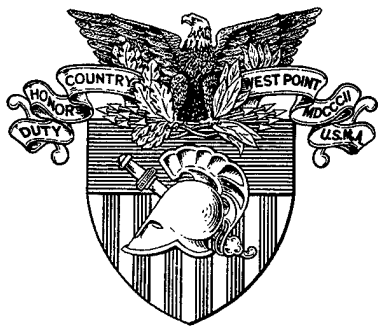




**United States Military Academy
West Point, New York 10996**

**Installation Decision Support Model (IDSM):
Analytical Capability**

**OPERATIONS RESEARCH CENTER
TECHNICAL REPORT 96-1-2**

Captain Elizabeth A. Lind

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

18 April 1997

The Operations Research Center is supported by the Assistant Secretary of the Army
(Financial Management & Comptroller)

DTIC QUALITY INSPECTED 1

19990325 013

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 18 APRIL 1997		3. REPORT TYPE AND DATES COVERED TECHNICAL REPORT	
4. TITLE AND SUBTITLE INSTALLATION DECISION SUPPORT MODEL (IDSM): ANALYTICAL CAPABILITY				5. FUNDING NUMBERS	
6. AUTHOR(S) CPT ELIZABETH A. LIND					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMA OPERATIONS RESEARCH CENTER WEST POINT, NEW YORK 10996-1779				8. PERFORMING ORGANIZATION REPORT NUMBER TECH RPT 96-1-2	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION / AVAILABILITY STATEMENT DISTRIBUTION STATEMENT A. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) THE INSTALLATION DECISION SUPPORT MODEL (IDSM) WAS DEVELOPED BY THE OPERATIONS RESEARCH CENTER OF EXCELLENCE, UNITED STATES MILITARY ACADEMY, AS AN INSTALLATION LEVEL BUDGETING PRIORITY TOOL FOR USE BY U.S. ARMY INSTALLATION AND GARRISON COMMANDERS IN ALLOCATING FUNDS. THE IDSM UTILIZES INSTALLATION STATUS REPORT (ISR) DATA, COMMANDER'S PRIORITIES, AND FUNDING STRATEGIES TO ASSIST IN THE ALLOCATION OF INFRASTRUCTURE FUNDS; IN THE FUTURE IT WILL ALSO HELP ALLOCATE ENVIRONMENTAL AND SERVICES FUNDING. THE SYSTEM FEATURES: DATABASE VIEWING AND EDITING CAPABILITY, SITUATIONAL MAP AWARENESS, COMMANDER'S GUIDANCE FOR DEVELOPING PROJECTS, CREATION AND COMPARISON OF FUNDING STRATEGIES, AND AN AFTER ACTION REPORT ON THE EFFECTIVENESS OF LAST YEAR'S BUDGET. THE IDSM IS CRITICAL TO THE CONTINUED SUCCESS OF THE ISR AND U.S. ARMY INFRASTRUCTURE MANAGEMENT. IT EFFECTS CHANGE AT THE INSTALLATION LEVEL WHERE INFRASTRUCTURE DOLLARS ARE SPENT, WHERE INFRASTRUCTURE PROJECTS ARE CREATED AND EXECUTED, AND WHERE INFRASTRUCTURE EXISTS. THE IDSM WILL BE FIELDIED WITH THE ISR SOFTWARE AS AN OPTIONAL USE TOOL TO ENHANCE INSTALLATION BUDGETING.					
14. SUBJECT TERMS INSTALLATION DECISION SUPPORT MODEL (IDSM): ANALYTICAL CAPABILITY				15. NUMBER OF PAGES 114	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT		

Installation Decision Support Model (IDSM): Analytical Capability

CPT Elizabeth A. Lind
Analyst, Operations Research Center

Senior Investigator
John V. Farr, Ph.D., PE
Associate Professor, Department of Systems Engineering

*A Technical Report Of The
Operations Research Center Of Excellence
United States Military Academy*

Approved By
Colonel James L. Kays, Ph.D.
Professor and Head, Department of Systems Engineering

18 April 1997

The Operations Research Center is supported by the Assistant Secretary of the Army
(Financial Management and Comptroller)

ACKNOWLEDGEMENTS

First I want to thank the people who helped me with my master's thesis which was the beginning of my installation management work: Mr. David Frye, Mr. Paul DesRoches, and Dr. Gunter Sharp. Next I would like to express my appreciation to COL James Kays and LTC Mike McGinnis for selecting me to work in the Operations Research Center and to further my thesis work. Thanks to ASA-FM&C for their continued support and ACSIM for their cooperation; COL Robert Kane, Mrs. Marianne Franklin, Mr. Tony Marchesani, and Mrs. Geri Wildenburg at the United States Military Academy, West Point, New York for their valuable user input; and to Dr. John Farr for his advice and guidance. I would like to thank everyone in the Department of Systems Engineering for supporting me in what has been a rather difficult time. And most of all I want to thank Mr. Mike Rowat; without his help I would not have made it through this year.

TABLE OF CONTENTS

LIST OF TABLES.....	v
LIST OF FIGURES.....	vi
LIST OF EQUATIONS.....	vii
EXECUTIVE SUMMARY.....	viii
1.0 PROBLEM DEFINITION.....	1
1.1 Introduction.....	1
1.1.1 Report Objective.....	1
1.1.2 Infrastructure Management Process.....	2
1.2 Background Information.....	3
1.2.1 ISR Overview.....	3
1.2.2 IDSM Needs Analysis.....	5
1.3 Model Definition and Requirements.....	6
2.0 SYSTEM DEVELOPMENT.....	8
2.1 System Development - Data Management Capability.....	10
2.2 System Development - Analytical Capability.....	10
2.3 System Development - IDSM Assumptions.....	13
3.0 DATA MANAGEMENT.....	14
3.1 ISR Database Viewer.....	14
3.2 ISR Database Editor.....	14
3.3 Installation Map.....	14
3.4 FCG Prioritization.....	15
4.0 INSTALLATION ANALYSIS.....	16
4.1 Commander's Intent.....	16
4.1.1 Purpose.....	16
4.1.2 Inputs.....	16
4.1.3 Process.....	20
4.1.4 Outputs.....	20
4.2 Build and Edit Projects.....	21
4.2.1 Purpose.....	21
4.2.2 Project Scope.....	21
4.2.3 Project Funds.....	22
4.2.4 Project Commander's Intent Score.....	23
4.2.5 Project Impact Worksheet.....	23
4.3 Build and Compare Courses of Action.....	25
4.3.1 Purpose.....	25
4.3.2 Inputs.....	25
4.3.3 Outputs.....	25
4.3.4 Process.....	25
4.4 After Action Review.....	31
4.4.1 Purpose.....	31
4.4.2 Inputs.....	31
4.4.3 Outputs.....	32
4.4.4 Process.....	32
5.0 ADMINISTRATIVE CAPABILITY.....	36

5.1 Purpose.....	36
5.2 IDSM Set Up.....	36
5.3 Building Fault Report	36
6.0 FUTURE WORK.....	37
6.1 Prototype Implementation.....	37
6.2 Expansion of IDSM to Include ISR Parts II and Part III.....	37
6.3 Use of Other Databases.....	37
6.4 Improved ISR Costing Model.....	38
6.5 Future Internet Applications	38
6.6 Other Resource Allocation Problems.....	38
6.7 Programmed Sustainment and Renovation Budget Requirements.....	38
7.0 CONCLUSION.....	40
SELECTED BIBLIOGRAPHY	41
APPENDIX A Commander's Intent Calculations	42
Appendix A: Importance Factor (FacIPT _x , FCGIPT _{x1}).....	43
Appendix A: Improvement Factor (FCGIPV _{x1} , FacIPV _x)	45
Appendix A: Strategy (IPTsf, IPVsf).....	46
APPENDIX B Project Impact Worksheet and Calculations.....	47
Appendix B: Sample Worksheet.....	48
Appendix B: Project Impact Calculations.....	49
Appendix B: Project Impact Worksheet Default Criteria Descriptions	50
APPENDIX C Course of Action Calculations.....	53
Appendix C: Measure of Effectiveness Calculations	58
Appendix C: Additional COA Calculations	64
Appendix C: What If? Calculations.....	67
APPENDIX D Software Overview - Analytical Capability	71
APPENDIX E Program Menus - Analytical Capability	72
Appendix E: Main Menu	73
Appendix E: Commander' Intent Menu.....	74
Appendix E: Build and Edit Projects Menu.....	76
Appendix E: Build/Compare COAs Main Menu.....	78
Appendix E: After Action Review Menu	87
Appendix E: Set Up Menu.....	88
APPENDIX F Data Base Structure - Analytical Capability	90
Appendix F: Data Used From ISR Data Tables.....	91
Appendix F: Organizational Tables	92
Appendix F: Functional Tables.....	101
APPENDIX G Software Code - Analytical Capability.....	112
APPENDIX H Acronyms	113

LIST OF TABLES

Table 1 Facility Importance Weights.....	17
Table 2 Task Importance.....	18
Table 3 Facility Improvement Weights.....	18
Table 4 Commander's Intent Strategies.....	20
Table 5 Fund Categories.....	22
Table 6 Project Fund Priorities	22
Table 7 IDSM Project Impact Worksheet Default Criteria.....	24
Table 8 COA Process Summary	26
Table 9 IDSM Funding Strategies.....	27
Table 10 Cost Effectiveness Strategies.....	27
Table 11 IDSM Variables.....	30
Table 12 After Action Review Output.....	32
Table 13 COA Task Process.....	53
Table 14 What If? Analysis Variables.....	68

LIST OF FIGURES

Figure 1 ISR Structure	4
Figure 2 IDSM Process.....	9
Figure 3 IDSM Process With Fund Types.....	13
Figure 4 Project Example.....	21
Figure 5 What If? Analysis Graphical Display.....	67

LIST OF EQUATIONS

Equation 1 Facility Globalized Importance Rating.....	17
Equation 2 FCG Importance Factor.....	18
Equation 3 Facility Importance Factor.....	18
Equation 4 FCG Task Improvement Factor.....	19
Equation 5 Facility Task Improvement Factor.....	19
Equation 6 Facility Level Commander's Intent Score.....	20
Equation 7 Project Commander's Intent Score.....	23
Equation 8 Project Value Equation.....	28
Equation 9 Example Weighted COA Strategy.....	28
Equation 10 Projected Degradation Using 3 Year Moving Average.....	35
Equation 11 FCG Commander's Intent Score	42
Equation 12 Project Impact Equation	49
Equation 13 Project Value and Cost have Equal Importance	56
Equation 14 Project Value has Greater Importance.....	56
Equation 15 Project Cost has Greater Importance	57
Equation 16 MOE Commander's Intent	58
Equation 17 MOE Project Impact.....	58

EXECUTIVE SUMMARY

The Installation Decision Support Model (IDSM) was developed by the Operations Research Center Of Excellence, United States Military Academy, as an installation level budgeting priority tool for use by U.S. Army installation and garrison commanders in allocating funds. The IDSM utilizes Installation Status Report (ISR) data, commander's priorities, and funding strategies to assist in the allocation of infrastructure funds; in the future it will also help allocate environmental and services funding. The system features: database viewing and editing capability, situational map awareness, commander's guidance for developing projects, creation and comparison of funding strategies, and an after action report on the effectiveness of last year's budget. The IDSM is critical to the continued success of the ISR and U.S. Army infrastructure management. It effects change at the installation level where infrastructure dollars are spent, where infrastructure projects are created and executed, and where infrastructure exists. The IDSM will be fielded with the ISR software as an optional use tool to enhance installation budgeting.

1.0 PROBLEM DEFINITION

1.1 Introduction

For the Department of the Army (DA), installation infrastructure management, is a complex task with many inherent problems. These involve how to account for the commander's infrastructure goals, how to standardize infrastructure evaluation, how to determine infrastructure needs, and probably most difficult, how to allocate infrastructure funds. The Installation Decision Support Model (IDSM) utilizes Installation Status Report (ISR) data to assist commanders in developing an effective infrastructure management program.

A military installation is similar to a small city. It consists of land, buildings, roads, and utilities normally located in the same geographical area. Infrastructure is often viewed as consisting of transportation systems, water delivery and treatment, waste management, buildings and facilities, and energy systems of a city or other organization. U.S. Army infrastructure covers the broadest definitions; every building, utility, road, home, and training area on a military installation is an Army responsibility and part of the managed infrastructure.¹

1.1.1 Report Objective

This report discusses the development of an automated budget decision support model to assist DA decision makers with infrastructure management problems. This report expands work by CPT Thomas O'Hara, in his technical report "IDSM: Needs

¹ Lind, Page 1.

Analysis and Initial Model Development”, on an infrastructure management needs analysis and development an ISR data management tool.

1.1.2 Infrastructure Management Process

Perfect infrastructure management only exists when there is a complete knowledge of facility conditions, rates of degradation, and costs of construction, renovation, and sustainment and given an unlimited budget and unlimited personnel. Under these conditions, infrastructure management is simply a scheduling problem of when to build, sustain, and renovate. In the real world, however, conditions consist of imperfect knowledge and limited budgets and personnel. Thus, it becomes imperative to effectively manage infrastructure.

To assist Army commanders, the following six step infrastructure management process is proposed:

- a. *Determine Infrastructure Management Goals.* Commanders need to formally develop infrastructure management goals. There will be many competing and conflicting goals at an installation. By actually enumerating and prioritizing goals, it may be possible to reach a compromise between the infrastructure stakeholders.
- b. *Evaluate Infrastructure Facilities.* The ISR provides a user evaluation of the infrastructure facilities. Although this report is not very technical, and perhaps inaccurate - it is complete. Installations do not have the funding or engineering personnel to conduct a technical inspection of each facility.
- c. *Generate Project Options for Each Facility Requirement.* The installations develop several project options for each facility requirement. For example, if a building had a

leaky roof, the options may be to replace the entire roof, replace a portion of the roof, or just patch the leak.

- d. *Select a Project for Each Facility Requirement.* Once options have been developed for each facility requirement, one project is selected.
- e. *Determine Goal Contribution of Each Project.* From the group of projects created to fulfill facility requirements, some measurement or method of comparison must be created and used to determine the relative value of the projects. This is the hardest part and the focus of the IDSM.
- f. *Finance Projects with Greatest Goal Contributions.*² Finally, depending on budget amounts and types, the “best” projects are selected for funding in the following fiscal year. The remaining projects are available for completion if other funds become available, or in the following years.

1.2 Background Information

1.2.1 ISR Overview

The ISR was created to help DA reply to requests by the Office of the Secretary of Defense (OSD) and the Congress about the costs to sustain, upgrade, and construct new infrastructure, the status of current installation infrastructure, and to track the funds spent and their impact on the infrastructure. Until the late 1980's the Army had not made a formal effort to capture this information, but with ever decreasing budgets and aging infrastructure, it became more critical to identify and clearly state all infrastructure budget needs.

Initially, the ISR performed the following primary tasks:

- required user-evaluation of each facility using DA standards;
- created composite ratings using facility ratings; and
- generated sustainment, renovation and construction costs based on facility ratings, facility types and cost factors.

The ISR has been expanded to include an evaluation of installation environmental conditions, and, in the future, installation services. Part I (Infrastructure) of the ISR groups every infrastructure facility into one of five ISR areas: mission facilities, mobility

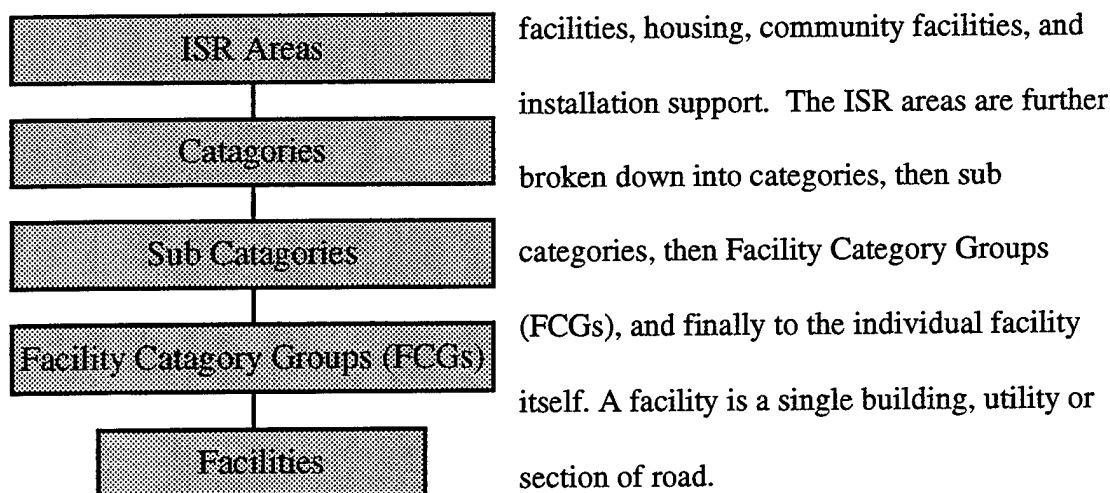


Figure 1. ISR Structure

Each facility is inspected by major subsystems

within a specific Facility Category Group (FCG. This requires a unique inspection checklist for each FCG that is used at every installation in the Army. The user inspects the facility's major subsystems using a detailed guide (including pictures) to assign a condition code of red (failed system), amber (substandard) or green (acceptable) to each subsystem. The condition codes of the subsystems are rolled up to generate a facility condition code of red, amber or green. The facility condition codes are entered into the

² Lind, Page 9.

ISR software and installation ratings and installation cost requirements are generated and reported to DA.

1.2.2 IDSM Needs Analysis

The first step in defining the IDSM was a needs analysis conducted by the Operations Research Center of Excellence (ORCEN). CPT Thomas O'Hara and Mr. Leonard Graham³ visited eight U.S. Army installations. These included a representative sample of sizes and Major Army Commands (MACOMs). They met with Garrison Commanders and their staffs to discuss what could be done to make the ISR more useful to the installations. They learned the installations felt the ISR was difficult to use, time consuming to complete, and had little payback for the installation. With minor exceptions, the ISR was not being used in the installation management process. The installations indicated that for the IDSM to be useful, it must have the following characteristics:

- No additional workload. Staffs continue to get smaller - for the IDSM to be successful it must reduce, not increase, the staff's workload.
- Provide a Return on Investment from the ISR. Installations do not feel the ISR is producing an adequate return at the installation level for the amount of work involved in collecting the data.
- Improve the utility of ISR data by tracking trends, discouraging "pet" projects, and adding more detail to the ISR data.⁴

³ Mr. Leonard Graham worked for the Facility Engineers at Fort Bragg, NC, and was assigned temporarily to USMA to work on this project.

⁴ O'Hara, Page 9.

1.3 Model Definition and Requirements

One goal of the IDSM is to function as an installation level budgeting priority tool. Although the ISR data is very useful to DA, OSD and Congress; its current configuration offers very little return on time invested by the installations. The bottom line is that the INSTALLATIONS SPEND THE INFRASTRUCTURE MONEY. The ISR makes DA very efficient at reporting on installation conditions, tracking money, and expressing installation needs; but if the installations are not assisted in spending their infrastructure dollars more effectively - no real change has been affected in infrastructure management. The more benefit and direct feedback the installations see from the ISR report, the more time and effort they will put in to the completion of the report. Since the installations are the source of the ISR data, it is essential to encourage high quality input data. The best analysis is worthless if the data is incorrect.

Infrastructure budgeting decision are large and difficult. There may be thousands of facility repairs required at an installation and the repair types are not directly comparable. For example, should repainting a building be funded first or repairing a sidewalk? Many decision criteria are involved: project cost, project duration, commander's priorities, current facility conditions, environmental impact, and more. Currently many installations solve this budgeting problem by conducting an installation staff meeting where all the primary staff sit at a table and argue for their personal projects. Those with the best or loudest arguments often get their projects funded. The IDSM provides computer support to these decisions; computers are excellent at handling large quantities of information, and many competing decision criteria. The IDSM allows the

commander to provide infrastructure goals or direction to the computer program, and the computer can help the commander manage the large amounts of data.

The IDSM also assists the commander in defending the small and vulnerable Repair and Preventive Maintenance Activity (RPMA) budget at the installation level. He is able to demonstrate the effects of budget cuts in terms of facility ratings and mission capability.

The IDSM is an optional use, computer based decision tool that will be included with the ISR software. Currently the IDSM uses only ISR data; in the future the IDSM may access information in other databases such as Integrated Facilities System - Micro/Mini (IFS-M) used for work order management at the installation.

2.0 SYSTEM DEVELOPMENT

The purpose of the IDSM is to make ISR data useful to the installations. Based on the model definition and requirements, the IDSM system is developed to:

- 1 - *Increase the commander's awareness of the condition of his infrastructure.* The commander's infrastructure awareness is increased through the use of an ISR database viewer. The viewer allows the commander to access the ISR data, create composite statistics, and construct an ISR overlay on the installation map - which allows the commander to visualize the condition of his infrastructure.
- 2 - *Allow the commander to express infrastructure priorities to the engineers and resource managers.* The commander is able to express infrastructure repair and construction priorities in terms of facility importance and facility condition to the engineers using the Commander's Intent module.
- 3 - *Assist the engineers in the design of infrastructure projects.* The IDSM accesses the facility fault data as identified by the ISR to help design renovation and construction projects.
- 4 - *Assist the commander in the creation of funding strategies that will prioritize the projects.* The create Course Of Action (COA) module offers 12 different funding strategies that may be selected in combinations of up to three different strategies to create a funding COA consisting of a prioritized project list.
- 5 - *Create Measures of Effectiveness (MOEs) to compare the different funding strategies.* The Compare COA module lets the commander compare different funding courses of

action by the using four Measures Of Effectiveness (MOEs): projected improvement, projected change, compliance with commander's guidance, and total project impact.

6 - *Recommend a set of projects for funding.* Once a funding COA has been selected, the IDSM recommends which projects to fund this year, and which projects to defer. Any deferred projects may be completed if other funds become available, or they will be programmed into future years.

7 - *Provide feedback data.* The IDSM After Action Review (AAR) module provides feedback to the commander about facility improvement, degradation, money budgeted, and money spent.

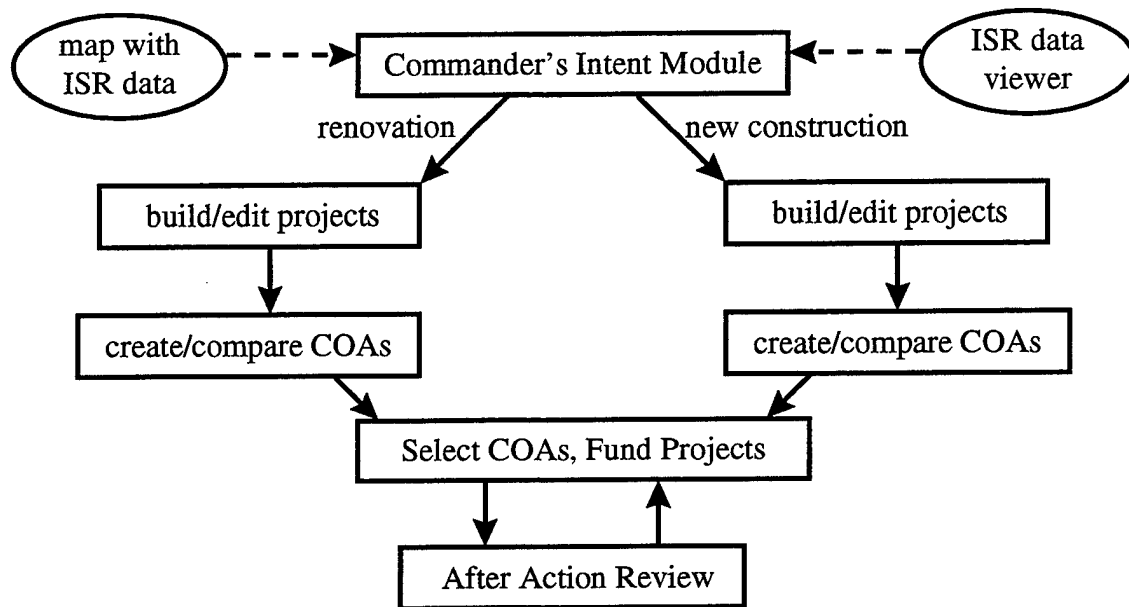


Figure 2. IDSM Process

Administrative task capabilities provided by the IDSM include editing the ISR database, creating work orders, and creating building faults lists.

2.1 System Development - Data Management Capability

The data management capability improves the commander's situational awareness of his installation infrastructure condition. This work was completed in by O'Hara (1996). The IDSM data management capability provides the commander with user-friendly access to the results of the ISR inspection. From this, the commander can see the results displayed on an installation map, and look at summary statistics at all levels to help pinpoint problem areas.

2.2 System Development - Analytical Capability

The IDSM analytical capability assists installation commanders in spending their infrastructure budgets more effectively. There are two major tasks required to budget infrastructure money effectively: create "good" projects, and prioritize the projects.

What is a "good" project? Clearly that is subjective and will differ by installation and commander. For this model, a good project is defined as one having significant internal and external value, as well as, being cost effective. The external value of a project is defined as the relative value of doing a project on a *particular facility* or set of facilities. In other words, it is the importance of the facility that is being repaired, not the nature of the actual repair. The external value of a project is determined using the Commander's Intent module. Internal value of a project is defined as the relative value of doing a *particular project*. In other words, it is the value of the nature of the repair, not the importance of the facility that is being repaired. It can reflect many measures of project value such as energy savings, operations and maintenance savings, duration of project, effects of delaying the project; and is defined uniquely by each installation.

Internal project value is created using the Project Impact Worksheet, part of the Build/Edit Projects Module. The cost effectiveness factor allows the commander to determine the relative importance of the project cost. If the commander feels cost is the most important decision criteria, then the value of the project may be divided by the cost as a way to then rank order the project list. If cost is not important to the commander, the project list will be rank ordered based on the project value. Alternatively, the commander may use a modified cost effectiveness factor falling between these two extremes.

Why define projects? The ISR does not provide data in a form that installations actually use for planning, work and financing purposes. The ISR identifies failed facility subsystems and generates renovation costs and condition data for a complete facility. Installations rarely renovate an entire facility; they more often fix one failed subsystem for a group of facilities. For example, as opposed to renovating one entire housing unit, a project would be created where the roofs would be replaced on 10 housing units. Also, the ISR identifies sustainment costs at the FCG level. Installations rarely consider sustainment costs at the FCG level; they look at their actual bills which usually reflect a service provided to the entire installation, not broken out by FCGs.

Why define "good" projects? The installations do not have the manpower to capture every failed subsystem, as identified by the ISR, in a project. For the facilities engineers to create a project, they must send engineers for a technical inspection of the facility and then design and budget the project. Therefore the engineers must focus their attention on a more limited set of facilities.

The second major task for the IDSM analytical capability is to prioritize the projects for funding. Prioritization is critical because the budget is limited. The

installations must be able to quantifiably compare and choose projects with the greatest abilities to meet the needs of the installation and the goals of the commander. Funding from the DA comes to the installation earmarked (or sometimes called "colored") for specific types of projects. The most common types of funds used for infrastructure management are:

- OMA - *Operations and Maintenance Army*, used for sustainment, repair and renovation of infrastructure. The majority of the infrastructure dollars that an installation controls are OMA funds.
- AFH - *Army Family Housing*, used for sustainment, repair and renovation of family housing. The installation controls the allocation of these funds.
- NAF - *Non Appropriated Funds*, used for most Morale and Welfare facilities. The installation has input on how these funds are spent.
- MCA - *Major Construction, Army*, used for major new construction. The installation does not control these funds; Congress must approve each new MCA construction project. The installation may request specific construction projects on their annual request for new construction.
- Other - this may cover gifts, donations, bequeaths and usually the installation has complete control over how the funds are spent.

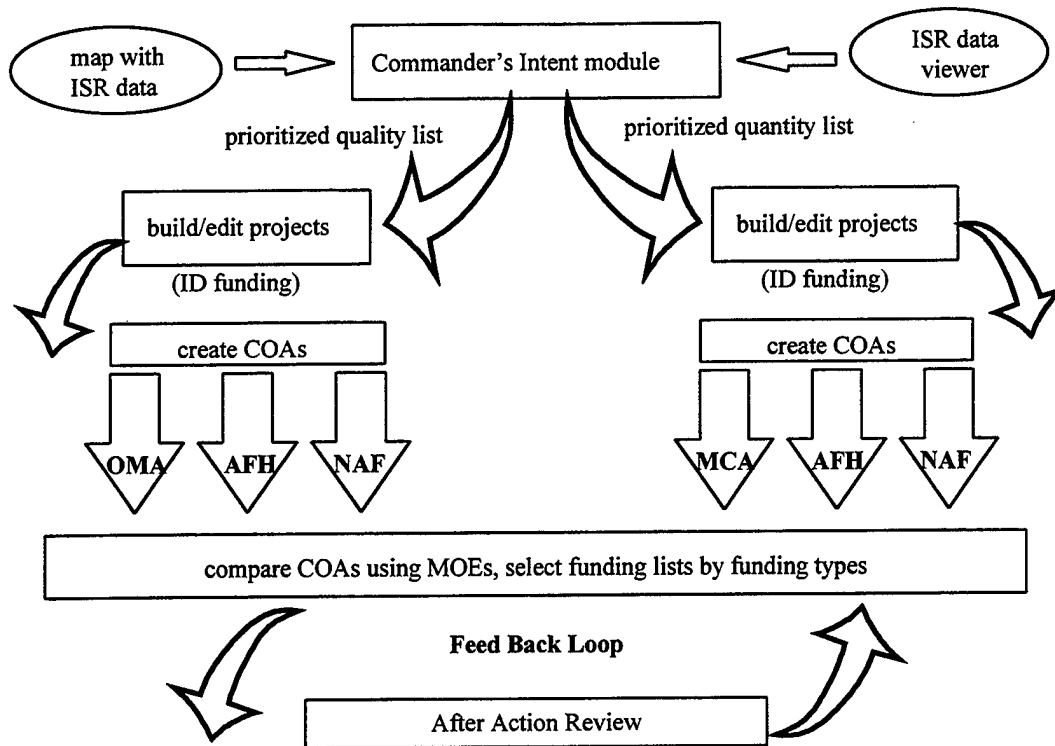


Figure 3. IDSM Process With Fund Types

2.3 System Development - IDSM Assumptions

- For IDSM calculations, when a facility subsystem is identified and funded for repair in the next year, it's future condition becomes green.
- Future degradation is similar to what occurred in the past (able to forecast degradation using a time series model).
- When calculating the project value score, the internal project value (the project impact worksheet score) and the external value (the commander's intent score) will be weighted equally.

3.0 DATA MANAGEMENT

See O'Hara (1996) for a complete report on the data management capability and the IDSM needs analysis.

3.1 ISR Database Viewer

The ISR Database Viewer used by the IDSM is a modification of the Richardson & Kirmse Engineering, Inc. (R&K)'s ISR viewer. The database viewer allows the user to view composite statistics and ratings from facility level to ISR area level for all of the major subcommands on an installation. The IDSM adds the capability to look at composite subsystem faults to help determine any systemic problems.

3.2 ISR Database Editor

The ISR Database Editor was created out of necessity for IDSM development and provides an essential service to the user. The editor allows access and edit capability of the ISR database. The most important task performed by the editor is that it captures all of the facility subsystem data. Until recently, the ISR software only recorded the facility rating, while failing to capture the subsystem data collected. The installation needs more detail than a facility rating; they need to know why a facility has a specific rating.

3.3 Installation Map

The IDSM Installation Map Module allows the user to overlay ISR results on an installation map. An installation map in Geographic Information System (GIS) format must be used, and with the fielding of Real Property Management Tool (RMAT), this type of map will become the Army standard. If the installation has a GIS database, the

IDSMS software needs access to the map through a Local Area Network (LAN) using a PC based GIS viewer. Once the data is accessed, it is possible to run queries and have the results displayed graphically. For example, it is possible to run a query to see which buildings have red or amber rated roofs, and show the results on the installation map.

3.4 FCG Prioritization

The FCG Prioritization Module is a precursor to the Commander's Intent Module. It captures the commander's priorities for facility importance, facility condition, and target ratings, and turns that input into rank ordered lists of FCGs.

4.0 INSTALLATION ANALYSIS

4.1 Commander's Intent

4.1.1 Purpose

The Commander's Intent Module allows the commander to communicate his infrastructure management priorities and goals to the facility engineers for use in creating infrastructure projects and developing funding strategies. The Commander's Intent Module follows a process where the commander numerically weights both the relative importance of his facilities, and the relative importance of improving the condition of his facilities. These weights are used to create a prioritized listing of either FCGs or facilities (depending on the resolution desired by the commander) to provide guidance to the facilities engineers. In short, the commander creates a prioritized list for the engineers that tells them where to concentrate their study efforts and work.

It is recommended that several different people create prioritized work lists for infrastructure work using the commander's intent module. These different work lists can be discussed and compared and a composite list created that reflects the vision of several decision makers.

4.1.2 Inputs

Creating the prioritized lists requires four inputs:

- Relative Importance Weights (from commander),
- Relative Improvement Weights (from commander),
- Current ISR Ratings (from ISR database), and

- Strategy (from commander).

The relative importance weights are selected from a descriptive list for each facility, FCG, sub category, category, and ISR area. If importance weights are not selected, the model assumes equal importance. The Commander may only wish to determine the relative importance of the ISR areas and leave the rest of the importance ratings for his staff to determine.

<u>Weight</u>	<u>Facility Importance</u>
10	Most Important Facility
8	Critical Facility
6	Above Average Importance
4	Below Average Importance
2	Facility is Not Important
0	Facility is of No Importance

Table 1. Facility Importance Weights

The relative importance ratings are then normalized within each area, category, sub category, FCG and facility. Then the normalized importance ratings are used to calculate a globalized importance rating for the FCG or facility. For example:

$$\begin{aligned} \text{Facility Globalized Importance Rating} = & \text{Facility Normalized Rating} \\ & \times \text{FCG Normalized Rating} \times \text{Sub Category Normalized Rating} \\ & \times \text{Category Normalized Rating} \times \text{Area Normalized Rating} \end{aligned}$$

where: the facility is a unique member of an FCG, sub category, category, and an area

Equation 1. Facility Globalized Importance Rating

Using the facility or FCG globalized importance rating, the Importance Factor is then calculated:

FCG Importance Factor = FCG Globalized Rating x Number of FCGs at Installation

Equation 2. FCG Importance Factor

Facility Importance Factor = Facility Globalized Rating x Number of Facilities at Installation

Equation 3. Facility Importance Factor

The globally normalized rating must be multiplied by the quantity of facilities or FCGs to ensure that the importance factor and the improvement factor remain of the same magnitude. Appendix A contains the details of the Commander's Intent calculations.

Relative improvement weights and current ISR ratings are used together to determine the improvement factor for a specific facility or FCG. The relative

<u>Weight</u>	<u>Task Importance</u>	<u>Task</u>	<u>Weight</u>
10	Most Important Task	1. Fix Red Facilities	(Score 0 -10)
8	Critical Task	2. Fix Amber Facilities	(Score 0 -10)
6	Above Average Importance	3. Fix Green Facilities	(Score 0 -10)
4	Below Average Importance	Table 3. Facility Improvement Weights	
2	Task is Not Important		
0	Task is of No Importance		
Table 2. Task Importance		improvement task weights are defined similarly to the facility importance weights.	

Based on the ISR rating system, there are three possible improvement tasks for facilities: fix red facilities (fix subsystems of a red facility), fix amber facilities, and fix

green facilities. There are four improvements tasks for FCGs: fix C4 FCGs (fix subsystems of a facility within a C4 rated FCG), fix C3 FCGs, fix C2 FCGs , and fix C1 FCGs. Each task is assigned a relative task weight by the commander.

A normalized improvement task weight is calculated for the 3 facility improvement tasks and the 4 FCG improvement tasks. The normalized task weight is then multiplied by the number of tasks to calculate the improvement factor.

Task Improvement Factor = FCG Normalized Improvement Rating x 4 FCG Tasks
**calculated for each of 4 possible FCG tasks*

Equation 4. FCG Task Improvement Factor

Task Improvement Factor = Facility Normalized Improvement Rating x 3 Facility Tasks
** calculated for each of 3 possible Facility tasks*

Equation 5. Facility Task Improvement Factor

Finally, the improvement factor is assigned to each specific FCG or facility based on their current ISR rating. For example, if a facility is rated red, the “Improve Red Facility” Improvement Factor will be assigned to that facility as its improvement factor.

The strategy followed in the Commander’s Intent module allows the commander to emphasize fixing his important facilities or fixing his broken facilities, or to emphasize importance and improvement equally. The strategy selected determines the ratio of importance factor and improvement factor in the final commander’s intent score.

Strategies

1 - Facility Importance and Facility Improvement are of equal value.

2 - Stress Facility Importance X times over Facility Improvement.

3 - Stress Facility Improvement X times over Facility Importance.

(X will be entered by user)

Table 4. Commander's Intent Strategies

4.1.3 Process

The process used to determine commander's intent score is to multiply the importance factor by the improvement factor at either the facility or FCG level.

$$\text{FacCI}_x = (\text{FacIPT}_x \times \text{IPTsf}) + (\text{FacIPV}_x \times \text{IPVsf}) \quad \forall x$$

where:

- | | |
|---------------------|---|
| x | - facility identification number |
| FacCI _x | - Commander's Intent score for facility x |
| FacIPT _x | - facility importance factor for facility x |
| IPTsf | - facility importance scaling factor (from strategy) |
| FacIPV _x | - facility improvement factor for facility x |
| IPVsf | - facility improvement scaling factor (from strategy) |

Equation 6. Facility Level Commander's Intent Score

4.1.4 Outputs

The output from the Commander's Intent module is a prioritized list of facilities or FCGs for the engineers. Two types of lists are created using the commander's input: quality and quantity. The quantity list tells the engineers the commander's new construction priorities. The quality list tells the engineers where the commander wants to

emphasize renovation and sustainment work. If the commander does not feel these lists reflect his true priorities, he may want to go back and look at his importance or improvement weights, change them if necessary, and recalculate the list. The commander has a manual override if there is an FCG or facility that is not represented properly on the prioritization list.

4.2 Build and Edit Projects

4.2.1 Purpose

The purpose of the Build and Edit Projects module is to assist facilities engineers in creating and editing infrastructure projects, as well as capturing the data necessary for IDSM analysis. A project consists of a set of facility subsystems to be repaired (the project scope), project fund categories, project fund amounts, project fund priority, project commander's intent score, and a project impact worksheet score. Currently, the engineers collect the project scope and project fund information. The project commander's intent score is calculated by the IDSM from the commander's intent module. The project impact worksheet, a concept already in use at some installations and several city governments⁵, provides a relative project value score.

Project Scope:	<i>Repair roof on HQ building</i>
Project Fund Amount:	<i>\$20,000 - OMA (K)</i>
Project Fund Priority:	<i>2 - needed work</i>
Commander's Intent Score:	<i>3.1416</i>
Project Impact Worksheet Score:	<i>126</i>

Figure 4. Project Example

⁵ Hatry et al, page 6.

4.2.2 Project Scope

The scope of the project is created by selecting red or amber subsystems to be repaired from the facility records of the IDSM database. The IDSM uses a point and click capability to identify the failed facility subsystems to be included in the project.

4.2.3 Project Funds

Fund information is entered manually into the IDSM. The IDSM does not automatically generate project cost or fund type information. At the installation decision level, project costs must be very accurate. There is substantial overhead to creating an effective costing model at the installation level. It is more time and cost effective to have installations use their current project costing procedures than to try to create an accurate cost prediction model. However, since subsystem data is now being collected for each

1 - Non Appropriated Funds (NAF)	1 - Must Fund
2 - Appropriated Funds	• utilities • some services • emergency work
MCA AFH (1000)	2 - Need
OMA (H) AFH (1910)	• services • building maintenance • some renovations
OMA (J) AFH (1920)	3 - Want
OMA (K) AFH (1930)	• renovations • cosmetic
OMA (L) AFH (1940)	
OMA (M) AFH (6000)	
RDTE UMMCA	
Other	
3 - Other (example: gift)	
Table 5. Fund Categories	Table 6. Project Fund Priorities

facility, it may be possible in the future for the ISR or IDSM to generate fairly accurate cost repair values. To create an infrastructure project, the fund amount, the fund type, and the project fund priority must be entered. The

fund type is critical for IDSM analysis because it identifies groups of projects that compete for a specific funding type. The project fund priority is used to capture the sustainment/baseline/fixed costs at the installation. Many installations stated during the IDSM needs analysis that the bulk of their RPMA funds (80% to 90%) were used to pay utility bills, salaries, contracts and other fixed costs.⁶ These costs are still funded first, but now they will be displayed with the RPMA renovation projects for better visibility. The fund priorities are: must fund, need and want.

4.2.4 Project Commander's Intent Score

The project Commander's Intent score is used to indicate to the engineers how closely this project follows the commander's guidance on infrastructure projects; it captures the external value of the project. The score is calculated automatically by IDSM based on the FCGs or facilities included in the project scope.

$$\text{ProjCI}_y = \frac{\sum_n \text{FacCI}_x}{n} \quad \forall x \text{ in project scope}$$

where:

x	- facility identification number
y	- project identification number
n	- total number of subsystems included in project
ProjCI_y	- Commander's Intent score for project y
FacCI_x	- Commander's Intent score for facility x

Equation 7. Project Commander's Intent Score

⁶ O'Hara, page 10.

4.2.5 Project Impact Worksheet

The purpose of the Project Impact Worksheet is to capture the internal value of completing this particular project as opposed to a different project for the same facility requirement. A project impact worksheet score is created by evaluating the project on several criteria. The IDSM contains 12 default criteria that may be used; the installation can add criteria to the default list, or the installation can use a locally created project impact worksheet. Appendix B contains a sample project impact worksheet and the development of criteria ratings.

Criteria	Description
Effects of delaying project	possible impact for not completing project this year
Duration of project	length of project (in days)
Change in operating and maintenance costs	increase or decrease on O&M costs of facility
Energy Savings	savings in energy costs
Amount of disruption caused by project	detours or other turmoil caused by completion of project
Regulations Compliance	project assists in regulations compliance
Distribution of project benefits	what % of population benefits from project
Benefits to other projects	does completion of this project benefit another project?
Building commandant/user priorities	the importance the user assigns to this project
Health and safety	health and safety benefits of project
Aesthetics	aesthetic improvements of project
Environmental Impact	positive or negative environmental impact of project

Table 7. IDSM Project Impact Worksheet Default Criteria

Installations may also use the project impact worksheet to assist in project selection decisions. For example, if an installation had a building with a leaky roof and the possible repair options were to replace or repair the roof, a project impact worksheet could be completed for both options to help choose the better project.

4.3 Build and Compare Courses of Action

4.3.1 Purpose

The purpose of the Build and Compare COA Module is to allow the engineers to create several funding strategies, or COAs to present to the commander to make a funding decision. The COAs are compared using the MOEs: projected change, projected improvement, total project impact, and support of commander's intent. The commander also has a "What If" capability to examine the COA and test for sensitivity. Finally the commander can manually adjust a course of action.

4.3.2 Inputs

The inputs used to build and compare COAs are the projects from the build/edit projects module and direct input from the commander. The projects include project scope, project cost, fund type, fund priority, project impact and commander's intent score. The commander's input will be captured by the COA module in the form of funding strategies and cost effectiveness strategies.

4.3.3 Outputs

The outputs from this module are prioritized funding lists for renovation and sustainment (RPMA) projects, construction (MCA) projects, family housing (AFH) projects, and morale and welfare (NAF) projects. The AFH and RPMA lists are primarily used to allocate installation funds. The MCA and NAF lists are sent to higher headquarters as requests for projects and funds.

4.3.4 Process

This is the process the IDSM follows in the build and compare COA module. Each step is discussed in the following paragraphs and Appendix C contains the mathematical description of this process.

Action	Purpose
1. Create Decision Space	Show budgeting extremes.
2. Create Baseline COA	Create funding list based on commander's current input.
3. Create Additional COAs	Vary baseline COA through use of different funding strategies.
4. Compare COAs	Use MOEs to compare.
5. What If? Analysis	See impact of minor variations to COA.
6. Select Funding List	Select projects to fund, by fund type.

Table 8. COA Process Summary

4.3.4.1 Create Decision Space

Budget decision space shows the commander his maximum budgeting capabilities. The IDSM budget decision space emphasizes selected funding strategies, one at a time, and shows the results in terms of projected change or improvement. When one funding strategy is selected, all funding is allocated to support that particular strategy. The budgeting strategies available in the IDSM are given in Table 9.

Strategy Name	Strategy Description
Mission Facilities	Improve mission facilities
Mobility Facilities	Improve mobility facilities
Housing	Improve housing
Community Facilities	Improve community facilities
Installation Support	Improve installation support facilities
Red Facilities	Improve red facilities
Important Facilities	Improve important facilities
Maximize Project Impact	Maximize project impact score
Minimize Degradation	Minimize expected degradation
Effects of Project Delay	Choose projects with possible delay effects
Project Duration	Choose projects with short duration
Project Benefits	Choose projects with greatest dispersion of project benefits to population
User Priorities	Choose projects that user feels are most important
Environmental	Choose projects with greatest positive impacts on environment

Table 9. IDSM Funding Strategies

The commander then selects a cost effectiveness strategy. The cost effectiveness strategy determines the impact that the project cost will play in the creation of the ordered list.

- 1 - Project Cost is the most important factor.
- 2 - Project Cost is X times more important than Project Value.
- 3 - Project Value is X times more important than Project Cost.
- 4 - Project Value is the most important factor.
- 5 - Project Value and Project Cost are of equal importance.

Table 10. Cost Effectiveness Strategies

Next the IDSM calculates the Project Value. Project Value is calculated by summing the Project Impact Worksheet score and the Project Commander's Intent score, the internal and external values of the project respectively.

$$\text{Project Value} = \text{Project Impact Score} + \text{Commander's Intent Score}$$

Equation 8. Project Value Equation

Once the COA strategy and the cost effectiveness strategy have been selected, the IDSM uses these to create a rank ordered list. If cost is the most important factor, projects will be rank ordered by Project Value divided by Project Cost. If Project Value is the most important factor, projects will be rank ordered based on Project Value score only. Other cost effectiveness strategies are a compromise of the two extremes.

4.3.4.2 Create Baseline COA

Using a cost effectiveness strategy and the information already input into the IDSM by the commander, the IDSM calculates project values and creates a baseline funding list COA. This list is used by the Commander for exploring the impacts of changing funding strategies on final funding decisions.

4.3.4.3 Create Additional COAs

The commander creates additional COAs by selecting a maximum of three funding strategies for implementation. The selected strategies are weighted by the commander to reflect their importance, and those weights are normalized.

$$0.5 (\text{Mission Facilities funding strategy}) + 0.5 (\text{Red Facilities funding strategy})$$

Equation 9. Example Weighted COA Strategy

In this example, the commander wants to emphasize funding of mission and red rated facilities from the baseline values.

4.3.4.4 Compare COAs

The baseline COA and any other created COAs can be compared using the following MOEs: Projected Change, Projected Improvement, Total Project Impact, and Support of Commander's Intent.

- a. *Projected Improvement* uses the project scope to determine exactly what improvement will occur based on the projected funding. It is assumed that every subsystem repair that is funded will bring the subsystem to green status. Projected Improvement is displayed by showing current year's red, amber and green facilities (by number and %) and then showing the projected improvement in terms of red, amber, and green facilities for comparison.
- b. *Projected Change* uses the project scope to determine the improvement, and a time series degradation forecast to create the projected change of the ISR area. To ensure an accurate forecast, the degradation forecast is only done at ISR area level where there is a larger quantity of facilities. Projected Change shows the current year's facilities ratings and the projected facilities ratings improvement, but also displays projected degradation and overall projected change. Project degradation is displayed in terms of number of facilities that have gone from Amber to Red, Green to Amber, and Green to Red, and the projected change in terms of number and % of red, amber and green facilities.
- c. *Total Project Impact* sums the project impact worksheet scores for each project selected for funding in the COA. Total Project Impact is a relative measure - its value is meaningless unless compared to the Total Project Impact from another funding strategy.

d. *Support of Commander's Intent* shows the average project commander's intent score for all projects selected in a specific COA. Support of commander's intent is also a relative measure.

4.3.4.5 What If? Analysis

After selecting a funding COA, the commander may vary the inputs to see the potential impacts on the MOEs. What If? Analysis varies the commander's input by -20% and +20% of the actual values. This allows the commander to see how sensitive his course of action is to the decision factors selected. The commander or his representative may vary the following inputs:

Variable	Description
Mission Facilities Importance	importance component of commander's intent (CI) score
Mobility Facilities Importance	importance component of CI score
Housing Importance	importance component of CI score
Community Facilities Importance	importance component of CI score
Installation Support Importance	importance component of CI score
Fix Red Facilities	improvement component of CI score
Fix Amber Facilities	improvement component of CI score
Fix Green Facilities	improvement component of CI score
Importance Scaling Factor	strategy component of CI score
Improvement Scaling Factor	strategy component of CI score
Project Impact Scaling Factor	project impact component of project value
Commander's Intent Scaling Factor	commander's intent component of project value
Criteria Weight for Project Delay	criteria on project impact worksheet
Criteria Weight for Project Duration	criteria on project impact worksheet
Criteria Weight for Project Benefits	criteria on project impact worksheet
Criteria Weight for User Priorities	criteria on project impact worksheet
Criteria Weight for Environmental Impact	criteria on project impact worksheet

Table 11. IDSM Variables

and see the following outputs: projected improvement or projected change in mission facilities, mobility facilities, housing, community facilities, installation support and overall facilities.

4.3.4.6 Select Funding List

When satisfied with the COA analysis, the commander selects the final funding list of infrastructure projects. The commander may manually adjust the order of the list to create the final list. Projects not selected for funding this year will be forecast out into future years. The engineers may enter the completion of the projects into the IDWSM through out the year for further analysis. If other funds become available, projects forecast for future years may be completed during the current year.

4.4 After Action Review

4.4.1 Purpose

The After Action Review (AAR) provides feedback to the commander about how well his budgeting strategies performed last year. The AAR module looks at: last year's ratings, where last year's money was budgeted, where last year's money was spent, actual improvement, actual degradation, unexpected change, current year's ratings, and projected degradation (ISR area level only).

4.4.2 Inputs

Most of the AAR calculations are completed with only ISR data, requiring no additional user input. To see where last year's money was budgeted, and where last

year's money was spent, the installation must enter the project and COA data, and update the IDSM as projects are completed.

4.4.3 Outputs

The outputs from the AAR Module are:

Information Output	Unit of Measure
last year's condition	number and percent of red, amber and green facilities
last year's budget	dollar amount and budget % by red, amber, and green facilities
last year's expenditures	dollar amount and budget % by red, amber, and green facilities
actual improvement	number and percent of facility rating changes, by type of change
actual degradation	number and percent of facility rating changes, by type of change
unexpected change	number and percent of facility rating changes, by type of change
current condition	number and percent of red, amber and green facilities
projected degradation	number and percent of facility rating changes, by type of change

Table 12. After Action Review Output

4.4.4 Process

4.4.4.1 Last Year's Condition

Last year's condition is displayed from the ISR database by number and percent of red, amber and green facilities. This data can be displayed by ISR area, category, sub category, and FCG. At the facility level, the subsystem data from the previous year is displayed.

4.4.4.2 Last Year's Budget

Last year's budget is displayed from the IDSM database in terms of dollars and percent of funds spent on previously red, amber and green facilities. This data can be displayed at ISR area, category, sub category, and FCG level. At the facility level, the actual budgeted dollars are displayed. In order to display last year's budget, the user

must select a COA for funding in the IDSM program. The budget numbers are determined using the project fund costs of the projects selected for funding.

4.4.4.3 Last Year's Expenditures

Last year's expenditures are also displayed in terms of dollars and percent of funds for red, amber and green facilities. This data can be displayed at ISR area, category, sub category, and FCG level. At the facility level, the actual dollars spent are displayed. In order to display last year's expenditures, the user must select a COA for funding and update the IDSM as the projects are completed or additional projects are funded.

4.4.4.4 Actual Improvement

Actual improvement is displayed by comparing last year's ISR database to this year's ISR database and finding all improvement that resulted from a funded project. Improvement is displayed in the format of the number and percent of red facilities that are now amber, red facilities that are now green, and amber facilities that are now green facilities. This data can be displayed by ISR area, category, sub category, and FCG.

4.4.4.5 Actual Degradation

Actual degradation is displayed by comparing last year's ISR database to this year's ISR database and finding all degradation that occurred. Degradation is displayed in the format of the number and percent of green facilities that are now amber, green facilities that are now red, and amber facilities that are now red facilities. This data can be displayed by ISR area, category, sub category, and FCG.

4.4.4.6 Unexpected Change

Unexpected change is displayed by comparing last year's ISR results to this year's ISR results and finding all improvement that occurred from other than a funded repair project (i.e. no logical reason that rating improved). This change is normally due to inspector subjectivity. Unexpected change is displayed in the format of the number and percent of red facilities that are now amber, red facilities that are now green, and amber facilities that are now green facilities. This data can be displayed by ISR area, category, sub category, and FCG.

4.4.4.7 Current Condition

The current year's condition is displayed from the ISR database in the format of the number and percent of red, amber and green facilities. This data can be displayed by ISR area, category, sub category, and FCG. At the facility level, the actual subsystem data is displayed.

4.4.4.8 Projected Degradation

Projected Degradation is calculated at the ISR area level from past degradation data forecasting future degradation over time. Projected degradation is displayed in the format of the number and percent of green facilities that are now amber, green facilities that are now red, and amber facilities that are now red facilities. This data can only be displayed at ISR area level because the simplistic forecasting methods used here are only be reasonably accurate using a large number of facilities. Currently, the forecasting method applied is a 3 year moving average. When more degradation data is collected in

the future, a more accurate forecasting method can be applied. The forecasted degradation value is also used to create a measure of effectiveness for estimating change.

$$\text{Projected Degradation} = (\text{Actual Degradation Last Year} \\ + \text{Actual Degradation 2 Years Ago} + \text{Actual Degradation 3 Years Ago}) / 3$$

Equation 10. Projected Degradation Using 3 Year Moving Average

5.0 ADMINISTRATIVE CAPABILITY

5.1 Purpose

The IDSM administrative capability produces building fault reports and sets up the IDSM for the individual user.

5.2 IDSM Set Up

During the IDSM set up, the user identifies the current year and past year ISR databases, alters the project impact worksheet if desired, and identifies the LAN connections required to view the installation map with the ISR ratings overlay.

5.3 Building Fault Report

The Building Fault Report Module will automatically generate either a general work order or a building fault list. The work order or fault list is then sent back to the building inspectors as feedback from the ISR inspection. A fault list can be used to get input from the building commandant for their building repair priorities or to prompt them to complete work orders. The general work order can be created for red and/or amber subsystems and require that the building commandant list the specific building fault requiring repair. In the future, this capability should be linked to IFS-M to automatically compare ISR inspection results with outstanding work orders.

6.0 FUTURE WORK

6.1 Prototype Implementation

Both the Data Management Module and the Analytical Module are working prototypes. Their purpose is to display the functionality of the IDSM, not to be fielded to the user. The IDSM prototypes need to be finalized and integrated into the ISR software.

6.2 Expansion of IDSM to Include ISR Parts II and Part III.

The IDSM has to be expanded to include Part II (Environmental) and Part III (Services) portions of the ISR report. The Part II analysis would be fairly easy to implement; simply include a new group of projects that encompass the installations environmental concerns and include the specific environmental budget moneys. It is hard to speculate about how to include Part III at this time as the product has not yet been fully developed or fielded.

6.3 Use of Other Databases

The IDSM's primary input is the ISR database, there are other databases that would provide useful information to commander's in making budget allocation decisions such as IFS-M. In order for IDSM and IFS-M to communicate, IFS-M must use facility identification numbers and ISR defined subsystems as a data entry on work orders. When the ISR inspection is completed, the results can then be automatically compared to the outstanding work orders in the IFS-M system, and new work orders can be created as required.

6.4 Improved ISR Costing Model.

Since the facility subsystem data is now able to be automatically collected, it should be possible to create a more accurate costing model for the renovation estimates of facilities. Currently the renovation cost estimates are based only on the overall condition rating of the facility. With the addition of the subsystem condition rating data, it would be logical to assume that a much more accurate renovation cost can be generated. The subsystem renovation estimates should be listed individually to allow the installation the maximum flexibility in creating infrastructure renovation projects.

6.5 Future Internet Applications

Hopefully, in the near future, all of the ISR and IDSM data, information, training and software will be located on a World Wide Web home page. This will give installations, MACOMs and DA immediate access to the most current ISR information, software program updates, and improved ISR submission process.

6.6 Other Resource Allocation Problems

This goal oriented methodology could be applied to any type of public sector resource allocation problem like the Army faces in the allocation of training dollars or personnel dollars.

6.7 Programmed Sustainment and Renovation Budget Requirements.

To preclude the continual fight for money, renovation and sustainment dollars should be forecast as part of any proposed new construction forecast, and programmed as a requirement in future budgets. At the time of design and construction, it is fairly easy to

make accurate predications of required renovation and sustainment funds in terms of current dollars. Programming renovation and sustainment dollar requirements into new construction would likely effect the project selection process also.

7.0 CONCLUSION

With continually decreasing military budgets and aging infrastructure, IDSM allows the installation to make the most of the limited renovation and sustainment funding available. By increasing the commander's infrastructure awareness, assisting the commander's articulation of problem areas, comparison of funding strategies, and report on past budgeting effectiveness - the IDSM is truly a budget decision support tool. IDSM is poised to become the critical link in the entire ISR process. By giving the installations data management and analytical tools so they benefit from their ISR data, the validity of data at the DA level is ensured. Also, to truly effect a change in infrastructure management, a change must be effected at the level where infrastructure money is spent, infrastructure projects are created and executed, and where infrastructure exists - at the Installation.

SELECTED BIBLIOGRAPHY

- Hatry, Harry P. et al. "Guide to Setting Priorities for Capital Investment", The Urban Institute Press, Washington DC, 1984.
- Lind, Elizabeth. "Goal Oriented Multiple Criteria Decision Making For Public Works Capital Investment Problems Involving Infrastructure With a Specific Case Study of the U.S. Army" , Master's Thesis, Georgia Institute of Technology, May 1995.
- O'Hara, Thomas. "Installation Decision Support Model(IDSM): Needs Analysis and Initial Model Development", Operations Research Center Technical Report 96-1, United States Military Academy, West Point, New York, 14 August 1996.

APPENDIX A Commander's Intent Calculations

As discussed in the main body of this paper, the equations below calculate the Commander's Intent score for a facility and an FCG.

$$\text{FacCI}_x = (\text{FacIPT}_x \times \text{IPTsf}) + (\text{FacIPV}_x \times \text{IPVsf}) \quad \forall x$$

where:

- x - facility identification number
- FacCI_x - Commander's Intent score for facility x
- FacIPT_x - facility importance factor for facility x
- IPTsf - importance scaling factor (from strategy)
- FacIPV_x - facility improvement factor for facility x
- IPVsf - improvement scaling factor (from strategy)

Equation 2. Facility Commander's Intent Score

$$\text{FCGCI}_{x1} = (\text{FCGIPT}_{x1} \times \text{IPTsf}) + (\text{FCGIPV}_{x1} \times \text{IPVsf}) \quad \forall x1$$

where:

- x1 - FCG identification number
- FCGCI_{x1} - Commander's Intent score for FCG x1
- FCGIPT_{x1} - FCG importance factor for FCG x1
- IPTsf - importance scaling factor (from strategy)
- FCGIPV_{x1} - FCG improvement factor for FCG x1
- IPVsf - improvement scaling factor (from strategy)

Equation 11. FCG Commander's Intent Score

Appendix A discusses the development of each variable in the Commander's Intent equations.

Appendix A: Importance Factor (FacIPT_x , FCGIPT_{x1})

As discussed in the main body of the report, the commander assigns importance weights to ISR areas, categories, sub categories, FCGs and facilities. Table 1 shows the facility weight definitions.

Weight	Facility Importance
10	Most Important Facility
8	Critical Facility
6	Above Average Importance
4	Below Average Importance
2	Facility is Not Important
0	Facility is of No Importance

Table 1. Facility Weight Definitions

Step 1. Normalize the importance weights assigned by the commander.

$$\text{ISR Area Normalized Rating} = \frac{\text{ISR Area Importance Weight}}{\sum \text{ISR Area Weights}}$$

For Categories:

$$\text{Normalized Rating} = \frac{\text{Importance Weight}}{\sum \text{Weights}} \quad \forall \text{ categories in same ISR area}$$

For Sub Categories:

$$\text{Normalized Rating} = \frac{\text{Importance Weight}}{\sum \text{Weights}} \quad \forall \text{ sub categories in same category}$$

For FCGs:

$$\text{Normalized Rating} = \frac{\text{Importance Weight}}{\sum \text{Weights}} \quad \forall \text{ FCGs in same sub category}$$

For Facilities:

$$\text{Normalized Rating} = \frac{\text{Importance Weight}}{\sum \text{Weights}} \quad \forall \text{ facilities in same FCG}$$

Step 2. Globalize the normalized importance scores.

$$\text{ISR Area Globalized Rating} = \text{ISR Area Normalized Rating}$$

For Categories:

$$\text{Globalized Rating} = \text{Category Normalized Rating} \times \text{Area Normalized Rating}$$

where: the category is a unique member of an area

For Sub Categories:

Globalized Rating = Sub Category Normalized Rating x Category Normalized Rating
x Area Normalized Rating

where: the sub category is a unique member of a category and an area

For FCGs:

Globalized Rating = FCG Normalized Rating x Sub Category Normalized Rating
x Category Normalized Rating x Area Normalized Rating

where: the FCG is a unique member of a sub category, category, and an area

For Facilities:

Globalized Rating = Facility Normalized Rating x FCG Normalized Rating
x Sub Category Normalized Rating x Category Normalized Rating
x Area Normalized Rating

where: the facility is a unique member of an FCG, sub category, category, and an area

Step 3. Calculate the facility and FCG importance factors.

FCG Importance Factor (FCGIPT_{x1})
= FCG Globalized Rating x Number of FCGs at Installation

Facility Importance Factor (FacIPT_x)
= Facility Globalized Rating x Number of Facilities at Installation

Note: It is necessary to multiply the global normalized rating by the quantity of facilities and FCGs to ensure that the importance factor and the improvement factor remain of the same magnitude.

Appendix A: Improvement Factor (FCGIPV_{x1}, FacIPV_x)

Based on the ISR rating system, there are three possible improvement tasks for facilities: fix red facilities, fix amber facilities, and fix green facilities. There are four improvements tasks for FCGs: fix C4 FCGs, fix C3 FCGs, fix C2 FCGs , and fix C1 FCGs. The commander assigns a weight to each of these tasks.

Step 1. Normalize weights assigned by commander to improvement tasks.

$$\text{FCG Task Normalized Value} = \frac{\text{FCG Task Weight}}{\Sigma \text{ FCG Task Weights}} \quad \text{for all 4 FCG tasks}$$

$$\text{Facility Task Normalized Value} = \frac{\text{Facility Task Weight}}{\Sigma \text{ Facility Task Weights}} \quad \text{for all 3 facility tasks}$$

Step 2. Calculate facility and FCG improvement factor.

$$\text{FCG Improvement Factor (FCGIPT}_{x1}) = \text{FCG Improvement Rating} \times 4 \text{ FCG Tasks}$$

$$\text{Facility Improvement Factor (FacIPT}_{x}) = \text{Facility Improvement Rating} \times 3 \text{ Facility Tasks}$$

Step 3. Assign improvement factors to facilities and FCGs depending on their current ISR ratings.

Appendix A: Strategy (IPTsf, IPVsf)

Strategies

1 - Facility Importance and Facility Improvement are of equal value.

2 - Stress Facility Importance X times over Facility Improvement.

3 - Stress Facility Improvement X times over Facility Importance.

(X will be entered by user)

Table 4. Commander's Intent Strategies

If Commander selects strategy 1 Then

 IPTsf = 1

 IPVsf = 1

Else If Commander selects strategy 2 Then

 IPTsf = X

 IPVsf = 1

Else If Commander selects strategy 1 Then

 IPTsf = 1

 IPVsf = X

End If

APPENDIX B Project Impact Worksheet and Calculations

Appendix B contains a sample project impact worksheet created using the IDSM default criteria. Each criteria is described and a sample criteria rating scale is included. The installation must define their project impact criteria clearly, and must establish quantitative and explicit rating scales.

Appendix B: Sample Worksheet

Name _____

Date _____

Project ID _____

Criteria	Weight (a)	Score (b)	Total (a x b)
1. Project Delay			
2. Project Duration			
3. Operating & Maintenance Costs			
4. Energy Savings			
5. Project Disruption			
6. Regulations Compliance			
7. Distribution of Project Benefits			
8. Benefits to Other Projects			
9. User Priorities			
10. Health and Safety			
11. Aesthetics			
12. Environmental Effects			
		TOTAL	

*** Note: Weight is assigned by commander for all projects.**

Appendix B: Project Impact Calculations

$$PI_y = \sum_z (PIW_z \times PIS_{yz}) \quad \forall z$$

Equation 12. Project Impact Equation

where:

y = project identification number

z = project impact criteria identification number

PI_y = project impact score for project y

PIW_z = weight for criteria z as assigned by commander

PIS_{yz} = score for criteria z for project y

The default criteria for this model are:

PIS_{y1} = criteria score for *project delay* for project y

PIS_{y2} = criteria score for *project duration* for project y

PIS_{y3} = criteria score for *o&m costs* for project y

PIS_{y4} = criteria score for *energy savings* for project y

PIS_{y5} = criteria score for *project disruption* for project y

PIS_{y6} = criteria score for *regulation compliance* for project y

PIS_{y7} = criteria score for *project benefits distribution* for project y

PIS_{y8} = criteria score for *benefits to other projects* for project y

PIS_{y9} = criteria score for *user priorities* for project y

PIS_{y10} = criteria score for *health and safety* for project y

PIS_{y11} = criteria score for *aesthetics* for project y

PIS_{y12} = criteria score for *environmental effects* for project y

PIW_1 = criteria weight for *project delay* as assigned by commander

PIW_2 = criteria weight for *project duration* as assigned by commander

PIW_3 = criteria weight for *o&m costs* as assigned by commander

PIW_4 = criteria weight for *energy savings* as assigned by commander

PIW_5 = criteria weight for *project disruption* as assigned by commander

PIW_6 = criteria weight for *regulation compliance* as assigned by commander

PIW_7 = criteria weight for *project benefits distribution* as assigned by commander

PIW_8 = criteria weight for *benefits to other projects* as assigned by commander

PIW_9 = criteria weight for *user priorities* as assigned by commander

PIW_{10} = criteria weight for *health and safety* as assigned by commander

PIW_{11} = criteria weight for *aesthetics* as assigned by commander

PIW_{12} = criteria weight for *environmental effects* as assigned by commander

Appendix B: Project Impact Worksheet Default Criteria Descriptions

Criteria Name: **Project Delay**
Description: Criteria describes possible effects of delaying project.
Scoring:
+ 2 possible major effects if work is delayed
+ 1 possible minor effects if work is delayed
0 no effects if work is delayed

Criteria Name: **Project Duration**
Description: Criteria describes duration of project in days.
Scoring:
+ 2 project duration < 30 days
+ 1 project duration < 60 days
0 project duration < 90 days
- 1 project duration < 1 year
- 2 project duration ≥ 1 year

Criteria Name: **Operating & Maintenance Costs**
Description: Criteria describes change in operating and maintenance costs.
Scoring:
+ 2 decrease in O&M costs >10%
+ 1 decrease in O&M costs ≤ 10%
0 no change in O&M costs
- 1 increase in O&M costs ≤ 10%
- 2 increase in O&M costs >10%

Criteria Name: **Energy Savings**
Description: Criteria describes change in energy consumption.
Scoring:
+ 2 decrease in energy usage >10%
+ 1 decrease in energy usage ≤ 10%
0 no change in energy usage
- 1 increase in energy usage ≤ 10%
- 2 increase in energy usage >10%

Criteria Name: **Project Disruption**
Description: Criteria describes amount of disruption caused by completing project.
Scoring:
0 no disruption
- 1 minor disruption
- 2 major disruption

Criteria Name: **Regulations Compliance**

Description: Criteria describes effect project will have on regulations compliance.

Scoring: + 2 assist regulations compliance, major effect
+ 1 assist regulations compliance, minor effect
0 no effect on regulations compliance

Criteria Name: **Distribution of Project Benefits**

Description: Criteria describes amount of personnel who will benefit from completion of project.

Scoring: + 2 benefits 75% or more of population
+ 1 benefits 25% to 75% of population
0 benefits less than 25% of population

Criteria Name: **Benefits to Other Projects**

Description: Criteria describes possible interaction or benefits to other projects caused by the completion of this project.

Scoring: + 2 benefits more than one other
+ 1 benefits one other project
0 no benefits to other projects

Criteria Name: **User Priorities**

Description: Criteria describes priority assigned by user to project.

Scoring: + 2 most important user project
+ 1 very important user project
0 average importance user project

Criteria Name: **Health and Safety**

Description: Criteria describes improvement in health and safety conditions.

Scoring: + 2 major improvement in health and safety conditions
+ 1 minor improvement in health and safety conditions
0 no change in health and safety conditions

Criteria Name: **Aesthetics**

Description: Criteria describes change in appearance or aesthetics caused by project completion.

Scoring: + 2 major aesthetic improvement
+ 1 minor aesthetic improvement
0 no change in aesthetics
- 1 minor aesthetic degradation
- 2 major aesthetic degradation

Criteria Name:

Environmental Effects

Description:

Criteria describes environmental impacts caused by project completion.

Scoring:

- + 2 major environmental improvement
- + 1 minor environmental improvement
- 0 no change in environmental condition
- 1 minor environmental degradation
- 2 major environmental degradation

APPENDIX C Course of Action Calculations

The following is the IDSM course of action process:

Action	Purpose
1. Create Decision Space	Show budgeting extremes.
2. Create Baseline COA	Create funding list based on commander's input.
3. Create Additional COAs	Vary baseline COA through use of different funding strategies.
4. Compare COAs	Use MOEs to compare.
5. What If? Analysis	Minor variations to COA, see impact.
6. Select Funding List	Select projects to fund, by fund type.

The Decision Space, Baseline COA, Additional COAs, and What If? actions require essentially the same basic mathematical process:

Action	Required Information
1 - Choose Cost Effectiveness Strategy	
2 - Calculate Project Value	Facility and/or FCG importance scores Improvement task scores Fix broken or important facilities Project fund type and amount Project fund priority Project scope Project impact worksheet
3 - Rank Order Projects	Project Value Cost Effectiveness Strategy Project Cost Project Fund Type

Table 13. COA Task Process

1 - Choose Cost Effectiveness Strategy

IDSMS Cost Effectiveness Strategies

- 1 - Project Cost is the most important factor.
- 2 - Project Cost is X times more important than Project Value.
- 3 - Project Value is X times more important than Project Cost.
- 4 - Project Value is the most important factor.
- 5 - Project Value and Project Cost are of equal importance.

2 - Calculate Project Value

General Equation:

Project Value = Project Impact Score (Appendix B) + Commander's Intent Score (Appendix A)

Note: the project impact score and the commander's intent score are assumed to be of equal weight.

Variables Used:

All IDSMS variables will not be varied for IDSMS analysis. The IDSMS analysis becomes confusing if too many variables are available; the following subgroup of IDSMS variables has been selected for analytic purposes because they make the greatest impact on allocation decisions. All other variables remain at baseline values from commander's intent module and build/edit projects module.

IDSMS Decision Variables

Variable	Description
Mission Facilities Importance	importance component of commander's intent score
Mobility Facilities Importance	importance component of commander's intent score
Housing Importance	importance component of commander's intent score
Community Facilities Importance	importance component of commander's intent score
Installation Support Importance	importance component of commander's intent score
Fix Red Facilities	improvement component of commander's intent score
Fix Amber Facilities	improvement component of commander's intent score
Fix Green Facilities	improvement component of commander's intent score
Importance Scaling Factor	strategy component of commander's intent score
Improvement Scaling Factor	strategy component of commander's intent score
Project Impact Scaling Factor	project impact component of project value

Variable cont...	Description cont...
Commander's Intent Scaling Factor	commander's intent component of project value
Criteria Weight for Project Delay	criteria on project impact worksheet
Criteria Weight for Project Duration	criteria on project impact worksheet
Criteria Weight for Project Benefits	criteria on project impact worksheet
Criteria Weight for User Priorities	criteria on project impact worksheet
Criteria Weight for Environmental Impact	criteria on project impact worksheet

Funding Strategies:

Funding strategies allow the commander to pick a word description of how he would like to impact his allocation decision. The mathematical impacts of the listed funding strategies are detailed in the following annexes. Each funding strategy changes the value of one or more decision variables.

IDSMS Funding Strategies

Strategy Name	Strategy Description
Mission Facilities	Improve mission facilities
Mobility Facilities	Improve mobility facilities
Housing	Improve housing
Community Facilities	Improve community facilities
Installation Support	Improve installation support facilities
Red Facilities	Improve red facilities
Important Facilities	Improve important facilities
Maximize Project Impact	Maximize project impact score
Minimize Degradation	Minimize expected degradation
Effects of Project Delay	Choose projects with possible delay effects
Project Duration	Choose projects with short duration
Project Benefits	Choose projects with greatest dispersion of project benefits to population
User Priorities	Choose projects that user feels are most important
Environmental	Choose projects with greatest positive impacts on environment

3 - Rank Order Projects

The projects are rank ordered depending on their project value, fund type and cost, and the cost strategy selected.

If cost strategy selected is: *Project Cost is the most important factor*

Then projects are rank ordered, greatest value to least, by Project Value/Project Cost, by fund type.

If cost strategy selected is: *Project Value is the most important factor*

Then projects are rank ordered, greatest value to least, by Project Value, by fund type.

If cost strategy selected is: *Project Value and Project Cost are of equal importance*

Then projects are rank ordered, greatest value to least, by fund type, by:

$$X1 * \left(\frac{\text{Project Value}}{\text{Largest Project Value}} \right) + X2 * \left(\frac{\text{Smallest Project Cost}}{\text{Project Cost}} \right)$$

where: $X1 = 1$
 $X2 = 1$

Smallest Project Cost and Largest Project Value are selected from the group of projects by fund type.

Equation 13. Project Value and Cost have Equal Importance

If cost strategy selected is: *Project Value is X times more important the Project Cost*

Then projects are rank ordered, greatest value to least, by fund type, by:

$$X1 * \left(\frac{\text{Project Value}}{\text{Largest Project Value}} \right) + X2 * \left(\frac{\text{Smallest Project Cost}}{\text{Project Cost}} \right)$$

where: $X1 = X$
 $X2 = 1$

Smallest Project Cost and Largest Project Value are selected from the group of projects by fund type.

Equation 14. Project Value has Greater Importance

If cost strategy selected is: *Project Cost is X times more important the Project Value*

Then projects are rank ordered, greatest value to least, by fund type, by:

$$X1 * \left(\frac{\text{Project Value}}{\text{Largest Project Value}} \right) + X2 \left(\frac{\text{Smallest Project Cost}}{\text{Project Cost}} \right)$$

where: $X1 = 1$
 $X2 = X$

Smallest Project Cost and Largest Project Value are selected from the group of projects by fund type.

Equation 15. Project Cost has Greater Importance

Appendix C: Measure of Effectiveness Calculations

The different funding COAs are compared by four MOE calculations: support of commander's intent, project impact, projected improvement, and projected change. MOEs are used in the Compare COAs, Create Decision Space, and What If? modules.

Support of Commander's Intent MOE

Purpose: To show a relative measure of how closely this funding COA supports the commander's intent for quality improvement.

$$MCI = \frac{\sum CI \text{ Score}_x}{\# \text{ of projects}} \quad \forall \text{ funded projects}$$

where: x = project ID number
 MCI = MOE commander's intent
 $CI \text{ Score}_x$ = commander's intent score for project x

Equation 16. MOE Commander's Intent

Project Impact MOE

Purpose: To show a relative measure of the quality of projects in a selected funding COA.

$$MPI = \sum PIW_x \quad \forall \text{ funded projects}$$

where: x = project ID
 MPI = MOE Project Impact
 PIW_x = project impact worksheet score for project x

Equation 17. MOE Project Impact

Projected Improvement MOE

Purpose: To show the projected improvement in facility ratings created by a selected funding COA.

Display	Format	Source
Current Year Ratings	# and % of R, A, G facilities	ISR database
Projected Improvement	# and % of R, A, G facilities	IDSMS calculates

Projected Improvement is calculated by taking the current ISR ratings, changing the facility ratings to reflect the completion of all the funded projects, and recalculating the ISR ratings. It is assumed that if a project is funded, it will be completed.

Projected Change MOE

Purpose: To show the projected change in facility ratings created by a selected funding COA.

Display	Format	Source
Current Year Ratings	# and % of R, A, G facilities	ISR database
Projected Improvement	# and % of R, A, G facilities	IDSMS calculates
Projected Degradation	A>R, G>R, G>A facilities	IDSMS calculates
Projected Change	# and % of R, A, G facilities	IDSMS calculates

Projected Change is calculated by taking Projected Improvement and attempting to forecast degradation. As discussed earlier in this paper, degradation forecasts are only made at the ISR area level and are based on a time series forecast. Because of the potential inaccuracies of the degradation forecast, Projected Change is a far less accurate measurement than Projected Improvement.

Appendix C: Baseline COA Calculations

Action	Required Information
1 - Choose Cost Effectiveness Strategy	
2 - Calculate Project Value	Facility and/or FCG importance scores Improvement task scores Fix broken or important facilities Project fund type and amount Project fund priority Project scope Project impact worksheet
3 - Rank Order Projects	Project Value Cost Effectiveness Strategy Project Cost Project Fund Type

For the baseline COA calculation, the IDSM uses the values previously entered by the commander in the IDSM modules of Commander's Intent (for importance, improvement scores and strategy) and Build/Edit Projects (for fund information, scope and worksheet) to calculate the Project Value. The commander chooses a cost effectiveness strategy, and the IDSM creates a rank ordered list of projects.

Appendix C: Decision Space Calculations

Action	Required Information
1 - Choose Cost Effectiveness Strategy	
2 - Calculate Project Value	Facility and/or FCG importance scores Improvement task scores Fix broken or important facilities Project fund type and amount Project fund priority Project scope Project impact worksheet
3 - Rank Order Projects	Project Value Cost Effectiveness Strategy Project Cost Project Fund Type

For the decision space calculations, the IDSM holds the baseline values entered by the commander constant, and changes one set of variables at a time corresponding to the funding strategy selected. The commander selects a cost effectiveness strategy, and the IDSM creates a rank ordered list of projects (a course of action) for each funding strategy selected. For the decision space calculations, a funding strategy equates to a funding COA, since only one strategy is selected at a time.

Decision Space Values For the Funding Strategy Mission Facilities:
(NOTE: All other variable values will remain at baseline values.)

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	10
Importance of Mobility Facilities	0 - 10	0
Importance of Housing	0 - 10	0
Importance of Community Facilities	0 - 10	0
Importance of Installation Support	0 - 10	0

Decision Space Values For the Funding Strategy Mobility Facilities:

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	0
Importance of Mobility Facilities	0 - 10	10
Importance of Housing	0 - 10	0
Importance of Community Facilities	0 - 10	0
Importance of Installation Support	0 - 10	0

Decision Space Values For the Funding Strategy Housing:

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	0
Importance of Mobility Facilities	0 - 10	0
Importance of Housing	0 - 10	10
Importance of Community Facilities	0 - 10	0
Importance of Installation Support	0 - 10	0

Decision Space Values For the Funding Strategy Community Facilities:

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	0
Importance of Mobility Facilities	0 - 10	0
Importance of Housing	0 - 10	0
Importance of Community Facilities	0 - 10	10
Importance of Installation Support	0 - 10	0

Decision Space Values For the Funding Strategy Installation Support:

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	0
Importance of Mobility Facilities	0 - 10	0
Importance of Housing	0 - 10	0
Importance of Community Facilities	0 - 10	0
Importance of Installation Support	0 - 10	10

Decision Space Values For the Funding Strategy Red Facilities:

Variable	Possible Range	Multiplier
Fix Red Facilities	0 - 10	10
Fix Amber Facilities	0 - 10	0
Fix Green Facilities	0 - 10	0

Decision Space Values For the Funding Strategy Important Facilities:

Variable	Possible Range	Multiplier
Importance Scaling Factor	0 - 10	10
Improvement Scaling Factor	0 - 10	0

Decision Space Values For the Funding Strategy Minimize Degradation:

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	Based on actual degradation
Importance of Mobility Facilities	0 - 10	Based on actual degradation

Importance of Housing	0 - 10	Based on actual degradation
Importance of Community Facilities	0 - 10	Based on actual degradation
Importance of Installation Support	0 - 10	Based on actual degradation

Note: The ISR areas with the greatest past degradation receive the highest importance multipliers.

Decision Space Values For the Funding Strategy Effects of Project Delay:

Variable	Possible Range	Multiplier
Project Impact Weight for Project Delay	0 - 10	10
All Other Project Impact Criteria Weights	0 - 10	0

Decision Space Values For the Funding Strategy Project Duration:

Variable	Possible Range	Multiplier
Project Impact Weight for Project Duration	0 - 10	10
All Other Project Impact Criteria Weights	0 - 10	0

Decision Space Values For the Funding Strategy Project Benefits:

Variable	Possible Range	Multiplier
Project Impact Weight for Project Benefits	0 - 10	10
All Other Project Impact Criteria Weights	0 - 10	0

Decision Space Values For the Funding Strategy User Priorities:

Variable	Possible Range	Multiplier
Project Impact Weight for User Priorities	0 - 10	10
All Other Project Impact Criteria Weights	0 - 10	0

Decision Space Values For the Funding Strategy Environmental:

Variable	Possible Range	Multiplier
Project Impact Weight for Environmental Impact	0 - 10	10
All Other Project Impact Criteria Weights	0 - 10	0

Appendix C: Additional COA Calculations

Action	Required Information
1 - Choose Cost Effectiveness Strategy	
2 - Calculate Project Value	Facility and/or FCG importance scores Improvement task scores Fix broken or important facilities Project fund type and amount Project fund priority Project scope Project impact worksheet
3 - Rank Order Projects	Project Value Cost Effectiveness Strategy Project Cost Project Fund Type

For the additional COA calculations, the IDSM holds the baseline values entered by the commander constant, and changes the set of variables corresponding to the funding strategies selected. If more than one funding strategy is selected, the funding strategies are weighted, and the corresponding sets of variables are weighted. The commander selects a cost effectiveness strategy, and the IDSM creates a rank ordered list of projects for the course of action.

Additional COA Values For the Funding Strategy Mission Facilities:

(NOTE: All other variable values will remain at baseline values.)

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	2

Additional COA Values For the Funding Strategy Mobility Facilities:

Variable	Possible Range	Multiplier
Importance of Mobility Facilities	0 - 10	2

Additional COA Values For the Funding Strategy Housing:

Variable	Possible Range	Multiplier
Importance of Housing	0 - 10	2

Additional COA Values For the Funding Strategy Community Facilities:

Variable	Possible Range	Multiplier
Importance of Community Facilities	0 - 10	2

Additional COA Values For the Funding Strategy Installation Support:

Variable	Possible Range	Multiplier
Importance of Installation Support	0 - 10	2

Additional COA Values For the Funding Strategy Red Facilities:

Variable	Possible Range	Multiplier
Fix Red Facilities	0 - 10	2

Additional COA Values For the Funding Strategy Important Facilities:

Variable	Possible Range	Multiplier
Importance Scaling Factor	0 - 10	2

Additional COA Values For the Funding Strategy Minimize Degradation:

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	Based on actual degradation
Importance of Mobility Facilities	0 - 10	Based on actual degradation
Importance of Housing	0 - 10	Based on actual degradation
Importance of Community Facilities	0 - 10	Based on actual degradation
Importance of Installation Support	0 - 10	Based on actual degradation

Note: The ISR areas with the greatest past degradation receive the highest importance multipliers.

Additional COA Values For the Funding Strategy Effects of Project Delay:

Variable	Possible Range	Multiplier
Project Impact Weight for Project Delay	0 - 10	2

Additional COA Values For the Funding Strategy Project Duration:

Variable	Possible Range	Multiplier
Project Impact Weight for Project Duration	0 - 10	2

*Additional COA Values For the Funding Strategy **Project Benefits**:*

Variable	Possible Range	Multiplier
Project Impact Weight for Project Benefits	0 - 10	2

*Additional COA Values For the Funding Strategy **User Priorities**:*

Variable	Possible Range	Multiplier
Project Impact Weight for User Priorities	0 - 10	2

*Additional COA Values For the Funding Strategy **Environmental**:*

Variable	Possible Range	Multiplier
Project Impact Weight for Environmental Impact	0 - 10	2

Appendix C: What If? Calculations

Action	Required Information
1 - Choose Cost Effectiveness Strategy	
2 - Calculate Project Value	Facility and/or FCG importance scores Improvement task scores Fix broken or important facilities Project fund type and amount Project fund priority Project scope Project impact worksheet
3 - Rank Order Projects	Project Value Cost Effectiveness Strategy Project Cost Project Fund Type

For the What If? calculations, the IDSM changes the set of variables corresponding to the independent variables strategies selected and holds the remaining variable at their baseline values. The commander selects a dependent variable of interest and the IDSM shows the sensitivity of the dependent variable to the independent variable graphically.

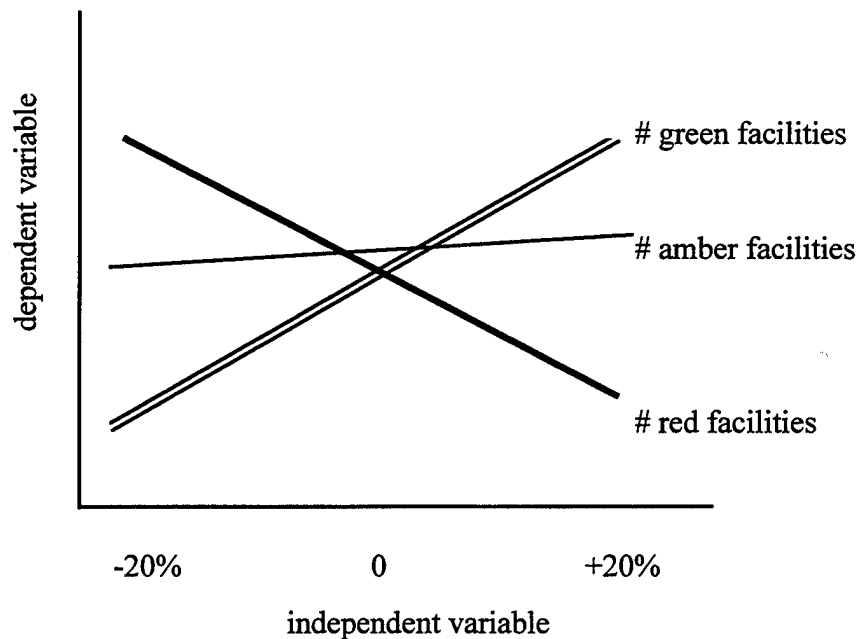


Figure 5. What If? Analysis Graphical Display

Independent Variables	Dependent Variables (MOEs)
Mission Facilities Importance	Mission Facilities Improvement
Mobility Facilities Importance	Mobility Facilities Improvement
Housing Importance	Housing Improvement
Community Facilities Importance	Community Facilities Improvement
Installation Support Importance	Installation Support Improvement
Fix Red Facilities	Overall Improvement
Fix Amber Facilities	Mission Facilities Change
Fix Green Facilities	Mobility Facilities Change
Importance Scaling Factor	Housing Change
Improvement Scaling Factor	Community Facilities Change
Project Impact Scaling Factor	Installation Support Change
Commander's Intent Scaling Factor	Overall Change
Criteria Weight for Project Delay	
Criteria Weight for Project Duration	
Criteria Weight for Project Benefits	
Criteria Weight for User Priorities	
Criteria Weight for Environmental Impact	

Table 14. What If? Analysis Variables

Additional COA Values For the Funding Strategy Mission Facilities:

(NOTE: All other variable values will remain at baseline values.)

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	base value -20% to +20%
Importance of Mobility Facilities	0 - 10	5
Importance of Housing	0 - 10	5
Importance of Community Facilities	0 - 10	5
Importance of Installation Support	0 - 10	5

Additional COA Values For the Funding Strategy Mobility Facilities:

Variable	Possible Range	Multiplier
Importance of Mobility Facilities	0 - 10	base value -20% to +20%

Additional COA Values For the Funding Strategy Housing:

Variable	Possible Range	Multiplier
Importance of Housing	0 - 10	base value -20% to +20%

Additional COA Values For the Funding Strategy Community Facilities:

Variable	Possible Range	Multiplier
Importance of Community Facilities	0 - 10	base value -20% to +20%

Additional COA Values For the Funding Strategy Installation Support:

Variable	Possible Range	Multiplier
Importance of Installation Support	0 - 10	base value -20% to +20%

Additional COA Values For the Funding Strategy Red Facilities:

Variable	Possible Range	Multiplier
Fix Red Facilities	0 - 10	base value -20% to +20%

Additional COA Values For the Funding Strategy Important Facilities:

Variable	Possible Range	Multiplier
Importance Scaling Factor	0 - 10	base value -20% to +20%

Additional COA Values For the Funding Strategy Minimize Degradation:

Variable	Possible Range	Multiplier
Importance of Mission Facilities	0 - 10	Based on actual degradation base value -20% to +20%
Importance of Mobility Facilities	0 - 10	Based on actual degradation base value -20% to +20%
Importance of Housing	0 - 10	Based on actual degradation base value -20% to +20%
Importance of Community Facilities	0 - 10	Based on actual degradation base value -20% to +20%
Importance of Installation Support	0 - 10	Based on actual degradation base value -20% to +20%

Note: The ISR areas with the greatest past degradation receive the highest importance multipliers.

Additional COA Values For the Funding Strategy Effects of Project Delay:

Variable	Possible Range	Multiplier
Project Impact Weight for Project Delay	0 - 10	base value -20% to +20%

*Additional COA Values For the Funding Strategy **Project Duration**:*

Variable	Possible Range	Multiplier
Project Impact Weight for Project Duration	0 - 10	base value -20% to +20%

*Additional COA Values For the Funding Strategy **Project Benefits**:*

Variable	Possible Range	Multiplier
Project Impact Weight for Project Benefits	0 - 10	base value -20% to +20%

*Additional COA Values For the Funding Strategy **User Priorities**:*

Variable	Possible Range	Multiplier
Project Impact Weight for User Priorities	0 - 10	base value -20% to +20%

*Additional COA Values For the Funding Strategy **Environmental**:*

Variable	Possible Range	Multiplier
Project Impact Weight for Environmental Impact	0 - 10	base value -20% to +20%

APPENDIX D Software Overview - Analytical Capability

The model prototype was created to demonstrate the functionality of the analytical module. It is not intended, or ready, for direct fielding. The specific actions that must be completed to make the IDSM prototype ready for fielding are:

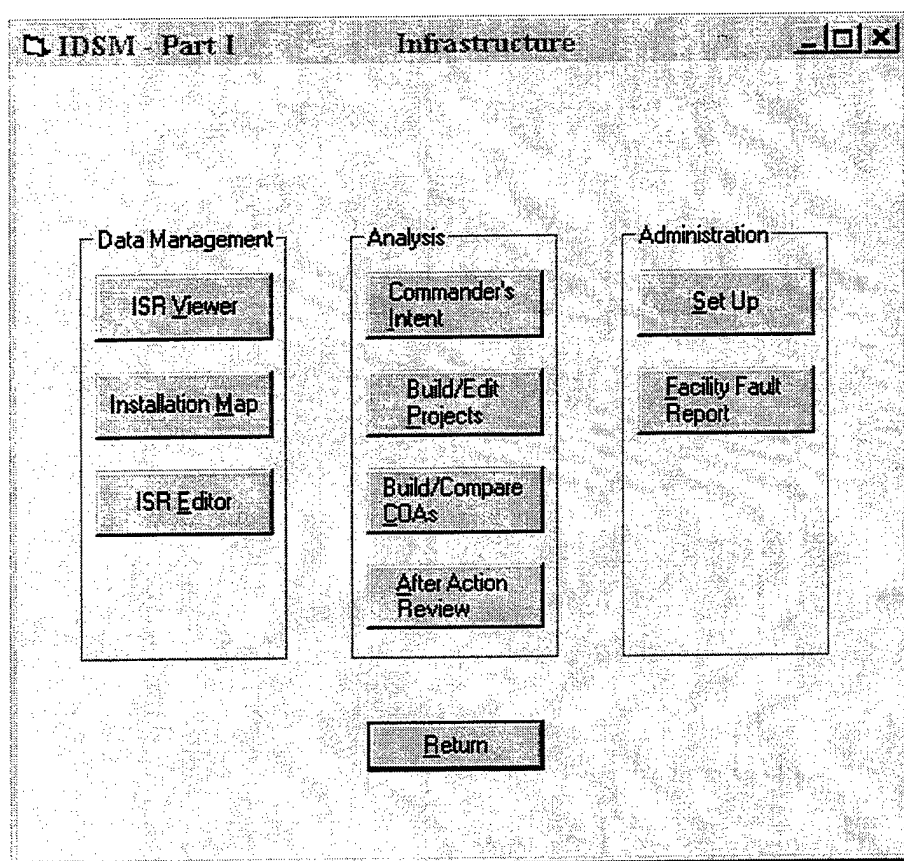
Action	Description
error proof model	place error trapping code in model
on line help	place help information on line
instruction manual	write instruction manual for user
read and store ISR subsystem data	already fielded with ISR software
calculate facility ratings	already fielded with ISR software
importance calculations	commander's intent module
calculate and edit FCG/facility list	commander's intent module
calculate project commander' intent score	build/edit projects module
calculate MOEs	build/compare COA module
calculate and edit funded project list	build/compare COA module
graph What If? analysis	build/compare COA module
save and update final project list	build/compare COA module
calculate AAR results	after action review module
create work order/fault list	administrative module

The majority of this work was not completed as it requires full integration with the current ISR software and would have repeated already finished and/or fielded work.

APPENDIX E Program Menus - Analytical Capability

The following pages contain pictures of the IDSM prototype menus. The purpose of these pictures is to give the reader a better idea of the program functionality.

Appendix E: Main Menu



This is the main selection menu for the infrastructure portion of the IDS-M. Each component is discussed in more detail in the following pages. The Data Management functions are discussed in detail in by O'Hara (1996). The Return button brings the user back to the main ISR menu.

Commander's Intent

Purpose:

Type of List: Quality

List By: ☒ FCG ☐ Facility

Choose strategy for determining priority list:
More Emphasis on Importance

Emphasize importance times over improvement

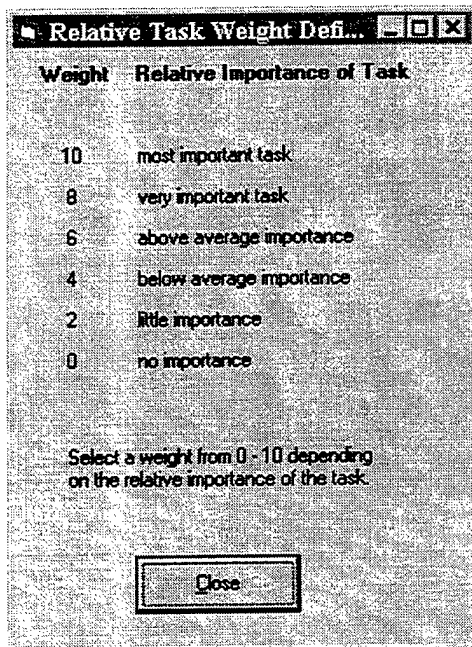
Task	Weight	Task	Weight
1 - Fix C4 FCGs		1 - Fix red facilities	
2 - Fix C3 FCGs		2 - Fix amber facilities	
3 - Fix C2 FCGs		3 - Fix green facilities	
4 - Fix C1 FCGs			

Importance

Select ISR Level: IS**R** Area Categories SubCategories FCGs Facilities

ISR Area	Area Importance	Normalized Importance
Mission	8	0.421052631578947
Mobility	5	0.263157894736842
Housing	1	5.26315789473684E-02
Community	4	0.210526315789474
Inst Support	1	5.26315789473684E-02

74



A screenshot of a software dialog box titled "Relative Task Weight Defi...". The dialog box contains a table with two columns: "Weight" and "Relative Importance of Task". The table lists seven weight values from 10 down to 0, each with a corresponding description of task importance. Below the table, there is a text instruction: "Select a weight from 0 - 10 depending on the relative importance of the task." At the bottom of the dialog box is a "Close" button.

Weight	Relative Importance of Task
10	most important task
8	very important task
6	above average importance
4	below average importance
2	little importance
0	no importance

Select a weight from 0 - 10 depending on the relative importance of the task.

Close

This form shows the task weight definitions. It is available for the user to review while making task weight decisions. The facility importance weights are based on a similar scale.

Appendix E: Build and Edit Projects Menu

Build and Edit Projects

Project Name: Project 1

scroll projects

Return

Misc

Commander's Intent Score: 0

Project Impact Worksheet

Project Impact Score: 179

Project Scope

Facility Number: 1

UIC: HQ

FCG: AA

Facility Rating: R

scroll facilities

Subsystem: Rating:

light	A
carpet	R
wall	R

scroll subsystems

Project Scope

Subsystem: Rating: Facility:

light	A	1
sink	A	3
Parking	G	4
Plumbing	A	2

scroll project scope

Project Fund Information

Fund Priority: 1 - must fund

Number of fund sources: 2

Type Fund: Fund Amount:

OMA (J) 1200

OMA (H) 870

This menu allows the engineers to select failed subsystems from the ISR database to create renovation projects. The menu collects the necessary fund type, fund amount and fund priority information. The engineers complete their project impact worksheet and the results are entered on this menu. The commander's intent score for the project is calculated automatically based on the facilities or FCGs being repaired.

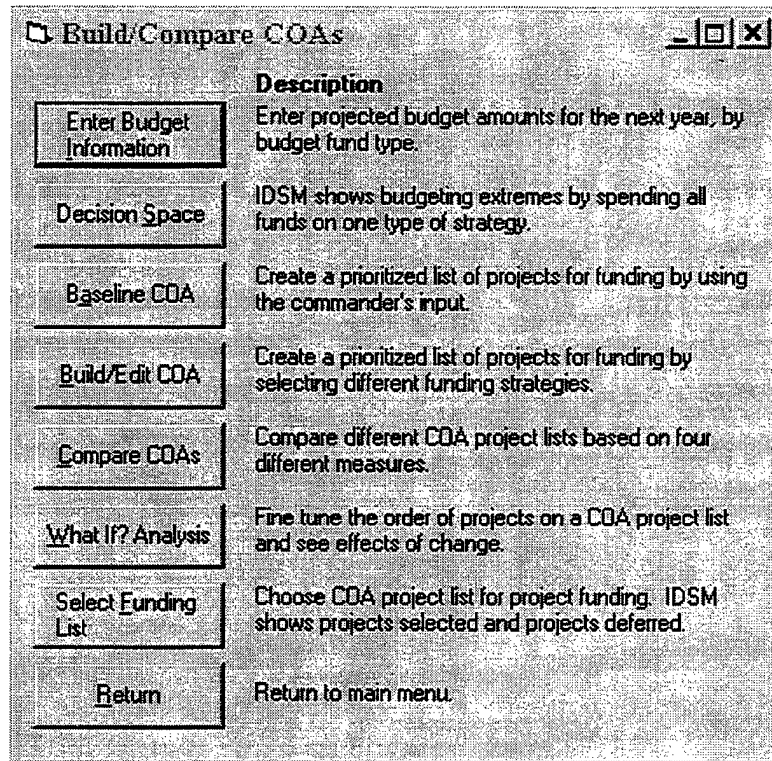
Project Impact Worksheet

Project Impacts	Weights	Scores
Project Delay	10	5
Project Duration	2	4
DM Costs	3	1
Project Disruption	5	3
Regulations Compliance	6	1
Distribution of Benefits	7	1
User Priorities	9	2
Health Safety	9	7
Environmental	9	1
Total		179

Weight Definitions Return

This is a sample project impact worksheet. The commander assigns weights to the criteria and each project receives a score in each criteria area.

Appendix E: Build/Compare COAs Main Menu



This is the main menu to access the building and comparing of courses of action, which is the heart of the IDSM.

Budget Information

Enter Budget Amount by Type:

☒ if funds may be combined in fund type

DMA

☐ DMA (H)	879
☒ DMA (J)	132
☒ DMA (K)	13
☒ DMA (L)	23
☒ DMA (M)	312

AFH

AFH (1000)	132
AFH (1910)	312
AFH (1920)	31
AFH (1930)	85
AFH (1940)	786
AFH (6000)	34

NAF

NAF	43
-----	----

Appropriated Funds

RDTE	654
Other	45

Other

Misc	3
------	---

Update Budget

Return

The budget information menu allows the user to enter in the projected budget, by fund type for the following year. There is an additional option of combining the allocation of OMA fund types if that is permissible in the planning stage.

Decision Space

Project Cost Impact

Measure of Effectiveness
☐ Projected Improvement ☐ Project Impact Score
☒ Projected Change ☐ Commander's Intent

Facility Type
☐ Mission ☐ Community
☐ Mobility ☐ Installation Support
☐ Housing ☐ Overall

Strategy Definitions

		Last Year Ratios			Projected Improvement			Projected Degradation			Projected Change		
		Red	Amb	Gm	Red	Amb	Gm	G>A	G>R	A>R	Red	Amb	Gm
Funding Strategy	Number												
Mission Facilities	Percent												
Left Right													
Funding Strategy	Number												
Mission Facilities	Percent												
Left Right													
Funding Strategy	Number												
Mission Facilities	Percent												
Left Right													
Funding Strategy	Number												
Mission Facilities	Percent												
Left Right													

The Decision Space menu allows the user to explore his budgeting extremes. The user selects several (up to four) funding strategies, a project cost strategy and a measure of effectiveness for comparison.

Funding Strategy Definitions

Strategy Name	Strategy Description
1 - Mission Facilities	Improve mission facilities
2 - Mobility Facilities	Improve mobility facilities
3 - Housing	Improve housing
4 - Community Facilities	Improve community facilities
5 - Installation Support	Improve installation support
6 - Red Facilities	Improve red facilities
7 - Important Facilities	Improve important facilities
8 - Minimize Degradation	Minimize expected degradation
9 - Effects of Project Delay	Choose projects with possible delay effects
10 - Project Duration	Choose projects with short duration
11 - Project Benefits	Choose projects with greatest dispersion of benefits
12 - Environmental	Choose projects with greatest positive impacts on environment

Baseline COA

COA Name: **Baseline**

Recommended COA

Funded:

- Project1
- Project2
- Project4
- Project5

By Fund Type:

OMA (J)

Funded:

- Project1

Unfunded:

- Project3

Project Cost Impact

Impact is more important than Cost.

Emphasize Project Impact **2** times over Project Cost.

Calculate COA

Edit COA

Return

The Baseline COA menu creates the first prioritized list of projects for funding. Using the information entered in the commander's intent and build/edit projects module, the IDSM creates a baseline list from which the commander can experiment. The user first selects a project cost strategy. The user may also look at the projects selected by fund type.

Build/Edit COA

COA Name
COA 1

Scroll COAs [Left Arrow] [Right Arrow]

COA Description
Quality of Life

Project Cost Impact
Impact is more important than Cost.

Emphasize Project Impact times over Project Cost.

COA Strategies

COA Strategies	Strategy Weights
Minimize Degradation	10
Housing	4
none	

Strategy Definitions **Weight Definitions**

Create COA **Edit COA** **Update COA**

Return

Recommended COA

Funded:
Project2
Project1
Project4
Project5

Fund Type:
DMA (K)

Funded:
Project4

Unfunded:
Project3

Unfunded:

The Build/Edit COA menu allows the user to modify the baseline COA by emphasizing different funding strategies and varying the project cost impact.

Compare COA			
COA Name COA 1	COA Name COA 2	COA Name COA 3	COA Name COA 1
COA Strategies Minimize Degradatio Housing none	COA Strategies Mission Facilities Installation Support none	COA Strategies Red Facilities Minimize Degradatio none	COA Strategies Minimize Degradatio Housing none
Fund Type: OMA (J)	Fund Type: OMA (H)	Fund Type: All Funds	Fund Type: All OMA
Project List Project1	Project List Project5 Project2	Project List Project4 Project3 Project1	Project List Project2 Project1 Project4 Project5
Return	COA Analysis	Print	

The Compare COA menu allows the user to see the COA funding strategies and the selected projects.

COA Analysis

Measure of Effectiveness:

☒ Projected Improvement ☐ Project Impact Score

☐ Projected Change ☐ Commander's Intent

Facility Type:

☐ Mission ☐ Community

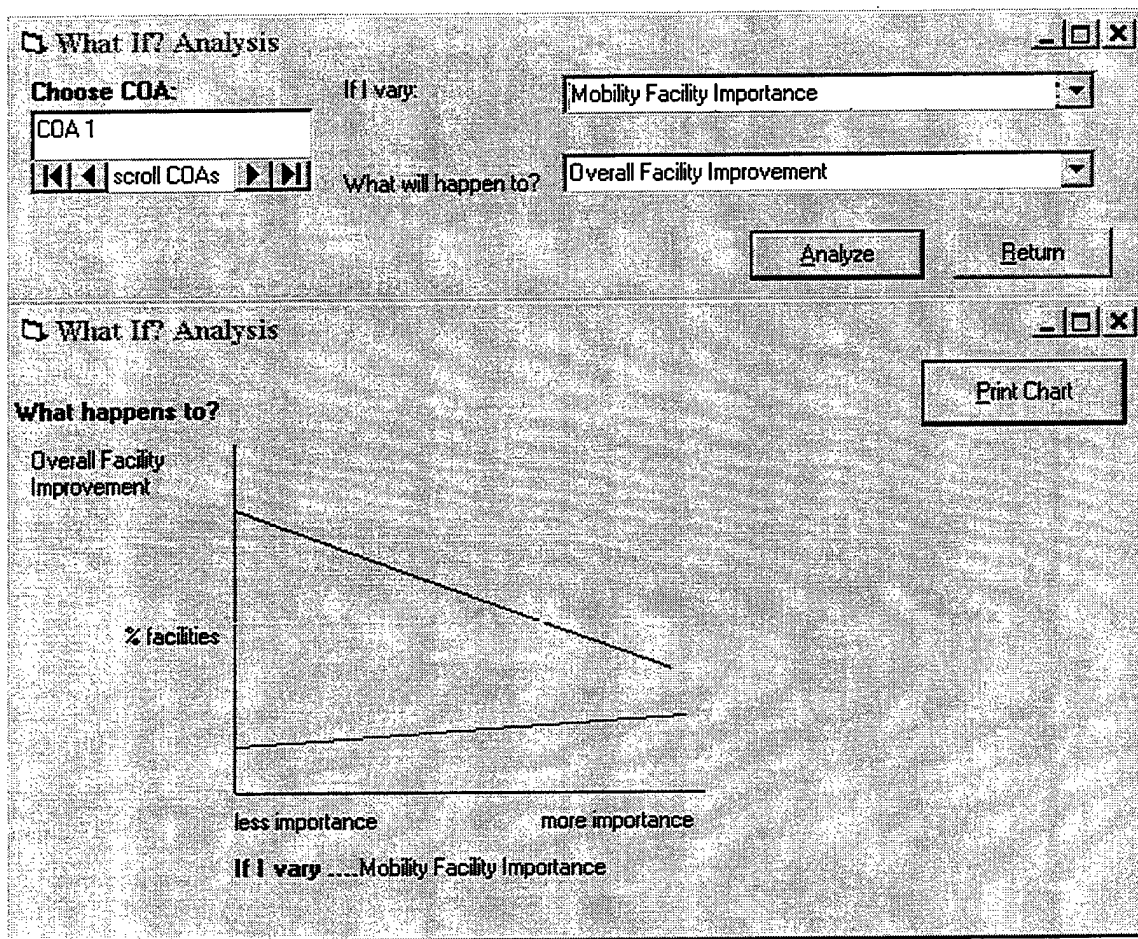
☐ Mobility ☐ Installation Support

☐ Housing ☐ Overall

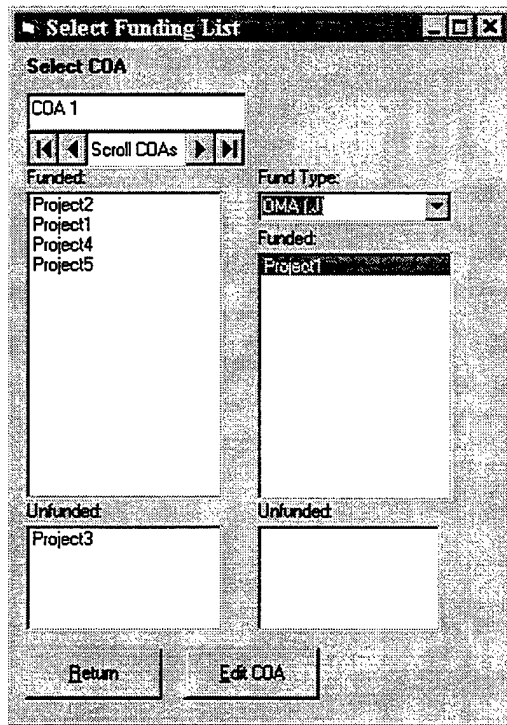
		Last Year Ratings			Projected Improvement		
		Red	Amb	Gm	Red	Amb	Gm
COA 1	COA 1	Number					
	scroll COA	Percent					
COA 2	COA 2	Number					
	scroll COA	Percent					
COA 3	COA 3	Number					
	scroll COA	Percent					
COA 4	COA 1	Number					
	scroll COA	Percent					

Return Print Chart

The COA Analysis menu allows the user to compare the courses of action he has created by the four different measures of effectiveness.



The What If? Analysis menu allows the user to select an independent variable, change it by +20% and -20% of its baseline value, and see the effect on a selected dependent variable.



The Select Funding List menu allows the user to make a final decision about which projects will be selected for funding in the upcoming year. The commander has manual override on the selection of any project, but the final list must meet all budget and fund type constraints.

Appendix E: After Action Review Menu

After Action Review

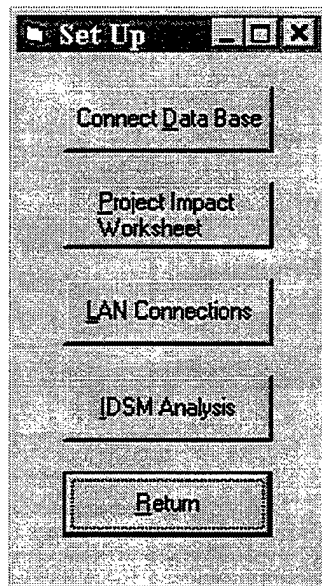
Select ISR Level: ISR Areas Categories SubCategories FCGs Facilities

Area	last year's condition						actual degradation						actual improvement						
	Last Year Red Facs		Last Year Amb Facs		Last Year Gm Facs		Degrade Gm>Amb		Degrade Gm>Red		Degrade Amb>Red		Improve Red>Amb		Improve Red>Gm		Improve Amb>Gm		
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
Mission																			
Mobility																			
Housing																			
Community																			
Inst Support																			

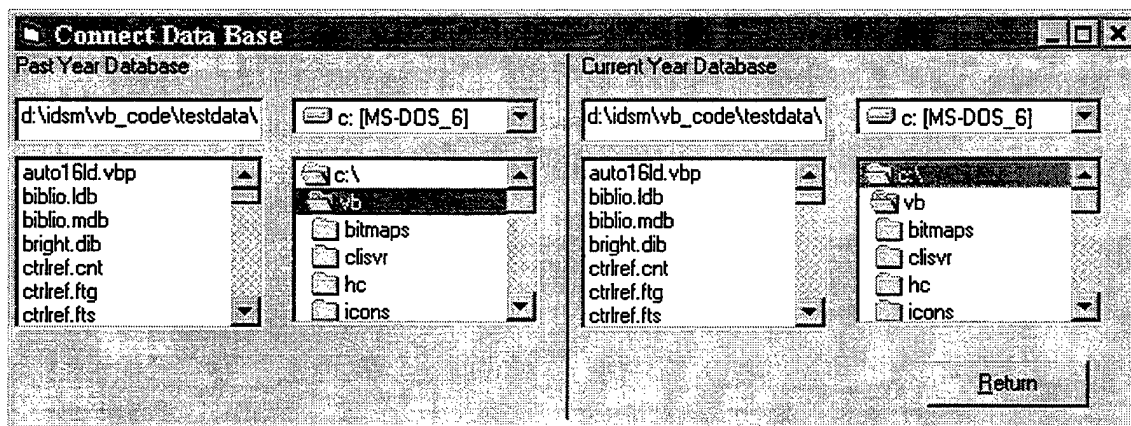
Return Print Chart Reload

The After Action Review menu allows the user to evaluate how effectively last year's infrastructure budget was allocated by looking at several criteria such as: last year's condition, last year's budget, last year's spending, actual improvement, actual degradation, unexpected change, current year's condition, and projected degradation.

Appendix E: Set Up Menu



The Set Up menu allows access to the administrative tasks required to run the IDSM.



The Connect Database menu allows the user to identify the files that contain the current and past years IDSM data. This function may be programmed into the model.

Set Up for Project Impact Worksheet

Select Criteria for Project Impact Worksheet:

Default Criteria

- ☐ effects of project delay
- ☐ project duration
- ☐ effect on O&M costs
- ☐ energy savings
- ☐ project disruption
- ☐ regulations compliance
- ☐ distribution of benefits
- ☐ benefits to other projects
- ☐ user priorities
- ☐ health and safety
- ☐ aesthetics
- ☐ effects on environment

Enter user defined criteria:

Return

The Set Up Project Worksheet menu allows the user to choose default criteria for the project impact worksheet or to enter their own user defined criteria.

Facility Faults Report

Type of Report

☒ Work Order

☐ Fault Listing

User ID (UIC)

Report Facility Faults For

- ☐ red facilities
- ☐ amber facilities
- ☐ green facilities

Return Print

The Facility Faults Report menu allows the user to create a facility fault report or a series of general work orders for the red and/or amber subsystems of all facilities.

APPENDIX F Data Base Structure - Analytical Capability

The database is used to store variable values that will be referenced more than one time. It is broken down into two primary types of tables: organizational and functional. The organizational tables are based on the organization or structure of ISR Part I and these tables perform multiple tasks. The functional tables are based on IDSM functions and usually perform one task. Some of the tables contain information about a single object while other tables contain composite information about several objects of the same type.

Appendix F: Data Used From ISR Data Tables

The following information is accessed from the ISR database and used as required in the IDSM:

- Ratings for the facilities, FCGs, sub categories, categories and ISR areas,
- Relationships between the facilities, FCGs, sub categories, categories and ISR areas,
- UIC that owns facility.

Facility Tables will be used from the ISR database as follows:

Table Name: "Facility ID Number" (Use actual number)

Quantity: 1 to # of facilities

Table Description:

Columns	Type	Description
ID	number	required
Subsystem	text	all facility subsystems
Rating	R, A or G	corresponding rating

Data Source: ISR

IDSM Use:

Commander's Intent

- define relationships between facilities, FCGs, sub categories, categories and areas

Build/Edit Projects

- provide subsystem data to be included in IDSM projects

Build/Compare COAs

- used to calculate MOEs of projected improvement and projected change

After Action Review

- show subsystem ratings

Appendix F: Organizational Tables

The IDSM uses the following organizational tables:

- Facility
- FCG
- SubCat
- Cat
- ISR Area

Table Name: Facility

Quantity: 1

Columns	Type	Description
ID	number	required
Facility Number	number	facility ID number
Facility Importance	number	entered in CI module
Normalized Importance	number	calculated in CI module
Global Importance	number	calculated in CI module
Dollars Budgeted	number	after final COA is selected
Dollars Spent	number	updated by user (if desired)

IDSM Use:

Commander's Intent

- facility importance score, normalized importance, globalized importance

After Action Review

- show dollars budgeted and spent for facilities

Table Name: FCG

Quantity: 1

Columns	Type	Description
ID	number	required
FCG	text	
FCG Importance	number	entered in CI module
Normalized Importance	number	calculated in CI module
Global Importance	number	calculated in CI module
Budgeted Amount Red	number	IDSM calculates based on COA
Budgeted Red %	number	IDSM calculates based on COA
Budgeted Amount Amber	number	IDSM calculates based on COA
Budgeted Amber %	number	IDSM calculates based on COA
Budgeted Amount Green	number	IDSM calculates based on COA
Budgeted Green %	number	IDSM calculates based on COA
Amount Spent Red	number	IDSM calculates based on facility
Spent Red %	number	IDSM calculates based on facility
Amount Spent Amber	number	IDSM calculates based on facility
Spent Amber %	number	IDSM calculates based on facility
Amount Spent Green	number	IDSM calculates based on facility
Spent Green %	number	IDSM calculates based on facility
Actual Improvement R>A	number	IDSM calculates
Actual Improvement R>A%	number	IDSM calculates
Actual Improvement R>G	number	IDSM calculates
Actual Improvement R>G%	number	IDSM calculates
Actual Improvement A>G	number	IDSM calculates
Actual Improvement A>G%	number	IDSM calculates
Actual Degradation G>A	number	IDSM calculates
Actual Degradation G>A%	number	IDSM calculates
Actual Degradation G>R	number	IDSM calculates
Actual Degradation G>R%	number	IDSM calculates
Actual Degradation A>R	number	IDSM calculates
Actual Degradation A>R%	number	IDSM calculates
Unexpected R>A	number	IDSM calculates
Unexpected R>A%	number	IDSM calculates
Unexpected R>G	number	IDSM calculates
Unexpected R>G%	number	IDSM calculates
Unexpected A>G	number	IDSM calculates
Unexpected A>G%	number	IDSM calculates
Current Red Number	number	ISR data
Current Red %	number	ISR data
Current Amber Number	number	ISR data

Current Amber %	number	ISR data
Current Green Number	number	ISR data
Current Green %	number	ISR data

IDS M Use:

Commander's Intent

- FCG importance, normalized importance, globalized importance

After Action Review

- remainder of information is used for AAR

Table Name: SubCat

Quantity: 1

Columns	Type	Description
ID	number	required
SubCat	text	
SubCat Importance	number	entered in CI module
Normalized Importance	number	calculated in CI module
Global Importance	number	calculated in CI module
Budgeted Amount Red	number	IDSMS calculates based on COA
Budgeted Red %	number	IDSMS calculates based on COA
Budgeted Amount Amber	number	IDSMS calculates based on COA
Budgeted Amber %	number	IDSMS calculates based on COA
Budgeted Amount Green	number	IDSMS calculates based on COA
Budgeted Green %	number	IDSMS calculates based on COA
Amount Spent Red	number	IDSMS calculates based on facility
Spent Red %	number	IDSMS calculates based on facility
Amount Spent Amber	number	IDSMS calculates based on facility
Spent Amber %	number	IDSMS calculates based on facility
Amount Spent Green	number	IDSMS calculates based on facility
Spent Green %	number	IDSMS calculates based on facility
Actual Improvement R>A	number	IDSMS calculates
Actual Improvement R>A%	number	IDSMS calculates
Actual Improvement R>G	number	IDSMS calculates
Actual Improvement R>G%	number	IDSMS calculates
Actual Improvement A>G	number	IDSMS calculates
Actual Improvement A>G%	number	IDSMS calculates
Actual Degradation G>A	number	IDSMS calculates
Actual Degradation G>A%	number	IDSMS calculates
Actual Degradation G>R	number	IDSMS calculates
Actual Degradation G>R%	number	IDSMS calculates
Actual Degradation A>R	number	IDSMS calculates
Actual Degradation A>R%	number	IDSMS calculates
Unexpected R>A	number	IDSMS calculates
Unexpected R>A%	number	IDSMS calculates
Unexpected R>G	number	IDSMS calculates
Unexpected R>G%	number	IDSMS calculates
Unexpected A>G	number	IDSMS calculates
Unexpected A>G%	number	IDSMS calculates
Current Red Number	number	ISR data
Current Red %	number	ISR data
Current Amber Number	number	ISR data

Current Amber %	number	ISR data
Current Green Number	number	ISR data
Current Green %	number	ISR data

IDSMS Use:

Commander's Intent

- SubCat importance, normalized importance, globalized importance

After Action Review

- remainder of information is used for AAR

Table Name: Cat

Quantity: 1

Columns	Type	Description
ID	number	required
Category	text	
Category Importance	number	entered in CI module
Normalized Importance	number	calculated in CI module
Global Importance	number	calculated in CI module
Budgeted Amount Red	number	IDSM calculates based on COA
Budgeted Red %	number	IDSM calculates based on COA
Budgeted Amount Amber	number	IDSM calculates based on COA
Budgeted Amber %	number	IDSM calculates based on COA
Budgeted Amount Green	number	IDSM calculates based on COA
Budgeted Green %	number	IDSM calculates based on COA
Amount Spent Red	number	IDSM calculates based on facility
Spent Red %	number	IDSM calculates based on facility
Amount Spent Amber	number	IDSM calculates based on facility
Spent Amber %	number	IDSM calculates based on facility
Amount Spent Green	number	IDSM calculates based on facility
Spent Green %	number	IDSM calculates based on facility
Actual Improvement R>A	number	IDSM calculates
Actual Improvement R>A%	number	IDSM calculates
Actual Improvement R>G	number	IDSM calculates
Actual Improvement R>G%	number	IDSM calculates
Actual Improvement A>G	number	IDSM calculates
Actual Improvement A>G%	number	IDSM calculates
Actual Degradation G>A	number	IDSM calculates
Actual Degradation G>A%	number	IDSM calculates
Actual Degradation G>R	number	IDSM calculates
Actual Degradation G>R%	number	IDSM calculates
Actual Degradation A>R	number	IDSM calculates
Actual Degradation A>R%	number	IDSM calculates
Unexpected R>A	number	IDSM calculates
Unexpected R>A%	number	IDSM calculates
Unexpected R>G	number	IDSM calculates
Unexpected R>G%	number	IDSM calculates
Unexpected A>G	number	IDSM calculates
Unexpected A>G%	number	IDSM calculates
Current Red Number	number	ISR data
Current Red %	number	ISR data
Current Amber Number	number	ISR data

Current Amber %	number	ISR data
Current Green Number	number	ISR data
Current Green %	number	ISR data

IDS M Use:

Commander's Intent

- Category importance, normalized importance, globalized importance

After Action Review

- remainder of information is used for AAR

Table Name: ISR Area

Quantity: 1

Columns	Type	Description
ID	number	required
ISR Area	text	
Area Importance	number	entered in CI module
Normalized Importance	number	calculated in CI module
Budgeted Amount Red	number	IDSMS calculates based on COA
Budgeted Red %	number	IDSMS calculates based on COA
Budgeted Amount Amber	number	IDSMS calculates based on COA
Budgeted Amber %	number	IDSMS calculates based on COA
Budgeted Amount Green	number	IDSMS calculates based on COA
Budgeted Green %	number	IDSMS calculates based on COA
Amount Spent Red	number	IDSMS calculates based on facility
Spent Red %	number	IDSMS calculates based on facility
Amount Spent Amber	number	IDSMS calculates based on facility
Spent Amber %	number	IDSMS calculates based on facility
Amount Spent Green	number	IDSMS calculates based on facility
Spent Green %	number	IDSMS calculates based on facility
Actual Improvement R>A	number	IDSMS calculates
Actual Improvement R>A%	number	IDSMS calculates
Actual Improvement R>G	number	IDSMS calculates
Actual Improvement R>G%	number	IDSMS calculates
Actual Improvement A>G	number	IDSMS calculates
Actual Improvement A>G%	number	IDSMS calculates
Actual Degradation G>A	number	IDSMS calculates
Actual Degradation G>A%	number	IDSMS calculates
Actual Degradation G>R	number	IDSMS calculates
Actual Degradation G>R%	number	IDSMS calculates
Actual Degradation A>R	number	IDSMS calculates
Actual Degradation A>R%	number	IDSMS calculates
Unexpected R>A	number	IDSMS calculates
Unexpected R>A%	number	IDSMS calculates
Unexpected R>G	number	IDSMS calculates
Unexpected R>G%	number	IDSMS calculates
Unexpected A>G	number	IDSMS calculates
Unexpected A>G%	number	IDSMS calculates
Current Red Number	number	ISR data
Current Red %	number	ISR data
Current Amber Number	number	ISR data
Current Amber %	number	ISR data

Current Green Number	number	ISR data
Current Green %	number	ISR data
Predicted G>A	number	IDSMS calculates
Predicted G>A%	number	IDSMS calculates
Predicted G>R	number	IDSMS calculates
Predicted G>R%	number	IDSMS calculates
Predicted A>R	number	IDSMS calculates
Predicted A>R%	number	IDSMS calculates

IDSMS Use:

Commander's Intent

- area importance, normalized importance

Build/Compare COAs

- uses current rating number and predicted degradation to calculate MOEs of projected improvement and projected change

After Action Review

- remainder of information is used for AAR

Appendix F: Functional Tables

The IDSM database uses tables in the following functional areas:

- commander's intent
- build/edit projects
- build/compare COA
- miscellaneous

Commander's Intent Tables

Table Name: CIntent

Quantity: 1

Columns	Type	Description
ID	number	required
List ID	number	list ID number
List Name	number	list name
List By	number	quality or quantity
Resolution	number	FCG or facility
Strategy	number	improvement or importance
Strategy Weight	number	amount of emphasis
Itask1 Score	number	Fix C4 FCGs Score from commander
Itask1 Factor	number	Fix C4 FCGs Factor calculated
Itask2 Score	number	Fix C3 FCGs Score from commander
Itask2 Factor	number	Fix C3 FCGs Factor calculated
Itask3 Score	number	Fix C2 FCGs Score from commander
Itask3 Factor	number	Fix C2 FCGs Factor calculated
Itask4 Score	number	Fix C1 FCGs Score from commander
Itask4 Factor	number	Fix C1 FCGs Factor calculated
Itask5 Score	number	Fix Red Facilities Score from commander
Itask5 Factor	number	Fix Red Facilities Factor calculated
Itask6 Score	number	Fix Amber Facilities Score from commander
Itask6 Factor	number	Fix Amber Facilities Factor calculated
Itask7 Factor	number	Fix Green Facilities Score from commander
Itask7 Factor	number	Fix Green Facilities Factor calculated

IDSMS Use:

Commander's Intent

- gives commander's intent list name
- list by quality or quantity
- list by FCG or facility
- strategy for improvement or importance
- records scores and calculated facility and FCG improvement factors

Table Name: List "X"

where X goes from 1 to 50 (max number of lists commander can save)

Quantity: 50 (or other max number)

Columns	Type	Description
ID	number	required
List ID	number	list ID number
FCG	text	name of FCG
FCG Score	number	FCG CI score
Facility	number	facility ID number
Facility Score	number	facility CI score

IDS M Use:

Commander's Intent

- stores actual ordered list of FCGs and facilities

Build/Edit Projects Tables

Table Name: Projects

Quantity: 1

Columns	Type	Description
ID	number	required
Project Name	text	
Project ID	number	
CI Score	number	commander's intent score for project
Impact Score	number	impact worksheet score for project
Number of Funds	number	number of fund types
Fund Priority	text	fund priority
Type Fund 1	text	1 st fund type
Amount Fund 1	number	1 st fund amount
Type Fund 2	text	2 nd fund type
Amount Fund 2	number	2 nd fund amount
Type Fund 3	text	3 rd fund type
Amount Fund 3	number	3 rd fund amount
Type Fund 4	text	4 th fund type
Amount Fund 4	number	4 th fund amount

IDSMS Use:

Build/Edit Project

- this composite list contains information on all projects

Table Name: Project "X"

where X goes from 1 to 5000 (max number of projects)

Quantity: 5000 (or other max number of projects)

Columns	Type	Description
ID	number	required
Project ID	number	project ID number
Facility Number	number	facility ID number
Subsystem	text	facility subsystem
Subsystem Rating	R, A or G	current subsystem rating

IDSMS Use:

Build/Edit Projects

- these lists contain the project scope for each project

Table Name: ImpactWS

Quantity: 1

Columns	Type	Description
ID	number	required
Criteria	text	list of worksheet criteria
Picked?	Y or N	were default criteria selected?
Weights	number	criteria weights
Project1	number	criteria scores for project 1
Project2....	number	criteria scores for project 2
Project5000	number	criteria scores for project 5000

IDSMS Use:

Build/Edit Projects

- provides project impact worksheet information for all projects, feeds into projects table

Build/Compare COA

Table Name: COA

Quantity: 1

Columns	Type	Description
ID	number	required
COA ID	text	
COA Name	text	
Cost Strategy	text	by Value, Value/Cost or other
Cost Strategy Weight	number	if required
Fund Strategy 1	text	selected fund strategy 1
Weight 1	number	importance of strategy 1
Fund Strategy 2	text	selected fund strategy 2
Weight 2	number	importance of strategy 2
Fund Strategy 3	text	selected fund strategy 3
Weight 3	number	importance of strategy 3
Project Impact Score	number	sum of impact scores for all funded projects
Commander's Intent	number	average CI score for all funded projects
PImprove Mis Red #	number	projected number of red mission facilities
PImprove Mis Red %	number	projected % of red mission facilities
PImprove Mis Amb #	number	projected number of amber mission facilities
PImprove Mis Amb %	number	projected % of amber mission facilities
PImprove Mis Grn #	number	projected number of green mission facilities
PImprove Mis Grn %	number	projected % of green mission facilities
PImprove Mob Red #	number	projected number of red mobility facilities
PImprove Mob Red %	number	projected % of red mobility facilities
PImprove Mob Amb #	number	projected number of amber mobility facilities
PImprove Mob Amb %	number	projected % of amber mobility facilities
PImprove Mob Grn #	number	projected number of green mobility facilities
PImprove Mob Grn %	number	projected % of green mobility facilities
PImprove Hou Red #	number	projected number of red housing facilities
PImprove Hou Red %	number	projected % of red housing facilities
PImprove Hou Amb #	number	projected number of amber housing facilities
PImprove Hou Amb %	number	projected % of amber housing facilities
PImprove Hou Grn #	number	projected number of green housing facilities
PImprove Hou Grn %	number	projected % of green housing facilities
PImprove Com Red #	number	projected number of red community facilities
PImprove Com Red %	number	projected % of red community facilities
PImprove Com Amb #	number	projected number of amber community facilities
PImprove Com Amb %	number	projected % of amber community facilities
PImprove Com Grn #	number	projected number of green community facilities

PImprove Com Grn %	number	projected % of green community facilities
PImprove IS Red #	number	projected number of red inst support facilities
PImprove IS Red %	number	projected % of red inst support facilities
PImprove IS Amb #	number	projected number of amber inst support facilities
PImprove IS Amb %	number	projected % of amber inst support facilities
PImprove IS Grn #	number	projected number of green inst support facilities
PImprove IS Grn %	number	projected % of green inst support facilities
PImprove All Red #	number	projected number of all red facilities
PImprove All Red %	number	projected % of all red facilities
PImprove All Amb #	number	projected number of all amber facilities
PImprove All Amb %	number	projected % of all amber inst support facilities
PImprove All Grn #	number	projected number of all green facilities
PImprove All Grn %	number	projected % of all green facilities
PChange Mis Red #	number	projected number of red mission facilities
PChange Mis Red %	number	projected % of red mission facilities
PChange Mis Amb #	number	projected number of amber mission facilities
PChange Mis Amb %	number	projected % of amber mission facilities
PChange Mis Grn #	number	projected number of green mission facilities
PChange Mis Grn %	number	projected % of green mission facilities
PChange Mob Red #	number	projected number of red mobility facilities
PChange Mob Red %	number	projected % of red mobility facilities
PChange Mob Amb #	number	projected number of amber mobility facilities
PChange Mob Amb %	number	projected % of amber mobility facilities
PChange Mob Grn #	number	projected number of green mobility facilities
PChange Mob Grn %	number	projected % of green mobility facilities
PChange Hou Red #	number	projected number of red housing facilities
PChange Hou Red %	number	projected % of red housing facilities
PChange Hou Amb #	number	projected number of amber housing facilities
PChange Hou Amb %	number	projected % of amber housing facilities
PChange Hou Grn #	number	projected number of green housing facilities
PChange Hou Grn %	number	projected % of green housing facilities
PChange Com Red #	number	projected number of red community facilities
PChange Com Red %	number	projected % of red community facilities
PChange Com Amb #	number	projected number of amber community facilities
PChange Com Amb %	number	projected % of amber community facilities
PChange Com Grn #	number	projected number of green community facilities
PChange Com Grn %	number	projected % of green community facilities
PChange IS Red #	number	projected number of red inst support facilities
PChange IS Red %	number	projected % of red inst support facilities
PChange IS Amb #	number	projected number of amber inst support facilities
PChange IS Amb %	number	projected % of amber inst support facilities
PChange IS Grn #	number	projected number of green inst support facilities

PChange IS Grn %	number	projected % of green inst support facilities
PChange All Red #	number	projected number of all red facilities
PChange All Red %	number	projected % of all red facilities
PChange All Amb #	number	projected number of all amber facilities
PChange All Amb %	number	projected % of all amber inst support facilities
PChange All Grn #	number	projected number of all green facilities
PChange All Grn %	number	projected % of all green facilities

IDSMS Use:

Build/Compare COAs

- records COA name, cost strategy and fund strategy data
- records calculated MOE data

Table Name: Variables

Quantity: 1

Columns	Type	Description
ID	number	required
Variables	text	facility ID number
Baseline Values	number	entered in CI module

IDSMS Use:

Build/Compare COAs

- records baseline variable values from user entries in commander's intent and build/edit projects

Table Name: COA "X" where X goes from 1 to 20 (or other max number of COAs)

Quantity: 20 (or other max number of COAs)

Note: These are the COAs created by the user.

Columns	Type	Description
ID	number	required
COA ID	text	
Project ID	text	ordered list of projects
Funded?	Y or N	selected for funding or not

IDSMS Use:

Build/Compare COAs

- contains ordered project list with fund information (Y or N) for a COA

Table Name: COA200 - COA212

Quantity: 13

Note: These tables contain the baseline and decision space COAs.

Columns	Type	Description
ID	number	required
COA ID	text	
Project ID	text	ordered list of projects
Funded?	Y or N	selected for funding or not

IDSMS Use:

Build/Compare COAs

- contains ordered project list with fund information (Y or N) for a COA
- these COAs are the baseline COA and a COA for each decision space funding strategy

Miscellaneous Tables

Table Name: Budget

Quantity: 1

Columns	Type	Description
ID	number	required
OMAH Amount	number	OMA.H budget dollars
OMAH Checked?	Y or N	combine with other OMA dollars
OMAJ Amount	number	OMA.J budget dollars
OMAJ Checked?	Y or N	combine with other OMA dollars
OMAK Amount	number	OMA.K budget dollars
OMAK Checked?	Y or N	combine with other OMA dollars
OMAL Amount	number	OMA.L budget dollars
OMAL Checked?	Y or N	combine with other OMA dollars
OMAM Amount	number	OMA.M budget dollars
OMAM Checked?	Y or N	combine with other OMA dollars
AFH1000 Amount	number	AFH(1000) budget dollars
AFH1910 Amount	number	AFH(1910) budget dollars
AFH1920 Amount	number	AFH(1920) budget dollars
AFH1930 Amount	number	AFH(1930) budget dollars
AFH1940 Amount	number	AFH(1940) budget dollars
AFH6000 Amount	number	AFH(6000) budget dollars
NAF Amount	number	NAF budget dollars
RDTE Amount	number	RDTE budget dollars
Other Appropriated	number	Other budget dollars
Miscellaneous	number	Misc budget dollars

IDSM Use:

Build/Compare COAs

- user enters all data and information is used as a constraint for number of projects funded in each fund type

Table Name: Year

Quantity: 1

Columns	Type	Description
ID	number	required
Current Year	text	file location of current database
Past Year	text	file location of past database

IDS M Use:

Set Up

- stores location of current and past IDS M databases needed for running the IDS M

APPENDIX G Software Code - Analytical Capability

A copy of the IDSM prototype software is available on CD from:

Operations Research Center of Excellence
United States Military Academy
West Point, New York 10996
(914) 938-2700
DSN 688-2700

APPENDIX H Acronyms

AFH	Army Family Housing
COA	Course of Action
DA	Department of the Army
FCG	Facility Category Group
IDSM	Installation Decision Support Model
ISR	Installation Status Report
MCA	Military Construction, Army
MOE	Measure of Effectiveness
NAF	Non Appropriated Funds
OMA	Operations & Maintenance, Army
RMAT	Real Property
RPMA	Renovation and Preventive Maintenance Activity