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SYMBOL STANDARDIZATION IN AIRWAY FACILITIES

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16. Abstract

The purpose of this project was to develop and evaluate visual symbols for future Airway Facilities (AF) systems. A research team designed symbols, developed test software, and evaluated test procedures. A subsequent field evaluation of these symbols resulted in user assessment of two alternative visual symbols for 32 AF facilities and services. Two groups of 14 AF field subjects learned and evaluated alternative symbols. The report provides sufficient data to show the quality differences between the various symbols as judged by the user community. This report provides a recommended set of AF facility/service symbols for standardized use.

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Executive Summary

This report describes the development and user evaluation of pictorial symbols representing 32 Federal Aviation Administration (FAA) facilities and services. The potential users, Airway Facilities (AF) system specialists, evaluated these symbols objectively and subjectively. After completing the evaluation and analysis process, the researchers created a recommended set of symbols for AF use.

The development and evaluation process consisted of a literature survey, a brainstorming session involving subject matter experts (SMEs), creation of software, and a field study. The literature survey provided a basis for the development of symbols and the preparation of evaluation procedures. The researchers designed symbols to represent 32 facilities and services using information gained from the literature survey and the advice of SMEs.

Eleven specialists participated in the symbol evaluation at the FAA William J. Hughes Technical Center. Seventeen AF specialists and managers participated in the symbol evaluation at Dallas-Fort Worth Air Route Traffic Control Center (ARTCC) and Prototype Operational Control Center. The groups were similar in age, experience, and education.

The participants were trained on recognition and recall of the symbols. Following the training sessions, the participants rated each symbol's representation of the facility or service, learning difficulty, and distinctiveness. The researchers then conducted recognition and recall testing, recording the number of errors the participants made for each symbol. Finally, the researchers collected exit preference data using an Exit Questionnaire, which let the participants choose a preferred symbol from the symbols developed for each facility or service.

The research team used three criteria to determine which of the two symbols developed for each facility and service is better. The first selection criterion was the number of recognition errors. The second selection criterion was the participant ratings of the symbols. The exit preference data provided the third selection criterion to differentiate the better symbol if the two other criteria had not made clear which was the better symbol.

After evaluating the symbols using the three selection criteria, the researchers developed a set of recommended visual symbols for use in AF displays. Use of these symbols will help standardize display interfaces across the AF environment.

1. Introduction

The Federal Aviation Administration (FAA) plans to increase the number of Airway Facility (AF) systems remotely monitored and controlled at centralized locations. Therefore, AF system specialists at these locations must recognize and respond to information about an increasing number of services and facilities. This creates a problem about how to represent the information. Personal computer software routinely uses visual symbols to identify software applications and computer functions. The FAA has started to use a similar approach to represent information about facilities and services on computer displays. However, standardized symbols representing facilities and services do not currently exist. Lack of standardization may cause AF specialists to encounter different symbols representing the same object or the same symbol representing different objects. Furthermore, it may increase time to learn the symbols and increase the possibility of error in interpreting the symbols. The adoption of standardized symbols that have been evaluated for usability would alleviate these problems, thereby improving human performance.

1.1 Background

The development and assessment of AF symbols began in 1994. Initially FAA psychologists, AF consultants, and human factors personnel developed symbols for AF. Phase I of this work represented a first step in an effort to develop a set of standard symbols for use throughout AF, resulting in a literature review of the human factors literature on visual and auditory symbols (Duncanson, 1994). Phase II evaluated a set of 121 symbols resulting in a recommended symbol set of 38 pictorial symbols for AF use (Duncanson et al., 1996). This report is a continuation of the work presented in the initial two reports, looking at 32 symbols representing facilities and services not represented in the Phase II study.

1.2 Purpose and Rationale

The project purpose was to develop, evaluate, and recommend symbols based on their suitability to support computer-human interface requirements within the AF domain.

2. Method

This section explains the development process, evaluation techniques, and the formulation of evaluation criteria for this project.

2.1 Participants

The participants included system specialists and managers from several FAA regions. They included 11 AF system specialists who visited the FAA Research Development and Human Factors Laboratory at the FAA William J. Hughes Technical Center. Seventeen AF specialists and managers from the Dallas Fort Worth Air Route Traffic Control Center (ARTCC) and Prototype Operational Control Center (POCC) participated in the symbol evaluation at their location. The researchers divided the 28 participants into two groups of 14. Each group evaluated one of two sets of symbols (referred to as Group A and Group B) for facilities and services. The groups were similar in experience, age, and education. The researchers briefed all participants on the purpose of the study and the confidentiality of the test data. All participants gave an oral acceptance for participating in the study.

2.2 Apparatus

The research team developed a software tool to support data collection, training, and testing for the symbol research. The software presented grayscale symbols that were .5 in. x .5 in. square (51 pixels x 51pixels). The symbols were presented on a Toshiba TECRA 720CDT laptop with a .28 mm. dot pitch and a resolution of 1028 x 1028.

2.3 Procedure

2.3.1 Symbol Development

Former FAA AF employees served as subject matter experts (SMEs) and assisted the research team in identifying symbols requiring development. The team reviewed previously developed symbols and identified AF facilities and services requiring new or enhanced symbols. Because some facilities have similar functions, the SMEs recommended developing one symbol to represent groups of facilities (e.g., combining visual aid facilities into a common symbol). Appendix A describes these combined symbols.

The research team reviewed industry and government documents to provide a basis for symbol development and evaluation activities. The literature search revealed that brainstorming sessions are used frequently to develop symbols for applications (Crist & Aurelio, 1990; Howard, O'Boyle, Eastman, Andre, & Motoyama, 1991; Microsoft, 1995). The research team decided to adopt the same approach for the development of symbols for this study.

SME expertise, literature survey insights, and the *Guidelines for Developing Symbols in Airway Facilities* by Ramakrishnan, Cranston, and Grayson (1997) contributed to the brainstorming sessions. The researchers derived symbols through the adoption or modification of existing symbols or through the brainstorming sessions. They designed and modified symbols so that the symbols either had a physical resemblance to or an association with the actual facility or service they represented or depicted a functional aspect of the facility or service represented. The developers standardized the representation of clouds, aircraft, control towers, ARTCC buildings, and borders used within the symbols. The researchers developed two symbols for each facility or service except the airport and regional facilities, for which only one symbol each was developed. Pilot studies had indicated that the symbols for Airport and Region were acceptable and thus submitted each one to testing without an alternative.

2.3.2 Training

The participants learned the symbols using first recognition and then recall training. Recognition training began with a briefing on the features of the symbol. Using a task similar to a multiple choice test, a participant viewed a facility or service name on the screen with five randomly positioned symbols (one target symbol and four distracter symbols; see Figure 1). The participant's task was to click on the symbol representing the named facility or service. The participant continued to click on the symbols until he/she picked the correct symbol. Once a participant picked the correct symbol, the facility/service name and the correct symbol remained on the screen for 3 seconds to reinforce the learning process. The researchers considered this symbol identification process to be one cycle of testing for analysis purposes. The task of recognizing the correct symbol continued until the participant identified each symbol correctly on two consecutive cycles.

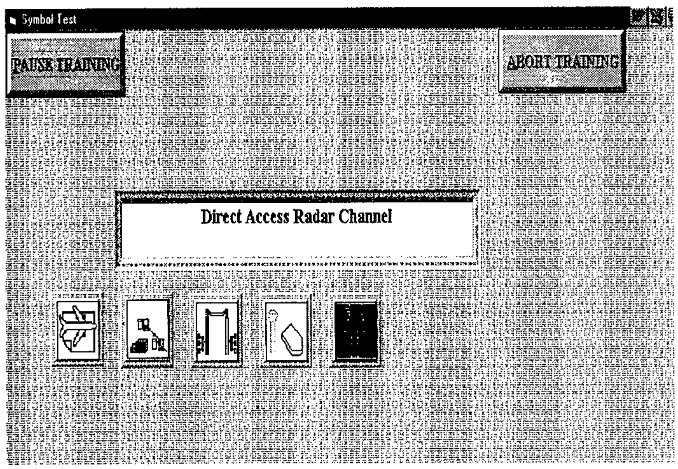

Figure 1. Computer display used for recognition training.

The participants then took part in recall training (see Figure 2). Each participant orally recalled the name of the facility or service when presented with its respective symbol. The researchers provided the participant with the correct name for the facility or service after each response and recorded any errors made in remembering the facility or service name. Presentation order of the symbols was randomized to prevent order effects. The symbol presentation continued until the participant correctly recalled the complete name of the facility or service represented by the symbol on two consecutive cycles. The researchers considered training complete when the participants successfully completed the recognition and recall tasks for all the symbols.

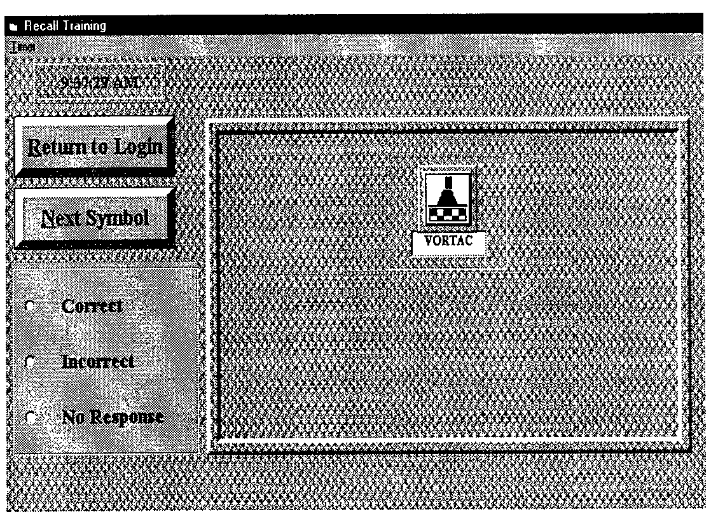

Figure 2. Computer display used to collect recall data.

2.3.3 Symbol Evaluation

Researchers have used both objective and subjective methods to assess symbol quality. Kaufmann and Eaton (1994) employed user preference to study symbols for a marine navigation electronic chart display and information system. Researchers such as Whitaker (1985) and Kirkpatrick, Dutra, Heasly, Granda, and Vingelis (1992) used accuracy and speed as objective indicators of symbol goodness. Blackwell and Cuomo (1991) used search time and errors as variables on a space and missile warning symbol set. Green and Pew (1978), Kantowitz and Sorkin (1983), and Aurelio and Crist (1990) constructed confusion matrices based on error data. Other symbol evaluation techniques have included using focus groups and usability assessments.

The research team for this study decided to use a combination of recall and recognition testing, subjective ratings, and user preference to evaluate the quality of the symbols. They began the study by collecting biographical information about the participants and data related to participant familiarity with each facility and service. The researchers presented each participant with a brief introduction to all the symbols. They discussed how the symbol represented the actual facility or service, functions depicted, and associative relationships of the symbol components. The participants were asked to rate their familiarity with the associated facility or service on a scale of 1 (not familiar) to 7 (high familiarity). Figure 3 presents the computer display used to collect familiarity data.

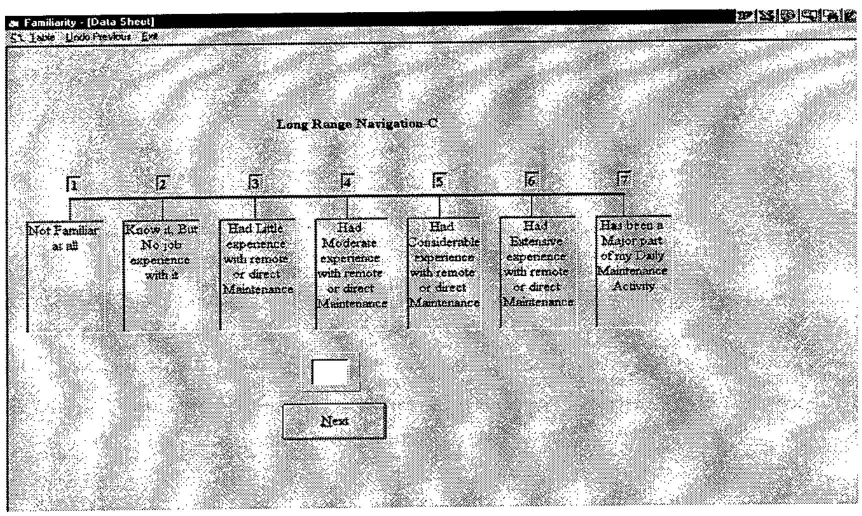

Figure 3. Computer display used to collect familiarity data.

The participants were then trained with the different symbols as described in Section 2.3.2. Following the training sessions, the researchers collected ratings on how well each symbol represented a facility or service, its learning difficulty, and how easily it could be confused with other symbols. The rating scales ranged from one to seven with a rating of seven indicating the symbol was an excellent representation, very easy to learn, and not confusing with other symbols (see Appendix B for an example).

After the ratings data collection, participants took a 10-minute break to minimize some of the short memory storage that would have occurred if testing had immediately followed. The symbol testing followed the break.

The researchers used a multiple choice recognition task to test the ability of the participants to recognize each symbol. The test process was similar to the recognition training except there were 16 multiple choices (see Figure 4). The researchers used 16 symbol choices because the AF SMEs thought that a typical operational display reflecting degraded or out-of-service facilities might contain approximately 16 different symbols. The software immediately moved to the next test symbol after selection of a correct symbol. Testing continued until participants correctly identified each symbol twice consecutively.

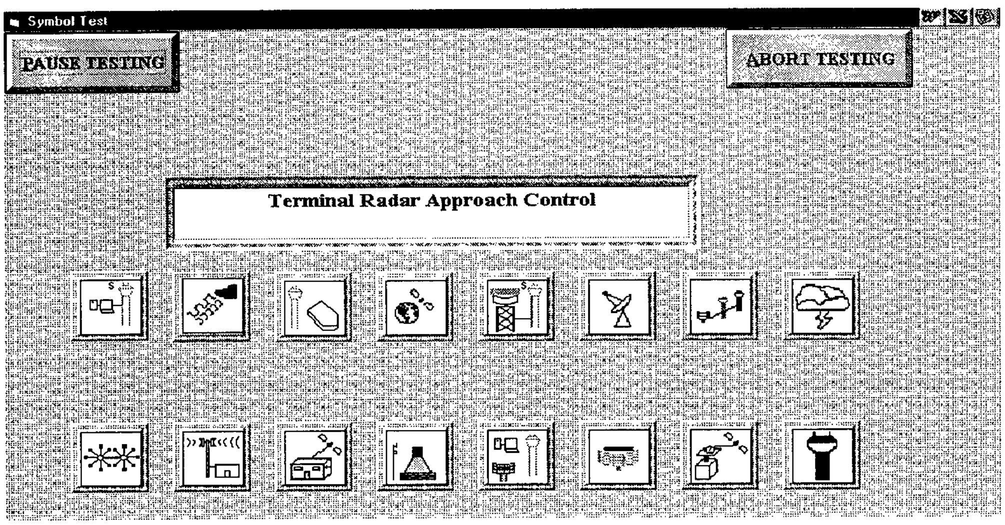

Figure 4. Computer display of recognition testing.

Before recall testing, researchers instructed that accuracy was the most important consideration when recalling symbol names. Recall testing repeated the training recall step with trials continuing until the participants recalled the full name of each symbol correctly. The researcher recorded a participant's response even if erroneous.

The paper and pencil Exit Questionnaire provided participants with an opportunity to select between two symbols, express opinions, and identify preferred symbol characteristics (see Appendix C). The participants were given a randomized sheet of Group A and Group B symbols. The symbol selection exercise asked participants to indicate a preference for either the symbol their group had learned or the symbol that had been learned by the other group.

3. Results

3.1 Subjective rating

Table 1 shows that Representation (how well the symbol represented the service/facility), Difficulty (how difficult the symbol was to learn), and Distinctiveness (how easily the target symbol was confused with other symbols) were all highly correlated. Therefore, the researchers averaged the three ratings to create a composite rating for each symbol.

Table 1. Regression Analysis Results

	Representation	**Difficulty**	**Distinctiveness**
Representation	1.000	-	-
Difficulty To Learn	0.836	1.000	-
Distinctiveness	0.845	0.826	1.000

3.2 Symbol Selection

Table 2 shows the symbol selection based on the three criteria of errors, average rating, and exit preference. The number of recognition errors was the first criterion used for selecting between two symbols[1]. When recognition errors did not clearly depict a better symbol, the researchers used a second criterion based on the average rating of subjective symbol qualities. The researchers set an average rating of 3 or less as the failure criterion for a symbol. Based on this criterion, symbols with an average rating of 3 or less are determined to be too poor representations, too difficult to learn, or too confusable to be useful in the field. Symbol preference was the third criterion used to select between highly similar symbols. This preference variable represented the participants' preference between the two choices for a facility or service. The number in the user preference column indicates the number of participants who preferred the symbol. Totals of less than 28 occurred for some symbols because some participants did not express a preference.

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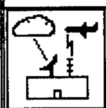
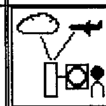
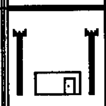
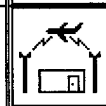
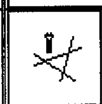
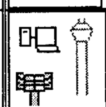
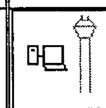
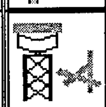
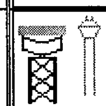
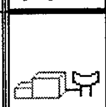
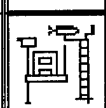
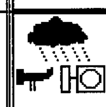
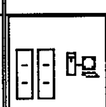
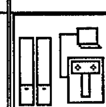
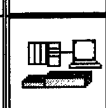
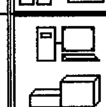
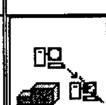
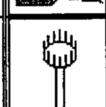
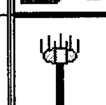
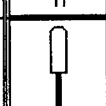
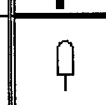
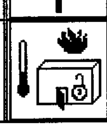
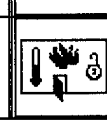
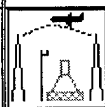
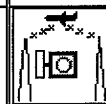
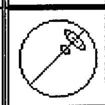
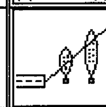
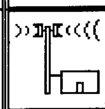
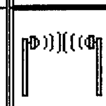
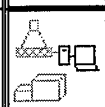
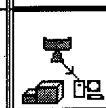
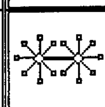
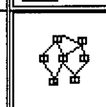
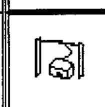
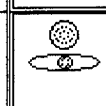
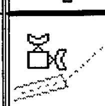
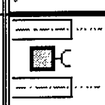
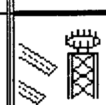
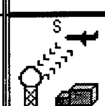
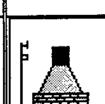
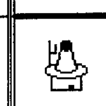
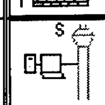
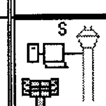
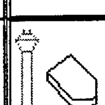
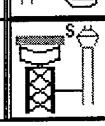
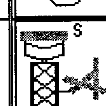
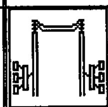
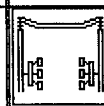
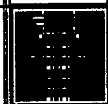
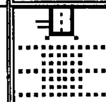
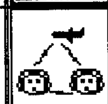
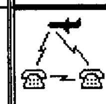
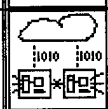
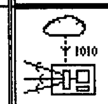
[1] The researchers initially considered recall data for analysis purposes until discovering that long, difficult, or unfamiliar names resulted in errors that had little to do with how well the symbol represented the service or facility. As an example, the Weather Message Switching Center Replacement (WMSCR) symbol had three and four recall errors respectively but no recognition errors. Therefore, they eliminated recall errors from the final analysis.

Table 2. Symbol Selection

	Group A				Group B			
Facility/Service	Symbol	Recognition Errors	Average Rating	User Preference	Symbol	Recognition Errors	Average Rating	User Preference
Automated Flight Service Station (AFSS)		0	5.57 (SD=1.59)	12		0	5.74 (SD=1.42)	16
Air Ground Communications Facilities (AGCF)		0	5.90 (SD=1.28)	6		0	5.90 (SD=1.25)	21*
Airport		0	6.21 (SD=1.36)	N/A				
Automated Radar Terminal System (ARTS)		7	4.21 (SD=1.85)	13		3	5.21 (SD=2.01)	14
Airport Surveillance Radar (ASR)		3	4.86 (SD=1.84)	16		1	5.36 (SD=1.70)	12
Air Traffic Control Beacon Interrogator (ATCBI)		0	4.14 (SD=2.04)	6		1	4.50 (SD=1.42)	20*
Automated Weather Observation System (AWOS)/ Automated Surface Observing System (ASOS)		2	5.35 (SD=1.53)	12		1	4.98 (SD=1.69)	16
Central Computer Complex Host (CCCH)		2	4.76 (SD=1.53)	8		0	5.26 (SD=2.00)	19*
Computer Display Channel (CDC)/ Display Channel Complex (DCC)		4	4.48 (SD=1.65)	12		3	4.52 (SD=1.91)	13
Direct Access Radar Channel (DARC)		1	5.07 (SD=1.68)	13		2	4.59 (SD=1.70)	13
Direction Finder (DF)		0	6.33 (SD=0.84)	15		0	5.86 (SD=1.19)	11
Distance Measuring Equipment (DME)		2	5.95 (SD=0.89)	19*		1	5.45 (SD=1.48)	8
Environmental Systems (EVS)		0	6.43 (SD=1.16)	19		1	6.45 (SD=0.64)	8

	Group A				Group B			
Facility/Service	Symbol	Recognition Errors	Average Rating	User Preference	Symbol	Recognition Errors	Average Rating	User Preference
LORAN C Monitor (LRNCM)		1	5.02* (SD=0.83)	14		2	4.14 (SD=1.75)	13
Markers		0*	6.21 (SD=0.99)	18*		4	5.81 (SD=1.59)	9
Microwave Communications Systems (MCS)		0	6.50* (SD=0.62)	11		0	5.76 (SD=1.24)	16
Maintenance Processing System (MPS)		0	4.74 (SD=1.60)	14		1	3.83 (SD=1.79)	13
National Air Space Data Interchange Network (NADIN)		0	6.33* (SD=0.70)	11		1	5.19 (SD=1.90)	16
Non-Directional Beacon (NDB) Locator Outer Marker (LOM)		1	5.67 (SD=1.42)	19*		1	5.07 (SD=2.09)	8
Oceanic Display and Planning System (ODAPS)		0	5.83 (SD=1.03)	10		0	5.71 (SD=1.48)	17
Precision Approach Radar (PAR)		0	6.40 (SD=0.82)	17		2	5.88 (SD=0.99)	11
Precision Runway Monitor (PRM)		0	5.04 (SD=0.87)	19*		0	4.67 (SD=1.55)	7
Radar Data Service (RDAT)		5	4.64 (SD=1.49)	11		4	5.21 (SD=1.55)	16
Region						0	6.81 (SD=0.34)	N/A
Tactical Air Navigation at VOR (TACR)		3	5.21 (SD=1.74)	13		0*	5.78 (SD=1.34)	14
Terminal Automated Radar Service (TARS)		14	4.00 (SD=1.72)	5		6	5.60* (SD=1.19)	21*
Terminal Radar Approach Control (TRACON)		16	4.83 (SD=1.88)	5		2*	5.62 (SD=1.50)	21*
Terminal Radar Service (TRAD)		5	4.90 (SD=1.89)	6		3	5.36 (SD=1.71)	22*

	Group A				Group B			
Facility/Service	Symbol	Recognition Errors	Average Rating	User Preference	Symbol	Recognition Errors	Average Rating	User Preference
Telecommunications Systems (TS)		2	6.07* (SD=1.33)	17		4	5.00 (SD=1.47)	9
Visual Aids (VA)		0	6.52* (SD=0.87)	13		0	5.59 (SD=1.41)	13
Voice Systems (VS)		0	5.88 (SD=1.36)	13		0	5.33 (SD=1.48)	14
Weather Message Switching Center Replacement (WMSCR)		0	4.52 (SD=1.57)	12		0	4.69 (SD=1.52)	14

The Recognition Errors column in Table 2 shows the total number of recognition errors summed over all participants in that group. The Average Rating column shows the means and standard deviations of the rating data over all the participants in a group. Asterisks denote statistical significance for Average Rating and Recognition Errors at $p < .10$ (student's t test). For user preference, asterisks denote statistical significance for that symbol at $p < .05$ (Fisher's Exact Probability test).

There was no predefined maximum number of errors above which a symbol would have been deemed unacceptable. Therefore, the researchers looked at the relative number of errors between the two groups rather than the absolute number of errors to determine which was the better of the two symbols.

All of the symbols exceeded the criteria for an average rating of 3 or better, implying that, although some of the symbols are preferable to others, any of the developed symbols are acceptable for use. Where more than one of the criterion for a particular symbol was statistically significant, the statistically significant criteria were in agreement as to which symbol was better. For 11 of the services/facilities, there was no statistical significance between the two alternative symbols for any of the three measures. For these cases, SMEs were asked to make the final decision on which symbols should be included in the recommended symbol set.

The Airport and Region facilities had only one developed symbol each. Both of these symbols had no errors and subjective rating data rated them highly.

3.3 Participant Comments and Resulting Symbol Modifications

The Exit Questionnaire asked the participants for suggestions on how to improve the symbols. This section of the report summarizes the main results of these suggestions.

In developing the candidate symbols, the SMEs and researchers had combined similar facilities into a single symbol to reduce potential symbol clutter for high level operations such as an operational control center (OCC) display. For example, a Marker symbol reflected the Fan Marker (FM), Inner Marker (IM), Middle Marker (MM), and Outer Marker (OM). The test participants frequently commented that the grouped symbols were more difficult to recall. Eventually, consolidated groups such as markers and visual aids may require specific symbols representing specific equipment to access lower level menus.

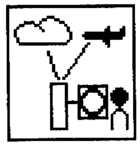
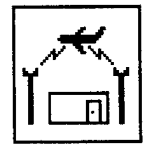
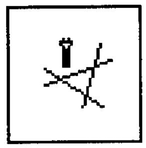
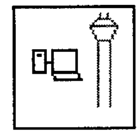
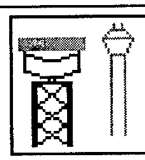
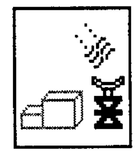
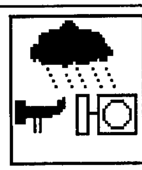
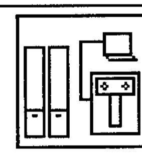
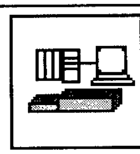
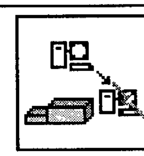
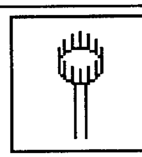
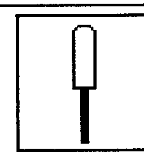
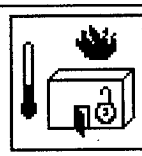
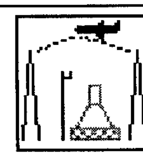
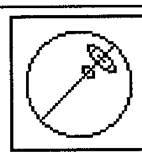
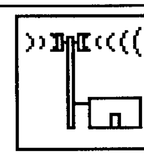
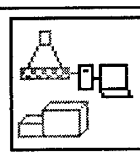
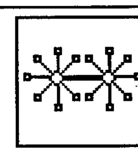
The participants recommended standardizing symbol components such as tower shading and antenna shapes. Participants commented that symbols such as TARS, TRAD, ARTS, and ASR were difficult to learn due to their similarity with other symbols. They suggested the addition of an "s" to the TARS and TRAD symbols to reduce the confusion factor for service related symbols by making them unique to the service category.

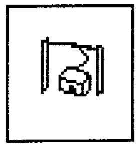
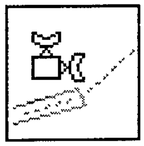
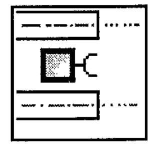
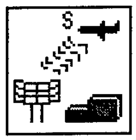
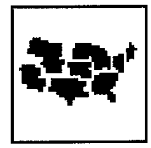
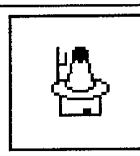
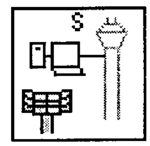
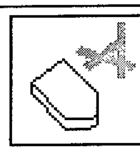
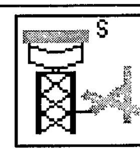
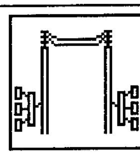
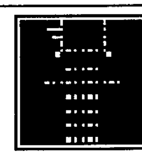
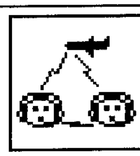
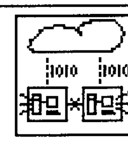
4. Conclusion

The results of the data analysis suggest that the 32 visual symbols presented in Table 3 are effective for representing services and facilities on AF displays. System designers can use these symbols to standardize the AF environment. Evaluated by potential users, they are likely to perform well in future AF environments.

This study did not address the issue of symbol size. Additional research may be needed to determine the optimal symbol size. In future operational displays, users may need to adjust symbol sizes to accommodate large quantities of data. It will be necessary to ascertain that the symbols are not too small for the viewing distance. Future research could specify the minimum recommended symbol size. In addition, future research could determine the optimal size necessary to minimize eyestrain and to accommodate users with vision limitations.

Table 3. Recommended Symbol Set

Acronym	Recommended	Acronym	Recommended
AFSS Automated Flight Service Station		(consolidated facilities) AGCF Air Ground Communications Facilities	
AIRPORT Airport		ARTS Automated Radar Terminal System	
ASR Airport Surveillance Radar		ATCBI Air Traffic Control Beacon Interrogator	
(consolidated facilities) AWOS/ASOS Automated Weather Observing System/ Automated Surface Observing System		CCCH Central Computer Complex Host	
(consolidated facilities) CDC/DCC Computer Display Channel / Display Channel Complex		DARC Direct Access Radar Channel	
DF Direction Finder		DME Distance Measuring Equipment	
EVS Environmental Systems		LRNCM Long Range Navigation C Monitor	
(consolidated facilities) MARKERS		(consolidated facilities) MCS Microwave Communications Systems	
MPS Maintenance Processing System		NADIN National Airspace Data Interchange Network	

Acronym	Recommended	Acronym	Recommended
(consolidated facilities) NDB/LOM Non Directional Beacon / Locator Outer Marker		ODAPS Oceanic Display And Planning System	
PAR Precision Approach Radar		PRM Precision Runway Monitor	
RDAT Radar Data Service		REGION Regions	
TACR Tactical Air Navigation at VHF Omidirectional Range (VOR)		(modified) TARS Terminal Automated Radar Service	
TRACON Terminal Radar Approach Control		(modified) TRAD Terminal Radar Service	
(consolidated facilities) TS Telecommunications Systems		(consolidated facilities) VA Visual Aids	
(consolidated facilities) VS Voice Systems		WMSCR Weather Message Switching Center Replacement	

Acronyms

AF	Airway Facilities
AFSS	Automated Flight Service Station
AGCF	Air Ground Communications Facilities
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASOS	Automated Surface Observing System
ASR	Airport Surveillance Radar
ATCBI	Air Traffic Control Beacon Interrogator
AWOS	Automated Weather Observation System
CCCH	Central Computer Complex Host
CDC	Computer Display Channel
DARC	Direct Access Radar Channel
DCC	Display Channel Complex
DF	Direction Finder
DME	Distance Measuring Equipment
EVS	Environmental Systems
FAA	Federal Aviation Administration
FM	Fan Marker
IM	Inner Marker
LOM	Locator Outer Marker
LRNCM	LORAN C Monitor
MCS	Microwave Communications Systems
MM	Middle Marker
MPS	Maintenance Processing System
NADIN	National Airspace Data Interchange Network
NDB	Non-Directional Beacon
OCC	Operations Control Center
ODAPS	Oceanic Display and Planning System
OM	Outer Marker
PAR	Precision Approach Radar
POCC	Prototype Operations Control Center
PRM	Precision Runway Monitor
RDAT	Radar Data Service
SME	Subject Matter Expert
TACR	Tactical Air Navigation at VOR
TARS	Terminal Automated Radar Service
TRACON	Terminal Radar Approach Control
TRAD	Terminal Radar Service
TS	Telecommunications Systems
VA	Visual Aids
VOR	Very High Frequency Omnidirectional Range
VS	Voice Systems
WMSCR	Weather Message Switching Center Replacement

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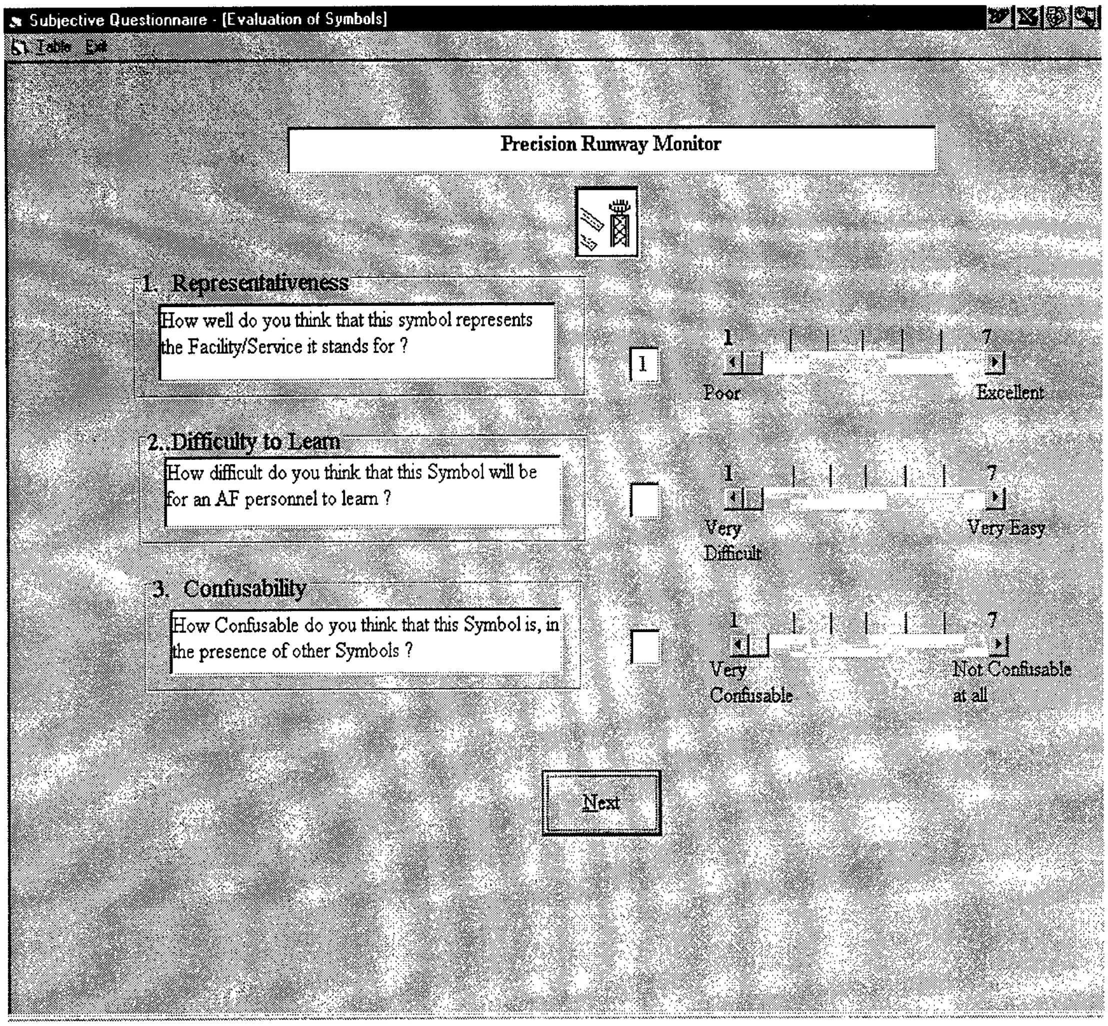
Appendix A
Combined Facility Symbols

Individual Facilities	Combined Facility
Backup Emergency Communications (BUEC), Remote Communications Air/Ground (RCAG), Remote Communications Outlet (RCO), and Remote Transmitter/Receiver (RTR)	Air/Ground Communications Facilities (AGCF)
Air Traffic Control Radar Beacon (ATCRB), and Mode-S	ATCRB/MODES
Automated Weather Observing System (AWOS) and Automated Surface Observing System (ASOS)	AWOS/ASOS
Computer Display Channel (CDC) and Display Channel Complex (DCC)	CDC/DCC
Central Control Monitoring Systems (CCMS) and Environmental Remote Maintenance Systems (ERMS)	Environmental Systems (EVS)
Fan Marker (FM), Inner Marker (IM), Middle Marker (MM), and Outer Marker (OM)	Markers (MARKER)
Radio Communications Link Repeater (RCLR), Radio Communications Link Terminal (RCLT), Radar Microwave Link Repeater (RMLT), Radar Microwave Link Terminal (RMLT), Television Microwave Link Repeater (TMLT), Television Microwave Link Transmitter (TMLT), and Television Microwave Link Indicator (TMLI)	Microwave Communications Systems (MCS)
Non-Directional Beacon (NDB) and Locator Outer Marker (LOM)	NDB/LOM
Data Multiplexing Network (DMN) and Leased Interfacility NAS Communications Systems (LINCS)	Telecommunications Systems (TS)
Approach Light System (ALS), Medium Intensity ALS (MALS), Precision Approach Path Indicator (PAPI), Runway End Identification Lights (REIL), Visual Approach Slope Indicator (VASI), and MALS with Runway Alignment Indicator Light (MALSR)	Visual Aids (VA)
Integrated Communications Switching System (ICSS) and Voice Switching and Control System (VSCS)	Voice Systems (VS)

Appendix B
Subjective Data Collection Sample Screen



Appendix C
Exit Questionnaire

Name:

User ID:

Date:

1. Did you find the entire testing process to be mentally demanding?

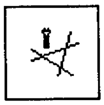
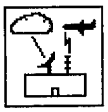
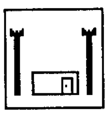
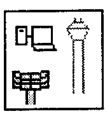
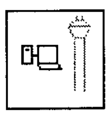
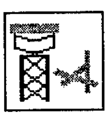
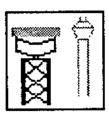
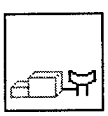
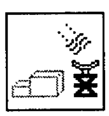
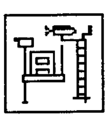
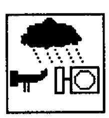
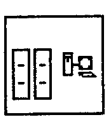
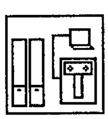
2. Do you think there were too many symbols to learn or could you have learned a few more?

3. What do you think of the methods of training? Do you have any suggestions for improvement?

4. Is there any particular symbol you dislike? If yes, do have any suggestions for improvement?

5. Can you circle the symbol you prefer for each facility or service (out of the two alternatives), on the attached sheets?

Note: The following symbols are organized by group. During testing they were randomly presented. Changes and modifications were made to some of the symbols so the recommended symbol

	Group A	**Group B**
Airport		
AFSS		
AGCF		
ARTS		
ASR		
ATCBI		
AWOS		
CCCH		

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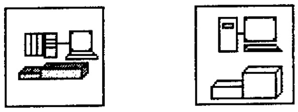

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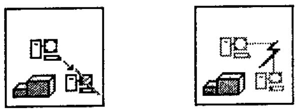

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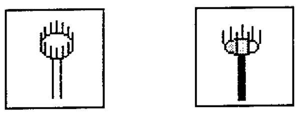

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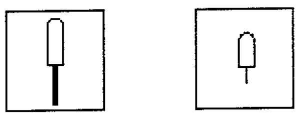

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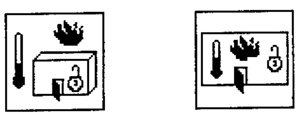

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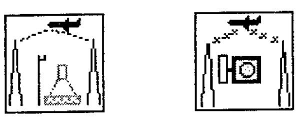

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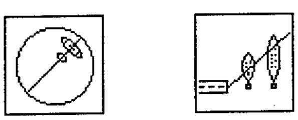

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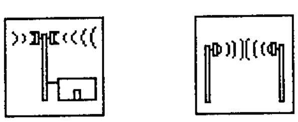

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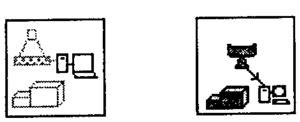
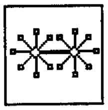
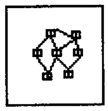
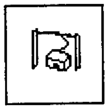
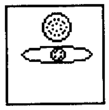


NADIN  

NDB  

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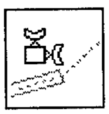
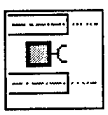
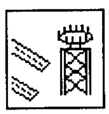
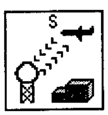
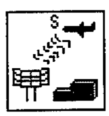
PAR  

PRM  

RDAT  

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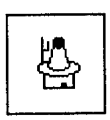
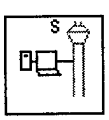
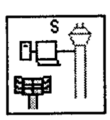
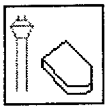
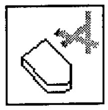
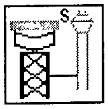
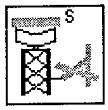
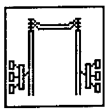
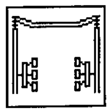
TACR  

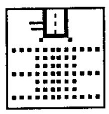
TARS  

TRACON  

TRAD 



TS  

VA  

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