrated Navigation Systems (INS), Electronic Chart Display and Information Systems (ECDIS) and Radar equipment. They may be applied to other electronic navigation equipment, and navigation sensors where applicable where it would improve standardization and usability. The aim of these guidelines is to promote standardization of user interfaces to help meet user needs. The guidance within these guidelines has been developed in close collaboration with an international association of equipment producers to ensure its efficient implementation. The guidance also aims 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.

4.2 Scope

The guidance stems 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 and will be useful for the design of interoperable systems by different producers.

While the operation of navigation equipment requires specialist training and familiarization, variations across different producers' 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, which will assist in the seafarer's decision making process.

The guidance has been informed by past research into human factors, cognitive science and human centred design (HCD) as the findings stemming from this research has been seen to be advantageous and should be considered as part of system design (background information can be found in [4], 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.

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:

- default and user settings;
- standardized terminology, abbreviations and icons for commonly-used functions (Hot Keys) and groups of functions (Shortcuts);
- logical grouping of related information;
- access requirements for essential information and functions.

There are a number of IMO instruments and other international standards that deal with system design and information portrayal. The guidelines builds on such standards. A list of relevant references used and/or consulted during the drafting of the guidelines appears at the end of the document.

4.3 User needs

The 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.

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 producers. 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. 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.

4.4 Standardization design principles for S-Mode

User feedback and testing has 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.

Vast amounts of information are 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. 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.

The following principles were applied when designing the appendices to these guidelines [2, 4]:

- 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:
  - Standard vocabulary – which should be in accordance with Standards of Training, Certification and Watchkeeping for Seafarers, 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).
  - Standard symbols and icons – many function-related icons vary across different navigation equipment and between producers. 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.
  - Patterns, 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.
  - 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 has identified high frequency use areas that may be places and locations on a display screen requiring standardisation. Colocation of related essential information is beneficial.

- Recognition – Using the location and grouping for consistency provides for recognition. Human perception and search works faster with cues than complete recall – which is 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 a process 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.
- 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.
- 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 and/or PNT data.
- Projection to real world – There are two elements to projecting to the real world.
  - 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"…,
  - 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.
- 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.
- 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

4.5 Navigation-related terminology and icons of functions

This appendix to the Guideline 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, should be used for the display of navigation-related information, to promote consistency of presentation across navigational equipment. The terminology and icons listed in appendix 1 should replace symbols which are currently contained in existing performance standards. Where icons, terms and/or abbreviations are used, they must meet the requirements of the guidelines. 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 guidelines.

All terms and abbreviations in this appendix are mandatory to implement. Use of icons is not mandatory; but if icons are implemented then they must meet the requirements specified. 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). Only the shape of the icon is specified; the guidelines 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. For some functions, multiple icon options are suggested for consideration. The final S-Mode Guideline should provide only one icon for each function. 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) were presented in 6 tables [4]:

- Table 1: General navigation functions,
- Table 2: Control of chart display function,
- Table 3: Control of chart functionality,
- Table 4: Database functions,
- Table 5: Route plan and monitoring functions,
- Table 6: Groups of functions.

Here, in the article are presented two example tables.

5. Conclusion

This paper supports the IMO 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 paper 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. S-Mode aims to reduce variation in navigation systems and equipment through the standardization of some aspects of the user interfaces. This in turn will help provide users with timely access to essential information and functions that support safe navigation. This guidance stems from a strong user need for consistency of essential information, to perform key tasks and functions, irrespective of an equipment's manufacturer. While the operation of navigation equipment requires specialist training, specific training or familiarisation should ideally be minimised where possible. S-Mode enables users to locate and interpret information quickly and react decisively, which is crucial to safe navigation. The above statements have shaped the development of the S-Mode guideline. This guideline is intended for electronic navigation equipment, specifically Electronic Chart and Display Information System (ECDIS), Integrated Navigation System (INS), Integrated Bridge System (IBS), and Radar/ARPA. The usability of other electronic navigation equipment and systems may also be improved through the application of this guideline in the design process.

All opportunities should now be taken to promote the existence of the guideline and to encourage those involved in purchasing navigation equipment to source equipment that embodies the content of the guideline.

Table 1. General navigation functions [4]

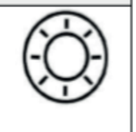
Explanation	Term	Abbreviation	Icon (hot key)
To set display brilliance	Display brilliance	BRILL	
To select ECDIS mode (for multifunction displays)	ECDIS	ECDIS	
To select Radar mode (for multifunction displays)	Radar	RADAR	
To select Conning display or to select "navigation control data" task of the INS (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

Table 2. Control of chart display function [4]

Explanation	Term	Abbreviation	Hydrographic symbol	Proposed 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	-3.0-	-3.0-
Deep contour	Deep contour	DEEPCNT		DEEP CNT
Selector for viewing group layer	Display base	DISPBASE		DISP BASE
Use four shades	Four shades	4SHADE		

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