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Command Decision Aiding Technology (COMDAT) Symbology and Design Study

Version 2.0

Unger Campbell and Associates

Gweneth Unger Campbell, Ph.D. and Kevin Baker

5020 204th Street
Langley, British Columbia V3A 7K3

(604) 306-0253
gu.campbell@verizon.net

DRDC-RDDC

CR 2003-036
2003-03-15

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(604) 306-0253
gu.campbell@verizon.net

DRDC-Toronto

DRDC-Toronto Scientific Authorities
Sharon McFadden/Kim Kubeck
(416) 635-2189/(416) 635-2000 (ext. 3087)

CR2003-036
2003-3-15

COMDAT SYMBOLOGY AND DESIGN STUDY
Version 2.0

on behalf of
DRDC-Toronto

by
Gweneth Unger Campbell and Kevin Baker
Unger Campbell and Associates

March 2003

ABSTRACT

This document is part of support provided by Defence Research and Development Canada – Toronto (DRDC Toronto) to the Command Decision Aiding Technology (COMDAT) project. The report includes a description of three Human Factors efforts carried out to support the upgrade of the Halifax Class Command and Control System (CCS) in the area of battlespace awareness. The first section is comprised of a report on an evaluation of symbology developed to convey the certainty of Multi-Source Data Fusion displays. The remaining sections are comprised of annotated illustrations of COMDAT Operator-Machine Interface (OMI) Style Guide compliant displays.

RÉSUMÉ

Le présent document fait partie du soutien qu'apporte Recherche et Développement pour la défense Canada – Toronto (RDDC Toronto) au projet de technologie d'aide aux décisions de commandement (COMDAT). Le rapport comprend une description de trois mesures ergonomiques adoptées pour favoriser l'amélioration du système de commandement et de contrôle (SCC) des navires de classe Halifax pour la connaissance de l'espace de combat. Dans la première partie, on trouve un rapport d'évaluation de la symbologie utilisée pour indiquer la certitude des affichages de fusion de données de sources diverses. Les autres parties se composent d'illustrations annotées montrant les affichages conformes au guide de style pour l'interface opérateur-machine (IOM) de la COMDAT.

EXECUTIVE SUMMARY

This document is part of support provided by Defence Research and Development Canada Toronto (DRDC Toronto) to the Command Decision Aiding Technology (COMDAT) project.

The purpose of the larger project is to research and demonstrate Multi-Source Data Fusion (MSDF) technologies and to carry out Human Factors studies to support the evolutionary upgrade to the Halifax Class Command and Control System (CCS) in areas of battlespace awareness, over the first decade of the new millennium.

One of the objectives of the COMDAT project is to develop and demonstrate an improved Operator-Machine Interface (OMI) for use with the TD on Naval Tactical Display (NTD) technology in an evolutionary development. The current work addresses potential improvements to the Halifax Class Canadian Patrol Frigate (CPF) Command and Control System (CCS).

This document describes three Human Factors efforts as follows:

- Evaluation of MSDF Symbology. The majority of the report addresses an evaluation of MSDF symbology. The MSDF symbology is designed to indicate to the operators the certainty of contacts in MSDF displays. The report presents a discussion of the best design of the designs that were evaluated. Suggestions are offered for further development. Design requirements for successful future development are presented.

- Illustrations for the COMDAT OMI Style Guide. Annotated illustrations of COMDAT Operator-Machine Interface (OMI) Style Guide compliant displays are presented.

- Static Design for an Upgraded CPF CCS Display. The final section of this report presents a CPF CCS display re-designed to illustrate its appearance when it is consistent with the COMDAT Style Guide.

SOMMAIRE ADMINISTRATIF

Le pr□sent document fait partie du soutien qu□apporte Recherche et d□veloppement pour la d□fense Canada □ Toronto (RDDC Toronto) au projet de technologie d□aide aux d□cisions de commandement (COMDAT).

L□objet du projet plus vaste est la recherche et la d□monstration de technologies de fusion de donn□es de sources diverses (FDSD) ainsi que la conduite d□□tudes sur des facteurs humains dans le but de favoriser, tout au long de la premi□re d□cennie du nouveau mill□naire, l□am□lioration □volutive du syst□me de commandement et de contr□le (SCC) des navires de classe Halifax pour la connaissance de l□espace de combat.

L□un des objectifs du projet COMDAT est de concevoir, de d□montrer et d□am□liorer l□interface op□rateur-machine (IOM) utilis□e dans l□AT pour la technologie d□affichage tactique naval (ATN) dans le cadre d□un d□veloppement □volutif. Le travail en cours porte sur l□examen d□am□liorations possibles au syst□me de commande et de contr□le (SCC) des fr□gates canadiennes de patrouille (FCP) de classe Halifax.

Le pr□sent document d□crit les trois mesures ergonomiques suivantes :

- □valuation de la technologie de la FDSD. La plus grande partie du rapport pr□sente une □valuation de la symbologie de la FDSD. Celle-ci est con□ue pour indiquer aux op□rateurs la certitude des contacts dans l□affichage de la FDSD. On trouve aussi dans le rapport un examen du meilleur des concepts qui ont □t□ □valu□s. On y propose des suggestions en vue de d□veloppements futurs et l□on pr□cise les exigences du projet pour en assurer le succ□s.

- Illustrations pour le guide de style de l□IOM de la COMDAT. Des illustrations annot□es montrant les dispositifs d□affichage conformes au guide de style pour l□interface op□rateur-machine (IOM) de la COMDAT sont pr□sent□es.

- Concept permanent pour un affichage am□lior□ du SCC des FCP. La derni□re section du rapport propose un affichage du SCC des FCP redessin□ pour illustrer la pr□sentation qu□il doit avoir afin d□□tre conforme au guide de style COMBA

ACKNOWLEDGEMENTS

The conduct of the evaluation could not have taken place without the assistance of officers and crewmembers from the Canadian Patrol Frigate HMCS Vancouver. Thanks to all of those participated as subject matter experts. Your willing and thoughtful help is greatly appreciated.

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INTRODUCTION

Defence Research and Development Canada - Toronto (DRDC Toronto) is charged with the responsibility to provide human factors support for the COMDAT project. DRDC has approved COMDAT I (Command Decision Aiding Technology) as a Technology Demonstrator (TD) project scheduled to take place during the June 2000 to June 2003 period. The purpose of the larger project is to research and demonstrate Multi-Source Data Fusion (MSDF) technologies and to carry out Human Factors studies to support the evolutionary upgrade to the Halifax Class Command and Control System (CCS) in areas of battlespace awareness, over the first decade of the new millennium.

One of the objectives of the COMDAT project is to develop and demonstrate an improved Operator-Machine Interface (OMI) for use with the TD on Naval Tactical Display (NTD) technology in an evolutionary development. The focus of the current work is three fold as follows:

- MSDF Certainty Symbology Evaluation. Evaluate symbology that is designed to provide information to the operators as to the certainty of the fused data.
- Design Illustrations. Develop a set of examples of design illustrations to enhance the usability of the COMDAT OMI Style Guide.
- CCS Look and Feel Upgrade. Provide an example of a CCS display that illustrates its appearance when consistent with the COMDAT Style Guide.

This report is divided into three sections, each reflecting one of the foci of support for the COMDAT project.

1.0 MSDF Certainty Symbology Evaluation

Section 1.0 includes the method and results of an evaluation of MSDF Certainty symbology. Lockheed Martin developed the initial symbology in support of the COMDAT project.

2.0 Design Illustrations

Section 2.0 is a set of illustrations designed to enhance the existing COMDAT OMI Style Guide. The COMDAT OMI Style Guide was created under separate contract to DRDC. (See Campbell, Gweneth U. 2001. *COMDAT OMI Style Guide Version 1.0*. DCIEM-CR- 2001-151, Delta, British Columbia: Unger Campbell and Associates). The current work provides illustrations for a portion of the design guidance described in the COMDAT OMI Style Guide.

3.0 CCS Look and Feel Upgrade

Section 3.0 presents a static re-design of the current Halifax Class CCS functionality and layout. The upgraded design was created to illustrate the application of the COMDAT OMI Style Guide without changing the functionality or organization of the current CCS.

1.0 MSDF CERTAINTY SYMBOLOGY EVALUATION

The evaluation of the proposed MSDF certainty symbology portion of this report is divided into seven sections, eight annexes, and three appendices as follows:

1.1 MSDF Introduction
1.2 Description of the Symbols
1.3 Summary Description of the Participants
1.4 Conduct of the Trials
1.5 Highlights of the Results
1.6 New Design Concepts
1.7 Conclusions

Annex A: Certainty Symbology
Annex B: Demographic Information
Annex C: Pre-Testing Details
Annex D: Intuitiveness Evaluation Details
    Appendix D: Evaluation Materials Intuitiveness
Annex E: Set Context Evaluation Details
    Appendix E: Evaluation Materials Set Context
Annex F: Operational Context Evaluation Details
    Appendix F: Evaluation Materials Operational Context
Annex G: Desired Design Characteristics
Annex H: Acronym List

1.1 MSDF Introduction

A fundamental issue surrounding the development of MSDF technology is the display of the fused information. One concern with MSDF displays is the variability in how frequently the information is updated. In the current operations the displays from different sources are displayed on dedicated screens; the operators have information about the freshness (or certainty) of the data because of the screen on which it appears. When the contacts from a variety of new sources are integrated into a single display the issue arises as to whether there is a need for symbology that informs the operators of the certainty of the information and if so, how should it be optimally presented. Heretofore there have been several attempts to develop certainty symbology within a variety of defence applications without particular success.

As part of a separate contract Lockheed Martin was retained to develop a set of symbology to indicate MSDF certainty. The symbology evaluation presented here examines a selection of the Lockheed Martin symbology plus symbology developed by Unger Campbell. In addition, Unger Campbell investigated some of the issues surrounding the criteria for successful certainty symbology; those results are presented here.

Upon agreement with the DRDC team, it was initially determined that two of the Lockheed Martin sets should be evaluated; a third set would be developed by Unger Campbell and would also be part of the evaluation. Although the contract required the evaluation of only three symbology sets Unger Campbell determined that the evaluation would be more valuable if a third set developed by Lockheed Martin were included. Accordingly, in agreement with DRDC, four sets of symbols were included in the evaluation.

The evaluation had five parts as follows:

- Pre-test and collection of demographic information.
- Evaluation of intuitiveness of the symbols both for their representation of certainty (Uncertain versus Certain) and their representation of types of certainty (e.g., position, time, etc.).
- Evaluation of the effectiveness of the symbols within like symbols from the same set.
- Evaluation of the symbols within the operational context.
- Group discussion.

The evaluation included both performance and preference measures. Performance refers to behavior: how well the SMEs can determine the meaning of the symbol. Preference measures, on the other hand, measure the SMEs opinions regarding how well the symbols convey the intended meanings. It is possible for participants to prefer a solution that does not improve operational effectiveness or which is confusable. Using both types of measurements results in a more complete picture of the suitability of the icons than does either type of measure alone. Accordingly, in the Intuitiveness and in the Set Context portions of the evaluation performance was measured; within the Operational Context evaluation preference ratings were gathered.

1.2 Description of the Symbols

Four sets of symbols were selected or designed. For the purpose of evaluation the names for the symbols were chosen so as to be as neutral as possible. The symbol sets were designated as follows:

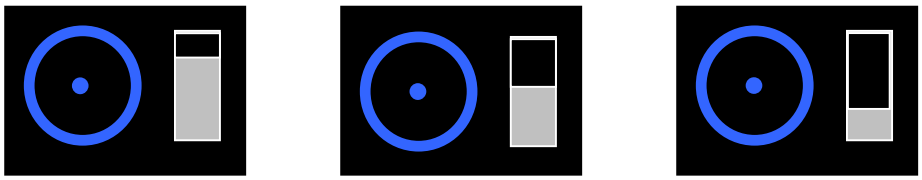
- Slider
- Sights
- Bars
- Dots

The symbol sets are shown in Figures 1.2.1 through 1.2.4 below and a description of each is presented below each figure. (See also Annex A: Certainty Symbology)

Within the evaluation the visual context was the same for each symbol. As can be seen in Figures 1.2.1 through 1.2.4 the symbols were presented within the following visual context:

- Each MSDF certainty symbol was presented co-located with a single symbol from the existing CCS symbol set. The contact symbol represents a friendly surface contact.
- Because the background of the CCS tactical display is dark, the symbology was presented on a dark background throughout.
- With the exception of the final, Operational Contextual evaluation, the sets were presented on paper and were in grey-scale.

Symbol Set 1: Slider (also known as Draining Bucket)

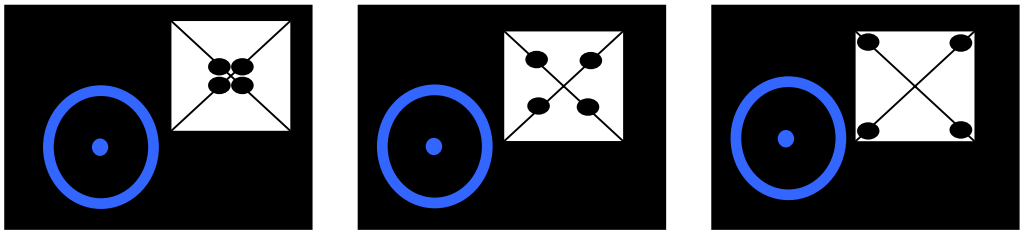


Most Certain | Mid-Level Certainty | Least Certain

Figure 1.2.1 Symbol Set 1: Slider

The intent of the Slider symbol set (designed by Lockheed Martin) was to indicate the time that the report was received. In this symbol set the more full the "bucket" appears the more recent the report and hence more certain the contact. Lockheed Martin mentions in their report that the interpretation could just as easily be reversed so that the more full the bucket the more time that has passed since the report.

Symbol Set 2: Sights (also known as Gun Sights)



Most Certain | Mid-Level Certainty | Least Certain

Figure 1.2.2 Symbol Set 2: Sights

This symbol set was designed by Lockheed Martin using the metaphor of a gunsight. The sight symbol set was designed to indicate positional uncertainty. The closer the dots are to the center of the sight the more certain the operator can be that the position is current.

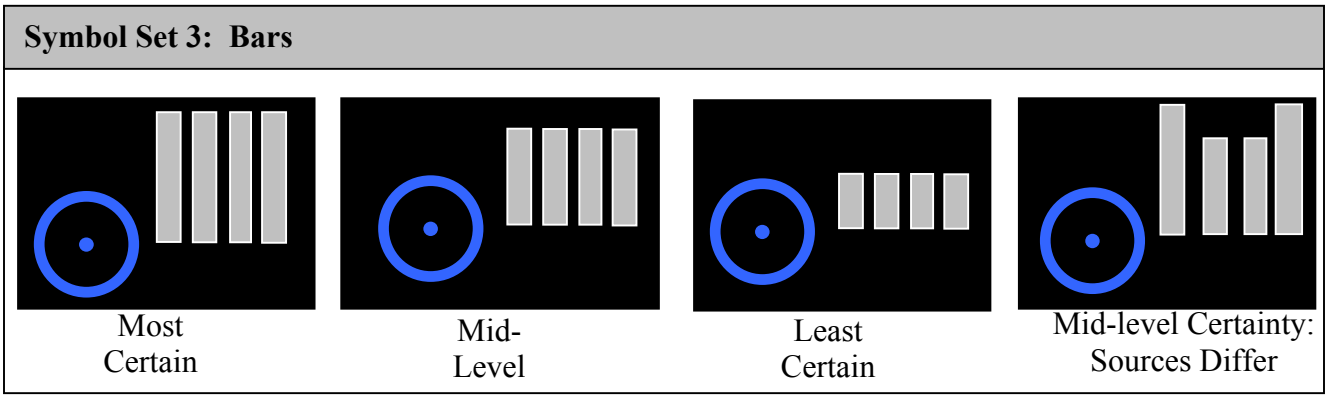


Figure 1.2.3 Symbol Set 3: Bars

The Bar symbol set was designed by Lockheed Martin using a bar-graph metaphor. Each bar is designed to represent a particular type of uncertainty: corresponding to Who (source), What (identification), When (time), and Where (Position). The intent of the design was that the graph would be interpreted so that "Big is Bad" and the larger bars would draw the eye to the most uncertain of the contacts.

An underlying design concept for the bars is that a Square would represent High Uncertainty whereas a rectangle would represent less certainty. However, as can be seen in the figure, the Bars are displayed in the reverse of what was intended. The reversal is presented here because the results of the evaluation show that the SMEs perceive the Bars, and other symbols, as "Bigger is More Certain". When the symbols were printed for the evaluation the "Most Certain" and "Mid-Level Certainty" graphics were indistinguishable.

Symbol Set 4: Dots

Most Certain | Mid-Level Certainty | Least Certain | Least OR Most Certain

Figure 1.2.4 Symbol Set 4: Dots

The Dot symbols were developed by Unger Campbell as a simplified version of certainty symbology. The intent was to provide a very simple representation of the MSDF certainty symbology. As can be seen in the figure, an example was included that did not incorporate a MSDF symbol. While it is not good Human Engineering practice to use the lack of a symbol as a modifier it was worth exploring how the lack of a symbol would be intuitively interpreted in the MSDF context.

1.3 Summary Description of the Participants

The trials were conducted at Canadian Forces Base Esquimalt. Officers and crewmembers from HMCS Vancouver were invited to participate as Subject Matter Experts (SMEs). The SMEs represented a wide range of experience, ages, and ranks. It was reported that many of the SMEs had been recently deployed and hence had combat-duty experience. A summary of the demographic profile is presented below (see Figure 1.3.1: Demographic Information Summary). For more detail see Annex B: Demographic Information.

DEMOGRAPHIC INFORMATION SUMMARY	
Question	**Summary**
Rank of Participant	6 ranks: OS through Lt.
Qualified CCS Positions	12 Positions
Months Experience on Position	2.3 Years (Mean)
Familiarity with Other CCSs	CCS 280 (Most Common)
Age of Participant	35.5 years (Mean)

Figure 1.3.1 Demographic Information Summary

The computer experience of the participants was also collected. These SMEs are familiar with computers and use PCs frequently. A summary of their computer experience is presented below (see Figure 1.3.2: Computer Experience). For more detail see Annex C: Pre-testing Details.

COMPUTER EXPERIENCE	
Question	**Summary**
Rank of Computer Use	e-mail used most often, followed by other internet use, other office use, and games.
Frequency of Computer Use	PCs used at least 1-2 week, some game playing, Organizers and Macintosh are used infrequently.

Figure 1.3.2 Computer Experience Summary

1.4 Conduct of the Trials

The evaluation was conducted in five steps as listed below. A short description of each is included in this section. Further detail regarding the method and results of each step are available in the Annexes. Each Annex contains a description of the method used and a detailed presentation of the results of each step. A sample of the materials used in each portion of the evaluation is appended to the appropriate annex.

- Pre-Testing (See Annex C: Pre-Testing Details)
- Intuitiveness Evaluation (See Annex D: Intuitiveness Evaluation Details)
- Set Context Evaluation (See Annex E: Set Context Evaluation Details)
- Operational Context Evaluation (See Annex F: Operational Context Evaluation Details)
- Group Session

1.4.1 Pre-Testing

A pre-testing step was conducted to gather demographic data. The pre-testing step also tapped the SMEs impression of the information requirement for MSDF certainty symbology prior to being exposed to the proposed symbol designs. Details regarding the SMEs initial impressions of the MSDF certainty information requirement are available in Annex C: Pre-Testing Details.

1.4.2 Intuitiveness Evaluation

The Intuitiveness evaluation step was designed to evaluate the intrinsic meaningfulness and potential confusability of the symbols. The most successful symbols are those that are most readily and accurately interpreted by the users. In this step the symbols were presented one at a time. The SMEs indicated what level of certainty each symbol represented and they also selected the type of certainty that they thought the symbol represented (e.g., Time, Position, etc.). A description of the method used, a sample of the materials presented to the SMEs, and a detailed presentation of the results of the Intuitiveness evaluation is presented in Annex D: Intuitiveness Evaluation Details.

1.4.3 Set Context Evaluation

Evaluations were also completed in the context of each complete set of symbols. When the complete set of symbols was presented the SMEs were able to see the symbols within the context of each symbol set. For each set the SMEs indicated what level of certainty each symbol within the set represented and the type of uncertainty they thought the symbol set represented (e.g., Time, Position, etc.). A description of the method used, a sample of the materials presented to the SMEs, and a detailed presentation of the results of the Intuitiveness evaluation is presented in Annex E: Set Context Evaluation Details.

1.4.4 Operational Context

In the Operational Context evaluation the SMEs were shown the symbols as the symbols would appear on a tactical display. The symbols from each set were shown one set at a time in a pre-determined contact-rich environment. For this step the presentation of the display was in color. The SMEs ranked the four symbol sets according to their perceived usefulness to the operators. A description of the method used, a sample of the materials

presented to the SMEs, and a detailed presentation of the results of the Intuitiveness evaluation is presented in Annex E: Set Context Evaluation Details.

1.4.5 Group Session

At the end of the evaluation process all of the SMEs participated in a discussion session. A range of topics was discussed, including the necessity for MSDF certainty symbols, potential improvements on the symbology, and criteria for the display of MSDF certainty symbols.

1.5 Highlights of the Results

1.5.1 Introduction

Sufficient information was uncovered by the evaluation to permit Unger Campbell to make recommendations concerning the design of successful MSDF certainty symbology. The symbols sets evaluated here are discussed below in order of their fitness for purpose. Each discussion includes a brief description of the rationale for the recommendations.

The evaluation revealed a number of specific characteristics required for successful MSDF certainty symbology. While a selection of the best set can be made from the recommended symbology set evaluated here, Unger Campbell recommends that the best choice from this set (the Slider) be modified to make it consistent with the desirable design features uncovered by the evaluation and presented in Annex G: Desired Design Features.

The desired design features illuminated by this evaluation and the cumulative results from this evaluation form the basis for recommendations regarding modifications and improvements on the symbols tested here. The new design candidates are presented in Section 1.6: New Design Concepts.

1.5.2 Recommendations and Rationale

1.5.2.1 *Slider*. The best candidate from the symbology evaluated here is the Slider, particularly if Time is the type of uncertainty depicted. The Slider symbols were intrinsically meaningful and were rarely misinterpreted. The Slider was the second preference of the SMEs.

1.5.2.2 *Dot*. The second best candidate overall is the Dot set. The Dots are the set of symbols most preferred by the SMEs and, in contrast to the Slider, are not strongly associated with a particular type of uncertainty. Because the Dots are not intrinsically interpreted as representing a particular type of uncertainty they can be successfully used to depict any type of uncertainty without causing conflict. The Slider and Dots are the most promising candidates not only because they are interpreted more consistently than are the Sight and Bar symbols, but also the SMEs prefer the Slider and the Dots to either the Sight or the Bar symbology.

1.5.2.3 *Sight and Bars*. The Sight symbology was successfully interpreted as depicting Positional uncertainty, as intended in the design. However, the SMEs made it clear that the Sight symbols were simply too large and obtrusive to be used successfully. Similar objections were raised concerning the Bars. While the SMEs showed some interest in the concept of depicting multiple types of uncertainty, the Bar symbols were too large and too difficult to interpret.

1.5.2.4 *Lack of Symbol*. As expected, the contact symbol without a modifying MSDF certainty symbol was frequently inverted: it was equally interpreted as representing Certainty and Uncertainty. Accordingly, the final design should avoid using the absence of a certainty symbol as part of the symbol set.

1.5.3 Concept Issues

Before implementing any MSDF symbols on the tactical display care should be taken to ensure that the MSDF symbols would enhance the performance of the command and control task. The SMEs all resisted the concept that the MSDF would be useful to them at the CCS level. At the discussion group that followed the structured evaluation, 100% of the participants stated that they did not find the concept of certainty symbology to be useful at the CCS except perhaps to help with situation awareness when the operator first comes on shift. The SMEs indicted that the concept would be more useful in a planning display rather than in real time on the tactical display. Arguments made by the SMEs included the following:

- Any contact that was not clear would be examined in detail by the operator via the tabular displays. The SMEs suggest that interpreting the certainty measure would produce a distraction rather than help.
- Identification is not an issue at the CCS level. The identities of contacts represented on the CCS have already been confirmed elsewhere.
- Track quality is already identified by a number. These SMEs were quite clear that the main concern of the operators is whether the track quality is good enough; the quality is either good enough to engage or it is not. Levels of information about the track quality when it is anything less than "Good to Go" are less critical. It is not clear whether the less critical information is used at all. Additional detail, other than "Good to Go" or "Not Good to Go" in certainty displays is perceived by the operators to be a hindrance rather than help during a real-time CCS task.

1.6 New Design Concepts

The results of this evaluation suggested further design options that should be explored.

1.6.1 Modified Slider

The slider can be modified so that it is narrower. As well the design could incorporate a feature that permits the value to be seen unambiguously. For example, the Slider could be modified to include boxes to show how full the Slider is. The new design then would appear as small boxes in a vertical stack. The number of boxes filled, starting at the bottom, would reflect more certainty as more boxes are filled.

1.6.2 Background Symbol

A second design concept was presented by the SMEs. They suggested that the symbol for MSDF certainty be designed so that it is physically underneath the current contact symbol. The certainty information would form a background for the contact symbol. The design frame would be a square located underneath the current symbol and the certainty could be presented by the amount of fill as is done with the Slider. The SMEs acknowledged that such a design would be difficult to achieve without interfering with the ability to recognize and interpret the contact symbol.

1.6.3 Go-No Go

The SMEs were very concerned about clutter and about increasing their secondary task load by requiring them to interpret MSDF certainty symbology. In order to reduce each of these Unger Campbell proposes a third design concept. In the Go-No Go symbology the Slider, Dots, or Background symbol would be designed so that the information presented is that the Contact is either good to engage or not. A two-level symbol (e.g., outline squares or circles for Low Certainty (No-Go) contacts and filled squares or circles for High Certainty (Go) contacts would reduce the clutter as well reduce as the cognitive effort to interpret the symbols. The SMEs would be able to see the situation at a glance and then remove the symbols from the display.

1.7 Conclusions

The MSDF certainty symbology evaluation reported here revealed a number of details that can be applied to the design of MSDF certainty symbology. As intended, the evaluation permitted Unger Campbell to recommend the best option for the presentation of specific types of certainty. The Slider is the best option of the sets evaluated particularly if the type of certainty indicated is Time. If the certainty measure is other than Time, the Dots or a variant may be more successful.

In addition, the evaluation revealed or confirmed general information about certainty symbology. One particularly valuable finding is that these SMEs tend to interpret fuller symbols as indicating More Certainty.

Unger Campbell recommends that the results of this work be applied to modifying the designs to incorporate the information obtained here. The new symbols should be small, unambiguous, and clear.

If a clear, unambiguous, and small certainty symbol is presented on the CCS the operators may use it most frequently as a quick and general aid for situation awareness rather than as a continuous part of the Tactical display. Its value may be in helping to orient the operators as they come on duty as opposed to the original thinking that the information would be used throughout the CCS task.

2.0 DESIGN ILLUSTRATIONS

The following section provides a set of illustrations designed to enhance the existing COMDAT OMI Style Guide (See Campbell, Gweneth U. 2001. *COMDAT OMI Style Guide Version 1.0*. DCIEM-CR- 2001-151, Delta, British Columbia: Unger Campbell and Associates). Each illustration presented here is accompanied by a short description as well as the associated COMDAT OMI Style Guide reference in parentheses.

All brand names and trade names used in the illustrations in this document are the property of their respective owners. The illustrations in the following sections are after Microsoft styles.

2.1 Pointer Shapes

The table below illustrates pointer shapes associated with each function type depicted in Table 4.1 of the COMDAT OMI Style Guide (COMDAT OMI 4.3.1.17). The purpose of the shapes is to provide feedback in response to a user initiated action as well as denote the acceptable actions that are available in the given mode.

REPRESENTATIVE POINTER SHAPES		
Pointer	**Primary Function**	**Description**
	Pointing	The upper-left-pointing arrow is typically the pointer used in window areas for object selection. The hotspot is the arrow point.
	Moving	The four-directional arrow pointer indicates a move operation in progress. The hotspot is the point where the arrows intersect.
	Selecting Text	The I-beam pointer is used in text areas to position the text insertion cursor and perform actions on text (e.g. selecting text). The hotspot is on the vertical bar of the I-beam one-third from the top.
	Processing an Operation	The hourglass pointer indicates that an operation is being performed in a window area. When this pointer is displayed, all actions initiated by either the pointing device or keyboard are ignored in the area.
	Processing in the background	The hourglass-arrow pointer denotes that the system is processing an action in the background. The user is still able to perform other functions in spite of this processing. The hotspot is the arrow point.
	Context-sensitive help mode	The question mark-arrow pointer indicates that the user is in a context-sensitive help mode (e.g. invoked when a user selects the "What's This" button on the upper right corner of a secondary window). The hotspot is the arrow point.
 	Zoom-in & Zoom-out	The zoom-in pointer indicates the ability to "zoom-in" in order to see the object in more detail. The zoom-out pointer performs the reverse action.

	Resizing edges in specific orientations	The resize pointers indicate the directions for resizing an area. The horizontal and vertical resize pointers indicate resize in either the horizontal or vertical direction. The diagonal resize pointers indicate simultaneous resize in both the horizontal and vertical directions. The appropriate resize pointer appears when the pointer is placed on a frame boarder or size grip.
	Resizing a column	The column resize pointer denotes the ability to increase or decrease the width of a column. This pointer appears when the pointer is positioned on a column's vertical border or when vertically splitting a window.
	Resizing a row	The row resize pointer indicates the ability to increase or decrease the height of a row. This pointer appears when the pointer is positioned on a row's horizontal border.
	Not available as a drop target	The caution pointer appears when a user attempts to drop an object in a non-valid area.
	Navigate to linked reference	The hand pointer with the index finger extended appears when the cursor is placed over a hyperlink thereby indicating its function. The hotspot is the end of the index finger.
	Panning	The hand pointer with all the fingers extended denotes that the user is in the panning mode. Pressing the primary mouse button causes the fingers to "curl" as in a grabbing motion.

Figure 2.1 Defined Pointer Shapes for Functions

2.2 Primary Windows

Primary windows provide the screen area under which most applications run. Figure 2.2.1 Components of Primary Windows illustrates the standard components (e.g. title bar, window menu, minimize/maximize/close buttons) residing within a primary window (COMDAT OMI 5.2, 10.2). Specifically, Figure 2.2.1 illustrates the following:

- **Title text**. The window title appears in the title bar. The title is also left-justified and presented in mixed-case letters (COMDAT OMI 10.2.2.1, 10.2.2.2).
- **Title bar buttons**. Title bar buttons appear in the title bar in the following order: Minimize, Restore/Maximize, Close (COMDAT OMI 10.2.3.5).
- **Menu bar.** The menu bar is located below the title bar (COMDAT OMI 10.2.4.1).
- **Menu titles**. The menu titles begin at the left margin and extend to the right (COMDAT OMI 10.2.4.3). Each menu title also contains a mnemonic (COMDAT OMI 10.2.4.4).

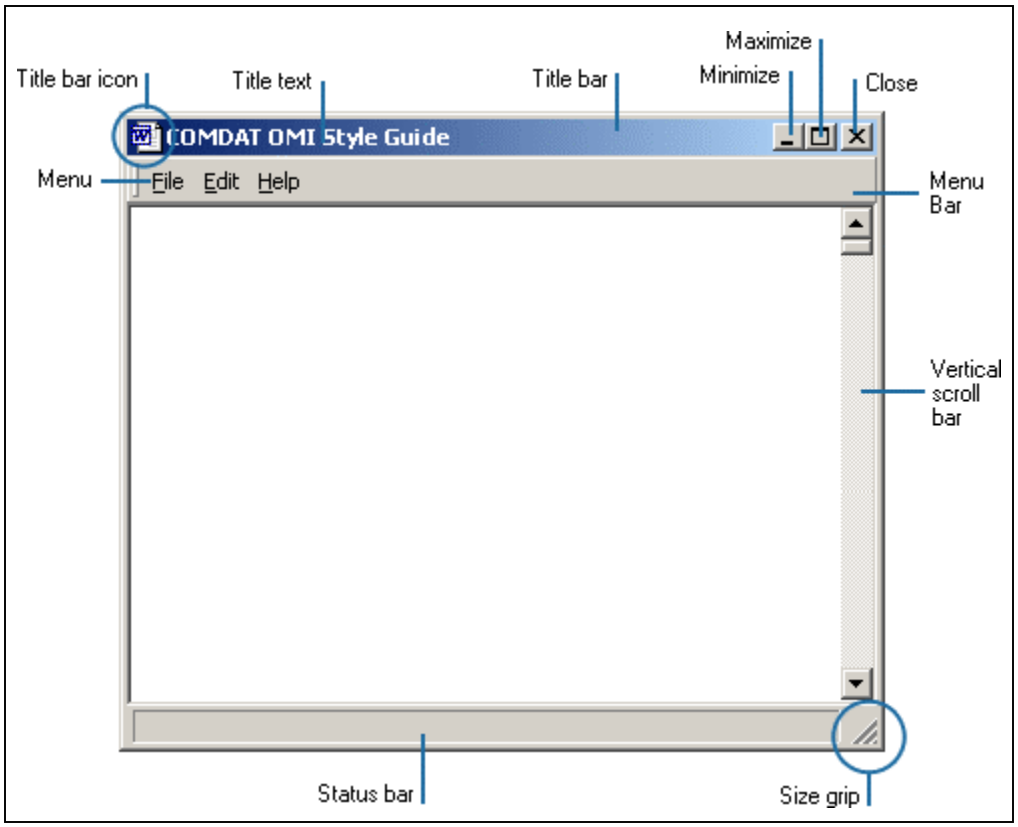


Figure 2.2.1 Components of Primary Windows

The title bar icon for the primary window also provides access to a pull-down menu that contains window management options as shown below in Figure 2.2.2 Window Pull-down Menu (COMDAT OMI 10.2.5):

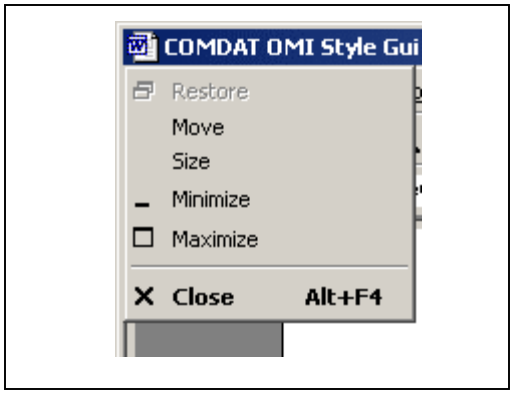


Figure 2.2.2 Window Pull-down Menu

2.3 Secondary Windows

Secondary windows are called from primary windows to display information to or obtain information from the user. Below are common examples of dialog and message secondary windows as listed in Section 5.3.1.1 of the COMDAT OMI Style Guide. Each type serves a different purpose depending on the current interaction between user and system.

2.3.1 Dialog Window

A dialog window (or box) provides an exchange of information or dialog between the user and the application. Typically, a dialog window is used to obtain additional information from the user that is needed to carry out a particular command or task. The commonly-used Microsoft Open dialog window is presented to when the user chooses to open a new file from within an application. An example of a dialog window is presented in Figure 2.3.1 Example of Dialog Window below:

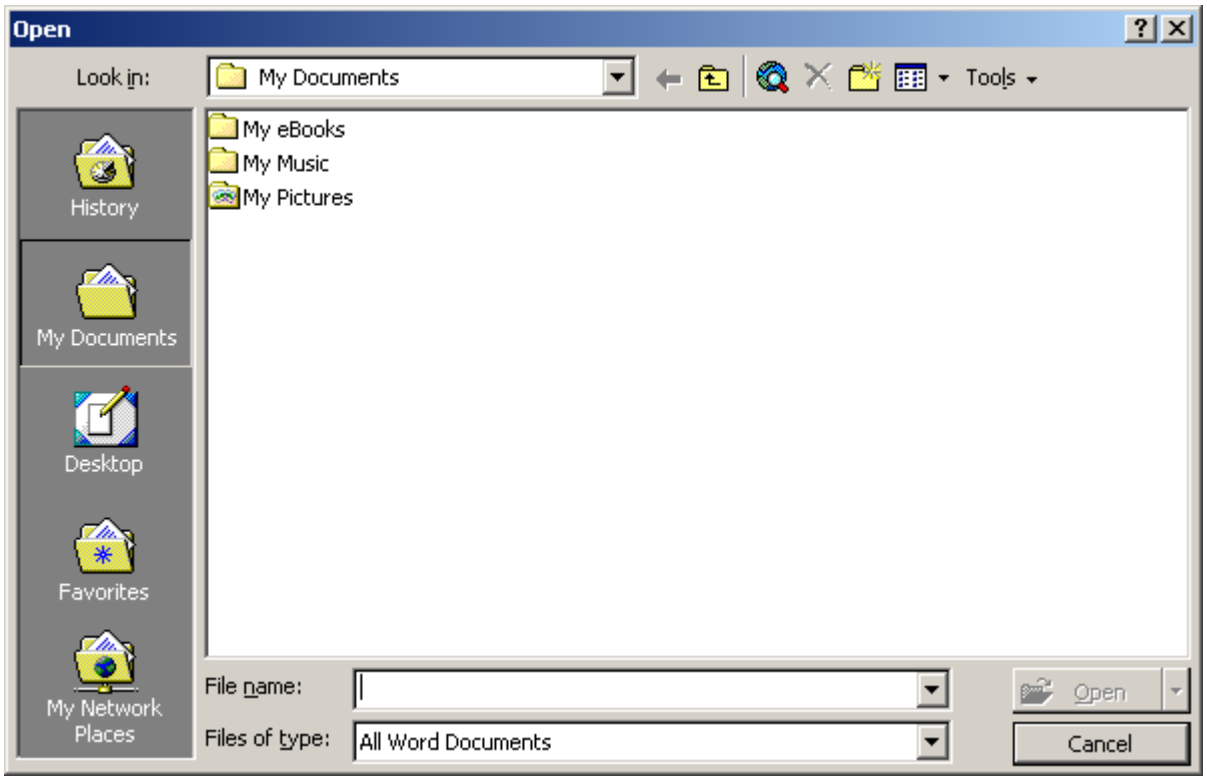


Figure 2.3.1 Example of a Dialog Window

2.3.2 Message Boxes

A message box is a secondary window that displays a message about a particular situation or condition such as error messages and warnings of potentially harmful actions. Four common types of Microsoft message boxes are illustrated below as follows:

- Error
- Information
- Question
- Warning message

2.3.2.1 *Error Message Box*. An error message box informs the user of a serious problem that requires intervention or correction before work can continue. An example of an Error message box is presented below:

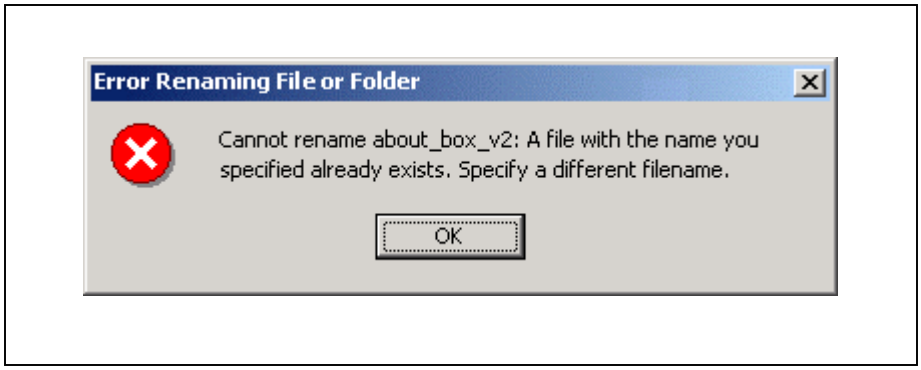


Figure 2.3.2.1 Example of an Error Message Box

2.3.2.2 *Information Message Box*. An Information message box presents general information to users such as the results of a command. An example of an Information message box is presented below:

Figure 2.3.2.2 Example of an Information Message Box

2.3.2.3 *Warning Message Box*. A Warning message box alerts the user to a condition or situation that requires the user's decision and input before proceeding. Examples include an impending action with potentially destructive, irreversible consequences. An example of a Warning message box is presented below:

Figure 2.3.2.3 Example of a Warning Message Box

2.3.2.4 *Question Message Box*. A question message box can be used to query the user prior to performing certain actions. An example of a Question message box is presented below:

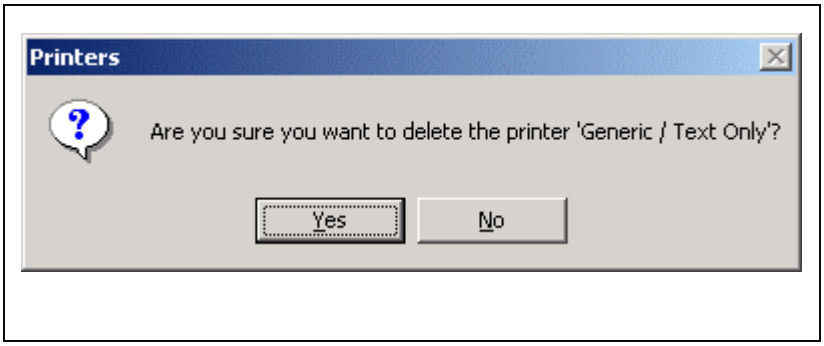


Figure 2.3.3.4 Example of a Question Message Box

2.4 Drag Transfer (Drag and Drop)

Movable or copyable text and objects can be moved or copied to a new location by using the pointer and the drag function. The figure below illustrates the available drag options as well as their associated visual representation (COMDAT OMI 7.4.5.2). Refer to Section 7.4.5.1 for details regarding the execution of the Move Drag. Note: the link and copy variants add undue complexity to the COMDAT OMI and should not be used.

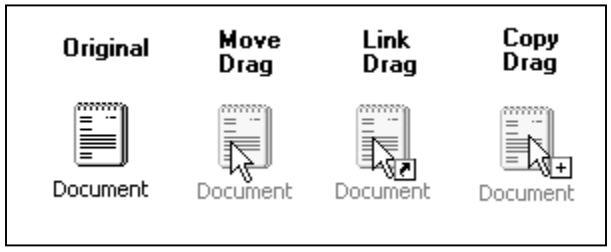


Figure 2.4 Drag Transfer (Drag and Drop)

2.5 System Response Time

The system should always keep users informed about what is going on, through appropriate feedback to their actions (COMDAT OMI 7.5.4). The Microsoft Copy dialog box presented below is a good example that illustrates how the system can provide feedback during the conduct of a time-intensive function. Note the progress bar and time to indicate the expected length for executing the actions as well as the ability to cancel the operation. In addition, the dialog box can provide a simple animation to let the user know that the action is being carried out.

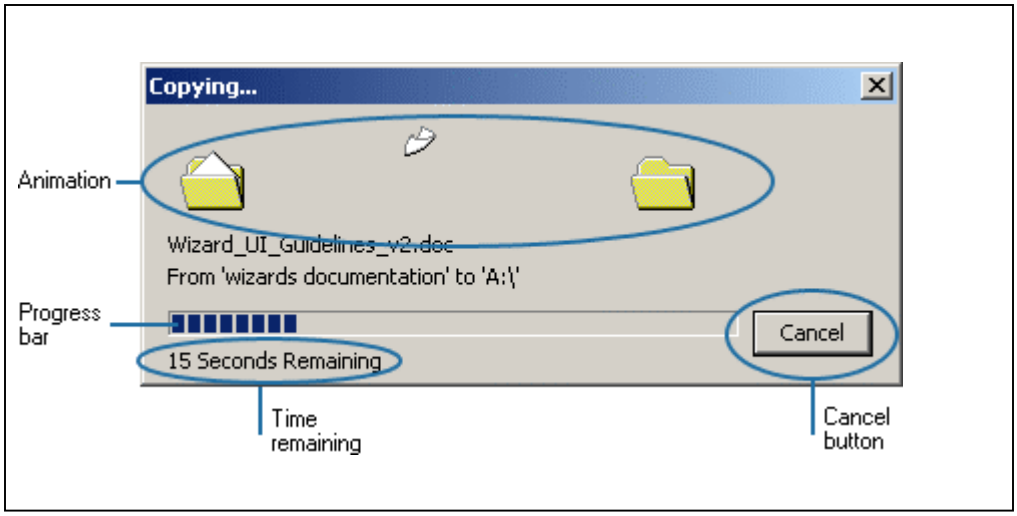


Figure 2.5 Example of System Feedback

2.6 Action Icons

Action icons provide unique graphic images that enable the user to recognize the action to be performed (COMDAT OMI 8.4). In the following table are some of the common action icons that exist across Microsoft applications. (Note: Refer to Section 2.8: Toolbars to see these action icons located within toolbar configurations.)

ACTION ICONS		
Icon	**Term**	**Action Performed**
	New	Opens a new document within the application.
	Open	Launches the Open dialog box in order to open an existing document.
	Save	Saves the current document.
	Print	Prints the current document.
	Print Preview	Opens the preview window so that the print version of the document can be viewed on-line.
	Cut	Removes an object from a window and stores it on the clipboard
	Copy	Duplicates an object to the clipboard without deleting it from the window.
	Paste	Inserts an object from the clipboard into a window at the selected location.
	Undo	Returns an object to its state prior to the last operation being executed.
	Redo	Reverts the Undo operation.
	Delete	Deletes the selected object from the window.
	Bold	Bolds the selected text.
	Italics	Changes the selected text to italics.

Figure 2.6 Examples of Action Icons

2.7 Push buttons

2.7.1 Appearance

Push buttons are used to initiate an action. All push buttons in an action area of a dialog window should be the same size (COMDAT OMI 8.5.2.6). Below is an example of buttons of equal size that are compliant to the COMDAT OMI Style Guide and buttons of unequal size that are non-compliant.

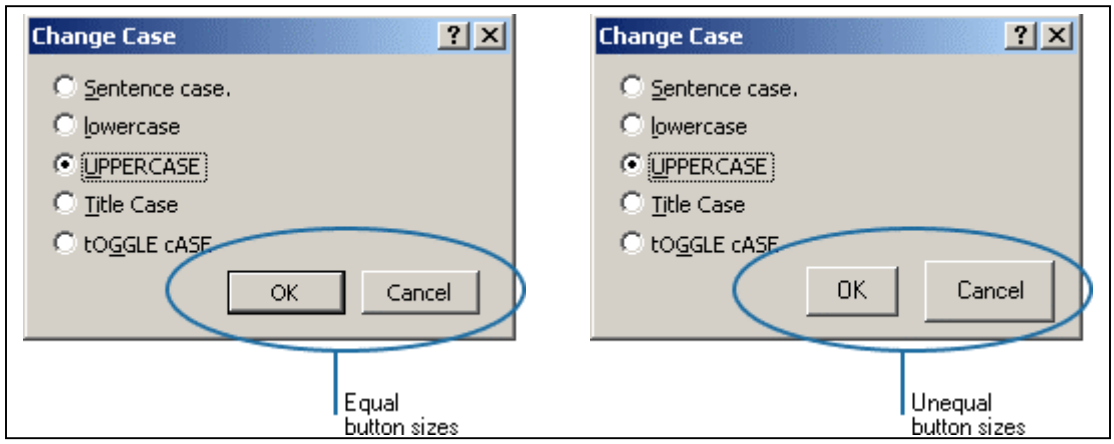


Figure 2.7.1 Example of Equal and Unequal Button Sizes (taken from Microsoft Word)

2.7.2 Default push buttons

The default push button on a given window is indicated by providing that button with an extra border (COMDAT OMI 8.5.6). Below is an example of the default push button on a MS warning message window:

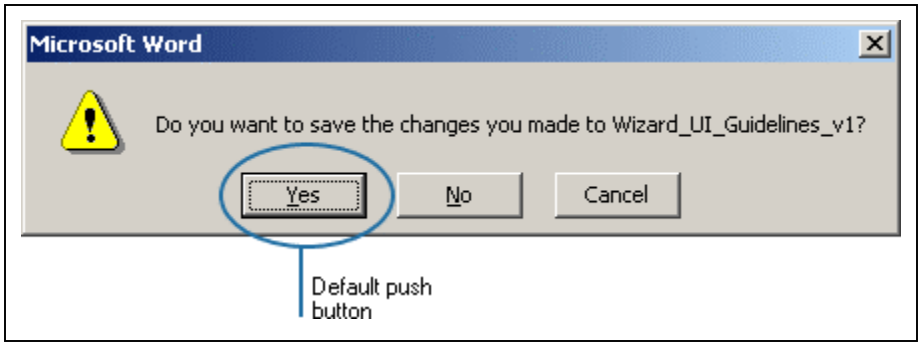


Figure 2.7.2 Example of a Default Push Button

2.8 Toolbars

Toolbars are on-screen menus that use action icons instead of words to represent functions. Figure 2.7.1 illustrates the horizontal configuration for the Standard and Formatting toolbars that are typically docked at the top of the application window for Microsoft Word. To assist with their identification, labels for each action icon in the toolbars in Microsoft Word are presented via the ToolTips functionality.

2.8.1 Docked Toolbars

Compliance to the following requirements is depicted in Figure 2.8: Example of Docked Toolbars:

- **Toolbar location**. The toolbars are located directly below the menu bar (COMDAT OMI 8.6.1.2);
- **Toolbar groups**. Toolbar functions are grouped together in order to support a specific task (COMDAT OMI 8.6.1.3).
- **Action icon size**. All action icons are the same size (COMDAT OMI 8.6.1.5).

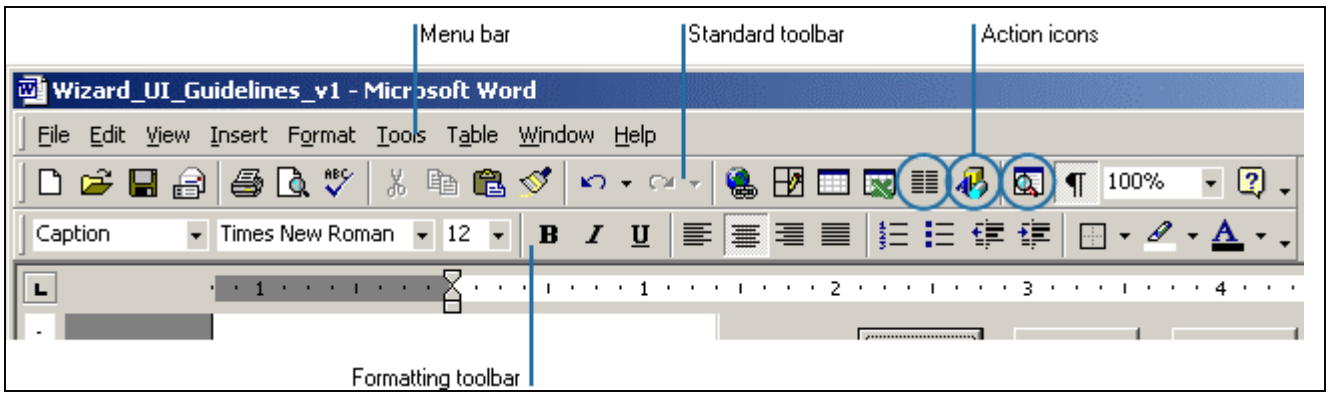


Figure 2.8.1 Example of Docked Toolbars

Figure 2.8.2 illustrates a floating configuration for the Microsoft Standard toolbar presented in Figure 2.8.1 Example of Docked Toolbars above. In addition, in the figure below the shape of the toolbar has been changed to align the buttons across two rows as opposed to one.

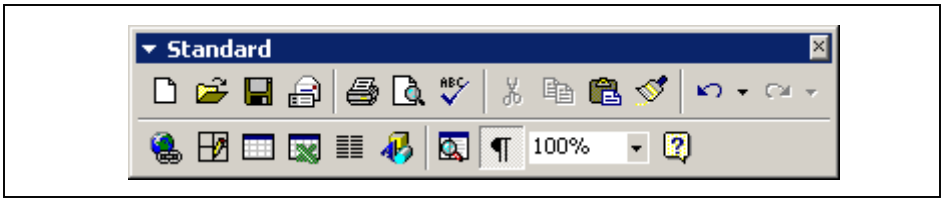


Figure 2.8.2 Example of a Floating Toolbar

2.9 Radio Buttons

Radio buttons allow users to select one option from a group of mutually exclusive options (COMDAT OMI 8.7). The radio buttons illustrated below are typically found on the Print dialog box for Microsoft applications whereby the three "Page range" options allow the user to select one of three distinct settings for printing the document.

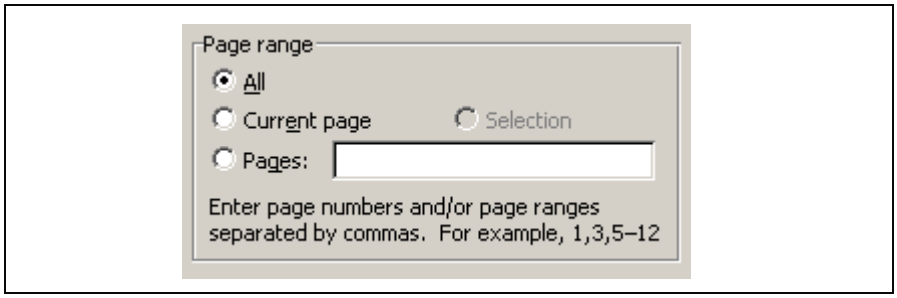


Figure 2.9 Example of Radio Buttons

2.10 Toggle Buttons

Toggle buttons allow users to "toggle" the states for a given object (COMDAT OMI 8.8). For example the Show/Hide button ( ) on a toolbar can be pressed to display the formatting symbols in a Microsoft Word document. For the "Show" state, the button remains visually pressed (left figure) until the user clicks the button again and reverses the setting to the "Hide" state.

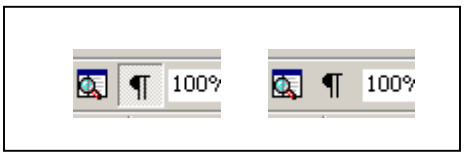


Figure 2.10.1 Example of a Show/Hide Toggle Button

Another implementation of a toggle button is the Maximize/Restore (middle) button found on the top right corner of Microsoft windows. When the window is not maximized, the Maximize button is displayed to denote the ability to perform the "Maximize" action. When the window is maximized, the Restore button replaces the Maximize button thereby indicating the ability to return the window to its previous state.

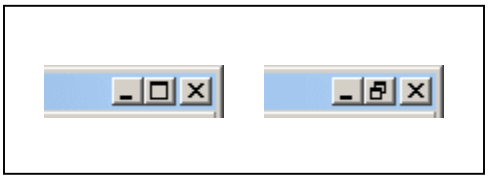


Figure 2.10.2 Example of a Maximize/Restore Toggle Button

2.11 Check boxes

Check boxes allow users to toggle the state or setting for option(s) (COMDAT OMI 8.9). The example shown below is of a check box implementation that allows the user to adjust the various Pagination settings for a Microsoft Word document.

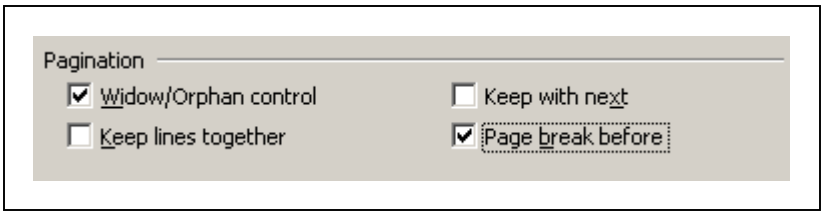


Figure 2.11 Example of Check Boxes

2.12 List boxes

List boxes are used to view and scroll through several items that are related (COMDAT OMI 8.10). The illustrated list box provides the user with a list of several toolbar types.

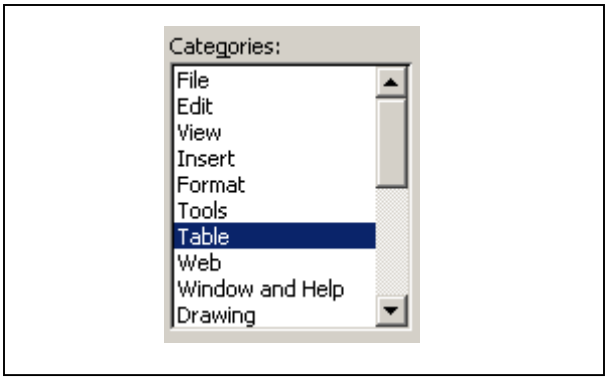


Figure 2.12 Example of a List Box (taken from Microsoft Word)

2.13 Scroll bars

Scroll bars allow users to view textual or graphic information when that information exceeds the available display area in the window (COMDAT OMI 8.11). Below is a horizontal scroll bar with the various components labeled. If scroll bars are required, vertical scroll bars are preferred.

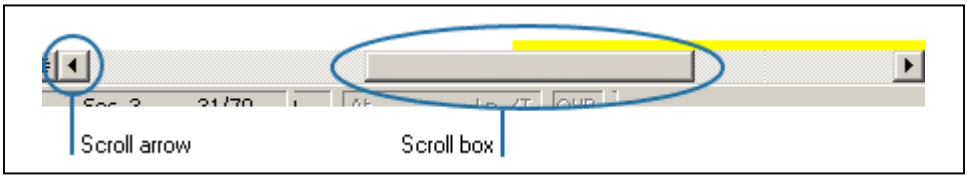


Figure 2.13 Example of a Scroll Bar

2.14 Scales

A scale is used to set or display a value in a continuous range (COMDAT OMI 8.12). To adjust the values along a scale, a slider can be implemented whereby the user can drag the pointer across specified positions along the line. The slider illustrated below in Figure 2.14.1 Example of a Scale provides the capability to adjust the speed with which the pointer moves within the Microsoft operating system.

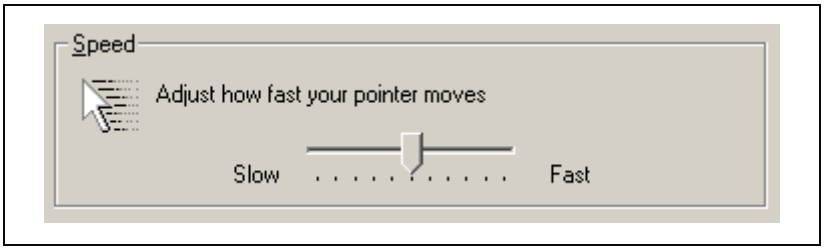


Figure 2.14 Example of a Scale

2.15 Drop-down Combination Boxes

Similar to a list box, a drop-down combination box uses the standard text field and list widgets. A drop-down combination box allows the selected item to be set off from the list and allows for subsequent letter speed search instead of only first letter speed search (COMDAT OMI 8.13.3). As shown in Figure 2.15 Example of a Drop-down Combination Box presented below, these boxes allow the user to create a new file name or select from a pre-defined list of file names as well as to select a format for saving the file.

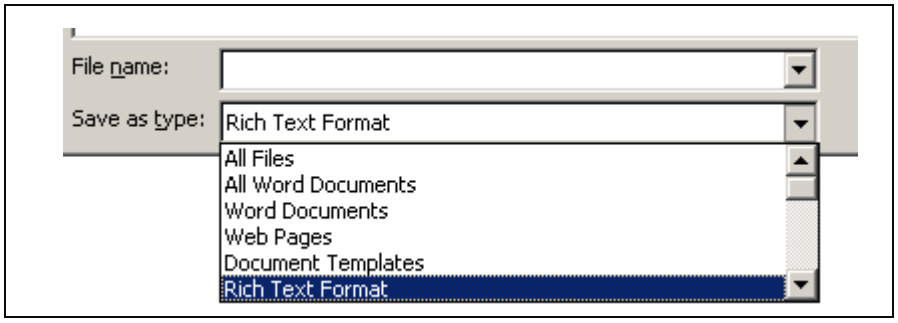


Figure 2.15 Example of a Drop-down Combination Box (taken from Microsoft Word)

2.16 Spin Boxes

Spin boxes consist of a text field with arrows attached to the right side of the text field. The arrows are organized with an upward pointing arrow above a downward pointing arrow (COMDAT OMI 8.13.4). Pressing the arrow buttons allows the user to increment (or decrement) the value in the text field. The spin boxes illustrated below in Figure 2.16.1: Example of a Spin Box provides the user with the ability to change the spacing before and after a paragraph in a Microsoft Word document.

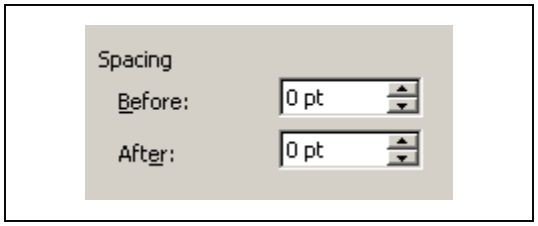


Figure 2.16.1 Example of a Spin Box

Figure 2.16.2 Example of a Component Spin box, below, is an example of a spin box with several subcomponents with the text fields separated by colons whereby the arrows affect the highlighted text field (i.e. minutes) (COMDAT OMI 8.13.4.6).

Figure 2.16.2 Example of a Component Spin Box

2.17 Menus

2.17.1 Menu Components

Menus provide a means for the operator to access functions in a hierarchical fashion. The following diagram illustrates several generic menu characteristics including the following:

- **Design**. General menu design in accordance with the MSWUE (COMDAT OMI 9.1.1).
- **Grouping**. Grouping of menu items with separator lines (COMDAT OMI 9.1.6, 9.4.3.1).
- **Ellipsis**. Use of the ellipsis to depict a menu option that displays a window (COMDAT OMI 9.1.9).
- **Cascading submenus**. Use of a right-pointing arrow to denote a cascading submenu (COMDAT OMI 9.1.10). Cascading menus appear to the right of the parent menu if the space is available (COMDAT OMI 9.7.4.1). The first option in the submenu does not repeat the parent option and it is aligned with the right-pointing arrow in the parent menu (COMDAT OMI 9.7.4.3, 9.7.4.4).
- **Mnemonics**. Use of unique mnemonics for all menu titles in the menu bar and every option in the menu (COMDAT OMI 9.3).
- **Justification**. All menu options are left-justified and appear on a single line (COMDAT OMI 9.4.2.1).
- **Unavailable options**. Temporarily unavailable options are displayed in the menu but are dimmed to indicate that they cannot be selected (COMDAT OMI 9.4.4.2).
- **Option selection**. Use of inverse video to indicate the selection of a menu item (COMDAT OMI 9.5.1).
- **Accelerators**. Use of keyboard accelerators for menu options that are frequently selected (COMDAT OMI 9.5.2). These accelerators are right justified on the same line as the menu option (COMDAT OMI 9.5.2.3).

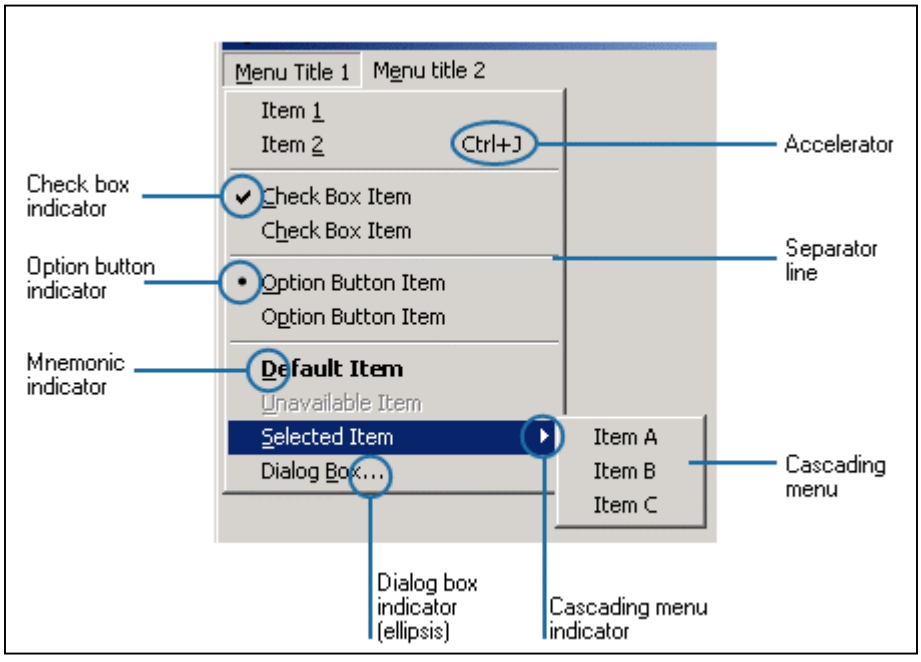


Figure 2.17.1 Types of Menu Options

2.17.2 Pop-up menus

Pop-up menus provided quick access to actions that can be performed on the selected object (COMDAT OMI 9.7.1). The figure below illustrates a typical pop-up menu. The pop-up menu exhibits many of the menu characteristics highlighted in the Section 2.17.1 Menu Components, above. The Pop-up menu illustrated in Figure 2.17.2 Example of a Pop-up Menu, is displayed when a user right-clicks while editing text in a Microsoft Word document. The figure illustrates the following:

- **Design**. Pop-up menu design in accordance with the MSWUE (COMDAT OMI 9.7.1.1.2)
- **Mnemonics**. Use of unique mnemonics for all menu options (COMDAT OMI 9.7.1.1.4)
- **Unavailable options**. Dimming of temporarily unavailable options (COMDAT OMI 9.7.1.1.5)
- **Location**. Menu displaying near the element with which it is associated (COMDAT OMI 9.7.1.1.8)

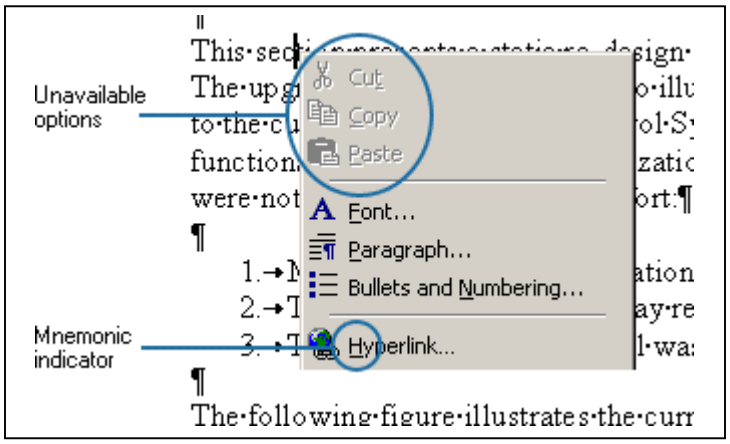


Figure 2.17.2 Example of a Pop-up Menu

2.17.3 Pull-down (or Drop-down) Menus

The figure below (Figure 2.17.3 Example of a Pull-down Menu) illustrates a standard Pull-down menu (COMDAT OMI 9.7.2). The example presented here is from the menu structure for Microsoft WordPad. The figure illustrates the following:

- **Menu bar**. The title of a pull-down menu is displayed in the menu bar at the top of the window (COMDAT OMI 9.6.1, 9.7.2.5).
- **Capitalization**. The first letter of each word in the menu title is capitalized (COMDAT OMI 9.6.2, 9.7.2.6).
- **Help menu**. The Help menu title is the right-most item in the menu bar (COMDAT OMI 9.6.6).
- **Menu titles**. Menu titles in the menu bar have an equal amount of space between them (COMDAT OMI 9.6.7).

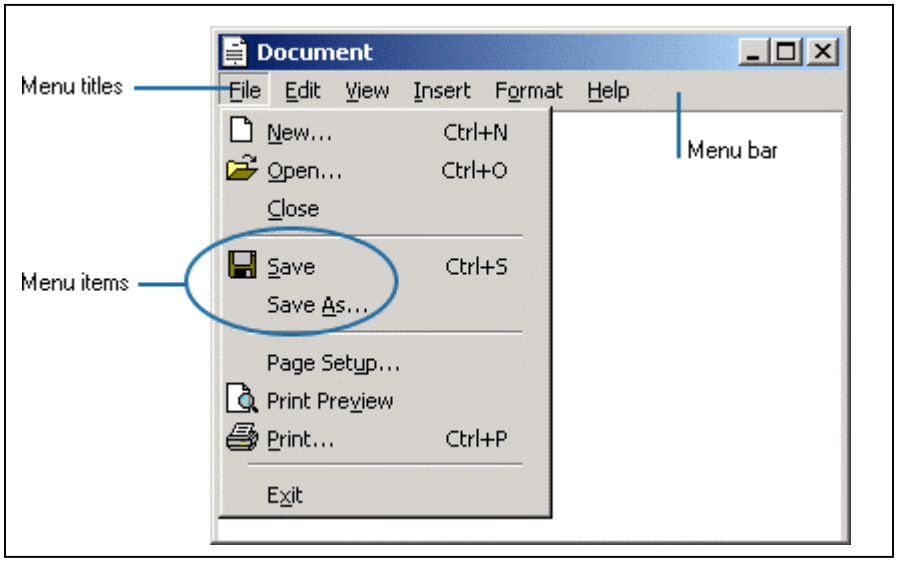


Figure 2.17.3 Example of a Pull-down Menu

2.18 System Login

Login windows, such as the example below (Figure 2.18 Example of a Login Window), can be implemented to restrict access to sensitive applications (COMDAT OMI 11.2). As a minimum, the login window contains two text fields: one for entering a user name and one for a password. For security purposes, asterisks are displayed for each password character entered.

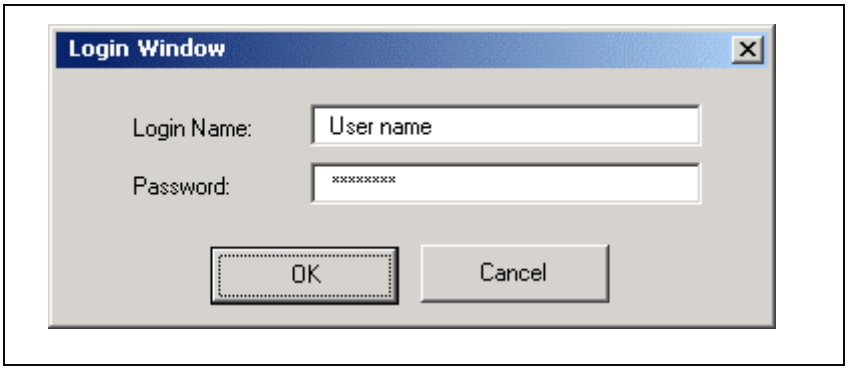


Figure 2.18 Example of a Login Window

2.19 List-to-list transfer

A list-to-list transfer is used to copy (or move) items from a source list (master list) to a destination list (COMDAT OMI 13.4). Figure 2.19 Example of a List-to-list Transfer, below, depicts a typical convention used for performing this type of action.

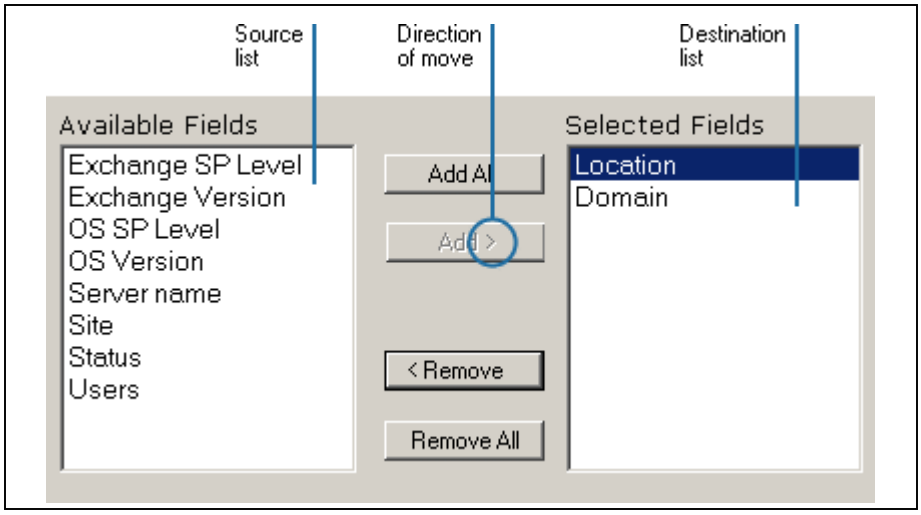


Figure 2.19 Example of a List-to-list Transfer

2.20 Spell Checking

Spell checking can highlight erroneous entries to the user as well as provide suggestions for corrections (COMDAT OMI 13.6). For instance, Microsoft Word provides the following dialog box to assist the user with checking the spelling of a text document.

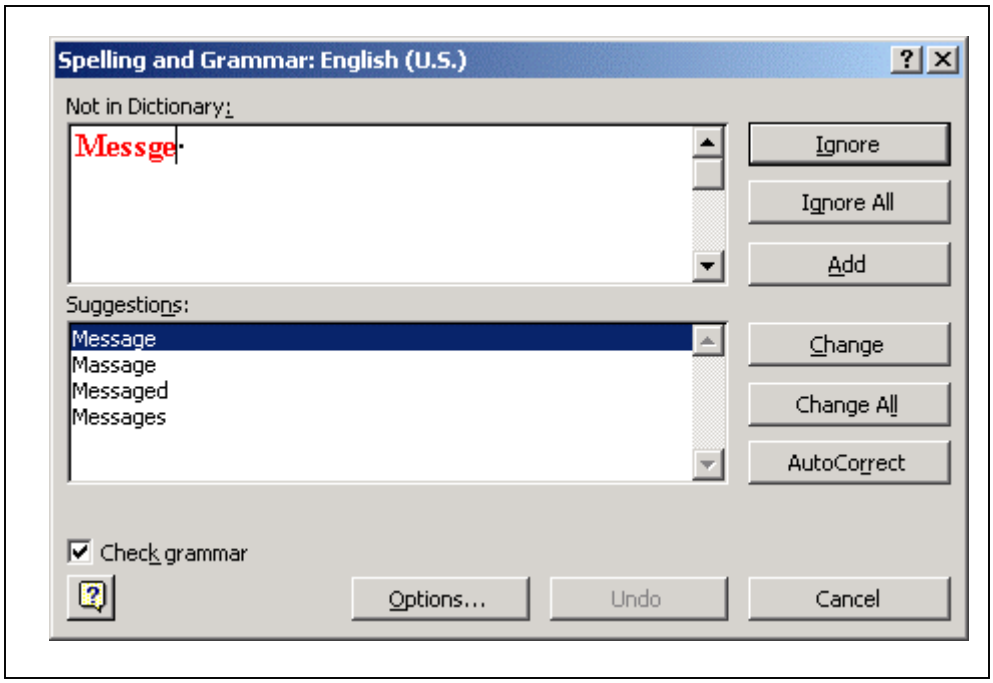


Figure 2.20 Example of a Spell Checker Window

2.21 Printing

Print dialog boxes allow the user to specify print settings such as the capability to print a single page, or a sequence of pages, by specifying the page numbers (COMDAT OMI 13.7). For instance, Figure 2.21 Example of a Print Dialog illustrates an Microsoft Word dialog box with the ability to adjust printer settings. Printer setting depicted here include the choice of output printer, page range, number of copies, and zoom size of the print out.

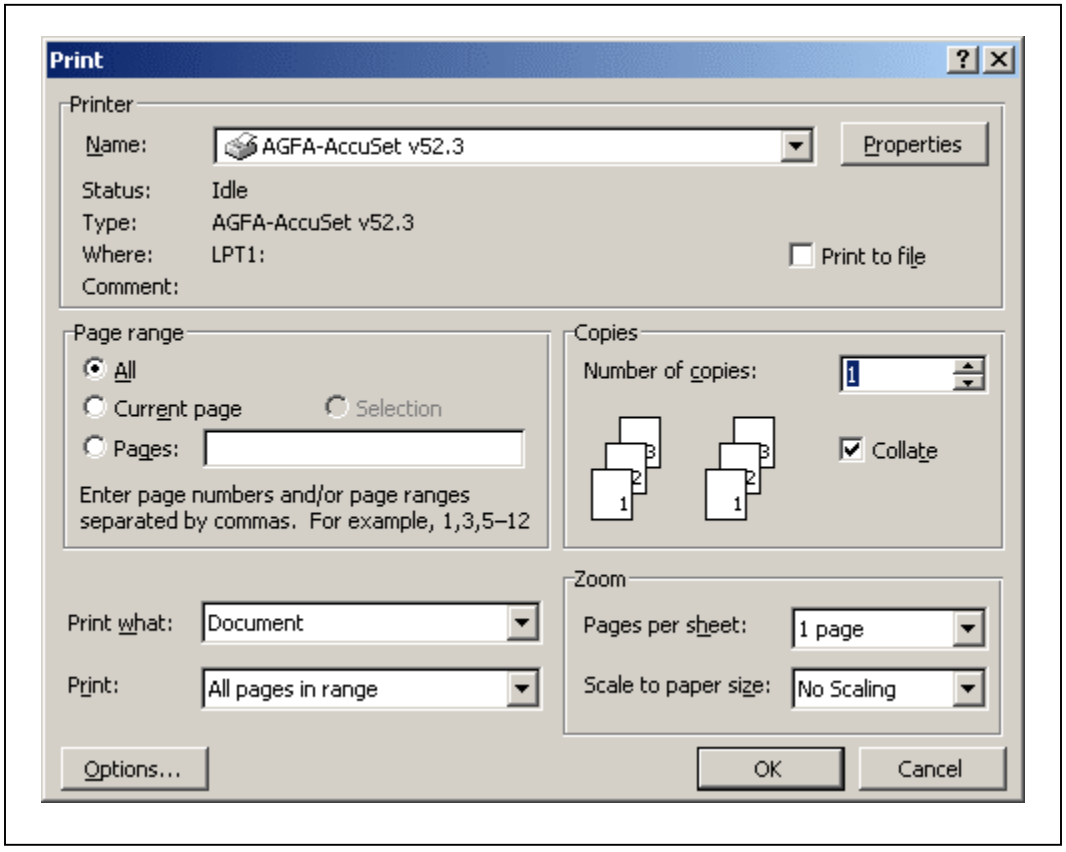


Figure 2.21 Example of a Print Dialog

2.22 Graph Display

Graphs can be used to present assessment of trend information, spatially structured data, time critical information or relatively imprecise information (COMDAT OMI 14.1). There are a number of types of graphs; an example of a line graph and a bar graph is presented here.

2.22.1 Line Graph

Figure 2.22.1 Example of a Line Graph depicts the hypothetical operating costs over one year for two different ships:

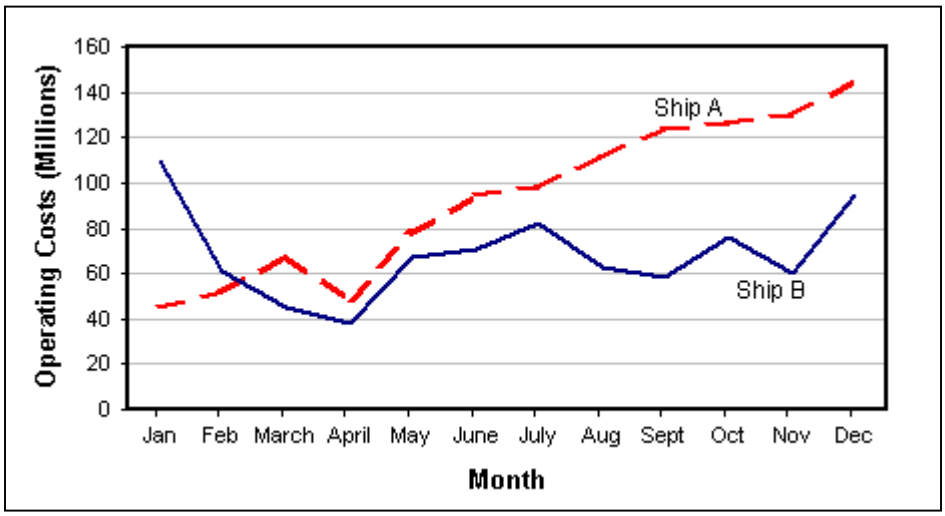


Figure 2.22.1 Example of a Line Graph

2.22.2 Bar Graph

Similarly, a bar graph (or histogram) can be used to display the same information on a month by month basis as shown below:

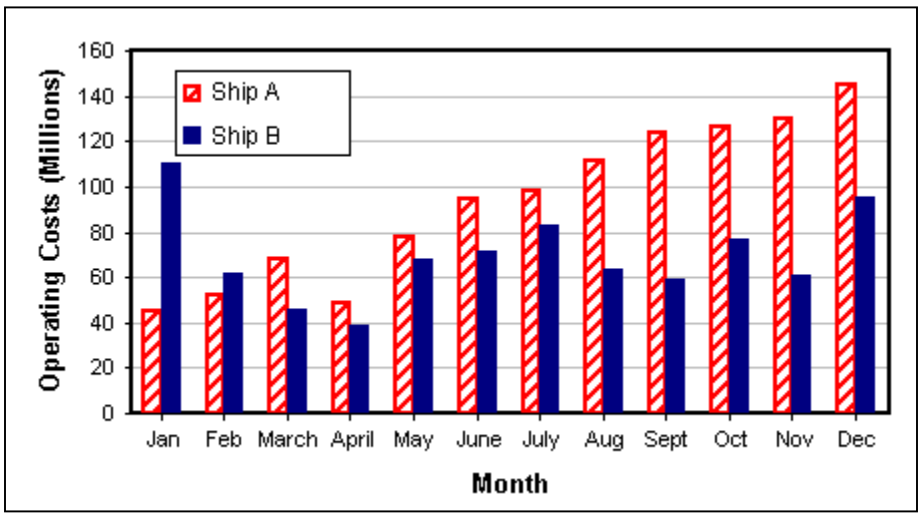


Figure 2.22.2 Example of a Bar Graph

3.0 CCS LOOK AND FEEL UPGRADE

This section presents a static re-design of the current Halifax Class CCS functionality and layout. The upgraded design was created to illustrate the application of the COMDAT OMI Style Guide to the current Command and Control System. Re-design of the functionality, navigation, or organization of the current CCS was out of scope of the current effort and was not addressed here. Specifically, the following items were not addressed by the design effort:

- Major groupings of information remained intact as well as their position on the screen.
- The tactical graphical display remained intact.
- The Quick Action Button (QAB) interaction model was not changed.
- Text labels and fields were not removed from the design.
- The tactical display was not altered.

In addition to improving the look and feel of the CCS, an important area of improvement for the operators is the interaction model for the QABs. The QABs are the primary means for the operators to interact with the system. Currently the operators are required to memorize both the location of functionality within the QAB matrix and the navigation to locate each necessary button. The memory requirements are error-prone and the navigation is inefficient. Experienced operators have difficulty with Command and Control tasks due to difficulties with the QAB matrix. Further development should address the functions of the CCS and navigation through the entire system.

Section 3.0 is divided into three parts as follows:

3.1 Illustration of a current CCS screen as displayed to the ORO.
3.2 Illustration of the re-designed CCS screen.
3.3 Highlights and detailed illustrations of the re-designed CCS screen.

3.1 Illustration of a Current CCS Screen as Displayed to the ORO

The following figure (Figure 3.1 Current Version of the CCS) illustrates a view of the current Command and Control System as seen by the ORO. The current CCS is designed to be consistent with OSF Motif design guidelines.

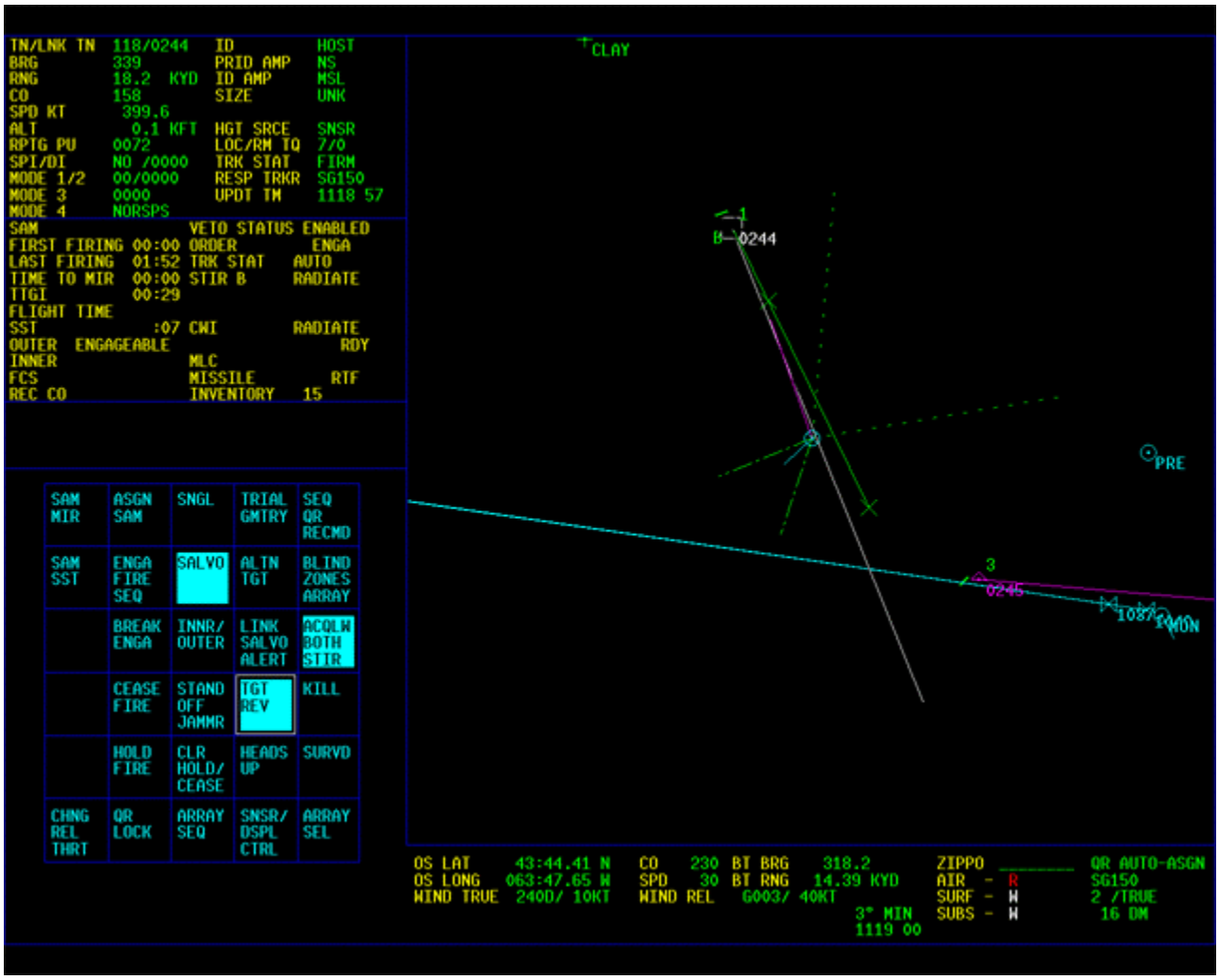


Figure 3.1 Current Version of the CCS

3.2 Illustration of the Re-designed CCS

Figure 3.2 COMDAT OMI Style Guide Version of the CCS, below, depicts the same view of the CCS as presented above, however the screen has been re-designed to illustrate how it could look if it were compliant with the COMDAT OMI Style Guide.

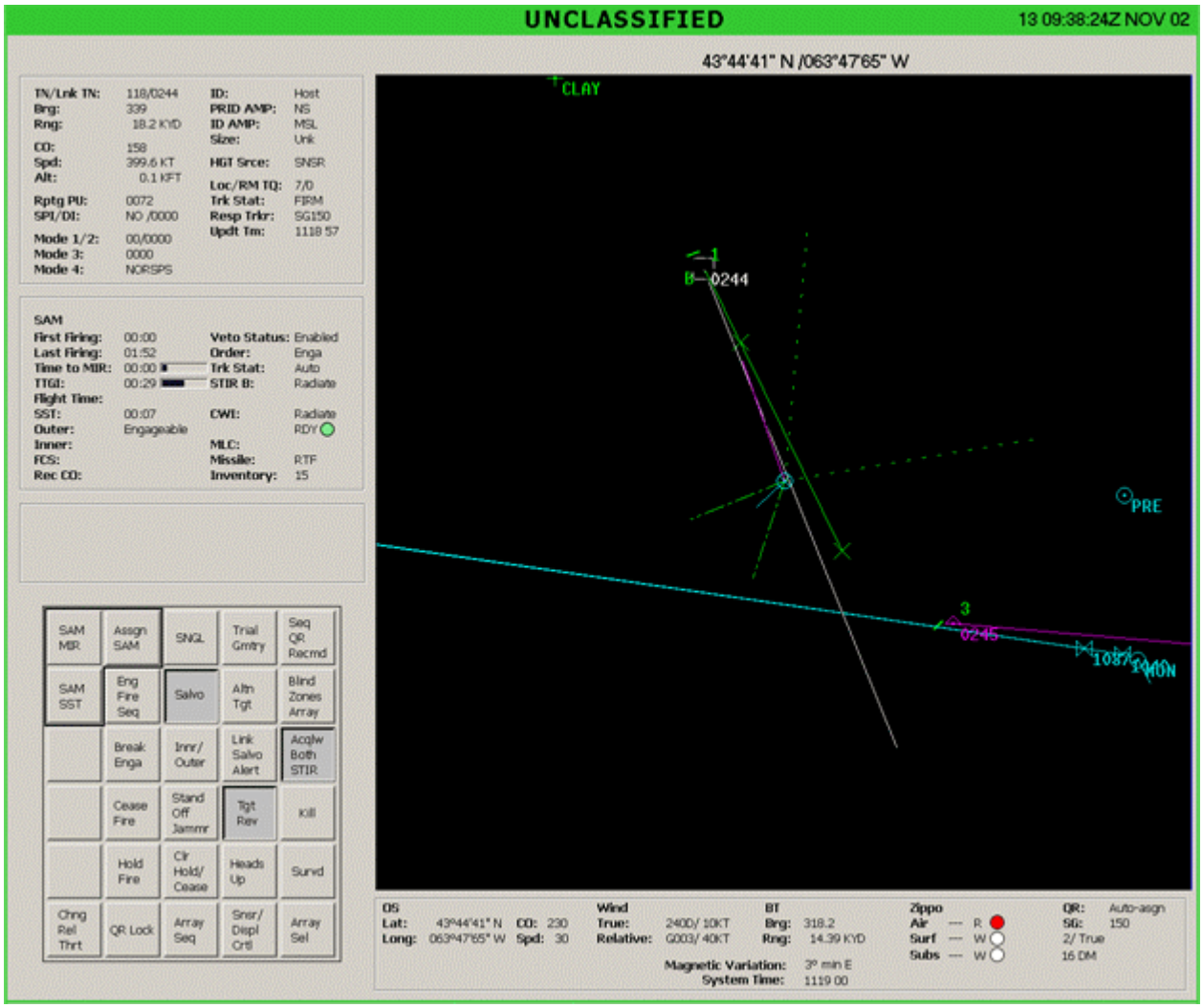


Figure 3.2 COMDAT OMI Style Guide Version of the CCS

3.3 Highlights and Detailed Illustrations of the Re-designed CCS Screen

Section 3.3 describes in more detail the highlights of the changes made to the ORO screen shown in Figure 3.2 COMDAT OMI Style Guide Version of the CCS. Letter identifiers indicate the highlighted features. The letters are explained in detail below the figure. Where applicable, the specific section within the COMDAT OMI Style Guide is provided in parenthesis after each description.

3.3.1 Microsoft "look and feel"

Overall, the re-designed version of the CCS was provided a Microsoft flavour by changing the background to grey and using the Tahoma font for all of the text.

3.3.2 COMDAT Status Bar

At the top of the CCS screen, a COMDAT Status Bar was added. Figure 3.3.2.1 provides a more detailed view of the features of the status bar. In addition to the status bar, the window border is also colour coded to depict the classification level (see Figure 3.2 COMDAT OMI Style Guide Version of the CCS; COMDAT OMI 5.1.2).

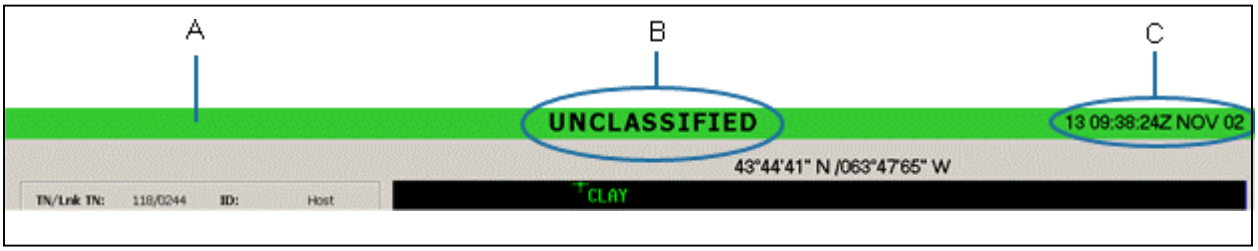


Figure 3.3.2 COMDAT Status Bar

The COMDAT Status Bar was designed to illustrate the following requirements:

A. **Status bar**. The Unclassified bar is displayed in green as the background of the classification text (COMDAT OMI 5.1.2.10, 5.1.2.11). The classification bar is located at the top of the screen (COMDAT OMI 5.1.1).
B. **Classification level**. The classification level is displayed in the middle of the status bar using all caps and greater than 14-point bold Tahoma font (COMDAT OMI 5.1.1.3, 5.1.2.4, 12.3.3.15).
C. **Clock**. The digital clock is displayed to the right end of the status bar, showing the Date/Time Group (COMDAT OMI 5.1.1.4, 13.2.1.4, 13.2.1.6).

3.3.3. Presentation of Text

A significant portion of the CCS is the display of read-only information to the operators. Examples include contact information and information regarding own ship parameters. Figures 3.3.3.1 and 3.3.3.2 provide an enlargement of the information as shown on the re-designed Tactical Read-out (TR)01, TR02, and TR04 on the CCS.

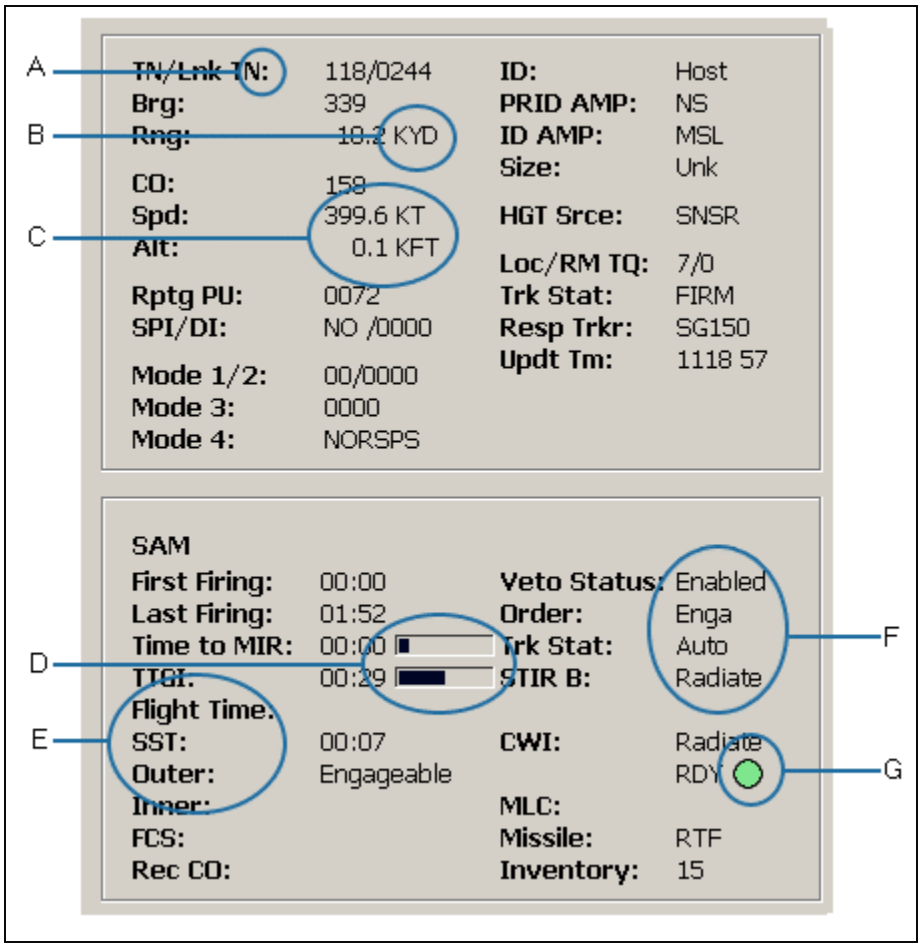


Figure 3.3.3.1 Presentation of Read-only Information: TR01 and TR02

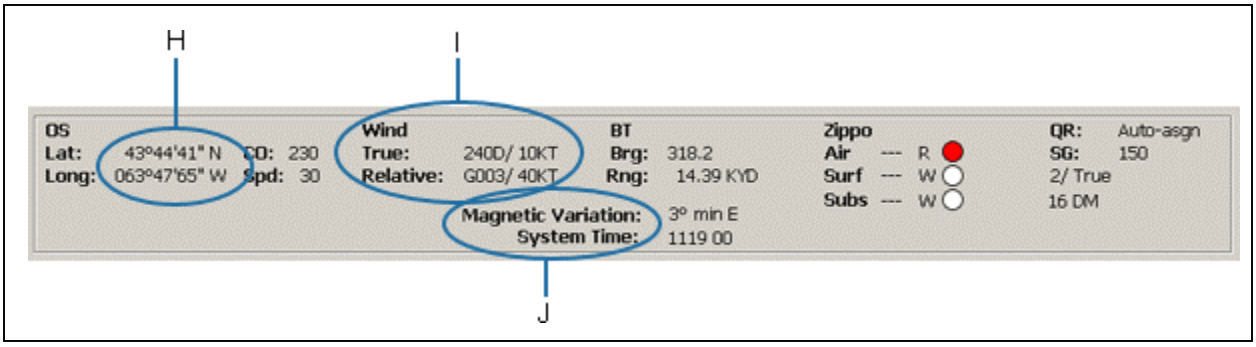


Figure 3.3.3.2 Presentation of Read-only Information: TR04. (Note: For convenience of illustration, the scale of the TR04 is smaller than that of the previous figure, Figure 3.3.3.1)

As can be seen in Figures 3.3.3.1 and 3.3.3.2 above, all text labels and fields are in Tahoma font style and the colour is black (COMDAT OMI 12.3.3.5, 12.3.3.14). Labels are also visually distinct from their associated fields (COMDAT OMI 12.3.4.18). In addition, the following features are illustrated in the figures:

A. **Colons**. Colons appear after each text field label (COMDAT OMI 12.3.4.1, 12.3.4.9).
B. **Dimensions**. Standard and consistent dimensions are provided by the system and listed to the right of the field (COMDAT OMI 12.3.8.1).
C. **Justification of numeric data**. Numeric data without decimals are right justified and numeric data with decimals are justified on the decimal point (COMDAT OMI 12.3.5.4).
D. **Progress bars**. Progress bars have been added to provide a graphical representation for time (COMDAT OMI 12.3.7.9).
E. **Capitalization**. Book title is used for labels (COMDAT OMI 12.3.9.1). Uppercase labels are reserved for acronyms and security classification banners (COMDAT OMI 12.3.9.2).
F. **Justification of alphanumeric data**. Text labels and alphanumeric fields are left justified (COMDAT OMI 12.3.5.1).
G. **Use of colour**. A green circle has been added to enhance the □RDY□condition (COMDAT OMI 17.1).
H. **Lat/Long format**. Correction format for Latitude and Longitude data have been implemented (COMDAT OMI 13.2.1.8, 13.2.1.9).
I. **Grouping**. Test fields have been grouped by related functionality. For example, the two types of wind speeds (true and relative) have been grouped together under the □Wind□header.
J. **Missing labels**. Text labels that were missing from the original ORO screen (□Magnetic Variation□and □System Time□) have been included for consistency.

3.3.4 Quick Action Buttons (QABs)

The Quick Action Buttons were updated without altering their positions, text, or navigation access. The changes are designed to illustrate the types of changes that result from consistency with the COMDAT OMI Style Guide. A letter indicates the highlights and the explanation for each highlighted feature is presented below the figure.

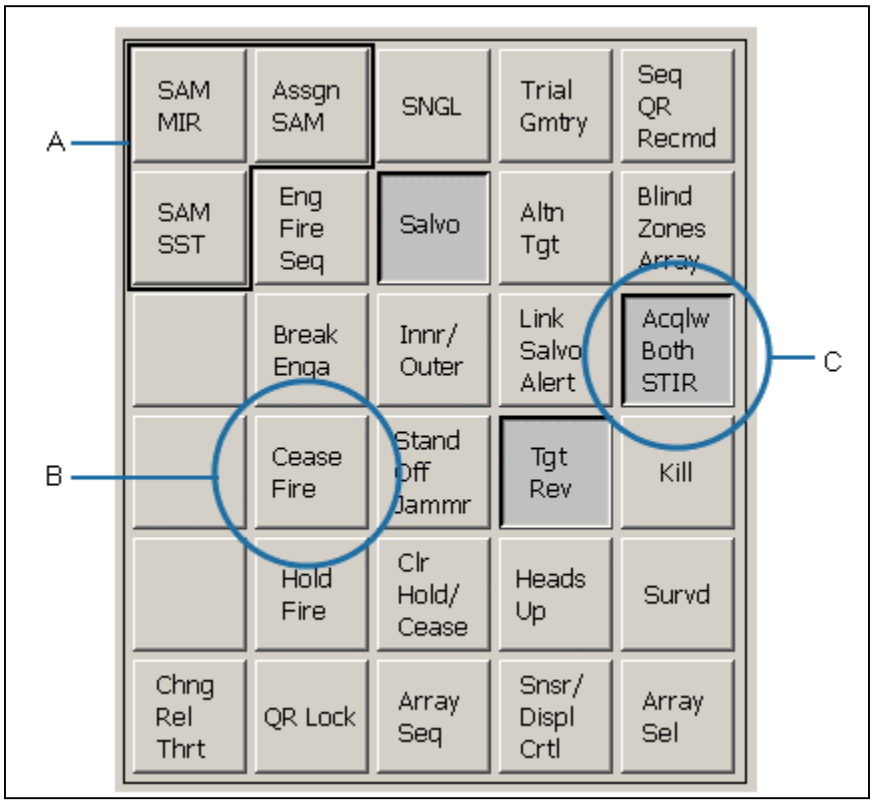


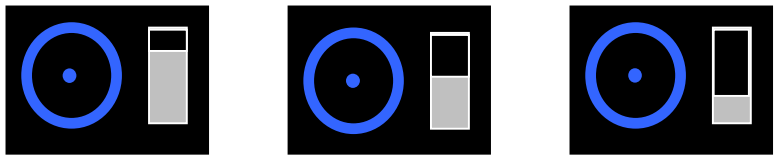
Figure 3.3.4 COMDAT QABs

A. **Grouping**. A box was placed around the functionally related SAM buttons to illustrate their relationship.
B. **Design**. All buttons were re-designed to look like 3D buttons as per Microsoft guidelines (COMDAT OMI 8.5).
C. **Pressed state**. The addition of shading was added to the usual 3-dimensional effect to indicate that a button is pressed. The shading added to make the state of the button less ambiguous.

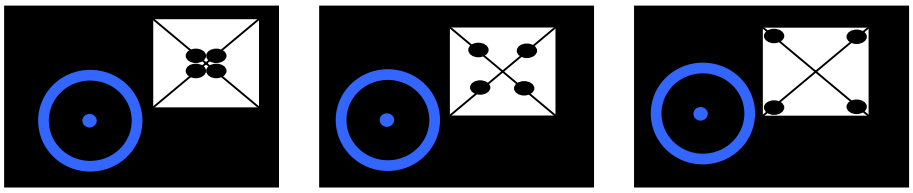
ANNEX A: Certainty Symbology

The symbology sets used in the evaluation are presented here. Note that the Least Certain symbol of the Bars set was indistinguishable from the Mid-Level certainty in the actual evaluation materials.

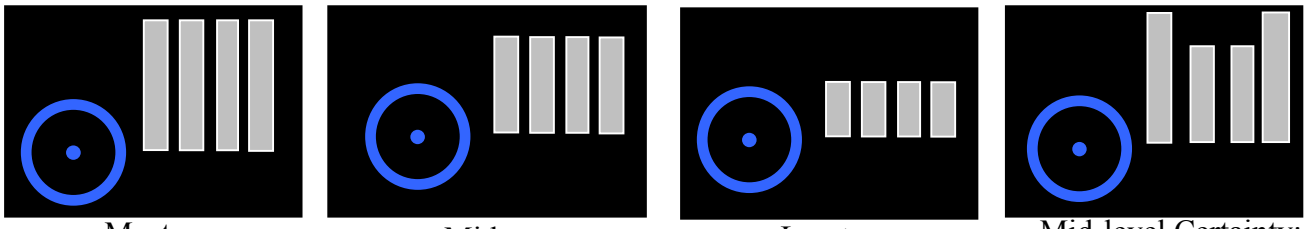
Symbol Set 1: Slider (also known as Draining Bucket)



Symbol Set 2: Sights (also known as Gun Sights)



Symbol Set 3: Bars



Symbol Set 4: Dots

Figure Annex A.1 Symbology Sets

ANNEX B: Demographic Information

The following information was collected from the 10 SMEs who completed the demographic questionnaire.

1. Rank
2. Age
3. Computer experience
4. Computer platforms used
5. Positions Qualified
6. Depth of Experience
7. Familiarity with other CCSs

Annex B.1 Rank

Eleven SMEs from six ranks participated in the evaluation, of these 10 completed the questionnaire. The ranks represented by those ten were OS through Lt (N).

Number (total = 10)	Rank
1	Lt (N)
2	PO1
3	PO2
2	MS
1	LS
1	OS

Figure Annex B.1 Rank

Annex B.2 Age

The ages of the participants ranged from 28 to 49 years, the average age is 35.5.

Range (in years)	Average
28-49	35.5

Figure Annex B.2 Age

Annex B.3 Computer Experience

Participants ranked the relative frequency of their computer experiences. The average rank is presented here. Outside of the work environment e-mail is used most frequently by these SMEs followed by Internet usage.

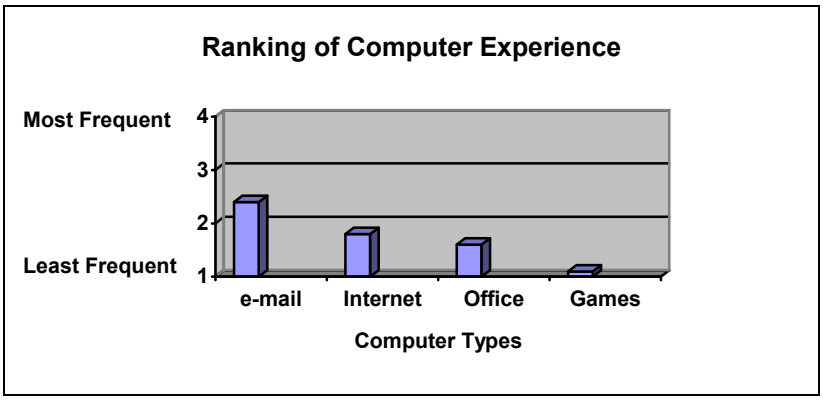


Figure Annex B.3 Computer Experience

Annex B.4 Familiarity with Computer Platforms

All but one of the participants reported using a computer daily. PCs were used most frequently, followed by Game Systems. Hand-held organizers and Macintosh computers were used *Never* or *Rarely* by 9 of the 10 respondents.

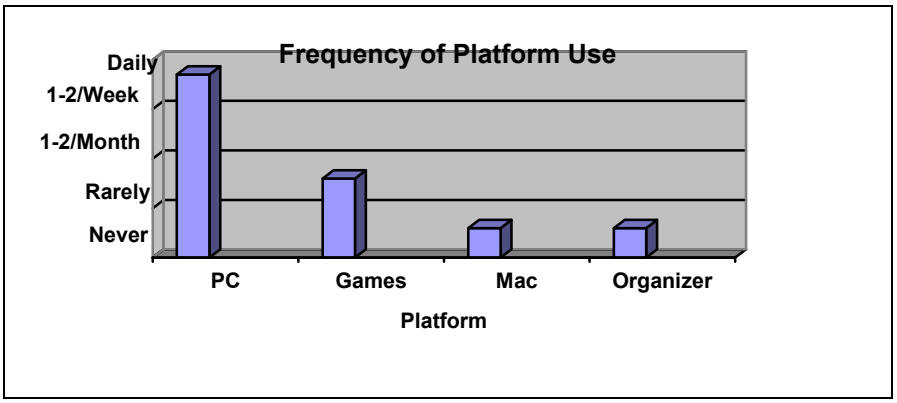


Figure Annex B.4 Familiarity with Computer Platforms

Annex B.5 Positions Qualified
The participants reported being qualified on the following 12 positions.

Number Qualified	Position
1	ORO
2	SWC
1	ASWC
1	SCS
2	EWS
2	FCS
1	EW
1	SAC
1	ORS
1	TS
1	ARRO
1	ASPO

Figure Annex B.5 Positions Qualified

Annex B.6 Depth of Experience
The amount of experience each participant had as a CCS operator varied widely. The experience reported ranged from zero months through 10 years. The average time (in months) is 27.3 months (2.3 years).

Range	Average
0-120 months	27.3 months

Figure Annex B.6 Depth of Experience

Annex B.7 Familiarity with other CCS
Eight of the 10 respondents report at least some familiarity with other CCS. The most commonly reported experience was with the CCS 280.

Number	System
6	CCS 280
1	ADLIPS
3	CCS 330
1	USN CCS

Figure Annex B.7 Familiarity with other CCS

ANNEX C: Pre-Testing Details

The evaluation of the symbology was conducted in a structured manner so as to avoid introducing a bias to the results. After a brief introduction that described the COMDAT MSDF project and the trials the SMEs were asked to complete a questionnaire. SMEs were also asked to rank four decision-aid concepts according to which they thought would be the most useful to them. The SMEs were not exposed to the proposed designs at that time. The initial query was intended to tap into their understanding of the tasks required of the CCS operators without being limited or swayed by the proposed design solutions.

In the pre-testing step the SMEs completed questionnaires that provided demographic data and an initial ranking of four types of uncertainty. The types of uncertainty were the Source of the Information (where source refers to where the information came from; examples include sensors or other resources), Time, Position, and Overall Uncertainty. The ranking of uncertainty was included in order to determine what the SMEs initial opinions were based on their operational experience.

The results of the ranking task are presented below:

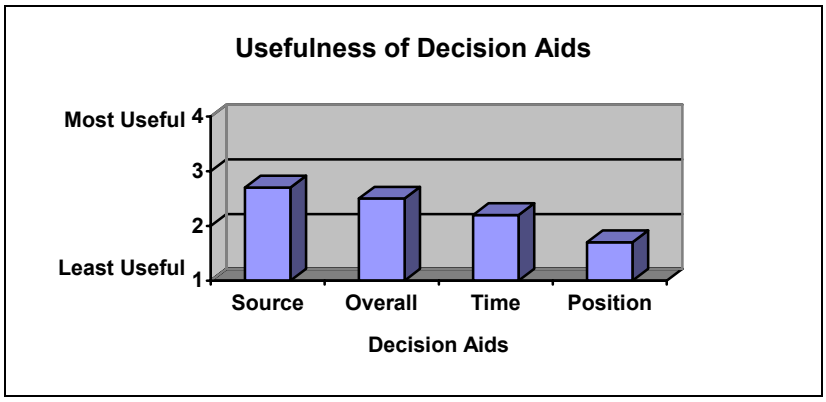


Figure Annex C.1 Usefulness of Decision Aids

As can be seen in the figure, the pre-evaluation rating of a selection of decision aids favored the source of the information, followed by overall certainty, followed by time and position information.

At the end of the structured evaluation process further discussion took place. In the context of the evaluation and the discussion that followed, the SMEs indicated that time and position would be the most useful types of certainty to be displayed.

ANNEX D: Intuitive Evaluation Details

The Intuitive evaluation was designed to evaluate the intrinsic meaningfulness and potential confusability of the symbols. The most successful symbols are those that are most readily and accurately interpreted by the users. Intuitive symbols reduce the training required to learn the symbols and reduce errors in operation.

In the Intuitive evaluation the symbols were presented one at a time in a different random order for each SME. The SMEs were informed of the general intent of the symbology as depictions of certainty within a MSDF environment.

The SMEs were asked to rate on a 5-point scale the level of certainty of the contact represented by the symbol. For each symbol they were also asked to indicate the type of certainty represented. The type of certainty was indicated from a selection of the following:

- Time
- Position
- Identification
- Source of the Contact
- General Uncertainty

The materials for this portion of the evaluation are presented in Appendix D: Evaluation Materials Intuitiveness.

In this annex the data are presented in three figures (Figures Annex D.1 through Annex D.3). Each figure is preceded by an explanation of the figure and followed by a description of the highlights of the results.

As can be seen in Figure Annex D.1: Rating of the Symbols that Represent Least Certainty, the Slider is the most unambiguous symbol set. The SMEs rate the Slider Uncertain symbol most frequently on the uncertain side of the scale and rarely interpret it as depicting high levels of certainty.

Figure Annex D.1 also illustrates that the Slider is the symbol set that is most consistently interpreted by the SMEs.
In the following figure (Figure Annex D.1: Rating of the Symbols that Represent Least Certainty) the symbol portraying the Least Certain contact (see also Figures 1.2.1 through 1.2.4 for an illustration of each symbol set) from each set is presented. The numbers represent the number of ratings the symbol received at each end of the certainty scale (the middle value was not included).

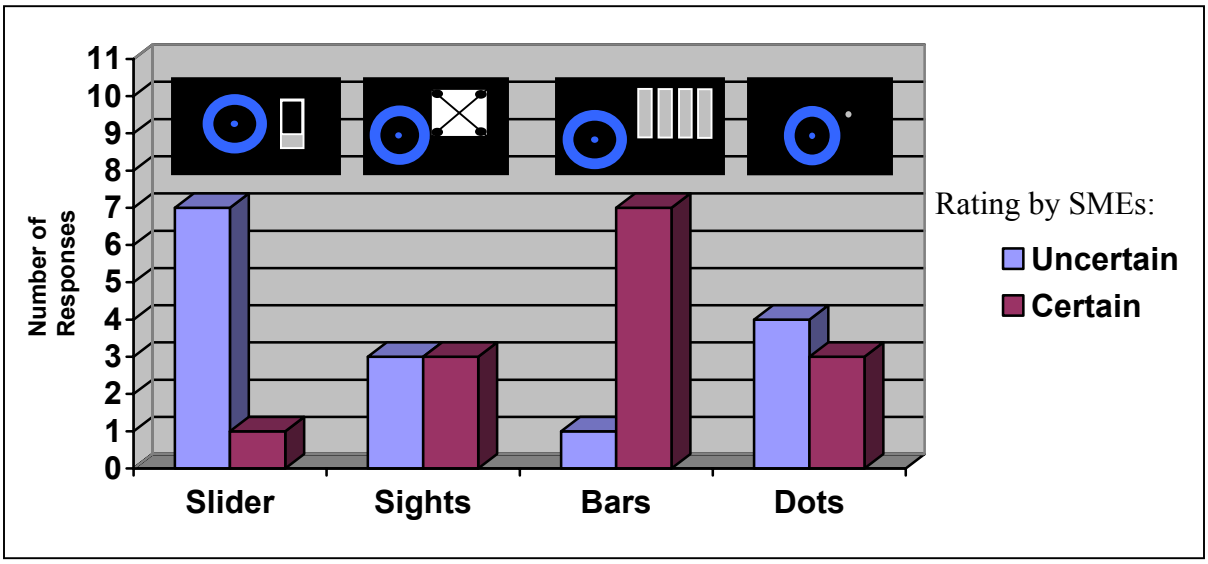


Figure Annex D.1: Rating of the Symbols that Represent Least Certainty

In the following figure (Figure Annex D.2: Rating of the Symbols that Represent Most Certainty) the symbol portraying the Most Certain contact from each set is presented. The numbers represent the number of ratings the symbol received at each end of the certainty scale (the middle value was not included).

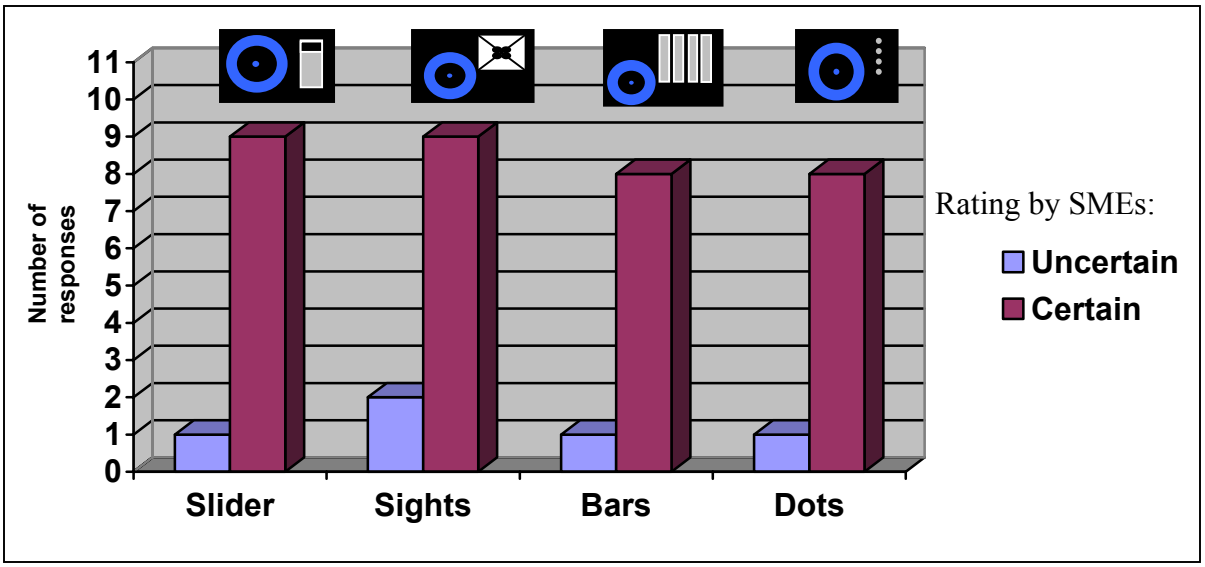


Figure Annex D.2 Rating of the Symbols that Represent Most Certainty

In addition to interpreting each symbol as regards its representation of level of certainty the SMEs were asked to indicate the type of certainty each symbol represents. The number of responses for each symbol set was totaled across each level of certainty (Low, medium, and High); the sums are presented here. The data are presented in Figure Annex D.3: Type of Certainty below:

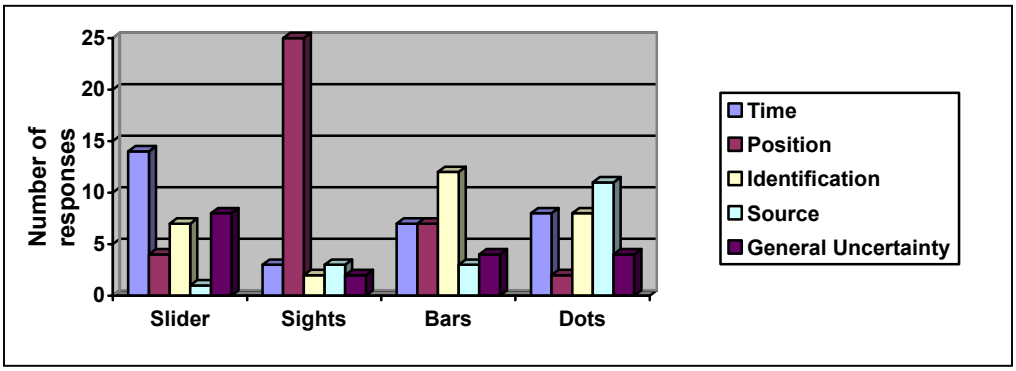


Figure Annex D.3: Type of Certainty

The following can be seen in the figure:

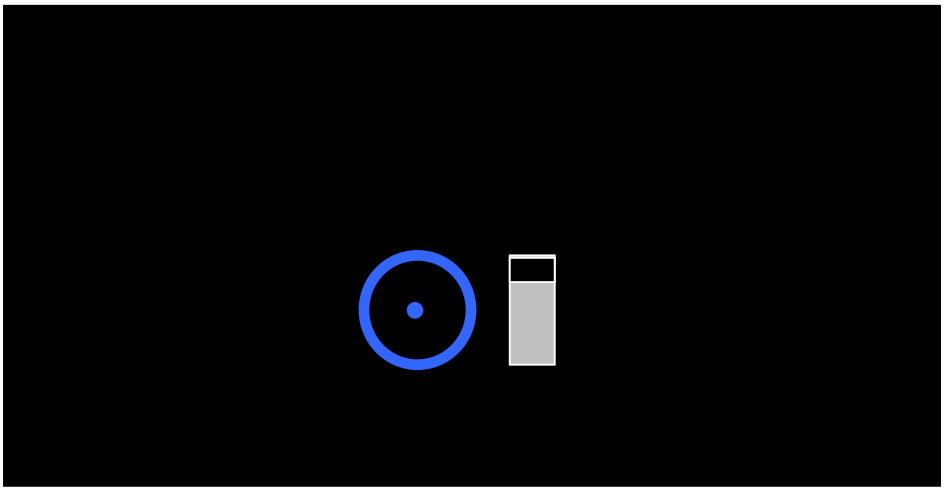
- Slider symbols are most frequently associated with time certainty
- Sight symbols are strongly associated with position certainty
- Bar and Dot symbols are not strongly associated with a specific type of certainty.

APPENDIX D: Evaluation Materials--Intuitiveness

Appendix D is comprised of a sample of the evaluation materials used in the Intuitiveness portion of the evaluation.

The complete set of symbols was shown to the SMEs one symbol at a time in a small book. The symbols were in a different random order for each SME.

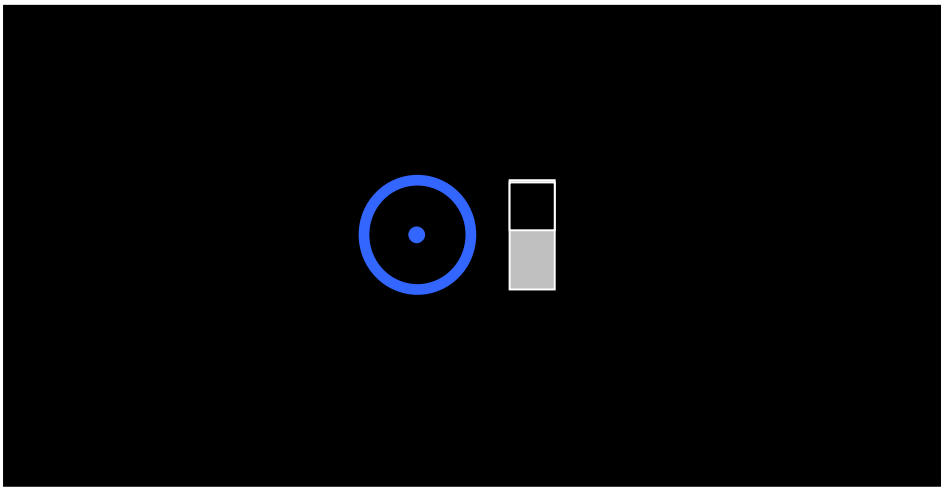
Note that the symbols were presented one at a time, not two per page as shown in the appendix.



Very Uncertain 1 2 3 4 5 Very Certain

Time Position Identification Source Uncertainty

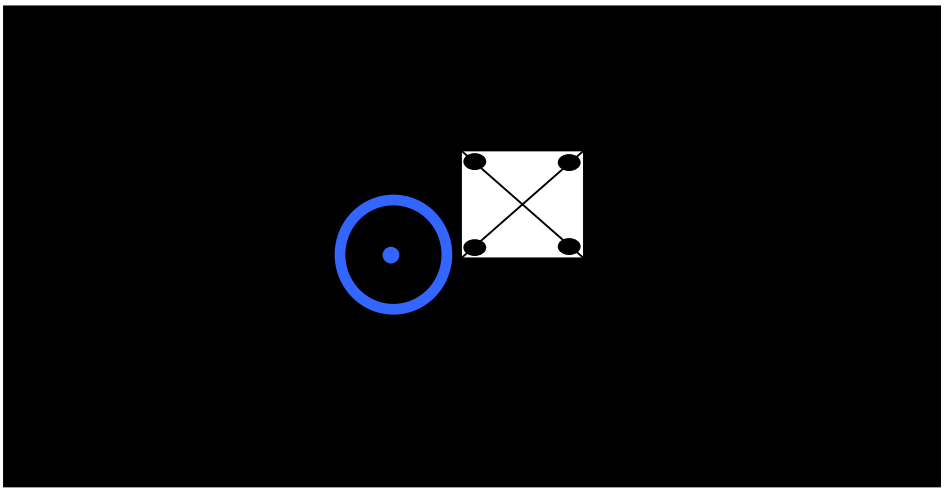
☐ ☐ ☐ ☐ ☐



Very Uncertain 1 2 3 4 5 Very Certain

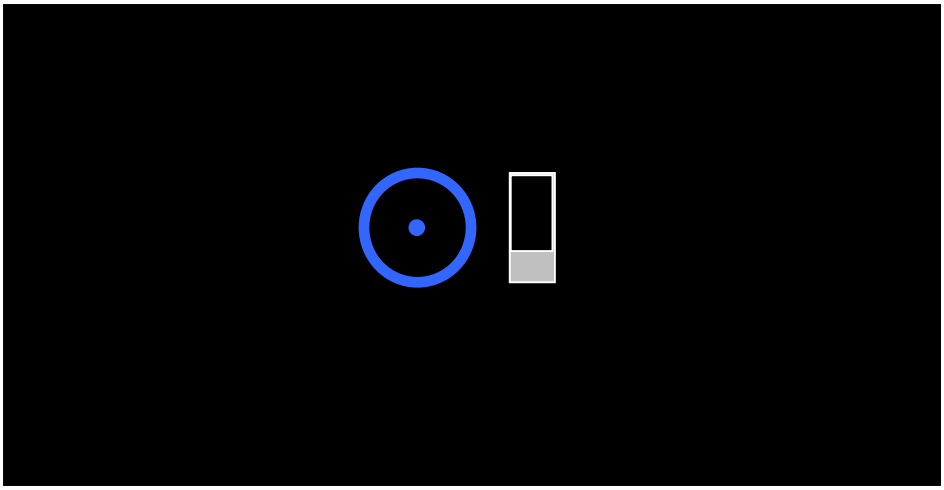
Time Position Identification Source Uncertainty

☐ ☐ ☐ ☐ ☐



Very Uncertain [1] [2] [3] [4] [5] Very Certain

Time ☐ Position ☐ Identification ☐ Source ☐ Uncertainty ☐



Very Uncertain [1] [2] [3] [4] [5] Very Certain

Time ☐ Position ☐ Identification ☐ Source ☐ Uncertainty ☐

ANNEX E: Set Context Evaluation Details

In the Set Context Evaluation the SMEs were shown each set of symbols separately and were asked to indicate the type of certainty they thought each set represented. They were also asked to indicate what level of certainty each symbol represented.

The sets were presented in a separate random order for each SME. Within each set the individual symbols were presented in a separate random order.

An example of the Set Context materials is available in Appendix E: Evaluation Materials--Set Context.

The data from the Set Context evaluation is presented below. The responses to the type of certainty represented by the symbols are presented in graph form followed by a discussion. The responses to the level of certainty ratings for each symbol within the set are presented in point format.

Annex E.1 Type of Certainty
The identification of the type of certainty represented by each symbol set is presented below:

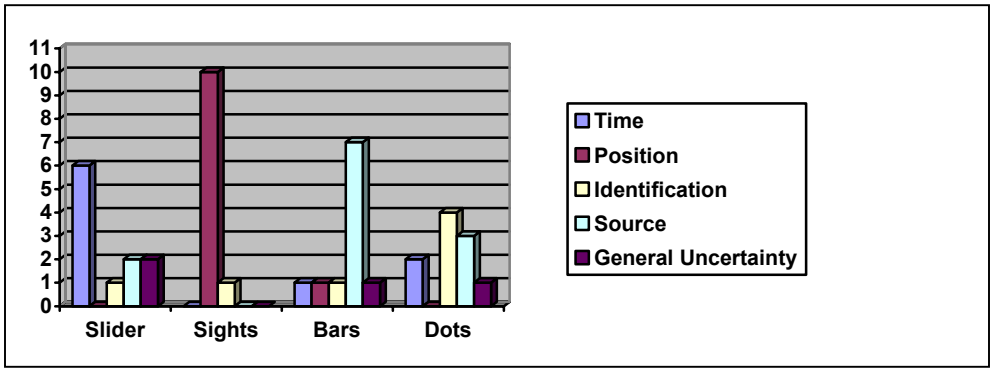


Figure Annex E.1 Type of Certainty in Set Context

As can be seen in Figure Annex E.1: Type of Certainty in Set Context the results are consistent with the interpretation of type of certainty the SMEs made when the symbols were presented one at a time.

Regardless of whether the symbols are presented without prior experience one at a time, or in sets the Slider is associated with time, the Sights are associated with Position, and the dots are not strongly associated with a single type of certainty. The Bars, however, are more strongly associated with the source of the certainty when the symbols are presented as sets than they are if the symbols are presented singly.

Annex E.2 Certainty Ratings
The results from the rating of certainty for each symbol within the set are clear. There are few inversions when the complete set of symbols is presented and the SMEs can compare their relative appearance. The results are as follows:

- The Slider was never interpreted in an inversion in this context. When the Slider rectangle is full the SMEs interpret the symbol as representing Certainty whereas when the rectangle is less full the SMEs interpret the sliding bars as representing Uncertainty. The Sliders are the least prone to inversions of interpretation.

- The Dots were interpreted inverted only once. Large numbers of Dots are interpreted as representative of more certainty, however the SMEs are somewhat less certain that a single dot represents uncertainty.

- The Bars and Sights were each inverted only once. The larger Bars were interpreted as representing certainty whereas the smaller Bars were interpreted as representing uncertainty. The Sights were interpreted consistently.

APPENDIX E: Evaluation Materials Set Context

The appendix is comprised of a sample of the evaluation materials used in the Set Context portion of the evaluation.

The four symbol sets were presented with each set on a single page in a different random order for each SME; within each set the symbols were also presented in a different random order for each SME.

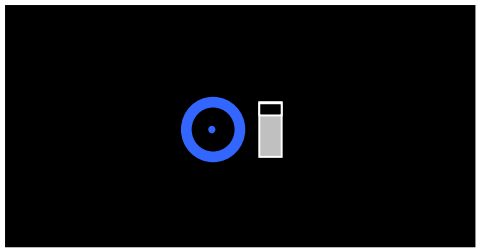
SET #1

This set of symbols refers to one or more of the following; please put a check in the boxes that you think these symbols represent:

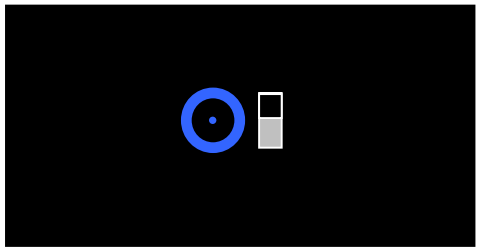
Time	Position	Identification	Source	Uncertainty
☐	☐	☐	☐	☐

For each symbol please put the letter that identifies the symbol (A, B, or C) in the space that indicates the amount of certainty the symbol represents.

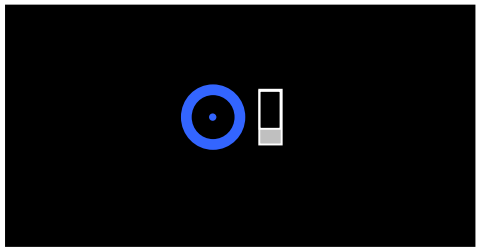
A.



B.



C.



_____Very Certain _____ Mid-level Certainty _____ Not at all Certain

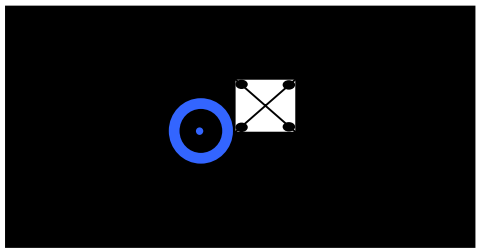
SET # 2

This set of symbols refers to one or more of the following; please put a check in the boxes that you think these symbols represent:

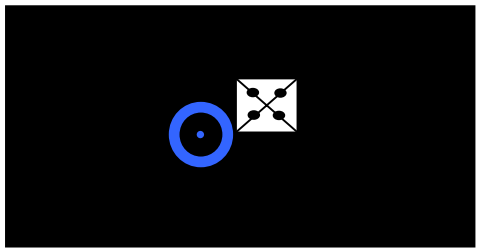
Time	Position	Identification	Source	Uncertainty
☐	☐	☐	☐	☐

For each symbol please put the letter that identifies the symbol (A, B, or C) in the space that indicates the amount of certainty the symbol represents.

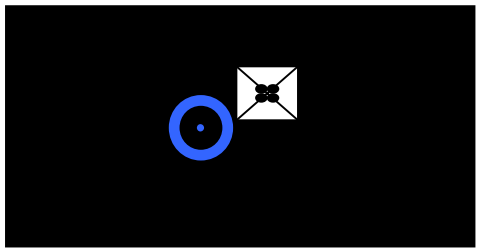
A.



B.



C.



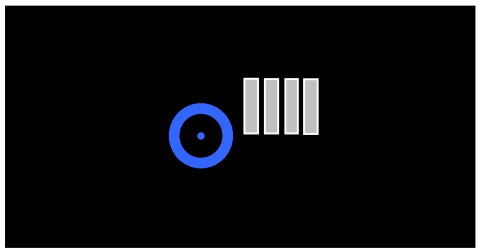
_____Very Certain _____ Mid-level Certainty _____ Not at all Certain

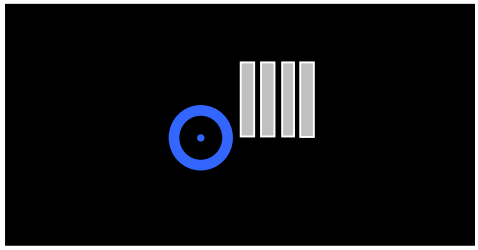
SET #3

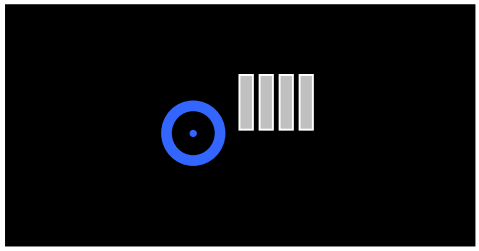
This set of symbols refers to one or more of the following; please put a check in the boxes that you think these symbols represent:

Time ☐ Position ☐ Identification ☐ Source ☐ Uncertainty ☐

For each symbol please put the letter that identifies the symbol (A, B, C, or D) in the space that indicates the amount of certainty the symbol represents (you can put more than one letter in each space but please only use each letter once):

A. 

B. 

C. 

D. 

_____Very Certain _____ Mid-level Certainty _____ Not at all Certain

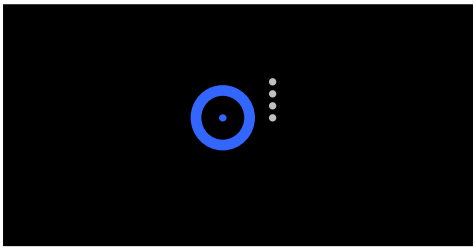
SET #4

This set of symbols refers to one or more of the following; please put a check in the boxes that you think these symbols represent:

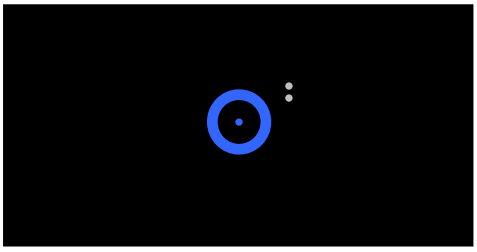
Time	Position	Identification	Source	Uncertainty
☐	☐	☐	☐	☐

For each symbol please put the letter that identifies the symbol (A, B, or C) in the space that indicates the amount of certainty the symbol represents.

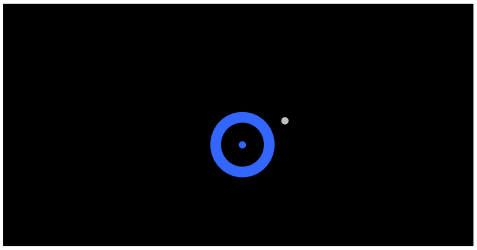
A.



B.



C.



_____Very Certain _____ Mid-level Certainty _____ Not at all Certain

ANNEX F: Operational Context Evaluation Details

In the Operational Context evaluation the SMEs were shown the symbols in the context of a contact-rich environment. The SMEs were shown a colored version of the symbols on a computer monitor prior to asking the SMEs to rank the symbols sets according how useful the set would be in supporting the CCS tasks.

An example of the materials for the Operational Context portion of the evaluation is presented in Appendix F: Evaluation Materials Operational Context.

The results are presented in Figure Annex F.1: Preference in Operational Context below:

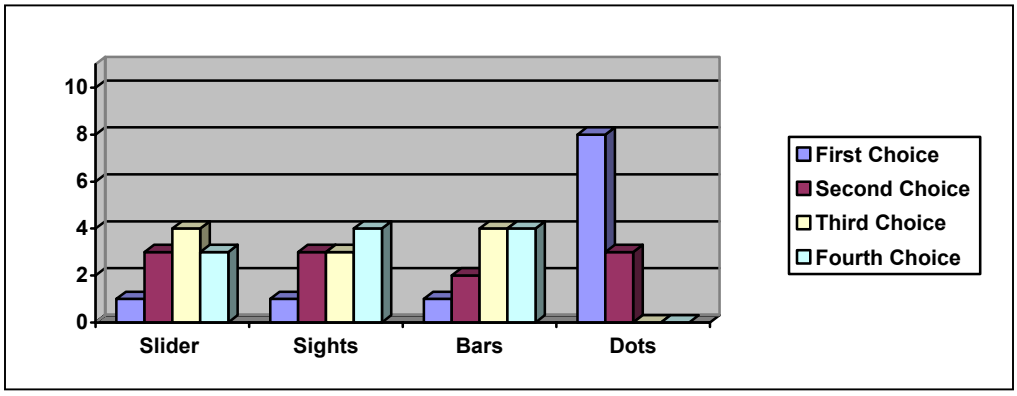


Figure Annex F.1: Preference in Operational Context

As can be seen in the figure the SMEs prefer the Dots to all of the other symbology when the symbols are presented in a contact-rich environment. The dots are rated as the first choice by 8 of the 11 SMEs and rated as the second choice by the remaining SMEs.

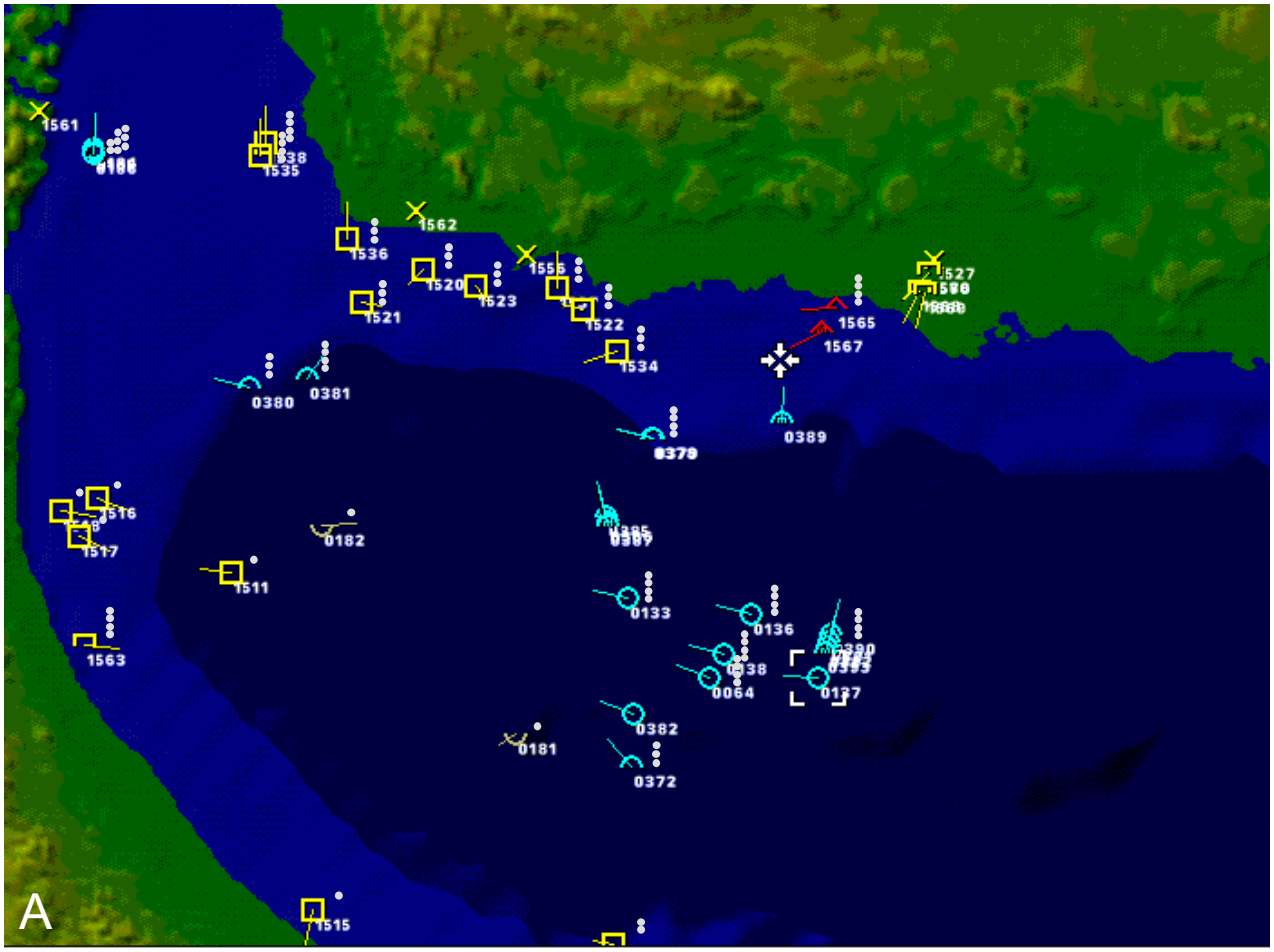
APPENDIX F: Evaluation Materials Operational Context

Appendix F is comprised of two of the four sets of symbols that were presented to the SMEs to illustrate how the symbols might look in an operational context. Set A: Dots and Set C: Gun Sights are included here.

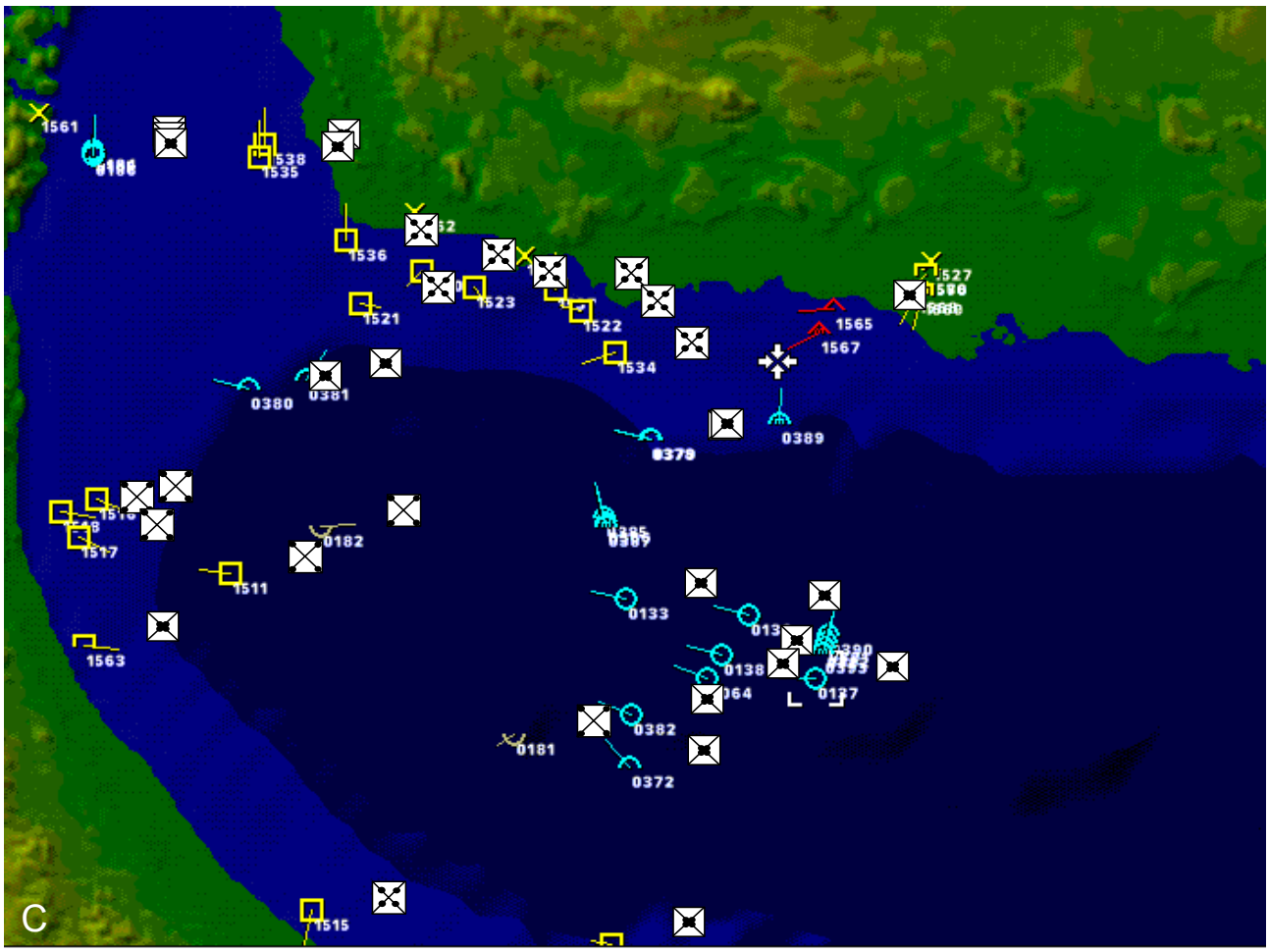
The SMEs were first shown a computer display with the material in color.

The SMEs were shown the four sets of symbols in an operational context in a different random order for each SME.

SET A: DOTS


1561
1535
1562
1536
1520
1523
1555
1521
1522
1534
1565
1567
1527
0380
0381
0379
0389
1516
1517
0182
1511
0133
0136
1563
0064
0137
0382
0181
0372
1515
A

Set C: Gun Sights



ANNEX G: Desired Design Characteristics

The results of this evaluation indicated that the MSDF symbology should have several characteristics in order to be maximally usable. A selection of the design characteristic is discussed here.

Annex G.1 Size of the Symbols. The SMEs all indicated that the symbology must be small and unobtrusive. The symbols must not interfere with the task nor cover too much of the display.

Annex G.2 Obstruction. The SMEs expressed concern that the MSDF symbol would obstruct the display of the actual contact source image. Operators use the underlying contact rather than symbology in combat situations.

Annex G.3 Clutter. These SMEs were, to a person, concerned about screen clutter. If MSDF certainty symbology is to be successful it is imperative that the symbols be as compact as possible.

Annex G.4 Selectability of the Symbols. MSDF symbols must be selectable. The operators must be able to turn them off or on as desired.

Annex G.5 Fill as Certainty. These SMEs interpreted the more filled in, or larger symbols, as depicting More Certainty. In the design of this evaluation Unger Campbell was careful to use language that avoided associating the uncertainty level with size (for example: the scale values were from *Very Certain* to *Very Uncertain*. In both ends of the scale the value is *Very*; as opposed to using the standard values of *Very Certain* and *Not at All Certain*. The latter scale values introduce a bias). It is clear from these results, then, that the SMEs associate certainty with the amount of fill on the display. More certainty is associated with more fill. The association obtains for the Dots, Slider, and Bars; in each case the larger number or fuller display was interpreted as representing more certainty.

Annex G.6 Ease of Reading. The preference of the Dots over the Slider symbology appears to be related to two design elements. First, the dots are smaller; they are narrower than the Slider presentation. The narrow presentation is more compact and is preferred by the SMEs. Secondly, it is easy to determine the absolute value of the dots. The dots are perceived as discrete elements rather than as elements in a continuum. The discrete visual of the dots makes them easier to interpret.

Annex G.7 Selectability of the Type of Uncertainty Displayed. The SMEs indicated that it might be useful to not only select whether the MSDF symbols were on or off, but also to select which type of uncertainty is presented. In some instances time may be the important element, in others the position may be the most important.

Annex H: Acronym List

ADLIPS	Automatic Data Link Plotting System
ARRO	Air Raid Reporting Operator
ASPO	Anti Submarine Plot (or Plotting) Operator
ASWC	Assistant Sensor Weapons Controller
CCS	Command and Control System
COMDAT	Command Decision Aiding Technology
DCIEM	Defence and Civil Institute of Environment Medicine
DRDC	Defence Research and Development Canada
EW	Electronic Warfare
EWS	Electronic Warfare Supervisor
FCS	Fire Control Supervisor
LS	Leading Seaman
Lt (N)	Lieutenant (Navy)
MS	Master Seaman
MSDF	Multi-Source Data Fusion
NTD	Naval Tactical Display
OMI	Operator-Machine Interface
ORO	Operations Room Officer
ORS	Operations Room Supervisor
OS	Ordinary Seaman
PO1	Petty Officer First Class
PO2	Petty Officer Second Class
QAB(s)	Quick Action Buttons
SAC	Shipborne Aircraft Controller
SCS	Sonar Control Supervisor
SME(s)	Subject Matter Expert(s)
SWC	Sensor Weapons Controller
TD	Technology Demonstrator
TR	Tactical Read-Out
TS	Track Supervisor
USN	United States Navy

DOCUMENT CONTROL DATA SHEET

1a. PERFORMING AGENCY

Unger Campbell and Associates, 5020 204th Street, Langley, British Columbia V3A 7K3

2. SECURITY CLASSIFICATION

UNCLASSIFIED
- Unlimited distribution -

1b. PUBLISHING AGENCY

DRDC Toronto

3. TITLE

(U) COMmand Decision Aiding Technology (COMDAT) Symbology and Design Study

4. AUTHORS

Gweneth Unger Campbell, Kevin Baker

5. DATE OF PUBLICATION

March 15, 2003

6. NO. OF PAGES

81

7. DESCRIPTIVE NOTES

8. SPONSORSHIP/MONITORING/CONTRACTING/ASKING AGENCY

Sponsoring Agency:
Monitoring Agency:
Contracting Agency: DRDC Toronto
Tasking Agency:

9. ORIGINATOR'S DOCUMENT NO.	10. CONTRACT, GRANT AND/OR PROJECT NO.	11. OTHER DOCUMENT NOS.
Contract Report CR 2003-036	W77110007659/001/TOR	

12. DOCUMENT RELEASABILITY

Unlimited announcement

12. DOCUMENT ANNOUNCEMENT

Unlimited announcement

14. ABSTRACT

This document is part of support provided by Defence Research and Development Canada - Toronto (DRDC Toronto) to the Command Decision Aiding Technology (COMDAT) project. The report includes a description of three Human Factors efforts carried out to support the upgrade of the Halifax Class Command and Control System (CCS) in the area of battlespace awareness. The first section is comprised of a report on an evaluation of symbology developed to convey the certainty of Multi-Source Data Fusion displays. The remaining sections are comprised of annotated illustrations of COMDAT Operator-Machine Interface (OMI) Style Guide compliant displays.

R□sum□

Le pr□sent document fait partie du soutien qu□apporte Recherche et D□veloppement pour la d□fense Canada □Toronto (RDDC Toronto) au projet de technologie d□aide aux d□cisions de commandement (COMDAT). Le rapport comprend une description de trois mesures ergonomiques adopt□es pour favoriser l□am□lioration du syst□me de commandement et de contr□le (SCC) des navires de classe Halifax pour la connaissance de l□espace de combat. Dans la premi□re partie, on trouve un rapport d□□valuation de la symbologie utilis□e pour indiquer la certitude des affichages de fusion de donn□es de sources diverses. Les autres parties se composent d□illustrations annot□es montrant les affichages conformes au guide de style pour l□interface op□rateur-machine (IOM) de la COMDAT.

15. KEYWORDS, DESCRIPTORS OR IDENTIFIERS

(U) COMDAT; symbology; design guidelines; uncertainty; style guide; OMI; operator-machine interface; naval systems; command and control; human factors