A COMPARATIVE USABILITY AND END-USER SATISFACTION ANALYSIS

OF TWO GEOGRAPHIC INFORMATION SYSTEM (GIS) APPLICATIONS

THESIS

Mark E. Barner, SMSgt, USAF

AFIT/GIR/ENV/06M-01

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the United States Government.

AFIT/GIR/ENV/06M-01

A COMPARATIVE USABILITY AND END-USER SATISFACTION ANALYSIS OF

TWO GEOGRAPHIC INFORMATION SYSTEM (GIS) APPLICATIONS

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Information Resource Management

Mark E. Barner, BS

SMSgt, USAF

March 2006

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

AFIT/GIR/ENV/06M-01

A COMPARATIVE USABILITY AND END-USER SATISFACTION ANALYSIS OF TWO GEOGRAPHIC INFORMATION SYSTEM (GIS) APPLICATIONS

Mark E. Barner, BS

SMSgt, USAF

Approved:

/signed/	14 Mar 2006
Summer E. Bartczak (Chairman)	Date
/signed/	13 Mar 2006
Brian G. Hermann (Member)	Date
/signed/	13 Mar 2006
Kevin L. Elder (Member)	Date

AFIT/GIR/ENV/06M-01

Abstract

The U.S. Air Force has recognized that organizations across Air Force (AF) installations often require geospatial information resources or maps to accomplish mission essential tasks. To provide an AF-wide approach to addressing this need, in 2001, the Headquarters Air Force Geo Integration Office formed the USAF GeoBase program. GeoBase is the name given to the Air Force's GIS program. Although the AF has specific needs and requirements for GIS, the foundation for the AF GeoBase program remains in the use of private sector GIS technology. As GeoBase has been implemented across the AF, there have been no mandated product standards for GIS applications.

This thesis focuses on two different GIS applications being used across the Civil Engineer (CE) community for the management of airfield obstructions. These two applications are the Airfield Obstruction Management System (AOMS) and the Airfield Obstruction Tracking, Analysis, and Management System (AIROBS). In addition to the development of a unique methodological approach for accomplishing analyses, this research presents how each application rates in usability of accomplishing tasks and the level of satisfaction as determined by the end-user. Overall, the results revealed that AOMS was identified as having fewer problems in usability and rated slightly higher in End-User Computing Satisfaction. The methodology is also offered as a way to compare other GIS applications where there is an intent to determine the best application for a specific mission purpose.

To my wife and daughter

Acknowledgments

First, I would like to thank my thesis advisor, Lt Col Bartczak, for her continuous guidance and support throughout this thesis effort. I would also like to thank Dr Charles Fenno for his words of encouragement and logistical support. The dedicated location and computer support to conduct the evaluations made this thesis possible.

Additionally, I want to thank Ms Susan Kil and Lt Col Jeth Fogg for providing a worthwhile thesis topic. Also, many thanks go out to the evaluators, community planners, and others who had input to this research.

Most importantly, my deepest appreciation goes out to my wife. Her continuous support of my career and pursuit of education made it possible for me to get to AFIT and complete this thesis effort.

Mark E. Barner

Table of Contents

List of Figures

List of Tables

A COMPARATIVE USABILITY AND END-USER SATISFACTION ANALYSIS OF TWO GEOGRAPHIC INFORMATION SYSTEM (GIS) APPLICATIONS

I. Introduction

Background

A Geographic Information System (GIS) is a specialized class of database management system that allows users to analyze, relate, and display spatial attributes of data in addition to conventional relational data (West, 2000). The Environmental Systems Research Institute (ESRI) defines GIS as "an organized collection of computer hardware, software, geographical data and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced materials" (Heikkila, 1998). The purpose of GIS software applications is to perform the same kinds of spatial analyses once done by hand, but to do them with much greater speed and accuracy (Gilbrook, 1999). GIS can display maps on a computer screen and can also provide detailed information about map features, including roads, buildings, streams, etc. GIS are being used to store feature attributes and analyze the "spatial" relationships which can help manage forests, utilities, and petroleum exploration (Korte, 2001). As such, public corporations; federal, state, and local governments; and even the military is using GIS technology.

The U.S. Air Force has also recognized that organizations across AF installations often require geospatial information resources or maps to accomplish mission essential tasks such as land use planning, identifying disaster response cordon/stand-off distances and emergency response routes, and locating underground utilities just to name a few. To provide an AF-wide approach to addressing this need, in 2001, the Headquarters Air Force Geo Integration Office (HAF GIO) formed the USAF GeoBase program. GeoBase is the name given to the Air Force's GIS program. In 2002, wing-level CE organizations were identified as the central point of contact for all base-level mapping requirements and were granted responsibility for the installation GeoBase program by the Office of the Civil Engineer, Installation and Logistics, Headquarters, United States Air Force (ILE). Although the AF has specific needs and requirements for GIS, the foundation for the AF GeoBase program remains in the use of private sector GIS technology. The specific mission of the USAF GeoBase program is to "attain, maintain, and sustain one geospatial infostructure to address Air Force installation requirements," with a vision toward "one installation, one map" (Zettler, 2002). The GeoBase program is built around three conceptual views: Strategic, Expeditionary (also known as GeoReach), and Garrison. Strategic GeoBase is a generalized view of AF installations served to agencies beyond the Major Commands (MAJCOM) via a central repository of digital GeoBase data at the Pentagon. Expeditionary GeoBase is a forward deployed version of Garrison GeoBase with capabilities affording commanders and airmen enhanced situational awareness of expeditionary bases. Garrison GeoBase consolidates an installation's mapping needs and provides a common digital map throughout the installation network. In addition, Garrison GeoBase allows a command and control capability that provides commanders and first responders increased ability to respond to emergency situations by visualizing incident location and status in relation to base assets and resources using a common map.

The installation geospatial data is organized into layers that represent buildings, roads, airfield surfaces, etc. and are then synthesized into the Common Installation Picture (CIP). The CIP is the high-fidelity base map that can be viewed for reference by all functional communities at a given installation (HAF GIO, 2003a, p. 5).

As GeoBase has been implemented across the AF, there have been no mandated product standards for GIS applications. No single GeoBase application for a specific purpose, such as managing airfield obstructions, exists for use across the CE community (HAF GIO, 2003a, p. 17). As such, MAJCOMs and installations are using different vendors for various GIS applications. This has led to multiple software applications being developed and purchased for similar uses. In turn, this has caused general difficulty in the CE leadership's visibility and management of the many applications in use across the MAJCOMs and installations. This has caused MAJCOMs and installations to purchase and/or have applications developed for specific purposes, whereas a suitable application may already exist. At this point, one must wonder if one application is better than another and, if so, should the better application be mandated for that purpose. This research focuses on analyzing two such GeoBase applications that are used by CE organizations across the AF.

Problem and Purpose Statement

Currently there are two different GIS applications being used across the CE community for the management of airfield obstructions. These two applications are the Airfield Obstruction Management System (AOMS) and the Airfield Obstruction Tracking, Analysis, and Management System (AIROBS). The two applications are being implemented and funded by MAJCOMs and installations without any funding oversight or management by the Headquarters Air Force Geo Integration Office (HAF GIO). Since the GeoBase program started in 2002, the need to understand what GIS applications are in use across the AF and the management of those applications by the HAF GIO has become increasingly important to ensure that application purchasing and development can be leveraged across the AF. As such, this research project will attempt to complete a comparative analysis of AOMS and AIROBS to be used as a foundation in any future discussions regarding the implementation of only one application across the AF. The analysis will address how each application rates in usability of accomplishing tasks and the level of satisfaction as determined by the end-user. To carry out this research, the following research questions will be addressed.

Research Questions

1. How do AOMS and AIROBS compare in software usability, where usability criteria measures error abatement, responsiveness, descriptiveness, consistency, and simplicity?
2. How do AOMS and AIROBS compare in end-user computing satisfaction (EUCS), as determined by the measures of content, format, and ease of use provided by each application?

Methodology

To address the research questions, the method of analysis will consist of an evaluation questionnaire focusing on software usability and end-user computing satisfaction. Task scenarios will be used to provide the evaluators some interactive situations with the applications prior to answering the questionnaire. The task scenarios were developed based on the application's purpose of tracking, analyzing, and managing airfield obstructions and input from AF community planners. The evaluation questionnaire is a combination of software usability and EUCS criteria. The software usability evaluation is a non-statistical method aimed at identifying problem areas within the applications by measuring software functions which are not always present when performing the task scenarios. The EUCS items are closed-ended responses that describe the level of satisfaction provided to the evaluators by the application. These responses will be analyzed using descriptive statistics (Doll & Torkzadeh, 1988, p. 263). The population for the evaluations will include CE officers and CE civilians who are either AFIT graduate students or instructors assigned to the AFIT Civil Engineer and Services School.

Benefits/Implications of Research

This research will be the first known attempt in the GeoBase arena to compare two applications being used for the same purpose. The evaluations will assess application usability and end-user satisfaction which may identify which application is perceived to be more effective in task/requirement accomplishment by respondents. The results of this study may assist in identifying a standard application for airfield obstruction management that could be implemented AF wide. In addition, this research methodology may lend itself to be used with other application comparison analyses.

Thesis Overview

Chapter one provides a background for the thesis research. In chapter two, a literature review of GIS and how GIS are being used in the AF will be provided. Chapter three will detail the research methodology used, along with how the data was collected and analyzed. The fourth chapter will present the results and analysis of the findings based on the research questions. In the last chapter, a discussion of the results which may be used to guide decision making will be presented. In addition, limitations of this research and suggestions for future research will be given.

II. Literature Review

An analysis of airfield obstruction management systems must begin by exploring the history of Information Systems (IS) and Geographic Information Systems (GIS). This literature review will take a historical look at IS and how these systems have progressed over the last 40 years. In addition, the evolution of GIS and the similarities GIS holds with traditional IS will be presented. Then, a discussion of GIS in the AF, or GeoBase, will be presented. The next area of the chapter will describe airfield obstructions and airfield surfaces. Finally, airfield obstruction management systems will be discussed. This discussion will include why and how airfield management has become so important. Furthermore, the two airfield obstruction management systems in use by the Air Force will be profiled.

Information Systems

"An information system or IS is a system designed to collect, store, manipulate, and analyze information and then use the information for the purpose that it was collected" (Pittman, 1990, p. 4). Laudon and Laudon define an information system "as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in organizations" (Laudon, 1998, p. 7). Worboys and Duckham further define an information system as "an association of people, machines, data, and procedures working together to collect, manage, and distribute information of importance to individuals or organizations" (Worboys & Duckham, 2004, p. 1). The relationship between the computer and information was the theme of Edward Berkeley's 1949 book, *Giant Brains, or Machines That Think*. This was the first book to make the connection between computers and their potential use in business (Haigh, 2001, p. 32). Early information systems, from the 1950s through the mid-1960s, were mostly oriented toward data processing and hardware/software technologies (Lee, 1988, p. 17). It was during the late 1950s and early 1960s that the concept of the "totally integrated management information system" came into being. The idea was to have an integrated computer system designed to encompass all administrative and managerial activities (Haigh, 2001, p. 15). During the data processing era, most applications were used at the operations level such as in the finance departments. As the technology changed the applications also began to move from mainframes, to minicomputers, and on to personal computers. These changes brought about the decentralization of the information systems organization (Lee, 1988, p. 18). Information systems now play a larger role in organizational life. Today, information systems are rooted in organizational strategy and daily operations (Laudon, 1998, p. 29).

GIS-Another Type of IS

"A GIS is a special type of information system concerned with geographically referenced data" (Worboys & Duckham, 2004, p.2). A GIS has two distinguishing characteristics that make it different from a standard information system. First, the data in a GIS are "spatially referenced, usually with x-y or latitude-longitude coordinates." Second, a GIS will normally have mapping capabilities associated with them (Pittman, 1990, p. 4). As with a standard IS, the central part of any GIS is the database. Because the data is geographically referenced, the GIS data sets are usually larger and more complex than other IS's (Worboys & Duckham, 2004, p.3). The database contains map layers (Figure 1) that represent geographic features, which are referenced to a standard coordinate system such as the Universal Transverse Mercator (UTC) or State Plane Coordinate system (Fung & Remsen, 1997, p. 18). With this type of mapping, any one

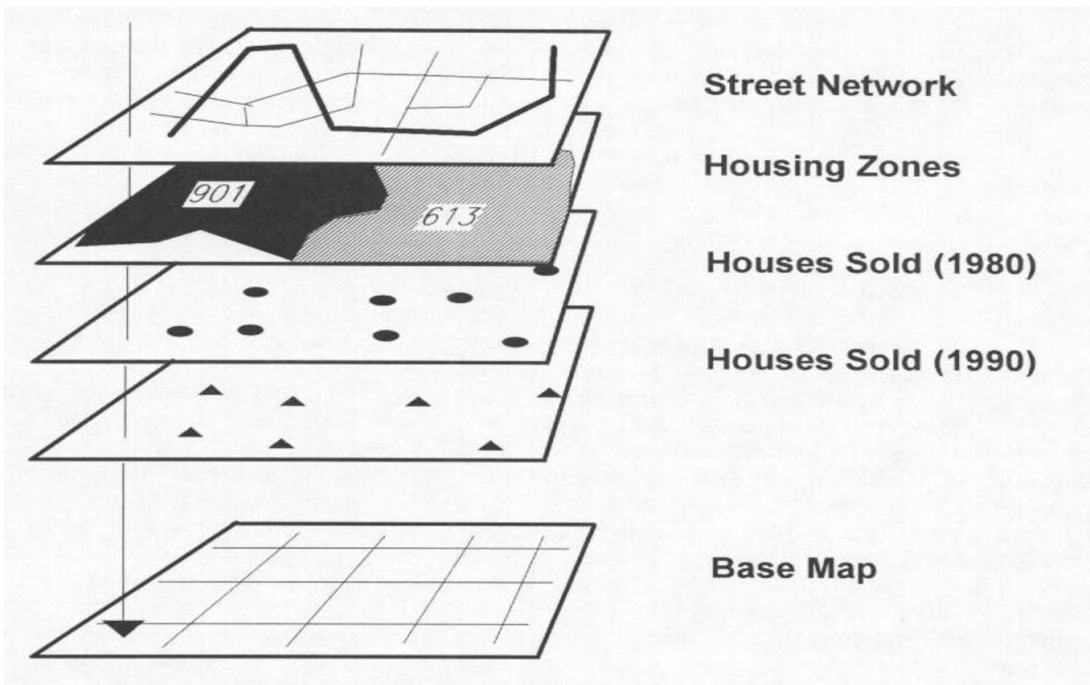

Figure 1. A GIS database may be conceptualized as a stack of floating map layers registered to a common map base. (Adapted from Fung & Remsen, 1997)

of the layers can be accessed independently or in combination with other layers (Fung & Remsen, 1997, p. 18). A primary function of GIS tools is to perform spatial analyses with more accuracy and speed than was previously done by hand (Gilbrook, 1999, p. 34).

GIS History and Evolution

As was stated in Chapter 1, the Environmental Systems Research Institute (ESRI) defines GIS as "an organized collection of computer hardware, software, geographical data and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced materials" (Heikkila, 1998). This definition includes technology and people, but the essence for GIS evolution lies in computer technology. As technology has advanced and expanded across wider markets, more applications are being developed to handle the spatial information. Automated GIS began in the 1960s with the Canadian forestry service. Dr. Roger Tomlinson led the development of the first industry-wide automated GIS, known as the Canadian Geographic Information System. After this initiative, the term "geographic information system" became widespread (Foresman, 1998, p. 10). GISs continued to expand as North American government and university researchers sought to develop methods to represent the earth's geography using a computer database, display it on a computer screen, and print it on paper (Korte, 2001, p. 6). In the U.S., the National Environmental Policy Act (NEPA) of 1970 continued the trend toward increased land use management and environmental protection that led to many mandated programs that bolstered GIS technological development. NEPA is recognized as having the most influence for advancing the use of GIS in the federal government (Foresman, 1998, p. 10). Several corporations were founded in the 1970s to develop and sell systems for computer mapping and analysis. Initially, only the largest government agencies and corporations could afford GIS. However, in the 1980s, the GIS market continued to grow because of the benefits provided to organizations. From the late 1980s through the 1990s, personal computers and the World Wide Web have expanded the use of GIS to practically anyone (Korte, 2001, p. 6).

GIS in the Air Force

As stated previously, the Air Force's GIS program, or GeoBase, started in 2002 by direction of the AF Civil Engineer. The guiding documents for the GeoBase program are the *USAF Garrison Mapping Concept of Operations (CONOPS) Version 2.0* (2003), the *USAF GeoBase Common Installation Picture Data Model Standardization Work Plan Version 1.0* (2003), and the *USAF GeoBase Enterprise Architecture Version 1.0* (2003). The vision of the AF GeoBase program is "one installation, one map with a mission to attain and sustain a breakthrough capability enabling shared, efficient use of trusted, integrated, and georeferenced information delivering situational awareness across installations" (HAF GIO, 2003a, p.4).

GeoBase Standards

In October 1990, the Office of Management and Budget established the Federal Geographic Data Committee (FGDC) to further the development, use, and sharing of geographic data within and across the federal agencies and departments (Mangan, 1995, p. 99). In 1992, in response to the need for standardization policy across Department of Defense (DOD) installations, the DoD, along with FGDC, created the Computer-Aided Design and Drafting (CADD)/GIS Technology Center to advance GIS technology across the DoD (Korte, 2001, p. 84). The Center developed and now annually updates the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) ("Spatial

Data Standard", 2005). The SDSFIE provides standardized groups and names for geographically referenced features and also provides an attribute table containing data about the geospatial feature (Korte, 2001, p. 85). The SDSFIE is a nonproprietary GIS standard designed to be used with commercial GIS software. As a result, the DoD has adopted the SDSFIE as the standard for GIS implementation ("Spatial Data Standard", 2005). In 2003, the *USAF GeoBase Enterprise Architecture Version 1.0* was developed to "guide USAF organizations in the process of selecting IT standards and technologies to deploy and exploit GeoBase capabilities." The GeoBase architecture is based on the *Air Force Command, Control, Communications, Computers, and Intelligence, Surveillance, and Reconnaissance* (C4ISR) *Architecture Plan*, developed by the Deputy Chief of Staff for Warfighting Integration, Headquarters U.S. Air Force (HAF GIO, 2003b, p. iii). The *C4ISR Architecture Plan* has been replaced by the *Department of Defense Architecture Framework (DoDAF) Version 1.0*, dated August 2003. These standards have been applied to GeoBase applications such as airfield obstruction management systems.

Airfield Obstruction Reduction Initiative Background

On July 24, 1998, at Misawa Air Base (AB), Japan, an F-16 pilot aborted takeoff and the F-16 crashed off the end of the runway. The pilot ejected when the aircraft speed was at 56 knots. The aircraft went off the runway and struck various structures of the approach lighting and instrument landing system (ILS) localizer antenna systems. The external fuel tanks were damaged and the aircraft caught fire. The pilot drifted into the fire before reaching the ground. The pilot was fatally injured from the burns (Holliday, 2001, p. 1). From August – October 1999, SAF/IG conducted a review of construction and repair projects at Misawa AB. In response to the Secretary of the Air Force Inspector General (SAF/IG) Report of Review, the Air Force Chief of Staff directed that corrective action be taken to reduce airfield obstructions. Based on this directive, AF/ILE instructed that all AF bases identify airfield obstructions and directed a plan be developed to mitigate airfield obstructions (Air Force Tiger Team, 2000 p. 7). The *Airfield Obstruction Reduction Initiative (AORI) Report*, dated Nov 2000, is the response to the SAF/IG inspection. HQ AF/ILE assigned a team to collect and analyze the data provided by the bases. The primary purpose of the team was to investigate possible problems and make recommendations for improvement (Ates, 2001). During the AF/ILE tiger team assessment, the team recommended that AF/ILE establish "standards (and perhaps a standardized system) for collecting, and reporting, AF-wide airfield obstruction waiver data." At the time of this assessment, there was "no standardized format for collecting and reporting annual waiver data" (Air Force Tiger Team, 2000, p. 18). This lack of a standard reduced the effective management of airfield obstructions that required a waiver. The waivers can be permanent or temporary and are used to allow deviations from the standards. This ineffective waiver management reduced the ability to mitigate airfield obstructions. The team also found that Air Combat Command (ACC) was using a GIS-based Airfield Obstruction Management System (AOMS) that greatly enhanced the management of the airfield waiver program. At that time, Pacific Air Forces (PACAF) had also adapted the AOMS. The team recommended that AF/ILE endorse the AOMS for all MAJCOMs (Air Force Tiger Team, 2000, p. 18). Prior to using AOMS, the most common method of tracking airfield obstructions was through the use of Computer-Aided Drafting and Design (CADD) drawings and Microsoft Word, Microsoft Excel, or paper files. Although airfield obstruction management systems will be discussed later, it is necessary to provide some background concerning the airfield environment and airfield obstruction classification.

Airfield Environment and Obstruction Criteria

The airfield environment (Figure 2) consists of actual and imaginary surfaces that define the obstacle free zone around the airfield (Air Force Tiger Team, 2000, p. 29).

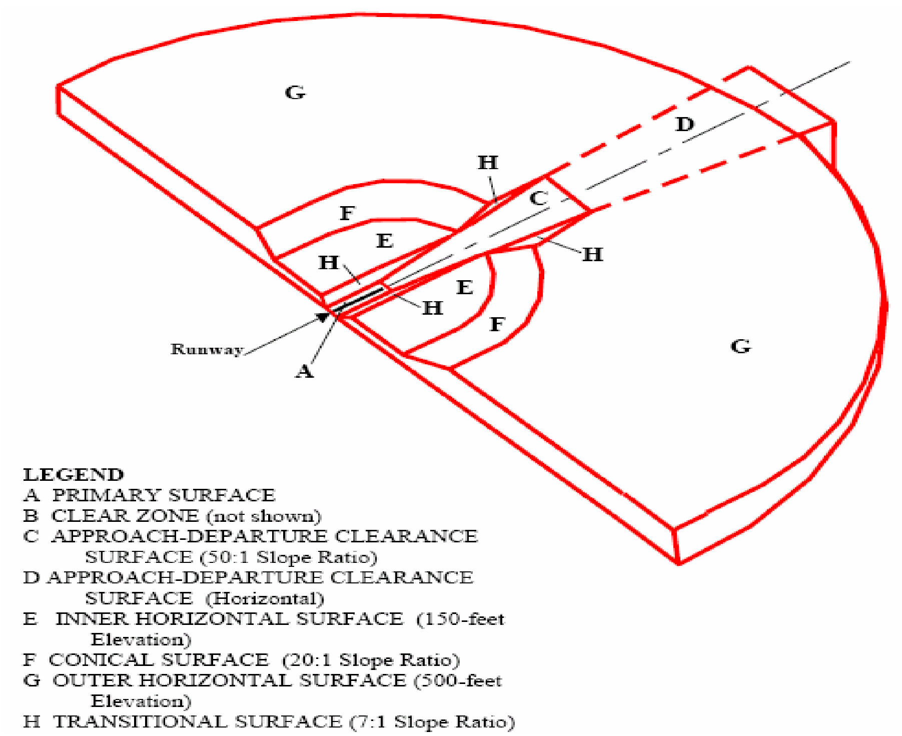

Figure 2. Airfield Surfaces (Adapted from Airfield Obstruction Reduction Initiative Report, Nov 2000)

The imaginary surfaces (Figure 3) for DoD airfields are "the primary surface, the approach-departure clearance surface, the transitional surface, the inner horizontal surface, the conical surface (fixed-wing only), and the outer horizontal surface (fixed-wing only)" ("*Unified Facilities Criteria* ", 2001, p. 217). An airfield obstacle is defined as "all fixed objects located within the airfield environment that extend above any of the imaginary surfaces of the airfield or are located within the mandatory zone of frangibility. Airfield obstacles may be of either standard or nonstandard design. Obstructions are also classified as obstacles" (AFCESA/CES, 2001, p. 3). An obstruction can be natural or man-made objects that violate airfield clearances (Air Force Tiger Team, 2000, p. 4).

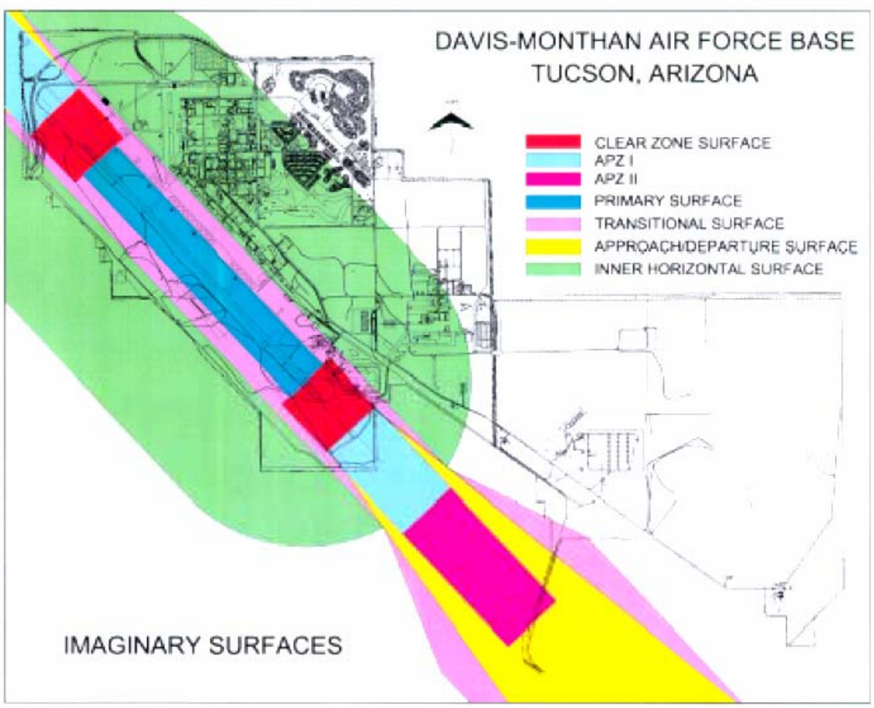

Figure 3. Imaginary Surfaces (Adapted from Airfield Obstruction Initiative Report, 2000)

Obstructions can be objects such as signs, towers, buildings, landforms, trees and other vegetation that "penetrate regulatory airspace surfaces"(CH2M Hill, n.d.). Frangibility is defined as "the ability of an object to collapse or fall over when struck by a moving aircraft such as to cause damage to aircraft, not impede the motion of the aircraft, or radically alter the path of the aircraft" (AFCESA/CES, 2001, p. 3). The frangibility zone consists of all areas within 250 feet of the runway center line along its entire length out to a distance of 3000 feet beyond the runway threshold or to the base boundary. It also includes a 200 foot lateral distance from all taxiway centerlines (AFCESA/CES, 2001, p. 4). Air Force policy mandates that all obstructions within the primary surface and clear

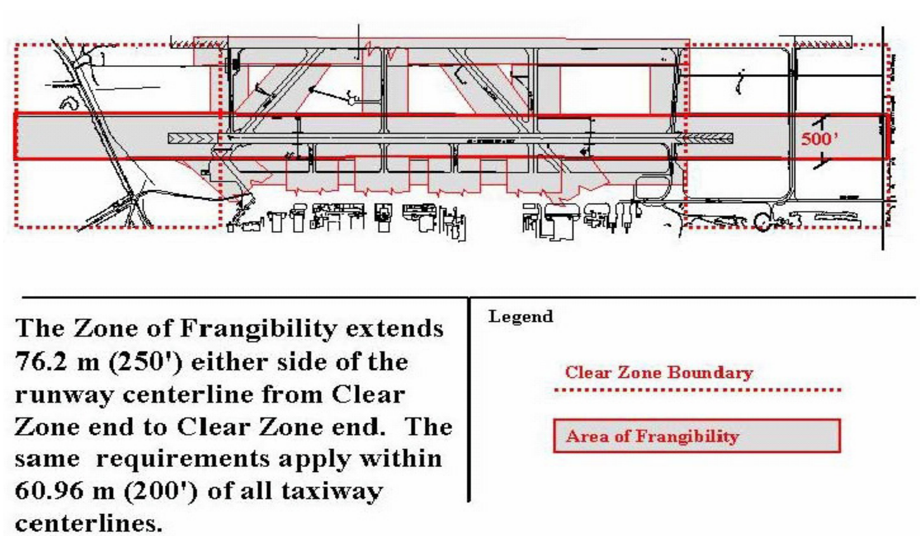

Figure 4. Frangibility Zone (Adapted from AFCESA ETL, 2001)

zone be identified as either a permissible deviation or exemption. A permissible deviation can be visual and navigational aid facilities necessary for airfield operations. Permissible deviations can also be made frangible, if possible. An obstruction exemption is identified as objects or facilities constructed before 1964. A waiver is required for any obstruction that is not identified as a permissible deviation or exemption. A waiver can be temporary or permanent and is intended for those situations when compliance with the standards cannot be achieved (Air Force Tiger Team, 2000, p. 4).

Airfield Obstruction Management Systems

A GeoBase application "is a stand-alone application designed to access the GeoBase service to display a map, query mission data via the map or perform specific spatial analysis functions using geospatial data" (HAF GIO, 2003b. p. 5). Both airfield obstruction management systems in use by the AF are GeoBase applications. The two systems in use are the Airfield Obstruction Management System (AOMS) and the Airfield Obstruction Tracking, Analysis, and Management System (AIROBS). Both systems were developed to facilitate the documenting, mapping, analysis, tracking, and management of airfield obstructions("AIROBS: Airfield Obstruction Management System", 2004; HB&A, 2004).

AOMS was developed by Higganbotham, Briggs, and Associates (HB&A). The AOMS concept began after HB&A personnel visited ACC headquarters in 1997. Based on the paper process being used to track and manage obstructions, HB&A started the development of an electronic process for this purpose. HB&A started the development without any "prompting or direction from the AF" (Mael, 2005). The first version of AOMS used in the field came in October 1998. ACC implemented the application as a pilot project at Davis-Monthan AFB, Shaw AFB, and Barksdale AFB. The CADD/GIS Technology Center continues to develop AOMS and the application is non-proprietary and government-owned. AOMS version 8.x complies with the *HAF GIO GeoBase Enterprise Architecture Version 1.0* (2003), and the *USAF Garrison Mapping CONOPS Version 2.0* (2003). AOMS version 8.x also provides the ability to produce command-specific reports, and the AORI report (Briggs, 2004, p. 2, 5). AOMS is being used at approximately 60 military installations worldwide (Mael, 2005). Figure 5 is a screen capture of the AOMS Database Menu and Figure 6 is a screen capture example of the AOMS Edit Obstructions view.

Figure 5. AOMS Database Menu Screen

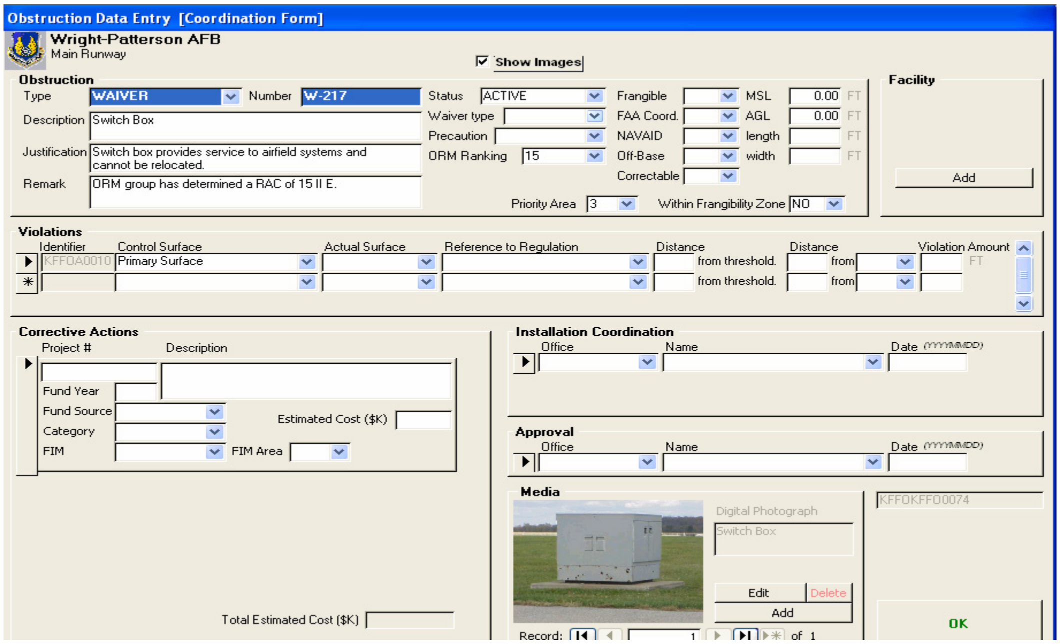

Figure 6. AOMS Edit Obstructions Screen

AIROBS was developed by CH2M Hill for the United States Air Forces in Europe (USAFE) to assist with the analysis and management of airfield obstructions (CH2M Hill, 2003, p. 19). USAFE had determined that "no existing application could meet its specifications and performance requirements." Therefore, USAFE contracted with CH2M Hill to develop a new application (Moreno, 2005). AIROBS was developed to "perform three-dimensional analyses to determine surface violations, display data visually, create waivers for new obstructions, and produce summary reports and maps of identified obstructions." CH2M Hill holds the copyright, but the application is owned by the AF (CH2M Hill, 2003, p. 19-20). AIROBS is in use at approximately 12 AF installations world-wide (CH2M Hill, 2004). Figure 7 is a screen capture of the AIROBS Tools Menu and Figure 8 is a screen capture of the AIROBS Edit Obstructions view.

Figure 7. AIROBS Tools Menu

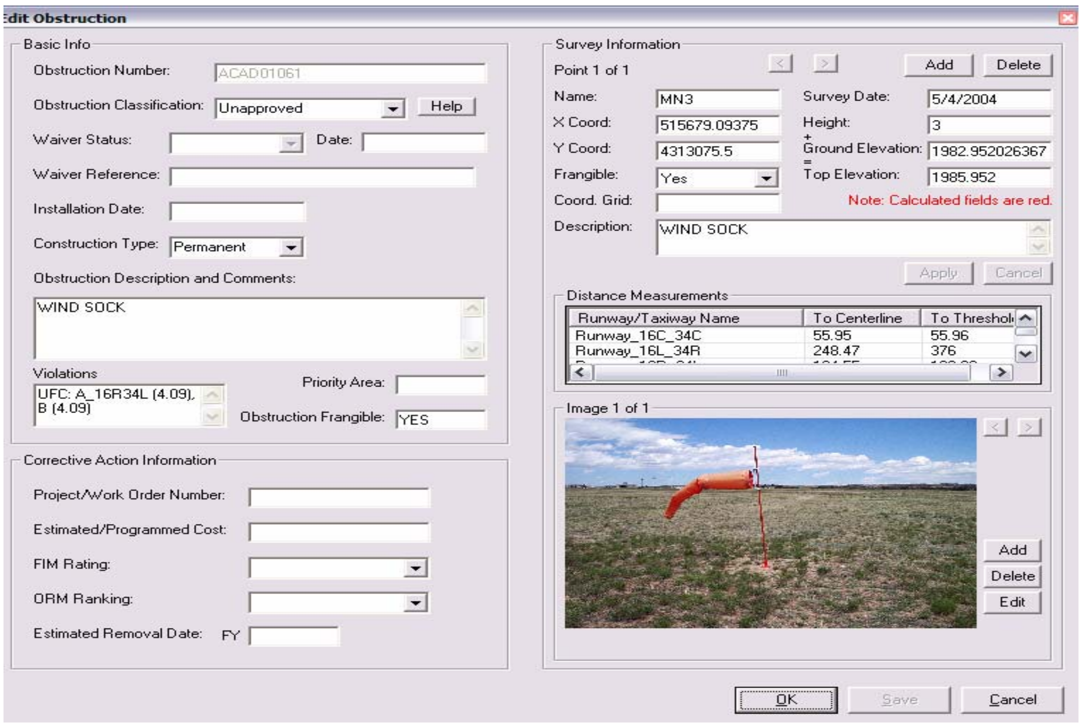

Figure 8. AIROBS Edit Obstructions Screen

Common Characteristics of Both Systems

According to Mr Michael Ates, Civil Engineer Division at the Air Force Civil Engineer Support Agency (AFCESA), "AOMS and AIROBS are essentially the same but refined by two different companies" (Ates, 2005). Both applications:

1. Use ESRI ArcGIS 8.x software as its platform
2. Displays the installation CIP
3. Analyzes obstructions
4. Tracks and reports airfield waivers
5. Use Microsoft Access as the database
6. Have database information organized by the SDSFIE (Briggs, 2004 p. 2-3; CH2M Hill, 2004)

Both applications are available for AF use and can be downloaded from the CADD/GIS Technology Center's website. According to the CADD/GIS Technology Center Project #02.030, both applications in their final form were posted to the Center's website in September 2004. Also, the project's timeline reveals that the decision to support both programs was made by the AF in December 2003 (Horner, 2004). The applications are owned by the AF but the copyrights are held by their respective company. Since each of the applications are dependent on Microsoft Access for the database and the ESRI ArcGIS platform, there is substantial cost involved every time Access or ArcGIS is upgraded.

Literature Review Summary

The chapter began with an overview and condensed history of IS and GIS. Then, the background of the GeoBase program was presented in order to establish a basis for airfield obstruction management systems. Next, a discussion of the airfield surfaces, airfield obstructions, and the AORI was provided. This discussion established the foundation to the establishment of airfield obstruction management systems. The chapter closes with a profile of the two airfield obstructions systems in use across the AF today.

III. Methodology

Overview

This research was conducted using a qualitative methodology. Qualitative research can use various data collection and analysis methods (Schwab, 2005). The AFOTEC Software Usability Evaluation assesses the usability of a software application by identifying problem areas within the functions of the application. The EUCS evaluation uses a numerical scale for the item responses to determine the level of satisfaction provided by the software application to the end-user. The scale data are "nominal" because the numbers represent categories (Alreck, 2004). The categories range from *Almost Never* (1) to *Almost Always* (5). This chapter describes each assessment and the data collection methodology. A discussion of the evaluation instrument along with details about the sample and data analysis is presented.

AFOTEC Software Usability Evaluation

The AFOTEC Software Usability Evaluation focuses on the user's interaction with a software-intensive system (HQ Air Force Operational Test and Evaluation Center, 1994, p. 26). Usability has been described as the learnability, functionality, effectiveness, acceptability, and ease-of-use of a software application or product. There are many views on the definition of usability. Bevan, et al, defines usability as "the ease of use and acceptability of a system or product for a particular class of users carrying out specific tasks in a specific environment" (Bevan *et al.*, 1991). The International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC), 9126-1 (2000) defines usability as "the capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions" (Bevan, 2003). Along with the many definitions of usability, there are many attributes associated with the usability construct. Some of those attributes include learnability, understandability, reliability, and satisfaction, just to name a few (Bevan, 2003; Juristo *et al.*, 2003). The AFOTEC Software Usability Evaluation identifies the attributes of error abatement, responsiveness, descriptiveness, consistency, and simplicity (HQ Air Force Operational Test and Evaluation Center, 1994, p. 148) Table 1 identifies the AFOTEC Software Usability Evaluation attributes and their definitions.

Table 1. Usability Attributes

AFOTEC Usability Attributes and Definitions	
Error Abatement	Aids in validating data and avoiding or correcting errors
Responsiveness	Allows the user to effectively direct system operation
Descriptiveness	Provides the user with adequate explanations of every function he/she is required to perform and every function the system performs
Consistency	The behavior of the software corresponds to the expectations of the user
Simplicity	Information presented to the user is grouped into short, readily understandable structures

As stated earlier, the applications that are the focus of this research are already in use. Since these applications are already being used, it was necessary to find an evaluation methodology in which the results could be used to make improvements to the applications in the field. After reviewing several methods of evaluating the usability of software applications, such as heuristic evaluation and cognitive walkthroughs, the researcher determined that the AFOTEC Software Usability Evaluation methodology could be adapted for this comparative analysis. This methodology focuses on identifying problem areas with functions of the applications which would be effective for this type of comparative analysis. Dumas and Redish (1993) suggest that even though there are many ways to conduct usability testing, there are five common characteristics.

1. The primary goal is to improve the usability of the product.
2. The participants represent real users.
3. The participants do real tasks.
4. Observation and recording of what participants do and say.
5. Analyze the data, diagnose the real problems, and recommend changes to fix those problems (Dumas & Redish, 1993, p. 22).

Even though this software evaluation was conducted with applications that are already in use, the characteristics above still apply. The AFOTEC Software Usability Evaluation instrument and process was developed from the source documents of Smith and Mosier (1986), Ravden and Johnson (1989), Military Standard (MIL-STD)-1472D, and MIL-STD-1801. AFOTEC began by testing and evaluating major weapons systems, but grew to include the evaluation of the operator-software interface that has become so important in the systems that the AF uses. The AFOTEC evaluation instrument is based on a subset of questions from 177 evaluation items covering the attributes described earlier (HQ Air Force Operational Test and Evaluation Center, 1994). The 35 items used in this research to measure software usability were selected by the researcher after reviewing both applications and based on the applicability of the evaluation items to the tasks being performed in the scenarios. The selected items were subsequently reviewed and approved by the researcher's three committee members who have extensive knowledge and experience with software applications. The next area for discussion is the EUCS methodology.

End-User Computing Satisfaction

Prior to the development of Doll and Torkzadeh's EUCS instrument, measures of user information satisfaction primarily focused around a data processing environment or overall computer user satisfaction. Doll and Torkzadeh's primary goal in the development of the EUCS instrument was to "focus on satisfaction with the information product provided by a specific application (Doll & Torkzadeh, 1988, p. 260). They also conceptualized EUCS as the "affective attitude towards a specific computer application by someone who interacts with the application directly" (Doll & Torkzadeh, 1988, p. 261). The EUCS construct contains five subscales (content, accuracy, format, ease of use, and timeliness). The EUCS instrument used to measure overall satisfaction and the five subscales consists of 12 items. The instrument has been validated in several past studies by Doll and Torkzadeh (1988); Torkzadeh and Doll (1991); McHaney and Cronan (1998); and Abdinnour-Helm, et al (2005) (Abdinnour-Helm *et al.*, 2005; Doll & Torkzadeh, 1988; McHaney & Cronan, 1998; Torkzadeh & Doll, 1991). The internal consistency reliability (Cronbach's alpha) for the overall EUCS instrument used in the previous studies was .92, .94, .91, and .94 respectively. For the purpose of this research the subscales of accuracy and timeliness were not assessed. Accuracy of the data used by the application could not be assessed because the database information was borrowed from two active CE organizations. These organizations loaded the data as it pertained to their airfields. Therefore, the researcher had no control over the accuracy of the provided data. Also, timeliness was not measured because the borrowed databases were similar in the data provided for the assessment, but were not the same size. The difference in size could affect the application's speed in retrieving the necessary data. Therefore, measuring the timeliness of each application's retrieval of data would be inappropriate. The resulting instrument used in this research had eight items measuring content, format, and ease of use. The original EUCS instrument items and the adapted items are shown in Table 2. The internal consistency measure for the adapted instrument was .76. A value of .70 (Cronbach's alpha) is considered acceptable (Nunnally & Bernstein, 1994).

Table 2. List of Original Questions and Current Questions Used for this Research

Subscale	Original Question	Modified Question
Content (Doll & Torkzadeh, 1988, p. 268)	Does the system provide the precise information you need?	Does the application provide the precise information you need?
	Does the information content meet your needs?	Does the information content meet your needs?
	Does the system provide reports that seem to be just about exactly what you need?	Does the application provide reports that seem to be just about exactly what you need?
	Does the system provide sufficient information?	Does the application provide sufficient information?
Format (Doll & Torkzadeh, 1988, p. 268)	Do you think the output is presented in a useful manner?	Do you think the output is presented in a useful manner?
	Is the information clear?	Is the information clear?
Ease of Use (Doll & Torkzadeh, 1988, p. 268)	Is the system user friendly?	Is the application user friendly?
	Is the system easy to use?	Is the application easy to use?

Task Scenario Development

The AFOTEC Software Usability Evaluation methodology and the EUCS methodology require that users have interaction with the applications in order to conduct a fair assessment using the instrument items. The evaluators used to conduct the evaluations had no prior experience with the airfield obstruction management systems being assessed for this research. The development of task scenarios was necessary in order for the application evaluators to have some hands-on experience with the GIS applications. The interaction in completing the task scenarios provided the background to assist the evaluators in answering the instrument items. Prior to the task scenario development, an attempt was made to locate the task/requirements documentation that led to the development of each application. The researcher requested information concerning the initial tasks/requirements from HAF GIO, ACC, and PACAF. No historical documentation that led to the development of either application was provided. Therefore, the task scenarios for this research were developed based on necessary functions of the applications for the effective management of airfield obstruction information. CE community planners provided these functional requirements through email feedback and telephone conversations. The initial email request for support can be found at Appendix A**.** The email was sent to over 30 AF personnel who had knowledge of and/or experience with airfield obstruction management. The email requested that the personnel "provide the 10 most important tasks/requirements that an airfield obstruction management system should provide/perform". After very little response from the field, a follow-up email was sent requesting support. The researcher received information from only four respondents. Based on this feedback and the author's limited knowledge of the applications, five scenarios were developed. The scenarios encompass tasks such as loading a new obstruction, editing an existing obstruction, and producing a summary report. An example of one of the scenarios used for the AIROBS application follows:

> The Flight Chief comes over and wants you to load a new obstruction that the airfield manager has reported to him.

1. Select Tools, and then select Analyze Obstructions on the AIROBS menu.
2. In the Analyze Obstructions box, fill in the following information.
    a. Select New Siting Analysis
    b. For the purpose of this exercise, select any area on the map outside of the Analyzed Obstructions box. Once a site is selected the X Coord:, Y Coord:, and Ground Elevations should auto fill. The height of the obstruction must be filled in to run the analysis.
    c. Height: 3.0
    d. UFC needs to be moved from Applicable Criteria to Selected for Analysis
    e. In the Selected Analysis area, check the boxes for Airspace Surface and Taxiway/Apron clearance.
    f. Select the Analyze button.
    g. When the Result Summary appears, select Save Data to DB. At this time the Add New Structure window opens. Fill in the following information:
        Obstruction Number: Use any number between 1 -100
        Obstruction Classification: Temporary Waiver
        Waiver Status: Pending
        Date: Today's Date
        Construction Type: Permanent
        Obstruction Description and Comments: metal pole sticking out of ground
        Frangible: No
    h. Select the OK button

The Add New Structure window closes and the Analyze Obstructions window appears. Close this window.
This is all that is needed to load the obstruction data. The Engineering Assistant will collect and complete the identifying information for the obstruction.

The entire set of scenarios can be found at Appendix B and C**.** Now that the task scenario development has been discussed, it is necessary to explain the evaluation instrument that was used to conduct the comparative analysis of the airfield obstruction management systems.

Evaluation Instrument

The HAF GIO suggested that a comparative analysis be conducted with the two airfield obstruction management systems. This research is a combination of two methods that focus on the software usability and end-user computing satisfaction constructs. The software usability evaluation is a non-statistical method aimed at identifying problem areas within the applications. In addition to the usability evaluation, the author decided to measure the overall end-user satisfaction of the applications. This area was measured using a revised version of the EUCS instrument discussed earlier. The resulting instrument consisted of 48 items made up of open-ended, close-ended, and some demographic questions.

Items 1-35 were selected from 177 items found in the AFOTEC Software Usability Evaluation guidance. The evaluator's initial response was to expresses his/her opinion on whether the design feature was either *Always* or *Not Always* present in the software application. The additional choices of *Don't Know* and *Not Applicable* could also be selected, if appropriate. Where a design feature was lacking (i.e., the response being *Not Always*), the evaluator was asked to provide an estimate of the difficulty caused by the absence of that feature. These ratings were expressed in terms of the impact on operational effectiveness, ranging from *Very Low* to *Very High*. For those features that had a response of *Not Always* the evaluator was also asked to provide an example of where or how that feature was lacking. Such an example might be: "Menu selection options are readily understandable." Table 3 provides an example of an item from the AFOTEC Software Usability Evaluation.

Table 3. AFOTEC Software Evaluation Example

<table>
<tr><td colspan="20">10. Menu selection options are readily understandable.</td></tr>
<tr><td colspan="5">ALWAYS</td><td colspan="5">NOT ALWAYS</td><td colspan="5">DON'T KNOW</td><td colspan="5">NOT APPLICABLE</td></tr>
<tr><td colspan="5">○</td><td colspan="5">○</td><td colspan="5">○</td><td colspan="5">○</td></tr>
<tr><td colspan="20">For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:
____
______________________________</td></tr>
<tr><td colspan="20">What is the overall impact of this feature on operational effectiveness?</td></tr>
<tr><td colspan="4">VERY LOW</td><td colspan="4">LOW</td><td colspan="4">MEDIUM</td><td colspan="4">HIGH</td><td colspan="4">VERY HIGH</td></tr>
<tr><td colspan="4">○</td><td colspan="4">○</td><td colspan="4">○</td><td colspan="4">○</td><td colspan="4">○</td></tr>
</table>

The EUCS questionnaire items were the next area of the instrument. These items were close-ended questions using a five item Likert scale ranging from *Almost Always* to *Almost Never*. This part of the research was directed at measuring end-user satisfaction on the constructs of content, format, and ease of use. This section of the instrument was analyzed using simple descriptive statistics.

The last area of the instrument requested demographic information from the evaluators. The demographic questions simply addressed the rank, TIS, and experience level with GIS/GeoBase applications. The complete evaluation instrument can be found at Appendix D.

Evaluation Process and Sample

The application evaluations were conducted in a small conference room located in the Civil Engineer and Services School (CESS). Two personal computers were set up with AIROBS loaded on one computer and AOMS loaded on the other. The AIROBS and AOMS applications and their respective databases that were used for the evaluations came from active AF installations. ESRI's ArcGIS 8.3 provided the mapping capability and was used with both applications. ESRI ArcGIS is a GIS software used for visualizing, managing, and analyzing geographic data (ESRI, 2006). The scenarios and questionnaire was provided to the evaluators at the beginning of the evaluation process. The evaluators worked through the scenarios prior to answering the questionnaire. The evaluators were able to review any part of the application while answering the questionnaire. The evaluators were assigned to an application on an alternating basis. This allowed for the researcher to get an equal number of evaluations for each application. There were 20 evaluators who provided ten evaluations for each application.

The installation community planner is normally the individual responsible for managing the airfield obstruction program. The community planner is usually an AF civilian assigned to the installation CE squadron. The evaluators chosen for this research consisted of CE officers and civilians who were Air Force Institute of Technology (AFIT) master's degree program students or staff personnel from the CESS. This sample was chosen because CE officers and civilians would likely be the most representative group outside of community planners themselves. All evaluators were volunteers who were requested to participate via email. The email requesting participant support can be found at Appendix E. This group was selected based on their knowledge of CE organizational processes. The rank of the evaluators ranged from Second Lieutenant to Major with one GS-14 civilian. The majority of the evaluators carried the rank of Captain. The average time-in-service for all evaluators was six years and five months with only four months separating the average time-in-service for the AIROBS and AOMS evaluators. Just over half of the evaluators had worked with GIS/GeoBase applications, and those evaluators rated their level of experience as "some".

Data Analysis

The objective of the AFOTEC Software Usability Evaluation was to identify problem areas within the features of the application. The analysis is qualitative and focuses on the *Not Always* responses and the comments that accompany those responses. A three step process is used to complete the analysis. First, the items receiving a *Not Always* response are grouped together in order of the impact ratings (*Very High* to *Very Low*) assigned by each evaluator. The next step is to group the responses by attribute and function. This will enable easier identification of interrelated problems. The last step is to review the comments provided by the evaluators in order to further identify problem areas (HQ Air Force Operational Test and Evaluation Center, 1994, pg. 148). Appendix F and G identifies the items, for both applications, that received *Not Always* responses and the attribute, function, and comments associated with those items. The results of the analysis are normally provided in narrative format that describe the key application usability problems and how those problems relate to mission effectiveness (HQ Air Force Operational Test and Evaluation Center, 1994, p. 148).

The goal of the EUCS items was to measure the satisfaction provided to the evaluators by the application. As stated earlier, this was assessed using a five item Likert scale ranging from *Almost Never* to *Almost Always*. The intent is to provide the results of the analysis by identifying problem areas and positive aspects of the applications. The descriptive statistics of the EUCS items was analyzed using SPSS statistical software. Each application was analyzed independently and the results will be provided in Chapter IV.

Summary

The intent of the evaluation is to provide an overall assessment of the identified problem areas and also assess the satisfaction provided by the application to the end-users. The evaluation instrument was made using AF software evaluation techniques along with an adapted version of the validated EUCS instrument. A total of 20 evaluators were used to assess the AIROBS and AOMS applications, 10 evaluators for each, respectively. In Chapter IV the data from the assessment is analyzed according to this methodology. Chapter V presents final conclusions and the author’s recommendations as a result of this research.

IV. Results and Analysis

The focus of this chapter is to present the results and analysis of the data collected from the assessment of the airfield obstruction management system applications. The analysis for each application will be presented within the context of the research questions. The results of the AFOTEC Software Usability Evaluation will be given using a narrative format. The narrative will describe the key software interface features most frequently rated as problems and the impact of those design features on operational effectiveness as identified by the evaluators. Operational effectiveness refers to the application's ability to accomplish the necessary tasks. The initial response by an evaluator indicated whether the design feature was either *Always* or *Not Always* present in the application. The problem areas were identified by grouping the *Not Always* responses. Where a design feature was lacking (i.e., an evaluator responded with *Not Always*), the evaluator provided an estimate of the difficulty caused by the absence of that feature. These estimates ranged from *Very Low* to *Very High* and were used to rate the overall impact of that feature on operational effectiveness. In addition, when an item received a *Not Always* response, the evaluator then provided comments to support the response. The narratives in this chapter will focus on the impact ratings of *Very High*, *High*, and *Medium*, where two or more evaluators made comments about similar system functions or features that were lacking in the application. For a complete breakdown of the evaluator statements and impact ratings please see Appendices F and G. Although identification of software interface problem areas is the focus of the research, the researcher has also identified evaluation items which received *Always* responses by a majority of the evaluators. This information could be used to identify favorable design features. The EUCS instrument focuses on the satisfaction with the information as provided by an application (Doll & Torkzadeh, 1988, p. 260). Doll and Torkzadeh also conceptualized EUCS as the "affective attitude towards a specific computer application by someone who interacts with the application directly" (Doll & Torkzadeh, 1988 p. 261). The original EUCS construct contains five subscales (content, accuracy, format, ease of use, and timeliness). The EUCS is representative of the underlying component of these five subscales (Abdinnour-Helm *et al.*, 2005 p. 350). For the purpose of this research the subscales of accuracy and timeliness were not assessed. Accuracy of the data used by the application could not be assessed because the database information was borrowed from two active CE organizations. These organizations loaded the data as it pertained to their airfields. Therefore, the researcher had no control over the accuracy of the provided data. Also, timeliness was not measured because the borrowed databases were similar in the data provided for the assessment, but were not the same size. The difference in size could affect the application's speed in retrieving the necessary data. Therefore, measuring the timeliness of each application's retrieval of data would be inappropriate. The resulting instrument used in this research had eight items measuring content, format, and ease of use. The EUCS questionnaire used a five item Likert scale ranging from *Almost Never* (1), *Some of the Time* (2), *About Half of the Time* (3), *Most of the Time* (4), and *Almost Always* (5). The EUCS results will be discussed based on the descriptive statistics of the EUCS data. The results discussion will begin with the first research question.

Research Question One (AOMS)

How does AOMS rate in software usability, where usability criteria measures error abatement, responsiveness, descriptiveness, consistency, and simplicity?

The results of the AFOTEC Software Usability Evaluation as applied to the AOMS application indicated a few problems in the usability attribute areas of responsiveness, descriptiveness, and simplicity. There were no overarching problems identified with the error abatement nor consistency attributes.

Responsiveness

As for the responsiveness attribute, there was only one feature which received negative comments with impact ratings from *Very High* to *Medium*. Several evaluators identified that opening the GIS feature from the AOMS Launcher took too long. Otherwise, the responsiveness attribute was rated well overall. Of the six evaluation items, five of the items were identified by a majority (six or more) of evaluators as *Always* having the design feature represented by the evaluation item. For example, item 5 (*Text inputs are easy to edit*) received an *Always* response from 8 of 10 evaluators.

Descriptiveness

The descriptiveness attribute received the largest number of *High* impact ratings on operational effectiveness. Within the descriptiveness attribute there were four negative comments which pertained to a lack of field definition guidance and five negative comments related to the manipulation of window overlays. The evaluator's comments indicated that some of the field definitions were difficult to understand. For example, within the Status field there were many options on the pull down menu that would be difficult to understand without knowledge of airfield terminology. With regards to the window overlays (multiple windows of various size that reside on top of other windows), the comments revealed that the window overlays had to be manipulated by minimizing or by moving an interfering window to another area on the screen in order to see the obstruction on the underlying map window. Of the nine evaluation items representing the descriptiveness attribute, seven of the items were identified by a majority (six or more) of evaluators as *Always* having the design feature represented by the evaluation item. For example, item 4 (*Data fields are adequately labeled*) received an *Always* response from 8 of 10 evaluators.

Simplicity

The simplicity attribute received comments with impact ratings ranging from *High* to *Very Low*. The features that received negative comments pertained to display colors and button locations. For example, the light blue dot used to identify the obstruction was difficult to locate on the ArcView map. The buttons are used instead of having to locate options on the pull down menus. With regards to the button feature, it was noted that the Analyze Location button and function was difficult to understand. All nine of the evaluation items received an *Always* response from a majority of the evaluators.

Summary

The number of *Always* responses received by each item can be found at Appendix H. Also, the complete list of AOMS usability statements that received *Not Always* responses along with the evaluators' comments can be found at Appendix F. Out of the 35 AFOTEC Software Usability Evaluation items there were five items that did not receive an *Always* response by a majority (six or more) of evaluators (Table 1).

Table 4. AOMS Items That Did Not Receive an *Always* Response by a Majority of Evaluators

Item #	Attribute	Item
7	*Responsiveness*	The system provides quick, positive feedback on the acceptance or rejection of data entry.
8	*Error Abatement*	The system validates user inputs before processing them.
9	*Error Abatement*	The system provides adequate notification when it detects a data entry error.
24	*Descriptiveness*	Window overlays are situated so that they do not obscure important information.
31	*Descriptiveness*	The system provides adequate feedback when an internal fault is detected.

Research Question One (AIROBS)

How does AIROBS compare in software usability, where usability criteria measures error abatement, responsiveness, descriptiveness, consistency, and simplicity?

The results of the AFOTEC Software Usability Evaluation as applied to the AIROBS application indicated a few problems in the usability attribute areas of descriptiveness, simplicity, and responsiveness. There were no overarching problems identified with the error abatement nor consistency attributes.

Responsiveness

Within the responsiveness attribute the comments revealed a general concern for the system response to data inputs and the system speed when using the zoom feature. For example, one comment stated, “When zooming, screen refresh was choppy and sluggish." Of the six evaluation items, five of the items received an *Always* response from a majority of the evaluators.

Descriptiveness

The descriptiveness attribute received the most *Very High* to *Medium* operational effectiveness impact ratings. The majority of the comments received by the descriptiveness attribute pertained to the obstruction identifier, window overlays, and data fields. Based on the comments provided by the evaluators it seemed that the evaluators experienced difficulty in locating the obstruction on the ArcView Map after it had been selected from the Edit Obstructions list. Also, there were comments about the acronyms and drop down menus used for data field inputs. The acronyms [FIM (Facility Index Matrix), etc.] and selections from the drop down menus could be confusing for an airfield manager who has access to the application. The largest amount of comments was centered on the window overlays. Of the ten evaluators, nine provided negative comments to item 24 of the evaluation. This item received impact ratings ranging from *Medium* to *Very High*. The evaluators found that the window overlays were difficult to manipulate in order to view necessary information on underlying windows. Some of the windows had to be closed in order to access previously opened windows. Of the nine descriptiveness items, seven of the items were identified by a majority (six or more) of evaluators as *Always* having the design feature represented by the evaluation item.

Simplicity

The simplicity attribute received impact ratings that ranged from *Very High* to *Low*. The simplicity attribute refers to the information being grouped and presented to the user in short, readily understandable structures. The items that received the highest impact ratings pertained to the lack of ease when trying to locate information on the screen, general difficulty understanding data field options, and difficulty with the window overlays. The comments received about finding information on the screen and the difficulty with the window overlays were very similar to the comments received for those same features described previously within the descriptiveness attribute narrative. Again, the evaluators had difficulty finding the selected obstruction and it was not easy to manipulate the windows when several were open at the same time. One comment concerning the window overlays was, "I had difficulty with viewing map and getting rid of overlays". In addition, several evaluators found that the data field options were difficult to understand. An example of a comment concerning the data fields was, "Confusion with 'Obstruction Frangible' and 'Frangible' field". Of the ten items relating to the simplicity attribute, three items received *Not Always* responses from a majority of the evaluators.

Summary

The number of *Always* responses received by each item for the AIROBS application can be found at Appendix H. In addition, the complete list of AIROBS usability statements that received *Not Always* responses along with the evaluators' comments can be found at Appendix G. Out of the 35 evaluation items there were eight items that did not receive an *Always* response by a majority (six or more) of evaluators (Table 5).   Three of the eight items pertained to a lack of guidance on data entry format and a lack of system validation and feedback. The other items concerning ease of locating information and window overlays were discussed previously. The next section will address the second research question.

Table 5. AIROBS Items That Did Not Receive an *Always* Response by a Majority of Evaluators

Item #	Attribute	Item
6	*Consistency*	Where data are entered from source documents, the format for data entry corresponds to that of the source documents.
7	*Responsiveness*	The system provides quick, positive feedback on the acceptance or rejection of data entry.
8	*Error Abatement*	The system validates user inputs before processing them.
17	*Simplicity*	Information is easy to find on the screen.
24	*Descriptiveness*	Window overlays are situated so that they do not obscure important information.
25	*Simplicity*	Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.
28	*Simplicity*	Graphic symbology is appropriate for the information it represents.
31	*Descriptiveness*	The system provides adequate feedback when an internal fault is detected.

Research Question Two

The EUCS questionnaire items were close-ended questions which addressed the content, format, ease of use, and global satisfaction with the software application. The EUCS questionnaire sought to measure the satisfaction with the content and format of the information provided by the application and the overall ease of use of the application. The questionnaire used a five item Likert scale ranging from *Almost Never* (1), *Some of the Time* (2), *About Half of the Time* (3), *Most of the Time* (4), and *Almost Always* (5).

Based on this scale, a mean of 4 (Most of the Time) or better would indicate that the evaluators found the application provided the intent of the questionnaire item between *Most of the Time* (4) and *Almost Always* (5). Means that are above 4.5 would indicate a higher number of evaluators rated the application as *Almost Always* in terms of the content, format, and ease of use as specified by the questionnaire items. As stated previously in the chapter, the EUCS is representative of the underlying components of the five subscales (Abdinnour-Helm et al., 2005, p. 350). Although, for this research, only the subscales of content, format, and ease of use was measured. The data from the questionnaire was input by the researcher and analyzed using SPSS, a statistics software application. The next section will use descriptive statistics to discuss the results of the EUCS questionnaire.

AOMS

How did AOMS rate in end-user computing satisfaction (EUCS), as determined by the measures of content, format, and ease of use provided by each application?

The internal consistency measure and mean for the global EUCS construct as applied to the AOMS application was .83 and 4.61 respectively. The standard deviation of the overall questionnaire (3.81) and the content subscale (2.37) reveal a higher level of variation in the responses for these two areas. The reliability measure (.83) indicates good internal consistency of the items in the scale. A value of .70 (Cronbach’s alpha) is considered acceptable (Nunnally & Bernstein, 1994). Table 6 provides the descriptive statistics for the AOMS application to include results from the content, format, and ease of use constructs. The means for the items within the content construct ranged from 4.5

to 4.7 with an overall mean of 4.65 and the internal consistency measure was .78. The mean for the format construct was 4.6 with an internal consistency measure of .86. The ease of use construct had a mean of 4.55 with an internal consistency measure of .95. As shown in Table 6, the means for the subscales and the overall AOMS EUCS construct range from 4.55 to 4.65. The ratings received for the subscales and the overall questionnaire as applied to the task scenarios revealed that the aspects of the application (content, format, ease of use) highly influenced the satisfaction of the evaluators.

Table 6. AOMS EUCS Statistics

Item/Subscale	**α**	**M**	**SD**
Overall EUCS Statistics for AOMS	***.83***	***4.61***	***3.81***
Content	***.78***	***4.65***	***2.37***
36. Does the application provide the precise information you need?		4.70	.67
37. Does the information content meet your needs?		4.50	1.10
38. Does the application provide reports that seem to be just about exactly what you need?		4.70	.48
39. Does the application provide sufficient information?		4.70	.67
Format	***.86***	***4.60***	***1.14***
40. Do you think the output is presented in a useful manner?		4.50	.70
41. Is the information clear?		4.70	.48
Ease of Use	***.95***	***4.55***	***1.37***
42. Is the application user friendly?		4.60	.70
43. Is the application easy to use?		4.50	.70

n=10

AIROBS

How did AIROBS rate in end-user computing satisfaction (EUCS), as determined by the measures of content, format, and ease of use provided by the application?

The internal consistency measure and mean for the questionnaire as applied to the AIROBS application was .62 and 4.43 respectively. The standard deviation of the overall questionnaire (2.72) reveals variation in the responses provided by the evaluators, but is lower than the standard deviation for AOMS (3.81). Based on the reliability measure of the AOMS application and other past studies referenced in chapter 2, the reliability measure (.62) is lower than desired when compared to the AOMS reliability measure (.83). According to Guilford (1954), there are no “hard-and-fast” rules to indicate how high the reliability coefficients should be (Guilford, 1954). When a reliability measure (Cronbach’s alpha) “proves to be very low, either the test is too short or the items have very little in common” (Nunnally, 1978, p. 231). In this case, the questionnaire is short, but the items have been proven through past research to be internally consistent. Table 7 identifies the descriptive statistics for the AIROBS application to include the content, format, and ease of use constructs. The means for the items within the content construct ranged from 4.4 to 4.8 with an overall mean of 4.55 and the internal consistency measure was .67. The mean for the format construct is 4.4 with an internal consistency measure of .21. As a rule of thumb an internal consistency measure “below .5 would be considered unacceptable” (George & Mallery, 2005). The ease of use construct had a mean of 4.2 with an internal consistency measure of .90. As shown in Table 7, the means for the subscales and the overall AIROBS EUCS construct range from 4.2 to 4.55. The ratings received for the subscales and the overall questionnaire as applied to the task scenarios revealed that the aspects of the application (content, format, ease of use) influenced the satisfaction of the evaluators.

Table 7. AIROBS EUCS Statistics

Item/Subscale	**α**	**M**	**SD**
Overall EUCS Statistics for AIROBS	***.62***	***4.43***	***2.72***
Content	***.67***	***4.55***	***1.55***
36. Does the application provide the precise information you need?		4.60	.52
37. Does the information content meet your needs?		4.40	.52
38. Does the application provide reports that seem to be just about exactly what you need?		4.40	.70
39. Does the application provide sufficient information?		4.80	.42
Format	***.21***	***4.40***	***1.03***
40. Do you think the output is presented in a useful manner?		4.50	.71
41. Is the information clear?		4.30	.67
Ease of Use	***.90***	***4.20***	***1.51***
42. Is the application user friendly?		4.20	.63
43. Is the application easy to use?		4.20	.92

n=10

Summary

This chapter outlined the results of the AFOTEC Software Usability Evaluation and the EUCS questionnaire. The AFOTEC evaluation identified problem areas within both applications that could benefit the improvement of the products. The EUCS simply used descriptive statistics to measure the constructs of content, format, and ease of use along with the overall satisfaction provided by the application. Since the internal consistency of the format construct for the AIROBS EUCS assessment was so low, it was not used in any comparative judgment. Chapter V will present conclusions and recommendations based on the analysis described in this chapter and the researcher's observations throughout this study.

V. Discussion and Conclusions

The purpose of this chapter is to present the conclusions that resulted from this research study. It will begin with a brief discussion of the findings from the comparative analysis of AOMS and AIROBS. Next, some recommendations of the researcher will be provided. Then, the limitations discovered during this research will be presented. The chapter will close with some suggestions for future research.

Findings

Research Question One

How do AOMS and AIROBS compare in software usability, where usability criteria measures error abatement, responsiveness, descriptiveness, consistency, and simplicity?

The AFOTEC Software Usability Evaluation revealed that AOMS revealed fewer usability problems than AIROBS. The AOMS application received 19 *Not Always* responses versus the 25 received by AIROBS. Also, AOMS received fewer negative comments (37) overall, than did AIROBS (61). Both applications had problems identified with the window overlays and data fields, but AIROBS received more negative comments in both areas. Also, as shown by Table 8, there were five items that received a significant difference of *Always* responses between the two applications. A significant difference means that one application received a majority of *Always* responses while the other application did not receive a majority of *Always* responses for the same item. The AOMS application received a majority of *Always* responses for four of the five items.

The AIROBS application only received a majority of *Always* responses for one of the five items. Finally, as stated in chapter 2, AOMS is being used at approximately 60 military installations worldwide and AIROBS is in use at approximately 12 AF installations world-wide (CH2M Hill, 2004; Mael, 2005).

Table 8. Items with a Significant Difference of *Always* Responses

Item #	Attribute	Item	# *Always* AOMS	# *Always* AIROBS
6	*Consistency*	Where data are entered from source documents, the format for data entry corresponds to that of the source documents.	6	2
9	*Error Abatement*	The system provides adequate notification when it detects a data entry error.	3	6
17	*Simplicity*	Information is easy to find on the screen.	7	5
25	*Simplicity*	Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.	9	4
28	*Simplicity*	Graphic symbology is appropriate for the information it represents.	10	5

n=10

Research Question Two

How do AOMS and AIROBS compare in end-user computing satisfaction (EUCS), as determined by the measures of content, format, and ease of use provided by each application?

The EUCS analysis revealed that AOMS had higher means for overall EUCS, content and ease of use. For the overall EUCS, the mean for AOMS was 4.61 as opposed to 4.43 for AIROBS. The means for the content subscale were 4.65 and 4.55 for AOMS and AIROBS, respectively. The ease of use subscale had a mean of 4.55 for AOMS and 4.2 for AIROBS.

Recommendations

This research focused on conducting a comparative analysis of the AOMS and AIROBS applications using the AFOTEC Software Usability Evaluation and EUCS questionnaire as the framework for the research. Although, during this research process there were some discoveries made which have led to the recommendations that are presented in the next few paragraphs.

Single Owner for Applications

Currently, there is no "owner" for the AOMS or AIROBS applications. "Owner" in this respect would be the organization that is the POC for the application. The owner would be the keeper and maintainer of the requirements documents that led to an application's development. In addition, the owner would be the single POC for customers to contact for support and guidance and the application developer would also contact the owner when new upgrades or versions are ready for implementation. The owner would be the sole representative of the AF when conducting business with application developers. It would also be advantageous when fielding changes and upgrades to the applications because the owner would be responsible to ensure that all users have the same versions of the applications.

Application Registry and Development Process

The HAF GIO should adapt and mandate the use of a GIS application registry and an application development process as suggested by Colby Free of ACC. Colby Free is a contractor assigned to Headquarters ACC Installations and Support division, where he was given the responsibility to draft an application development process for the HAF GIO. The purpose of the application development process and application registry is to reduce redundancy by creating a process to coordinate and identify the applications that are being used for specific purposes (Free, 2005). A GIS application registry would give potential users/organizations visibility to what applications are already in use for specific missions. This would provide the potential user/organization the application owner who could be contacted for information and/or implementation. The registry would identify the application owner who could be contacted for information about the product. If an application could not be found for a specific mission purpose, then the application development process could be followed prior to purchasing a COTS application or pursuing the development of a new application. The registry would provide visibility to the applications in use and provide visibility to other functional areas (i.e., Security Forces, Communications) who may be able to gain from existing applications (Free, 2005).

Single Application for Single Purpose

During the research process it was discovered that both AOMS and AIROBS were supported and approved for use across the AF. It would seem advantageous for the AF to have software application companies produce prototypes (based on sound requirements documents) to be field tested for the application's intended mission purpose. This process could be similar to the process used by the acquisitions community in order to prevent purchasing and maintaining multiple similar applications.

Once the testing is complete, the AF could select the best application to field across the AF, as opposed to what happened with AOMS and AIROBS. The use of the best, single application could save funds in software upgrades and also reduce funds spent on training personnel to use multiple applications.

Limitations

There were several limitations that may have impacted this research. First of all, earlier in the research process, the researcher contacted community planners and MAJCOM Geo Integration Officers in an effort to locate the requirements documents/list that led to the development of AOMS and AIROBS. No documented information could be located. Due to this lack of information the task scenarios used by the evaluators may not have been as robust as scenarios developed from the requirements documents/list.

Secondly, this research did not uncover an existing process or validated instrument for the purpose of conducting comparative analyses of fielded software applications. The usability evaluation portion of this research was conducted using a process that was intended to be used in the application design process. Even though every effort was made by the researcher to choose evaluation items that could be applied to fielded applications, there were some questionnaire items that were not applicable to the applications evaluated as indicated by the responses from the evaluators. Therefore, there may have been other AFOTEC Software Usability Evaluation items that could have made this research more robust with regards to completeness of responses.

Next, the evaluators had no prior experience with automated airfield obstruction management systems. In addition, the evaluators had a limited amount of time to spend with the applications. The task scenarios were developed to be accomplished in a step-by-step manner. Due to this structure, the evaluators did not spend additional time exploring other features of the applications. Because of the lack of experience with airfield obstruction management systems and the limited time spent using the applications; the evaluators may have been "impressed" by the applications which could have led to the inflation of scores that were recorded for the EUCS portion of the evaluation.

Finally, there could be an issue with validity and reliability of the evaluation. The AFOTEC Software Usability Evaluation is primarily used in the design process of military systems and software applications. It dates back to 1994, and has not had any recent updating of the process. Also, no documentation was found which supported its use in the civilian sector. The EUCS with all five subscales (content, format, accuracy, ease of use, timeliness) was validated and proved reliable in recent studies, but this research elected not to measure accuracy and timeliness. Without these two subscales, one must question the validity and reliability of the questionnaire until additional testing can be accomplished. Overall, this is the first known attempt to combine these two distinct methodologies to conduct a research project. Therefore, the generalizability of this methodology will be unknown until future testing of this tool.

Future Research

This was the first time an in-depth comparative analysis has been conducted on two GIS applications being used in the AF. This research process could be used as a benchmark to conduct other comparative analyses against applications which are similar and being used for the same mission purpose. Also, future research could be conducted to assess the status and implementation of the recommended GIS application registry and application development process.

Appendix A: Initial E-mail Request for Support

I am an Air Force Institute of Technology (AFIT) student currently working on a thesis research project in the area of airfield obstruction management systems. I am asking for your support in my research effort. This research effort is supported by Headquarters Air Force Geo Integration Office (HAF GIO) and the GIS Support Center.

Each of you was selected based on either being a user of either AOMS or AIROBS, or having familiarity with managing airfield obstructions.

No personal identifying information will be used in the final research product. All collected information will be retained by the researcher.

Based on your own experience and understanding of airfield obstruction management systems, please provide the following:

1. Without regard to the system/process that you currently use, please provide the 10 most important tasks/requirements that an airfield obstruction management system should provide/perform. Please provide the tasks/requirements in rank order of importance.

2. (Optional) Please provide a short scenario that could be used to demonstrate the functionality/usability of an airfield obstruction management system. The scenario can be an input, update, retrieval, etc. If the scenario includes other documentation such as a request for waiver, feel free to send the electronic documentation.

Please return the requested information by Wednesday, 9 Nov.

I sincerely appreciate your support with my research project. Please feel free to contact me or my thesis advisor (Lt Col Summer Bartczak, email: Summer.Bartczak@afit.edu) if you have any questions regarding this request or the research.

//SIGNED//
Mark E. Barner, SMSgt, USAF
Graduate Student
AFIT/ENV

Appendix B: Airfield Obstruction Management System (AOMS) Scenarios

These scenarios have been designed to give you some hands-on interaction with the application. The scenarios will give you some familiarization with a few of the most important requirements expected of an airfield obstruction management system. If you feel it is necessary, please take notes throughout the completion of the scenarios. Upon completion of the scenarios you should be able to complete the evaluation questionnaire. You may also review the questionnaire prior to or during the completion of the scenarios. If you think that more interaction is needed, feel free to spend additional time with the application.

Log into the computer using the following information:
User Name: Tester
Password: XSW@cde3
Log on to: CEXP33XY (this computer)

Scenario 1

You've recently arrived at your new duty station, XYZ AFB. You are assigned to the Engineering Flight and the Flight Chief wants you to have some familiarity with all of the areas within the flight. You are going to be working with the community planner to get some familiarization with that position. One of the responsibilities of the community planner is to track, manage, and analyze airfield obstructions. There is a fairly new system in place which assists in accomplishing this task. The Airfield Obstruction Management System is the program used at XYZ AFB. The application uses Microsoft Access as its database and ESRI ArcView 8.3 for its mapping capability.

1. Open AOMS from the desktop.
2. Select the HELP button on the AOMS Launcher menu.
3. Select the STARTUP tab and spend a few minutes reviewing the features of the STARTUP area.
4. When finished in the STARTUP area, select the ArcMap User's Manual from the HELP system menu. Spend a few minutes reviewing the features of the ArcMap User's Manual.
5. When finished in the ArcMap User's Manual area, select the Database User's Manual from the HELP system menu. Spend a few minutes reviewing the features of the Database User's manual area.
6. When finished, close the HELP system.

You should be back at the AOMS Launcher menu.

Scenario 2

The Flight Chief comes over and wants you to load a new obstruction that the airfield manager has reported to him.

3. Select the GIS button on the AOMS Launcher menu. This loads the maps.
4. You can adjust the window size and move the toolbar.
5. Find and select the Launch AOMS2000 Database button (should be 4^{th} button from the right on the toolbar). This opens the AOMS Database window.
6. Select the New Obstruction button. You will input a New Obstruction with the following information:
7. The obstruction **Type** will be **Waiver**. AOMS assigns the obstruction **Number** as the next available number for that obstruction type (auto-numbering). This number can be changed if desired to match any existing numbering scheme. Alphanumeric values can be used, but will not be evaluated for obstruction auto-numbering. Fill in the rest of the obstruction data with the following information: **Description**: 2 ft. by 3 ft. by 2 ft deep hole near arresting barrier shack on the north end, base side

Justification: hole meets criteria to be an obstruction
Remark: recommend that this be repaired with an in-house work order
Status: Active
Waiver type: Temporary
Safety Precaution: Other
Frangible: No
FAA Coordination: No
NAVAID: No
Off-Base: No
Correctable: Yes
In the **Violatio**ns area, **Control Surface** field, select **None**
Select the **OK** button
Once this is done you should be back at the AOMS Database Menu

This is all that is needed to load the obstruction data. The Engineering Assistant will collect the specific obstruction coordinates and complete the identifying information for the obstruction.

<u>Scenario 3</u>

It is now at the end of the day and you receive a call from the Horizontal shop foreman. He informs you that the hole out near the barrier shack has been filled and the area seeded. Since it is now determined that the hole is no longer an obstruction then the AOMS needs to be updated.

1. From the AOMS Launcher menu select the DATABASE button.
2. Select the Browse Obstructions button from the AOMS database menu.
3. Find the obstruction that you loaded for the hole near the barrier shack.

4. Once the obstruction is located, open the obstruction information.
5. In the Status data field, change the status to Corrected and select the OK button.
6. Close the Browse Airfield Obstruction Records window.
7. You have now updated the database with the new status.

Scenario 4

The Airfield Manager has requested a summary report of all obstructions.

1. Select the Reports tab on the AOMS Database Menu
2. Select the Summary Report option, and then select All Obstructions.
3. When the Summary Report appears you can Close the report and Close the Build Obstruction Report window.

Scenario 5

An individual from the Weather Squadron is in your office requesting some information concerning one of their weather stations on the airfield. This will require you complete an analysis using AOMS. Your customer does not know any identifying information for the weather station so you will have to use the mapping capability to locate the weather station.

1. If the ArcMap view is not open, then Open the GIS feature from AOMS Launcher Menu.
2. You determine that the easiest way to find the weather stations is to use the Browse Obstructions feature. Select the Browse Obstructions button from the toolbar. This will assist in finding the correct weather station. You can move the Browse Obstructions window to another location on the existing window.
3. You select the first Weather Station listed in the list of obstructions. To more easily identify the obstruction, select the Highlight Selected Features with Arrows button (yellow arrow) on the toolbar. Your customer tells you that this is not the Weather Station she is inquiring about.
4. You select the next Weather Station listed in the list of obstructions. The number is NC-18.
5. Select the Media Window button (looks like a camera) from the toolbar. This opens a picture of the obstruction. You can click inside the picture to get a larger view (if you do this you will have to close the window to see the obstruction location on the ArcMap view.
6. You can also identify this obstruction with the yellow arrow. Your customer tells you that this is the correct Weather Station.
7. Your customer wants the distance information and violation information of the Weather Station. Using the Zoom buttons on the toolbar, zoom in on the obstruction.

8. Find and select the Analyze Location button from the toolbar. This opens the AOMS analysis window and highlights the centerline of the main runway. The analysis information can be determined from any runway that is loaded.
9. Select the obstruction using the crosshair selection tool. The obstruction information is now updated in the AOMS Analysis window. You can now scroll through the tabs on the AOMS Analysis window and provide the customer with the necessary information. You can now close any of the opened AOMS features.

These scenarios have been designed to give you some hands-on interaction with the application. You should now be able to complete the application evaluation questionnaire. If you need to use the application to assist in completing the questionnaire, please do so. Your thorough investigation of the application is critical to providing an appropriate assessment. When completed, please close all programs and return the computer to the Desktop configuration.

Appendix C: Airfield Obstruction Tracking, Analysis, and Management System (AIROBS) Scenarios

These scenarios have been designed to give you some hands-on interaction with the application. The scenarios will give you some familiarization with a few of the most important requirements expected of an airfield obstruction management system. If you feel it is necessary, please take notes throughout the completion of the scenarios. Upon completion of the scenarios you should be able to complete the evaluation questionnaire. You may also review the questionnaire prior to or during the completion of the scenarios. If you think that more interaction is needed, feel free to spend additional time with the application.

Log into the computer using the following information:
User Name: Tester
Password: XSW@cde3
Log on to: CEXP32XY (this computer)

<u>Scenario 1</u>

You've recently arrived at your new duty station, XYZ AFB. You are assigned to the Engineering Flight and the Flight Chief wants you to have some familiarity with all of the areas within the flight. You are going to be working with the community planner to get some familiarization with that position. One of the responsibilities of the community planner is to track, manage, and analyze airfield obstructions. There is a fairly new system in place which assists in accomplishing this task. AIROBS is the program used at XYZ AFB. The application uses Microsoft Access as its database and ESRI ArcView 8.3 for its mapping capability.

7. Open AIROBS from the desktop (this will take approximately one minute).
8. Select HELP on the AIROBS menu.
9. Select the AIROBS User Manual and spend a brief amount of time in the following areas:
    - How do I enter a new obstruction? (pg 10)
    - How do I modify the information about an obstruction? (pg 14)
    - How do I delete an obstruction? (pg 15)
    - How can I create a Form 583? (pg 17)
    - Edit existing obstructions (pg 47)
    - Query obstructions (pg 51)
    - Reports (pg 52)
10. On the ArcMap view, pan over the buttons in order to get the descriptions of each button's function.
11. When finished in the AIROBS User Manual, close the Acrobat Reader.

You should be back at the AIROBS main menu area.

Scenario 2

The Flight Chief comes over and wants you to load a new obstruction that the airfield manager has reported to him.

8. Select Tools, and then select Analyze Obstructions on the AIROBS menu.

9. In the Analyze Obstructions box, fill in the following information.
    a. Select New Siting Analysis
    b. For the purpose of this exercise, select any area on the map outside of the Analyzed Obstructions box. Once a site is selected the X Coord:, Y Coord:, and Ground Elevations should auto fill. The height of the obstruction must be filled in to run the analysis.
    c. Height: 3.0
    d. UFC needs to be moved from Applicable Criteria to Selected for Analysis
    e. In the Selected Analysis area, check the boxes for Airspace Surface and Taxiway/Apron clearance.
    f. Select the Analyze button.
    g. When the Result Summary appears, select Save Data to DB. At this time the Add New Structure window opens. Fill in the following information:
       Obstruction Number: Use any number between 1 -100
       Obstruction Classification: Temporary Waiver
       Waiver Status: Pending
       Date: Today's Date
       Construction Type: Permanent
       Obstruction Description and Comments: metal pole sticking out of ground
       Frangible: No
    h. Select the OK button

    The Add New Structure window closes and the Analyze Obstructions window appears. Close this window.

This is all that is needed to load the obstruction data. The Engineering Assistant will collect and complete the identifying information for the obstruction.

Scenario 3

It is now at the end of the day and you receive a call from the Horizontal shop foreman. He informs you that the metal pole sticking out of the ground on the airfield has been removed. Since the obstruction was taken care of so quickly, it is not necessary to maintain the information in AIROBS.

8. From the AIROBS main menu select Edit Obstructions.

9. Scroll through the list and find the obstruction that you previously loaded.
10. Select the obstruction then select the Delete button.
11. A Windows dialog box will appear and ask "Are you sure you want to delete the obstruction from the database?"
12. Select Yes, then close the Edit Obstructions window.

Scenario 4

The Airfield Manager has requested a summary report of all obstructions. The Summary Report can be generated from the AIROBS main menu or the ArcMap Tools drop down.

10. Select Forms and Reports from the AIROBS main menu or select Reports from the Tools drop down list on the ArcMap view.
11. For the Report Type: Select 583 (Annual Waiver Report Summary)
12. For Save Path: You can leave it at the default or change where the report will be saved. Remember where it is saved.
13. Select Next, then for Select Structures, choose All
14. Select Finish
15. Once the report is finished you should receive a Report Successfully Created dialog box.
16. Close the Forms and Reports window.
17. You can now go to the report where it was saved and view the 583 Summary Report.

Scenario 5

An individual from the Weather Squadron is in your office requesting some information concerning a weather antenna on the airfield. This will require you complete an analysis using AIROBS. Your customer does not know any identifying information for the weather antenna so you will have to use the mapping capability to locate the weather antenna.

1. You determine that the easiest way to find the weather antenna is to use the Edit Obstructions feature. From the AIROBS main menu, select Tools and then the Edit Obstructions feature. This will assist in finding the correct weather station.
2. Scroll through the list of obstructions until you find the first Weather Antenna. It should be obstruction number ACAD01025. You select the first Weather Antenna listed in the list of obstructions.
3. Once the Weather Antenna is selected it is identified on the ArcMap view with a light blue arrow. You will have to close the Edit Obstructions window in order to move the AIROBS main menu window out of the way.
4. When the windows have been moved, you can use the Zoom Out feature (zoom out about 3 times) to locate the light blue arrow identifying the obstruction.

5. When the light blue arrow is located, your customer informs you that the weather antenna is the correct one. Now you will need to get the obstruction information for your customer.
6. Find the Identify Obstruction button on the ArcMap toolbar (fourth button from the right).
7. After the Identify Obstruction button is selected, (using the mouse) place the arrow on the obstruction identified by the blue arrow and select the obstruction.
8. The Edit Obstruction window opens with all of the identifying information for the obstruction.
9. Based on the ArcMap location, the correct Weather Antenna has been located. Your customer takes all the needed information for the Weather Antenna and thanks you for your help.

These scenarios have been designed to give you some hands-on interaction with the application. You should now be able to complete the application evaluation questionnaire. If you need to use the application to assist in completing the questionnaire, please do so. Your thorough investigation of the application is critical to providing an appropriate assessment. When completed, please close all programs and return the computer to the Desktop configuration.

Appendix D: Airfield Obstruction Management Systems Evaluation Questionnaire

Purpose: To conduct a comparative analysis of two Geographic Information System (GIS) applications; the Airfield Obstruction Management System (AOMS) and the Airfield Obstruction Tracking, Analysis, and Management System (AIROBS)

Participation: I appreciate your participation in this research effort. Your participation is completely voluntary.

Confidentiality: I ask for some demographic information in order to interpret the results more accurately. All answers are anonymous.

Contact Information: If you have any questions or comments about the evaluation, please contact me.

SMSgt Mark E. Barner
AFIT/ENV
2950 Hobson Way
WPAFB, OH 45433-7765
Email: mark.barner@afit.edu

INSTRUCTIONS

- Base your answers on your experience with the application
- Please print your answers clearly when asked to write a response or when providing comments
- Make dark marks when asked to use specific response options
- Avoid stray marks. If you make corrections, erase marks completely or clearly indicate the intended response if you use an ink pen

MARKING EXAMPLES

SOFTWARE USABILITY EVALUATION

INSTRUCTIONS TO RESPONDENTS

This questionnaire contains a series of questions about the usability of the software you will be testing. In general, "usability" simply means how easy the software is to use. In this questionnaire, usability will be assessed in terms of presence or absence of a set of software quality features that are indicative of good interface design. For each assessment item, you will be asked to indicate whether or not the listed design feature is consistently implemented in the software interface being evaluated.

Responses are to be made by darkening the circle below or adjacent to the descriptor that best expresses your opinion. The initial response is to indicate whether the design feature is either ***Always*** or ***Not Always*** present in the software interface you are evaluating. The additional choices of ***Don't Know*** and ***Not Applicable*** may also be selected, if appropriate.

Where a design feature is lacking (i.e., your response is ***Not Always***), please provide an estimate of the difficulty caused by the absence of that feature. These ratings are expressed in terms of the impact on operational effectiveness, ranging from ***Very Low*** to ***Very High***. Taking notes while working through the scenarios may assist in completing the questionnaire.

Where a design feature is lacking, you are also asked to provide an example of where or how that feature is lacking. Such an example might be: "The cursor is difficult to locate on the screen."

In addition to the usability of the application, questions 36-43 address End-User Computing Satisfaction. These items use a Likert scale ranging from (1) Almost Never to (5) Almost Always.

The estimated time to complete the evaluation is 1 hour 30 minutes.

Please answer all the questions at your own pace. If you have any uncertainty about the meaning of terms or the intent of the questions, please contact the questionnaire administrator,
SMSgt Mark Barner.

Thank you for your assistance!

PROCEED TO THE NEXT PAGE

1. The user is adequately prompted as to where on the display data are to be entered.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

2. Input devices (e.g., keyboard, cursor, mouse) are appropriate for the tasks being performed.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

3. The cursor is easy to locate.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

4. Data fields are adequately labeled.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

5. Text inputs are easy to edit.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

6. Where data are entered from source documents, the format for data entry corresponds to that of the source documents.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

7. The system provides quick, positive feedback on the acceptance or rejection of data entry.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

8. The system validates user inputs before processing them.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

9. The system provides adequate notification when it detects a data entry error.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

10. Menu selection options are readily understandable.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

11. Menu selection options are logically organized by similarity of function and/or by order of use.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

12. Wording of menu options is consistent with the functions and processes they control.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

13. The system responds quickly and accurately to menu commands.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

14. The system responds quickly and accurately to mouse selection button presses.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

15. Manipulation of objects does not require excessively fine pointing or manual adjustment.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

16. The status of manipulated objects (e.g., active, selected, unavailable) is clearly displayed.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

17. Information is easy to find on the screen.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

18. The amount of data presented at any one time is appropriate.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

19. Data entry errors are easy to correct.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

20. Data display formats are consistent across the system.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

21. Wording is consistent across displays.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

22. Text displays are easy to read.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

23. The method for controlling windows is consistent across displays.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

24. Window overlays are situated so that they do not obscure important information.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

25. Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

26. Formats for data entry are consistent across different displays.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

27. Schematic and pictorial displays are clearly drawn and labeled.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

28. Graphic symbology is appropriate for the information it represents.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

29. Colors used in displays are easy to distinguish from one another.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

30. Color coding is used consistently across different displays.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

31. The system provides adequate feedback when an internal fault is detected.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

32. The system provides an adequate amount of on-line user guidance.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

33. On-line user guidance is readily understandable.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

34. System functions are organized in a manner that is consistent with the tasks they are designed to perform.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

35. The system provides the user with all of the information needed to perform required tasks.

ALWAYS	NOT ALWAYS	DON'T KNOW	NOT APPLICABLE
○	○	○	○

For a response of "NOT ALWAYS", please provide an example of where the feature is lacking:

____

____

What is the overall impact of this feature on operational effectiveness?

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
○	○	○	○	○

PLEASE PROCEED TO THE NEXT PAGE

For each statement below; please fill in the circle for the number that indicates the extent to which you agree with each statement. Use the scale below for your responses.

① Almost Never	② Some of the Time	③ About Half Of the Time	④ Most of the Time	⑤ Almost Always

36. Does the application provide the precise information you need?	① ② ③ ④ ⑤
37. Does the information content meet your needs?	① ② ③ ④ ⑤
38. Does the application provide reports that seem to be just about exactly what you need?	① ② ③ ④ ⑤
39. Does the application provide sufficient information?	① ② ③ ④ ⑤
40. Do you think the output is presented in a useful manner?	① ② ③ ④ ⑤
41. Is the information clear?	① ② ③ ④ ⑤
42. Is the application user friendly?	① ② ③ ④ ⑤
43. Is the application easy to use?	① ② ③ ④ ⑤

This section contains items regarding personal work related information. Respond to each item by WRITING in the information requested or FILLING in the corresponding circles that best describe you.

44. What is your current rank?

O-1	O-2	O-3	O-4
○	○	○	○

45. What is your total time-in-service (Total Federal Active Military Service)?
Years _______ Months _______

46. Which Civil Engineer Flights have you been previously assigned (mark all that apply)?

EOD	Engineering	Environmental	Fire Department
○	○	○	○
Housing	Operations	Readiness	Resources
○	○	○	○

PLEASE PROCEED TO THE NEXT PAGE

47. Have you worked with Geographic Information Systems/GeoBase applications previously?

Yes	No
○	○

48. How would you rate your level of experience with GIS/GeoBase applications?

None	Some	Moderate	Extensive
○	○	○	○

Questions/Concerns

If you have any questions or concerns please feel free to contact me. My contact information is on the cover sheet. I appreciate your participation and would be happy to address any questions you may have regarding the questionnaire or the research in general.

Thanks again for your assistance in this research project.

Please leave completed questionnaire in the evaluation room or return completed questionnaire to SMSgt Barner.

Appendix E: E-mail Request for Evaluator Support

To All,

I am a fellow CE troop (enlisted) working on my AFIT thesis project. The project involves evaluating two airfield obstruction management systems currently in use by CE Community Planners across the Air Force. I know everyone is very busy with classes in the CESS or with preparing and taking final exams, but I would sincerely appreciate your help in conducting these evaluations.

This research was requested to be conducted by the Headquarters Air Force Geo Integration Office (HAF GIO) and is also supported by the GIS Support Center. Benefits of this research may include; identifying which application is superior in usability; identifying a standard application for AF wide use; and providing a methodology to assess other applications. As a CE officer this evaluation would also give you familiarization to a program that you could be responsible for in the future.

It is not required that you have previous knowledge of airfield obstruction management systems. Your task will be to complete the scenarios and evaluation questionnaire of one of the applications. The scenarios have been designed to give you some hands-on interaction with the application. The scenarios will give you some familiarization with a few of the most important requirements expected of an airfield obstruction management system. Upon completion of the scenarios, you should have no problem completing the evaluation questionnaire. The interaction and questionnaire completion should take approximately 1 hour and 30 minutes. I realize this is a lot of time to ask of you, but it is necessary in order for an appropriate assessment to be accomplished.

The applications are loaded on two computers located in the small conference room, third floor of the CESS. Available dates/times to complete the evaluations are:

Friday, 9 Dec 1000 – 1600 hrs

Monday, 12 Dec – Friday, 16 Dec 0800-1600 hrs

Please consider my request for support with this project. If you would like to assist please reply to this email and provide a block of time that is convenient for you.

SMSgt Mark E. Barner
AFIT/ENV

Appendix F: AOMS Not Always Responses

AOMS-Usability Statements with ***Not Always*** Responses				
Item	Attribute	Function	*Statement*/Comments	Impact
1	Descriptiveness	Data Entry	*The user is adequately prompted as to where on the display data are to be entered.*	
			a. New Obstruction screen could have more guidance/instruction.	High
			b. Field definitions are not always clear thus making it difficult to know what needs to be filled and when.	High
4	Descriptiveness	Data Entry	*Data fields are adequately labeled.*	
			Field definitions are not always clear thus making it difficult to know what needs to be filled and when.	High
35	Descriptiveness	Mission Performance	*The system provides the user with all of the information needed to perform required tasks.*	
			a. Field sometimes cryptic but drop-down menus helpful.	High
			b. I could not have done the tasks if they were not in a step by step format.	High
24	Descriptiveness	Data Display	*Window overlays are situated so that they do not obscure important information.*	
			a. Menus can be move which is ok.	High
			b. Pictures of obstructions popped up in middle of screen	Low
			c. Window displaying obstruction text data may obscure location on map. This easily corrected by ease of moving window.	Medium
			d. Browse Obstruction & Media widow blocked map data.	Very Low
			e. The 'browse obstruction' and 'analyze location' menus cover up map. Maybe a side bar could pop up that could hold these menus.	High

27	Descriptiveness	Data Display	*Schematic and pictorial displays are clearly drawn and labeled.*	
			a. Display example difficult to follow.	Medium
			b. The map did not have any labels; that could be helpful.	Medium
10	Descriptiveness	Interactive Control	*Menu selection options are readily understandable.*	
				Very Low
			a. Media window will not show picture if highlight feature w/arrow is on.	
			b. Didn't understand difference between "Browse Obstructions" & "Search Obstructions."	Very Low
16	Descriptiveness	Interactive Control	*The status of manipulated objects (e.g., active, selected, unavailable) is clearly displayed.*	
			In ArcMap's Analyze Location window the status of objects is shown to be unavailable.	Low
5	Responsiveness	Data Entry	*Text inputs are easy to edit.*	
			a. You might want to have a spell check option it that is important.	High
			b. Can't edit inside Browse Obstructions window, need to open up the obstruction's report first.	Very Low
13	Responsiveness	Interactive Control	*The system responds quickly and accurately to menu commands.*	
			a. GIS button in AOMS Launcher was slow.	High
			b. Only exception was initial entry into the system which took a long time.	Medium
			c. Slow to open GIS from Launcher menu.	Very High
			d. GIS took few minutes to load, system dependent.	Medium

14	Responsiveness	Interactive Control	*The system responds quickly and accurately to mouse selection button presses.*	
			The photo of the obstruction didn't load the first time and had to be reloaded.	Medium
15	Responsiveness	Interactive Control	*Manipulation of objects does not require excessively fine pointing or manual adjustment.*	
			Found it difficult to do graphic walk through.	High
23	Consistency	Data Display	*The method for controlling windows is consistent across displays.*	
			After closing the Analyze Location window, I was not able to reopen it. It appears the system still thinks its open.	Very High
30	Consistency	Data Display	*Color coding is used consistently across different displays.*	
			What did the colors on the map mean?	Medium
34	Consistency	Mission Performance	*System functions are organized in a manner that is consistent with the tasks they are designed to perform.*	
			See 11a. and 17a.	Very Low
19	Error Abatement	Data Entry	*Data entry errors are easy to correct.*	
			Easy to get lost in the layers.	High
29	Simplicity	Data Display	*Colors used in displays are easy to distinguish from one another.*	

			a. Light blue dot representing obstruction on may was difficult to spot. Compensated by large yellow arrow pointing to obstruction when this tool was selected.	Medium
			b. Map was pastel and very hard to see what was going on. When you scroll up or down. New area is a lighter color. Very hard to make heads or tails of.	High
17	Simplicity	Data Display	*Information is easy to find on the screen.*	
			a. Drop down menus are not explanatory or easy. Tabs were good most of the time, but Analyze Location information was a little confusing.	Very Low
			b. Not the first time around, but gets easier w/exposure.	Very Low
			c. The Analyze Location function is hard to understand.	High
11	Simplicity	Interactive Control	*Menu selection options are logically organized by similarity of function and/or by order of use.*	
			a. Some of the buttons (i.e., highlight feature with arrow) should be next to Browse Obstruction button. Also, could not find Analyze location on drop down menu).	Medium
			b. I had expected the Help Menu to be at the top of the screen as in MS applications.	Very Low
			c. Zoom is not on the edit toolbar.	Medium
25	Simplicity	Data Display	*Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.*	
			Yes, except main ArcMap buttons cannot be highlighted to see what they are when using extra windows (i.e. browse obstruction), but does not show on bottom of screen so I guess it's ok.	Medium

Appendix G: AIROBS Not Always Responses

AIROBS-Usability Statements with ***Not Always*** Responses				
Item	Attribute	Function	*Statement*/Comments	Impact
16	Descriptiveness	Interactive Control	*The status of manipulated objects (e.g., active, selected, unavailable) is clearly displayed.*	
			I could not immediately see the light blue arrow. Had to really look for it (weather antenna).	Very High
27	Descriptiveness	Data Display	*Schematic and pictorial displays are clearly drawn and labeled.*	
			a. The obstructions did not seem to be labeled on the map.	High
			b. Difficult to see light blue arrow.	Very High
24	Descriptiveness	Data Display	*Window overlays are situated so that they do not obscure important information.*	
			a. When selecting an airfield obstruction and then trying to locate the obstruction on the map, you had to move the "Edit Obstruction" and "Main Menu" dialogue box.	Medium
			b. I had to manually move the windows to look at the ArcView map.	Medium
			c. The AIROBS menu can be much smaller.	Medium
			d. "Edit Obstructions" window had to be closed to select weather antenna in scenario 5. Ability to just minimize might be helpful.	Medium
			e. Need to close screens to view map.	Medium
			f. You have to minimize or move windows to see the map.	High
			g. Should be able to move sub windows to view map. I had to close multiple windows to view map. Many software programs allow you to minimize worksheets that would be helpful/convenient.	High
			h. I had a lot of difficulty with viewing map & getting rid of overlays.	Medium

			i. Had to close dialog boxes to see selected item. Would rather "minimize" and use ArcView.	Very High
4	Descriptiveness	Data Entry	*Data fields are adequately labeled.*	
			In some cases the fields are labeled using acronyms which may be confusing for a new airfield manager (DB, FIM, etc.)	High
1	Descriptiveness	Data Entry	*The user is adequately prompted as to where on the display data are to be entered.*	
			a. When you type "Temporary Waiver" instead of using the drop down menu, the program doesn't recognize the entry.	High
			b. Add new structure – what is "obstruction frangible" used for? Prompt occurs only when information is missing.	Medium
			c. Confusion with "Obstruction Frangible" and "Frangible" field. Thought both were the same thing.	Low
31	Descriptiveness	User Guidance	*The system provides adequate feedback when an internal fault is detected.*	
			I could not zoom in or out and there was an error. However, no error message appeared.	High
35	Descriptiveness	Mission Performance	*The system provides the user with all of the information needed to perform required tasks.*	
			a. Sometimes I didn't know exactly what it was talking about in the non-critical selections.	Medium
			b. I don't think some of the functions I performed (adding a new obstruction, finding an obstruction) were prompted well by the system.	Medium
5	Responsiveness	Data Entry	*Text inputs are easy to edit.*	
			a. The directions said to enter "No" in the Frangible box and this box would not accept any text.	Low

			b. Need to differentiate fields that can be user modified and those that are calculated by the program.	Medium
7	Responsiveness	Data Entry	*The system provides quick, positive feedback on the acceptance or rejection of data entry.*	
			a. Sometimes slow.	Medium
			b. First time user might be unfamiliar w/data entry format (i.e. date). Date format is not followed menu prompts "insert date".	High
			c. Scenario #5 (2-4) blue arrow did not appear quickly – could not be found for 2-3 minutes.	Medium
13	Responsiveness	Interactive Control	*The system responds quickly and accurately to menu commands.*	
			a. Scrolling map or analyzing data.	Low
			b. As with all databases, it would be nice to have instant feedback from the system.	High
			c. See #7c	Medium
14	Responsiveness	Interactive Control	*The system responds quickly and accurately to mouse selection button presses.*	
			When zooming, screen refresh was choppy and sporadic.	Medium
15	Responsiveness	Interactive Control	*Manipulation of objects does not require excessively fine pointing or manual adjustment.*	
			a. The zoom features took some getting used to.	Very Low
			b. Not able to click on item on map w/blue arrow – nothing happened.	Medium
11	Simplicity	Interactive Control	*Menu selection options are logically organized by similarity of function and/or by order of use.*	
			a. Not until I get used to it. Following your instructions made it easy.	Medium

			b. Could not see a pattern.	High
			c. I would not intuitively think to use the “analyze obstructions” menu to add a new obstruction to the data base.	High
17	Simplicity	Data Display	*Information is easy to find on the screen.*	
			a. When selecting an airfield obstruction from the edit list, it was difficult to locate the obstruction on the map (couldn’t find the blue arrow), should automatically zoon in on the obstruction desired.	High
			b. Finding the selected obstruction on the map required zooming and searching.	Medium
			c. Marker on map is too cluttered when many objects are mapped. Either reduce marker size.	High
			d. All except blue arrow (change to vibrant color, red, black, etc…and big).	Very High
18	Simplicity	Data Display	*The amount of data presented at any one time is appropriate.*	
			Should be able to filter what objects are presented on map readily on map grid.	High
22	Simplicity	Data Display	*Text displays are easy to read.*	
			a. The “distance measurement” on the edit obstructions menu was very small & hard to read quickly.	Low
			b. It would be nice for reports to just pop up, if I’m querying, more than likely, I want it.	Medium
25	Simplicity	Data Display	*Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.*	
			a. Not all the windows are “minimizable.” Example: the “Edit Obstructions” window where you are selecting an existing obstruction.	Medium
			b. See #24e.	Medium

			c. This is lacking between the map and the menu screen.	Medium
			d. Some dialog boxes remained on top until it was closed by the user.	Low
			e. See #24h	Medium
			f. See #24i	High
28	Simplicity	Data Display	*Graphic symbology is appropriate for the information is represents.*	
			a. For example, one of the icons on the map screen is an “N”. That icon is for “Obstruction Analysis”. That doesn’t make sense.	Low
			b. We need a legend; perhaps.	Medium
			c. No idea what the symbols indicate.	Medium
			d. Graphics are not labeled on the map.	Medium
			e. Change blue arrow.	High
29	Simplicity	Data Display	*Colors used in displays are easy to distinguish from one another.*	
			a. Map when several items are selected, the entire screen gets lighter & has little contrast.	Medium
			b. Could not easily see blue arrow.	High
33	Simplicity	User Guidance	*On-line user guidance is readily understandable.*	
			The screen shots in the user manual aren’t readable-maybe blow those up-they are quicker to understand than reading the text.	Medium
6	Consistency	Data Entry	*Where data are entered from source documents, the format for data entry corresponds to that of the source documents.*	
			The data given was not in the same format. Example: there were two input blanks for “frangible.”	High

12	Consistency	Interactive Control	*Wording of menu options is consistent with the functions and processes they control.*	
			a. See #11c	High
			b. The ArcMap menu toolbar is good and the combining of ArcMap menu options w/AIROBS is also good. If differentiating the two sets of icons from each other is possible, it may make the toolbar more intuitive. For example, the “Add Data” button is to add GIS information to the map and not to add airfield obstruction data.	Low
23	Consistency	Data Display	*The method for controlling windows is consistent across displays.*	
			Once a user uses the system a few times, he/she will develop his own methods for controlling the windows. Recommend “Autoclosing” “Forms & Reports” dialog box when report generation is complete.	Low
34	Consistency	Mission Performance	*System functions are organized in a manner that is consistent with the tasks they are designed to perform.*	
			The tools list could be better organized.	Low
8	Error Abatement	Data Entry	*The system validates user inputs before processing them.*	
			a. Only for critical paths, I guess it can’t be as smart as us.	High
			b. I saw no validation process.	Medium

Appendix H: Always Responses Received by Item

Always Responses Received by Item				
Item #	Attribute	Item	AOMS	AIROBS
1	*Descriptiveness*	The user is adequately prompted as to where on the display data are to be entered.	7	7
2	*Responsiveness*	Input devices (e.g., keyboard, cursor, mouse) are appropriate for the tasks being performed.	10	10
3	*Simplicity*	The cursor is easy to locate.	10	10
4	*Descriptiveness*	Data fields are adequately labeled.	8	8
5	*Responsiveness*	Text inputs are easy to edit.	8	8
6	*Consistency*	Where data are entered from source documents, the format for data entry corresponds to that of the source documents.	6	2
7	*Responsiveness*	The system provides quick, positive feedback on the acceptance or rejection of data entry.	4	5
8	*Error Abatement*	The system validates user inputs before processing them.	4	4
9	*Error Abatement*	The system provides adequate notification when it detects a data entry error.	3	6
10	*Descriptiveness*	Menu selection options are readily understandable.	8	10
11	*Simplicity*	Menu selection options are logically organized by similarity of function and/or by order of use.	6	7
12	*Consistency*	Wording of menu options is consistent with the functions and processes they control.	10	8
13	*Responsiveness*	The system responds quickly and accurately to menu commands.	6	7
14	*Responsiveness*	The system responds quickly and accurately to mouse selection button presses.	9	9
15	*Responsiveness*	Manipulation of objects does not require excessively fine pointing or manual adjustment.	8	7
16	*Descriptiveness*	The status of manipulated objects (e.g., active, selected, unavailable) is clearly	8	6

		displayed.		
17	*Simplicity*	Information is easy to find on the screen.	7	5
18	*Simplicity*	The amount of data presented at any one time is appropriate.	10	9
19	*Error Abatement*	Data entry errors are easy to correct.	7	7
20	*Consistency*	Data display formats are consistent across the system.	9	10
21	*Consistency*	Wording is consistent across displays.	9	9
22	*Simplicity*	Text displays are easy to read.	10	8
23	*Consistency*	The method for controlling windows is consistent across displays.	7	9
24	*Descriptiveness*	Window overlays are situated so that they do not obscure important information.	4	1
25	*Simplicity*	Where several windows are displayed simultaneously, it is easy for the user to shift among them to select which window is to be made active.	9	4
26	*Consistency*	Formats for data entry are consistent across different displays.	10	10
27	*Descriptiveness*	Schematic and pictorial displays are clearly drawn and labeled.	8	6
28	*Simplicity*	Graphic symbology is appropriate for the information it represents.	10	5
29	*Simplicity*	Colors used in displays are easy to distinguish from one another.	6	8
30	*Consistency*	Color coding is used consistently across different displays.	7	9
31	*Descriptiveness*	The system provides adequate feedback when an internal fault is detected.	2	4
32	*Descriptiveness*	The system provides an adequate amount of on-line user guidance.	9	7
33	*Simplicity*	On-line user guidance is readily understandable.	8	7
34	*Consistency*	System functions are organized in a manner that is consistent with the tasks they are designed to perform.	9	8
35	*Descriptiveness*	The system provides the user with all of the information needed to perform required tasks.	6	7

Bibliography

Abdinnour-Helm, S., F., Chaparro, B., S., & Farmer, S., M. (2005). Using the End-User Computing Satisfaction (EUCS) Instrument to Measure Satisfaction with a Web Site. *Decision Sciences, 36*(2), 341.

AFCESA/CES. (2001). Engineering Technical Letter (ETL) 01-20: Guidelines for Airfield Frangibility Zones (pp. 23): AFCESA.

Air Force Tiger Team. (2000). *Airfield Obstruction Reduction Initiative Report* (pp. 36): HQ AF/ILE.

AIROBS: Airfield Obstruction Management System. (2004). Retrieved 18 October, 2005, from https://tsc.wes.army.mil/products/AIROBS/Website/airobs.asp

Alreck, P. L., & Settle, Robert B. (2004). *The Survey Research Handbook* (3rd ed.). New York: McGraw-Hill/Irwin.

Ates, M. (2001). *A-Gram: Airfield Obstruction Reduction Initiative* (pp. 1): Air Force Civil Engineer Support Agency.

----. (2005). (pp. Email correspondence between SMSgt Mark E. Barner and Mr Michael Ates in October 2005.). Dayton.

Bevan, N. (2003). International Standards for HCI and Usability. Retrieved 30 December 2005, from http://www.usabilitynet.org/tools/r_international.htm

Bevan, N., Kirakowski, J., & Maissel, J. (1991, September). *What Is Usability?* Paper presented at the 4th International Conference on Human Computer Interface, Stuttgart, Germany.

Briggs, R. (2004). AOMS8 Whitepaper (pp. 9): HB&A.

CH2M Hill. (2003). AIROBS Operations Manual, Version 1.2 (pp. 60): CH2M Hill.

----. (2004). AIROBS Powerpoint Presentation.

----. (n.d.). Airfield Obstructions Management at DoD Installations: GIS/CADD Technology Center.

Doll, W. J., & Torkzadeh, G. (1988). The Measurement of End-User Computing Satisfaction. *MIS Quarterly, 12*(2), 16.

Dumas, J. S., & Redish, J. (1993). *A Practical Guide to Usability Testing*. Norwood, N.J.: Ablex Pub. Corp.

ESRI. (2006). Arcview-Desktop GIS for Mapping, Data Integration, and Analysis. Retrieved 15 January, 2006, from http://www.esri.com/software/arcgis/arcview/index.html

Foresman, T. W. (1998). *The History of Geographic Information Systems: Perspectives from the Pioneers.* Upper Saddle River: Prentice Hall PTR.

Free, C. (2005). (pp. Telephone conversation between SMSgt Mark E. Barner and Mr Colby Free in October 2005.). Dayton.

Fung, D. S., & Remsen, A. P. (1997). Geographic Information Systems Technology for Business Applications. *Journal of Applied Business Research, 13*(3), 17.

George, D., & Mallery, P. (2005). *SPSS for Windows Step by Step: A Simple Guide and Reference, 12.0 Update* (5th ed.). Boston: Pearson Education.

Gilbrook, M., J. (1999). GIS Paves the Way. *Civil Engineering, 69*(11), 34.

Guilford, J. P. (1954). *Psychometric Methods* (2d ed.). New York: McGraw-Hill.

HAF GIO. (2003a). USAF Garrison Mapping Concept of Operations Version 2.0.

----. (2003b). USAF GeoBase Enterprise Architecture Version 1.0.

Haigh, T. (2001). Inventing Information Systems: The Systems Men and the Computer, 1950-1968. *Business History Review, 75*(1), 15.

HB&A. (2004). Airfield Obstruction Management System. Retrieved 18 October, 2005, from http://www.hbaa.com/project/geo/geo_aoms.htm

Heikkila, E., J. (1998). GIS Is Dead; Long Live GIS! *American Planning Association. Journal of the American Planning Association, 64*(3), 350.

Holliday, M. D. (2001). *Pacific Air Forces Implementation of Airfield Obstruction Management System Software.* Unpublished thesis, University of Alaska at Fairbanks, Fairbanks.

Horner, D. (2004). Center Project #02.030 Airfield Management Suite. Retrieved 30 December 2005, 2005, from htttps://tsc.wes.army.mil/projects.asp?fy=04&prj_id=2002.030&text=status

HQ Air Force Operational Test and Evaluation Center. (1994). AFOTEC Pamphlet 99-102: Software Usability Evaluation Guide (Vol. 4).

Juristo, N., Lopez, M., Moreno, A. M., & Sanchez, M. I. (2003, May 3-4). *Improving Software Usability through Architectural Patterns.* Paper presented at the International Conference on Software Engineering, Portland, Oregon.

Korte, G., B. (2001). *The GIS Book* (Fifth ed ed.). Albany: On Word Press.

Laudon, K. C., and Laudon, Jane P. (1998). *Management Information Systems: New Approaches to Organization and Technology* (5th ed.). Upper Saddle River: Simon & Schuster.

Lee, D. R. (1988). The Evolution of Information Systems and Technologies. *S.A.M. Advanced Management Journal, 53*(3), 17.

Mael, S. (2005). (pp. Email correspondence between SMSgt Mark E. Barner and Mr Stan Mael in October 2005.). Dayton, OH.

Mangan, E. U. (1995). The Making of a Standard. *Information Technology and Libraries, 14*(2), 12.

McHaney, R., & Cronan, T. P. (1998). Computer Simulation Success: On the Use of the End-User Computing Satisfaction Instrument: A Comment. *Decision Sciences, 29*(2), 525.

Moreno, D. (2005). (pp. Email correspondence between SMSgt Mark E. Barner and Mr Stan Mael in October 2005.).

Nunnally, J. C. (1978). *Psychometric Theory* (2d ed.). New York: McGraw-Hill.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric Theory* (3rd ed.). New York: McGraw-Hill.

Pittman, R. H. (1990). Geographic Information Systems: An Important New Tool for Economic Development Professionals. *Economic Development Review, 8*(4), 4.

Schwab, D. P. (2005). *Research Methods for Organizational Studies* (2nd ed.). Mahwah: Lawrence Erlbaum Associates, Inc.

Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE). (2005). Retrieved November 8, 2005, from https://tsc.wes.army.mil/products/TSSDS-TSFMS/tssds/html/

Torkzadeh, G., & Doll, W. J. (1991). Test-Retest Reliability of the End-User Computing Satisfaction Instrument. *Decision Sciences, 22*(1), 26.

Unified Facilities Criteria (UFC) 3-260-01: Airfield and Heliport Planning and Design. (2001). (pp. 357): AFCESA.

West, L., A. Jr. (2000). Designing End-User Geographic Information Systems. *Journal of End User Computing, 12*(3), 14.

Worboys, M., & Duckham, M. (2004). *GIS: A Computing Perspective* (2nd ed.). Boca Raton, Fla.: CRC Press.

Zettler, M. E. (2002). USAF GeoBase Policy Memo. In ALMAJCOM/FOA/DRU/CV (Ed.). Washington Dc.

Vita

Senior Master Sergeant Mark E. Barner graduated from Sharon High School, Sharon, Tennessee in May 1985. Sergeant Barner enlisted in the Air Force prior to his graduation from high school and was placed on the delayed enlistment program. After completing basic training he was trained as an Electrical Power Production Specialist. He arrived at his first duty station, Mountain Home AFB, Idaho, in January 1986. In February 1990, Sgt Barner retrained into his current specialty, Operations Management. He remained at Mountain Home until August 1992. At that time he was reassigned to the 564th Civil Engineer Squadron at Ramstein Air Base, Germany. There he worked as the NCOIC for Housing Maintenance Customer Service and was the Quality Assurance monitor for the squadron. In September 1996, Sgt Barner arrived at Bolling AFB, D.C and was the 11th Civil Engineer Squadron Customer Service Unit NCOIC. After serving over three years at Bolling, Sgt Barner was reassigned to the 12th Space Warning Squadron at Thule AB, Greenland. There he was a Quality Assurance Evaluator for the Thule Air Base Operations and Maintenance Contract. In March 2001, Sgt Barner arrived at the 11th Civil Engineer Squadron, Peterson Air Force Base, Colorado and was the Operations Management Superintendent. In May 2001, he graduated Cum Laude with a Bachelor's Degree in Management Studies from the University of Maryland University College. In August 2003, he entered the Graduate School of Engineering and Management, Air Force Institute of Technology. Upon graduation he will be assigned to the GIS Support Center, United States Air Force Academy.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 074-0188*

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to an penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
23-03-2006	Master's Thesis	Jun 2005 – Mar 2006

4. TITLE AND SUBTITLE

A Comparative Usability and End-User Satisfaction Analysis of Two Geographic Information System (GIS) Applications

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Barner, Mark, E., SMSgt, USAF

5d. PROJECT NUMBER
If funded, enter ENR #

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GIR/ENV/06M-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Jeth Fogg, PhD, P.E., Lt Col, USAF
Director, USAF GIS Support Center
Institute for Information Technology Applications
2354 Fairchild Drive, Suite 4K29
USAF Academy, CO 80840
DSN: 333-9191 email: jeth.fogg@usafa.af.mil

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Air Force has recognized that organizations across Air Force installations often require geospatial information resources or maps to accomplish mission essential tasks. To provide an AF-wide approach to addressing this need, in 2001, the Headquarters Air Force Geo Integration Office formed the USAF GeoBase program. GeoBase is the name given to the Air Force's GIS program. As GeoBase has been implemented across the Air Force, there have been no mandated product standards for GIS applications.

This thesis focuses on two different GIS applications being used across the CE community for the management of airfield obstructions. These two applications are the Airfield Obstruction Management System (AOMS) and the Airfield Obstruction Tracking, Analysis, and Management System (AIROBS). In addition to the development of a unique methodological approach for accomplishing analyses, this research presents how each application rates in usability of accomplishing tasks and the level of satisfaction as determined by the end-user. Overall, the results revealed that AOMS was identified as having fewer problems in usability and rated slightly higher in End-User Computing Satisfaction. The methodology is offered as a way to compare other GIS applications where there is an intent to determine the best application for a specific mission purpose.

15. SUBJECT TERMS
Geographical Information System, Information System, Civil Engineering, Airfields
Airfield Obstruction Management Systems, Airfield Obstruction Tracking, Analysis, and Management System,
AFOTEC Software Usability Evaluation, End-User Computing Satisfaction

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
					Lt Col Summer E. Bartczak, ENV
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(Include area code)*
U	U	U	UU	109	Example: (937) 255-3636, ext 4826)

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

Form Approved
OMB No. 074-0188