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DECISION ANALYSIS METHODOLOGY TO EVALUATE ORGANIZATION STRATEGIES FOR THE CIVIL ENGINEER OPERATIONS FLIGHT

THESIS

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THESIS

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Shawn C. Thompson

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List of Acronyms

AFB	Air Force Base
AFCE	Air Force Civil Engineer
AFI	Air Force Instruction
AFIT	Air Force Institute of Technology
AFCESA	Air Force Civil Engineer Support Agency
AFESC	Air Force Engineering and Services Center
AFPAM	Air Force Pamphlet
AFR	Air Force Regulation
AFSC	Air Force Specialty Code
ATC	Air Training Command
BCE	Base Civil Engineer
CE	Civil Engineer
CORE	Combat Oriented Results Engineering
DMRD	Defense Management Report Decision
DSW	Direct Scheduled Work
DPL	Decision Programming Language
HQ	Head Quarters
HVAC	Heating Ventilation and Air Conditioning
Lt Col	Lieutenant Colonel (Air Force abbreviation)
LTC	Lieutenant Colonel (Army abbreviation)
MAJCOM	Major Command
Prime BEEF	Primary Base Engineering Emergency Force
ROOM	Readiness and Ownership Oriented Management
RWP	Recurring Work Program
SAC	Strategic Air Command
SORTS	Status Of Resources and Training
TAC	Tactical Air Command
TDY	Temporary Duty
USAF	United States Air Force
WO	Work Order

Abstract

The organizational structure of the civil engineer squadron's operations flight has undergone numerous changes over the last fifty years. Today the structure of the flight to the element level is mandated by Air Force Instructions; however, each unit is given the flexibility to organize below the element level. Most civil engineer units are struggling through the decision of how to organize their flights without a sound methodology to guide their efforts. Providing such a methodology is the objective of this thesis.

To accomplish the objective, the history behind the operations flight structure was researched. In addition to this historical research, the current Air Force guidance was investigated for information concerning the structure, goals, and mission of the operations flight. With this background information at hand, a decision analysis methodology was developed to assist in the evaluation of organizational strategies. This methodology was tested at Wright-Patterson AFB and implemented at Little Rock AFB.

The result of this thesis effort is a decision analysis methodology that injects a dose of clarity and order into an otherwise cloudy and subjective decision problem. This methodology enables a comprehensive analysis of the decision problem while remaining flexible enough to accommodate the uniqueness of every unit.

DECISION ANALYSIS METHODOLOGY TO EVALUATE ORGANIZATION STRATEGIES FOR THE CIVIL ENGINEER OPERATIONS FLIGHT

I. INTRODUCTION

General Issue

The organizational structure of the civil engineer squadron's operations flight has undergone several changes since the early 1960s. Indeed, the strategic direction of the operations flight structural change has gone full circle from the centralization efforts of the 1960s, through the decentralization theme of the 1980s, and finally the momentum appears to be shifting back in the direction of centralization.

The operations flight was centralized in the 1960s to strengthen programming and facility inspection activities, to place emphasis on industrial engineering, and to improve career progression opportunities (Ward,1966: 7). This centralization was not seriously challenged until the mid 1980s when the Strategic Air Command (SAC) and Tactical Air Command (TAC) introduced programs to decentralize the operations flight. The purpose for the decentralization was to enhance the wartime training of the workforce and to improve customer satisfaction. The result of this decentralization is the zonal maintenance structure currently employed by most civil engineer units in the Air Force. Manpower and budget reductions in the early 1990s, combined with a high operations tempo, spurred another look at how the operations flight is organized.

For the past several years, civil engineer units have individually tackled the issue of how to reorganize the civil engineer operations flight to improve efficiency. The Air Force Civil Engineer, Maj. Gen. Eugene A. Lupia, approaching this issue from an Air Force-wide perspective, tasked the Air Force Civil Engineering Support Agency (AFCESA) with answering the question, "Should we maintain the current policy of zonal maintenance, go back to centralized shops, or make it optional?" (Lupia:1998: 2). AFCESA organized a workshop to look into this issue which resulted in a recommendation to make the structure of the operations flight optional below the element level.

Research Questions

The decision to allow each civil engineer unit to determine the best organization strategy, below the element level, for their operations flight was not accompanied by any specific guidance or methodology recommendations to accomplish the task. Providing the methodology is the basic objective of this study and is the root of the two research questions:

1. What are the important factors in deciding how to organize a civil engineer operations flight?

2. How can various organization strategy options (zonal maintenance, shop configuration, or a combination) be evaluated to facilitate a decision?

Research Objective

The ultimate objective of this research effort is to provide a methodology for evaluating operations flight organization structures to aid in the selection of one that maximizes the flight's goals and objectives.

Document Structure

Introduction. This chapter introduces the general issue from which the research questions and objective were derived. The research questions and objective are specifically stated herein. In addition, the basic structure of the document is provided in this chapter.

Research Approach and Background. The chapter opens with a brief discussion of the approach used for this thesis effort. This chapter also serves two additional purposes. The first purpose is to review the historical development of the operations flight structure in order to better understand the current situation. The second purpose is to review Air Force guidance concerning the structure, goals, and mission of the operations flight.

Resulting Methodology. The methodology chapter outlines the methodology that resulted from this thesis effort. This chapter also provides a discussion of the decision analysis techniques chosen for this study. The methodology was developed and tested on the 788th Civil Engineer Squadron located at Wright-Patterson AFB and was implemented for the 314th Civil Engineer Squadron at Little Rock AFB. The final reports submitted to those squadrons are provided in the appendices.

Discussion. The advantages and disadvantages of the methodology resulting from this thesis effort are discussed in this chapter. Suggestions concerning how this work can be used and areas for further study are also discussed in this chapter.

II. Literature/History Review

Research Approach

The results from the AFCESA workshop clearly indicate that any methodology utilized to aid in the selection of an operations flight structure would have to be developed at the base level. The unique demographics of each base preclude the use of a "one size fits all" structure. In spite of the unique aspects of each installation, the purpose of the operations flights across the Air Force are essentially the same; therefore, it is reasonable to assume that a methodology established for one base could be applied to another with minor alterations. The first step in establishing a methodology to evaluate and select from various operations flight organization structure alternatives is to determine the decision criteria, or the values, associated with selecting a structure. To answer this question, Air Force and Department of Defense literature was reviewed for such values. Historical operations flight reorganizations were studied as well to provide some insight into the important factors in this decision. The results of this work are summarized later in the chapter.

Given the number of organizational strategy alternatives that a base could generate and the multiple criteria by which they must be evaluated, this problem is well suited to decision analysis techniques. These techniques were researched and compiled into a methodology to accomplish the objective of this thesis. The development of this methodology was done in concert with the 788th Civil Engineer Squadron at Wright-Patterson AFB. The lessons learned from this methodology development exercise led to several improvements. The resulting methodology and a discussion of its implementation requirements is discussed in Chapter Three.

This resulting methodology was tested at the 314th Civil Engineer Squadron at Little Rock AFB with promising preliminary results. A discussion of the advantages and disadvantages of this methodology is discussed in Chapter Four.

Background Overview

This chapter begins with a historical review of Air Force civil engineering. This review begins with the 1960's civil engineer squadron structure and tracks the significant events that shaped the changes to that structure. The purpose of such a review is to provide an understanding of how the civil engineer squadron evolved over time in order to better understand how the issue of operations flight reorganization developed. This chapter concludes with a review of the current Air Force guidance concerning the structure and objectives of the Civil Engineer Squadron.

Early Organizational Structure Revisions

Early civil engineer organization, from the late 1940s, was based on a system called geographic maintenance. "Geographic maintenance subdivided a base into geographic areas and gave teams responsibility to maintain them. In essence, it was an early form of decentralized maintenance" (Cooley, 1990:6); however, maintaining this strategy for operation and maintenance of Air Force real property facilities presented an increasing challenge during the 1950s as the Air Force inventory grew in size, complexity and dollar value. From 1955 to 1965 the Air Force plant costs grew 177% from $6 billion to over $16 billion while the Operation and Maintenance funds grew by only 86% from $500 million to $930.7 million. Adding to the challenges created by the decreasing ratio of resource availability to inventory value was a 12% decrease in personnel during this same time period (Ward, 1966: 6).

To deal with these challenges major revisions were required to AFR 23-33. This regulation prescribed the organizational alignment of civil engineering since 1961. In June 1965, the Major Command Civil Engineers were asked to forward recommended AFR 23-33 changes to HQ US Air Force. The result of this exercise and an AFR 23-33 workshop at Wright-Patterson AFB's Civil Engineer Center was a single majority recommendation. This recommendation, a centralized civil engineer structure, was accepted in December 1965 at the

World-Wide Civil Engineer Conference. The proposed changes were distributed to the major commands for further study and tested at selected installations.

The test was planned for the period 1 April through 30 September 1966 at six installations. To assure a comprehensive analysis of the test, a panel was established to administer the test program and to prepare the final recommendation for consideration at the next World-Wide Civil Engineer Conference. This was aimed to provide time for regulation and manual rewrites to be published and distributed to the field before the proposed effective USAF-wide implementation date of 1 July 1967.

Participating Test Bases	
ATC	Keesler
ADC	Hamilton
	Oxnard and
	Suffolk County
SAC	Westover
TAC	Seymour-Johnson

The test was directed toward "centralizing and strengthening programming and facility inspection activities; greater emphasis on industrial engineering; work force consolidation; and improved career progression opportunities" (Ward, 1966:7).

The Return to Decentralization

The Air Force civil engineer organizational structure produced by this major AFR revision served the career field, with only minor revisions, throughout the 1970's and into the 1980's. During that time, however, many changes took place in the science of management theory. The value of individual initiative was formally recognized, and decentralization became a common Air Force theme. Although civil engineering was not stagnant throughout those years, the centralized maintenance approach of the revised AFR 23-33 was never seriously challenged until the Strategic Air Command (SAC) and Tactical Air Command (TAC) began developing Readiness and Ownership Oriented Management (ROOM) and Combat Oriented Results Engineering (CORE) respectively.

Both ROOM and CORE were, to a great degree, a return to the geographic maintenance structure used in the 1950's. These programs divided the base geographically or by facility type and assigned teams of craftsmen to maintain those facilities and areas. The ROOM and CORE strategies, implemented throughout SAC and TAC, gained Air Force-wide recognition. At the 1989 World-Wide Civil Engineer Conference, the Air Force Engineer and Services Center (AFESC), later renamed the Air Force Civil Engineer Support Agency (AFCESA), committed to evaluate the ROOM and CORE concepts and to produce a generic execution guide (Nay, 1990). The final product of this effort, the "Zonal Maintenance Guide", was completed and distributed to the bases in September 1990.

Recent Impacts on Decentralization

By the early 1990's, the zonal maintenance concept was well established in the USAF civil engineer community. This decentralization theme, however, was soon threatened by a number of factors. In 1990 the Defense Management Report Decision (DMRD 967), mandating a 15% manpower reduction, was released. This manpower reduction combined with a decreasing budget and increasing operations tempo spurred a new look at the way the civil engineer squadron was organized. The civil engineer career field in the mid 1990's was facing a very similar scenario that it faced in the 1960's: a decreasing ratio of resource availability to inventory value, reduced manpower, and a change in operational demands. In addition to these challenges, senior Air Force Civil Engineers, began to be concerned that the lack of organizational structure consistency was creating undue confusion in the career field.

During the December 1997 World-Wide Civil Engineer Conference, AFCESA was tasked to assess the options for improving organizational structure within the operations flight. A survey was constructed and sent to each Air Force base to determine how the operations flights were organized and to solicit comments about zonal maintenance and centralized maintenance, essentially a

"Zones versus Shops" commentary. Additional information concerning this survey is provided in Appendix A.

In addition to the survey, a workshop was held at Tyndall AFB FL to solicit further input from the civil engineer community. The workshop found that nearly all bases maintained the principle five elements of the objective squadron operations flight: Maintenance Engineering, Material Acquisition, Facility Maintenance, Infrastructure, and Heavy Repair. The recommendation of the workshop was to "strongly recommend" that these five elements be maintained. The workshop also revised the AFI 32-1031, the Air Force Instruction that provides the directives for civil engineer operations management. The workshop further recommended the Base Civil Engineers (BCE) be allowed the flexibility to alter the operations flight structure below the element level. The workshop cited manning limitations, diverse mission requirements, and a high operations tempo as reasons to grant the BCE this flexibility in structuring their operations flights.

The following timeline provides a more concise summary of the historical events discussed in this section

TIME	EVENT
Late 1950	Facility maintenance function was accomplished under a Geographic Maintenance structure
May 1961	AFR 23-33 prescribed the CE Squadron organizational alignment
Jun 1965	MAJCOM/CEs asked to forward recommended AFR 23-33 changes to HQ USAF
Nov 1965	The Civil Engineer Center at Wright-Patterson AFB, (WPAFB), hosted a workshop to review the recommended AFR 23-33 changes
Dec 1965	The World-wide Civil Engineer conference accepted the recommendations from the WPAFB workshop
Apr-Sep 1966	The AFR 23-33 changes were tested at six installations
Jul 1967	USAF-wide implementation of the AFR 23-33 changes
Fall 1986	Readiness and Ownership Oriented Management (ROOM) was tested at Pease AFB, Strategic Air Command (SAC)
1987	The Tactical Air Command (TAC) introduce Combat Oriented Results Engineering (CORE)
1988	SAC completed command-wide implementation of ROOM
Nov 1989	World-wide Engineering and Services Conference held Air Force Engineering and Services Center (AFESC) committed to evaluate the ROOM and CORE concepts and to produce an execution guide

1990	TAC committed to command-wide implementation of CORE
Sep 1990	AFESC distributed the Zonal Maintenance Guide to bases
Dec 1990	Defense Management Report Decision (DMRD) 967, mandating a 15% manpower reduction beginning in FY 92, was released
Jun 1994	AFI 38-101 set forth the "Objective Squadron" organizational Structure
Dec 1997	Air Force Civil Engineer Support Agency (AFCESA) was tasked at the World-wide Civil Engineer conference to investigate and make recommendations concerning the organization of the CE Operations Flight
Winter 1998	AFCESA constructed an Operations Flight survey for all Air Force bases to collect information
Apr 1998	AFCESA hosted a workshop at Tyndall AFB to review survey data and develop recommendations

Current Air Force Guidance

The BCE, granted this flexibility, is now faced with determining what operations flight organizational structure is best suited for their base; however, a methodology for evaluating the potential organizational structures and determining which structure best advances the goals and objectives of the squadron is not available. The development of such a methodology, the objective of this thesis, begins with a review of the current Air Force guidance concerning the structure and objectives, or values, of the civil engineer squadron.

Air Force Instruction (AFI) 38-101 prescribes the basic structure of the civil engineer squadron. This structure, called the 'objective squadron', is illustrated in Figure 2-1:

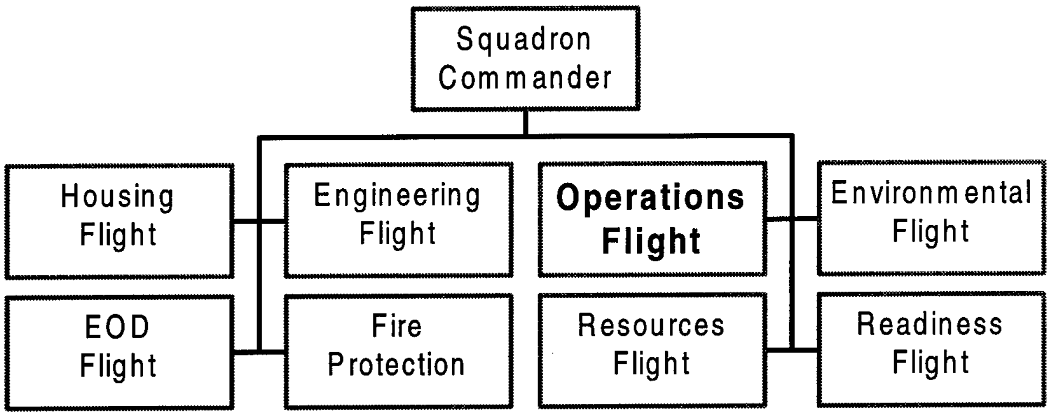


Figure 2-1: Civil Engineer Squadron Structure

The instruction also lists some of the elements that the operations flight contains: Material Acquisition, Facility Maintenance, Infrastructure Support, and Heavy Repair Elements. Maintenance Engineering was not specifically listed, nonetheless it is a standard element in the operations flight.

Additional information concerning the structure of the operations flight is provided in Air Force Pamphlet (AFPAM) 32-1004, Volume 1. As listed in this pamphlet, the primary duties of the flight are to:

1) operate, maintain, repair, alter, and construct real property facilities and utility systems;
2) manage the recurring work program;
3) be responsible for service contracts
4) provide logistical support; and
5) provide the civil engineer squadron its core capability and recovery of bases for protection of aerospace power.

Figure 2-2 depicts the organizational structure of the Operations Flight's five elements as described in AFPAM 32-1004V1.

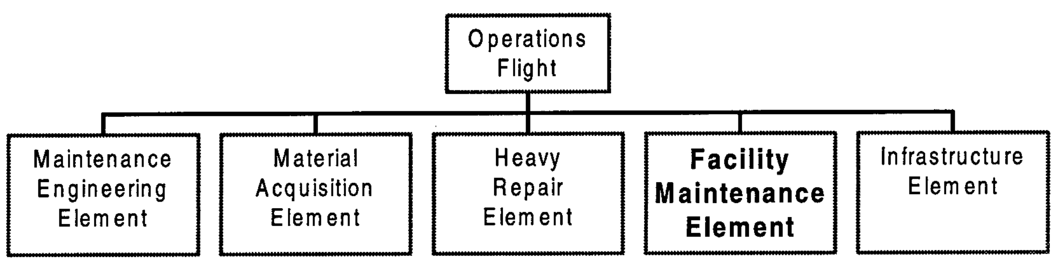


Figure 2-2: Five Element Operations Flight

The facility maintenance element houses the majority of the operations flight workforce and is typically the central figure in centralization vs. decentralization issues. The mission of the element is to "establish all recurring work, minor maintenance and repair, and selected work orders"(AFPAM 32-1004V1:17). To accomplish this mission the element has four overall objectives:

1) provide single-point customer support;

2) establish periodic facility reviews;
3) maintain, repair, and modify real property; and,
4) perform the recurring work program (AFPAM 32-1004V3:3).

Much of the Air Force guidance for the CE operations flight is devoted to facility maintenance; however, the focus on customer service is certainly not lost. Customer service cannot be ignored given the support role of civil engineering. Keeping these missions and objectives in mind is important when determining the best way to structure the operations flight; however, not only is it is difficult to quantify exactly how well a given organizational structure will facilitate the accomplishment of these missions and objectives, it is difficult for a decision maker to simultaneously consider them all at the same time. Decision analysis techniques can take an opaque issue such as this and, *via* a set of systematic transparent steps, enable to decision maker to make a clearer more insightful decision. Each step in this methodology is covered in more detail in the next chapter.

III Resulting Methodology

Introduction

The question of how to organize the civil engineer operations flight is very complex. There are numerous ways in which to organize the flight and each must be evaluated using multiple criteria: How will this organization affect training? How is customer service impacted? What are the impacts to the combat support mission? The list of potential criteria goes on.

Given the number of organizational strategy alternatives and the multiple criteria by which they must be evaluated, this problem is well suited for decision analysis techniques. Every decision maker has cognitive limitations, or bounded rationality, preventing them from considering every detail and uncertainty involved in a complex decision context. For this reason, a systematic procedure for transferring opaque decision problems into clear, lucid decision problems offers the decision maker more focused insight into a decision and facilitates better decisions (Howard 1988:680). Essentially, decision analysis is a "prescriptive approach designed for normally intelligent people who want to think hard and systematically about some real important problems" (Keeney and Raiffa, 1976:vii).

Methodology

The ten steps used in the development of this decision support model are discussed in general terms in this chapter. The framework for this study and an illustration of the ten steps are displayed in Figure 3-1. The methodology resulting from this thesis effort was constructed, in large part, during a course at the Air Force Institute of Technology (Kloeber, 1998). The discussion in this chapter will frequently refer to and draw from two specific applications of the methodology. These specific applications are summarized in Appendices B and C.

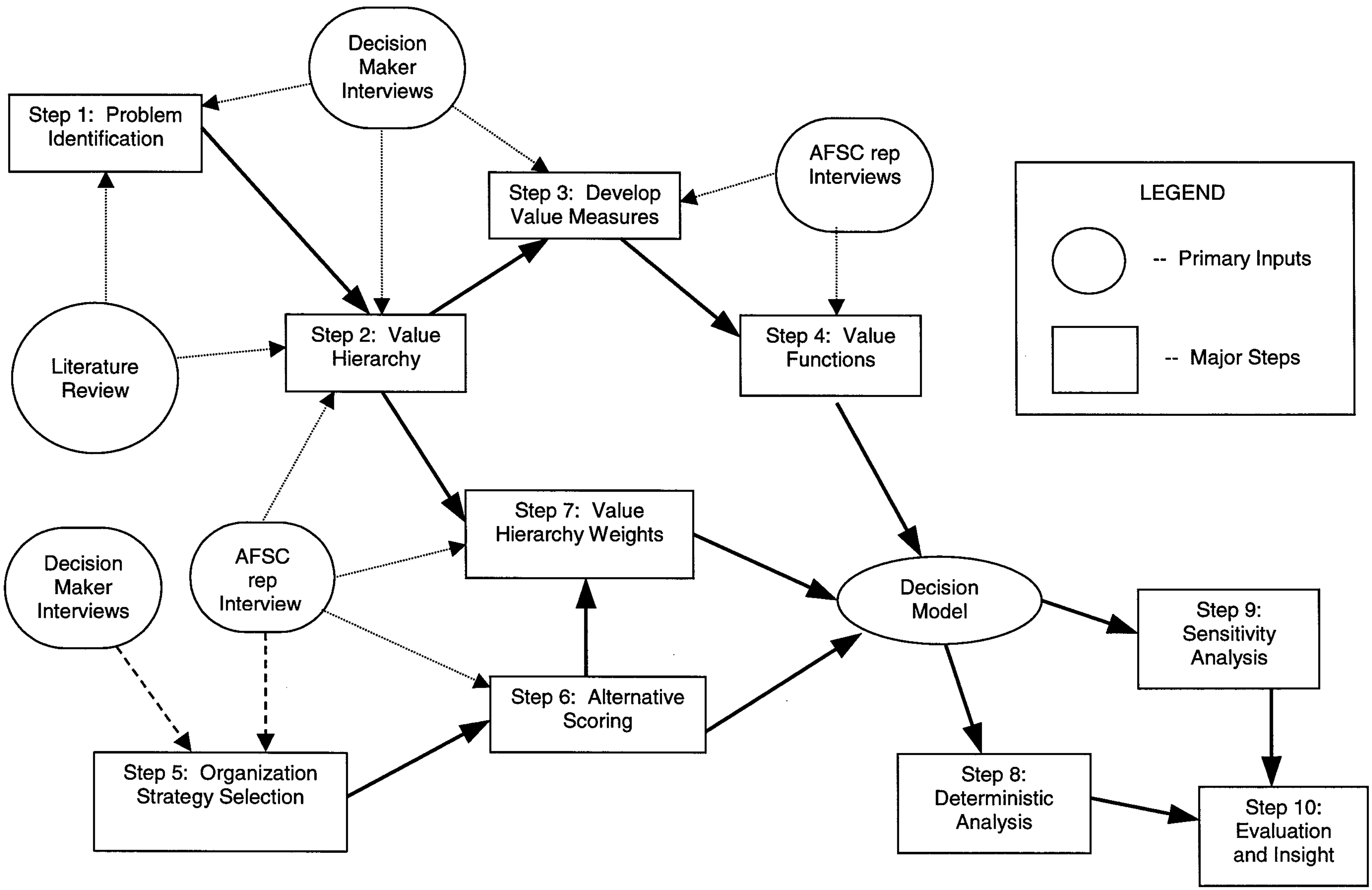


Figure 3-1. Decision Support Model Development Framework

Step 1. Identify the Problem. The first and most critical step in any decision analysis problem is correctly identifying the specific problem that the decision maker(s) wishes to solve. Incorrectly identifying the problem could result in wasted time and effort solving the wrong problem. This mistake is often called "an error of the third kind" (Clemen, 1996:5). The comments collected from civil engineer units around the Air Force *via* the AFCESA survey (Appendix A) clearly illustrate the difference of opinion concerning the best way to organize the operations flight. Some believe that a shop configuration is the most efficient organizational strategy, some elect the zonal maintenance structure, and still others prefer some sort of hybrid between the two. Many civil engineer units are investigating this issue and working to reorganize their operations flight to improve efficiency; however, no clear methodology has been established to guide their investigation. Clearly stated, the problem is: *how can various operations flight organizational strategies be evaluated to facilitate the selection of one that best advances the goals of the flight?*

Step 2. Identify the Values. As mentioned previously, the plethora of potential organizational strategies must be evaluated using multiple criteria, or values. The process of determining exactly what these criteria are is the focus of this step.

Typically, decision problems are faced by first identifying the possible alternative solutions and only then considering objectives or criteria to evaluate them. This approach is reactive rather than proactive. Ralph Keeney perhaps articulates the reason for starting the decision analysis process with the identification of values.

> Values, as I use the term, are principles for evaluating the desirability of any possible alternatives or consequences. They define all that you care about in a specific decision situation. It is these values that are fundamentally important in any decision situation, more fundamental than alternatives, and they should be the driving force for our decision making. Alternatives are relevant only because they are a means to achieve values. Thus, although it is useful to iterate between articulating values and creating alternatives, the principle should be "values first." This manner of thinking, which I refer to as value-focused thinking, is a way to channel a critical resource – hard thinking – in order to make better decisions (Keeney, 1994:33).

The ultimate determination of what criteria to use is made by the person or group charged with the decision of how to organize the operations flight. A significant input into the criteria selection process in this study is Air Force civil engineer guidance provided by senior leadership. The criteria used to evaluate alternatives are the things that the decision maker values with regard to the decision context. These values can be arranged in a hierarchical fashion with some values being of primary importance and others being supporting values.

Air Force civil engineer literature was researched to find fundamental values, generally worded as objectives, to form the framework of the value hierarchy. With this framework (Figure B-1 on page 76) established, the decision maker was interviewed to provide more detail and the specific perspective of the unit. This process was accomplished with the 788th Civil Engineer Squadron at Wright-Patterson AFB. Appendix B contains additional details concerning how the value hierarchy evolved. The value hierarchy utilized in the 314th Civil Engineer Squadron case study at Little Rock AFB (Appendix C) is provided in Figure 3-2.

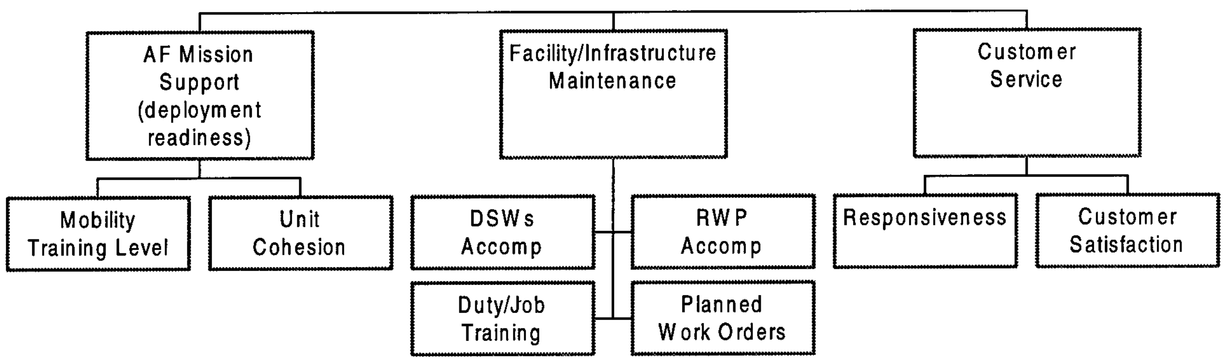


Figure 3-2. Value Hierarchy from Little Rock CE Squadron

Step 3. Value Measures. The three primary values, Air Force mission support, facility/infrastructure maintenance, and customer service, are broken down into supporting values. These supporting values are further subdivided until a value is reached that can be measured in some fashion. Figure 3-2 shows eight values at the lowest tier of the value hierarchy. The objective of this step is to devise a means of measuring success for these values.

The value “RWP accomplishment” provides a typical value measure. This value refers to the importance of accomplishing the recurring work program (RWP). Most CE units have a recurring work program and track how much of it is being accomplished. A good measure of how well an organizational strategy will facilitate RWP accomplishment is the percentage of the program that can be accomplished with such an organization structure. Therefore, the measure of RWP accomplishment is the percentage of the program completed. Additional examples of value measures are provided in the case study Appendices (B and C).

The most efficient way to develop the value measures is in a meeting with all team members present. This helps ensure that everyone understands the measures and approves of them. The decision maker makes the final approval of each value measure before proceeding to the next step.

Step 4. Value Functions. The value measures derived in Step 3 are generally not all in the same units, rendering it impossible to simply add up the scores into a total score for a given alternative. Prior to a summation exercise, these different units have to be converted into the same units. This is analogous to converting yards, inches, and leagues into a common unit, such as meters, before determining a total length. The common units into which all the measurements are converted is called a “value unit”. This “value unit” is simply a measure of the decision makers happiness or satisfaction on a scale of 0 to 100, with 0 being no happiness and 100 representing complete satisfaction or happiness. The conversion into value units is accomplished using a value function and a scaling factor – also called a weight.

To illustrate this process, the RWP accomplishment value example will be carried further. The level of happiness or satisfaction (value units) increases as the percentage of the RWP accomplished increases. For example, 50% of the RWP accomplished may result in a value score of 80 out of a possible 100. At this point it is likely evident that the value placed on RWP accomplishment depends greatly on which career field is being questioned. The Heating Ventilation and Air Conditioning (HVAC) career field places different emphasis and value on RWP than does the structural career field. For this reason, value functions are derived not only for each value measure but for each of the career fields supplying input into the decision. Figure 3-3 shows the value function used in the Wright-Patterson case to convert RWP accomplishment into value units for the HVAC career field. For comparison, Figure 3-4 shows the same function built for the structural career field.

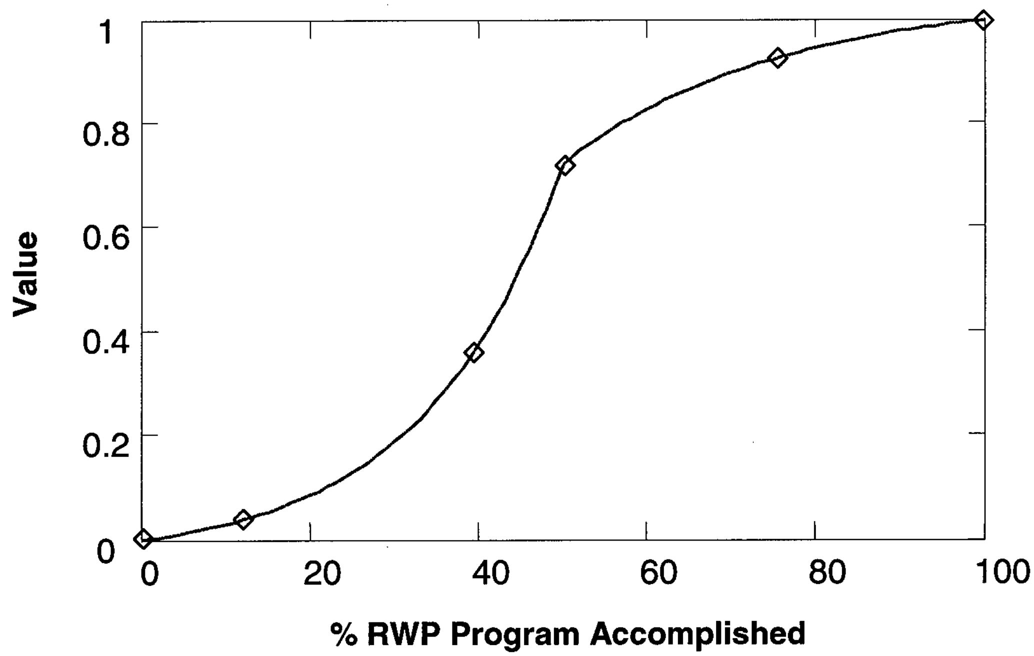


Figure 3-3. HVAC RWP Accomplishment Function

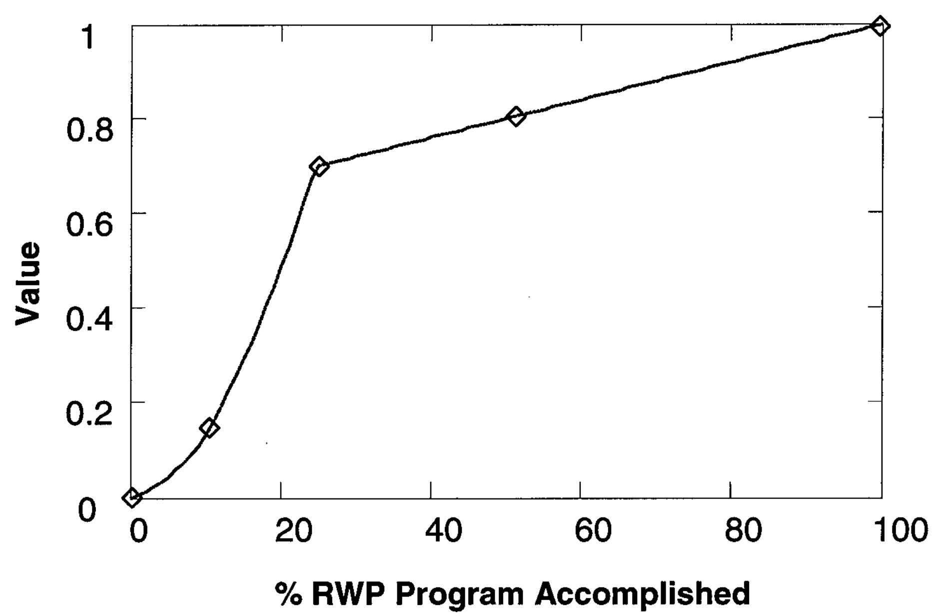


Figure 3-4. Structural RWP Accomplishment Function

An assumption made for the RWP accomplishment value measure is that the program is prioritized such that the more important projects are completed first. As expected, the structural career field derives more satisfaction with a smaller percentage of RWP accomplishment than the HVAC career field. If 30% of the structural RWP is accomplished, the structures personnel scored that a 75 out of a possible 100. On the other hand, that same 30% was not satisfactory to the HVAC personnel who scored that level of accomplishment a 20 out of 100. These functions reflect the importance of RWP to these two distinctly different career fields and support the decision to develop the value functions separately with each career field providing input for the decision.

The values from both case studies, Appendices B & C, are not completely independent from each other; for example, customer satisfaction is dependent on responsiveness, RWP accomplishment, etc. In subsequent steps, alternatives will be selected and given weighted scores which will be summed into a total value for each alternative. However, to ensure the validity of this simple summation, a certain independence assumption must first be checked. This independence is referred to as mutual preferential independence. This type of independence is explained *via* a hypothetical example using the RWP accomplishment value from the Little Rock case study.

RWP accomplishment is said to be preferentially independent of a value X if preferences of specific outcomes of RWP accomplishment do not depend on the level of Value X (Clemen, 1996:579). To explain this further, imagine two alternatives that have identical scores for all values except RWP accomplishment. Suppose that alternative #1 has an 80% RWP program completion score and alternative #2 has a 50% RWP program completion score and their unit cohesion scores are identical. If alternative #1 is always preferred to alternative #2 in this situation regardless of the level of their identical unit cohesion values, then RWP accomplishment is preferentially independent of unit cohesion. If the reverse logic holds then these two values have mutual preferential independence. Each value must be checked for this preferential independence. This check is accomplished by establishing hypothetical situations for each value combination like the one described above and asking the decision maker how varying these value levels impact their selection of alternatives.

Once the mutual preferential independence is checked, the individually weighted scores for each value can be summed together into a total value score for each alternative. If the mutual preferential independence assumption does not hold, the analysis becomes considerably more complicated and this methodology is not valid; however, this assumption is generally valid for many people in many situations (Clemen, 1996:579). This assumption was not checked during the Wright-Patterson case study when the methodology was being developed. The mutual preferential independence check was added during the Little Rock case study, confirmed the validity of the assumption in that particular case study, and provided an indication that it will likely hold in other cases as well.

Step 5. Alternative Selection. With the value hierarchy established and the means to measure and evaluate alternatives, the selection of organizational strategies for analysis can be concluded. Typically there are at least as many suggested ways to organize the operations flight as there are people involved in providing input to the decision; however, these numerous alternatives can often be classified into a handful of overall strategies. For example, numerous suggestions were put forth during the study at Little Rock AFB, but all were basic variations of four general strategies: a single-zone format, the current two-zone format, a two-zone format with the vertical shop portion of heavy repair absorbed by the zones, and an Air Force Specialty Code (AFSC) shop configuration.

Although the generation of alternatives can, and often does, start earlier than this point in the process, it should not be considered complete until the alternatives' scores are reviewed. The values and their measurements can often be used in brainstorming exercises to enhance the spectrum of alternatives being generated. The idea is to generate alternatives that score well in at least one of the values. A situation in which all the alternatives score poorly for a particular value usually indicates that some strategy is not being considered or that the value in question is not as important as initially believed.

Step 6. Alternative Scoring. The organizational strategy alternatives chosen for analysis are evaluated or scored using the value measures previously developed. The scoring is accomplished by direct assessment for each career field. Each career field's scores are converted into common units using their respective value functions. These scores should be reviewed as a measure of ensuring that a solid spectrum of alternatives have been considered for evaluation. If all alternatives score low in a particular area, it is likely that some alternative was overlooked.

In this step, three scores are obtained: the most likely score, a lower bound score below which the true value is not likely to be, and an upper bound above which the true value is not likely to be. The purpose of obtaining these three scores involves capturing the uncertainty of the scoring and will be discussed further in step 9.

Step 7. Value Hierarchy Weights. At this point each alternative being analyzed has a score for each value on the lowest tier of the value hierarchy (Figure 3-2). As alluded to in earlier steps, these scores will be summed together to get a total score for each alternative. The fact that not all of these values are of equal importance precludes the use of a straightforward simple summation. To account for the varying degree of importance of the values, a weight is assigned to the values. The value's weight is multiplied by the value's score and the weighted scores are then summed.

As one might expect, the importance, or weight, placed on the values is dependent on the career field being questioned. For this reason, the weighting exercise was conducted for each career field and the decision maker. The weights obtained from each career field were applied to their respective portions of the decision support model.

The weights were determined using a direct assessment of their swing weights. The concept of swing weights is explained later in this step. Each score is on a scale of 0 to 100 and the weights sum to one so the total scores will also be on the same scale. The technique used to assess the weights is described as the 'marble technique'. The value hierarchy from Figure 3-2 will be used to explain the process. First, the primary values (mission support, facility/infrastructure maintenance, and customer service) are assessed weights. The decision maker or the career field representative(s) is given 100 imaginary marbles and asked to place these marbles into one of the three 'value boxes' with each marble representing a degree of importance. Second, the next tier of value weights are assessed. For each primary value, the decision maker or career field representative(s) is given another 100 marbles and asked to place them into the 'value boxes' of the values supporting that primary value. This is done for each of the primary values. The results of this exercise from the Little Rock AFB case study are shown in Figure 3-5.

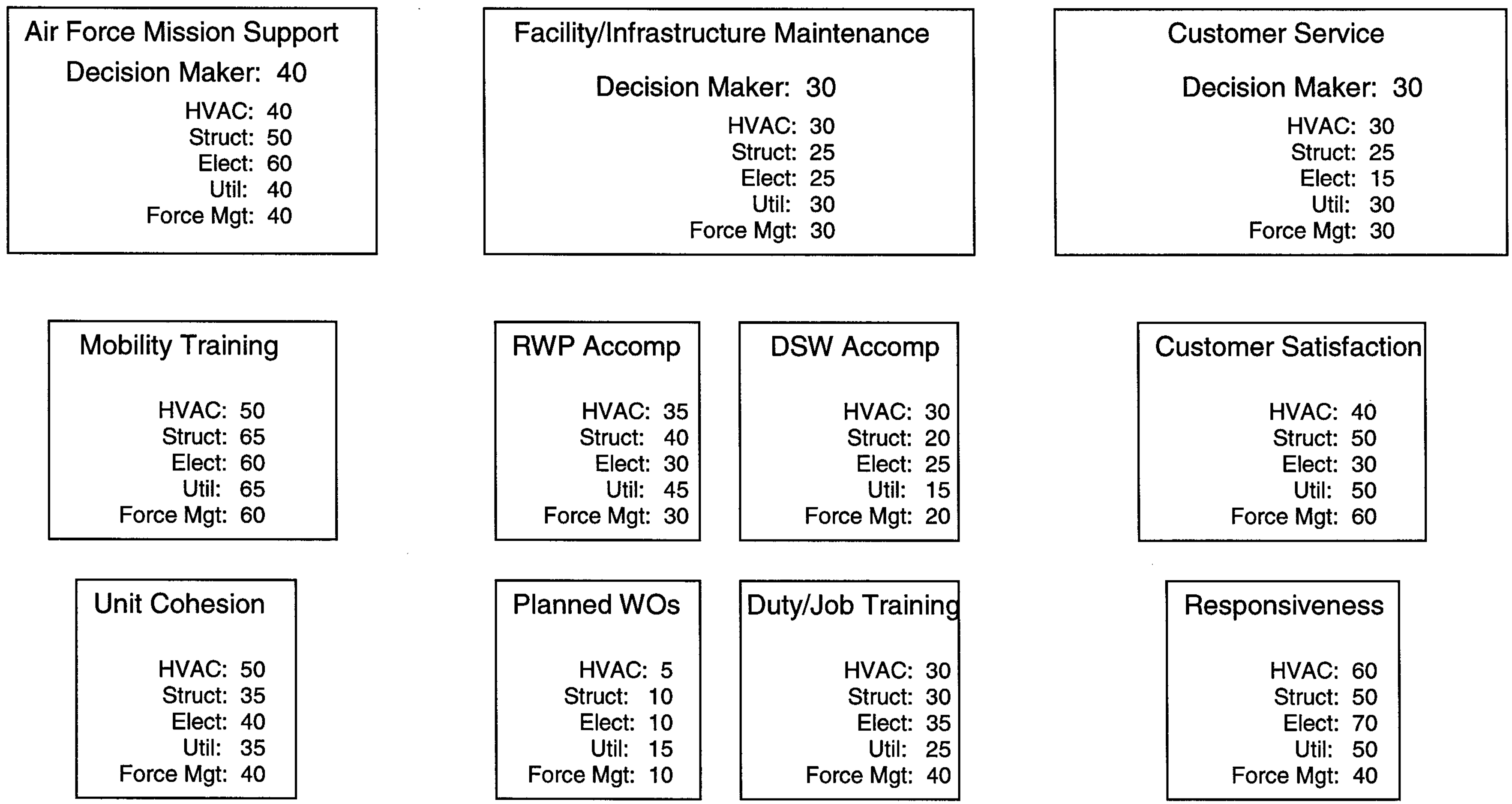


Figure 3–5. Weights (marbles) Applied to Values(Little Rock AFB)

To explain how to get from these imaginary marbles to useful weights, an example from Figure 3-5 will be used. The structural career field placed 50 marbles into the Air Force mission support primary value, meaning that half of the weight, 0.50, is to be applied to this score. The supporting values to Air Force mission support are mobility training and unit cohesion. The structural career field representatives placed 65 and 35 marbles into these boxes respectively. This means that 65% of the Air Force mission support weight is to be applied to mobility training and the remaining 35% is applied to unit cohesion:

Mobility Training Weight: 0.50 * 0.65 = 0.325

Unit cohesion Weight: 0.50 * 0.35 = 0.175

This process is completed for all eight values on the lowest tier of the value hierarchy. The final result is weights that sum to 1.00 and reflect the degree of importance of each value.

Why isn't this step done directly after the value hierarchy is developed? If the weights are assessed early in the process, the technique is referred to as direct weighting. The direct weighting technique is a direct assessment of the importance of one value over another without considering how much that value actually contributes to the total score of the alternatives. Factoring the relative contribution of a value on the total scores into that value's weight is called swing weighting (von Winterfeldt and Edwards 1986:274-275).

The technique is perhaps best explained by using another example. Suppose the decision "which new car to purchase" is the issue. Cost and performance are typical values important to the decision. Using the direct weighting technique, these two values would be weighted to determine how important they are relative to each other. In this situation, most people would probably place more weight on cost than performance. The swing weighting techniques requires a set of alternatives to be scored prior to establishing the weights. Suppose the choice of vehicles were reduced to three models to select from. If the cost of each of the models varied by no more than $300 but the performance of the three models varied significantly, the decision maker would likely place more emphasis on performance in making the selection. Swing weighting requires the determination of how much each value contributes to the total score of the vehicle models and incorporation of that information into the weight assigned to that value.

The organizational structure alternatives for the operations flight are generated and scored so the range of scores, analogous to the range of costs in the example, is known and accounted for in assessing the weights.

Step 8. Deterministic Analysis. The steps leading up to this point have built the pieces of the puzzle. In this step, these pieces are put together to determine the total score for each of the alternatives. This section provides a discussion of the basic process used in the analysis. Detailed information about the decision analysis model, including the influence diagrams and node equations, is provided in Appendix D.

Each of the alternatives is scored using the value measures which were derived from the value hierarchy. These scores are converted into common units using the value functions from step 4. These newly converted scores are multiplied by their respective weight and summed together to obtain a total score for each alternative. Since the data supplied to the model is highly career field dependent this exercise is done for each career field. The Deterministic Analysis section in Appendix B & C provides specific examples and illustrations of the results.

In addition to individual career field scores, the decision maker is often interested in a combined score of all the career fields. In both case studies, there was not a consensus among the career fields concerning which organizational strategy alternative was the best. To provide an indication of the one best alternative, a weighted sum of each career field's scores, a grand total score, was computed. Generally the weights applied to the career field's scores are a function of how much the different strategies impact the career fields. For example, in the Little Rock case study, five career fields were part of the analysis team. The decision makers determined that the structural, electrical, and utilities career fields were most impacted by the alternative strategies. The scores of these three career fields were each given a weight of 0.25. The HVAC career field was slightly less impacted by the proposed changes; therefore, their scores were given a weight of 0.15. Finally, the force management career field was the least impacted by the alternatives and their scores were given a weight of 0.10 by the decision maker.

Step 9. Sensitivity Analysis. The previous analysis provided a total score for each alternative, which enabled them to be ranked from best to worst. This ranking can be done using either the individual career field scores or the grand total score; however, this simple ranking does not paint the entire picture. Most of the data collected is subjective in nature and is therefore a source of uncertainty. Incorporating some of that uncertainty into the analysis is the focus of this step in the process. The incorporation of the uncertainty into the analysis provides the decision maker with insight into how much influence that uncertainty has on the results of the analysis.

One of the two most prominent sources of uncertainty involves the scoring of the alternatives. It is difficult to predict exactly how a given organizational strategy will impact RWP accomplishment, unit cohesion, etc. To deal with this uncertainty, three scores were provided by each career field for each value measure. The first score obtained was the 'most likely' score. This score reflects that career field's opinion of how a given alternative would most likely score. The lower and upper scores are the lower and upper bounds within which the career field is reasonably certain the true score would actually fall. These three scores capture both the best estimate and a measure of the uncertainty involved. The process employed to determine the scores is a simplified version of the one described in Kirkwood's Strategic Decision Making text. In his text, Kirkwood obtained an upper extreme, lower extreme, upper quartile, lower quartile and a median score (Kirkwood 1997:120-126).

These uncertainty values must be modeled using probability distributions. The triangle distribution is the probability distribution utilized for this research. Figure 3-6 shows a generic triangle distribution. This simple distribution allows the uncertainty of the expert opinion to be easily incorporated into the model.

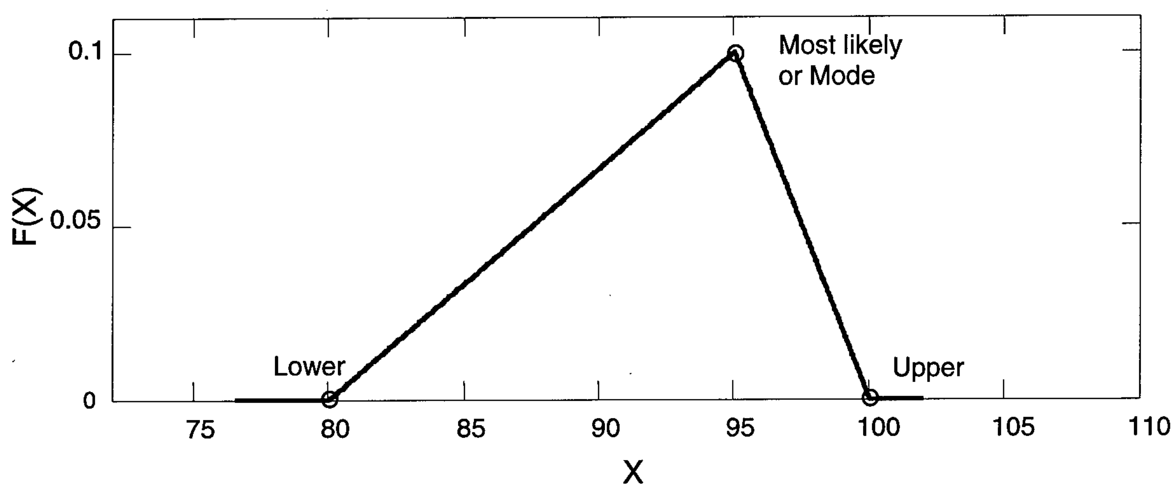


Figure 3-6. Generic Triangular Distribution

The second of the two most prominent sources of uncertainty concerns the weights assigned to the values. These weights are subjective, basically a matter of opinion. How would changes in the weights affect the total score and grand total score of an alternative? Analyzing the sensitivity of the final alternative ranking to changes in value weights often provides the decision maker(s) with valuable insight. This analysis is accomplished by systematically altering the weights of each value and tracking the impacts on the final scores and rankings. The other weights are adjusted to ensure they sum to one. The ratios of the other weights to each other are maintained as this adjustment is made.

Step 10. Results Presentation. Once the deterministic and sensitivity analysis is complete, the results are presented to the decision maker(s). The analysis and presentation steps may be iterative if the decision maker(s) has additional questions requiring more analysis. The format of the presentation of results depends on the insights gained by the analyst and the questions posed by the decision maker(s). The final sections of appendices B & C provide examples of the format used to present the analysis results from the two case studies.

Model Implementation

General Requirements. Baring any scheduling conflicts, such as an unexpected mobility deployment or other major event, this process requires about two weeks to complete. The first thing to establish is a decision analysis team. This team generally consists of a decision maker, a representative from each of the career fields impacted by the potential reorganization, a decision analyst, and an assistant. It is critical to maintain the integrity of the team to ensure that the information gathered in each step remains consistent. The teams established for each case study are displayed at the beginning of Appendices B and C.

Once the team is established, the decision maker and analysts establish a schedule for completing each step in the process. Typically, a few, two to three hour, blocks of time are required from each career field representative and periodically the entire team will meet during one of the blocks of time. It is a good idea, and generally requested by the decision maker, to have a short meeting with the decision maker at the end of each day. The purpose of this meeting is to review any unusual data collected during the day, to discuss how current progress is meeting the schedule, and to discuss any problems that may have arisen during the day. During these meetings and interviews, the assistant takes notes or operates computer software which allows the analyst to interact more efficiently with the team members.

Final Products. At the end of the decision analysis process there are two final products. The first is a briefing, or set of briefings, during which the decision analyst presents findings and insights gained to the decision maker and the decision analysis team. The second product is a written report that contains the information provided during the briefings, a basic description of the methodology used to develop the decision support model, and the raw data supplied to the model.

Appendices B and C are two examples of a written report provided at the conclusion of an analysis. These reports are from distinctly different bases with different missions, geographic layout, size, etc. Wright-Patterson AFB is a large base within the Air Force Materiel Command, while Little Rock AFB is much smaller and is part of the Air Education and Training Command. In spite of these differences, the methodology used to conduct this decision analysis was identical. The robustness of this methodology along with its other advantages and disadvantages are discussed in the next chapter.

IV Discussion

Overview

Civil engineer units across the Air Force are extremely diverse. The various geographic layouts of the bases, the wide range of base size and manning situations, and the distinct missions of each location are just a few of the diversities that preclude the implementation of a single organizational strategy that fits the needs of each unit's operations flight. As a result, each civil engineer unit is faced with determining the most effective way to organize their respective operations flights below the element level. To aid in making this determination, this researched focused on the following two questions:

1. What are the important factors in deciding how to organize a civil engineer operations flight?

2. How can various organization strategy options (zonal maintenance, shop configuration, or a combination) be evaluated to facilitate a decision?

The ultimate goal of this research was to provide a methodology for evaluating operations flight organizational structures to aid in the selection of one that maximizes the flight's goals and objectives. The methodology developed through this effort is discussed in this chapter.

Why Decision Analysis

The obvious reason for applying decision analysis to this problem is that careful applications of decision analysis techniques can lead to better decisions. Granted, other tools can lead to better decisions but decision analysis is most applicable to this particular decision context. Another tool considered for the methodology was system dynamics modeling; however, it was not as applicable to this problem as decision analysis techniques. System dynamics facilitates good decisions by looking at the long term trends resulting from decisions and helping the decision maker understand how their system works. Given the constant flux of the Air Force personnel, mission, and budget impacts on operations flight, this long term view is not as practical. The value focused decision from decision analysis is better suited than the long term outlook decision that would come from the employment of system dynamics.

Methodology Advantages

The fact that the methodology remains unchanged from its use during the Wright-Patterson AFB case study, Appendix B, to its use during the Little Rock AFB case study, Appendix C lends evidence to its robust nature. These two bases are from different commands and have significantly different sizes and geographic layouts. The methodology, proposed and tested, has a degree of flexibility which allows each base to customize their decision model to fit their unit's unique requirements. For example, Little Rock AFB added two values to the value hierarchy and one additional career field to the analysis team. These changes reflected their slightly different value system and their desire for the force management career field to provide input into the decision. The changes were easily accommodated since they only expanded the size of the model and not the methodology by which it was built.

Other than its robustness and flexibility, an important advantage of this methodology is its ability to get involvement from all levels of the operations flight. The craftsmen from each career field impacted by a potential reorganization provide important data during construction of the decision support model. Their active involvement in the decision process breaks down the traditional barriers between management and the workforce. The teamwork resulting from this methodology improves the chances of a decision being made that is supported by the entire flight. During the Little Rock AFB case study, the local civilian union sent a representative to several of the meetings. They were able to voice the fears of the civilian workforce (job loss, position downgrades) and to get first hand information about the process. Their involvement significantly reduced the "fear of the unknown" and kept the inevitable rumor mill from being counterproductive.

The methodology employed most frequently by civil engineer units investigating a possible reorganization is to assign a team to look into the issues and provide a recommendation to the Flight Chief or Base Civil Engineer. These teams typically focus on a handful of organizational strategy alternatives fall into an unproductive debate about the pros and cons of each but never establish a uniform way of comparing them to each other. The result is often a recommendation that is at best not unanimously accepted by the team and at worst is hotly contested. The methodology developed in this research focuses on the values and objectives of the flight and uses those to evaluate the alternatives. This helps reduce the tendency to plunge into a "Shops vs. Zones" debate by providing a methodical, value focused, process for developing and evaluating alternatives.

The fact that this methodology is fast and economical is perhaps its most appealing advantage. The process requires less than two weeks to complete and can be done without any significant disruption of day-to-day operations. A minimal manpower expense is attributed to a series of 2 to 3 hour meetings which can be scheduled to minimize the impact on the daily mission requirements of the flight. The travel expenses of the decision analyst are the only other expense of this methodology if the analyst is a military member or student working on research for a thesis or dissertation. If a private decision analyst is contracted, their consultant fee would naturally add to the cost of the decision analysis.

Methodology Disadvantages

The need for someone versed in decision analysis techniques is perhaps the most significant disadvantage of this methodology. A perfect methodology would entail a simple set of instructions that could be reproduced by anyone of reasonable intelligence; however this is not the case here. A decision analyst with at least rudimentary skills in decision analysis techniques is required. The decision analysis techniques and the underlying methodology are easily reproducible by different decision analysts; however, the accuracy of the final results are dependant on the skill of the analyst. For example, if a decision analyst does not understand a technique or lacks good communication skills, the accuracy and applicability of the data collected for analysis is reduced.

Given the limited amount of time to collect the data during the case studies, much of the information was collected using direct assessments. Although direct assessment conserves time, it does not reduce the impact of certain biases. There are several more advanced decision analysis techniques to extract data from experts that are less subjective and less susceptible to biases. The use of more advanced techniques should be limited to those that do not add undue complexity to the methodology. A methodology that utilizes the most advanced and academically current decision analysis techniques, but is difficult for a decision maker to understand, will not be trusted. It is not likely that the results from such a decision model will lead to any action by the decision maker.

It is important to emphasize at this point that this methodology is not a magic "black box" into which one pours data and extracts the one perfect solution. It is simply a tool the decision maker can use to gain insight into this complex decision situation and to methodically step through the problem.

Future Research and Applications

Decision analysis techniques can be applied to a wide variety of decision problems in civil engineering, the Air Force, the Department of Defense, and elsewhere. Construction of a methodology from these techniques that simplifies a decision situation can lead to numerous research efforts.

Given the fact that numerous civil engineer units are facing the same decision situation and the methodology developed during this research can be employed quickly and economically, it may prove beneficial to package this capability and send it to the field. This could be accomplished by establishing a two person analysis team, making Base Civil Engineers aware of this capability, and sending the team to those bases interested in applying the methodology.

Appendix A: Survey Questions

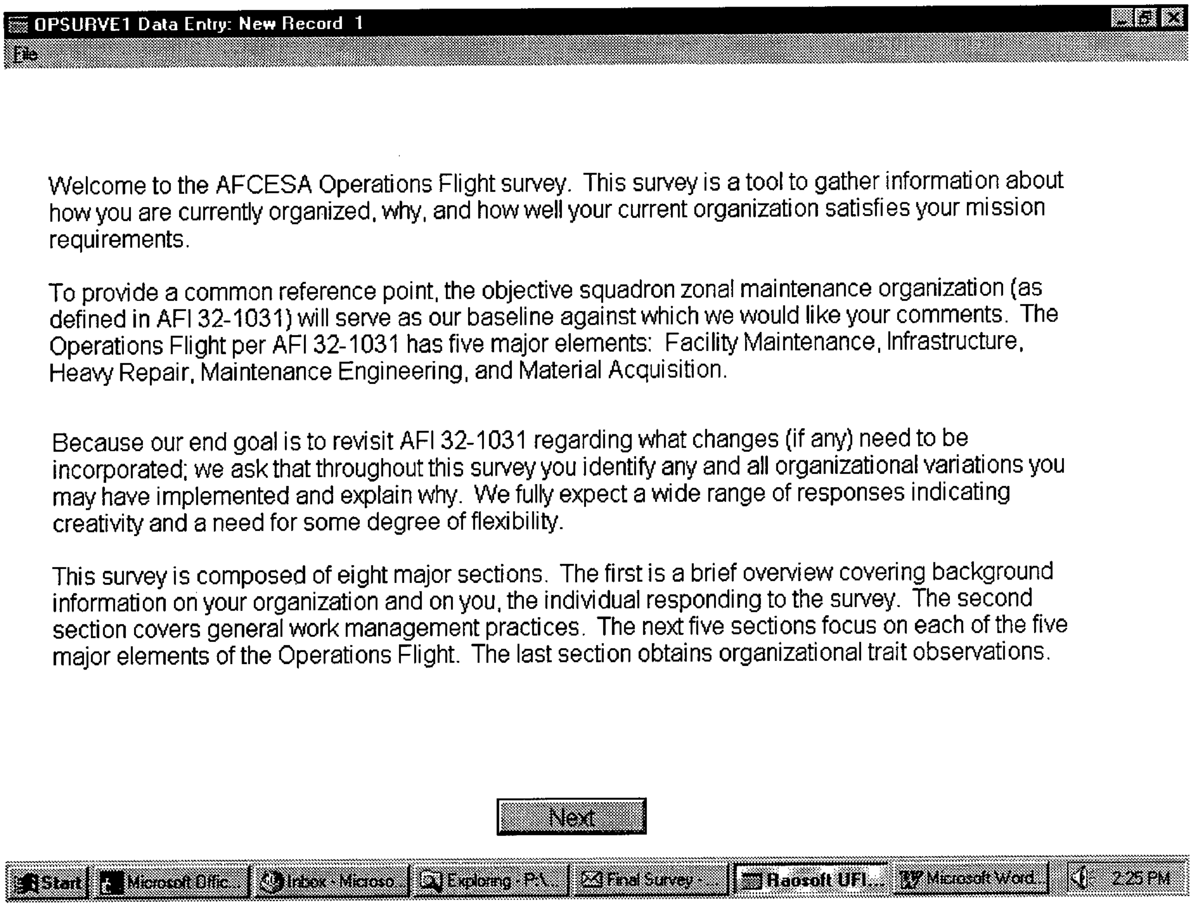
Introduction

The Air Force Civil Engineer Support Agency constructed a survey to be completed by civil engineer units Air Force-wide. The purpose of this survey was to gather information concerning how the units were organized and how that organization was supporting the overall Air Force mission. The survey was distributed electronically and the computer screens containing the questions are provided in this appendix.

To gain insight into the values and objectives used by the career field to evaluate their operations flight organization, the comments provided in response to the last section of the survey were studied. Much of the value hierarchy construction, done during the Wright-Patterson AFB case study (Appendix B), was based on these comments. A sampling of the comments is provided in this appendix following the computer survey screens.

Additional information concerning this survey and the report compiled for the Air Force Civil Engineer, Major General Lupia, can be obtained from AFCESA at Tyndall AFB, Florida.

AFCESA Computer Survey Screens



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All major installations will be surveyed regardless of the status of completed or ongoing A-76 outsourcing initiatives. We ask that you respond to this survey by comparing your current organizational structure to our baseline. We intend to perform some field visits following our analysis of the collected data and a MAJCOM workshop will likely be held in April 98 to look at the results and help determine how the AFI might be best developed to meet the Air Force's needs.

This survey has been designed to be as easy to use as possible incorporating drop down selections, answer buttons, and short fill in the blank areas to provide more detailed information. In addition to the "Next" and "Previous" buttons, you may navigate with the Page Up/Down keys. Using a mouse is the best way to move within a page by clicking on a box to enter text or clicking on a provided response. We feel we have struck a good balance between getting detailed and accurate information and ease of use for you, the survey participant. If you find a question unclear or are uncertain how to apply in your organizational situation, please contact either person listed below.

LTC Bryan Muller, HQ AFCESA/CEOM, DSN 523-6363, mullerb@afcesa.af.mil
Mr Andy Jackson, HQ AFCESA/CEOM, DSN 523-6401, jacksona@afcesa.af.mil

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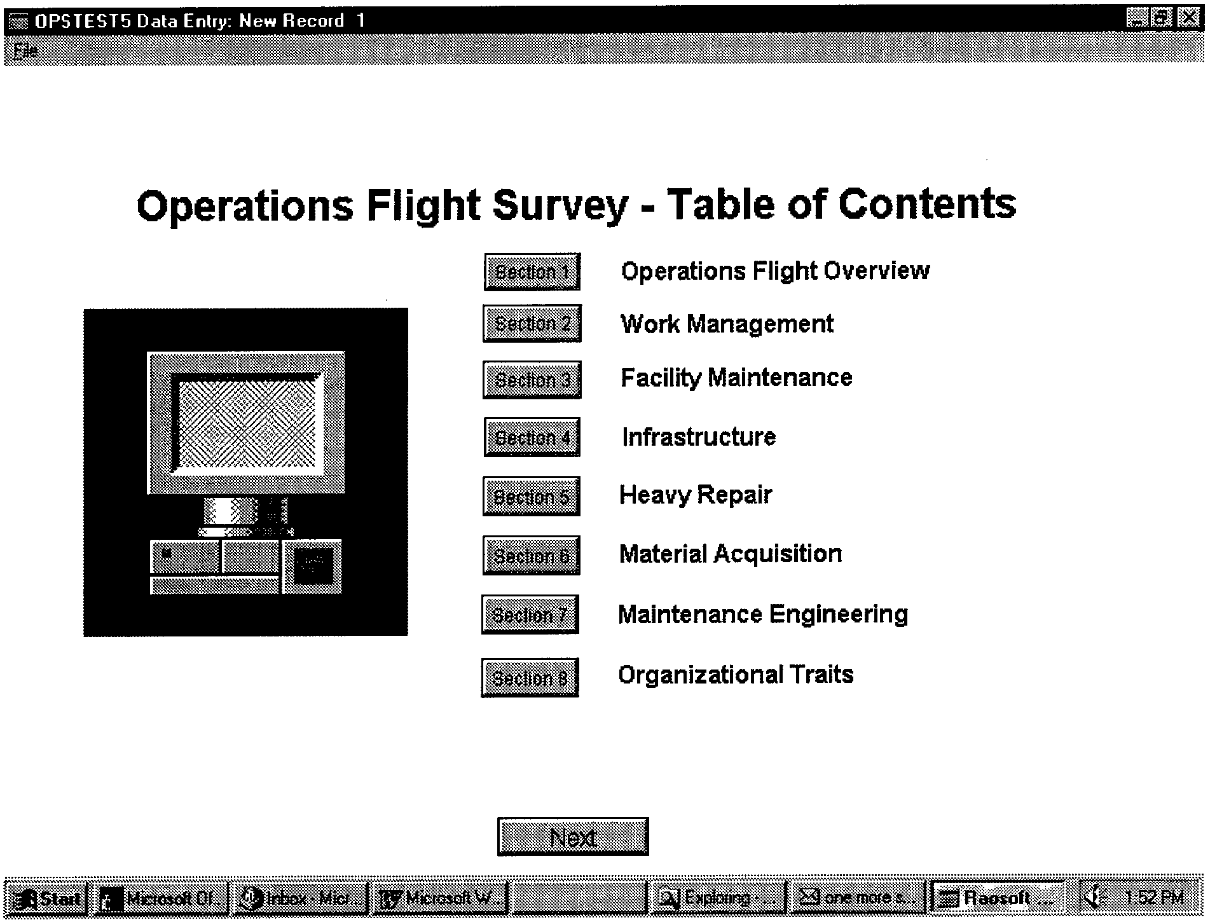
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Operations Flight Survey - Table of Contents
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Operations Flight Overview
Section 2
Work Management
Section 3
Facility Maintenance
Section 4
Infrastructure
Section 5
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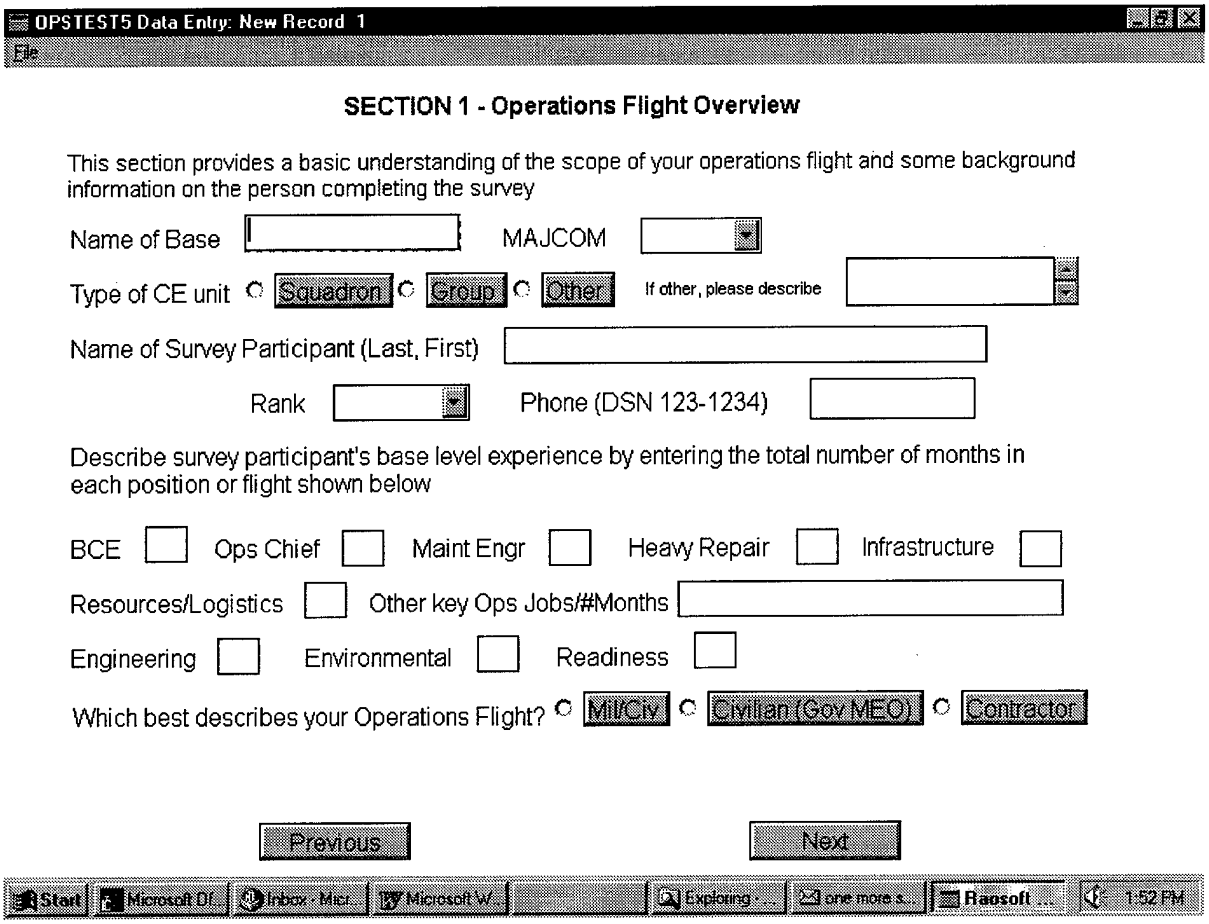
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SECTION 1 - Operations Flight Overview

This section provides a basic understanding of the scope of your operations flight and some background information on the person completing the survey

Name of Base [ ] MAJCOM [ ]

Type of CE unit ○ Squadron ○ Group ○ Other If other, please describe [ ]

Name of Survey Participant (Last, First) [ ]

Rank [ ] Phone (DSN 123-1234) [ ]

Describe survey participant's base level experience by entering the total number of months in each position or flight shown below

BCE [ ] Ops Chief [ ] Maint Engr [ ] Heavy Repair [ ] Infrastructure [ ]

Resources/Logistics [ ] Other key Ops Jobs/#Months [ ]

Engineering [ ] Environmental [ ] Readiness [ ]

Which best describes your Operations Flight? ○ Mil/Civ ○ Civilian (Gov MEO) ○ Contractor

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SECTION 1 - Operations Flight Overview

What is your total Operations flight manpower authorization for FY 97/4? Mil [ ] Civ [ ]

How many are assigned? Mil [ ] Civ [ ]

How many overhires/temporary/seasonal positions do you hire annually? [ ]

Is your budget authority decentralized, e.g. can sections beneath the flight chief approve their daily Operations and Maintenance expenses? ○ Yes ○ No

How many large (typically over 50-hours), multi-craft planned Work Orders (W/Os) are accomplished in-house each year? [ ]

How many Direct Scheduled Work (DSW) orders are accomplished each year? [ ]

AFI 32-1031 defines three classes of DSW: Emergency, Urgent, and Routine. Are there any classes of DSW you no longer use? ☐ Emergency ☐ Urgent ☐ Routine

If so, why? [ ]

What is the total facility square footage maintained by the flight? [ ] 000 square feet

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SECTION 2 - Work Management

This section examines your basic work management practices. The zonal model calls for each zone to have a Customer Service Unit (CSU) as the single focal point for customers to contact civil engineering with work requirements. Facility Maintenance, Heavy Repair and Infrastructure elements also normally have dedicated controllers who manage the element labor inputs and other WIMS and administrative tasks. Management of ongoing programs like Recurring Work Program (RWP), In-service Work Plan (IWP), W/O Approval Panels, and Facility Manager Program often fall to common sections within the model flight.

Do you use the CSU concept? ○ Yes ○ No If no, explain [ ]

Do you have a centralized CSU for the flight? ○ Yes ○ No

Do you have a centralized CSU for the facility maintenance element? ○ Yes ○ No

Do you have a CSU at each zone? ○ Yes ○ No

Where are after duty hours service calls received? ○ EMCS ○ CEF ○ Other Where? [ ]

Where do you have controllers? ☐ Maint Engr ☐ Heavy Repair ☐ Infrastructure ☐ Central CSU

☐ Don't Use Controllers Explain [ ]

Check all that apply.
Our controllers: ☐ Manage Labor Reporting ☐ Close Out W/Os ☐ Regularly Deal w/Customers

☐ Perform Material/Supply Duties ☐ Perform Additional Duties (safety, VCO, etc)

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SECTION 2 - Work Management

Is there an overall flight RWP? ○ Yes ○ No Is WIMS used? ○ Yes ○ No

Who produces/updates RWP schedule? ○ Work Centers ○ Central POC Where is POC? [ ]

Is there an overall flight IWP? ○ Yes ○ No Is WIMS used? ○ Yes ○ No

Who produces/updates IWP schedule? ○ Work Centers ○ Central POC Where is POC? [ ]

A Work Request Review Board (WRRB) is typically a panel composed of cross flight representatives, possibly cross base, to review work requests, validate, and assign appropriate methods of execution.

Do you have a WRRB type panel? ○ Yes ○ No Frequency [ ]

Who Chairs? [ ] Who Administers (agenda, records, meeting logisitics)? [ ]

Do you perform initial (shotgun) estimates of new W/Os? ○ Yes ○ No

If you have an allocation/priority system, describe how you "fair share" your limited resources (manpower/funds) among customers [ ]

Is there a specific wing commander allocation, e.g. special interest? ○ Yes ○ No

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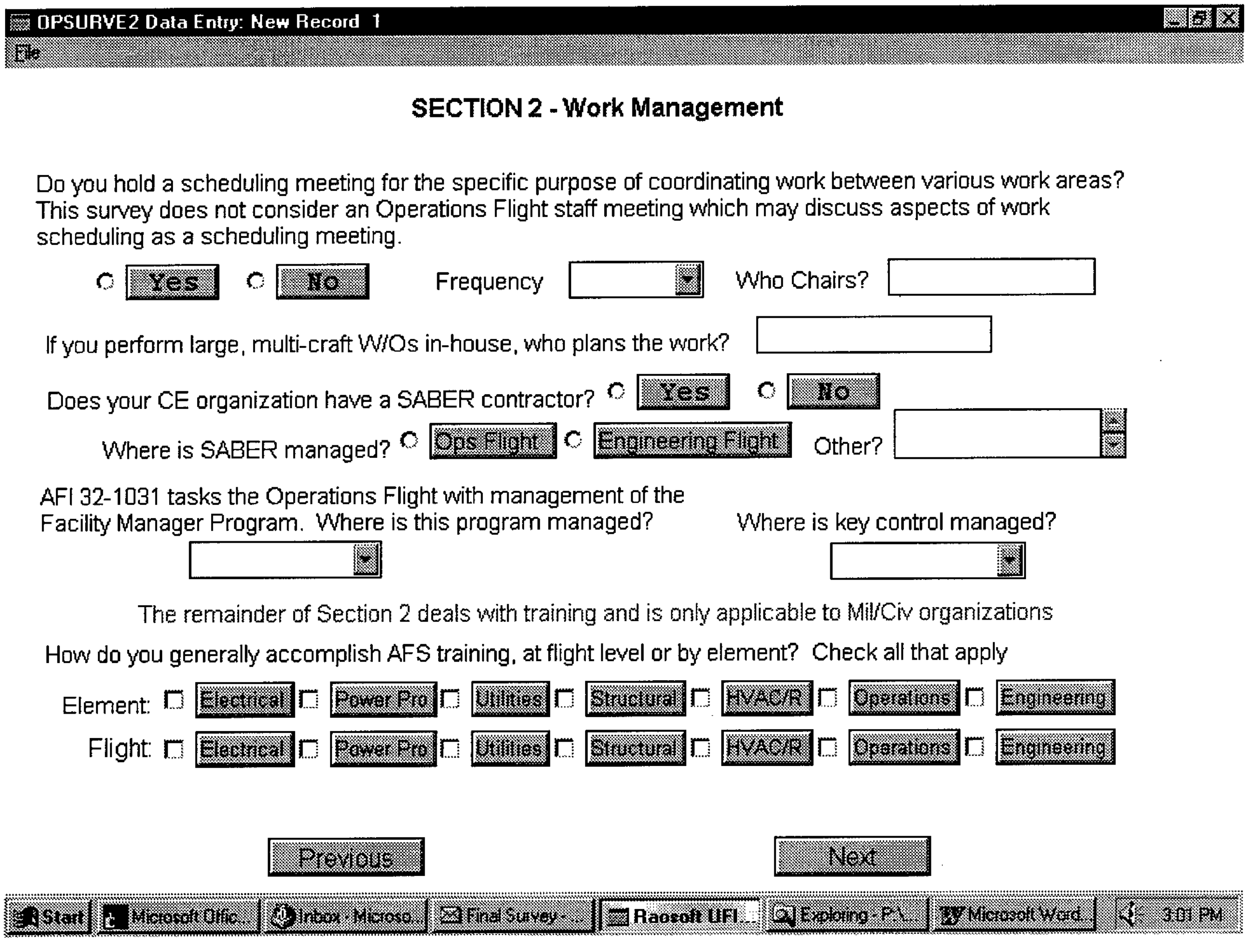
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SECTION 2 - Work Management

Do you hold a scheduling meeting for the specific purpose of coordinating work between various work areas? This survey does not consider an Operations Flight staff meeting which may discuss aspects of work scheduling as a scheduling meeting.

○ Yes ○ No Frequency [ ] Who Chairs? [ ]

If you perform large, multi-craft W/Os in-house, who plans the work? [ ]

Does your CE organization have a SABER contractor? ○ Yes ○ No

Where is SABER managed? ○ Ops Flight ○ Engineering Flight Other? [ ]

AFI 32-1031 tasks the Operations Flight with management of the Facility Manager Program. Where is this program managed? [ ]

Where is key control managed? [ ]

The remainder of Section 2 deals with training and is only applicable to Mil/Civ organizations

How do you generally accomplish AFS training, at flight level or by element? Check all that apply

Element: ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R ☐ Operations ☐ Engineering

Flight: ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R ☐ Operations ☐ Engineering

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SECTION 2 - Work Management

Identify where the task certifier(s) is located. Check all that apply

Element: ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R ☐ Operations ☐ Engineering

Flight: ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R ☐ Operations ☐ Engineering

Does the Operations Flight, as a whole, have a dedicated flight training time? ○ Yes ○ No

Frequency? [ ] Approximate number of hours per training session? [ ]

Complete using FY97 data

	# Passed 1st CDC Test	# Failed 1st CDC Test
Electrical		
Power Pro		
Utilities		
Structural		
HVAC/R		
Operations		
Engineering		

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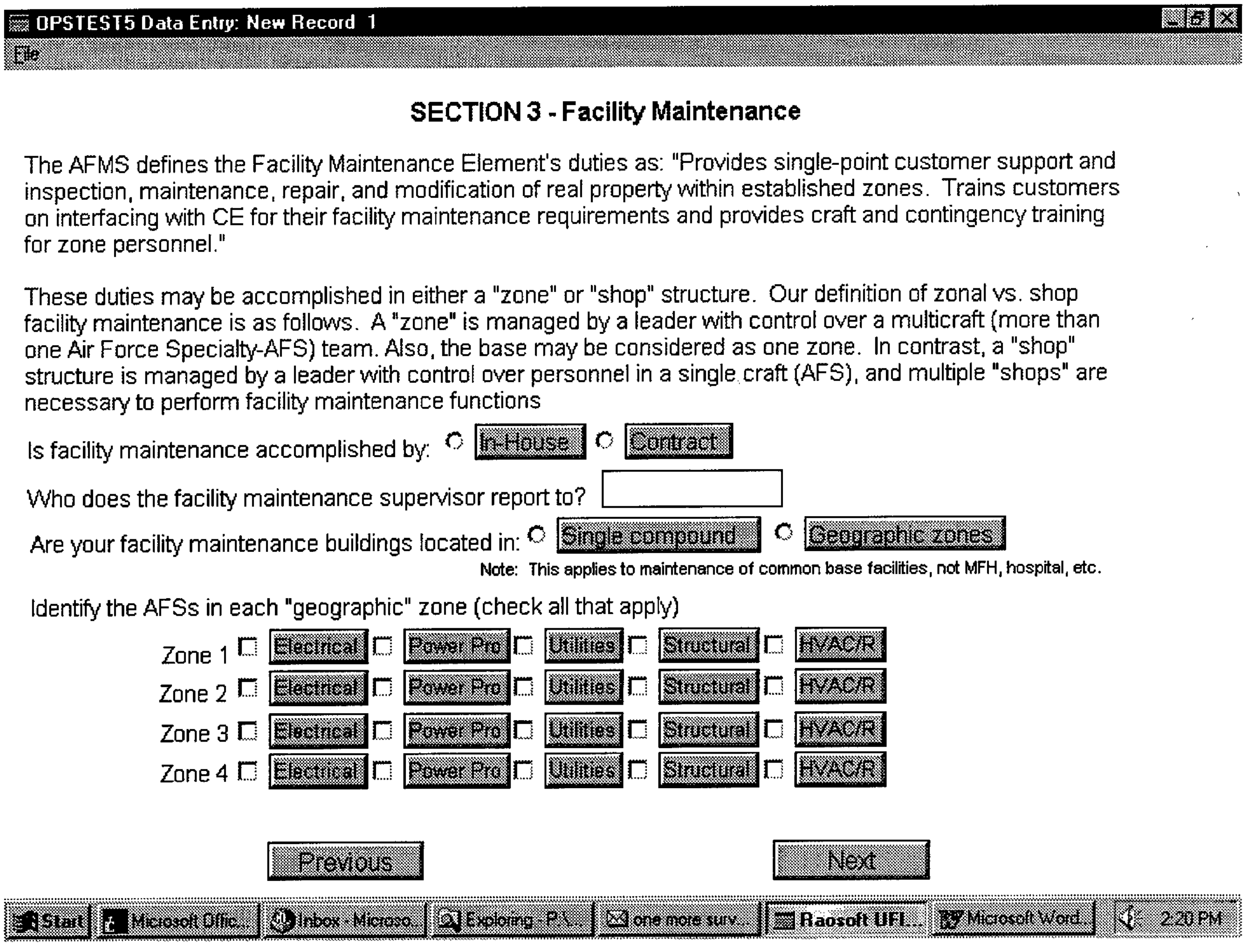

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SECTION 3 - Facility Maintenance

The AFMS defines the Facility Maintenance Element's duties as: "Provides single-point customer support and inspection, maintenance, repair, and modification of real property within established zones. Trains customers on interfacing with CE for their facility maintenance requirements and provides craft and contingency training for zone personnel."

These duties may be accomplished in either a "zone" or "shop" structure. Our definition of zonal vs. shop facility maintenance is as follows. A "zone" is managed by a leader with control over a multicraft (more than one Air Force Specialty-AFS) team. Also, the base may be considered as one zone. In contrast, a "shop" structure is managed by a leader with control over personnel in a single craft (AFS), and multiple "shops" are necessary to perform facility maintenance functions

Is facility maintenance accomplished by: ○ In-House ○ Contract

Who does the facility maintenance supervisor report to? [ ]

Are your facility maintenance buildings located in: ○ Single compound ○ Geographic zones

Note: This applies to maintenance of common base facilities, not MFH, hospital, etc.

Identify the AFSs in each "geographic" zone (check all that apply)

Zone 1 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Zone 2 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Zone 3 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Zone 4 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

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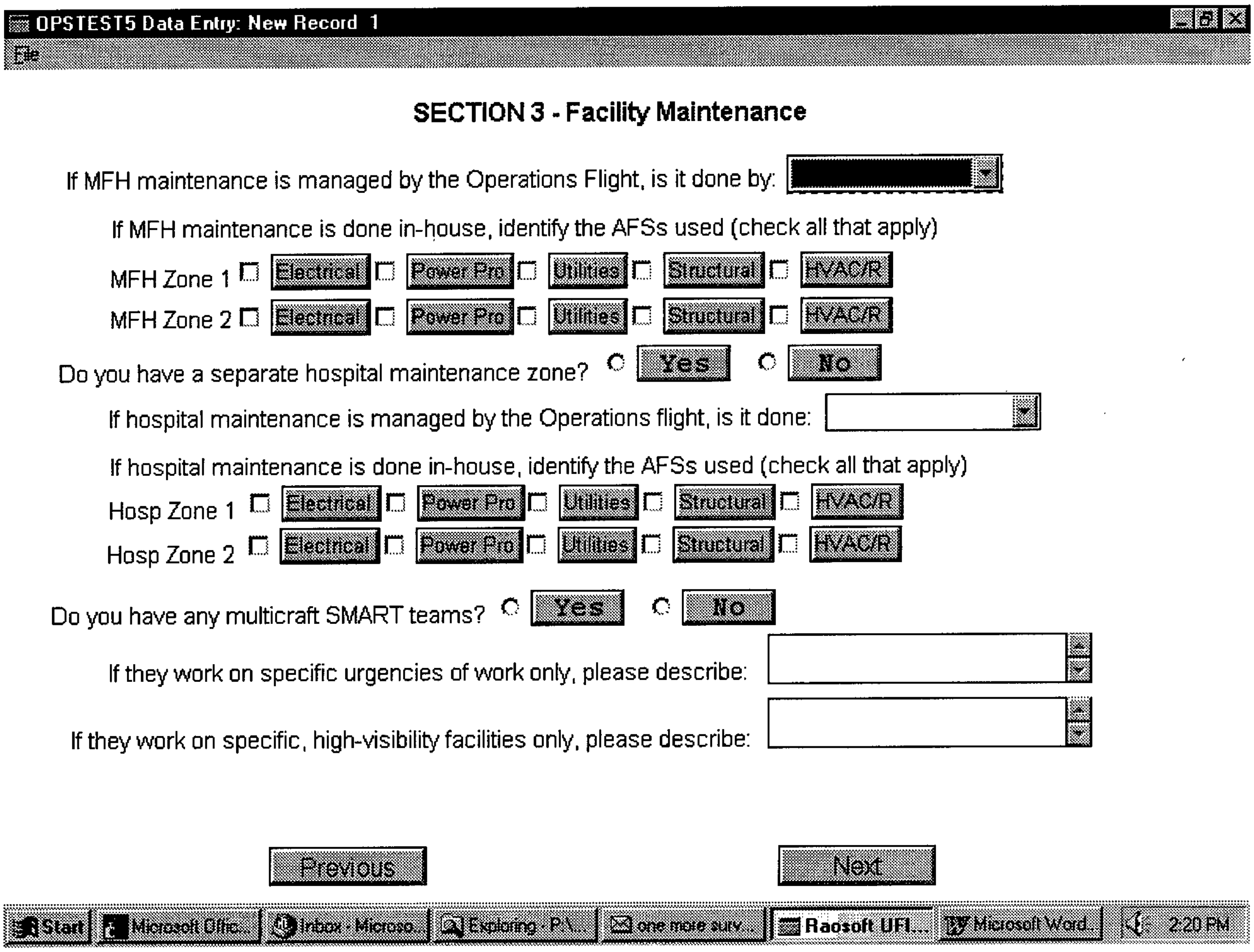

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SECTION 3 - Facility Maintenance

If MFH maintenance is managed by the Operations Flight, is it done by:

If MFH maintenance is done in-house, identify the AFSs used (check all that apply)

MFH Zone 1 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

MFH Zone 2 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Do you have a separate hospital maintenance zone? ○ Yes ○ No

If hospital maintenance is managed by the Operations flight, is it done:

If hospital maintenance is done in-house, identify the AFSs used (check all that apply)

Hosp Zone 1 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Hosp Zone 2 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Do you have any multicraft SMART teams? ○ Yes ○ No

If they work on specific urgencies of work only, please describe:

If they work on specific, high-visibility facilities only, please describe:

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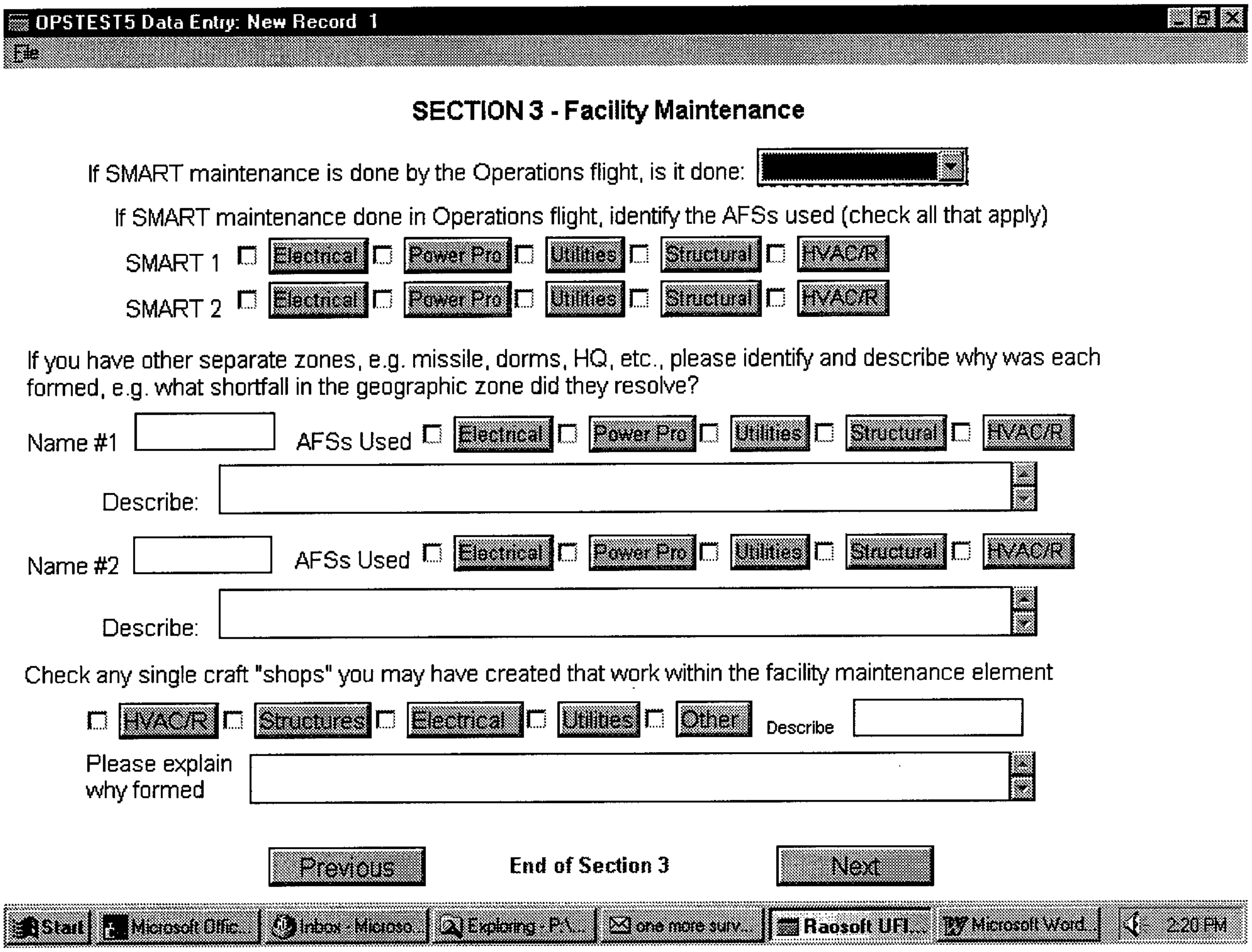
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SECTION 3 - Facility Maintenance

If SMART maintenance is done by the Operations flight, is it done:

If SMART maintenance done in Operations flight, identify the AFSs used (check all that apply)

SMART 1 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

SMART 2 ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

If you have other separate zones, e.g. missile, dorms, HQ, etc., please identify and describe why was each formed, e.g. what shortfall in the geographic zone did they resolve?

Name #1 ____ AFSs Used ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Describe: ____

Name #2 ____ AFSs Used ☐ Electrical ☐ Power Pro ☐ Utilities ☐ Structural ☐ HVAC/R

Describe: ____

Check any single craft "shops" you may have created that work within the facility maintenance element

☐ HVAC/R ☐ Structures ☐ Electrical ☐ Utilities ☐ Other Describe ____

Please explain why formed ____

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SECTION 4 - Infrastructure Support Element

The AFMS defines the Infrastructure Support Element's duties as: "Maintains aircraft arresting, exterior electrical, airfield lighting, alarm, sewage collection, water distribution, natural gas distribution, liquid fuel, grounding and cathodic protection, and generator systems."

Do you have an Infrastructure support element? ○ Yes ○ No

If not, how are duties performed?

Who does the Infrastructure Support supervisor report to?

Check the Infrastructure Support duties that are performed and whether each duty is performed in-house or by contract. If not performed in this element, explain where each duty is accomplished and why. If you accomplish major duties not listed, describe under "Other"

	In Infrastructure		Not in Infrastructure	
Aircraft Arresting Systems		Where?		Why?
Generators		Where?		Why?
Water Distr Systems		Where?		Why?
Waste Water Distr Systems		Where?		Why?

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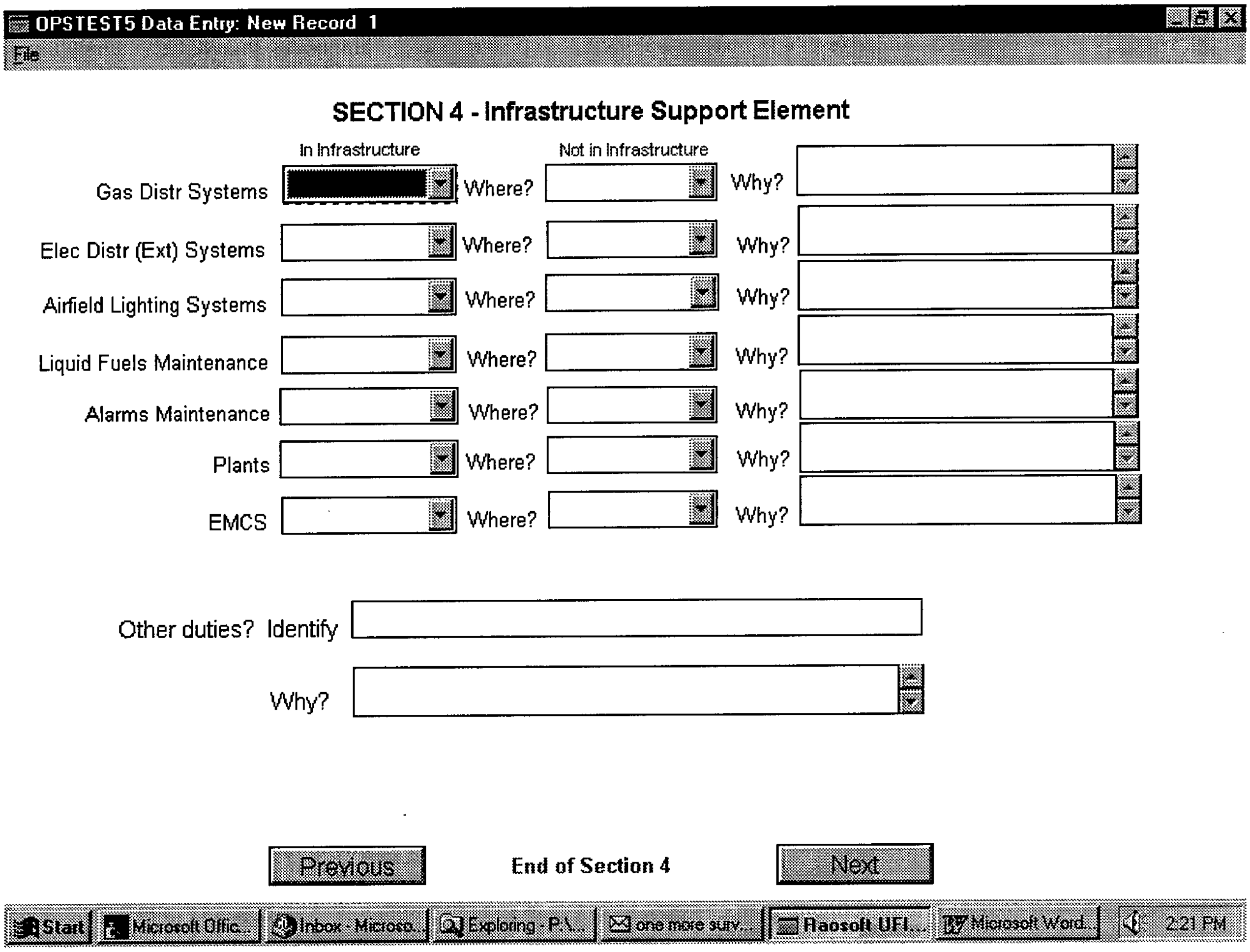
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SECTION 4 - Infrastructure Support Element
In Infrastructure
Not in Infrastructure
Gas Distr Systems
Where?
Why?
Elec Distr (Ext) Systems
Where?
Why?
Airfield Lighting Systems
Where?
Why?
Liquid Fuels Maintenance
Where?
Why?
Alarms Maintenance
Where?
Why?
Plants
Where?
Why?
EMCS
Where?
Why?
Other duties? Identify
Why?
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SECTION 5 - Heavy Repair Element

The AFMS defines the Heavy Repair element's duties as: "Accomplishes the majority of in-house large and multicraft work orders and all pavement and equipment work. Includes facility renovation and maintenance alteration projects. Includes all pavements, airfields, roads and sidewalks, sweeping, entomology, and equipment operation and repair."

Do you have a Heavy Repair Element? ○ Yes ○ No

If not, how are duties performed? [ ]

Who does the Heavy Repair supervisor report to? [ ]

Check the Heavy Repair duties that are performed and whether each duty is performed in-house or by contract. If not performed in this element, explain where each duty is accomplished and why. If you accomplish major duties not listed, describe under "Other"

	In Heavy Repair		Not in Heavy Repair	
Horizontal Section	[ ]	Where?	[ ]	Why? [ ]
Vertical Section	[ ]	Where?	[ ]	Why? [ ]
Pest Management	[ ]	Where?	[ ]	Why? [ ]
Grounds Maintenance	[ ]	Where?	[ ]	Why? [ ]
Locksmith Services	[ ]	Where?	[ ]	Why? [ ]

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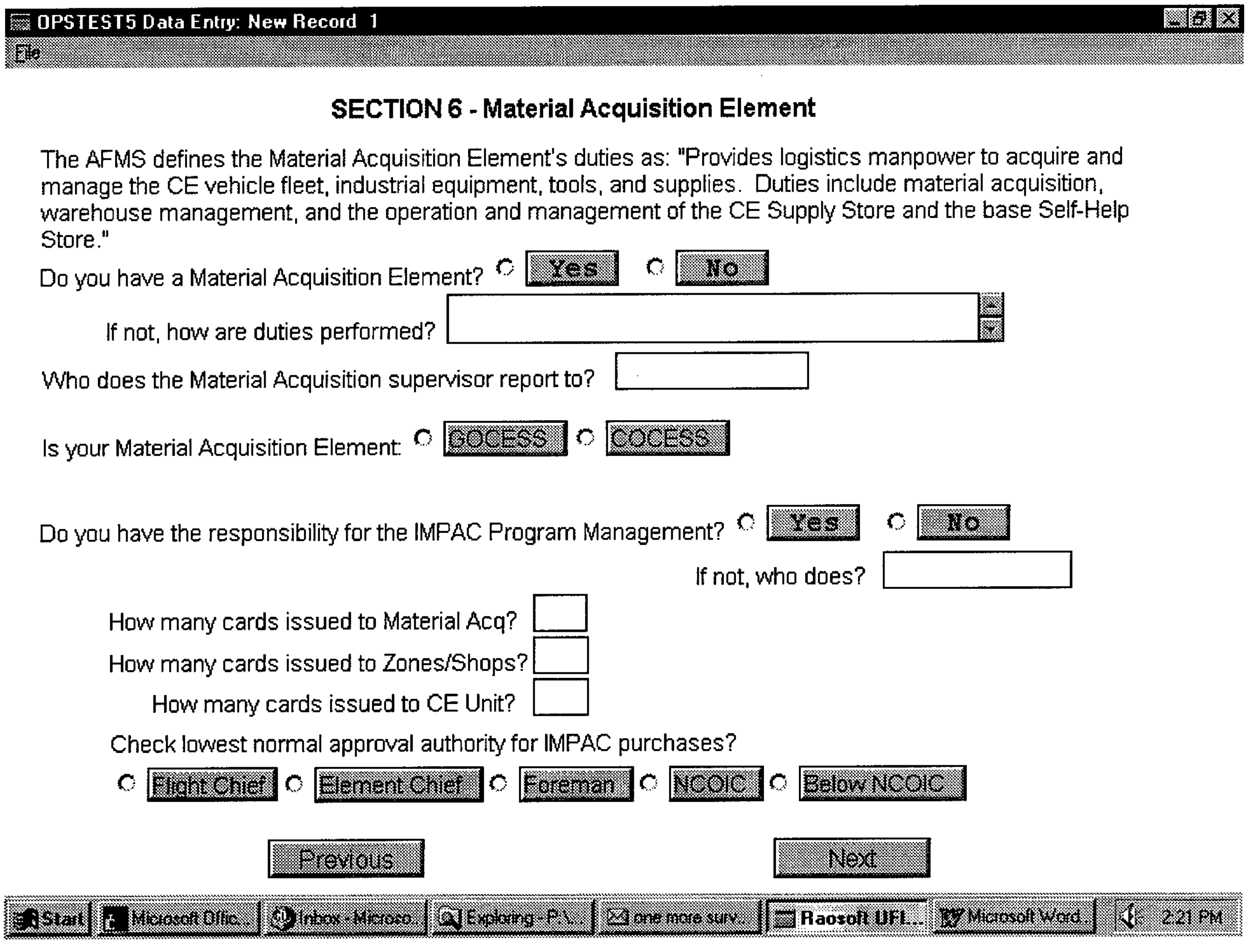

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SECTION 6 - Material Acquisition Element

The AFMS defines the Material Acquisition Element's duties as: "Provides logistics manpower to acquire and manage the CE vehicle fleet, industrial equipment, tools, and supplies. Duties include material acquisition, warehouse management, and the operation and management of the CE Supply Store and the base Self-Help Store."

Do you have a Material Acquisition Element? ○ Yes ○ No

If not, how are duties performed? [ ]

Who does the Material Acquisition supervisor report to? [ ]

Is your Material Acquisition Element ○ GOCESS ○ COCESS

Do you have the responsibility for the IMPAC Program Management? ○ Yes ○ No

If not, who does? [ ]

How many cards issued to Material Acq? [ ]

How many cards issued to Zones/Shops? [ ]

How many cards issued to CE Unit? [ ]

Check lowest normal approval authority for IMPAC purchases?

○ Flight Chief ○ Element Chief ○ Foreman ○ NCOIC ○ Below NCOIC

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SECTION 6 - Material Acquisition Element

Check the Material Acquisition duties that are performed and whether each duty is performed in-house or by contract. If not performed or performed in another location, explain why and identify the flight/element where each duty is accomplished. If you accomplish other major duties not listed, describe under "Other"

	In Material Acq		Not in Material Acq	
Vehicle NCO		Where?		Why?
Appliance Management		Where?		Why?
Self-Help		Where?		Why?

Other duties? Identify

Why?

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SECTION 7 - Maintenance Engineering Element

The AFMS defines the Maintenance Engineering Element's duties as: "Provides engineering expertise for the Operations Flight, support of infrastructure/facility project review, program management, nondesign drafting, service and utility contract management, and work analysis/methods improvement."

Do you have a Maintenance Engineering element? ○ Yes ○ No

If not, how are duties performed?

Who does the Maintenance Engineering supervisor report to?

Are you using the Maintenance Engineering EPSS? ○ Yes ○ No

Check the Maintenance Engineering duties that are performed and whether the duty is performed in-house or by contract. If not performed or performed in another location, explain why and identify the flight/element where the duty is accomplished. If you accomplish major duties not listed, describe under "Other"

	In Maint Engr		Not in Maint Engr		
Infrastructure Programs		Where?		Why?	
Warranty Programs		Where?		Why?	
Project Design Review		Where?		Why?	

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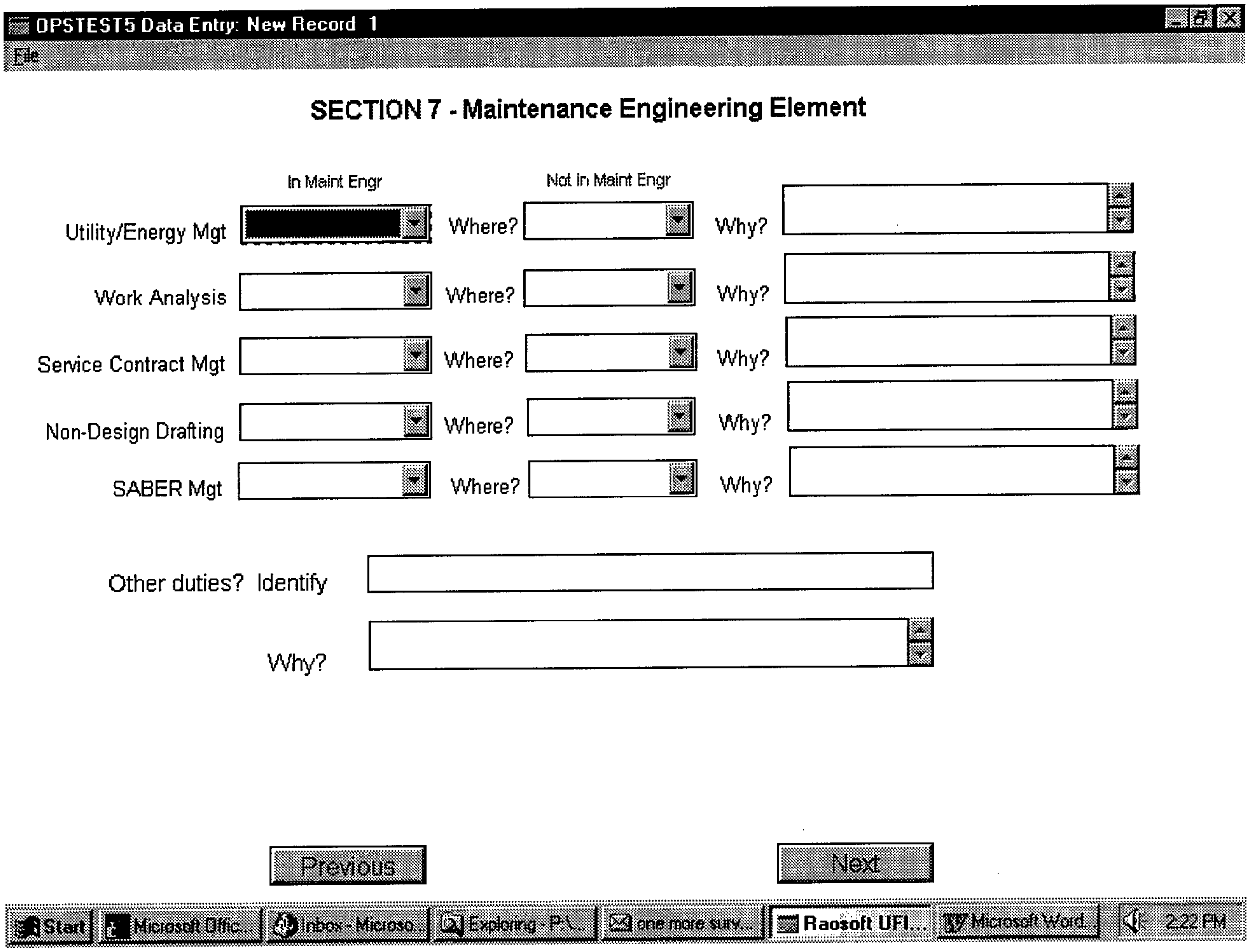
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SECTION 7 - Maintenance Engineering Element
In Maint Engr
Not in Maint Engr
Utility/Energy Mgt
Where?
Why?
Work Analysis
Where?
Why?
Service Contract Mgt
Where?
Why?
Non-Design Drafting
Where?
Why?
SABER Mgt
Where?
Why?
Other duties? Identify
Why?
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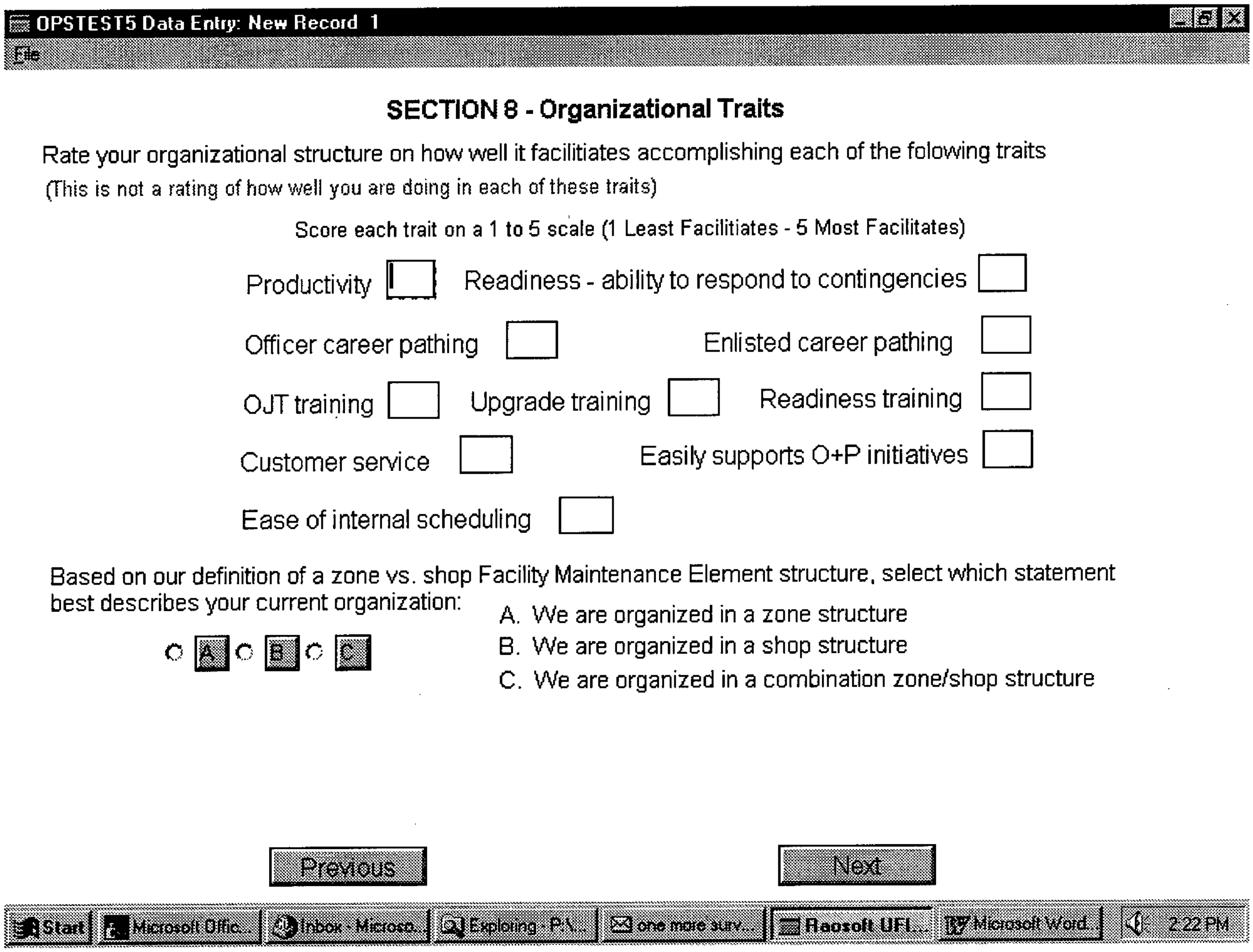
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SECTION 8 - Organizational Traits
Rate your organizational structure on how well it facilitiates accomplishing each of the folowing traits
(This is not a rating of how well you are doing in each of these traits)
Score each trait on a 1 to 5 scale (1 Least Facilitiates - 5 Most Facilitates)
Productivity
Readiness - ability to respond to contingencies
Officer career pathing
Enlisted career pathing
OJT training
Upgrade training
Readiness training
Customer service
Easily supports O+P initiatives
Ease of internal scheduling
Based on our definition of a zone vs. shop Facility Maintenance Element structure, select which statement best describes your current organization:
A
B
C
A. We are organized in a zone structure
B. We are organized in a shop structure
C. We are organized in a combination zone/shop structure
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SECTION 8 - Organizational Traits

If you could select any organizational structure, which structure would you select and why?

Please provide AFCESA an organizational chart of your CE unit. As a minimum, the chart should show all the flights, and the Operations Flight elements and sub-elements/functions. If possible, prepare the chart in Microsoft Power Point using the organization chart tool. Send an electronic copy via e-mail to:.

mullerb@afcesa.af.mil

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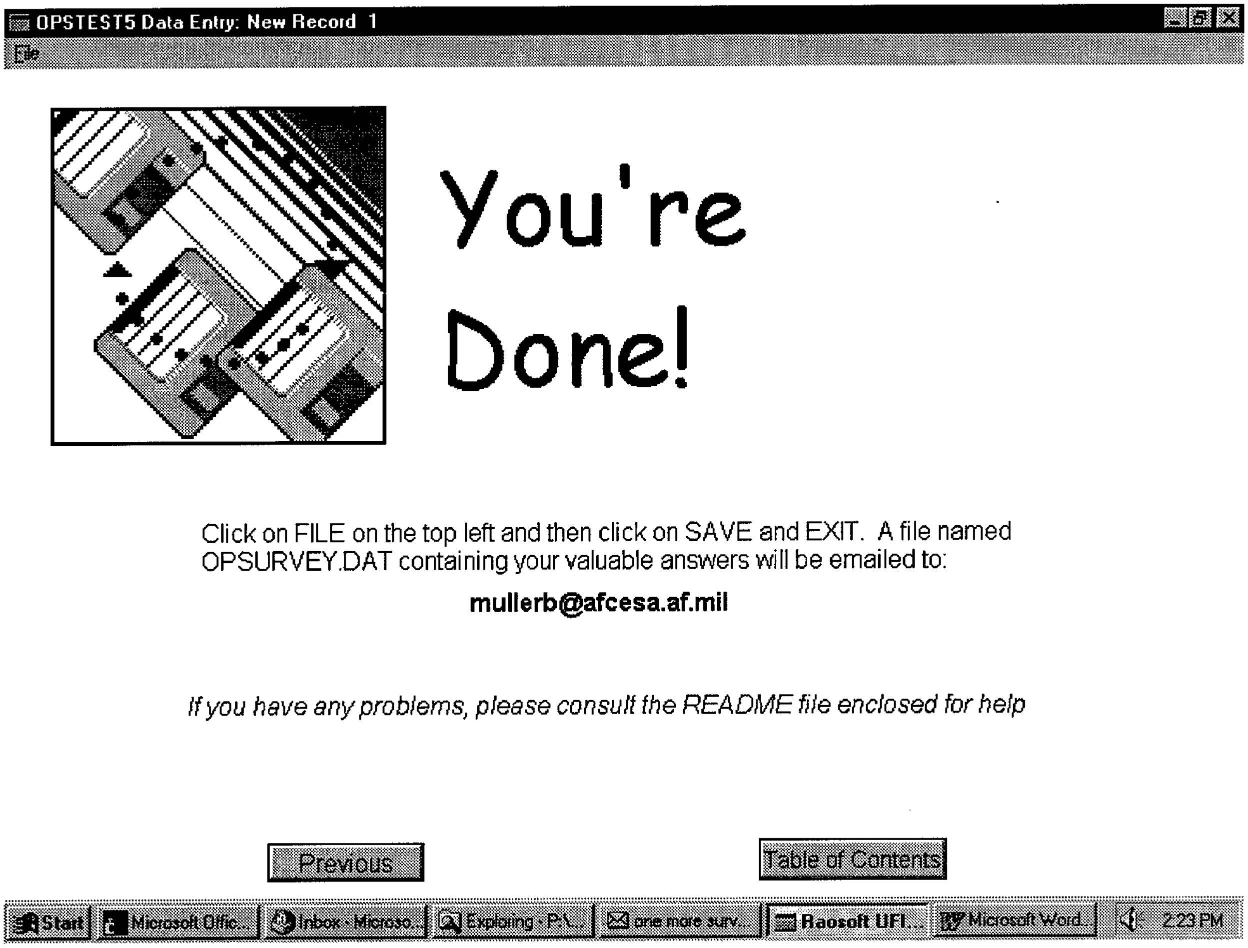
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You're Done!
Click on FILE on the top left and then click on SAVE and EXIT. A file named OPSURVEY.DAT containing your valuable answers will be emailed to:
mullerb@afcesa.af.mil
If you have any problems, please consult the README file enclosed for help
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Organizational Structure Comments

Comments concerning organizational structure from the bases were organized into three categories in the survey report: Pro Zones, Pro Shops, and Other. A sampling of each is provided below.

Pro Zones. I would select the zonal structure, because it gets the guy doing work closest to the customer where the real requirement lies. It decentralizes accountability to a low level where customers problems can be resolved quickly. It provides ownership of the system (the building) by one entity who can logically see the whole product, thus avoids local optimization. ... The zone structure forces us to be people and mission oriented (external) not internally focused on our own priorities. From a training standpoint this structure teaches us to solve problems, manage resources and be solution driven. It encourages professional excellence, teamwork, and productivity based change. ... The bureaucracy associated with central control and management as found in CE organization of old makes the internal members feel protected so they can do what they want (train, train, train,) while neglecting what the customer really wants (service, service, service). ... The notion that our readiness mission is different from our primary mission is false. We do the same things, just in a more hostile environment. Facility excellence is defined by the user.

If our primary goal is customer satisfaction, the zonal structure is best. Zones are the best way to accomplish day-to-day work. However, if we want to focus on training and building the skills necessary for war and MOOTW, the shop structure is best. As a compromise, a single zone may be the best "solution".

The one we presently have! The Zones are great due to the geographical separations between the grouping of facilities on the installation. The customers are also EXTREMELY satisfied with having one zone controller to contact versus multiple shops to determine status of work.

Pro Shops: We have just completed a "Quality" look at CEO and team and flight managers concur with a shop concept. Two major reasons dominated the "shop" consensus, CUSTOMER SUPPORT, and TRAINING. With reduction in manning, I do not have enough personnel to support multiple shops (zones). This adversely impacted the quality of service provided the customer. For instance, interior elect jobs would take an excessive amount of time (customer opinion and ours) to accomplish work due to limited personnel in each zone (2 or 3 electricians) and also delayed scheduling of work. The zones also developed a competitive nature and became focused on only "their facilities". Personnel lost sight of the big picture to support the Wing mission. The other overwhelming support for the shops was training, both specialty and readiness. The zone concept with limited manning stripped expertise from some zones, and it was extremely difficult to move personnel between zones to receive the best available training. By using shops personnel gain in the collaborative experience and knowledge of all personnel. Readiness training encountered the same problems.

Shops. The work force size was reduced making a decentralized work force ineffective. Zones were becoming one deep in specialties causing problems. Centralized shops provide improved training opportunity, mentoring by career field, overlap for leave/absences, and an improved management of workforce in conjunction with work requirements. We have seen improved morale and training since changing to shops.

In an unconstrained manpower environment, zones would be more supportive to immediate customer response. Greater interaction over a smaller geographic area would lead to better and more frequent customer interaction. However, today's manning picture is terribly constrained, due to ops tempo, manning shortages in middle skill levels, and reduced overall manpower authorizations. Today, the shop structure allows us to better control training, and makes assignments of more skilled personnel to more demanding jobs easier.

The "Shop" structure is definitely more advantageous. It allows flexibility in utilizing available resources and available manpower. It also helps cut-down on the number of required personnel. The Shop structure also is easier to manage when located at a base that for all intents and purposes is a geographical whole.

<u>Other:</u> We have recently (Dec 97) gone from two zones to a single base maintenance zone. Our recommendation would be to allow BCEs to have the flexibility to choose how to best organize the Ops Flight.

We're exploring a combination of both. We'll keep a "zone" with multiple crafts for our geographically separated sections, but may combine HVAC and Electrical forces into separate shops so we can cover the RWP better. Right now, emergencies and reactionary management are killing our ability to respond to the fires and perform RWP. Because RWP suffers, we're caught short on major inspections (JSI, WST, etc) and wind up responding to more emergency calls when things break.

I would select the structure that best fits the climate/mission of the base. Some bases natural geography are set up for zones while others are not. As civil engineering evolves (O&P, manpower reductions, funding cuts) those at the base level need to have the flexibility to be able to provide the best possible customer service they can.

Depends on local conditions and constraints. Air Force BCE/ops chiefs should be given the latitude ("empowered") to organize in a way that maximizes their resources/effectiveness. The most effective organizational structure here probably won't be most effective at Wright-Patterson, or at Ramstein, or at Lajes, or at Osan, etc. ACC has provided its bases some degree of latitude at organizing operations. My personal experience has been that zonal maintenance is not the most effective organization at small installations and that a single-craft "super-shop" concept enhances training and more effectively utilizes equipment/vehicle resources. However, I've heard larger bases do well under the zonal concept. This generalization is probably too broad. Other factors such as military/civilian mix, host nation workforce capabilities, location/geography, will all affect determining an optimal organizational structure. Bottom line: flexibility is good, mandating a single organizational structure for every AFB is bad.

Appendix B: Wright-Patterson AFB Final Report

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Introduction

This document contains background and analysis results for the decision analysis model used to investigate zonal maintenance organizational strategies for the 788th Civil Engineer Squadron located at Wright-Patterson AFB, Ohio. The key personnel for this decision analysis effort are as follows:

Individual	Role
Lt Col Lawrence E. (Ed) Manning, Jr. Commander, 788th Civil Engineer Squadron	Decision Maker
LTC Jack M. Kloeber, Jr.	Instructor/Advisor
Capt Shawn C. Thompson Graduate Student	Decision Analyst
MSgt Paul Horsely (Electrical) Self Help Center Manager	Team Member
MSgt Duvelle Blake (Utilities)	Team Member
Mr. Ken Cope (HVAC) Zone C Manager	Team Member
Mr. Tim Zwisler (Structural) Zone C-2 Shop Foreman	Team Member

Section A provides a brief overview of the methodology used for the analysis. The development of the value hierarchy is discussed in Section B. Subsequent sections provide information on each major step in the methodology.

SECTION A: Methodology

The steps in this decision analysis methodology are summarized below. The sections of this document follow this same basic format.

1. Problem Identification: Properly identifying the problem is perhaps the most critical step. For this particular case study the problem is how the Facility Maintenance Elements of the squadron should be reorganized to facilitate improved Air Force mission support, facility and infrastructure maintenance, and customer service.

2. Value Hierarchy (Section B): In this step, the items that are important to the decision maker and the decision analysis team in making this decision are developed and used to construct a hierarchy of values. This early step is very important because the value hierarchy will be referenced throughout the process.

3. Value Measures (Section C): The decision analysis team is then tasked with determining how to measure the values on the lowest tier of the value hierarchy. These measurements are used later in the process for scoring alternative solutions.

4. Value functions (Section D): The measurements just developed are usually in different units and measured on different scales which cannot be

summed together into a total score. To solve this problem, value functions are developed to convert the units of each value measure from step 3 into "value units". These "value units" are on a scale of 0 to 1.

5. Alternative Selection (Section E): The team or decision maker then determines organizational strategies that they would like to evaluate. Four strategies were put forth for evaluation during this exercise.

6. Alternative Scoring (Section F): The alternatives are evaluated using each of the measures derived in step 3. The value functions in step 4 are used to convert these scores into the same units (value units).

7. Value Hierarchy Weights (Section G): Once individual scores for each alternative are converted into "value units" the weight, or importance, placed on that score is assessed. Basically the scores are multiplied by their respective weights before they are summed.

8. Deterministic Analysis (Section H): The final result from completing steps one through seven is a total score for each alternative from each of the career fields which comprise the decision analysis team. These scores enable the alternatives to be ranked from best to worst. The input from the four career fields represented on the decision analysis team is also combined into a grand total score for each alternative.

9. Sensitivity Analysis (Section I): The final ranking of alternatives from best to worst can be very sensitive to the weights assigned to the values in the value hierarchy. This impact is evaluated by studying the effect that manipulating the weights has on the final scores and rankings. The results from this analysis are presented in Section I.

10. Results Presentation (Sections H-J): The deterministic and sensitivity analysis provide valuable insight into the decision problem. The analysis results are presented throughout Sections H, I, and J. The specific conclusions that can be drawn from these analyses and insights derived during this process are further discussed in Section J.

SECTION B: Value Hierarchy

The purpose of this section is to discuss the development of the value hierarchy. The value hierarchy is an illustration of the things that the decision maker values and how those values relate to one another with regard to the decision context. To most efficiently utilize the limited time with the decision maker, a draft of a hierarchy was made and then edited by the decision maker.

Two primary values were initially derived from research into Air Force publications concerning Civil Engineering operations. Specifically, Air Force Instruction 32-1031 "Civil Engineering Operations Management," listed support of the Air Force mission and the ability to maintain real property facilities as main objectives for the Base Civil Engineer. Air Force mission support was interpreted as being the war time civil engineering objective while real property facility maintenance was interpreted as encompassing the peacetime objectives of civil engineering. The initial values hierarchy is displayed in Figure B-1.

Being fully prepared for a deployment is key to supporting the Air Force mission. Ensuring that the personnel are trained to meet mission requirements is an important part of deployment readiness. Another important part is developing a unit that is cohesive and works well as a team.

The peacetime aspect of the civil engineering mission is to maintain the real property facilities on the installation. The work required to maintain these facilities is generated either from the customer in the form of job orders, work requests, or other forms of Direct Scheduled Work (DSW) or from within the civil engineering organization. The Recurring Work Program (RWP) is developed from these self identified work requirements.

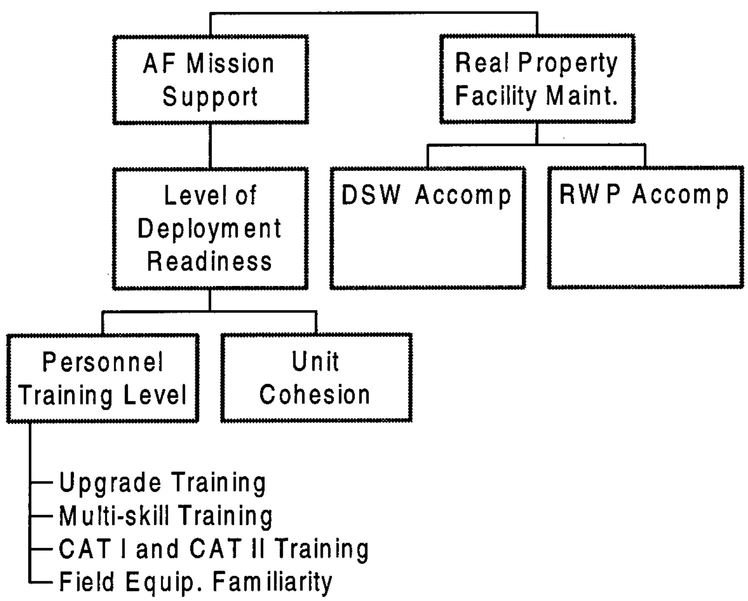

Figure B-1: Initial Values Hierarchy

This initial values hierarchy was reviewed by personnel from the civil engineering career field, and additional research into facility maintenance literature was conducted to ensure a comprehensive hierarchy. This effort resulted in the addition of Customer Service as a primary value in the hierarchy. Having positive interactions with the customer and responding to customer needs was defined as the components of good customer service. The updated values hierarchy is displayed in Figure B-2.

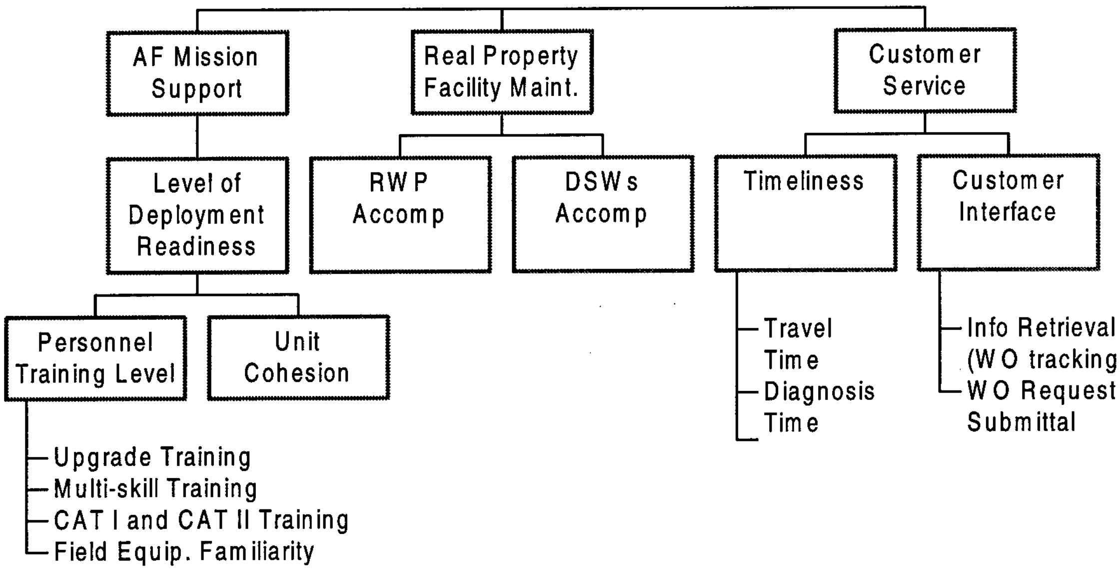

Figure B-2: Rough Draft of Complete Values Hierarchy

This draft of the values hierarchy was reviewed by the decision maker and revised to reflect his actual values (Figure B-3). The timeliness aspect of customer service was viewed as being more a function of accomplishing the job orders submitted by the customer, so this value was changed to 'responsiveness' which reflected the time required for a job order to travel from the customer to the craftsman tasked with accomplishing the work. The other part of customer service that was valued by the decision maker was customer satisfaction. Other aspects of the values hierarchy remained unchanged; however, some of the measures developed to grade the achievement of alternatives in each value were changed. These measures are the subject of the next section.

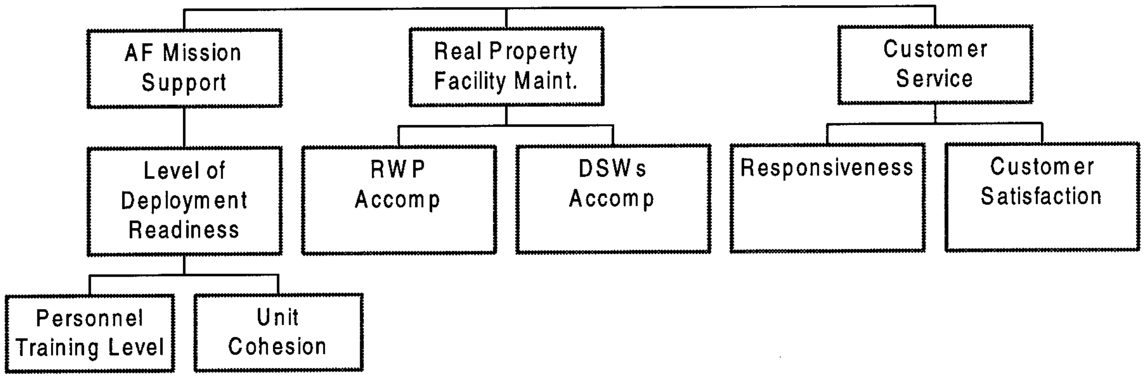

Figure B-3: Final Values Hierarchy

SECTION C: Hierarchy Evaluation Measures

Each organizational strategy is graded on how well it performs in the areas that are of value to the decision maker. To accomplish this evaluation, measures for each of the six values on the last level of the values hierarchy (Figure B-3) were developed.

Personnel Training Level: The measurement used to evaluate achievement for this value is the percentage of personnel adequately trained. An individual is considered 'adequately' trained if he/she has accomplished sufficient multi-skill training to allow him/her to be utilized on the majority of work requests and job orders that are encountered by the career field. Also this individual must have achieved the upgrade training commensurate with his/her rank and time in service. An adequately trained individual should also be familiar with the equipment utilized in a contingency environment and is current on Status of Resources and Training (SORTs) reportable training requirements.

Unit cohesion: The cohesiveness of the personnel in a particular career field is measured using a constructed scale. This constructed scale utilizes a five point system as illustrated below:

Score	Criteria
5	a) All craftsmen know each other fairly well b) All craftsmen are familiar with each others skill levels and capabilities c) All craftsmen work well together
4	a) Most craftsmen know each other fairly well b) Most craftsmen are somewhat familiar with each others skill levels and capabilities c) Craftsmen work fairly well together
3	a) Roughly half the craftsmen know each other fairly well b) Half the craftsmen are somewhat familiar with each others capabilities c) Most of the craftsmen work well together with a few problem groupings
2	a) A small percentage of the craftsmen know each other b) A small percentage of the craftsmen know the capabilities of their coworkers c) A small percentage of the craftsmen work well together
1	a) Almost none of the craftsmen know each other b) Most of the craftsmen know little about each others capabilities c) Few of the craftsmen work well together

RWP Accomplishment: Accomplishment of the RWP program is measured by estimating the percentage of the program that is completed. An assumption being made is that the individual RWP tasks are completed in order of importance.

DSW Accomplishment: Accomplishment of direct scheduled work, job orders, and work requests is not measured as directly as RWP accomplishment. Lack of funding and slow acquisition of materials are much more significant limiting factors in DSW accomplishment than organizational strategies. Changing organizational strategy has two primary effects on the daily accomplishment of job orders. The first effect is the changing travel times required to get to and from the job site or facility. The second effect is the changing level of worker familiarity with the facilities in their area and the systems in those facilities. This change in familiarity impacts the amount of time required to diagnose a problem and begin repair work. DSW accomplishment is therefore measured by estimating the travel time required to reach the job site, find adequate parking, locate the area of the facility or system in need of repair, diagnose the problem, and finally the return travel time to the shop. Basically this measure is the average total time required to complete a routine job order minus the time spent waiting for parts, funding, and actually performing the repair work.

Responsiveness: Different organizational strategies will alter the way job orders flow from the customer, through the organization, and finally into the hands of the craftsman that will accomplish the work. Responsiveness to customer needs is measured by estimating the time it takes a job order to travel from the customer to the craftsman responsible for performing the work.

Customer Satisfaction: Besides responsiveness, there are several other important aspects of good customer service. This value incorporates these aspects into a single measure. Customer satisfaction is a combined measure of the quality of the workmanship, the conduct of the craftsmen, and the overall customer's satisfaction of the completed work. Similar to unit cohesion, a constructed scale was used to measure customer satisfaction. This scale was derived from the Squadron's customer service survey sent periodically to various customers. The following measure utilizes the same six point scale used in the survey and is described below:

Score	Criteria
1	Very Dissatisfied
2	Dissatisfied
3	Somewhat Dissatisfied
4	Somewhat Satisfied
5	Satisfied
6	Very Satisfied

SECTION D: Value Functions

The transition from how a given organizational strategy scores on one of the six measures to the value derived from that score is accomplished by directly assessing a value function. These functions are highly dependent on the career field. For example, the Heating Ventilation and Air Conditioning (HVAC) career field places much more value on RWP accomplishment than does the Structural career field; as a result, functions for each of the four career fields were derived for each of the six values. This section discusses the development of these 24 value functions.

Air Force Mission Support: Personnel Training and Unit Cohesion are the components of this primary value and the measures for each are illustrated below.

Personnel Training: These functions convert each alternative's personnel training score into the value derived from that score. The value placed on various levels of personnel training changes somewhat for each career field as illustrated in Figures B-4 through B-7; however, as expected as the percent of personnel trained increases, the value increases.

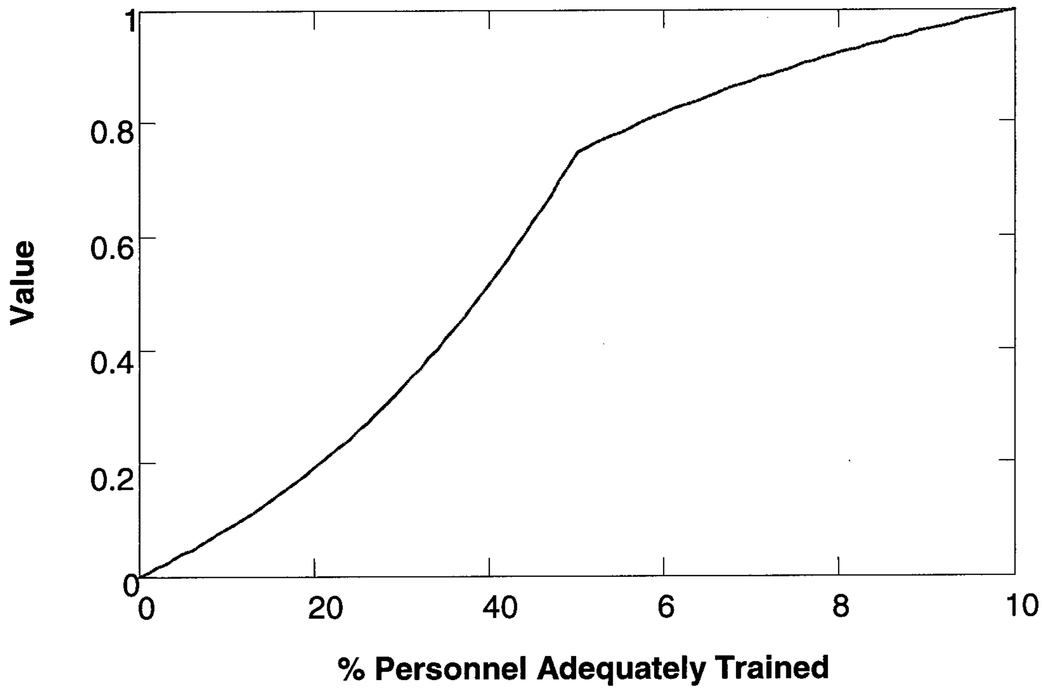

Figure B-4: Electrical Personnel Training Function

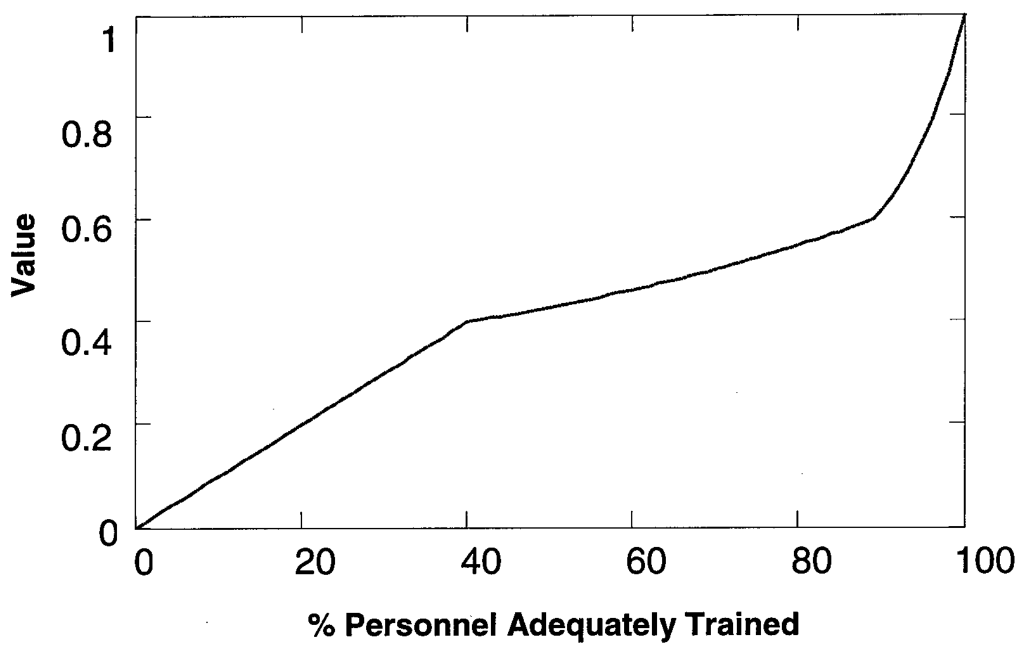

Figure B-5: HVAC Personnel Training Function

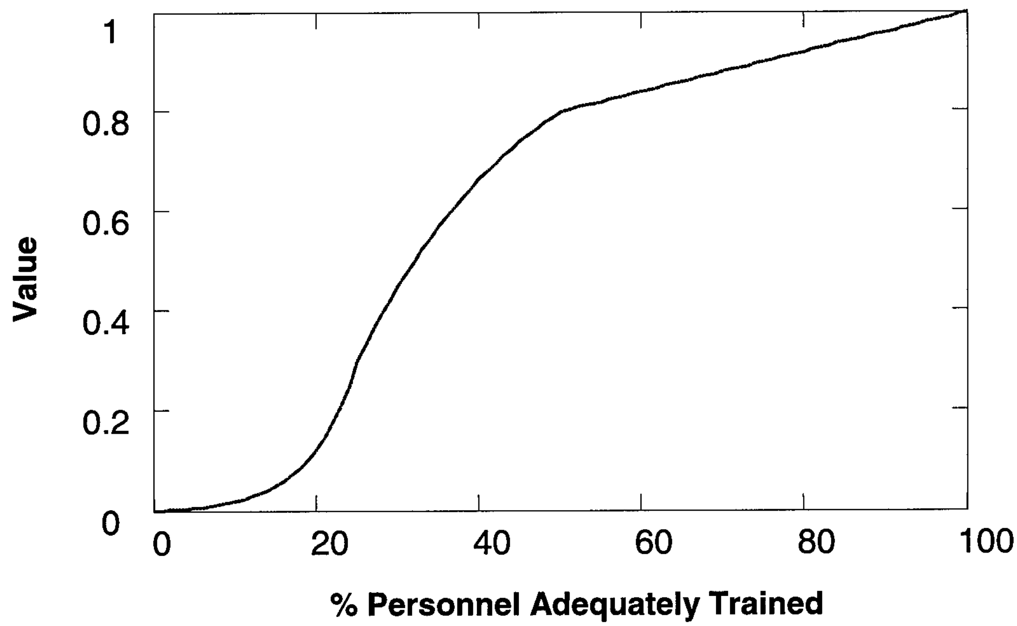

Figure B-6: Structural Personnel Training Function

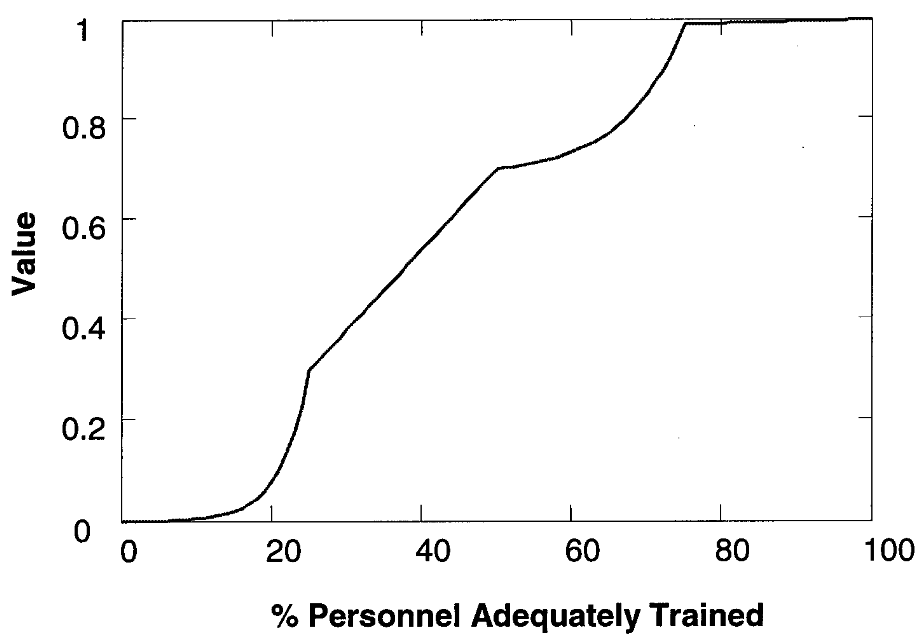

Figure B-7: Utilities Personnel Training Function

Unit Cohesion: This measure utilizes a constructed scale that places a value on each level of unit cohesion. More information on the criteria for this scale is provided in Section C.

Electrical Unit Cohesion Values

Criteria Score	Value
1	.10
2	.30
3	.60
4	.90
5	1.00

HVAC Unit Cohesion Values

Criteria Score	Value
1	.00
2	.15
3	.55
4	.75
5	.90

Structural Unit Cohesion Values

Criteria Score	Value
1	.05
2	.25
3	.45
4	.75
5	1.00

Utilities Unit Cohesion Values

Criteria Score	Value
1	.20
2	.40
3	.60
4	.80
5	1.00

Real Property Facility Maintenance: Accomplishment of the Recurring Work Program (RWP) and Direct Scheduled Work (DSW) are the components of this primary value and the measures for each are illustrated below.

Recurring Work Program (RWP) Accomplishment: These functions illustrated in Figures B-8 through B-11, convert each alternative's RWP accomplishment score into the value derived from that score. The value placed on accomplishing various percentages of the RWP program are highly dependent on the career field. For example, the structural career field typically does not have a comprehensive RWP program that has the potential to save large sums of money in the long term. The HVAC career field, on the other hand, can save future work and expenditures by operating a comprehensive RWP program. The differences in these two career fields is evident in Figures B-9 and B-10. The structural career field (Figure B-10) places a great deal of value on being able to accomplish the first 25% of the RWP program while the HVAC career field (Figure B-9) derives much less value from accomplishing only the first 25%.

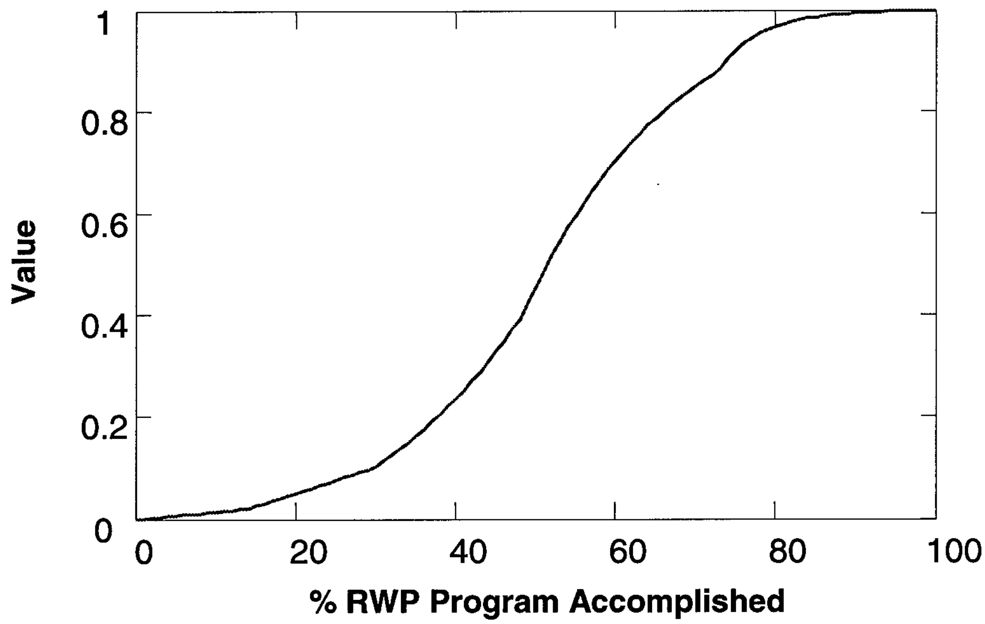

Figure B-8: Electrical RWP Accomplishment Function

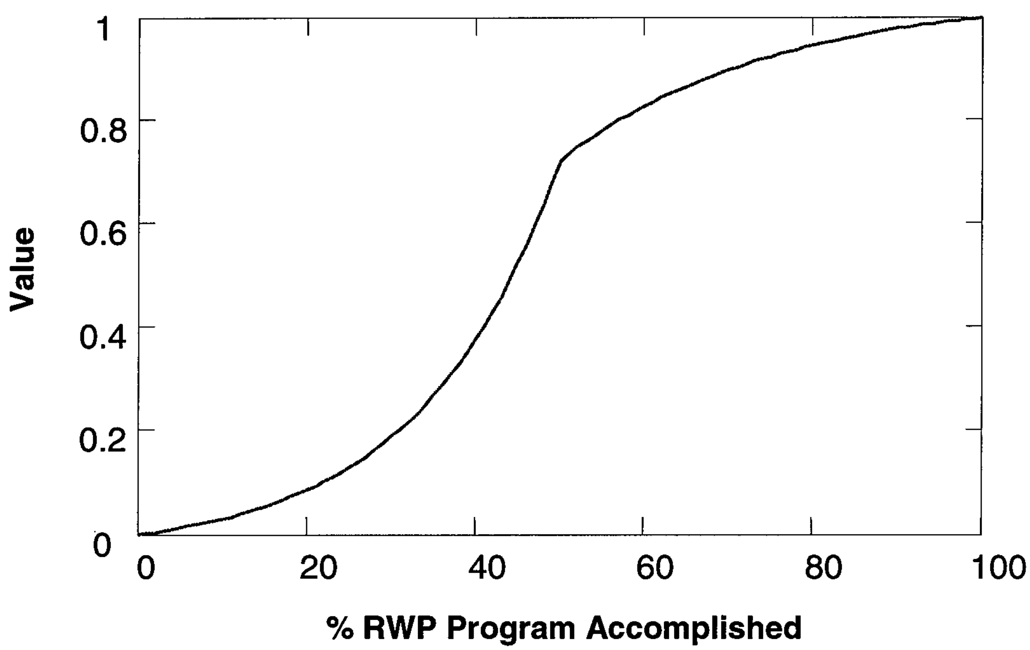

Figure B-9: HVAC RWP Accomplishment Function

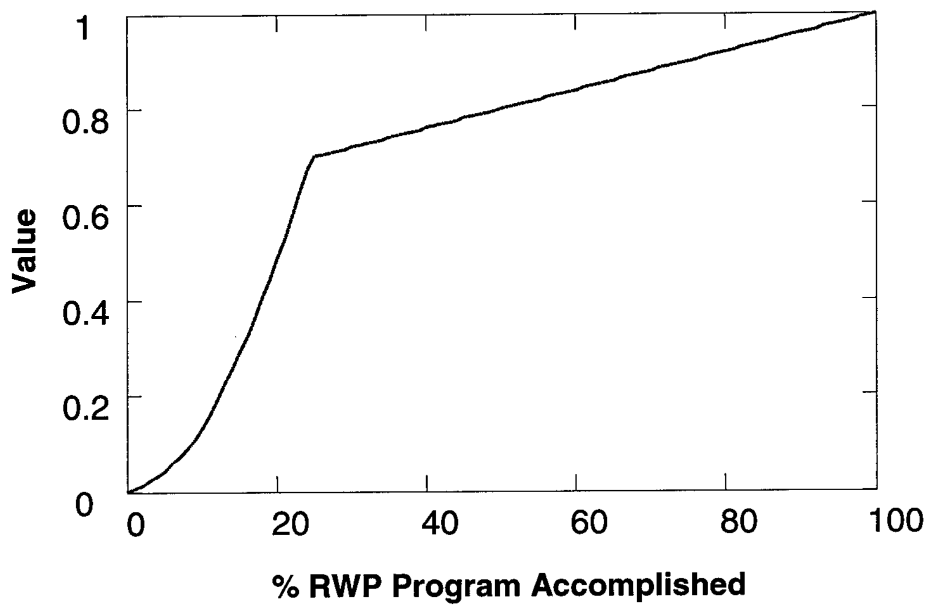

Figure B-10: Structural RWP Accomplishment Function

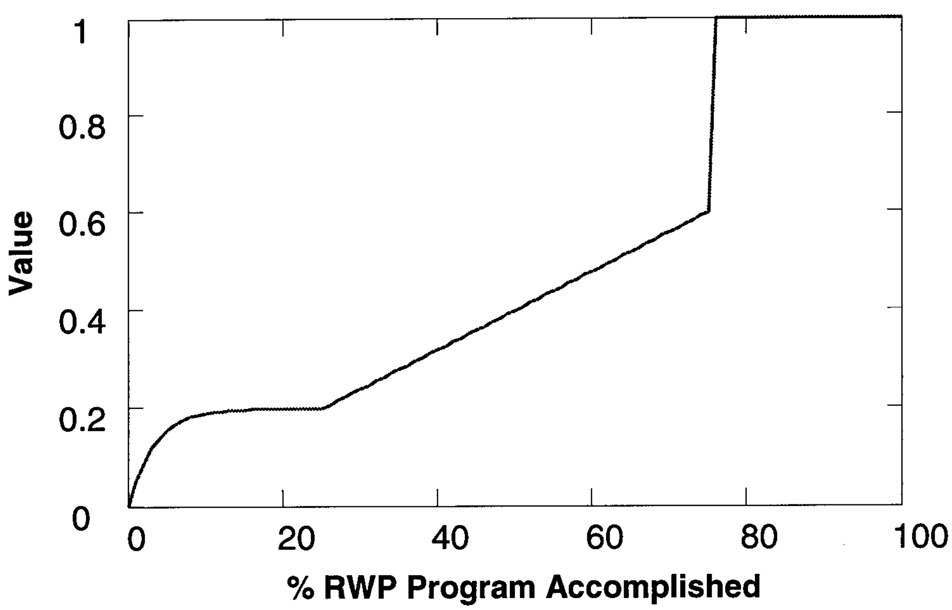

Figure B-11: Utilities RWP Accomplishment Function

Direct Scheduled Work Accomplishment: These functions convert each alternative's DSW accomplishment score into the value derived from that score. The value placed on different travel times changes somewhat for each career field as illustrated in Figures B-12 through B-15. However, as expected, an increase in travel time + diagnosis time leads to a decreased value.

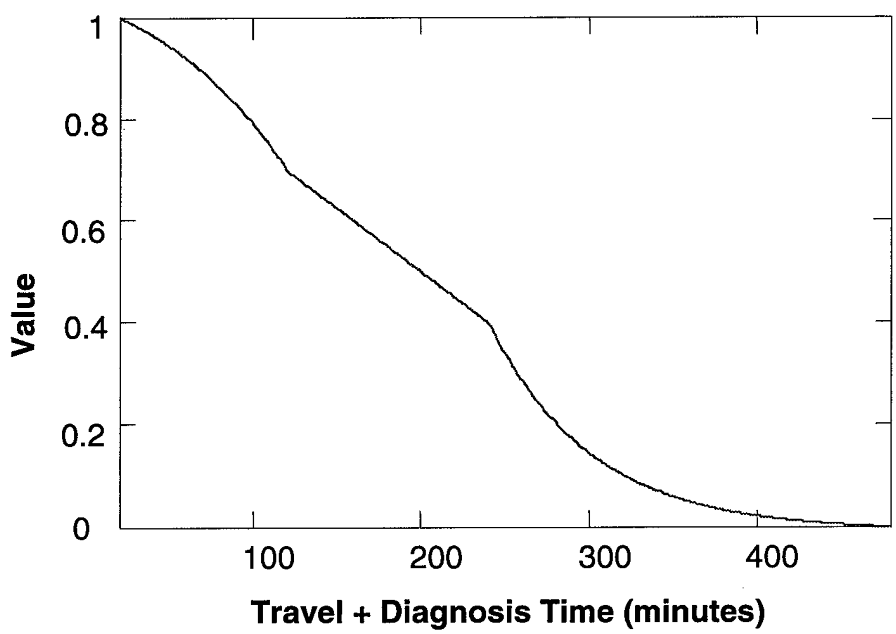

Figure B-12: Electrical DSW Accomplishment Function

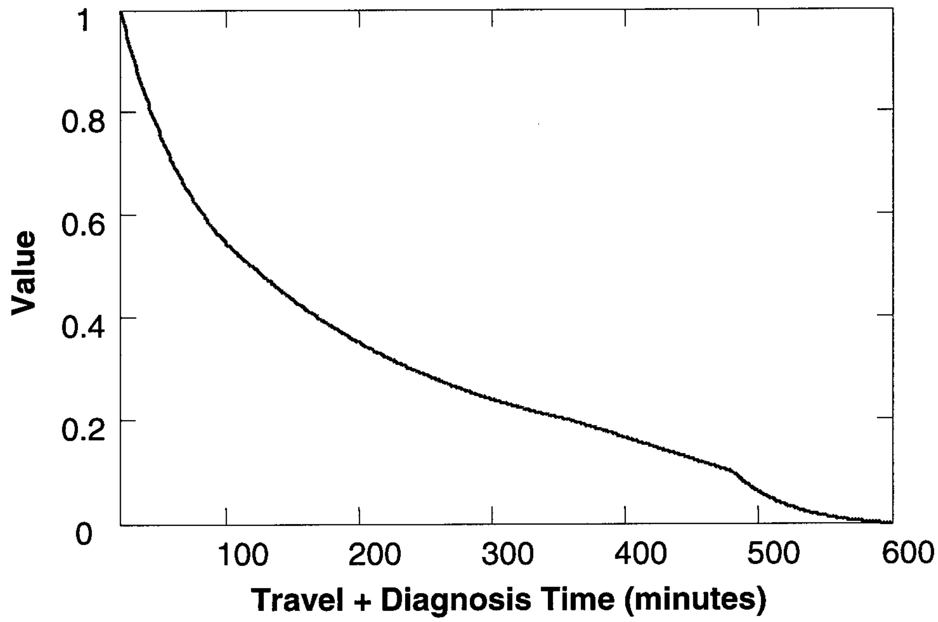

Figure B-13: HVAC DSW Accomplishment Function

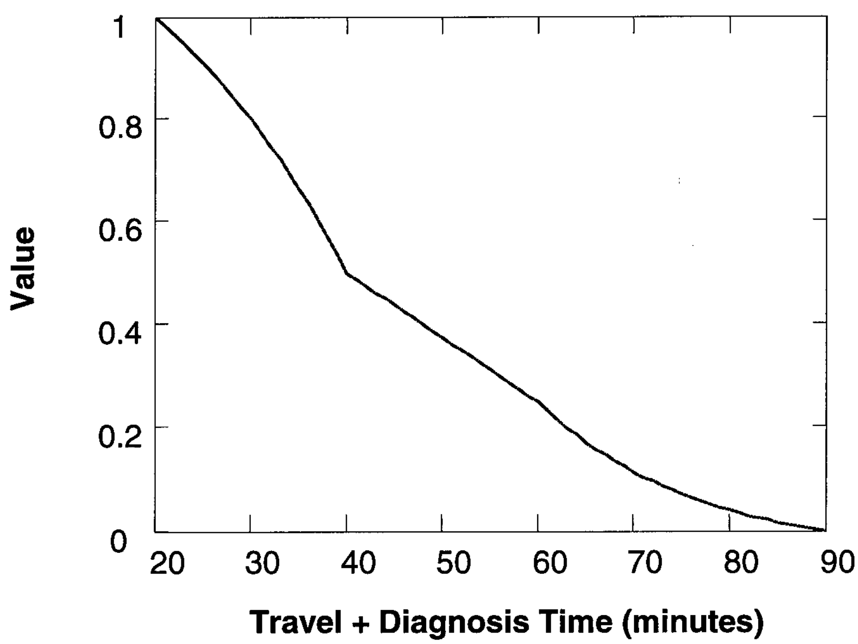

Figure B-14: Structural DSW Accomplishment Function

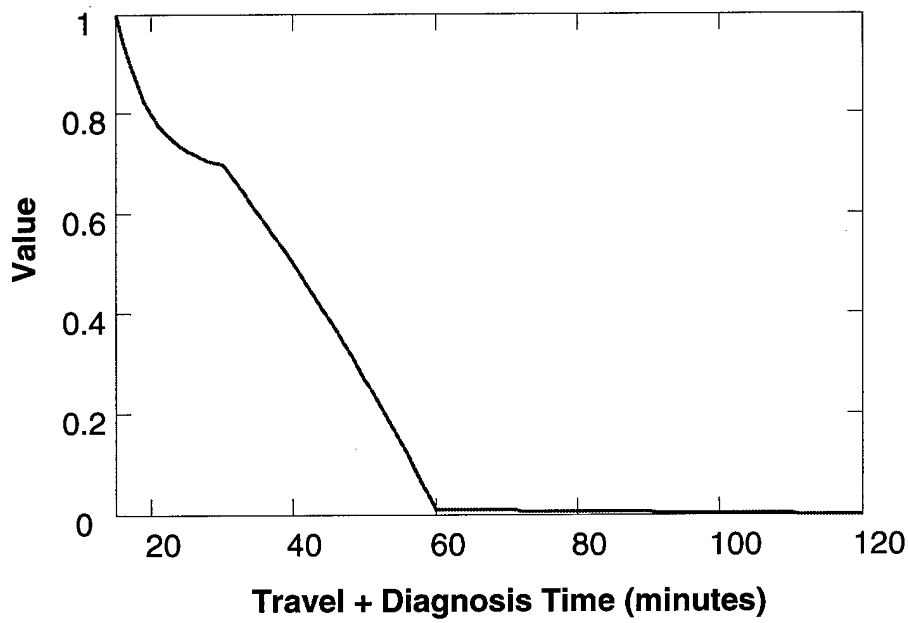

Figure B-15: Utilities DSW Accomplishment Function

Customer Service: Responding quickly to the customers' needs and having satisfied customers are objectives critical to this primary value and the measures for each are illustrated below.

Responsiveness to Customer Requests: These functions convert each alternative's Responsiveness score into the value derived from that score. The value placed on various responsiveness times varies somewhat for each career field as illustrated in Figures B-16 through B-19. However, as expected, as the times increase the values decrease.

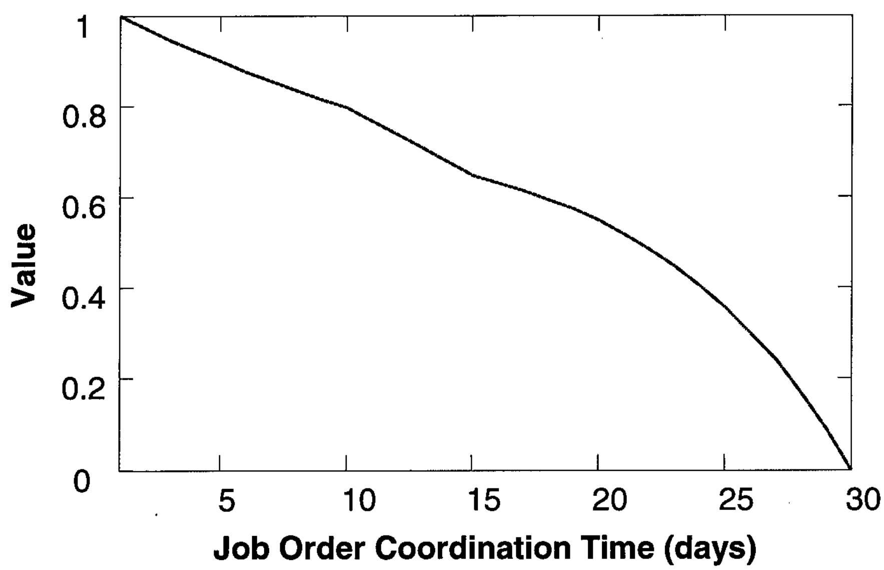

Figure B-16: Electrical Responsiveness Function

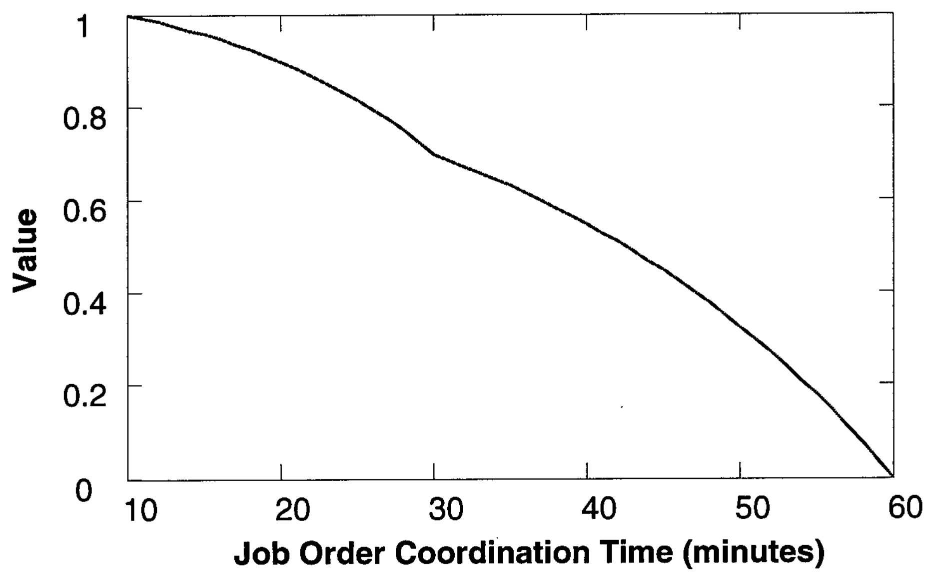

Figure B-17: HVAC Responsiveness Function

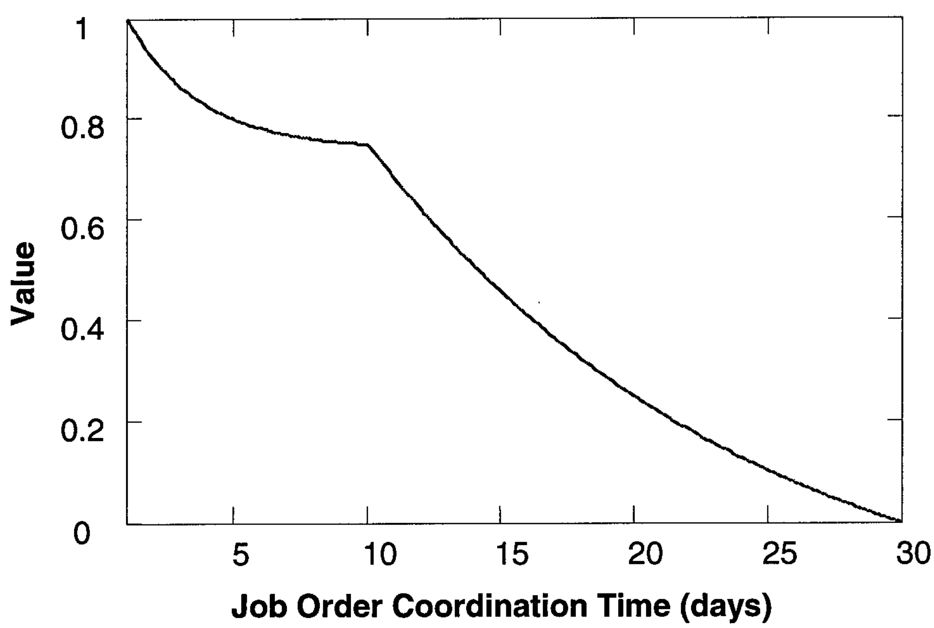

Figure B-18: Structural Responsiveness Function

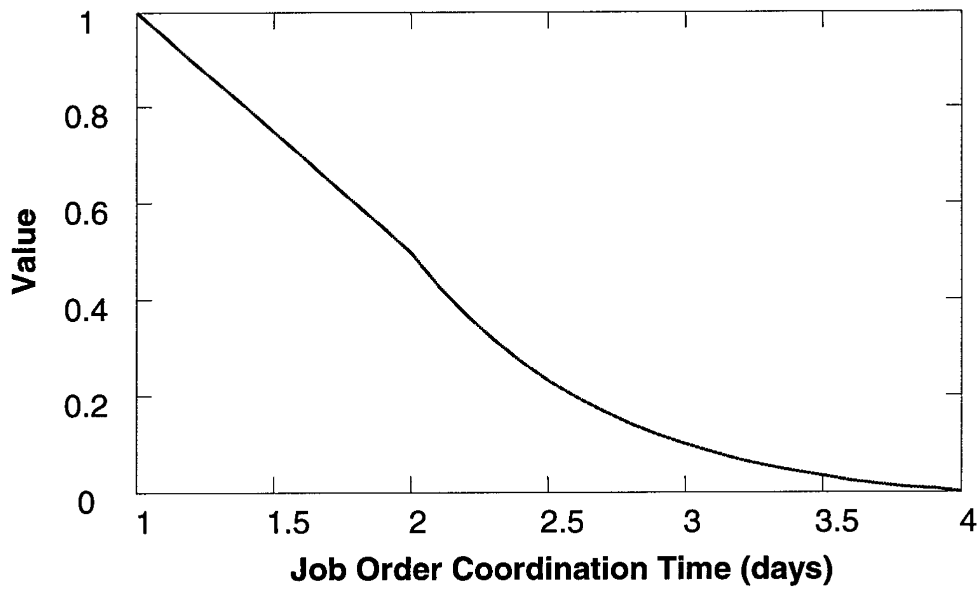

Figure B-19: Utilities Responsiveness Function

Customer Satisfaction: This measure utilizes a constructed scale that places a value on each level of customer satisfaction. More information on the criteria for this scale is provided in Section C.

Electrical Customer Satisfaction Values

Criteria Score	Value
1	.00
2	.15
3	.50
4	.75
5	.95
6	1.00

HVAC Customer Satisfaction Values

Criteria Score	Value
1	.10
2	.10
3	.35
4	.50
5	.75
6	1.00

Structural Customer Satisfaction Values

Criteria Score	Value
1	.00
2	.075
3	.175
4	.275
5	.80
6	1.00

Utilities Customer Satisfaction Values

Criteria Score	Value
1	.00
2	.10
3	.20
4	.50
5	.80
6	1.00

SECTION E: Organization Strategy Alternatives

Four organizational strategies were developed with the decision maker to run through the decision analysis model. These four alternatives are scored or graded against the six value measures described in Section B. No changes in zone or shop workshop locations are made in any of the alternatives. The following is a brief explanation of each organizational strategy.

Alternative #1 Do Nothing: In this alternative the current organization of the facility maintenance element is maintained. This current organization consists of three Zones (A, B, and C). Each of these zones is further divided into Shops.

Wright-Patterson AFB is divided into 9 sections, each with a team of craftsmen responsible for the facilities in that section.

Alternative #2 Zone B & C with 3 shops: This alternative does not change the configuration of Zone B with its three shops or Zone B's area of responsibility. It does, however, result in Zone C absorbing the personnel and responsibility of Zone A. Zone C's shops would maintain their present locations but would expand operations to include responsibility for the facilities that were previously part of Zone A. The base would be divided into 6 sections, three sections in Area B and three covering Areas A and C.

Alternative #3 Zone A, B & C (no shops): Under this strategy the current 3 Zone configuration would no longer be further divided into 3 shops each. The shops would be consolidated with the result being three large zones. The base would be divided into 3 sections, one section each in Areas A, B and C.

Alternative #4 Zone B & C (no shops): This strategy is the same as Alternative #2 with the exception that the two zones would not be subdivided into shops. The base would be divided into two sections, one covering Area B and the other covering Areas A and Area C.

SECTION F: Alternative Scoring

The four alternatives were scored using the measures derived for each of the six objectives. The functions in Section D were then used to translate these raw scores into values. The raw scores entered in the functions of Section D for each career field are provided below.

Table B-1: Alternative Scoring for the Electrical Career Field

	Training			Unit Cohesion			RWP Accomp		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	24	25	26	NA	2	NA	89	90	91
Alt 2 (6 Shops)	35	40	45	NA	3	NA	89	90	91
Alt 3 (3 Shops)	60	65	70	NA	4	NA	89	90	91
Alt 4 (2 Shops)	65	70	75	NA	4	NA	94	95	96

	DSW Accomp			Customer Satisfaction			Responsiveness		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	30	40	50	NA	5	NA	1	3	5
Alt 2 (6 Shops)	50	60	70	NA	5	NA	1	3	5
Alt 3 (3 Shops)	50	60	70	NA	4	NA	1	2	3
Alt 4 (2 Shops)	105	120	135	NA	3	NA	4	5	6

Table B-2: Alternative Scoring for the HVAC Career Field

	Training			Unit Cohesion			RWP Accomp		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	55	60	65	NA	4	NA	15	30	31
Alt 2 (6 Shops)	40	50	60	NA	4	NA	20	30	31
Alt 3 (3 Shops)	70	75	80	NA	5	NA	40	45	50
Alt 4 (2 Shops)	70	78	80	NA	5	NA	50	55	60

	DSW Accomp			Customer Satisfaction			Responsiveness		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	60	75	105	NA	4	NA	25	30	35
Alt 2 (6 Shops)	60	75	105	NA	4	NA	25	30	35
Alt 3 (3 Shops)	35	45	60	NA	5	NA	15	20	25
Alt 4 (2 Shops)	40	45	55	NA	5	NA	15	20	25

Table B-3: Alternative Scoring for the Structural Career Field

	Training			Unit Cohesion			RWP Accomp		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	65	70	75	NA	3	NA	0.1	1	2
Alt 2 (6 Shops)	70	75	80	NA	3	NA	4	5	6
Alt 3 (3 Shops)	75	80	85	NA	4	NA	10	15	20
Alt 4 (2 Shops)	75	80	85	NA	4	NA	15	20	25

	DSW Accomp			Customer Satisfaction			Responsiveness		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	25	30	45	NA	5	NA	4	4	5
Alt 2 (6 Shops)	40	45	60	NA	5	NA	4	4	5
Alt 3 (3 Shops)	30	35	40	NA	5	NA	3	4	4
Alt 4 (2 Shops)	40	45	60	NA	5	NA	3	4	4

Table B-4: Alternative Scoring for the Utilities Career Field

	Training			Unit Cohesion			RWP Accomp		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	95	98	100	NA	2	NA	80	83	85
Alt 2 (6 Shops)	95	98	100	NA	2	NA	65	70	80
Alt 3 (3 Shops)	95	98	100	NA	3	NA	85	90	95
Alt 4 (2 Shops)	95	98	100	NA	4	NA	90	95	100

	DSW Accomp			Customer Satisfaction			Responsiveness		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
Alt 1 (9 Shops)	30	45	50	NA	5	NA	1	2	3
Alt 2 (6 Shops)	30	45	50	NA	3	NA	1	2	3
Alt 3 (3 Shops)	30	45	50	NA	5	NA	1	2	3
Alt 4 (2 Shops)	30	45	50	NA	6	NA	1	2	3

SECTION G: Weight Assessment

Upon completion of the scoring exercise for the four organizational alternatives considered in this decision context, weights are assigned to each of the values. The individual values derived from each of the six measured objectives are multiplied by their respective weights and finally summed together to obtain a single total score for each alternative. Each of the technical experts on the decision analysis team were questioned with regard to how much importance they placed on the objectives being measured. The results of this exercise are provided on the following page (Figure B-20).

The first level in the values hierarchy contains the three primary values. The weights assigned to these values must sum to 100. The technical expert from the four career fields had varying opinions on the proper weighting. The weights used in the analysis are those obtained from the decision maker; however, a sensitivity analysis was conducted using the weights from the analysis team. For example the decision maker assessed a weight of 40 for the Air Force mission support value. This weight was used in the model analysis; however, a sensitivity analysis was done by ranging the weight from 35 (from the HVAC expert) to 50 (from the Electrical and utilities experts) and observing any changes in the ranking of alternatives.

The second level of the values hierarchy contains the six values which were measured in this decision analysis modeling effort. Each pair was weighted by each career field expert with the results shown in Figure B-20. The decision maker made a few changes in the weights proposed by the analysis team and those changes are reflected in Figure B-20.

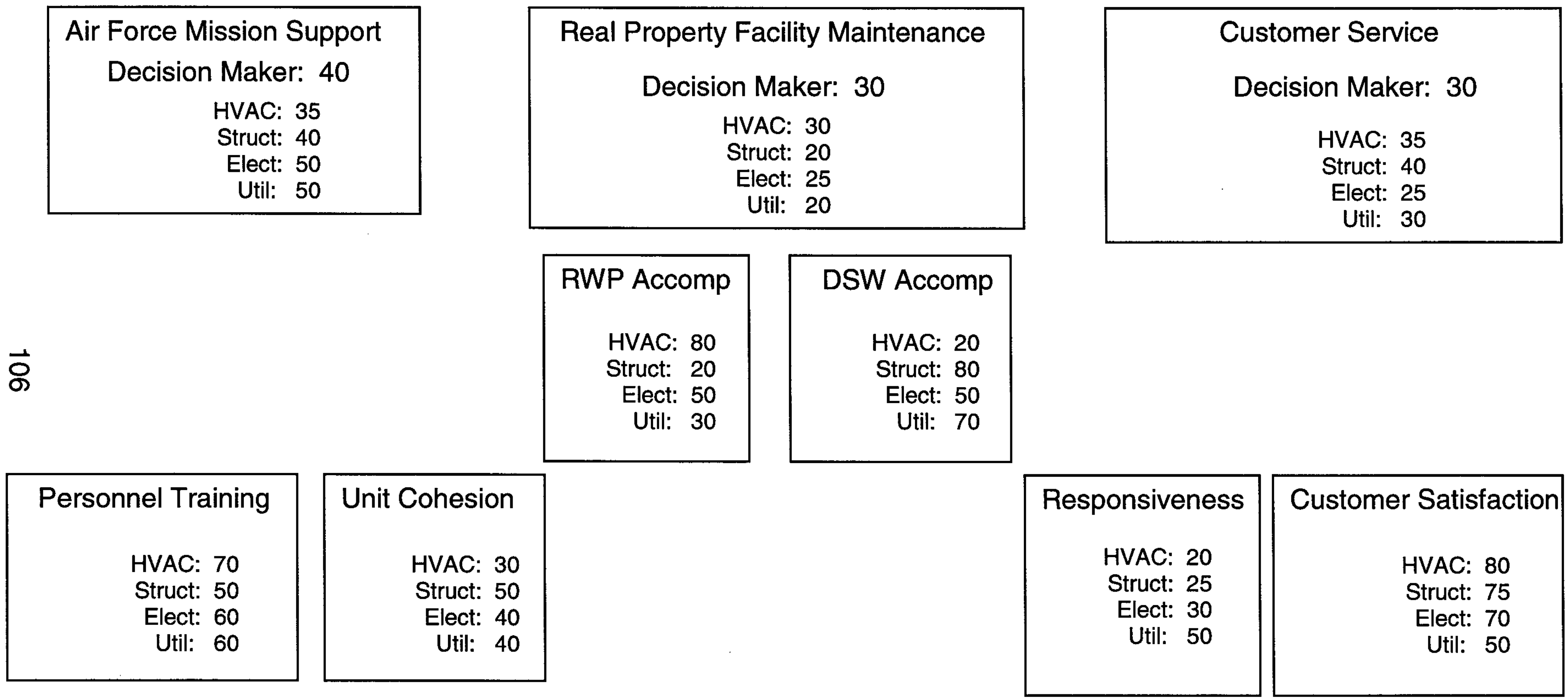

Figure B-20: Weights to Apply to Values

Section H: Deterministic Analysis

The ranking of the four alternatives for each of the career fields is illustrated in Figure B-21. The alternatives that do not further divide zones into shops returned the highest value for all four career fields. The HVAC and Utilities career field preferred the strategy without Zone A, while the structural and electrical preferred the strategy which included Zone A.

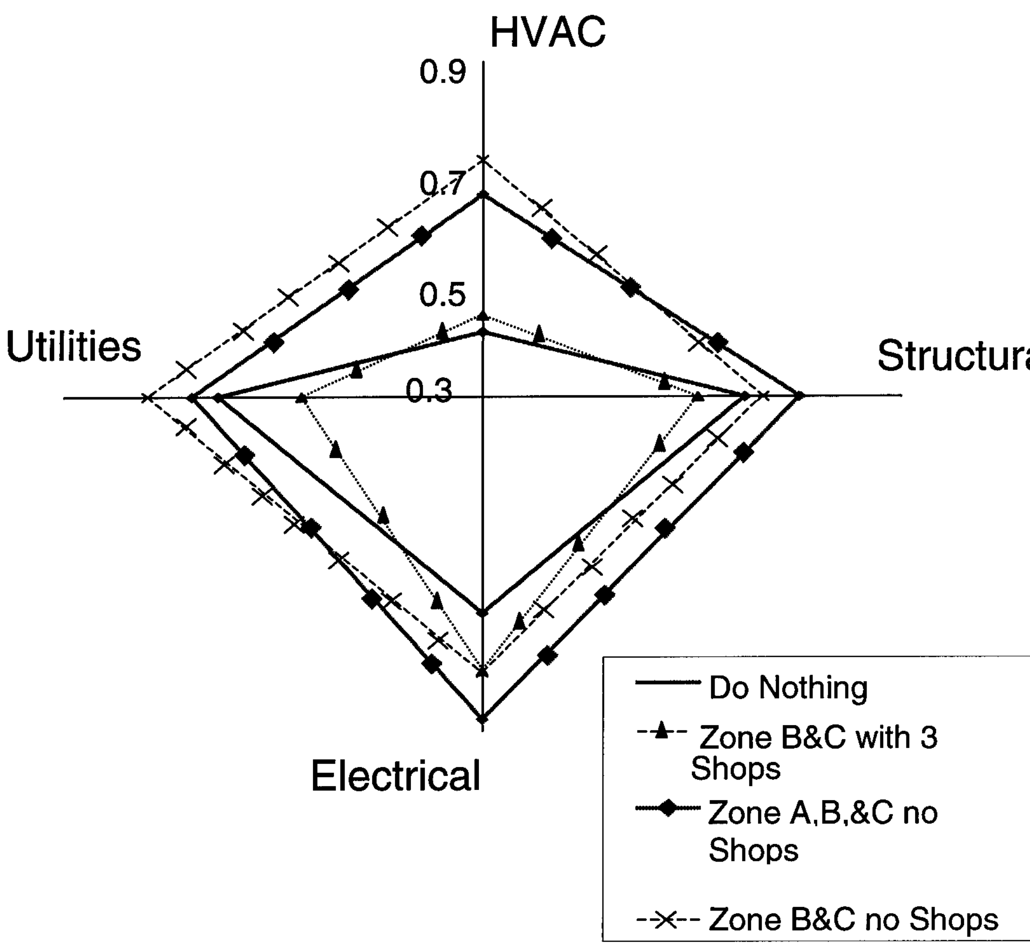

Figure B-21: Total Values by Career Field

All four career fields were assigned equal weighting in order to compute the organizational strategy that best suits the entire Facility Maintenance Element. The results are displayed in Figure B-22.

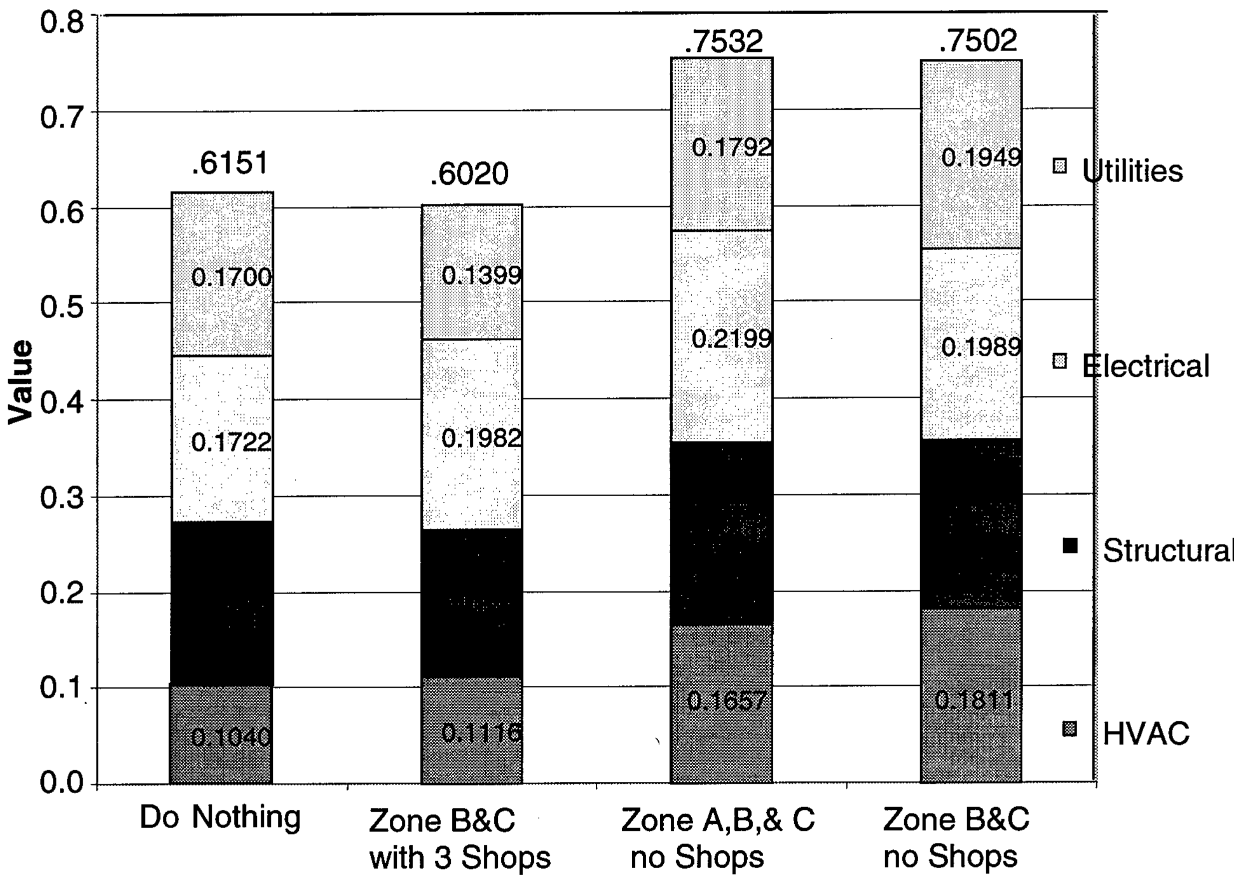

Figure B-22: Total Values Across Career Fields

The alternative with Zones A, B, and C without further division into shops is the highest scoring alternative when considering all four career fields together.

Section I: Sensitivity Analysis

The results from Section F can be sensitive to two uncertainties. The first uncertainty deals with how each alternative is scored. When scoring an alternative, the technical experts were asked to provide a best estimate of how that alternative would perform for each of the six measures. Naturally, the expert can not be 100% certain how an alternative will perform so an upper and lower bound for this estimate was also solicited from the experts to capture the range in which he was very confident that the *true* measure would fall. Figures B-23 through B-26 shown the cumulative distribution of total value for each career field. These figures illustrate that the scoring uncertainty does not affect the top alternative. The top alternative in each case at least stochastically dominates the other choices. The bottom line is that the scoring alternative need not be a significant factor in considering alternatives.

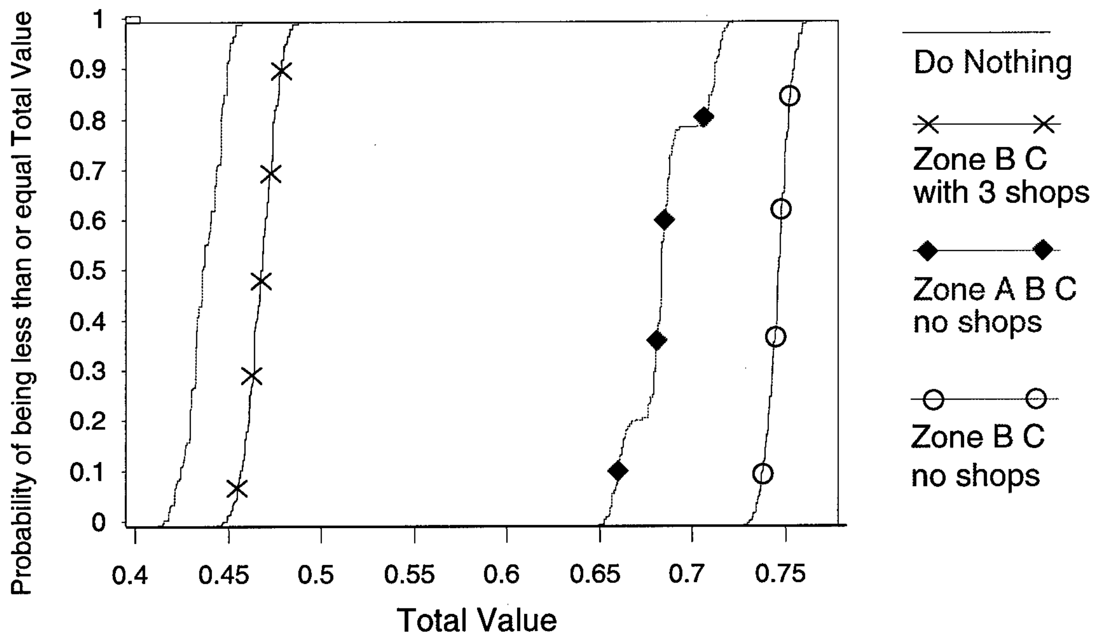

Figure B-23: HVAC Cumulative Distribution of Total Values

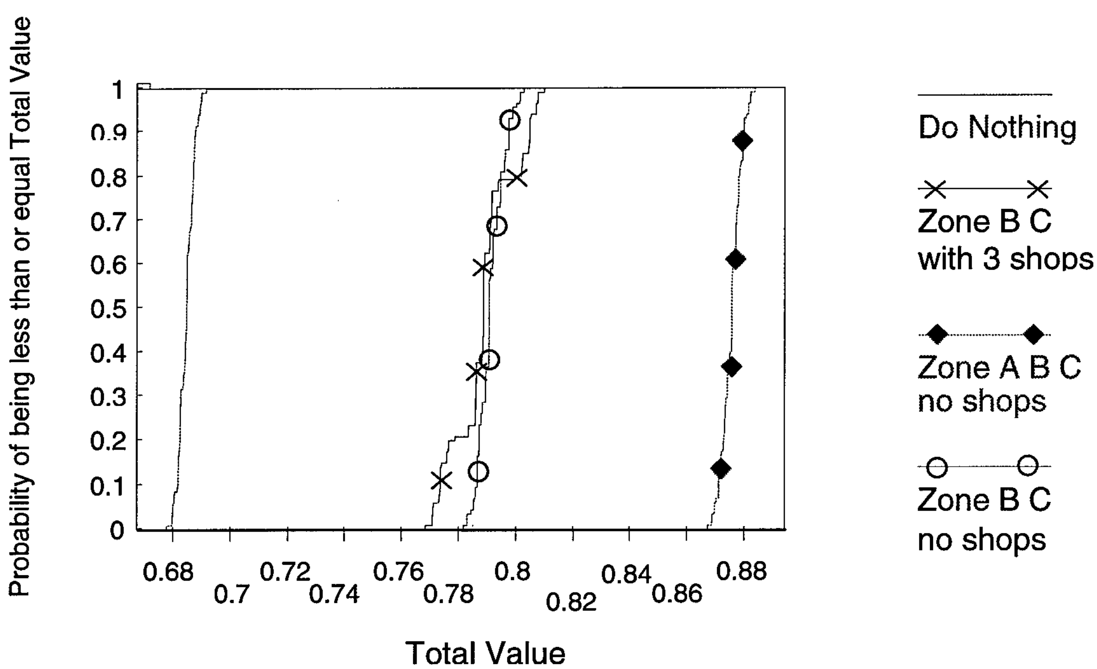

Figure B-24: Electrical Cumulative Distribution of Total Values

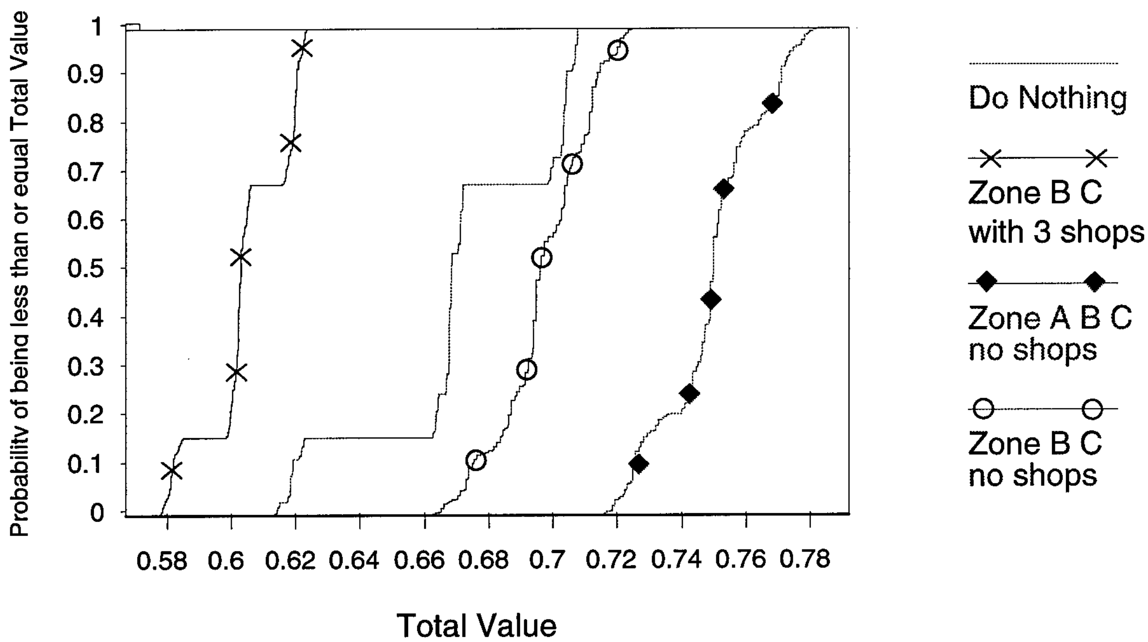

Figure B-25: Structural Cumulative Distribution of Total Values

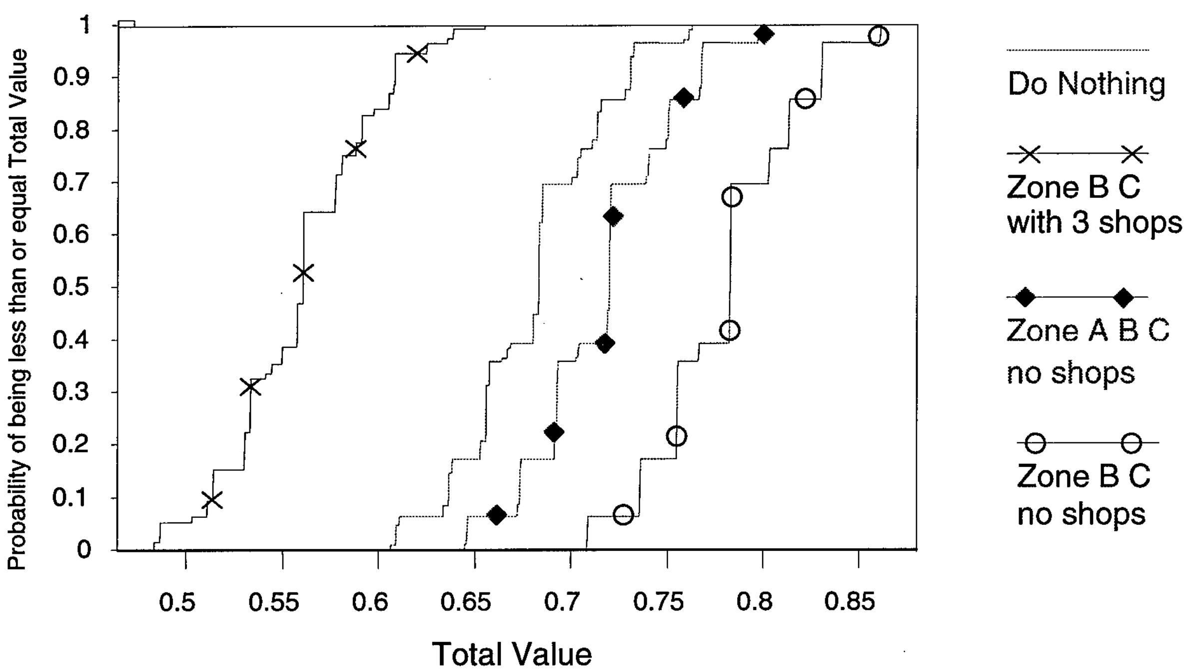

Figure B-26: Utilities Cumulative Distribution of Total Values

The second uncertainty that the results from Section H are sensitive to is the weights assigned to the values. These weights are discussed in Section G. Altering the weights assigned to the six values on the lowest level of the values hierarchy does not change the rankings of the alternatives unless extreme weightings are used. For example, the top choice for the HVAC career field does not change unless the weight assigned to the Personnel Training Level value is reduced to less than 1%. The same extremes hold true for the other values across all four career fields.

The weights assigned to the three primary values on the first tier of the value hierarchy do affect the selection of the top organizational strategy. In conducting this portion of the sensitivity analysis, the effect of varying one of the primary value weights on the grand total value (the one that combines the four career fields) was studied. Figures B-27 through B-29 illustrate the effect of varying these value weights. In Figure B-27, the choice of alternatives changes when the weight assigned to Air Force mission support increases beyond about 46%. The ratio of the weights for the other two primary values was kept constant. The choice of alternatives also changed when the weight assigned to real property facility maintenance was reduced to below approximately 18%, as shown in Figure B-28. Finally, Figure B-29 illustrates that reducing the weight of customer service below 22% resulted in a change of alternatives. The vertical lines in each graph reflect the weights chosen by the decision maker.

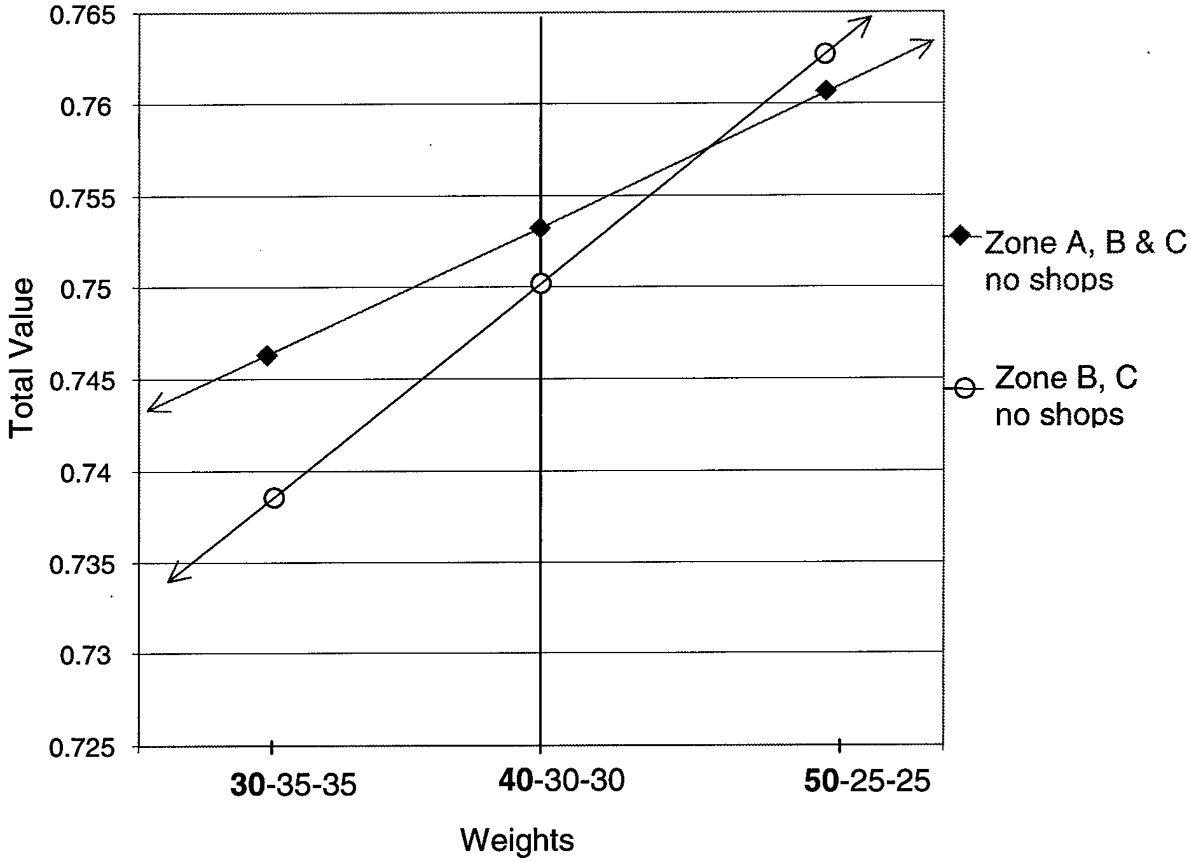

Figure B-27: Sensitivity of Air Force Mission Support Weight

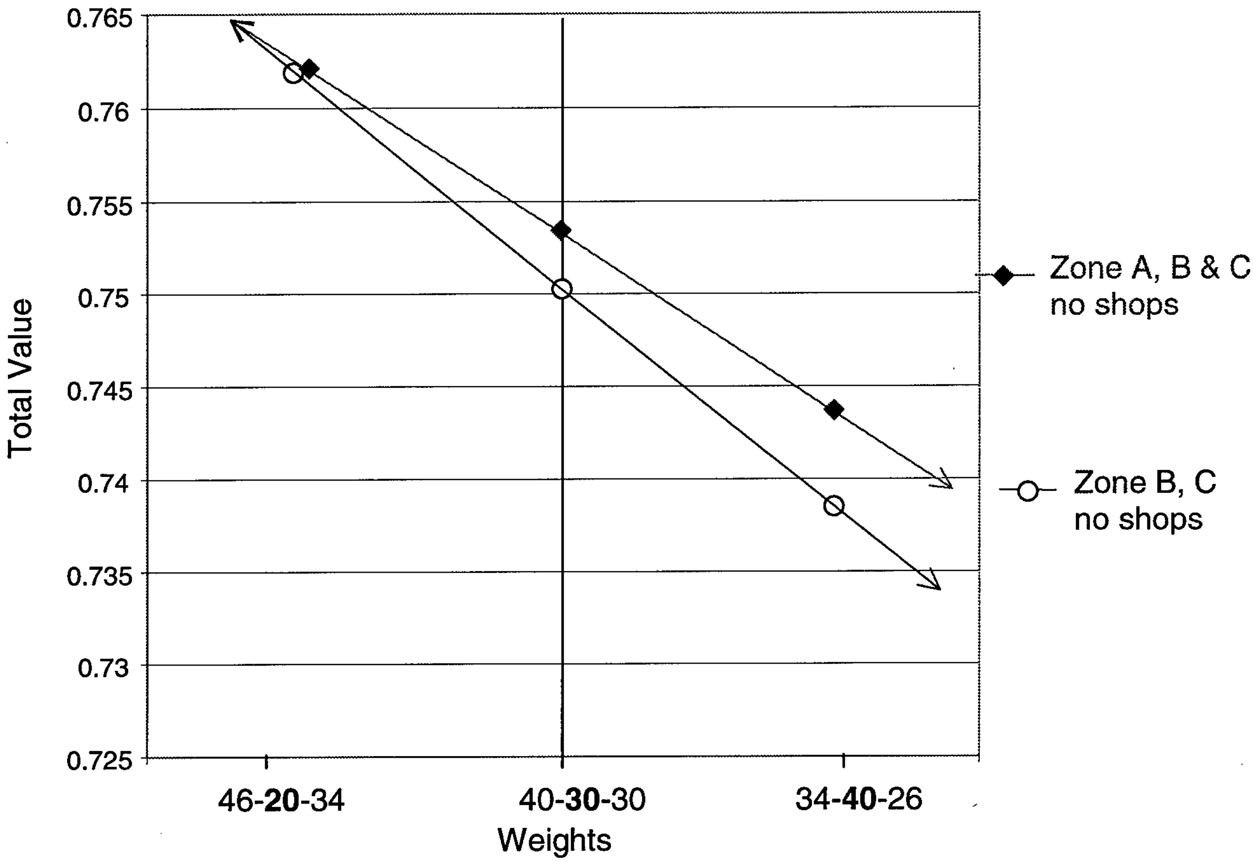

Figure B-28: Sensitivity of Real Property Facility Maintenance Weight

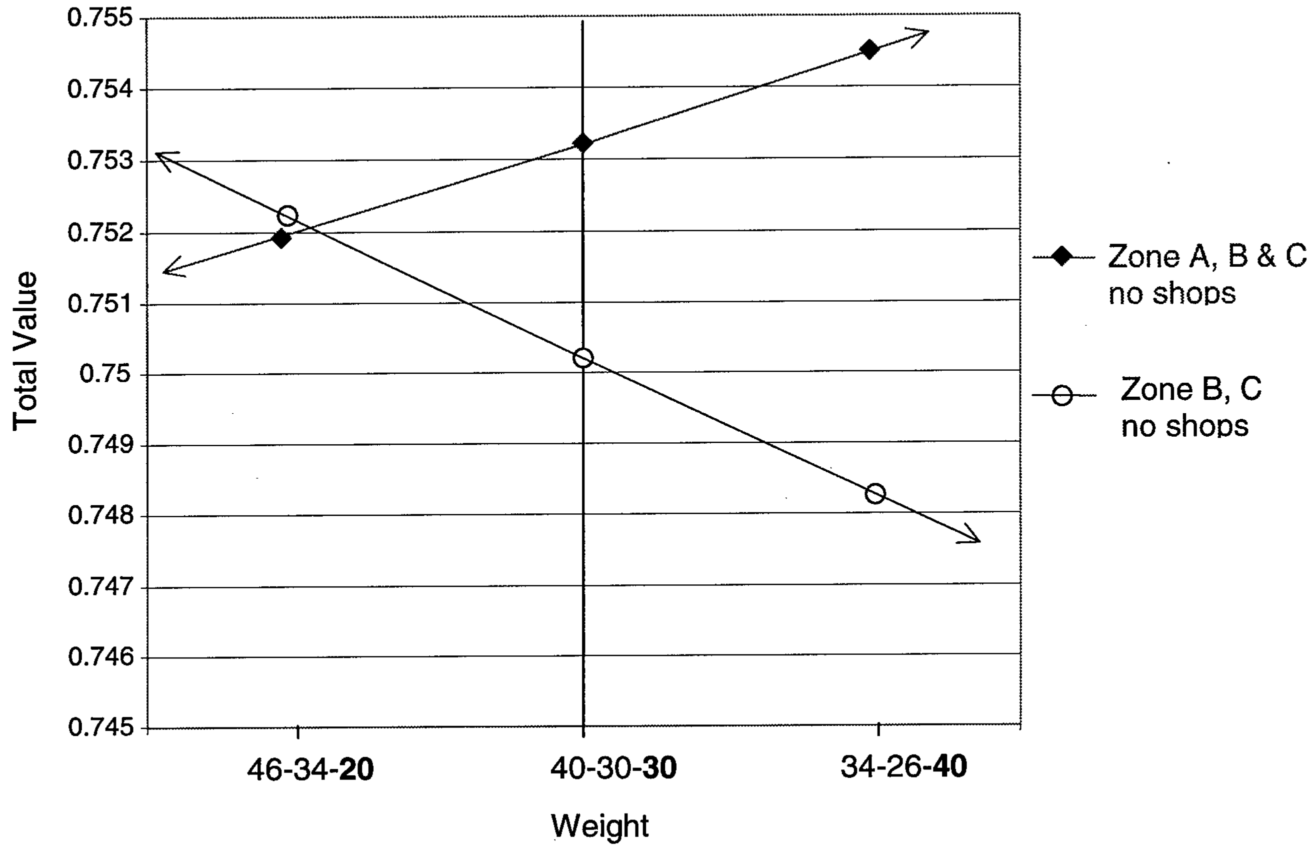

Figure B-29: Sensitivity of Customer Service Weight

Section J: Discussion

Given the current weights assigned to the value hierarchy, the highest scoring organizational strategy is to maintain Zones A, B and C in their current locations but consolidate the shops into a single workforce. The two alternative strategies that consolidated the shops scored higher than the two that divided the zones into shops.

The decision of whether to keep a Zone A is dependent on the weights assigned to the primary values, Air Force mission support, real property facility maintenance and customer service. If the weight assigned to Air Force mission support is higher than 46%, the weight assigned to real property facility maintenance is less than 18%, OR the weight assigned to customer service is less than 18%, then Zone A should be absorbed by Zone C. With the weights assigned by the decision maker, none of these conditions are met so the strategy that includes a Zone A scores the highest.

This analysis indicates that combining the top two scoring strategies should result in a better alternative. If Zone A was included but consisted of only Electrical and Structural craftsmen, a higher total value may be obtained. This assumes that this alternative strategy is feasible from a logistical and managerial perspective.

The poor performance of the "Do Nothing" alternative clearly shows that the need for change is shared by all four of the career fields providing input into this decision. All of the career fields saw the need to consolidate their personnel. This consolidation provides the supervisors the flexibility needed to efficiently utilize their human resources in the Air Force's environment of high operations tempo and frequent training.

Appendix C: Little Rock AFB Final Report

Table of Contents

INTRODUCTION

This product is one component of a thesis effort currently in progress at the GEEM program at AFIT. The document contains background information concerning the decision analysis model used to investigate organizational strategies that improve facility and infrastructure maintenance. This model was constructed and utilized by the 314th Civil Engineer Squadron located at Little Rock AFB, Arkansas. The key personnel for this decision analysis effort are as follows:

Individual	**Role**
Lt Col Drew Jeter Commander, 314th Civil Engineer Squadron	Decision Maker
Maj David Carlon Commander, Operations Flight	Decision Maker
Capt Shawn C. Thompson Graduate Student	Decision Analyst
Mr. Roger Forinash	Team Member (Electrical)
Mr. Douglas	Team Member (Electrical)
TSgt Bryan	Team Member (Electrical)
Mr. Davidson	Team Member (Plumbing)
Mr. Rucker	Team Member (Plumbing)
MSgt Dwight Henderson	Team Member (Utilities)
TSgt Bryant	Team Member (Utilities)
Mr. Dewey Higgs	Team Member (HVAC)
MSgt Carl Freeney	Team Member (HVAC)
TSgt Uptergrove	Team Member (HVAC)
Mr. Lloyd Hamby	Team Member (Structural)
SMSgt(s) James Merrill	Team Member (Structural)
Mr. Sinks	Team Member (Force Mgmt)
Mr. Art Brook	Team Member (Force Mgmt)
SMSgt Ehenger	Team Member (Force Mgmt)

A brief discussion of the decision analysis methodology utilized in this study is provided in Section A. The subsequent sections provide detailed information for each major step in this methodology. The analysis itself and the presentation of the results are the subjects of Sections H through J.

SECTION A: Methodology

The steps in this decision analysis methodology are summarized below. The sections of this appendix follow this same basic format.

1. Problem Identification: Properly identifying the problem is perhaps the most critical step. For this particular case study, the problem is how should the operations flight be reorganized to facilitate improved Air Force mission support, facility and infrastructure maintenance, and customer service.

2. Value Hierarchy (Section B): In this step, the items that are important to the decision maker and the decision analysis team in making this decision are developed and used to construct a hierarchy of values. This early step is very important because the value hierarchy will be referenced throughout the process.

3. Value Measurements (Section C): The decision analysis team is then tasked with determining how to measure the values on the lowest tier of the value hierarchy. These measurements are used later in the process for scoring alternative solutions.

4. Value functions (Section D): The measurements just developed are usually in different units and measured on different scales which cannot be summed together into a total score. To solve this problem, value functions are developed to convert the units of each value measure from step 3 into "value units". These "value units" are on a scale of 0 to 100.

5. Alternative Selection (Section E): The team or decision maker then determines organizational strategies that they would like to evaluate. Four strategies were put forth for evaluation during this exercise.

6. Alternative Scoring (Section F): Alternatives are evaluated using each of the measures derived in step 3. The value functions in step 4 are used to convert these scores into the same units (value units).

7. Value Hierarchy Weights (Section G): Once individual scores for each alternative are converted into "value units", the weight, or importance, placed on that score is assessed. Basically, the scores are multiplied by their respective weights before they are summed.

8. Deterministic Analysis (Section H): The final result from completing steps one through seven is a total score for each alternative from each of the career fields which comprise the decision analysis team. These scores enable the alternatives to be ranked from best to worst. The input from the five career fields represented on the decision analysis team is also combined into a grand total score for each alternative.

9. Sensitivity Analysis (Section I): The final ranking of alternatives from best to worst may be very sensitive to the weights assigned to the values in the value hierarchy. This impact is evaluated by studying the effect that manipulating the weights has on the final scores and rankings. The results from this analysis are presented in Section I.

10. Results Presentation (Sections H-J): The deterministic and sensitivity analysis provide valuable insight into the decision problem. The analysis results are presented throughout Sections H and J. The specific conclusions that can be drawn from these analyses and insights derived during this process are further discussed in Section J.

SECTION B: Value Hierarchy

The value hierarchy is an illustration of the things that the decision maker considers important and how those values relate to one another with regard to the decision context. To reduce TDY time and expenditure, a copy of the Wright-Patterson CE Squadron value hierarchy was forwarded to the CE Squadron at Little Rock AFB. This initial value hierarchy from Wright-Patterson is displayed in Figure C-1.

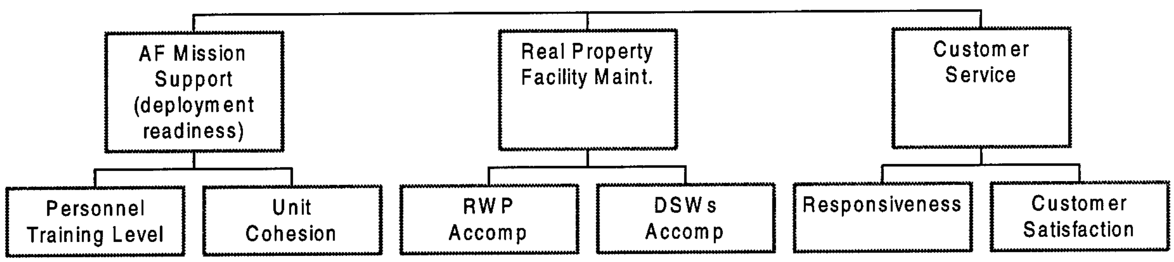

Figure C-1: Initial Value Hierarchy

After reviewing the value hierarchy from Wright-Patterson's CE squadron, the CE personnel at Little Rock AFB made changes to reflect the things that they considered important in making this decision. One change that was made was the splitting of Personnel Training Level into Mobility Training and the peace time, day-to-day Job Training. The addition of a separate value for Planned Work Order Accomplishment is another significant change. The resulting value hierarchy for the CE squadron at Little Rock AFB is presented in Figure C-2 and a discussion of each value is located on the following page.

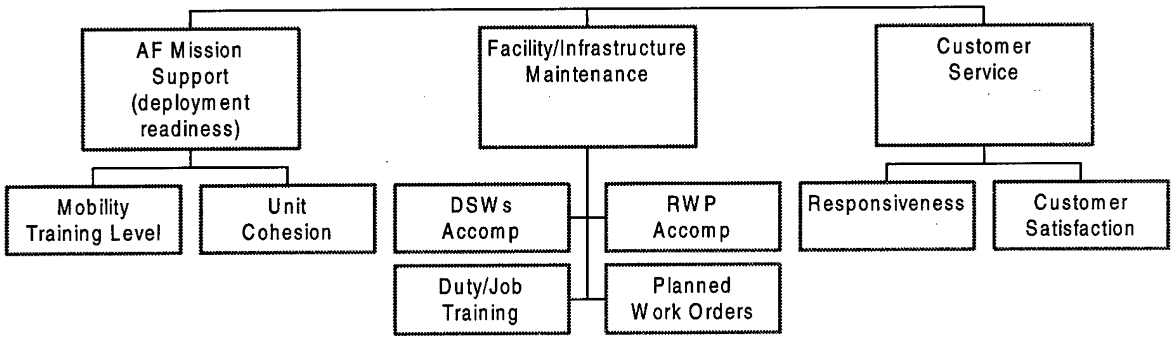

Figure C-2: Final Value Hierarchy

Air Force Mission Support: This value deals with the wartime mission of the Air Force. The way an Operations Flight is organized impacts the cohesiveness of the personnel and the frequency and quality of the training. A well trained and cohesive force are the primary aspects of mission support that are impacted by the organizational strategy of the Operations Flight.

Mobility Training Level: This value incorporates the training requirements for the military workforce to support Air Force mission taskings. These taskings can vary from individual mobility TDYs to a Prime BEEF team deployment. Primarily, mobility training involves SORTS reportable category I and II training.

Unit Cohesion: This value captures how well the military troops know each other personally, how familiar they are with each others job capabilities and skill level, and finally how well they work together as a team.

Facility/Infrastructure Maintenance: This value generally encompasses the peacetime mission of the Air Force. Maintaining Air Force installations is accomplished through RWP, DSWs, and to a lesser extent planned work orders. A trained workforce, both military and civilian, is crucial to carrying out these maintenance programs.

RWP Accomplishment: The ability to accomplish the work required in the Recurring Work Program is the focus of this value. RWP requirements usually occur with a known frequency and the scope of the work is predictable. This type of work is generally self-identified within the Civil Engineer Squadron.

DSW Accomplishment: This value captures the work not included in the RWP program. Direct scheduled work is the typical day-to-day maintenance work and is specifically defined as those work requests requiring less than 50 man-hours to complete.

Duty/Job Training: Both the military and civilian workforces require certain training to remain a productive part of their career fields. This training generally entails multi-skilling, upgrade training, special certifications, or other training deemed necessary for an individual, given their grade and time in service, to remain qualified to do their job.

Planned WOs: When work requests require more than 50 hours to complete and/or when they require planning or involvement from several crafts, they are no longer in the DSW category. These work requests are called planned work orders. The accomplishment of this type of work is the focus of this value.

Customer Service: Besides the wartime and peacetime missions of the Air Force, customer service is another item of primary importance to most Civil Engineer Squadrons. Customer Service is the third primary value in the hierarchy and is divided into responsiveness to customer needs and the customer's satisfaction with the product or service received.

Responsiveness: The average time required from the time a customer calls in a work request to the time the work is completed is embodied in this value.

Customer Satisfaction: This value incorporates the other aspects of good customer service, such as quality of workmanship and courtesy of workers.

SECTION C: Hierarchy Evaluation Measures

Each organizational strategy is graded on how well it performs in the areas that are of value to the decision maker. To accomplish this evaluation, measures for each of the eight values on the last level of the value hierarchy (Figure C-2) were developed.

Mobility Training Level: The measurement used to evaluate achievement for this value is the percentage of personnel ready for deployment. An individual is considered deployment ready if he/she is current on all category I and II mobility training, has current shot records, and has a general familiarity with the equipment utilized by the career field in a contingency environment.

Unit cohesion: The cohesiveness of the personnel in a particular career field is measured using a constructed scale. This constructed scale utilizes a five point system as illustrated below:

Score	Criteria
5	a) All craftsmen know each other fairly well b) All craftsmen are familiar with each others skill levels and capabilities c) All craftsmen work well together
4	a) Most craftsmen know each other fairly well b) Most craftsmen are somewhat familiar with each others skill levels and capabilities c) Craftsmen work fairly well together
3	a) Roughly half the craftsmen know each other fairly well b) Half the craftsmen are somewhat familiar with each others capabilities c) Most of the craftsmen work well together with a few problem groupings
2	a) A small percentage of the craftsmen know each other b) A small percentage of the craftsmen know the capabilities of their coworkers c) A small percentage of the craftsmen work well together
1	a) Almost none of the craftsmen know each other b) Most of the craftsmen know little about each others capabilities c) Few of the craftsmen work well together

RWP Accomplishment: Accomplishment of the RWP program is measured by estimating the percentage of the program that is completed. An assumption that was made is the individual RWP tasks are completed in order of importance. For example, maintenance on sewage lift station pumps is completed before periodic checks on the structural integrity of manholes covers.

DSW Accomplishment: Direct Scheduled Work is divided into Emergency, Urgent, and Routine work. Each category has a time limit for the work to be completed. For example, routine work is required to be completed within 30 days. The on time completion rate for DSW is the yardstick by which the DSW accomplishment value is measured.

Duty/Job Training: The ability for workers, both military and civilian, to do their job is impacted by the amount of training they receive. The military is required to complete multi-skill training and achieve skill level upgrades during their careers. Typically civilians are hired to fill a certain position and have the skills required for that position; however, civilian workforce training is a continuous process and necessary for these workers to obtain promotions. Military and civilian workers are expected to be trained to a level commensurate with their position and time spent in the career field. The workers that are trained to the appropriate level are considered *duty qualified.* The percentage of the workforce that is considered *duty qualified* is the measurement used for this value.

Planned WOs: The ability to accomplish large scale work that requires planning, many man-hours, and multiple skills to complete is measured by the percentage of the total programmed requirement that can be met.

Responsiveness: Different organizational strategies will alter the way job orders flow from the customer, through the organization, and finally into the hands of the craftsman that will accomplish the work. Responsiveness to customer needs is measured by estimating the average time required for a work request to travel from the customer to the craftsman and for that craftsman to complete the work.

Customer Satisfaction: Besides responsiveness, there are several other important aspects of good customer service. This value incorporates these aspects into a single measure. Customer satisfaction is a combined measure of the quality of the workmanship, the conduct of the craftsmen, and the overall customer's satisfaction of the completed work. Similar to unit cohesion, a constructed scale was used to measure customer satisfaction. This scale was derived from the Squadron's customer service survey sent periodically to various customers. The following measure utilizes the same five point scale used in the survey and is described below:

Score	Criteria
1	Disappointed in Service
2	Almost Met Expectations
3	Met Expectations
4	Exceeded Expectations
5	Well Beyond Expectations

SECTION D: Value Functions

The transition from how a given organizational strategy scores on one of the eight measures to the value derived from that score is accomplished by directly assessing a value function. These functions are highly dependent on the career field. For example, the Heating Ventilation and Air Conditioning (HVAC) career field places much more value on RWP accomplishment than does the Structural career field; as a result, value functions for each of the five career fields were derived for each of the eight values. This section discusses the development of these 40 value functions.

Air Force Mission Support: Personnel Training and Unit Cohesion are the components of this primary value (Figure C-2) and the measures for each are illustrated below.

Personnel Training: These functions illustrate the relationship between the percentage of the military workforce that are deployment ready and the value placed on that level of readiness. These "value units" are on a 0 to 100 scale with 100 representing complete satisfaction with deployment readiness while a score of 0 represents complete dissatisfaction with deployment readiness. The value placed on various levels of deployment readiness are similar across all five career fields participating in this analysis; however, the differences are significant enough to warrant individual value functions for each career field. The value functions for Mobility Training are displayed in Figures C-3 through C-7.

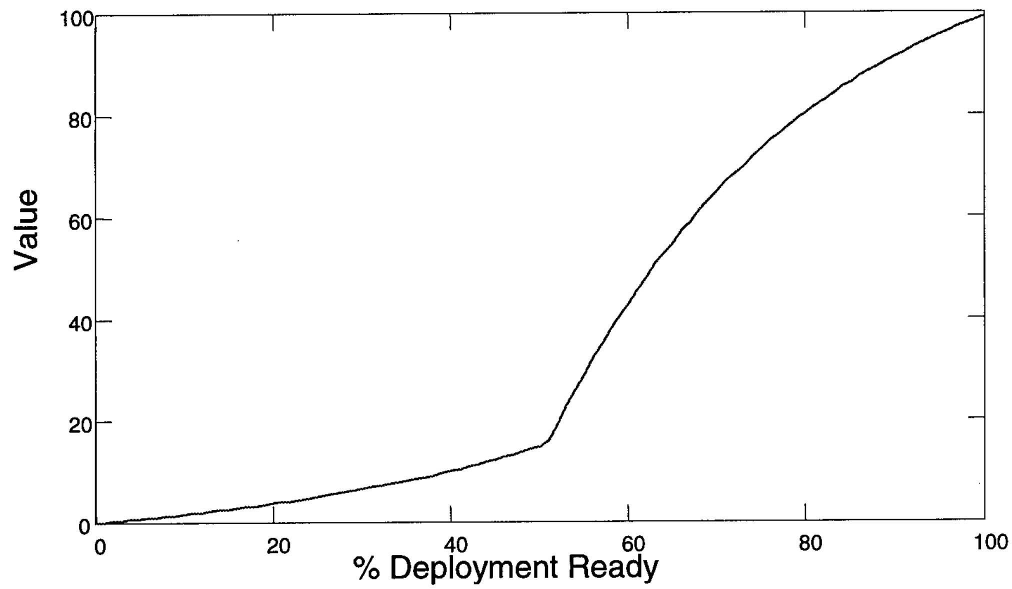

Figure C-3: Structural Mobility Training Function

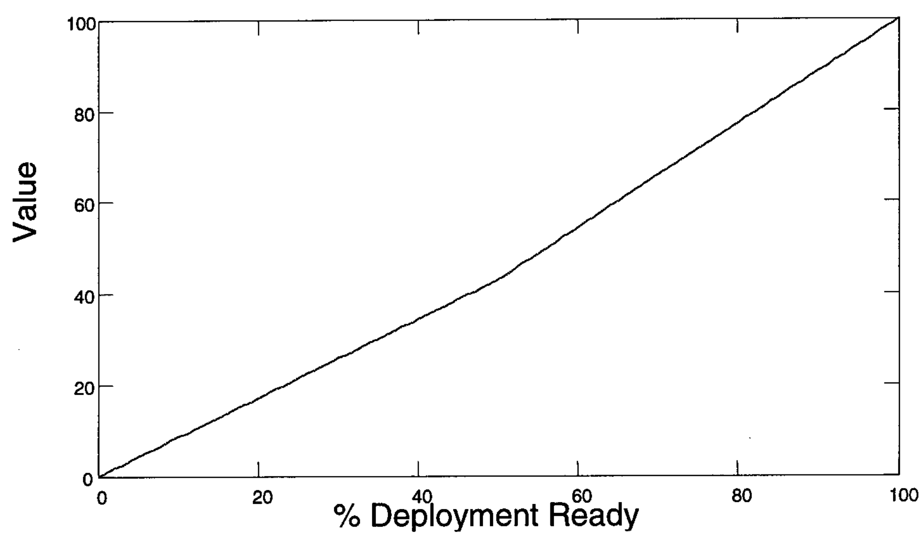

Figure C-4: Utilities Mobility Training Function

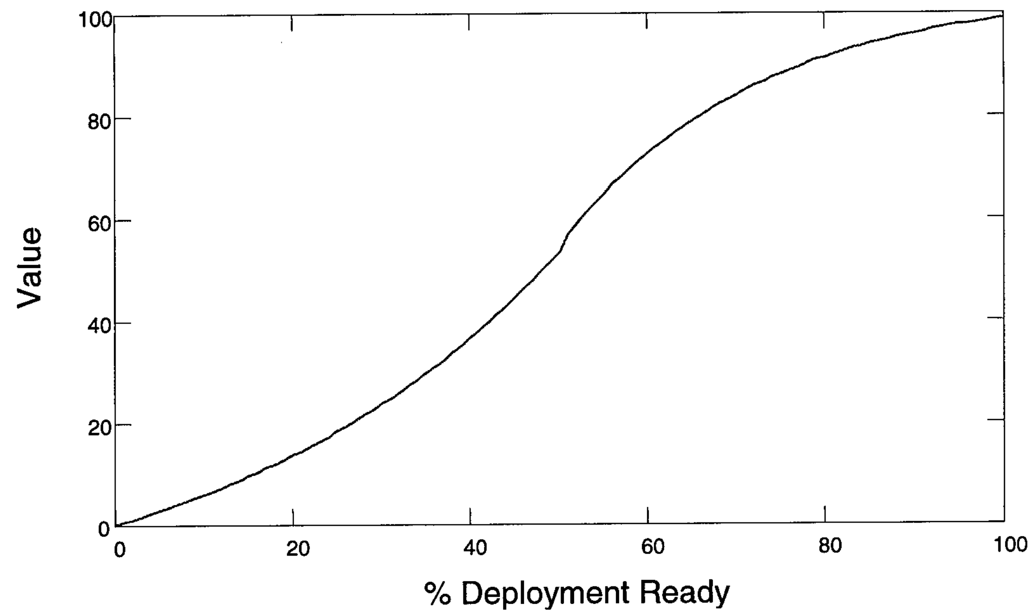

Figure C-5: Electrical Mobility Training Function

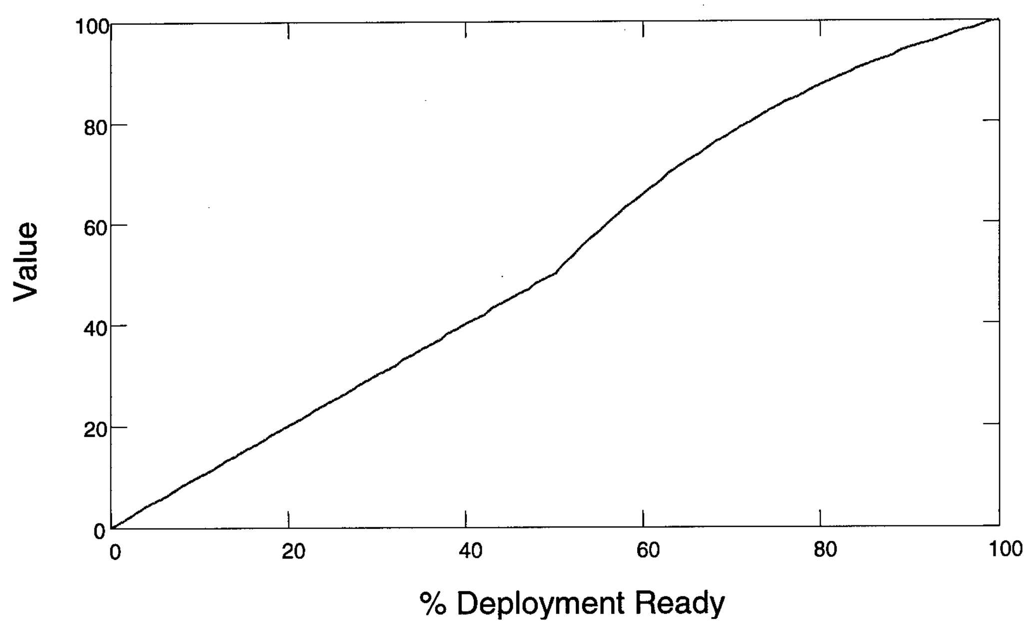

Figure C-6: HVAC Mobility Training Function

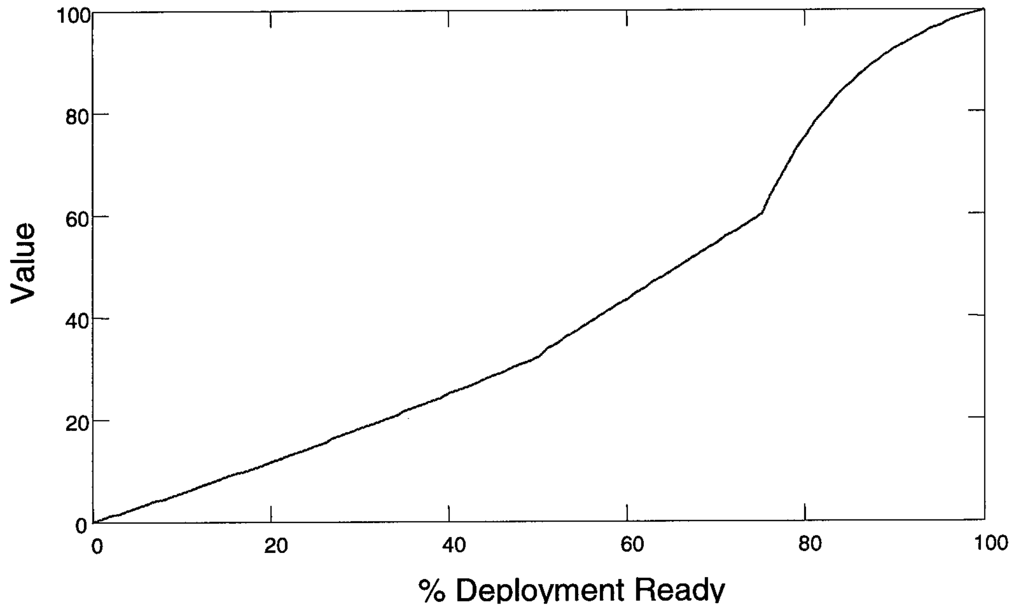

Figure C-7: Force Mgmt. Mobility Training Function

Unit Cohesion: This measure utilizes a constructed scale that places a value on each level of unit cohesion. More information on the criteria for this scale is provided in Section C.

Structural Unit Cohesion Values

Criteria Score	Value
1	.03
2	.10
3	.40
4	.78
5	1.00

Utilities Unit Cohesion Values

Criteria Score	Value
1	.05
2	.15
3	.43
4	.78
5	1.00

Electrical Unit Cohesion Values

Criteria Score	Value
1	.10
2	.28
3	.58
4	.88
5	1.00

HVAC Unit Cohesion Values

Criteria Score	Value
1	.00
2	.20
3	.40
4	.80
5	1.00

Force Mgt. Unit Cohesion Values

Criteria Score	Value
1	.03
2	.20
3	.45
4	.80
5	1.00

Facility/Infrastructure Maintenance: Accomplishment of the Recurring Work Program (RWP), Direct Scheduled Work (DSW), and Planned Work Orders are three of the four components of this primary value. The fourth component is Duty/Job training. The Value functions for all four components are illustrated below.

Recurring Work Program (RWP) Accomplishment: These functions illustrated in Figures C-8 through C-12, convert an RWP accomplishment percentage into the value derived from that percentage. These functions vary depending on the career field providing the input.

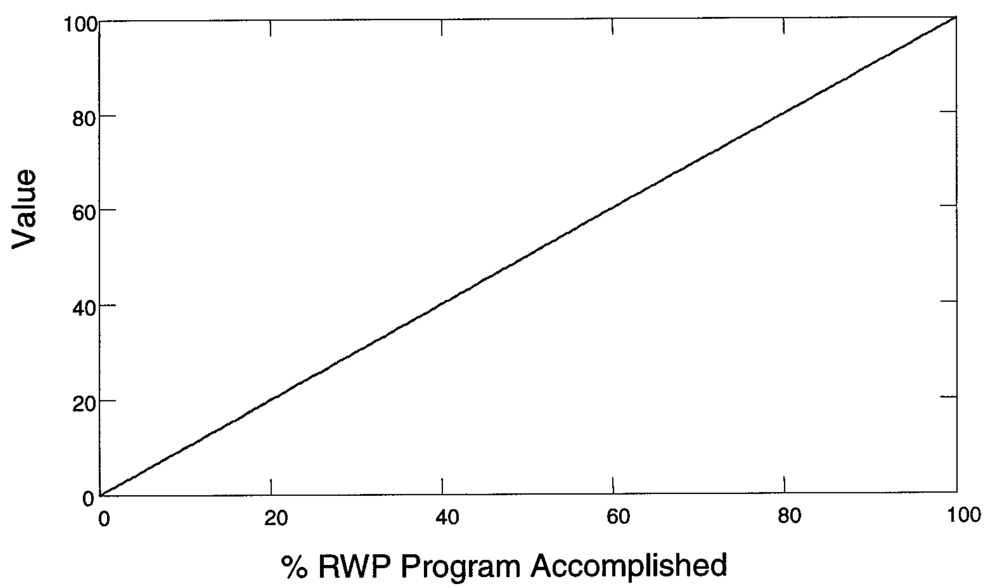

Figure C-8: Structural RWP Accomplishment Function

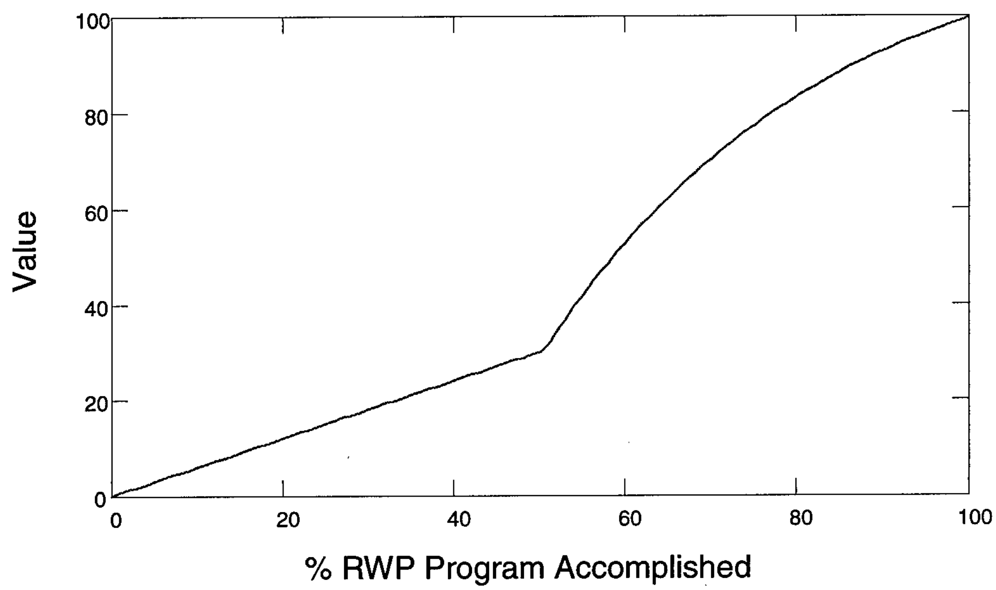

Figure C-9: Utilities RWP Accomplishment Function

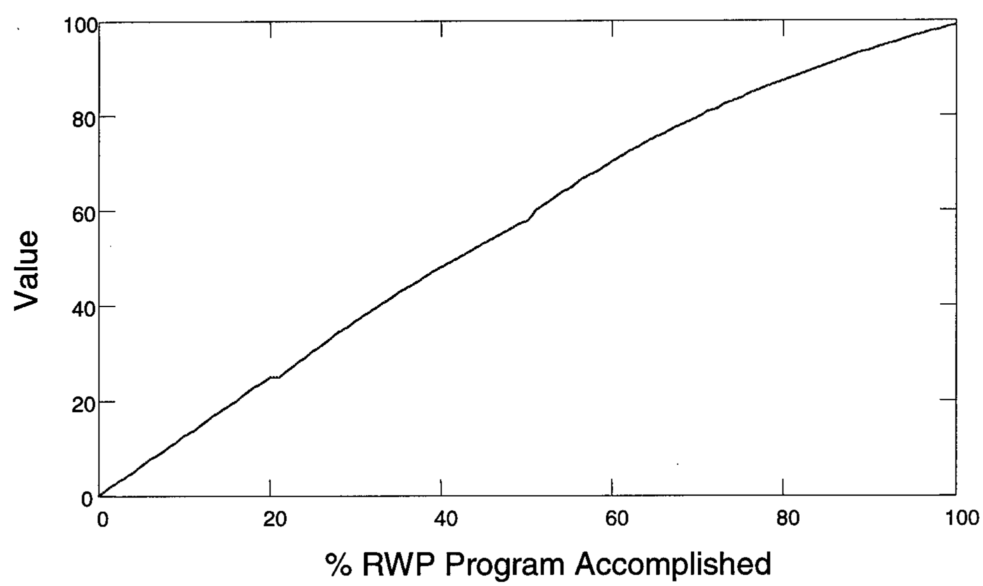

Figure C-10: Electrical RWP Accomplishment Function

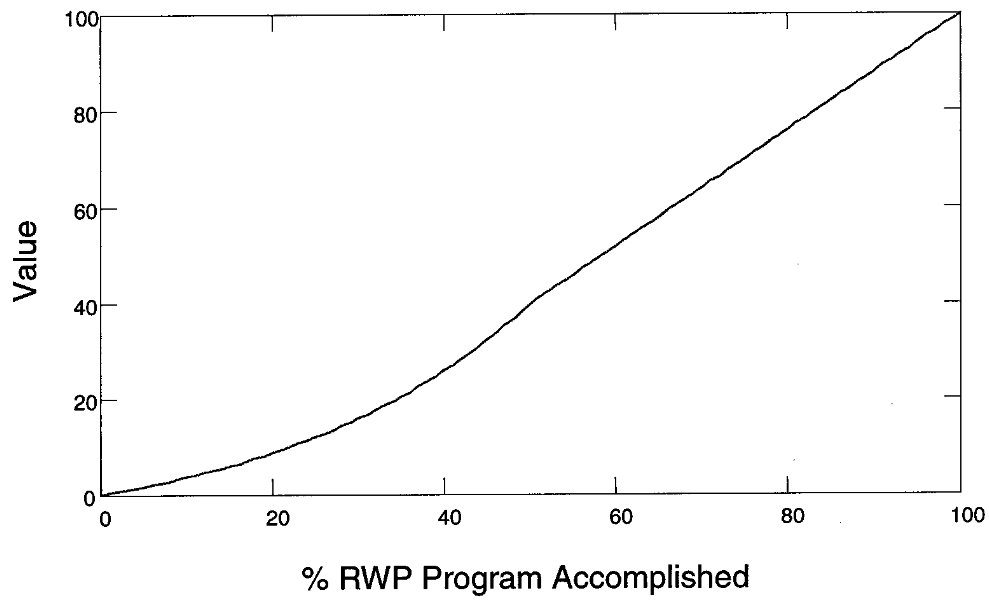

Figure C-11: HVAC RWP Accomplishment Function

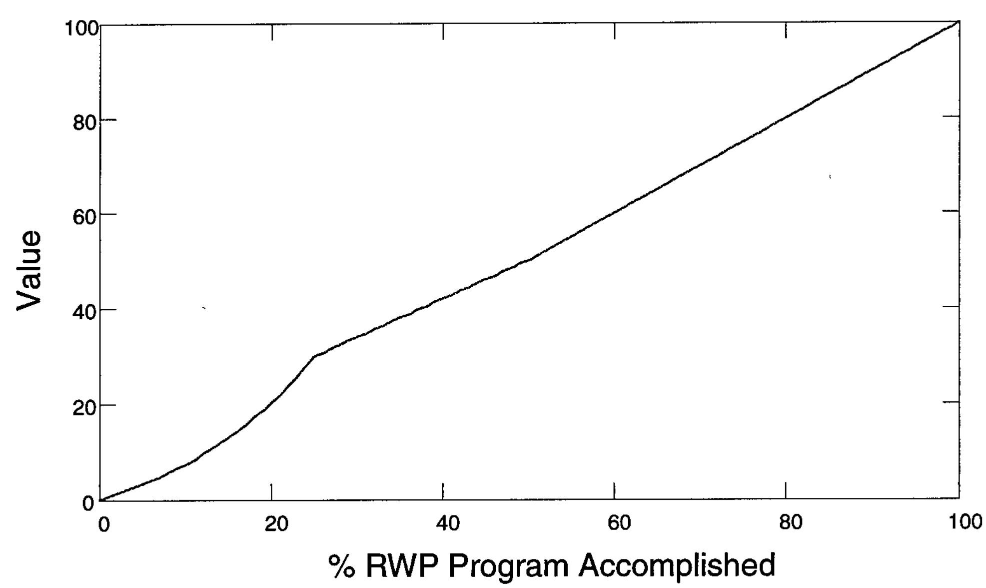

Figure C-12: Force Mgmt. RWP Accomplishment Function

Direct Scheduled Work Accomplishment: These functions convert each alternative's projected DSW on time completion rate into the value derived from that rate. Figures C-13 through C-17 illustrate the functions for the five career fields involved in this decision analysis.

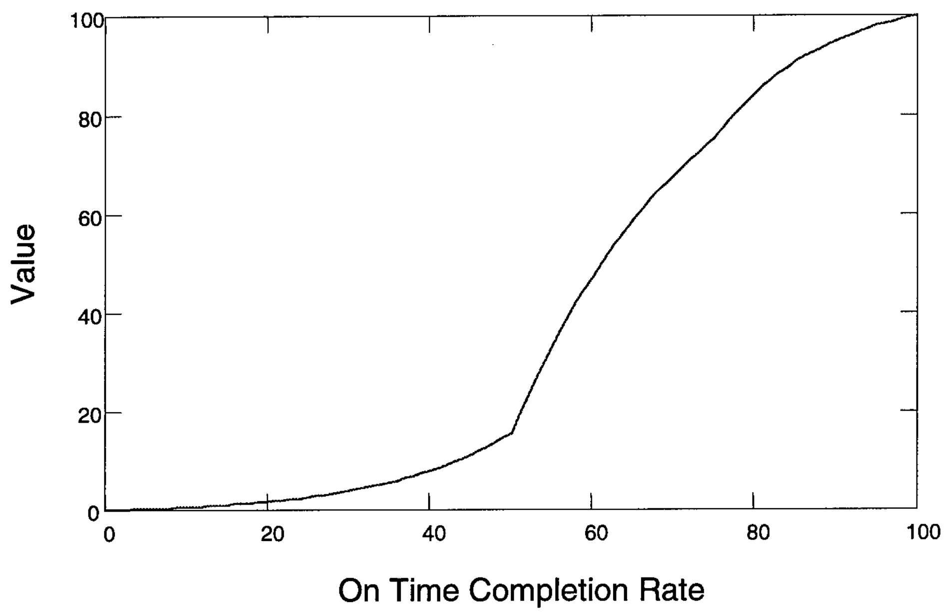

Figure C-13: Structural DSW Accomplishment Function

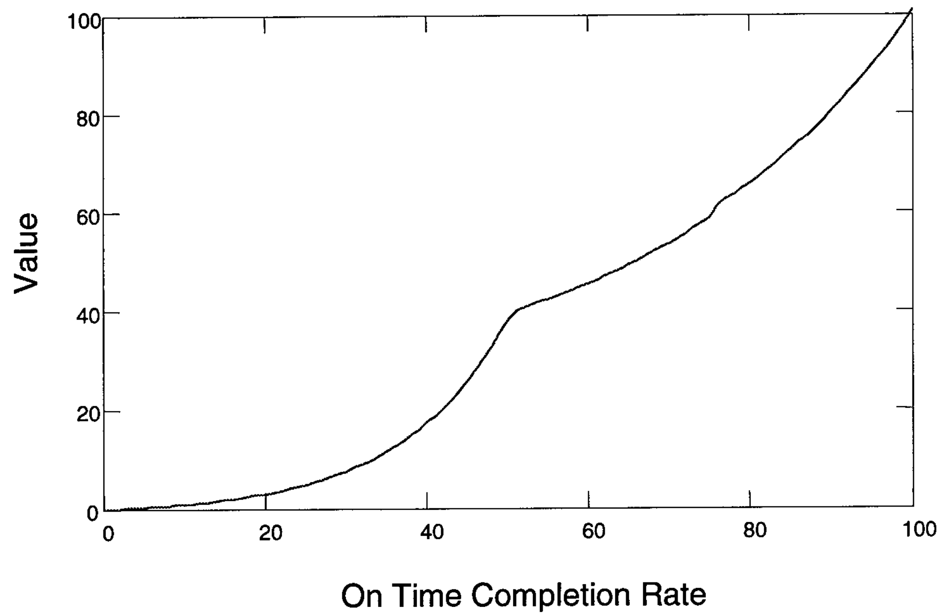

Figure C-14: Utilities DSW Accomplishment Function

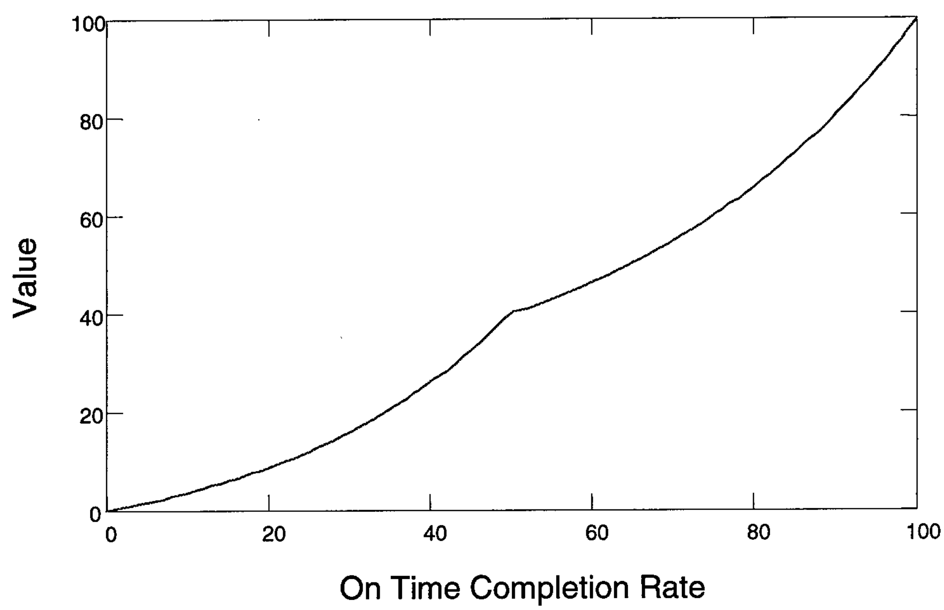

Figure C-15: Electrical DSW Accomplishment Function

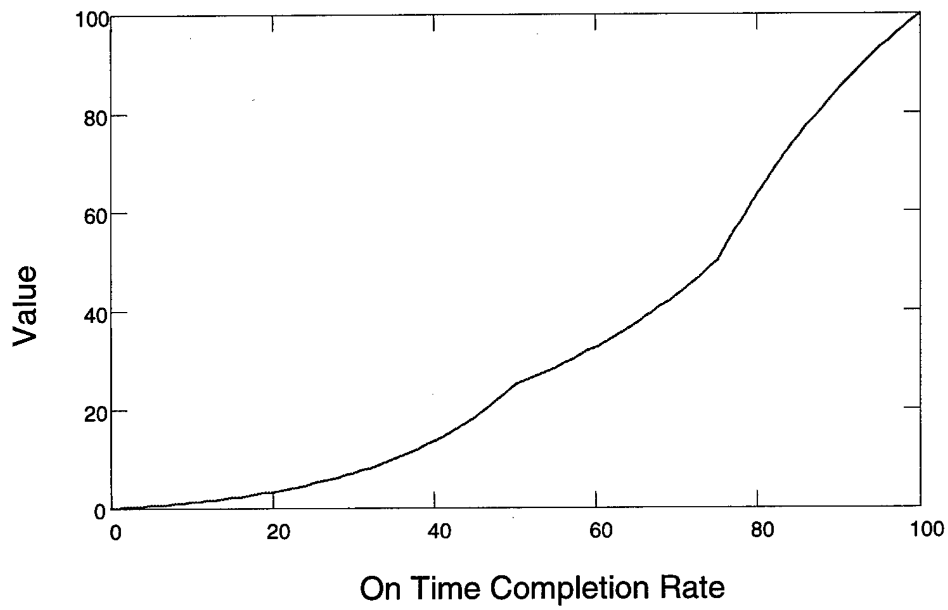

Figure C-16: HVAC DSW Accomplishment Function

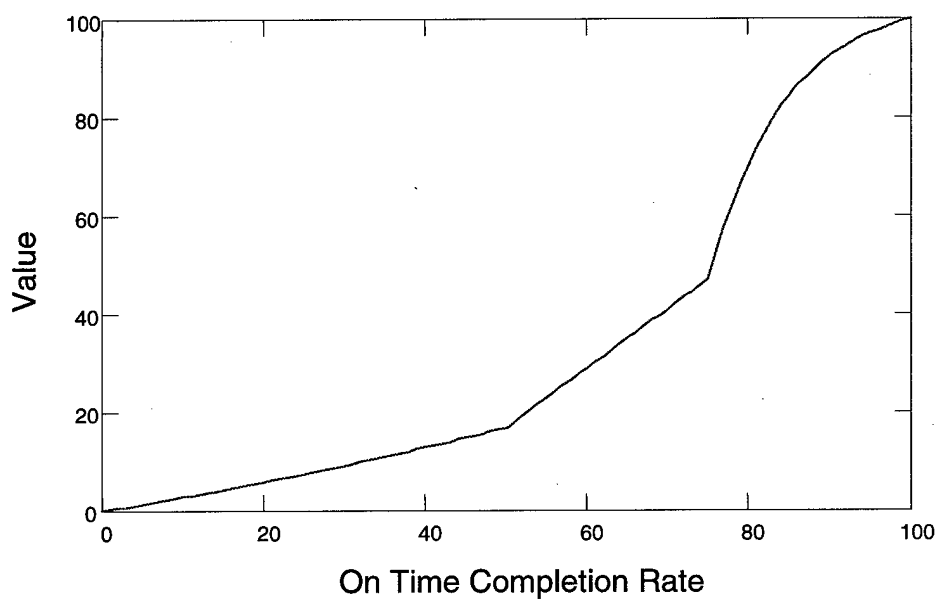

Figure C-17: Force Mgmt. DSW Accomplishment Function

Planned Work Order Accomplishment: These functions convert the percentage of the total man-hour requirement supplied into the value derived from that percentage. For example, if the planned work order program required 1000 man-hours from the Structural career field and that career field was able to provide 900 of those man-hours the result would be that 90% of the requirement was met. As Figure C-18 illustrates, that 90% for the structural career field translates into a value score of 70 out of a possible 100. The value functions for the other career fields are shown in Figures C-19 through C-22.

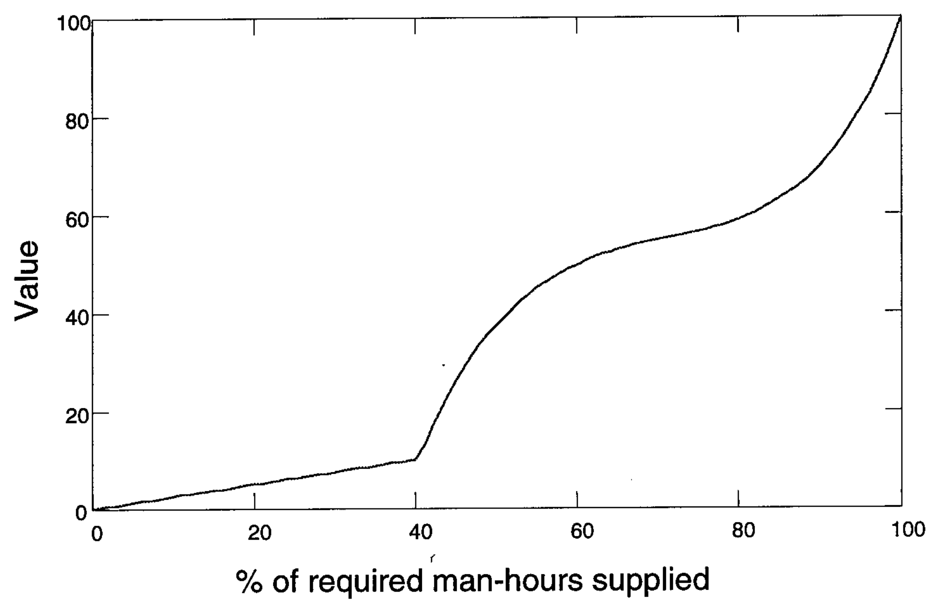

Figure C-18: Structural Planned Work Order Function

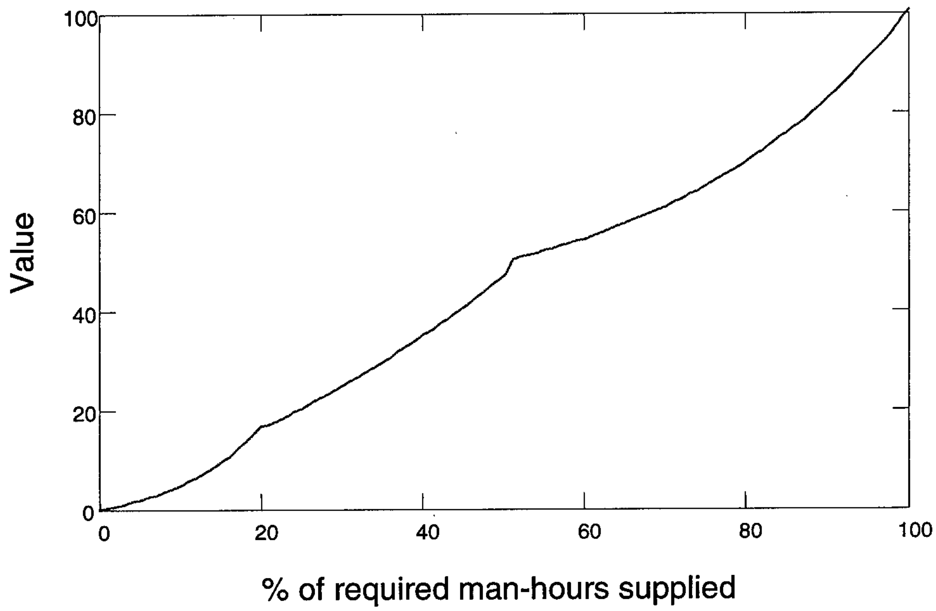

Figure C-19: Utilities Planned Work Order Function

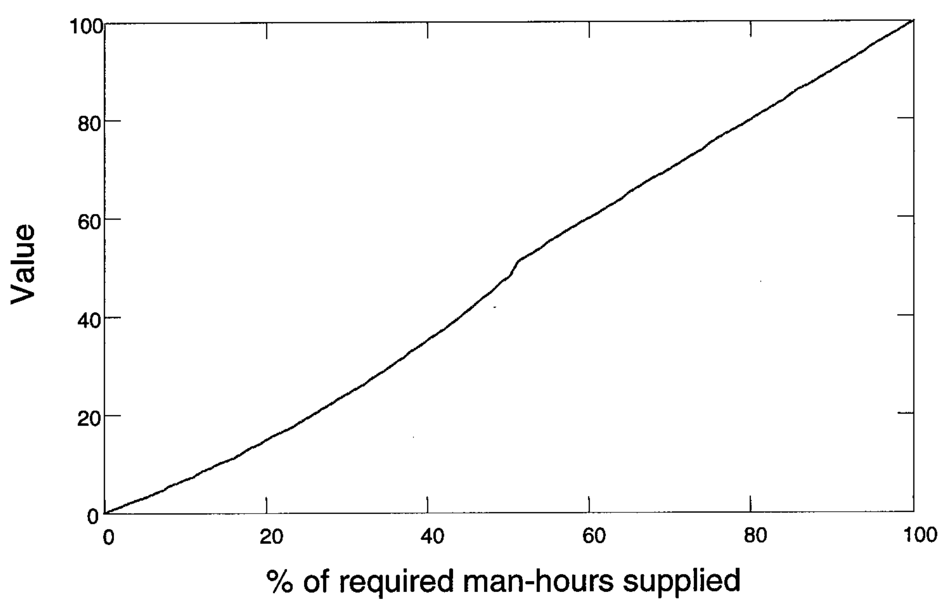

Figure C-20: Electrical Planned Work Order Function

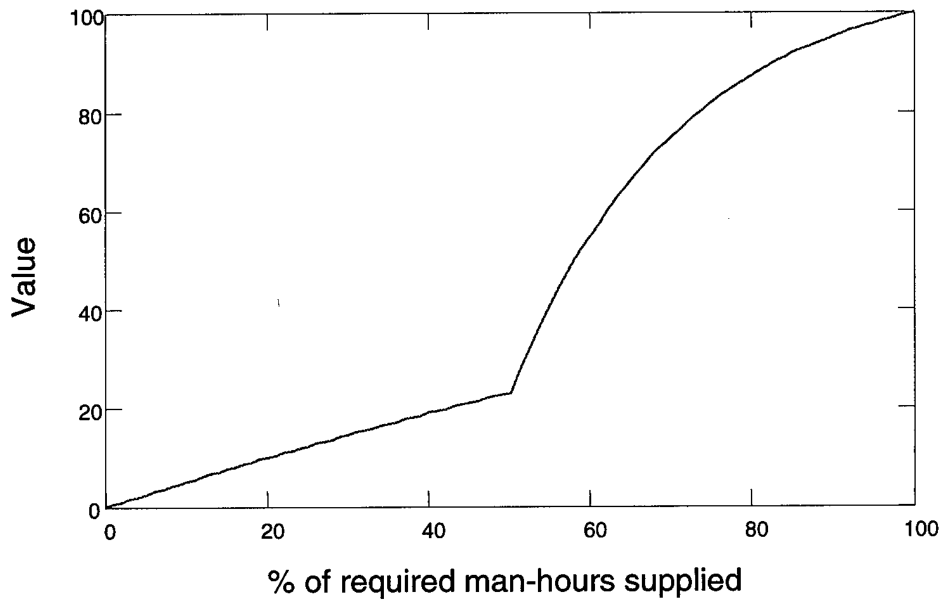

Figure C-21: HVAC Planned Work Order Function

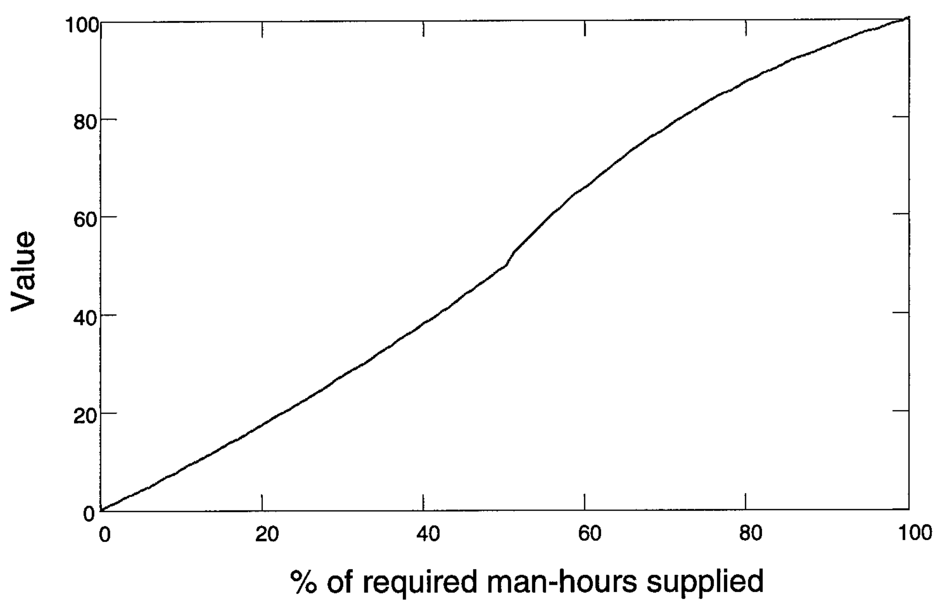

Figure C-22: Force Mgmt. Planned Work Order Function

Duty/Job Training: The functions in Figures C-23 through C-27 convert the percentage of personnel that are considered duty qualified into the value placed on that percentage.

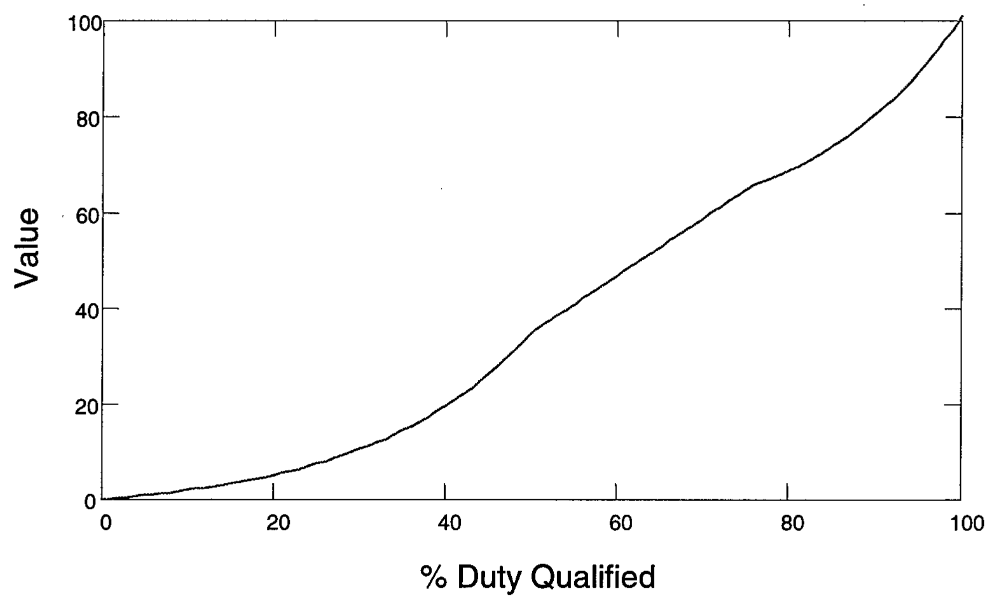

Figure C-23: Structural Duty/Job Training Function

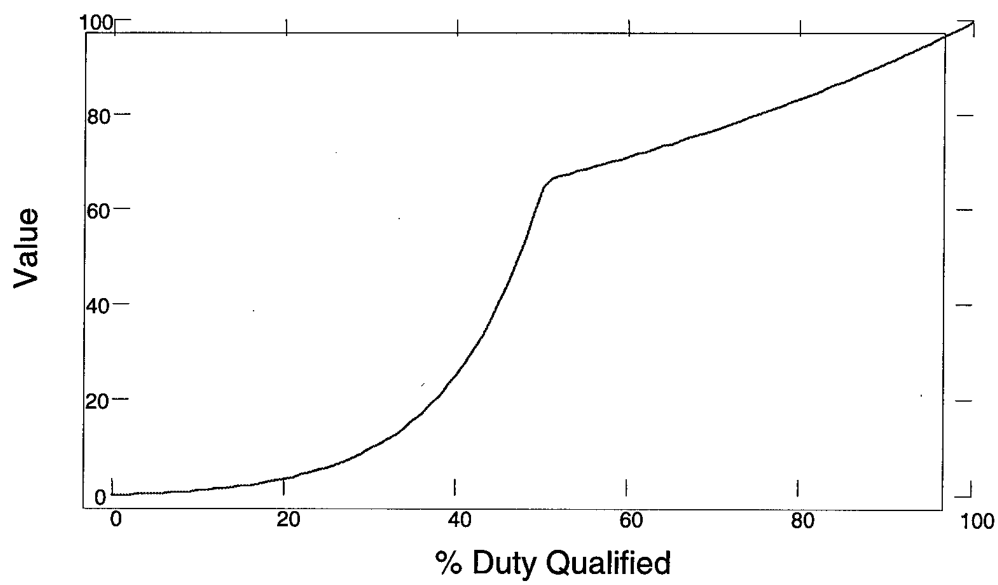

Figure C-24: Utilities Duty/Job Training Function

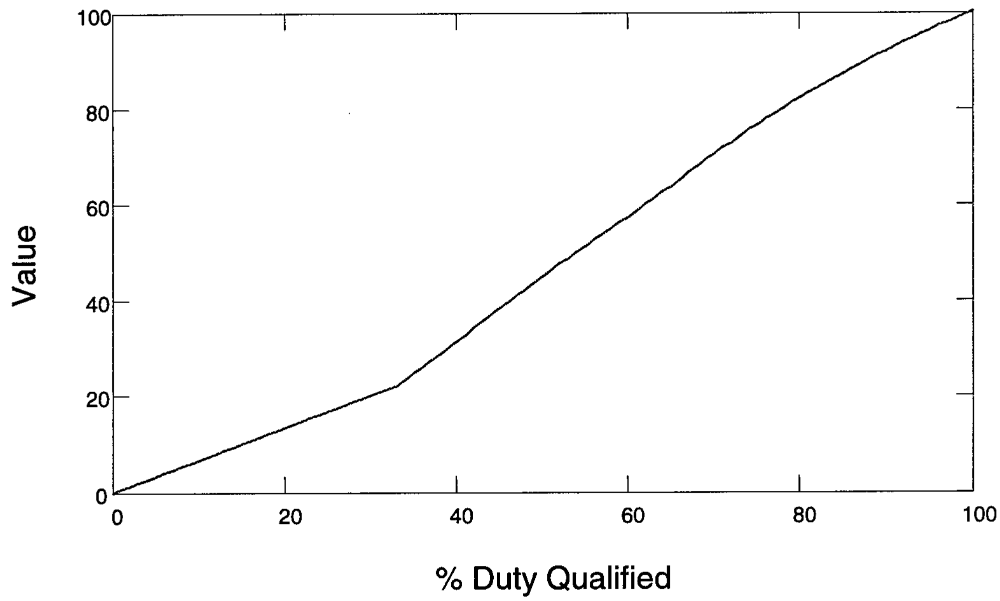

Figure C-25: Electrical Duty/Job Training Function

Figure C-26: HVAC Duty/Job Training Function

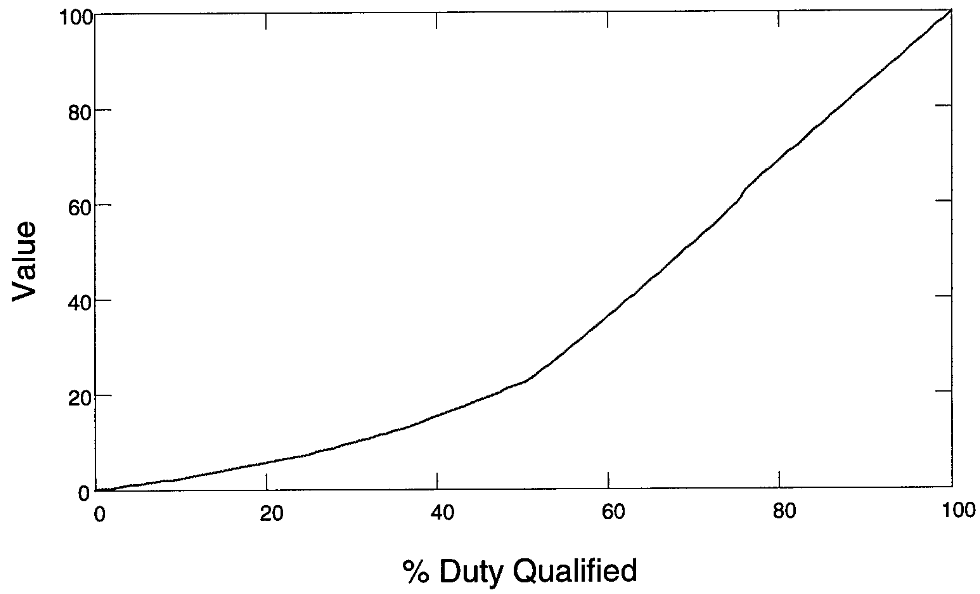

Figure C-27: Force Mgmt. Duty/Job Training Function

Customer Service: Responding quickly to the customers' needs and having satisfied customers are objectives critical to this primary value and the measures for each are illustrated below.

Responsiveness to Customer Requests: These functions convert the average time required to complete a DSW into the value derived from that time.

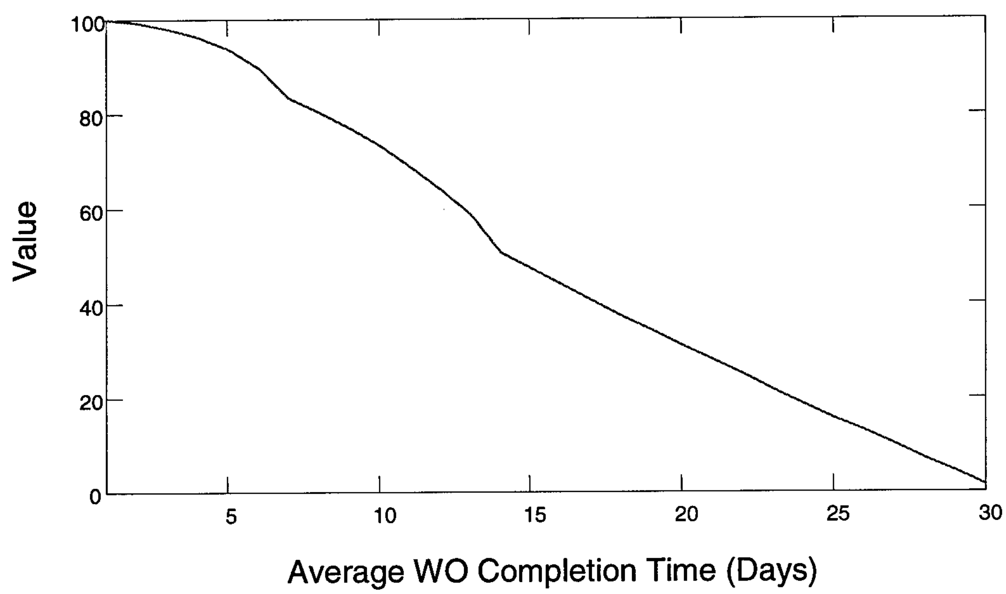

Figure C-28: Structural Responsiveness Function

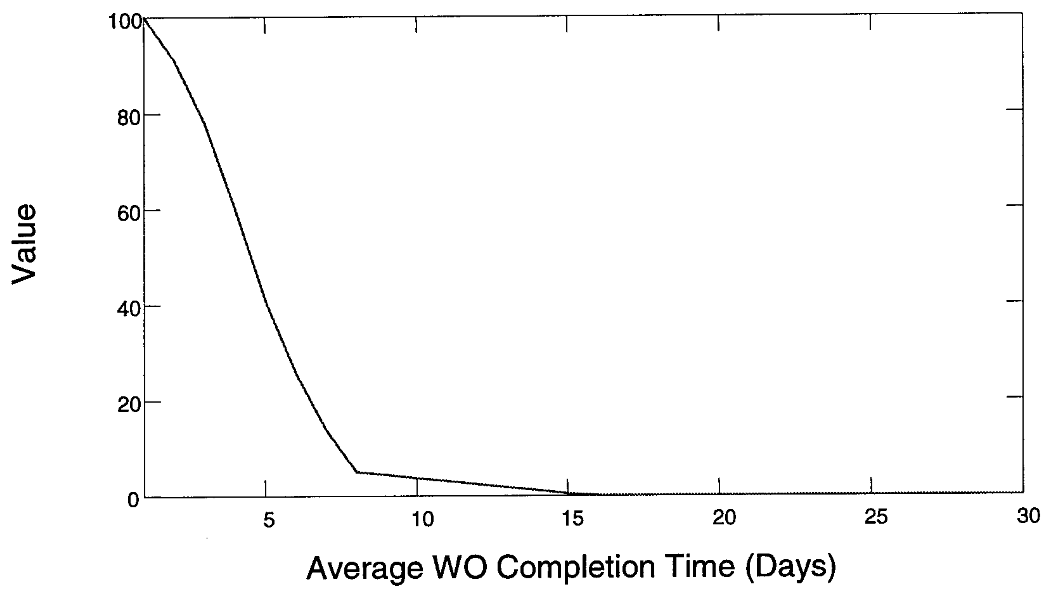

Figure C-29: Utilities Responsiveness Function

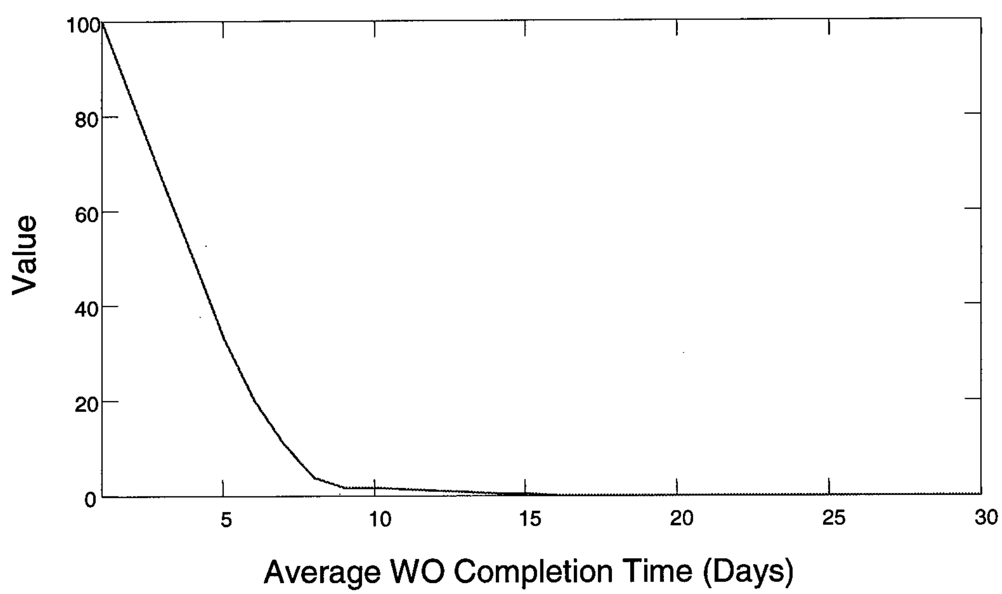

Figure C-30: Electrical Responsiveness Function

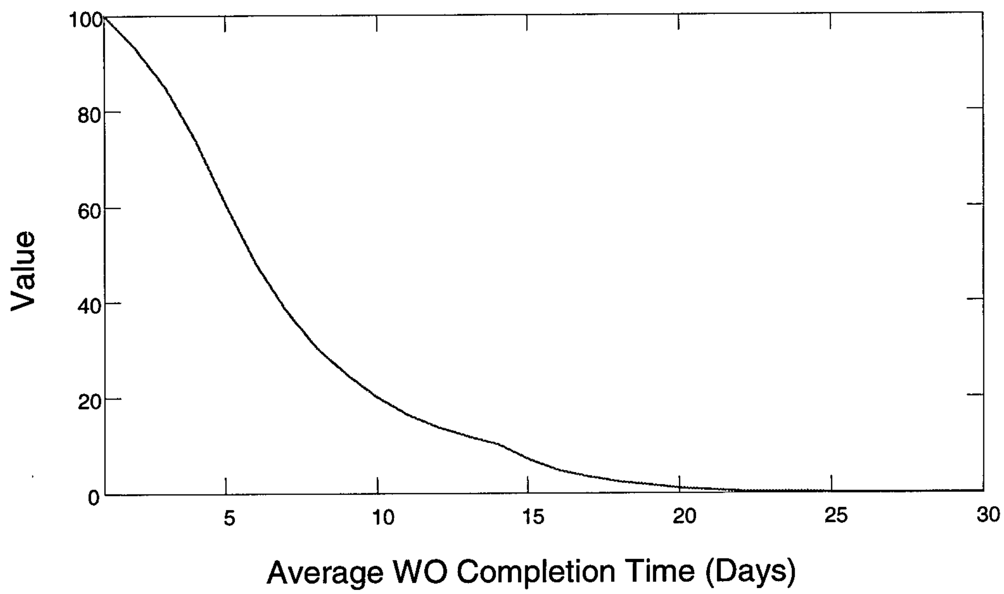

Figure C-31: HVAC Responsiveness Function

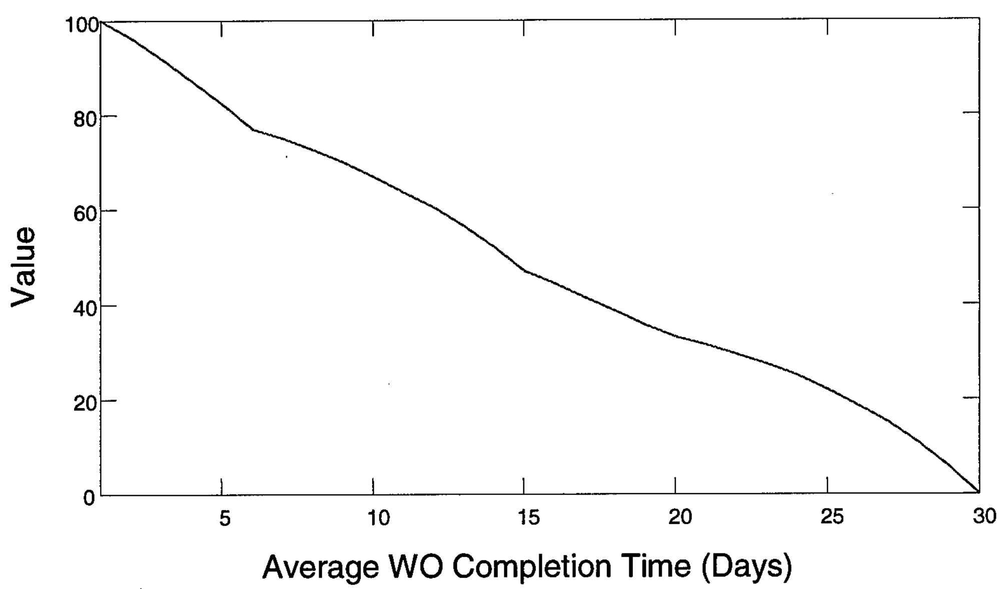

Figure C-32: Force Mgmt. Responsiveness Function

Customer Satisfaction: This measure utilizes a constructed scale that places a value on each level of customer satisfaction. More information on the criteria for this scale is provided in Section C.

Structural Customer Satisfaction Values

Criteria Score	Value
1	.00
2	.00
3	.30
4	.50
5	1.00

Utilities Customer Satisfaction Values

Criteria Score	Value
1	.00
2	.08
3	.35
4	.68
5	1.00

Electrical Customer Satisfaction Values

Criteria Score	Value
1	.03
2	.15
3	.45
4	.65
5	1.00

HVAC Customer Satisfaction Values

Criteria Score	Value
1	.10
2	.15
3	.50
4	.88
5	1.00

Force Mgt. Customer Satisfaction Values

Criteria Score	Value
1	.00
2	.10
3	.30
4	.75
5	1.00

SECTION E: Organizational Strategy Alternatives

Four organizational strategies were developed with the decision analysis team. These alternative strategies represented four distinctly different ways to organize the Operations Flight. The alternatives that rank the highest will be investigated further, prior to a final decision. The four alternatives are evaluated using the eight value measures described in Section C. The functions in Section D are then used to convert these scores into "value units". These value units will be summed together using the weights assigned to the values (Section G). The following is a brief explanation of each organizational strategy.

Alternative #1: No Change: In this alternative the current organization of the Operations Flight remains unchanged. Figure C-33 illustrates the current organization. The Maintenance Engineering section is not shown and other detail is omitted because these portions of the Operations Flight remain unchanged in all four organization strategies.

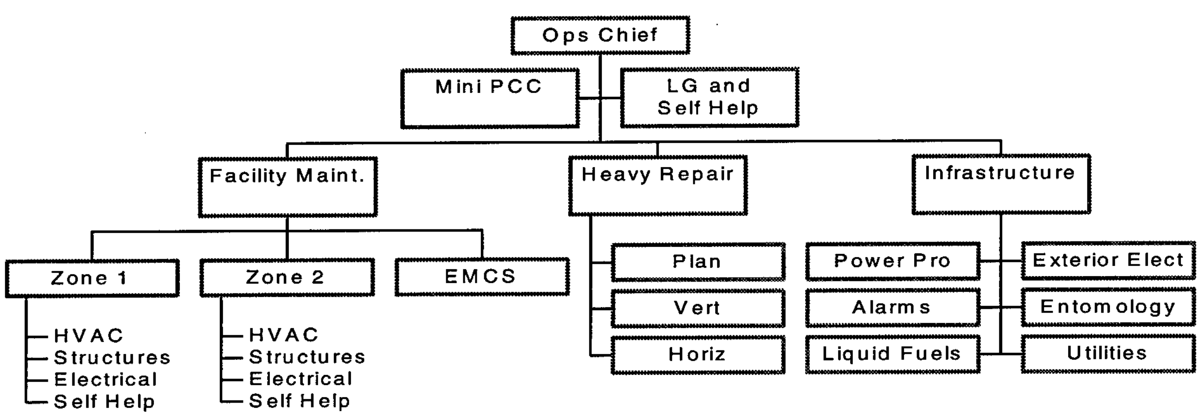

Figure C-33: No Change Option

Alternative #2: Absorb Vertical: This option removes the personnel and responsibilities from Heavy Repair's Vertical shop and disburses it among the two zones. The planning function and self help support would be provided within this new Facility Maintenance element. This strategy is illustrated in Figure C-34 below.

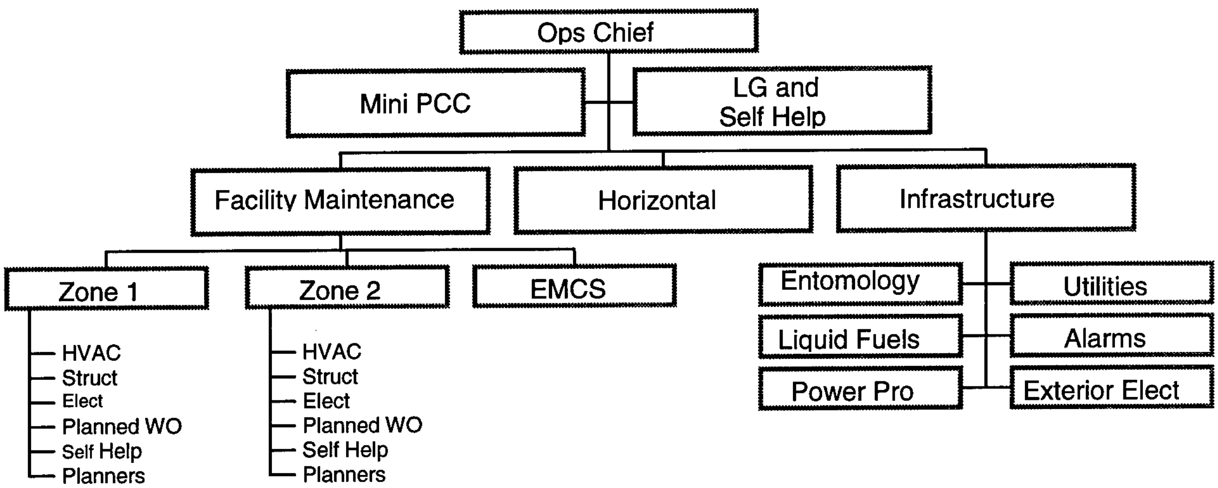

Figure C-34: Absorb Vertical Option

Alternative #3: Single Zone: As shown in Figure C-35, this strategy absorbs Vertical into the zones and combines the two zones. Another aspect of this strategy is that the HVAC personnel are removed from the Facility Maintenance element and placed into a shop of their own along with EMCS.

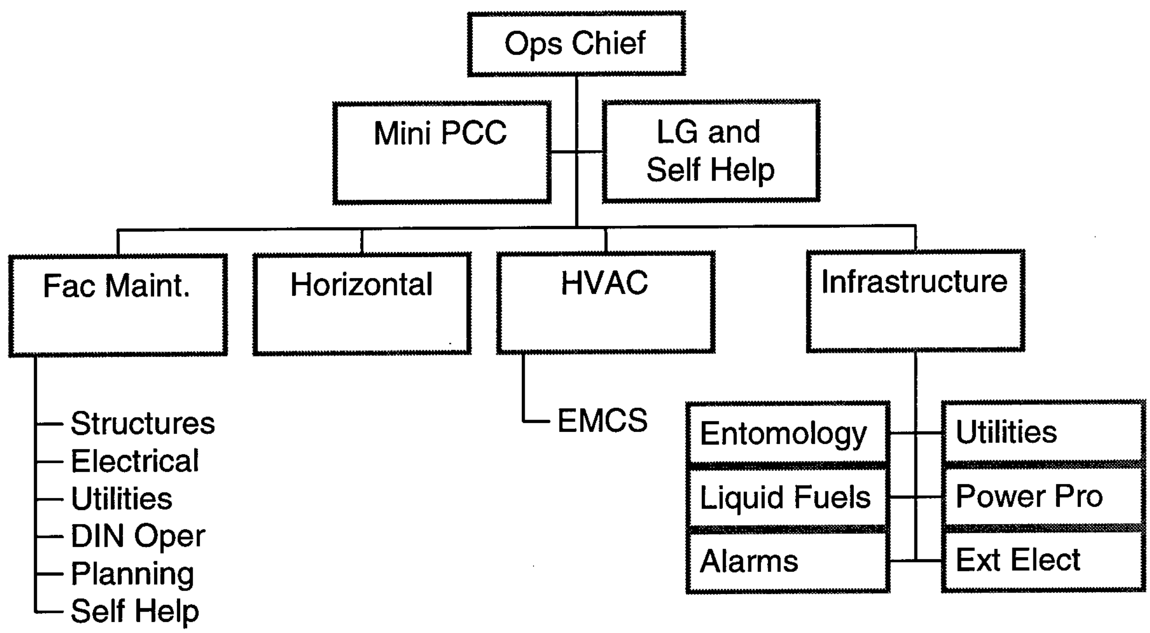

Figure C-35: Single Zone Option

Alternative #4 Shops: This strategy, illustrated in Figure C-36, places each career field into a shop. It is basically the former shop organization with the new AFSCs.

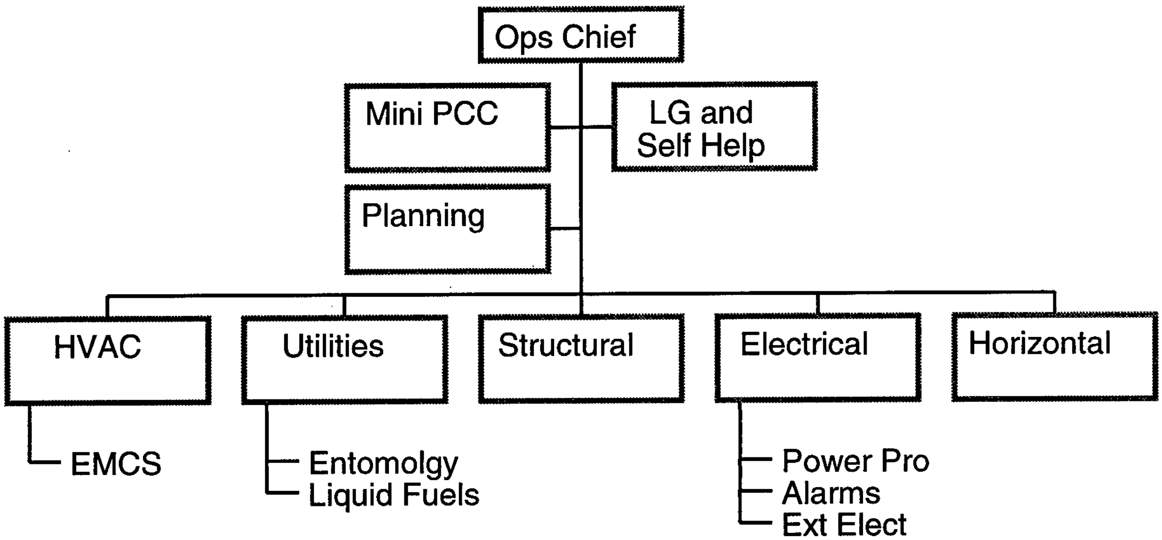

Figure C-36: Shops Option

SECTION F: Alternative Scoring

The four alternatives were scored using the measures derived for each of the eight values. The functions in Section D were then used to translate these raw scores into "value units". The raw scores entered into the functions of Section D for each career field are provided below.

Table C-1: Option Scores for the Structural Career Field

	Mobility Training			Unit Cohesion			RWP Accomp.		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	55	60	65	NA	3	NA	20	30	40
Absorb Vertical	75	80	85	NA	4	NA	70	75	80
Single Zone	85	90	95	NA	5	NA	80	95	100
AFSC Shops	95	98	100	NA	5	NA	80	95	100

	DSW Accomp			Planned WO Accomp.			Duty/Job Training		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	80	85	90	75	78	80	55	60	65
Absorb Vertical	80	85	90	75	78	80	70	80	85
Single Zone	90	93	95	85	90	100	95	98	100
AFSC Shops	90	93	95	85	90	100	95	98	100

	Responsiveness			Customer Satisfaction		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	10	11	15	NA	5	NA
Absorb Vertical	10	11	15	NA	5	NA
Single Zone	8	10	12	NA	4	NA
AFSC Shops	8	10	12	NA	4	NA

Table C-2: Option Scores for the Utilities Career Field

	Mobility Training			Unit Cohesion			RWP Accomp.		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	75	78	80	NA	4	NA	50	53	55
Absorb Vertical	75	78	80	NA	4	NA	50	53	55
Single Zone	80	83	85	NA	4	NA	80	83	85
AFSC Shops	90	93	95	NA	5	NA	90	93	95

	DSW Accomp			Planned WO Accomp.			Duty/Job Training		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	60	63	65	45	48	50	50	53	55
Absorb Vertical	60	63	65	80	83	85	50	53	55
Single Zone	75	78	80	90	93	95	75	78	80
AFSC Shops	85	88	90	50	53	55	85	88	90

	Responsiveness			Customer Satisfaction		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	6	7	8	NA	4	NA
Absorb Vertical	5	7	9	NA	4	NA
Single Zone	3	4	6	NA	5	NA
AFSC Shops	2	3	6	NA	2	NA

Table C-3: Option Scores for the Electrical Career Field

	Mobility Training			Unit Cohesion			RWP Accomp.		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	65	69	70	NA	3	NA	60	63	65
Absorb Vertical	70	73	75	NA	3	NA	65	68	70
Single Zone	75	78	80	NA	4	NA	75	78	80
AFSC Shops	75	78	80	NA	4	NA	75	78	80

	DSW Accomp			Planned WO Accomp.			Duty/Job Training		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	75	78	80	50	53	55	60	63	65
Absorb Vertical	80	83	85	65	66	70	65	68	70
Single Zone	85	88	90	75	79	80	80	83	85
AFSC Shops	80	81	85	70	73	75	85	88	90

	Responsiveness			Customer Satisfaction		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	2	3	3	NA	4	NA
Absorb Vertical	2	2.5	2.5	NA	4	NA
Single Zone	1.5	2	2	NA	5	NA
AFSC Shops	1.5	2	2	NA	3	NA

Table C-4: Option Scores for the HVAC Career Field

	Mobility Training			Unit Cohesion			RWP Accomp.		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	45	48	50	NA	3	NA	70	75	80
Absorb Vertical	45	48	50	NA	3	NA	70	75	80
Single Zone	60	70	75	NA	5	NA	85	88	90
AFSC Shops	60	70	75	NA	5	NA	85	88	90

	DSW Accomp			Planned WO Accomp.			Duty/Job Training		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	80	84	85	40	45	50	60	65	70
Absorb Vertical	80	84	85	40	45	50	60	65	70
Single Zone	85	88	90	60	65	70	75	80	85
AFSC Shops	85	88	90	60	65	70	75	80	85

	Responsiveness			Customer Satisfaction		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	7	10	12	NA	3	NA
Absorb Vertical	7	10	12	NA	3	NA
Single Zone	5	6	7	NA	4	NA
AFSC Shops	5	6	7	NA	4	NA

Table C-5: Option Scores for the Force Management Career Field

	Mobility Training			Unit Cohesion			RWP Accomp.		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	80	85	90	NA	3	NA	60	65	70
Absorb Vertical	80	85	90	NA	3	NA	60	65	70
Single Zone	80	85	90	NA	4	NA	65	74	75
AFSC Shops	90	95	100	NA	4	NA	85	88	90

	DSW Accomp			Planned WO Accomp.			Duty/Job Training		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	85	88	90	80	80	80	60	63	65
Absorb Vertical	85	88	90	70	73	75	60	63	65
Single Zone	88	89	90	75	79	80	65	68	70
AFSC Shops	90	93	95	85	88	90	80	83	85

	Responsiveness			Customer Satisfaction		
	Lower	Most Likely	Upper	Lower	Most Likely	Upper
No Change	5	6	7	NA	3	NA
Absorb Vertical	5	6	7	NA	3	NA
Single Zone	5	5	6	NA	3	NA
AFSC Shops	3	4	4	NA	4	NA

SECTION G: Weight Assessment

When the raw scores from Section F are converted into "value units" that value unit score for each of the values on the hierarchy is multiplied by its respective weight before a total score for each alternative can be calculated. These weights reflect the importance placed on the values in the value hierarchy. For example, if Mobility Training and Unit Cohesion were both considered to be equally important aspects of Air Force Mission Support, they would each be assigned a .50 weight. All five career fields represented on the decision analysis team provided their own separate weighting to be used in calculating their total scores for the alternatives. The results of this exercise are provided on the following page (Figure C-37).

The first level in the values hierarchy contains the three primary values. The weights assigned to these values must sum to 100 and establish their relative importance to one another. As illustrated in Figure C-37, there is a general consensus that Air Force Mission Support is the most important of the three primary values with Facility/Infrastructure Maintenance and Customer Service splitting the remainder of the weight. A sensitivity analysis was performed on these three weights to determine how sensitive the final alternative ranking is to changes in these weights. The 40-30-30 weighting from the Decision Maker was assessed for all career fields and manipulated as described in Section I to study this sensitivity.

The weight assigned to each of the primary values is further divided among the second tier values. For example, the HVAC career field determined that Air Force Mission Support should be given a .40 weight, and that weight should be split 50/50 between Mobility Training and Unit Cohesion.

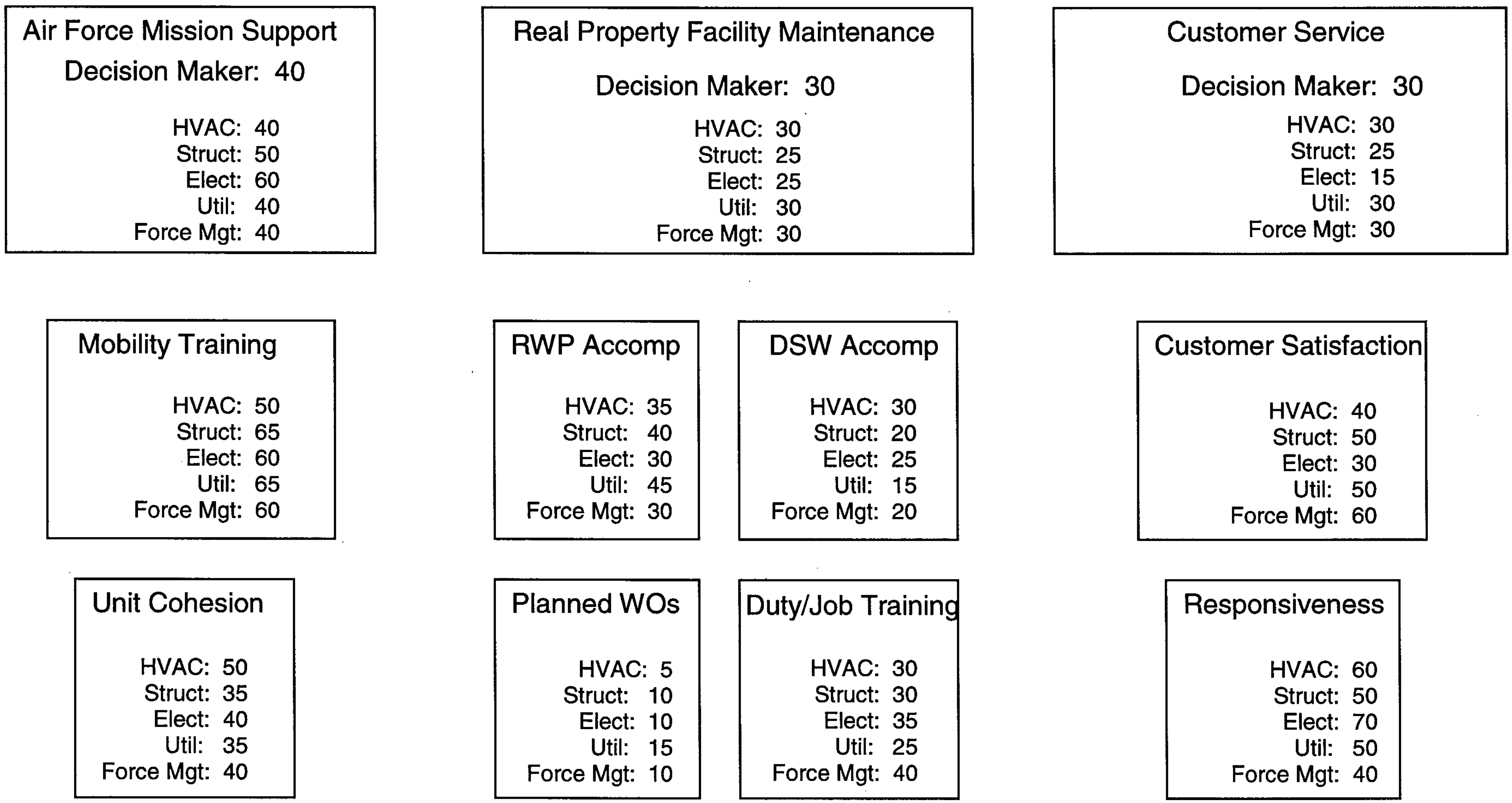

Figure C-37: Weights Applied to Values

SECTION H: Deterministic Analysis

Each of the career fields comprising the decision analysis team provided scores for the four alternatives, value functions to convert these scores into "value units", and weights used to compute a total score for each alternative. The result of this exercise was a total score for each alternative given by each career field. These total scores are summarized in Figure C-38 below.

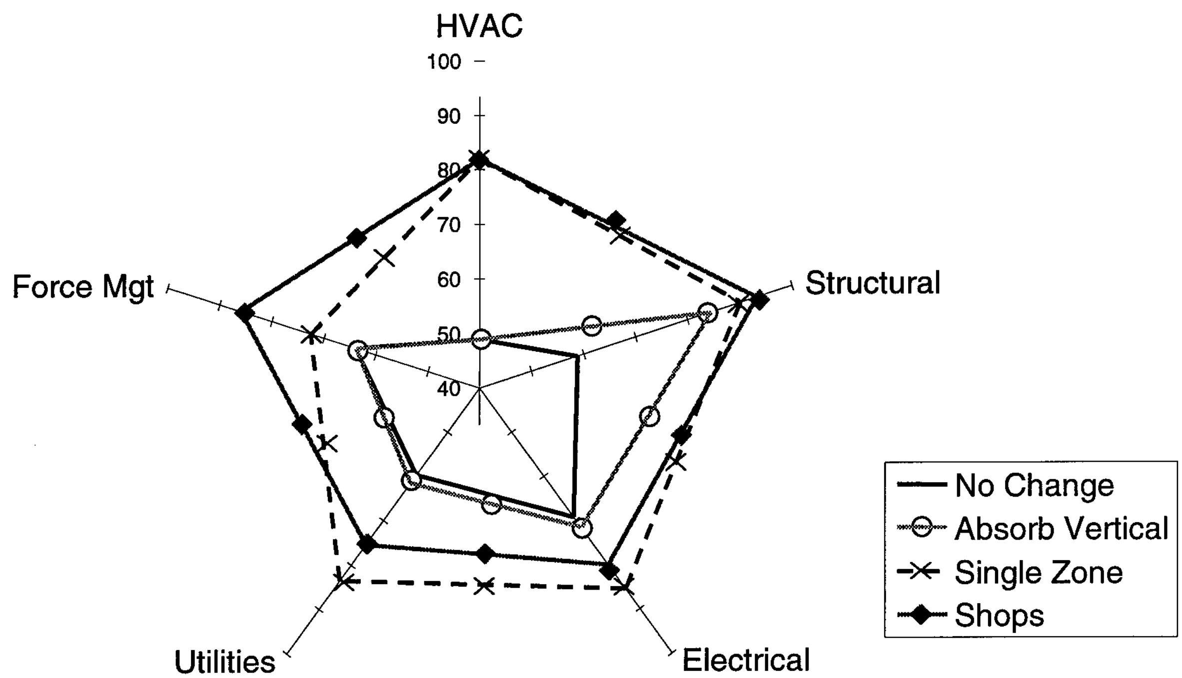

Figure C-38: Total Value by Career Field

Figure C-38 illustrates that all five career fields scored the No Change option the lowest indicating a unanimous attitude that a change is needed. The Single Zone and the Shops options scored #1 and #2 for all five career fields. These two options required the most consolidation of personnel verifying that the current organization is too decentralized and limits scheduling flexibility.

The four organizational strategy options evaluated in this process have varying degrees of impact on the five career fields comprising the analysis team. The decision maker assigned weights to each career field's input in order to combine their individual scores into a grand total score for each alternative. The weights assigned to each career field were based on the impact that the changing organizational strategy would have on the career fields. The Electrical, Structural, and Utilities career fields were determined to be impacted the most by the proposed organizational changes; therefore, their scores were assigned a weight of .25 each. The HVAC career field was impacted somewhat less and was therefore given a weight of .15. The Force Management career field was not as significantly impacted as the other four, so their input was given .10 weight. The grand total score for each organizational strategy option is illustrated in Figure C-39 with the portion contributed by each career field also annotated.

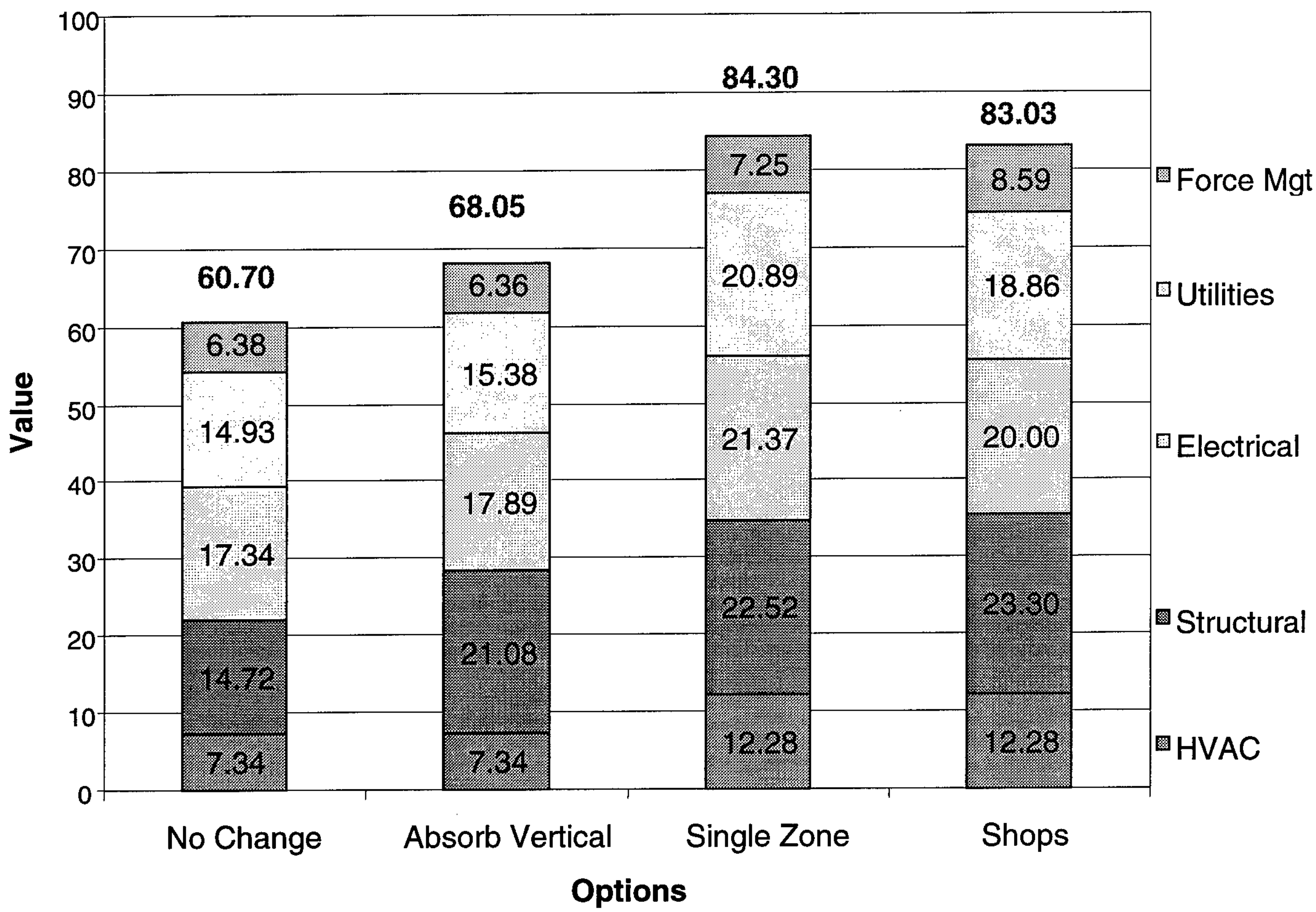

Figure C-39: Total Values Across Career Fields

SECTION I: Sensitivity Analysis

The results of the deterministic analysis can be sensitive to two uncertainties. The first uncertainty involves the scoring of the alternatives. When scoring an alternative, the technical experts were asked to provide a best estimate of how that alternative would perform for each of the six measures. Naturally, the expert can not be 100% certain how an alternative will perform so an upper and lower bound for this estimate was also solicited from the experts. The purpose of the lower and upper bound scores is to capture the range in which he/she was very confident that the *true* measure would fall. Figures C-40 through C-44 display the results of a sensitivity analysis performed using this range of values. The goal of the analysis was to determine the impact that the scoring uncertainty had on the total scores and the subsequent ranking of alternatives.

An explanation of Figure C-40 will help explain what these figures are intended to illustrate. The "Do Nothing" line on the cumulative distribution graph indicates that the total value of this alternative ranges from a value of just under 70 to just over 70. If all of the worst case scores for this alternative, generally the lower bound scores, were used in the model, the "Do nothing" alternative would receive a total score of just under 70. Likewise if this alternative was given the best case scores the total value would be just over 70. Note that the best possible score of the "Do nothing" alternative with regard to the scoring uncertainty data is still not as high as the worst possible score of the "Absorb

Vertical" alternative. Basically this means that the estimated uncertainty involved in scoring the alternatives does not impact the final ranking of the alternatives. Since none of the cumulative distribution lines of the four alternatives cross, the ranking of the alternatives is not impacted by the scoring uncertainty. The highest ranked alternative, the cumulative distribution line to the far right, clearly dominates the second highest ranked alternative and so on. This is true for all the career fields except HVAC. The HVAC career fields scored the "Shops" and the "Single Zone" alternatives exactly the same, resulting in overlapping cumulative distribution lines for these two alternatives. Careful examination of the organization chart reveals the reason. The placement of the HVAC career field personnel is identical for these two alternatives. The same is true when comparing the "Do Nothing" and the "Absorb Vertical" alternatives for the HVAC career field.

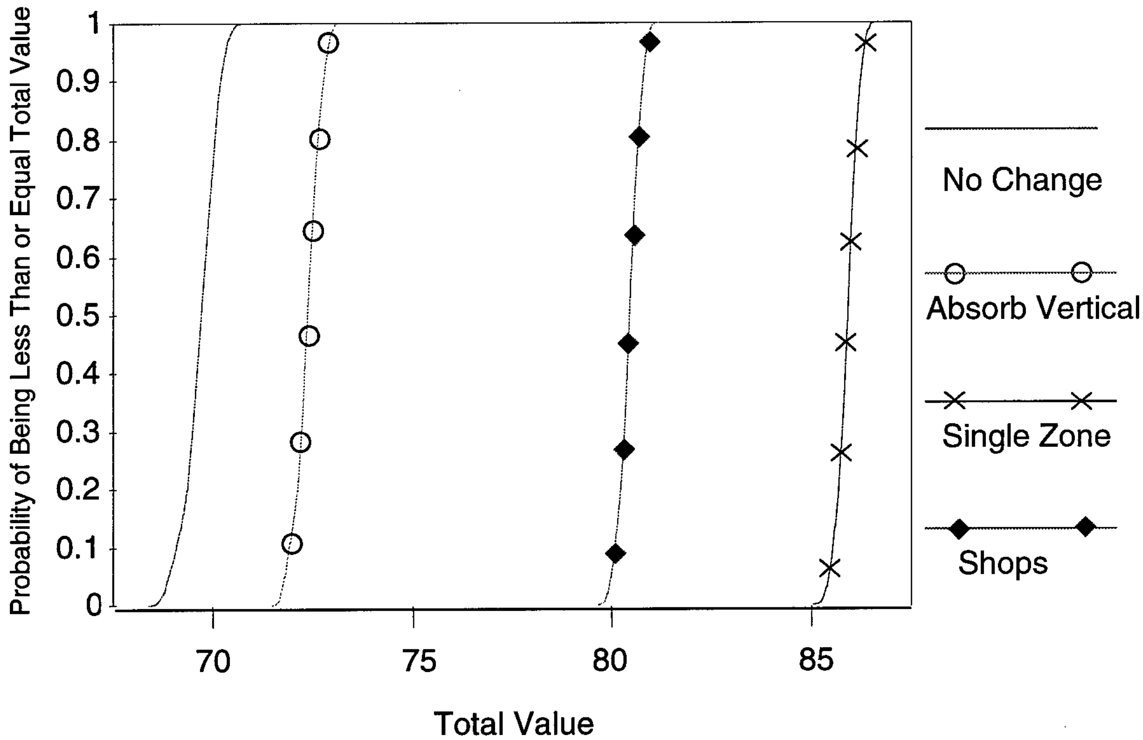

Figure C-40: Electrical Cumulative Distribution of Total Values

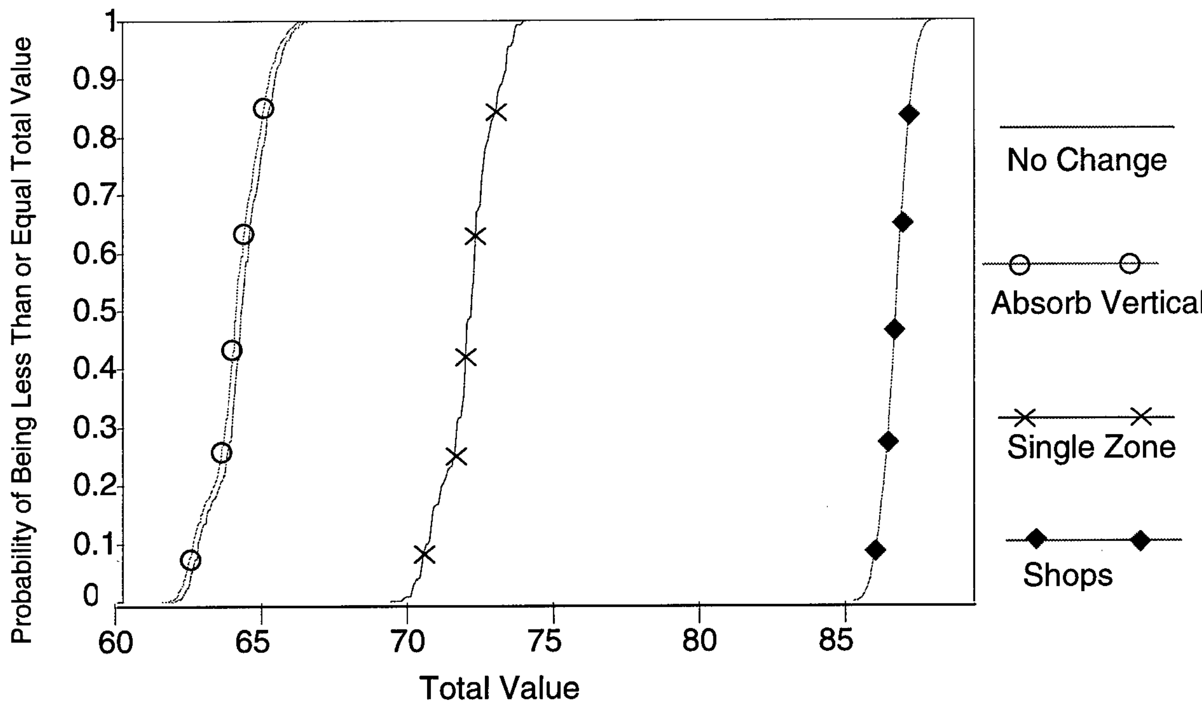

Figure C-41: Force Mgmt Cumulative Distribution of Total Values

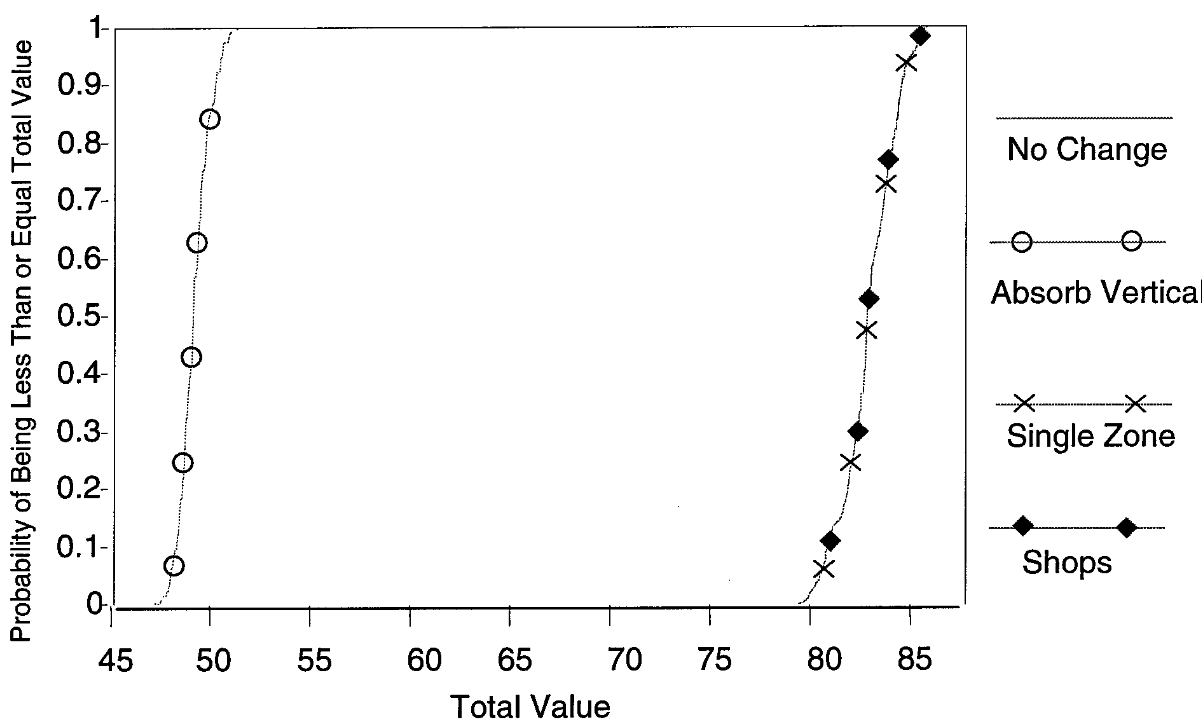

Figure C-42: HVAC Cumulative Distribution of Total Values

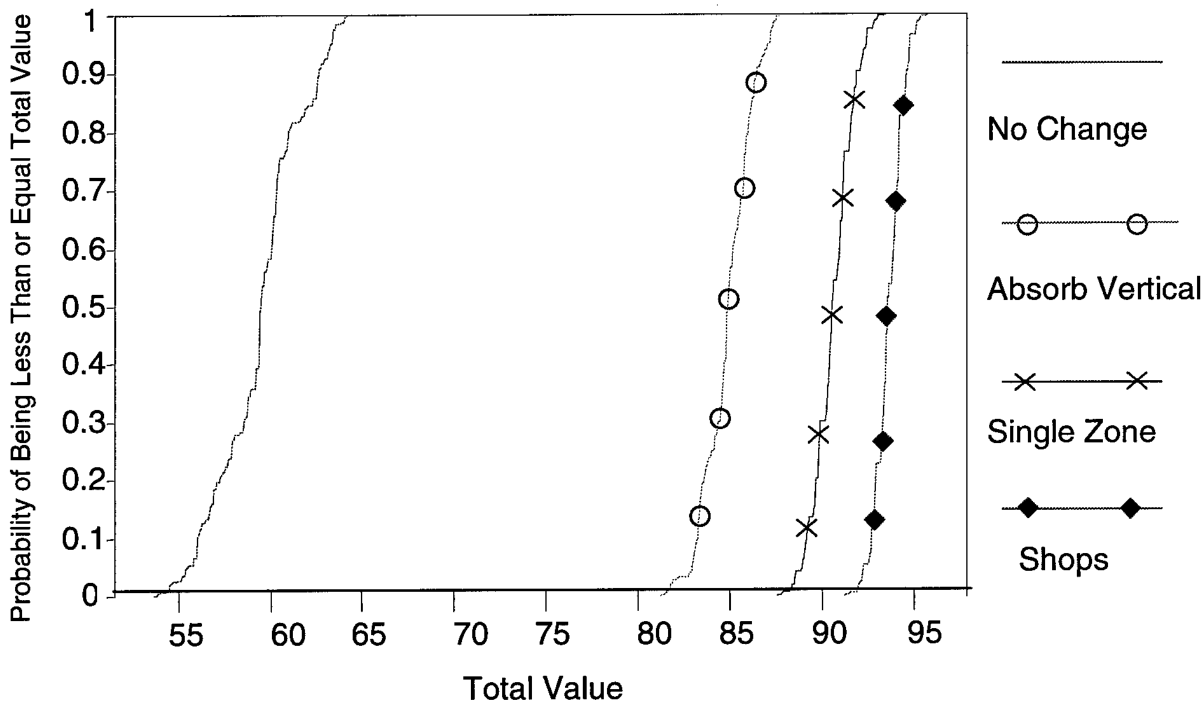

Figure C-43: Structural Cumulative Distribution of Total Values

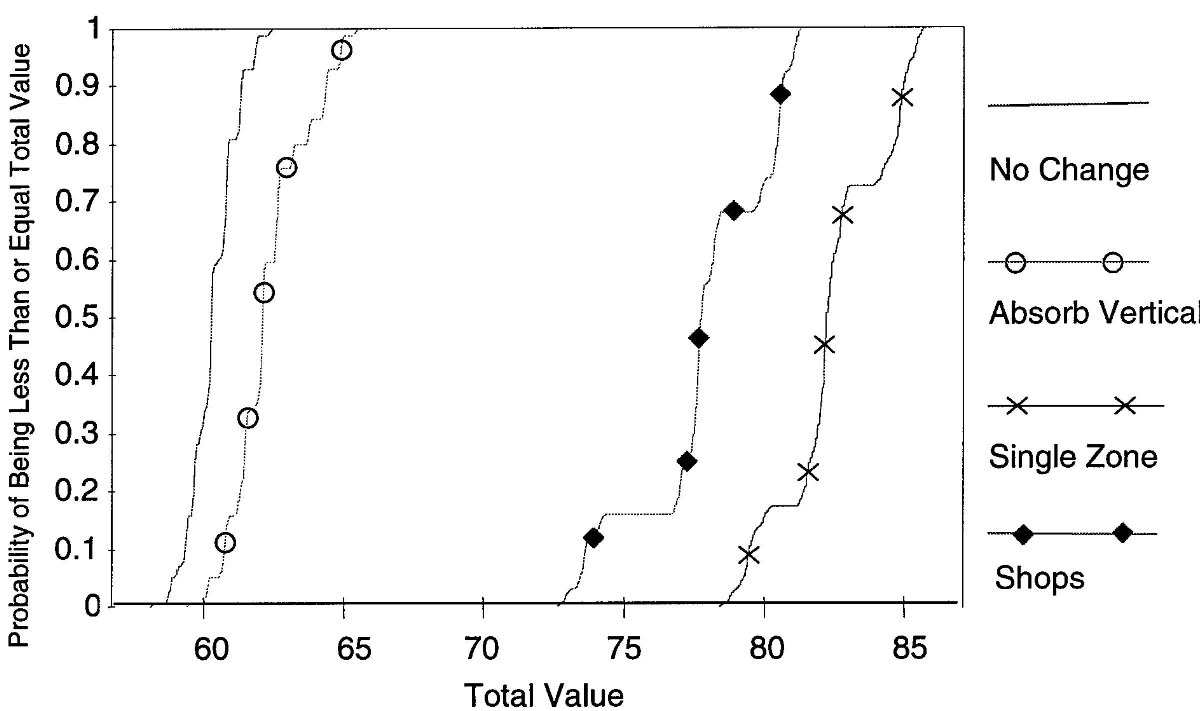

Figure C-44: Utilities Cumulative Distribution of Total Values

The preceding sensitivity analysis, illustrates that the Single-Zone and the Shops options scored very well and performed distinctly better than the other two options. However, their scores were very close and a clear ranking of #1 and #2 may not be appropriate. A consensus about which of these two organizational strategies is best does not exist among the five career fields. The Single Zone option did score slightly higher but the difference between it and the Shops option is too close to declare one option better than the other. The second sensitivity analysis was conducted to gain insight into the conditions that would lead to one alternative scoring higher than the other. Unlike the previous analysis, the uncertainty explored here is that involved with the weights assigned to the values.

Perhaps the single largest impact on the grand total scores (Figure C-39) is the weights assigned to the primary values. These weights were altered to determine the impact on the scores and the ranking of the top two alternatives. The Air Force Mission Support weight was analyzed first. A weight of 0.40 was assessed for all five career fields and the options were evaluated. This weight was increased by 0.20 and then decreased by 0.20 and the scores recomputed to study the effect that this value has on the ranking of the top alternative organizational strategies. The results are displayed in Figure C-45 below. The first number is the one associated with Air Force Mission Support and is the one that is adjusted. The ratio between the other two weights is maintained.

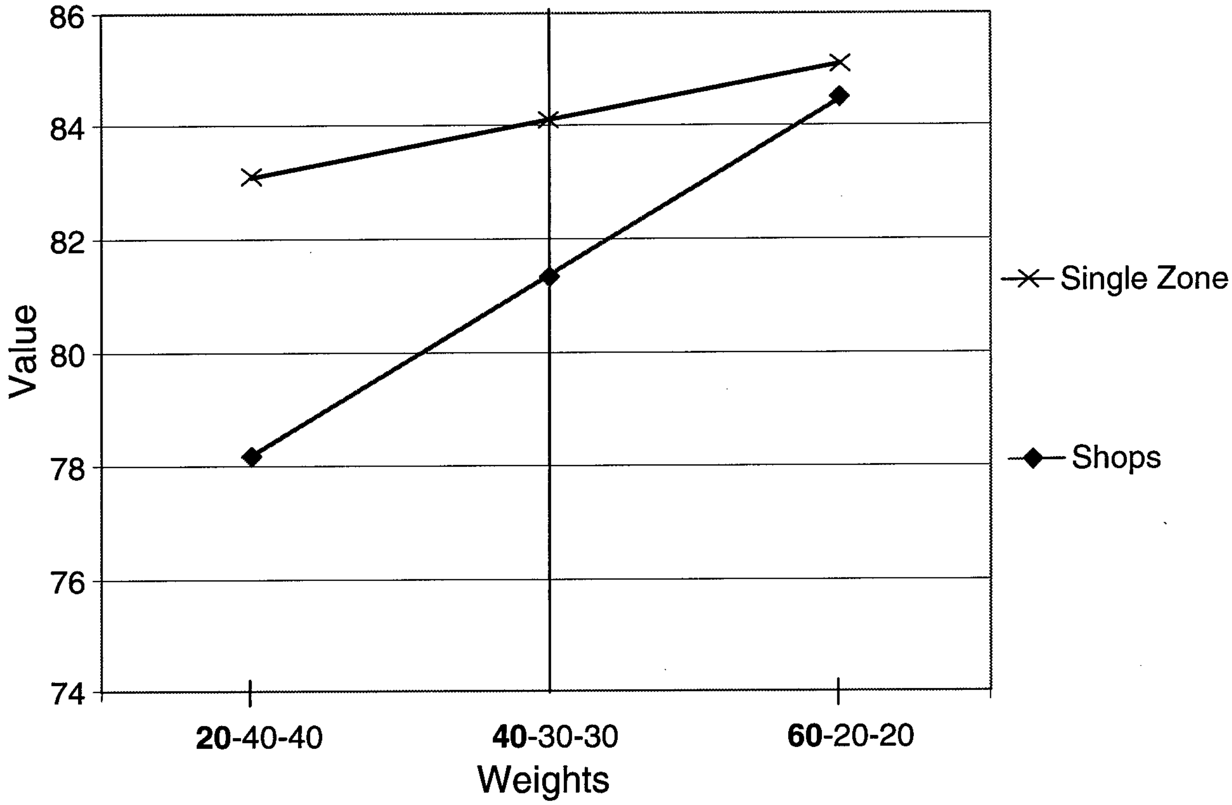

Figure C-45: Sensitivity Analysis for
Air Force Mission Support Weight

The same sensitivity analysis was conducted for the weight assigned to Facility/Infrastructure Maintenance. The results of that analysis are displayed in Figure C-46. The middle number (bolded) is the weight being changed while the ratio between the other two weights is maintained. Figure C-46 illustrates that although the Single Zone option is barely ranked #1, this ranking is not very sensitive to wide variations in Facility /Infrastructure Maintenance weight.

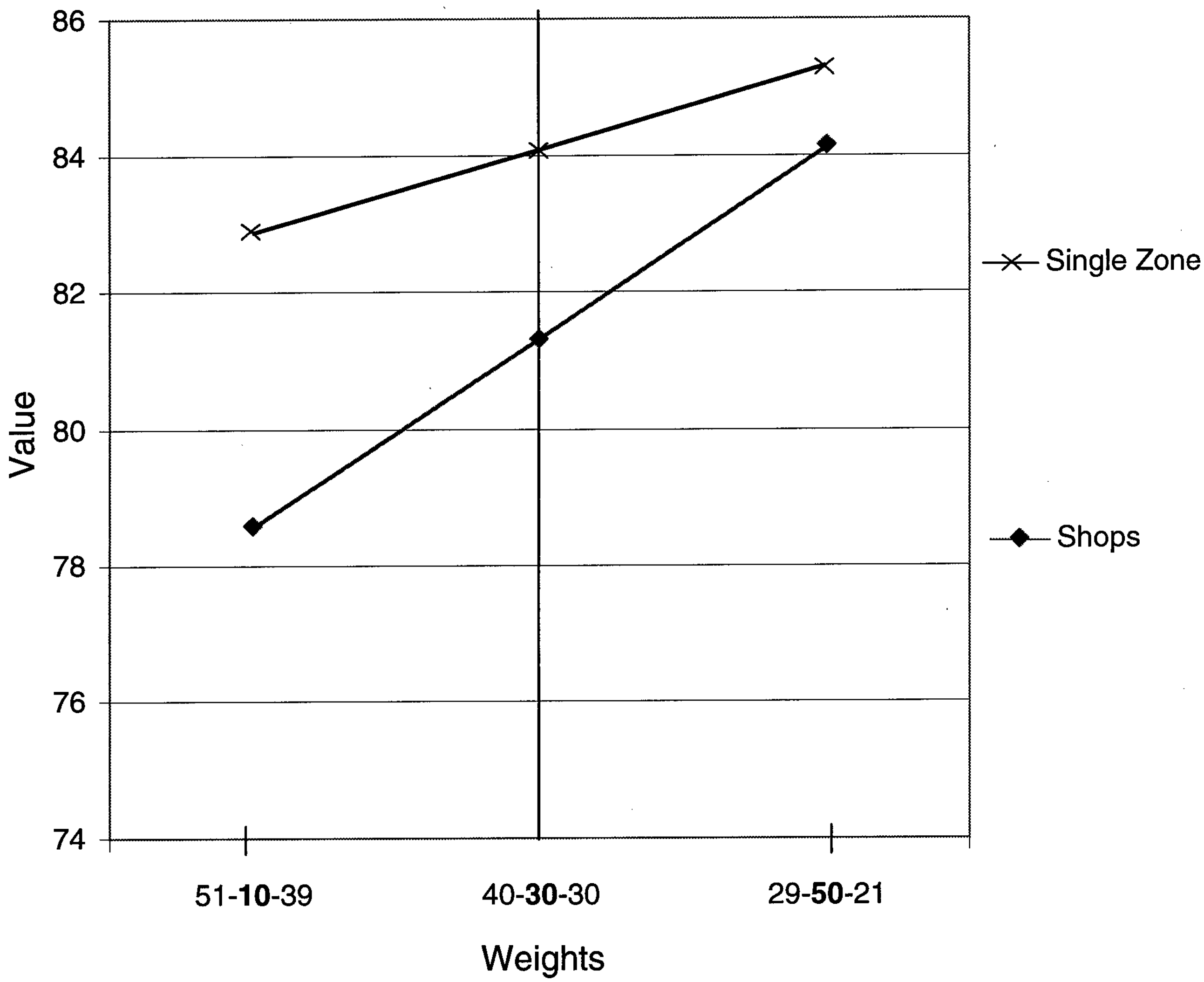

Figure C-46: Sensitivity Analysis for Facility/Infrastructure Maintenance Weight

Figure C-47 shows the results of the sensitivity analysis conducted on the Customer Service weight. The weight assigned to Customer Service is represented by the third number (bolded) on the chart. As illustrated in Figure C-47 the Single Zone option scores highest for a wide range of weights assigned to Customer Service; however, if that weight drops below 0.15, the Shops option becomes the highest ranked alternative.

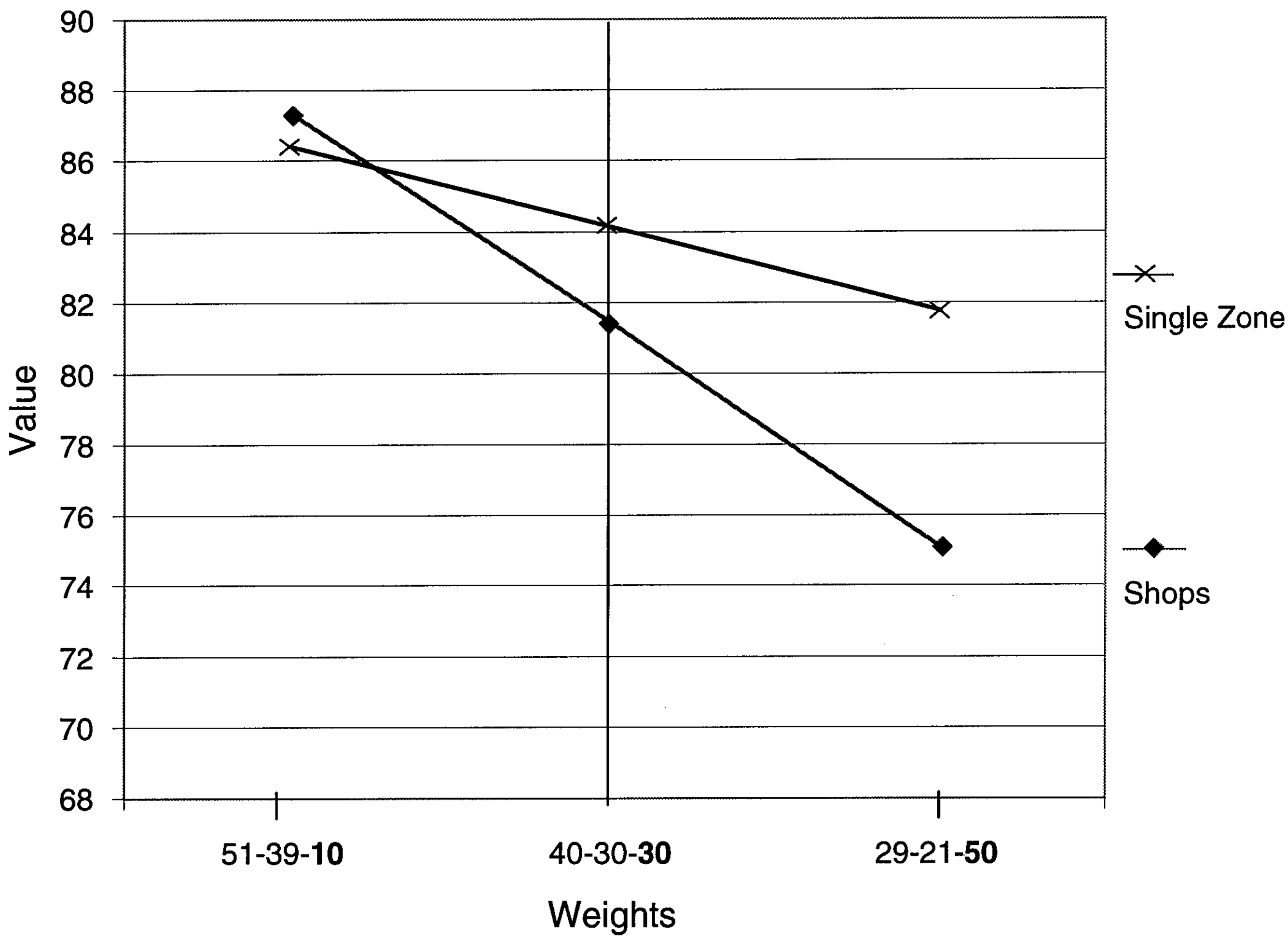

Figure C-47: Sensitivity Analysis
for Customer Service Weight

SECTION J: Discussion

This analysis clearly indicates that a desire for change is prevalent in all five career fields. The analysis suggests that consolidating personnel is the most favorable strategy. Of the four organizational strategies nominated for evaluation, the two options that provided the most consolidation scored the highest across all five career fields comprising the analysis team.

This need for change became quite apparent during the interviews and meetings with the analysis team members. A recurring problem with the *status quo* was that the limited manning was spread too thin. For example, the small number of electrical troops were disbursed primarily into zone1, zone 2, vertical, exterior, and alarms. This small force, divided by at least five, leaves each supervisor with a situation in which one absence for illness, training, TDY, or leave is a large portion of his/her workforce and impacts the entire schedule. If the personnel were more centralized the supervisors would have much more flexibility in coordinating leave and training requirements with a significantly smaller impact on the mission.

This added flexibility was the key issue when the alternatives were scored against the eight values. Improved flexibility generally led to a higher level of training, more DSW and RWP work being accomplished, and better customer service.

The Single Zone option was scored the highest; however, the Shops option was a close second. Figures C-35 and C-36 illustrate the significant personnel consolidation. The scores for these two alternatives were too close to declare one a better solution than the other. To make this determination, other aspects of this decision, not modeled by this methodology, should be considered. These other aspects include local union acceptance of the organizational change, ease of implementation and management, or logistical issues such as availability of space and facilities to house new shops.

In general, the Single Zone option scored higher in the areas that required coordination among the career fields. Planned work order accomplishment is an example. This improved cross-functional coordination was also the reason behind higher customer satisfaction scores. The Shops option, as expected, scored very well for the values involving training and routine DSW accomplishment.

The sensitivity analysis provided insight into how sensitive the #1 and #2 rankings were to changes in the weights assigned to the primary values. Figures C-45 through C-47 indicate that the Single Zone option retains its #1 ranking for a wide range of weights. For example as long as the weight applied to Customer Service (Figure C-47) is higher than 0.15, the Single-Zone option has the highest score.

As mentioned earlier, the scores between the Single-Zone and the Shops options are too close to confidently declare one the superior choice; however, the sensitivity analysis does provide some insight. The Single-Zone option does retain this narrow #1 ranking for a large variation in value weights which indicates that this ranking may not be as close as it appears on the surface. In any event, the aforementioned issues not included in the model (i.e. union acceptance, ease of implementation) will likely be the deciding factors between these two very different strategies.

Appendix D: Decision Support Model Information

Introduction

This appendix provides some information on the decision support model and a basic description of the software system utilized in its construction. Since an influence diagram is well suited for illustrating the structure of a complex decision problem, a module of the influence diagram for this decision problem is displayed and explained herein.

Primarily, the advanced version of DPL™ Decision Analysis Software was used to build the model. The graphical interface of Logical Decisions, however, was employed during the construction of the value functions. Once the value functions were established graphically, the exponential equations used by Logical Decisions to fit the data points were transferred into DPL™ for the analysis. Detailed information for both software packages is provided in their respective user manuals.

The Influence Diagram

An influence diagram represents all the components of a decision problem: decisions, uncertainties, values, and the relationships among them (DPL™, 1992: 189). These decisions, values, and uncertainties appear in the influence diagram in different shapes called nodes (Figure D-1).

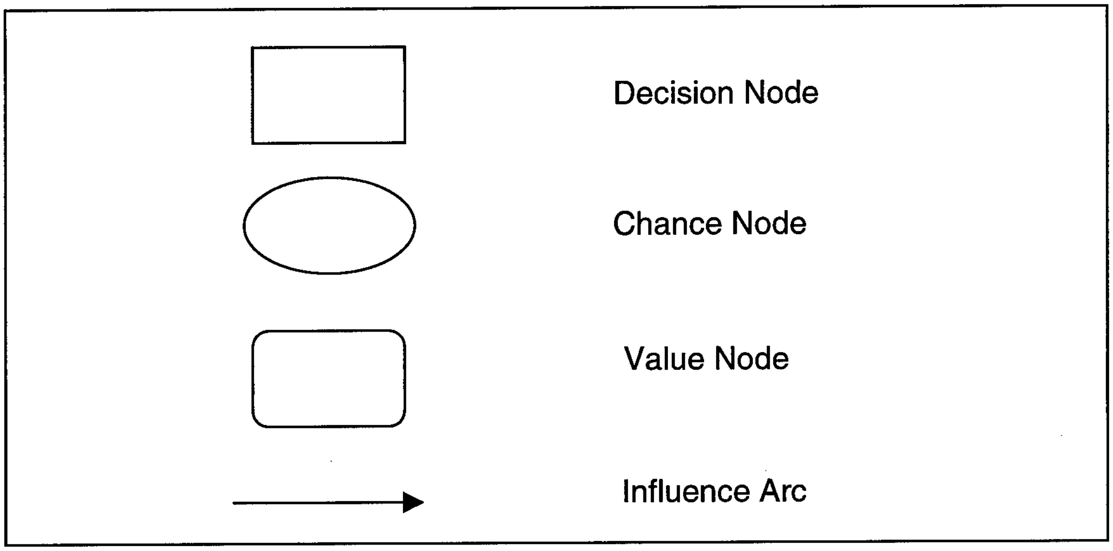

Figure D-1: Influence Diagram Shapes

As depicted in Figure D-1, a rectangular node represents a decision, an oval represents a chance event, and a mathematical equation or a value is represented by a rectangle with rounded corners. The nodes in an influence diagram are connected with arrows, called arcs, which indicate conditioning relationships. Although many relationship among nodes can be constructed, Figure D-2 illustrates the relationships used in this model's influence diagram.

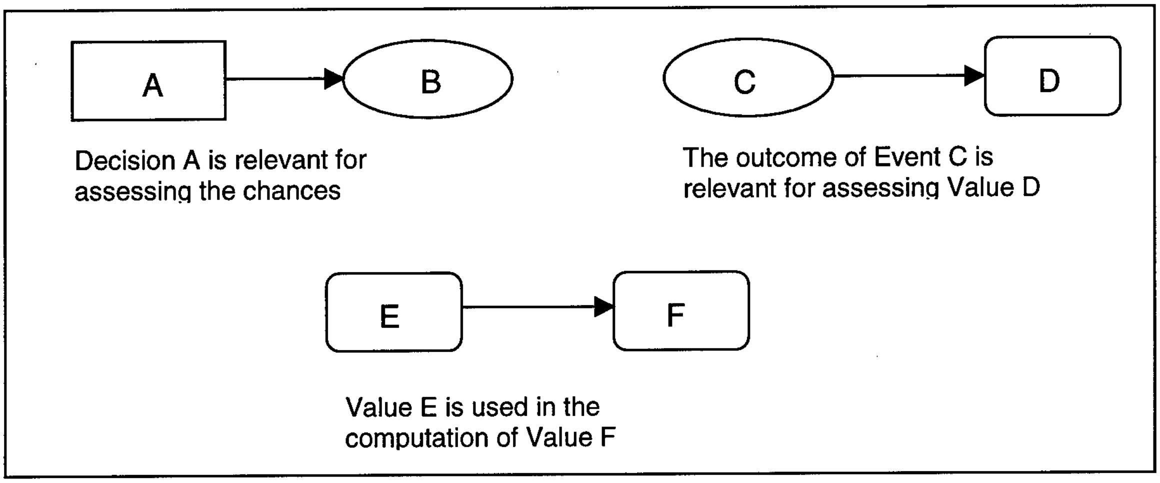

Figure D-2: Relationships Among Nodes
(Adapted from Ullmann, 1995: 89)

The influence diagram for this model consists of several modules. Each module contains the data from the individual career fields which comprised the decision analysis team. For the Wright-Patterson AFB case study, four career fields supplied data for the model: structures, electrical, utilities, and HVAC. The force management career field was added for the Little Rock AFB analysis. Figure D-3 illustrates the structural career field module from the Little Rock AFB case study. As mentioned previously, the other influence diagram modules are identical in structure but contain their respective career field's data.

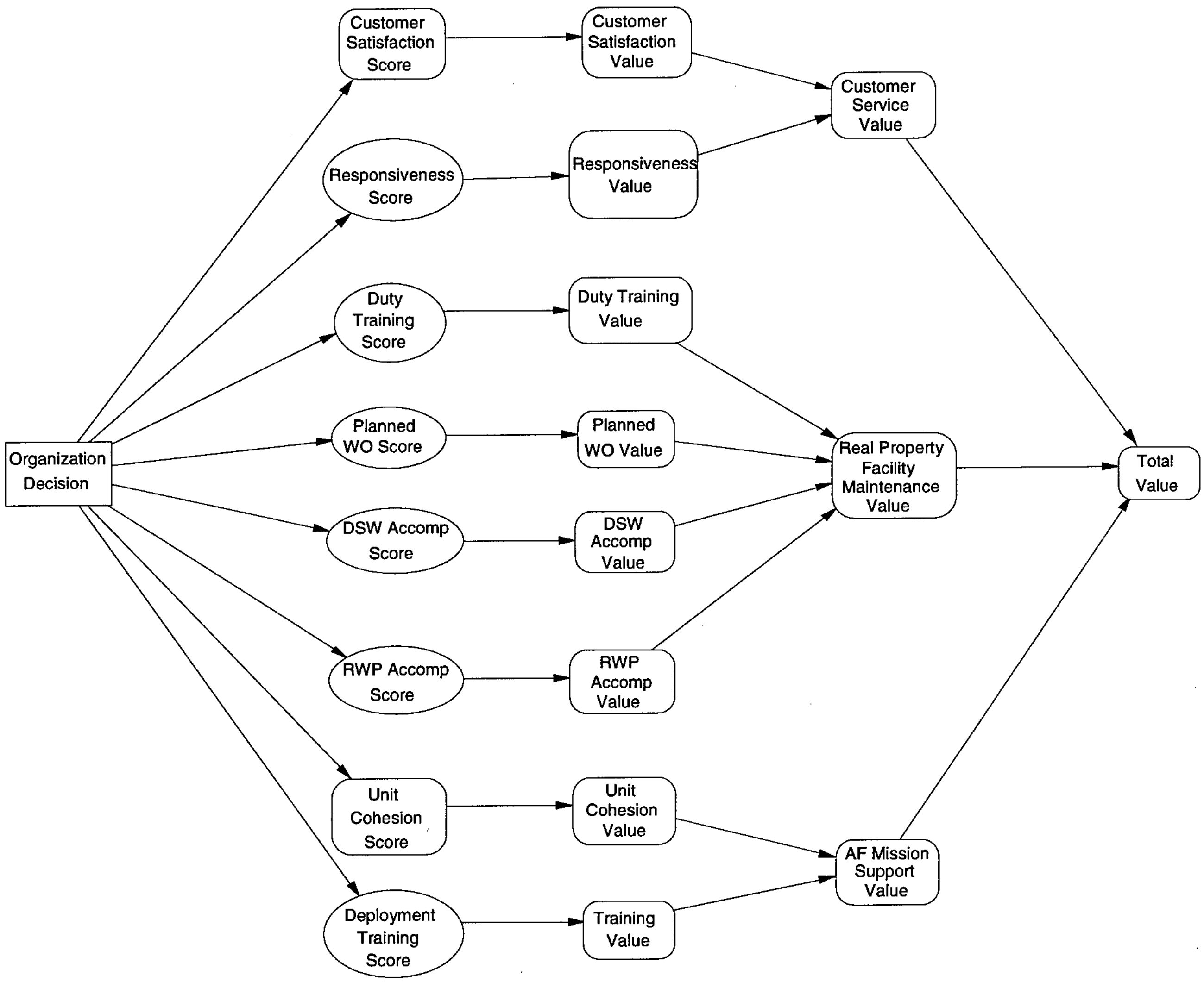

Figure D-3: Influence Diagram Module for DPL™

The decision node on the left side of the influence diagram represents the decision to be made among the four organizational strategies selected for analysis. These strategies were: maintaining the current two zone configuration (no change), absorbing the vertical section into the zones, a single zone organization, and a shop format. The program analyses these options and selects the option which maximizes the value of the 'total value' node at the other end of the diagram. The total scores for all four strategies are supplied at the end of the program.

The first column of nodes, most of which are chance nodes, contain the structural career fields scores for each alternative. These are chance nodes due to the uncertainty involved in predicting how well each alternative will perform for each value. The structural career field representatives assessed a most likely, lower bound, and upper bound score for each alternative. A triangle distribution was utilized to establish the probabilities associated with each score. The structural career field representatives, as well as the other career fields, felt little or no uncertainty about the scores assessed for the unit cohesion and customer satisfaction values. The measures used to evaluate performance for these two values are explained in Appendix C. Due to this lack of uncertainty, a triangular distribution of the range of possible scores was replaced with a direct score. The direct score changes the nature of the node from a chance node to a value node.

The value nodes comprising the second column convert the alternatives scores into value units. As described in Appendix C, this is accomplished using the value functions. The curves for the values functions were fitted using a series of exponential equations. These equations were programmed into the nodes using nested IF, THEN, ELSE statements. Once the scores for each alternative are converted into value units they are multiplied by the weight assigned to the value.

The value nodes containing the weights for each value are shown in Figure D-4 below. These nodes are part of the module shown in Figure D-3. Arrows, or arcs, could be drawn from these nodes to the nodes were the weights are multiplied, to show this relationship; however, these nodes are not required for the program and were omitted to avoid numerous unnecessary arcs rendering the influence diagram unreadable.

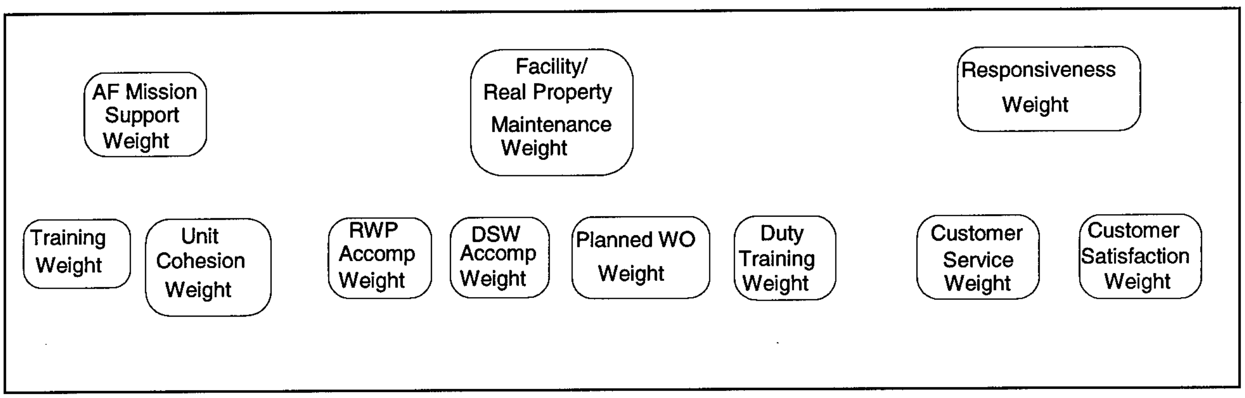

Figure D-4: Weight Value Nodes for Structures Module

The output from each of the eight value nodes in the second column, Figure D-3, is a score for each alternative in value units. These scores are summed in the next column, consisting of three value nodes. These three value nodes compute the alternative's scores for each of the primary values on the value hierarchy *via* a simple summation. The "Total Value" node adds these three scores into a total score for each alternative. These scores are reported at the end of the program and are displayed, for all career fields, in Figure C-38.

DPL Language Program

The following pages contain the DPL language program for the structures career field module of the decision support model. The type and name of each node is in bold and is followed by the section of DPL code applicable to that node.

value Training_Weight=.65;
value Unit_Cohesion_Weight=.35;
value RWP_Accomp_Weight=.4;
value DSW_Accomp_Weight=.2;
value Responsiveness_Weight=.5;
value Customer_Satisfaction_Weight=.5;
value AF_Mission_Support_Weight=.5;
value Real_Property_Facility_Maintenance_Weight=.25;
value Customer_Service_Weight=.25;
value Planned_WO_Weight=.1;
value Duty_Training_Weight=.3;

decision
Organization_Decision.{No_Change,Absorb_Vertical,Single_Zone,Shops};

chance Deployment_Training_Score.
{Worst_Case,Most_Likely,Best_Case}|Organization_Decision=

```
        triangular(55,65,60),       // Organization_Decision.No_Change
        triangular(75,85,80),       // Organization_Decision.Absorb_Vertical
        triangular(85,95,90),       // Organization_Decision.Single_Zone
        triangular(95,100,98);      // Organization_Decision.Shops
```

```
chance RWP_Accomp_Score.
{Worst_Case,Most_Likely,Best_Case}|Organization_Decision=
        triangular(20,40,30),       // Organization_Decision.No_Change
        triangular(70,80,75),       // Organization_Decision.Absorb_Vertical
        triangular(80,100,95),      // Organization_Decision.Single_Zone
        triangular(80,100,95);      // Organization_Decision.Shops

chance DSW_Accomp_Score.
{Worst_Case,Most_Likely,Best_Case}|Organization_Decision=
        triangular(80,90,85),       // Organization_Decision.No_Change
        triangular(80,90,85),       // Organization_Decision.Absorb_Vertical
        triangular(90,95,93),       // Organization_Decision.Single_Zone
        triangular(90,95,93);       // Organization_Decision.Shops

chance Planned_WO_Score.
{Worst_Case,Most_Likely,Best_Case}|Organization_Decision=
        triangular(75,80,78),       // Organization_Decision.No_Change
        triangular(75,80,78),       // Organization_Decision.Absorb_Vertical
        triangular(85,100,90),      // Organization_Decision.Single_Zone
        triangular(85,100,90);      // Organization_Decision.Shops

chance Duty_Training_Score.
{Worst_Case,Most_Likely,Best_Case}|Organization_Decision=
        triangular(55,65,60),       // Organization_Decision.No_Change
        triangular(70,85,80),       // Organization_Decision.Absorb_Vertical
        triangular(95,100,98),      // Organization_Decision.Single_Zone
        triangular(95,100,98);      // Organization_Decision.Shops

chance Responsiveness_Score.
{Worst_Case,Most_Likely,Best_Case}|Organization_Decision=
        triangular(10,15,11),       // Organization_Decision.No_Change
        triangular(10,15,11),       // Organization_Decision.Absorb_Vertical
        triangular(8,12,10),        // Organization_Decision.Single_Zone
        triangular(8,12,10);        // Organization_Decision.Shops

value Training_Value=
@if(Deployment_Training_Score<=50,
-.05+.05*@exp(.02*Deployment_Training_Score),
@if(Deployment_Training_Score<=100,
1.179-5.925*@exp(-.035*Deployment_Training_Score),9999))*Training_Weight;
```

```
value Unit_Cohesion_Score|Organization_Decision=
        3,              // Organization_Decision.No_Change
        4,              // Organization_Decision.Absorb_Vertical
        5,              // Organization_Decision.Single_Zone
        5;              // Organization_Decision.Shops

value Unit_Cohesion_Value=
@if(Unit_Cohesion_Score==1,.025,
@if(Unit_Cohesion_Score==2,.1,
@if(Unit_Cohesion_Score==3,.4,
@if(Unit_Cohesion_Score==4,.775,
@if(Unit_Cohesion_Score==5,1,9999)))))*Unit_Cohesion_Weight;

value RWP_Accomp_Value=
@if(RWP_Accomp_Score<=100,
.01*RWP_Accomp_Score,9999)*RWP_Accomp_Weight;

value DSW_Accomp_Value=
@if(DSW_Accomp_Score<=50,
-.00625+.00625*@exp(.06*DSW_Accomp_Score),
@if(DSW_Accomp_Score<=75,
1.05-8.092*@exp(-.043*DSW_Accomp_Score),
@if(DSW_Accomp_Score<=100,
1.044-88.42*@exp(-.076*DSW_Accomp_Score),9999)))*DSW_Accomp_Weight;

value Responsiveness_Value=
@if(Responsiveness_Score>=14,-2.121+3.154*@exp(-
.013*Responsiveness_Score),
@if(Responsiveness_Score>=7,1.071-.102*@exp(.12*Responsiveness_Score),
@if(Responsiveness_Score>=1,
1.016-.01031*@exp(.41*Responsiveness_Score),9999)))*Responsiveness_Weight;

value Customer_Satisfaction_Score|Organization_Decision=
        5,              // Organization_Decision.No_Change
        5,              // Organization_Decision.Absorb_Vertical
        4,              // Organization_Decision.Single_Zone
        4;              // Organization_Decision.Shops
```

value Customer_Satisfaction_Value=
@if(Customer_Satisfaction_Score==1,0,
@if(Customer_Satisfaction_Score==2,0,
@if(Customer_Satisfaction_Score==3,.3,
@if(Customer_Satisfaction_Score==4,.5,
@if(Customer_Satisfaction_Score==5,1,9999)))))*Customer_Satisfaction_Weight;

value Planned_WO_Value=
@if(Planned_WO_Score<=40,.0025*Planned_WO_Score,
@if(Planned_WO_Score<=70,.5864-15.41*@exp(-.086*Planned_WO_Score),
@if(Planned_WO_Score<=100,
.5268+.0000242*@exp(.1*Planned_WO_Score),9999)))*Planned_WO_Weight;

value Duty_Training_Value=
@if(Deployment_Training_Score<=50,-
.02812+.02812*@exp(.05*Deployment_Training_Score),
@if(Deployment_Training_Score<=75,-.25+.012*Deployment_Training_Score,
@if(Deployment_Training_Score<=100,
.5384+.001578*@exp(.05*Deployment_Training_Score),9999)))*Training_Weight;

value AF_Mission_Support_Value=
(Training_Value+Unit_Cohesion_Value)*AF_Mission_Support_Weight;

value Real_Property_Facility_Maintenance_Value=
(DSW_Accomp_Value+RWP_Accomp_Value+Planned_WO_Value
+Duty_Training_Value)*Real_Property_Facility_Maintenance_Weight;

value Customer_Service_Value=
(Responsiveness_Value+Customer_Satisfaction_Value)
*Customer_Service_Weight;

value Total_Value=
AF_Mission_Support_Value+Real_Property_Facility_Maintenance_Value
+Customer_Service_Value;

sequence:
decide about Organization_Decision then
gamble on Deployment_Training_Score then
gamble on RWP_Accomp_Score then
gamble on DSW_Accomp_Score then
gamble on Planned_WO_Score then
gamble on Duty_Training_Score then
gamble on Responsiveness_Score then
get Total_Value

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Vita

Captain Shawn C. Thompson was born 17 November, 1969 in Wolfe City, Texas. He graduated from Wolfe City High School in 1988 and entered undergraduate studies at Texas A&M University in College Station, Texas. He graduated with a Bachelor degree in Civil Engineering and was commissioned a Second Lieutenant through the Reserve Officer Training Corps, Detachment 805, in May 1994.

His first assignment was to Keesler AFB, Mississippi. While there, he served as a design engineer, commander of the readiness flight, and chief of the maintenance engineering section of the 81st Civil Engineer Squadron, Operations Flight. In August 1997, he entered the Engineering and Environmental Management program, Graduate School of Engineering, Air Force Institute of Technology. Following graduation, Captain Thompson will accept an assignment to the 5th Civil Engineer Squadron, Minot AFB, North Dakota.

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13. ABSTRACT *(Maximum 200 words)*

The organizational structure of the civil engineer squadron's operations flight has undergone numerous changes over the last fifty years. Today the structure of the flight to the element level is mandated by Air Force Instructions; however, each unit is given the flexibility to organize below the element level. Most civil engineer units are struggling through the decision of how to organize their flights without a sound methodology to guide their efforts. Providing such a methodology is the objective of this thesis.

To accomplish the objective, the history behind the operations flight structure was researched. In addition to this historical research, the current Air Force guidance was investigated for information concerning the structure, goals, and mission of the operations flight. With this background information at hand, a decision analysis methodology was developed to assist in the evaluation of organizational strategies. This methodology was tested at Wright-Patterson AFB and implemented at Little Rock AFB.

The result of this thesis effort is a decision analysis methodology that injects a dose of clarity and order into an otherwise cloudy and subjective decision problem. This methodology enables a comprehensive analysis of the decision problem while remaining flexible enough to accommodate the uniqueness of every unit.

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