



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

**Installation Decision Support Model (IDSM):
Needs Analysis and Initial
Model Development**

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

Captain Thomas E. O'Hara, Jr.

19990325 022

14 August 1996

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

DTIC QUALITY INSPECTED 4

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

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 <i>(Leave blank)</i>	2. REPORT DATE 14 August 1996	3. REPORT TYPE AND DATES COVERED Technical Report	
4. TITLE AND SUBTITLE Installation Decision Support Model (IDSM): Needs Analysis and Initial Model Development		5. FUNDING NUMBERS	
6. AUTHOR(S) CPT Thomas E. O'Hara, Jr		8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMA Operations Research Center West Point, New York 10996		10. SPONSORING / MONITORING AGENCY REPORT NUMBER 96-1	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)		11. SUPPLEMENTARY NOTES	
12a. DISTRIBUTION / AVAILABILITY STATEMENT Distribution Statement A. Approved for public Release; distribution unlimited.		12b. DISTRIBUTION CODE	
<p>13. ABSTRACT <i>(Maximum 200 words)</i></p> <p>The ORCEN and USMA developed the IDSM to make ISR and other installation management data more usable at the installation management data more usable at the installation level. The Office of the Assistant Secretary of the Army for Financial Management and Comptroller in conjunction with the Assistant Chief of Staff for Installation Management (ACSIM) sponsored the work on the IDSM. The prototype model was completed in July 1996. Follow-on work toward full model development will be conducted during FY 97.</p> <p>The IDSM developed out of a need to provide installations with tools that allow them to take advantage of the data available in the ISR. Its purpose is to help the installation commander and his/her staff develop an accurate picture of current infrastructure conditions. Given this, the IDSM will assist the commander in evaluating the impacts of various investment strategies on installation readiness.</p> <p>The fully developed model will also provide installations with easy access to existing data in a cost effective manner that minimizes the need for additional data collection. The ACSIM established a cost effective threshold of \$500 per user. Finally, the ACSIM also required that the IDSM be compatible with other automation systems currently under development by the Department of the Army.</p>			
14. SUBJECT TERMS Installation Decision Support Model		15. NUMBER OF PAGES 45	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED		16. PRICE CODE	
18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT	

Installation Decision Support Model (IDSMD): Needs Analysis and Initial Model Development

CPT Thomas E. O'Hara, Jr
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
UNITED STATES MILITARY ACADEMY

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

14 August 1996

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

About the Author

Captain Thomas O'Hara is an analyst in the Operations Research Center at the United States Military Academy (USMA) at West Point. He received a BS from St. John's University in Collegeville, Minnesota, in 1985, and MS degrees in Operations Research and Applied Mathematics from Pennsylvania State University. Previous analysis experience include a tour as an intern within the Capabilities Analysis Division (CAD) of J-8, Joint Staff in the Pentagon. He is an Engineer by branch. His tactical experience includes company command and staff assignments in the 11th Engineer Battalion(C)(H), the 23rd Engineer Battalion(C) in Germany and 1st Engineer Battalion(C) in Southwest Asia. As an Instructor and Assistant Professor in the Department of Systems Engineering at USMA, he has taught courses in Systems Design and Systems Design for Engineering Managers.

Acknowledgments

Like any mission in the Army, this project would not have been possible without the support and guidance of a great many people. I would like to take this opportunity to formal thank the following individuals who greatly assisted me on my journey over the last year.

First of all, I'd like to thank **Colonel James L. Kays** for providing the vision of what the IDSM should be and for allowing me to work on this project. As with all the work that the Operations Research Center (ORCEN) has done on Installation Status Report (ISR) related issues, Colonel Kays was the driving force behind the development of the IDSM. His focus on providing the field with a client driven project help ensure that the model that we developed truly met the installation's needs.

I also want to acknowledge the significant contributions made by **Mr. Leonard T. Graham** to the development of the IDSM. Mr. Graham was an invaluable member of the team that conducted the initial needs analysis and installation visits. His knowledge of and experience in installation operations lent credibility to team. His thorough understanding of the ISR at the installation level was invaluable as we attempted to define the problem that we were trying to solve.

I also received much needed direction and guidance from three individuals within the ORCEN. First of all, **Dr. John V. Farr** served as my Senior Investigator. He helped keep me on track and forced me to see how this project fit into the bigger picture within the department. **Lieutenant Colonel David W. Hutchison** was the ORCEN Director during this research. I appreciate the latitude he gave me to conduct my research. His analytical experience also helped me get past some of the many roadblocks I encountered. **Lieutenant Colonel Michael L. McGinnis'** vast writing experience was invaluable in the editing and formatting of this report. His clear analytical thought process helped me clarify some of the gray areas of the report.

I would like to thank the Office of the Assistant Secretary of the Army, Financial Management & Comptroller(OASA(FM&C)) for funding this research. I especially need to acknowledge the contributions of **Ms. Mary Walker** and **Ms. Sharon Weinhold** for their help in coordinating this effort with the Army staff. Also the guidance and support received from **Dr. Robert Raynsford**, **MG Robert T. Howard** and **Mr. Neil Ginnetti** were instrumental in the success of the project.

I also receive great help and support from the Office of the Assistant Chief of Staff for Installation Management (OACSIM) starting with **MG Frank L. Miller, Jr.** and **Ms. Jan Menig**. **Mr. Stan Shelton** was the driving force within the OACSIM for the development of all ISR related systems. His guidance and knowledge were critical in the development of the IDSM. **Mr. Greg Brewer** contributed much as the action officer within the OACSIM.

The IDSM is based on feedback received from various installation. The honest and dedication of the installation level points of contact were critical to the completion of this project. The final product incorporates many of their wise recommendations and reflects the lessons learned from their vast experience.

I want to thank the administrative staff of the Department of Systems Engineering, **Ms. Betty Melick**, **Ms. Caroline Mason**, **Mrs. Nicole Scott** and **Ms. Rae Ellis** for untiring support for me over the last year. Without their help, I would have been sleeping in a pup tent and traveling by pack mule most of the time.

Finally, and most importantly, I would like to thank my wife, **Beth**, and our two children, **Sean and Matthew**, for their patience, support and understanding while I worked on this project - particularly during my many travels to conduct field research and project briefings. As usual I can not begin to express the importance of having you all in my life.

Table of Contents

Executive Summary.....	vi
1. Introduction	1
2. Problem Definition	2
2.1 Background Information.....	2
2.2 Installation Status Report (ISR) Overview	2
2.3 Problem Statement	3
3. Needs Analysis	4
3.1 Initial Vision.....	4
3.1.1 General.....	4
3.1.2 Database Module.....	6
3.1.3 Mapping Module	7
3.1.4 "What-If ?" Module.....	7
3.2 Stakeholders.....	7
3.3 Installation Needs	8
3.4 Department of the Army (DA) Staff Objectives.....	10
3.5 Redefined Direction.....	11
3.6 Revised Development Plan	11
4. Validation of Need	12
5. Prototype Development.....	13
5.1 System Development.....	13
5.2 Component Development	15
5.2.1 Database Module	15
5.2.1.1 General Concept.....	15
5.2.1.2 Feasibility Screening	15
5.2.1.3 Expanded ISR Database	15
5.2.1.4 R&K Engineering's ISR Viewer.....	16
5.2.1.5 Subunit Ratings	16
5.2.2 Mapping Module.....	16
5.2.2.1 General Concept.....	16
5.2.2.2 Feasibility Screening	17
5.2.2.3 Implementation.....	17
5.2.2.4 Prototype Development	18
5.2.3 Prioritization Module	18
5.2.3.1 General Concept.....	18
5.2.3.2 Feasibility Screening	18
5.2.3.3 Implementation.....	20
5.2.3.4 Target C-Ratings	20
5.2.3.5 Current C-Ratings	20
5.2.3.6 Relative FCG Importance Factors.....	21
5.2.3.7 Improvement Factors.....	22

5.2.3.8	Priority Score Calculations	22
5.2.3.9	Alternatives Comparison.....	22
5.2.4	Software Interface Module.....	23
5.2.4.1	General Concept.....	23
5.2.4.2	Feasibility Screening	23
5.2.4.3	Implementation.....	23
5.3	Hardware/Software Requirements	23
6.	Future Work.....	23
6.1	Model Expansion.....	23
6.2	Software Enhancements.....	25
7.	Conclusion	25
	References	26

Appendices:

- A. Needs Analysis briefing given to installation staffs (September - October 1995)
- B. Related Computer Automation Management Systems
 - IFS-M
 - HQIFS
 - RPLANS
 - HQPLANS
 - RMAT
 - EIS
 - HQISR
 - CAS
- C. Initial Project Briefing for MG Howard (14 Nov 95) and MG Miller (8 Dec 95)
- D. ISR C-Rating Calculations
- E. Geographic Information System (GIS) Tables

Executive Summary

The Operations Research Center (ORCEN) at the United States Military Academy developed the Installation Decision Support Model (IDSM) to make Installation Status Report (ISR) and other installation management data more usable at the installation level. The Office of the Assistant Secretary of the Army for Financial Management and Comptroller (ASA(FM&C)) in conjunction with the Assistant Chief of Staff for Installation Management (ACSIM) sponsored the work on the IDSM. The prototype model was completed in July 1996. Follow-on work toward full model development will be conducted during FY97.

The IDSM developed out of a need to provide installations with tools that allow them to take advantage of the data available in the ISR. Its purpose is to help the installation commander and his/her staff develop an accurate picture of current infrastructure conditions. Given this, the IDSM will assist the commander in evaluating the impacts of various investment strategies on installation readiness.

The fully developed model will also provide installations with easy access to existing data in a cost effective manner that minimizes the need for additional data collection. The ACSIM established a cost effective threshold of \$500 per user. Finally, the ACSIM also required that the IDSM be compatible with other automation systems currently under development by the Department of the Army (DA).

Based on input received from installation management personnel during site visits and meetings with DA staff representatives, a two phased approach for model development was adopted. Phase I, conducted during FY 96, focused on building a user friendly interface for management data at the installation level. This interface has four sub-components. First, the Database Query module improves installations' access to existing data. Second, the Installation Map module produces a graphical overview of an installation's infrastructure status using a software tool called VistaMap from Intergraph Corporation. Third, the Database Updating module establishes linkages to existing software packages, such as, ISR Parts 1 and 2. Finally, the Impact Analysis module, helps installations build and evaluate various resource allocation and spending alternatives.

Phase II of the IDSM development is scheduled to be conducted in FY 97. Phase II will enhance the prototype by expanding the Impact Analysis module. The Impact Analysis module prototype currently uses a Facility Category Group (FCG) prioritization algorithm that needs to be improved to reflect how funding decisions are actually made at the installation level. This report covers the needs analysis and initial model prototype development work done during Phase I.

1. Introduction

Since the late 1980s, the defense operating budget has decreased steadily each year. Over the same period, the number and types of unprojected contingency operations involving Army units has increased significantly. In these times of limited defense dollars and increased mission requirements, installation infrastructure maintenance funds have been used to pay for unprojected contingency operations. As a result, the Army's installation infrastructure has deteriorated markedly.

One of the primary reasons this practice exists is that it is difficult to articulate the effects of siphoning money from infrastructure maintenance accounts into training accounts. It is relatively easy to show the impact on readiness if the Army fails to spend the money to properly train our soldiers for contingency operations. The effect being mission failure and unnecessary loss of life. It is more difficult to show the impact of not funding certain renovation projects. Although the effects are not as obvious, or as immediate, in some cases they can also lead to mission failure.

The Installation Status Report (ISR) was developed to help articulate these infrastructure needs. The ISR is one of many tools available to installations in the area of infrastructure management. It was originally developed to help the Department of the Army (DA) justify funding requests to Congress. It focuses on aggregating repair and maintenance (R & M) and new construction, Major Construction, Army (MCA), costs across the Army in order to establish Army-wide infrastructure requirements. As a result, the data generated by the ISR is very useful at DA level for identifying unfunded requirements but often doesn't have much use at the installation level. If the ISR is to survive as a viable management tool, it must be made more useful at the installation level.

The Installation Decision Support Model (IDSM) is intended to make the ISR and other installation management data more usable at the installation level. Its purpose is to help the installation commander and his/her staff develop an accurate picture of current infrastructure conditions. Once this picture has been established, the IDSM will then assist the commander in evaluating the impacts of various investment strategies on current conditions.

The IDSM is being developed by the Operations Research Center (ORCEN) at the United States Military Academy (USMA) in conjunction with the Assistant Chief of Staff for Installation Management (ACSIM) and the Office of the Assistant Secretary of the Army for Financial Management and Comptroller (ASA(FM&C)). It will be developed in four phases:

Phase I: Problem Definition/Establish the Need

The initial phase focused on determining what the installation commander and his/her staff want from the ISR data. Our focus was on making the ISR data useful to the installation. What type of tool would be helpful to the commander? his/her staff? How can we present the ISR data in a way that would reduce instead of increase the installation staff's workload? How can we help the commander more

clearly visualize the effects of funding or not funding various projects? How can we help show him the effects of various allocation strategies on the overall installation readiness level? How do we integrate this new system into existing systems and processes?

Phase II: Needs Validation

Phase II focused on the consolidation of the data collected in Phase I in order to get approval for the project at DA level.

Phase III: Prototype Development

Phase III concentrated on building a prototype model/system that will meet the needs established during Phases I and II.

Phase IV: Model Validation/Refinement

Phase IV entails confirming that the prototype model meets the installations' needs established in Phase I. This will be accomplished by demonstrating the prototype at various installations in order to solicit the users perspective on its effectiveness. The model will then be revised and expanded to incorporate the relevant comments.

Phases I - III were conducted in FY 96 with Phase IV following in FY 97. This report will focus on Phases I - III. This is a work in progress as the prototype is still under development and has not yet been validated.

2.0 Problem Definition

2.1 Background Information

The ORCEN has been actively involved in developing tools to help improve the efficiency of Army installation management since 1990. Most of the ORCEN's initial efforts were focused on the development of the Installation Status Report (ISR). [1], [2] The ISR was developed in three parts: Part I, Infrastructure; Part II, Environment; and, Part III, Services. The CSA approved the fielding of ISR Part I in 1st quarter, FY 95. ISR Part II was tested and briefed to the CSA in July 1995. Part III is currently being developed by ACSIM.

2.2 ISR Overview

ISR, Part I, was developed to address the need of the DA to articulate infrastructure problems in a common, understandable manner. Its focus was on providing DA a tool to justify infrastructure funding requests in the budget cycle. It has been very effective in meeting this need. Although ISR, Part I, has been effectively used at the DA level, the After Action Review (AAR) conducted following the field testing of ISR Part I [3] showed that there are some doubts about the utility of the ISR at the installation level.

The information flow within the ISR is currently seen as being one directional (Figure 1).

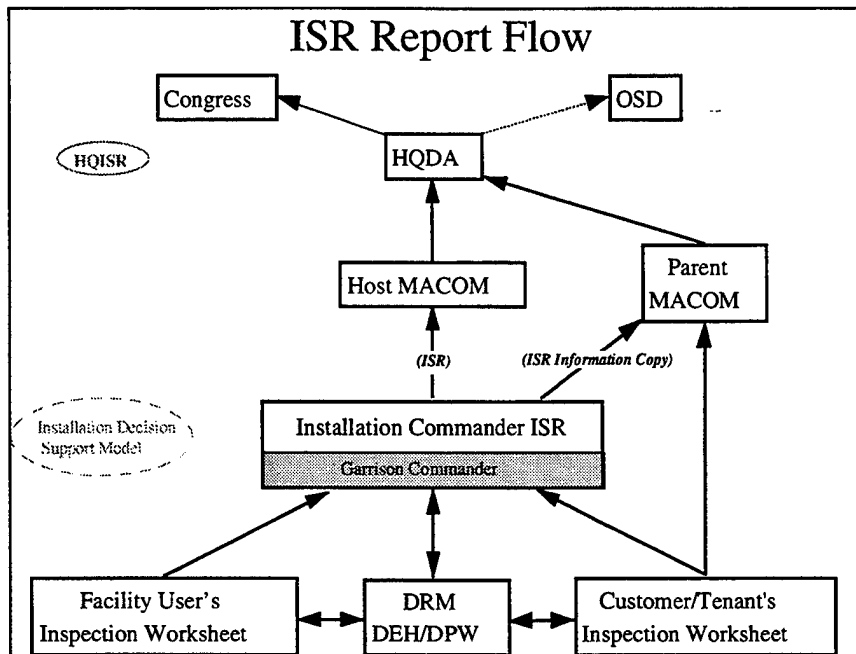


Figure 1. ISR Report Flow

Installations and their sub units collect and input all the facility data into the ISR. This is an extremely labor intensity operation. The estimated manpower requirement for ISR preparation range from 3000-5000 man-hours per installation.[4] The ISR software consolidates this facility data into C-ratings for Area, Category, Sub Category, and Facility Category Groups (FCGs) groupings. This consolidated data is forwarded through the installation's Major Commands (MACOMs) to Headquarters, Department of the Army (HQDA). HQDA uses this data to justify fund requests to Congress and OSD.

HQDA uses a software program called *Headquarters ISR* (HQISR) for viewing and analyzing the aggregated ISR data. HQISR is a very user-friendly computer program that helps users query the ISR database about funding questions. There is no equivalent package or capability available to the installations.

Based on feedback received from the field during fielding of ISR Parts I and II, it was determined that ISR data and other DA-directed infrastructure management tools needed to be more user friendly for the installations. This need is the basis for the development of the IDSM. The IDSM is being developed to provide the installations with a HQISR-type interface that is tailored to answer installation specific funding questions.

2.3 Problem Statement

During the last year, the ORCEN undertook the task of conducting a thorough needs analysis and building a prototype of a user-friendly installation decision support model (IDSM) that will enhance the installation commander's ability to allocate and manage an installation's facility renovation funds. The purpose of this effort is to give the installation commander a

tool to help make sound business decisions dealing with the allocation of limited infrastructure management resources.

3. Needs Analysis

3.1 Initial Vision

3.1.1 General

The ISR provides the method of establishing the current status of an installation's infrastructure. The initial vision for IDSM is that it would allow the installation staff to develop various investment alternatives that will transform the current infrastructure conditions into different future states. These alternatives could then be compared to each other and against the installation commander's priorities. The end result would be a clear evaluation of the future effects of the different alternatives. The installation commander would then have the information needed to make a sound decision about which alternative he wants to implement (see Figure 2).

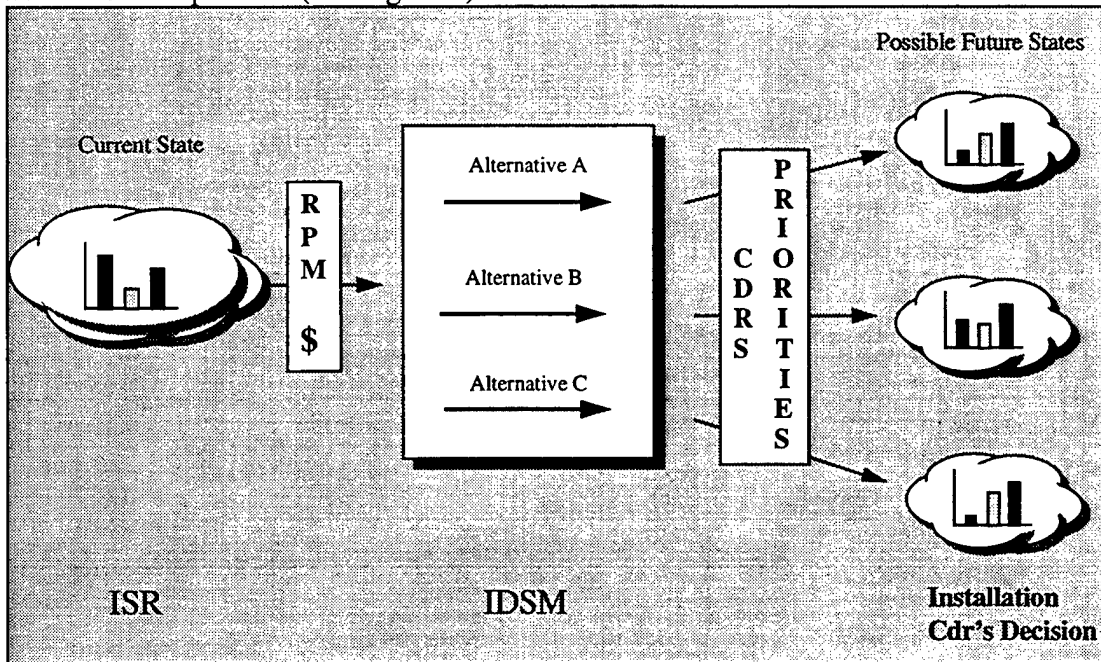


Figure 2. Initial IDSM Vision

IDSM was initially envisioned as a tool that would provide the installations with the following capabilities:

- enable installation staff to construct various infrastructure investment alternatives.
- conduct "What If?" analysis to evaluate the future effects of the different alternatives.
- view and analyze ISR and other existing data. Currently ISR provides reams of reports that contain a lot of very good information. The problem is that it is currently difficult to access this information. The IDSM should provide the installation commander and his staff a capability to easily view and use this data.

- measure progress toward infrastructure goals.

For the IDSM to meet its objectives, it needs to be user friendly and cost effective. Cost effectiveness is measured in terms of low startup costs (goal of less than \$500 per user) and minimal additional personnel requirements to operate the model. Because it is being designed to meet the installation commander's needs, the IDSM should be driven by the commander's priorities and establish a link between investment strategies and installation readiness.

Based on these capabilities and characteristics, we envisioned that the IDSM would function as portrayed in Figure 3.

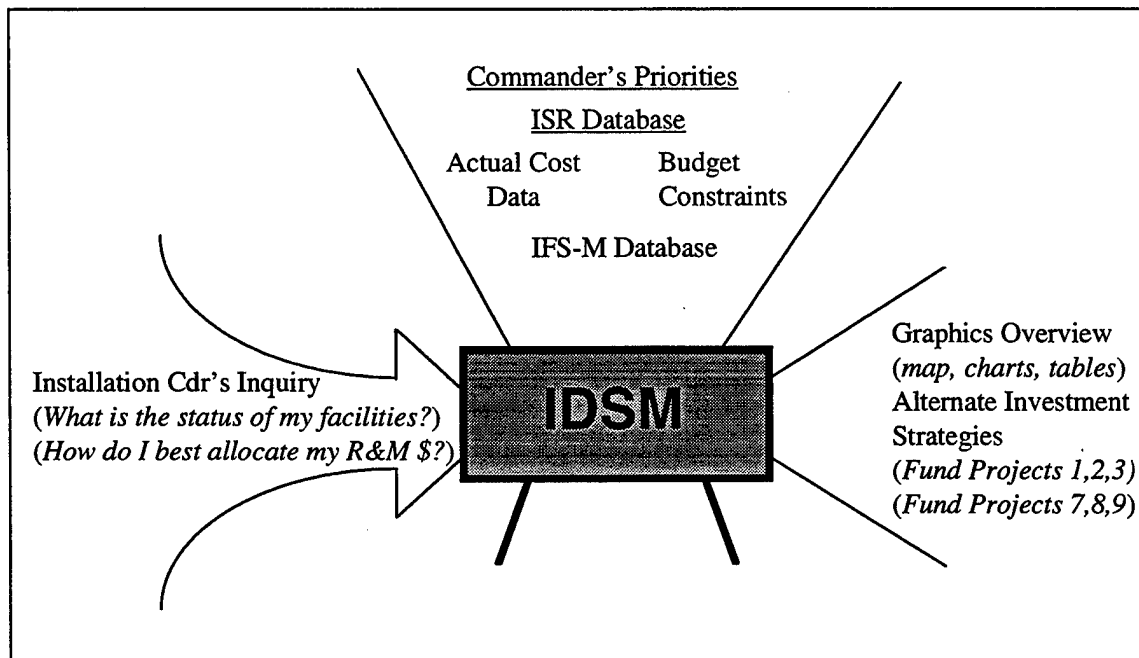


Figure 3. IDSM Process Schematic

The IDSM would be triggered by questions from the installation commander such as "What is the status of my facilities?" or "How do I best allocate my R&M dollars?" IDSM will answer these questions by linking with existing resources such as the ISR and IFS-M databases, as well as known inputs such as commander's priorities and actual cost data. Based on the analysis of these resources, the IDSM would then output answers to the commander's questions in terms of a graphical overview of the installation or alternate investment strategies.

From this schematic we identified the following three major components of the IDSM:

1. Database queries and analysis (Database Module)
2. Installation overview map (Mapping Module)
3. Funding alternative builder and analyzer ("What-If?" module)

Before soliciting input from the installations on what capabilities they would like to see in each of these components, we had to develop our initial vision of what each component

would do. This vision would serve as the starting point of our discussion with the installations. The following sections shows the initial vision for each component.

3.1.2 Database Module

This module is designed to produce database queries and comparison charts similar to those available in HQISR. The main addition is that the IDSM would give the installations the ability to drill down below installation ratings to look at major sub-unit ratings. These would show sub-unit ratings in Area, Category, Sub Category, and FCGs similar to the example shown in Figure 4.

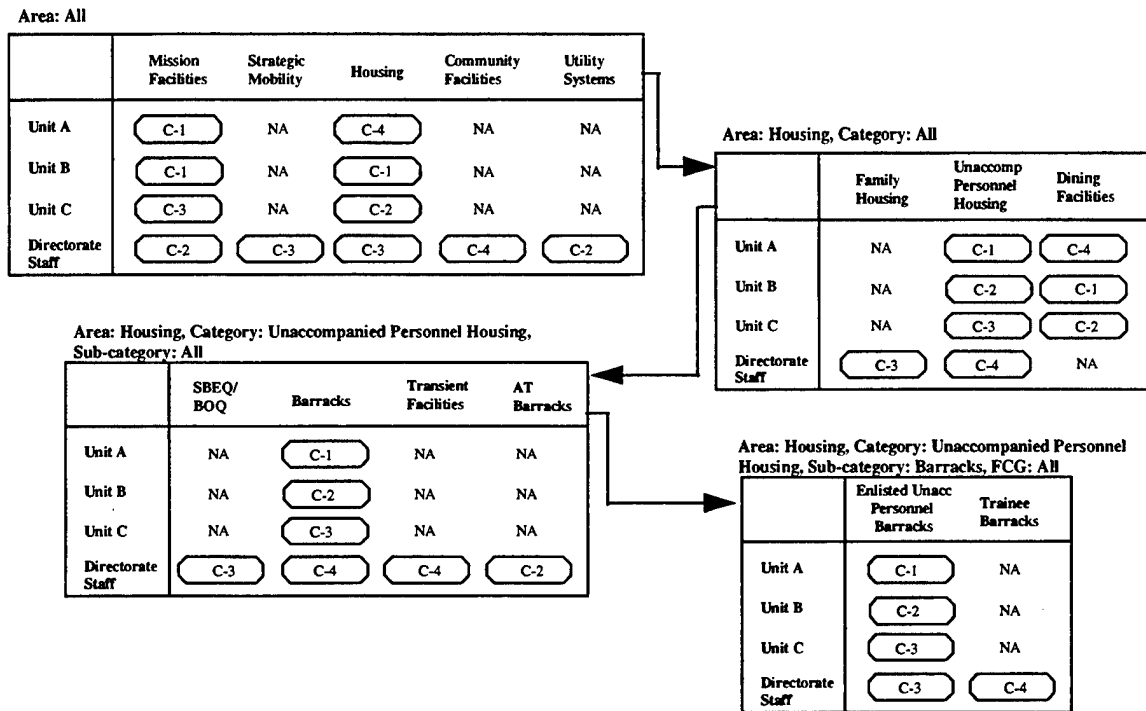


Figure 4. Database Drill-down Capability

This module should also give installations the ability to look at common faults within a FCG. For example, what sub-systems are causing the barracks to be rated Amber?

3.1.3 Mapping Module

The IDSM should also provide an installation overview map component that gives the commander a graphic picture of his/her overall installation status. This component would link ISR data to existing installation maps to provide an output similar to Figure 5. This module could be used to identify problem areas that may not be obvious from the tabular data. The purpose of this module is to give the commander the same type of situational awareness that the tactical commander has on the battlefield.

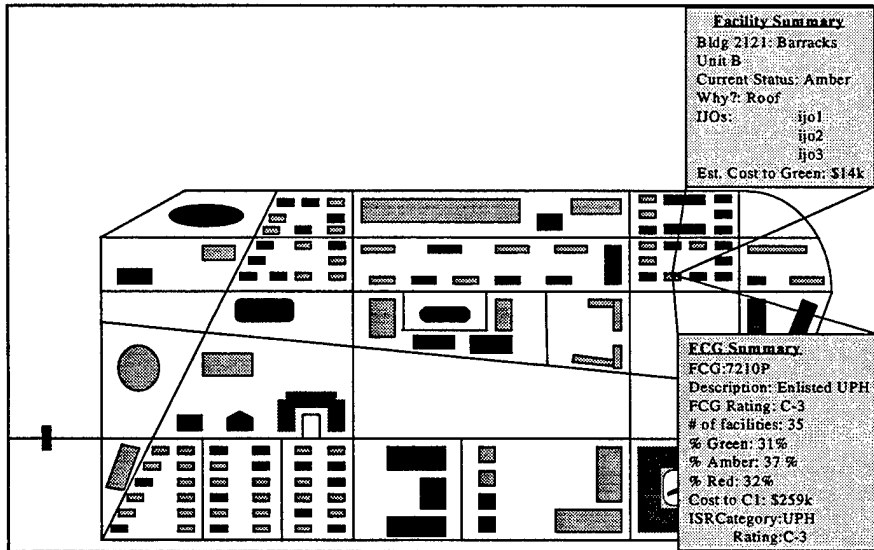


Figure 5. Mapping Module

3.1.4 "What-If ?" Module

The IDSM should also have a alternative building component that would allow commanders to evaluate the future impacts of various funding alternatives on installation readiness. This component would assist the commander and his/her staff in building different funding alternatives based on different priorities. For example, one alternative could be built based on the priority to fix all RED facilities first, another could be built that funds all Strategic Mobility facilities first, and, still a third could be built based on funding Quality of Life (Housing and Community Facilities) projects first. Each of these alternatives would produce a different installation readiness picture at the end of the planning horizon. This component of the IDSM would give the commander the ability to compare these future states before he/she makes his/her decision.

3.2 Stakeholders

Armed with the initial vision of the IDSM, a detailed needs analysis of the problem was conducted beginning with a study of the critical stakeholders of the model. The following are the "key players" that would have a vested interest in an IDSM-type model:

Installation commanders and their staffs will be the users of the model. The model is being developed to meet a perceived need at the installation level. It is critical that these needs be accurately evaluated before the tool is developed.

The Office of the Assistant Secretary of the Army (Financial Management & Comptroller)(ASA(FM&C)) is the sponsor of the IDSM. This office is interested in improving the efficiency of the installation-level resource management process.

The Assistant Chief of Staff for Installation Management (ACSIM) is the co-sponsor of the IDSM. ACSIM is the overall proponent of the ISR and is the DA-level proponent for all installation management issues.

The ORCEN is interested in ensuring that the ISR meets its initial objective to assist installations better manage their infrastructure.

Other Army analysis agencies such as Concepts Analysis Agency (CAA), Cost and Economic Analysis Center (CEAC), and United States Army Construction Engineering Research Laboratories (USACERL) would have an interest in IDSM as it pertains to ongoing projects that they have in this area.

Richardson & Kirmse Engineering, Inc. (R&K) and other ISR contractor would also be involved in any implementation of the IDSM as directed by ACSIM.

3.3 Installation Needs

To accurately establish what installations would want from an IDSM-type model, we needed to visit a representative set of Army installations. With the help of ASA(FM&C) and ACSIM, we were able to set up visits to the following installations:

Installation	Major Area Command (MACOM)
Ft. Hood	Forces Command (FORSCOM)
Ft. Riley	FORSCOM
Ft. Benning	Training & Doctrine Command (TRADOC)
Redstone Arsenal	Army Material Command (AMC)
Ft. Bragg	FORSCOM
Ft. Belvoir	Military District of Washington (MDW)
Ft. Detrick	Health Services Command (HSC)
Aberdeen Proving Ground	AMC

These visits were set up as fact-finding visits. Normally we met with the garrison commander or his deputy, as well as members from the main garrison staff elements: Directorate of Public Works (DPW), Directorate of Plans and Training (DPT), Directorate of Logistics (DOL), Directorate of Resource Management (DRM), Directorate of Community Activities (DCA), and any other interested personnel.

We began each briefing with a presentation of our initial vision and overview of the IDSM (See Appendix A). We then conducted an open ended discussion to solicit the

installation's input on how the IDSM could be modified to better meet their needs. We were very fortunate to receive meaningful contributions from all the installations visited. Since the IDSM uses ISR data as its basis, we received a lot of input into the installations' perspective on the ISR. The bottom line of these comments was that the ISR is difficult to use at the installation level, and therefore isn't being used effectively at the installation level. The installation's perception was that the ISR was another DA-directed report that required thousands of man-hours on their part yet brought nothing back to the installation. With a few minor exceptions, ISR data was not used in the installation management process.

For the IDSM to be helpful from the installation's perspective, the IDSM must have the following characteristics:

- No additional workload: As a result of the civilian drawdown, most installations' staffs have taken a 20 - 33% Reduction in Force (RIF). The functions and services required to be provided have not changed, but the number of people to do them has been greatly reduced. All staffs are "doing more with less." They do not have the personnel to adequately support labor-intensive requirements such as the ISR. If IDSM is to succeed, it must reduce, not increase, the staff's workload. If it fails to do this, then the IDSM will not be used. To this end, we must ensure that the IDSM links to existing databases and doesn't require installations to input new data as much as possible.
- Return on investment (ROI) from the ISR. Installations do not perceive that the ISR is producing an adequate return on investment for the amount of hours it takes to prepare. They are required to rate each of their facilities and report their installation readiness to their MACOMs, but they do not feel that their budgets are adjusted to fix the problem identified in the ISR report. For the IDSM to be effective, it must produce some tangible ROI for the installations. This does not have to be in terms of more Repair and Maintenance dollars, but it should be in terms of reducing the staff's workload. If the IDSM helps the staff do some of its current functions, such as to collect and display data, more efficiently without increasing workload, then it has provided an ROI to the installation.
- Improve the utility of ISR data
 - * Track trends: It would be helpful to be able to use ISR data to establish trends in infrastructure management. These are both trends over time (how have facility conditions changed from year to year), and trends within the current data (which type of facilities are in the worst condition and why).
 - * An "honest broker" tool, discourages "pet rocks" : The consensus is that project prioritization currently is being done based the "pet rock" principle as opposed to need. Normally, the annual project priority list is established by a board of colonels that votes on which projects get programmed for the next year. Often, the proponent that argues the best usually get the funding. Installation staffs, especially the DPWs, saw the IDSM as a tool to help level the playing field by showing the impacts of funding some of these pet projects.
 - * More microscopic view of problems: Overall facility ratings are more than adequate at MACOM and DA levels, but installations need more information

to make funding decisions. The installations were interested in being able to have a way of analyzing sub-system ratings in addition to overall facility ratings. What is causing Facility X to be rated RED? How many other buildings of the same type as Facility X are RED for the same reason? The current ISR checksheets require facility users to evaluate the major facility sub-systems in order to calculate the overall rating, but this data is not recorded in any automated format. It is therefore very difficult to conduct any meaningful analysis on the data except by stubby pencil.

- Keep it simple. Installations aren't looking for another large, complicated computer system that takes a lot of time and expertise to learn. They want something simple and flexible.

We also were able to collect the following insights into the installation-level resource allocation process:

- * The majority of the installations felt that the "What-If ?" capability of the IDSM will only be useful when and if the installations start getting larger Repair and Maintenance (RPM) budgets. They feel that right now they have very few infrastructure alternatives to evaluate. From their perspective, they don't even get enough money to sustain their current status and don't have the luxury of looking at how to get better.
- * The majority (80-90%) of an installation's RPM budget is locked up in paying utility costs, maintenance contracts, in-house supply and labor costs, and fixed operating expenses. The remaining 10-20% must be divided between high priority command directed projects and renovation projects. The end result is that there is very little money left from the normal RPM budget for renovation projects.
- * Installations have come to rely on end-of-year funds to allow them to complete non routine maintenance. Typically, an installation can plan on receiving as much as \$10 million in end-of-year funds. The problem with these funds is that they are very time-sensitive and must be allocated very quickly. Therefore, the project with a completed plan is usually the one that gets funded.

3.4 DA Staff's Objectives

In addition to the installation staffs, we were also very interested in establishing what the DA staff saw as the needs of the IDSM. Our initial guiding forces were Mr. Stan Shelton within ACSIM and Ms. Mary Walker within ASA(FM&C). The following were their common themes for the IDSM:

- Keep it simple.
- Keep it cost effective. This was in terms of both development costs and implementation costs. Don't build another system that installations have to buy new equipment to operate.

- Improve installation efficiency. Help installations do more with less assets (people and money).
- Do not duplicate other efforts. The big areas of concern were in terms of duplicating capabilities to be provided by the RMAT and EIS systems, as well as ongoing research by CAA, USACERL, and CEAC in the area of decision support. (See Appendix B for description of related systems.)
- Ensure compatibility with future systems. Ensure that whatever we develop for the IDSM will be able to be integrated into the RMAT and EIS systems.
- Foster integration. ACSIM is the proponent for all three parts of the ISR and they want to ensure that the IDSM would be applicable to all three parts.

3.5 Redefined Direction

After we completed the installation visits and established the DA-level objectives for the IDSM, it became clear that we needed to redefine our initial vision for the model. The initial focus of the IDSM was on providing a tool that would help commanders build and analyze investment alternative (“What-If ?” capability). These alternatives would be based on ISR data. Our installation visits showed that installation are not currently using ISR data to make funding decisions. Because the data is difficult to access at the installation level, installations haven’t discovered the potential uses of the ISR data. They therefore have very little confidence in its applicability at their level. As a result of this, they would also have very little confidence or use for investment alternatives based on such data.

Most installations agreed that the “What-If ?” capability would eventually be a useful tool, but it was ahead of its time. We first had to make the ISR data more accessible to the installations in a format that would be usable in their infrastructure management process. Doing this would allow the ISR and ISR data to become ingrained in installation operations. Once that was accomplished, it would then be appropriate to implement the “What-If ?” capability.

3.6 Revised Development Plan

Based on these conclusions, we proposed a two-phase development for the IDSM. The first phase would focus on making ISR data more accessible and usable at the installation level. This phase would concentrate on the following tasks:

- develop graphic interface with ISR data;
- integration with ACSIM’s ISR Final Operational Capability (FOC); and,
- integration within the RMAT installation automation system.

Phase II of the IDSM development would then focus on providing installations with the ability to build and evaluate the impacts of investment strategies and accomplish the following tasks:

- develop alternative investment strategy builder;
- develop tools to evaluate the impacts of various investment strategies; and,
- continue integration within RMAT.

Our installation visits and coordination with ASA(FM&C) and ACSIM helped us to develop the following characteristics for the redefined IDSM. The IDSM should:

- be timely, responsive, promote ISR utility;
- be inexpensive, avoid additional workloads;
- improve situational awareness of installation commanders;
- interface with current, future systems;
- address current installation needs;
- not duplicate existing or planned systems; and,
- be partnered with ACSIM initiatives.

The overall objective of the IDSM will still be to provide the **installation commander** with a tool to help make **sound business decisions** dealing with the allocation of RPM funds. Supporting objectives would be to improve access to and usability of ISR and other management data and to improve the commander's ability to analyze the impacts of funding decisions.

These objectives and characteristics form the basis of our revised vision for the IDSM.

4. Validation of Need

Upon completion of a thorough needs analysis, we were ready to present the concept of the IDSM for approval to the ASA(FM&C) and ACSIM primaries. The ORCEN presented a concept briefing to MG Howard and Mr. Genitti of the ASA(FM&C) and MG Miller and Ms. Menig of the ACSIM. (See presentation slides in Appendix C) All proponents supported the continued development of the model. The primary concerns were voiced by MG Miller. His guidance was as follows:

- Keep the model simple. The GIS portion is nice to have, but it should not be the focus of the model. The data access should be the focus. Not all installations will have or want the GIS capability, but all will need access to the ISR data.
- Give the installations a tool that they could use if they choose, but be careful not to overburden them. He was very concerned about forcing too much automation on the installations.
- Ensure that all new development efforts focus on integrating the various parts of ISR. He didn't want another unconnected system. He also wanted us to ensure that we weren't duplicating any other work.

Based on the approval of both ASA(FM&C) and ACSIM, the ORCEN began building the prototype.

5. Prototype Development

5.1 System Development

Once we had established the objectives of the IDSM, we were able to outline the specific functions that the model must be able to accomplish. These functions formed the basis of the prototype development. The following table shows the IDSM's major functions, as well as the activities and methods that the prototype will use to accomplish each function:

Function	Activities	Methods
Query and display ISR and related data	Database Module	Access/VB
Graphically display infrastructure conditions	GIS Module	VistaMap
Interface with ISR software	Software Interface Module	VB
Interface with the user	Visual Basic Shell	VB
Prioritize projects	Optimization Module	VB

Table 1. IDSM Functional Decomposition

Because one of the critical objectives of the IDSM is to improve the integration of ISR Parts I, II, and III, its structure must be expandable to address all three parts. It is also critical to acknowledge that ISR is not the only source of data used in the installation-level decision-making process. Figure 6 shows the relationships between ISR data and other data sources. The IDSM must ultimately be flexible enough to give commanders and their staffs access to all sources of data needed to make sound decisions dealing with installation management.

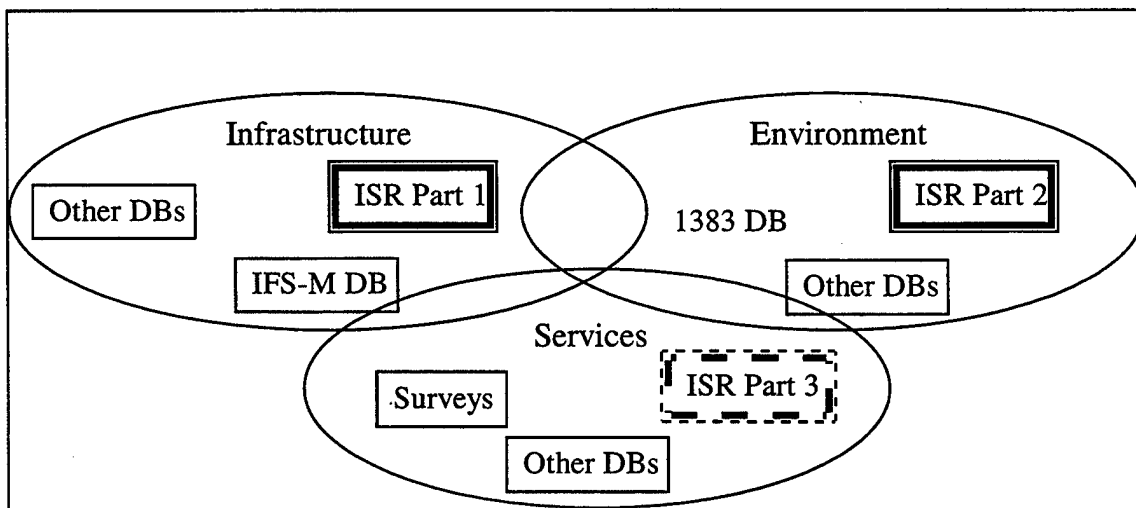


Figure 6. Installation Level Decision Making

If the IDSM is going to give commanders seamless access to the different types of databases shown in Figure 6, it will have to be able to address the following issues:

- The proponents of three parts of the IDSM may live in different areas of the post. Normally the DPW will be responsible for Infrastructure, but some installations have

separate directorates responsible for all or part of Environment and Services (DCA). The IDSM must assist in information sharing among agencies. The preferred method of data sharing would be via the Local Area Network (LAN) envisioned in RMAT.

- The databases from the various areas are in different formats (DBASE, ORACLE, MGE, etc.) IDSM must be flexible enough to be able to read the various file formats.

Flexibility and adaptability are two of the critical design specifications for the IDSM. Figure 7 shows the structure that the IDSM will use to build in this required flexibility.

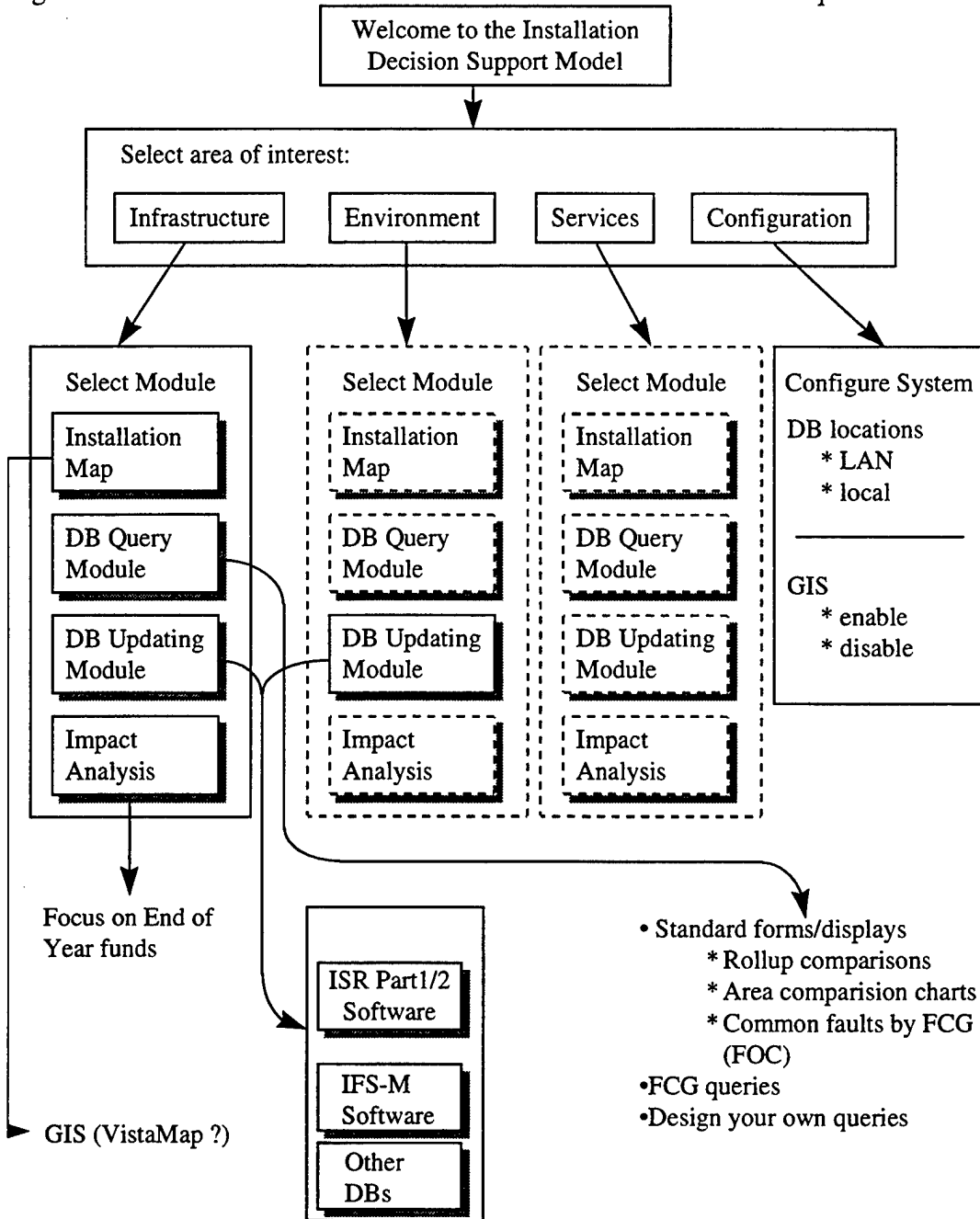


Figure 7. IDSM Prototype Structure

The prototype was developed using Infrastructure as its basis, but the same structure will be able to be expanded to Environment and Services. Infrastructure was chosen as the

basis for the prototype because ISR Part I is the oldest and most developed part of the ISR. FY96 is the third full reporting year for Part I, Infrastructure, while it is the first full year for Part II, Environment; and Part III, Services is still under development.

5.2 Component Development

The following sections cover the development considerations used for each of the IDSM base modules.

5.2.1 Database Module

5.2.1.1 General Concept. The database module is the centerpiece of the IDSM. The module allows the installation staffs to use the power of automation to access and analyze infrastructure management data. The main source of this data will be the ISR. The IDSM must also have the flexibility to be able to access data from other sources such as work management databases (IFS-M), as well as other locally generated databases. The prototype incorporates actual FY95 ISR data from Ft. Bragg.

5.2.1.2 Feasibility Screening. The IDSM uses Microsoft(MS) ACCESS and Visual Basic to link the various databases. ACCESS was used to develop the table structure and some of the basic queries used by the database module. The module itself was written in Visual Basic. The decision to write the module in Visual Basic as opposed to using the built functionality of MS ACCESS was made to reduce the software purchasing requirements on the installations. If it were written in MS ACCESS, the installation would have to buy MS ACCESS in order to use the module. Visual Basic code can be compiled in an executable file which could be delivered to the installations at no additional cost.

5.2.1.3 Expanded ISR Database. For the IDSM to provide installations with the more micro-level information that they are looking for, the ISR database must be expanded to include sub-systems' ratings in addition to overall facility ratings. ACSIM's FOC calls for the addition of MARKSENSE reading software to the ISR software to give the installations the capability to collect this data without addition manual entry. This software is currently under development with an expected fielding in FY 97. It was therefore necessary for us to manually populate an expanded ISR database.

The ORCEN developed a Visual Basic editor which allowed us to manually input the subsystem ratings for each facility in the Ft. Bragg ISR database. We then requested and received copies of each facility inspection checksheet from the Ft. Bragg ISR POC. Each sheet was then manually entered to produced the expanded ISR database. This operation required 49 man-hours of data entry.

This ISR database editor is being included in the IDSM in the Software Interface Module. This editor can be used to develop the expanded database in the event that an installation doesn't have the MarkSense scanning capability.

5.2.1.4 Richardson & Kirmse Engineering, Inc. (R&K)'s ISR Viewer. R&K Engineering developed the ISR Viewer as part of its FY96 ISR software enhancements. The ISR

Viewer was designed to give the installations the same graphics and query capabilities that are available at the DA level in HQISR. It very effectively provides this capability. The ISR Viewer is limited in that it does not give the installations the capability to drill below the installation level to show ratings for the major sub-units. For instance, the ISR Viewer could show that Ft. Bragg was rated AMBER in the Barracks FCG, but it does not show how 82nd Airborne Division (a sub-unit at Ft. Bragg) was rated in the same FCG. Similarly, the Viewer doesn't have the capability to show which subsystems were causing the Barracks to be rated AMBER. These two types of queries are examples of the more micro-level data that the installations want to be able to get out of the IDSM.

In January 1996, ACSIM, ORCEN, and R&K Engineering agreed that R&K would continue to work on their viewer as originally envisioned. Upon completion, R&K would provide a copy of their source code to the ORCEN. The ORCEN would then modify to source code to incorporate the changes needed to provide the full IDSM capabilities. This code would then be provided to R&K for inclusion in the next ISR software update. It was also agreed that the name of the ISR Viewer should be changed to IDSM Viewer because it will be part of the IDSM.

5.2.1.5 Sub Unit Ratings. The ISR was designed to calculate an overall C rating for each FCG, Sub-category, Category, and Area on an installation. This rating is a composite of the Quality and Quantity ratings for each element. Quantity ratings are based on a percentage of on-hand versus required square footage for each element. This data is only maintained at the installation level. It would be very difficult to subdivide this quantity rating among an installation's sub-units. The Quality rating, on the other hand, is based on the quality rating of each individual facility. Each facility is rated RED, AMBER, or GREEN. Each facility also has an assigned Unit Identification Code (UIC) which represents who uses or owns the facility. Based on this rating and UIC it is possible to determine the sub-unit Quality ratings for the various FCGs, Sub-categories, Categories and Areas.

For this reason, the IDSM will only produce Quality ratings for sub-units. It will list Quality and Total C-Ratings only at the installation level. The Quality ratings for the sub-units will be calculated using the same algorithm used by the ISR. (See Appendix D.)

5.2.2 Mapping Module

5.2.2.1 General Concept. The purpose of the Mapping Module is to give the commander the capability of getting a graphic overview of his/her installation's infrastructure condition. This overview will assist the commander to see and identify systemic problems and issues on the installation.

The Mapping Module is based on Geographic Information System (GIS) technology. GIS takes digitized maps of an installation and links them with databases containing information about the elements, or features of the map. Each element on the map is a feature and each feature has data associated with it. This data is known as attribute data. An example of a feature is a building exterior or outline. Examples of attribute data associated with this building outline are owner, type, size, condition, building number, etc.

GIS allows us to link the "dumb" feature with its attribute data. This linked data can then be queried to help graphically display certain aspects of the database. An example of such a query would be to show all buildings of type = barracks with condition code = Amber.

GIS is a very technical system. It requires very specific training and equipment to operate. Currently, most installations have design sections within their DPWs which have the personnel and equipment necessary to build and maintain the GIS maps and databases. The issue is that no one outside these design sections have access to the GIS databases. The only way to get maps of the installation is to request them from the design section who then run the requested queries on their machine and produce the hardcopy output.

The mapping module of the IDSM is being designed to give the installation commander and his primary staff real time access to the GIS database. This access will allow them to view and analyze GIS data using their desktop computer. This will be done via a GIS viewing program called VistaMap. VistaMap gives its user read only access to all the maps and data within the GIS system.

5.2.2.2 Feasibility Screening. There currently are two major PC based GIS viewers: ArcView by ESRI, and, VistaMap by Intergraph. We evaluated both of these packages but settled on VistaMap primarily because of its compatibility with the RMA system. The platform for RMA is the Intergraph workstations and Intergraph's MGE produce suite. VistaMap is fully compatible with these products while ArcView is not.

5.2.2.3 Implementation. The GIS module is an option part of the IDSM. The IDSM is being designed to allow an installation to decide whether they can use its capabilities. In order to be able to use this module, an installation will already have to have the basic MGE GIS tools that are the basis of RMA. The requirements for VistaMap is that the MGE project directory and GIS database management system(DBMS) must be accessible to the computer that is running VistaMap. Normally, this means that the PC is connected via a Local Area Network (LAN) to the project directory and the DBMS. The project directory and DBMS would normally reside in the design section of the DPW.

If an installation doesn't have a LAN in place, it is also possible to run VistaMap via remote login. This option connects the PC with the project directory and DBMS via modem. Although this option is appealing to those installations who don't have LANs, it must be noted that this remote login significantly slows down the responsiveness of VistaMap.

If the installation doesn't have these tools, they will be able to disable the GIS module and still use the rest of the tools within the IDSM.

5.2.2.4 Prototype Development. The prototype is being developed using the Ft. Bragg GIS database. Fort Bragg was selected because it is one of the more advanced installations in terms of GIS automation. The Ft. Bragg database is very detailed. All major activities on the installation have been digitized. The level of resolution of maps range from large, once-over-the-world installation maps to detailed building floor plans. The GIS database that links to these drawings contains thousands of records which include hundreds of

elements of data on each feature. Feature type, size, location, usage, condition and owner are examples of the types of data stored in these records. These records cover physical data such as buildings, road, etc., as well as information on environment issues, hydrology and general topography. (See Appendix E for a listing of all the table in the Ft. Bragg database.)

One critical element of data in this database is a field called *ISR_condition* in the *Facilities and Structures* table. This field contains the Red Amber Green ISR rating for each facility. This data was not originally part of the database, but it was imported directly from electronic ISR output files with minimal effort. The FCG number and UIC for each building were also imported into that table. This data formed the basis of the queries that are used in the IDSMS.

5.2.3 Prioritization Module

5.2.3.1 General Concept. The purpose of the prioritization model is to provide the commander with the capability to build and compare various investment strategies. The Database Module and Mapping Module help paint the picture of the current installation infrastructure status. The Prioritization Module will use this current picture as a starting point. It will then attempt to assist the commander in determining where renovation and construction funds should be allocated to produce a desired future infrastructure status.

During Phase II of the IDSMS's development we plan to focus our efforts on building a detailed prioritization module. The intent for the prototype was to include a basic prioritization model in the IDSMS to highlight the potential capability.

5.2.3.2 Feasibility Screening. There are two major methods that can be used to prioritize projects. Projects can be prioritized based on the cost effectiveness of the project; or, projects can be prioritized based on how well they meet commander established priorities.

Cost effectiveness is usually measured in terms of improvement per dollar. In other words, there is a cost associated with each project. There also would be a measurable improvement (usually measured in terms of change in ISR condition codes from Amber to Green, or Red to Green). We could then calculate the ratio of the improvement score versus cost for each project. Those projects with higher improvement scores versus cost (i.e., more cost effective projects) would be listed higher on the priority listing. Ranking projects using commanders priorities would not take cost into account. This method would use the same improvement score discussed above. In this case, we wouldn't create a ratio of improvement to cost; instead, we would simply multiply the improvement score by a factor which reflects how well each project fits into the commander's established priorities. Those projects in areas that the commander has established as higher priority areas will be higher on the priority listing.

Based on the feedback that we received from our installation visits, we decided to base our Prioritization Module on commander's priorities as opposed to cost effectiveness. While cost effectiveness is critical in these times of shrinking defense budgets, the overriding concern from the installations perspective is the source of the cost data that

would be used to calculate cost effectiveness. The obvious candidate for this source is ISR cost data. The ISR produces renovation cost estimates for each non-Green project. These estimates are based on square footage and a DA wide cost factor for each type of facility. While these estimates are very good when aggregated across the Army, they are normally significantly off at specific installations. Therefore, most installations have very little confidence in the cost estimates that the ISR produces. If we based our prioritization module on these cost estimate, then the installations would also have very little confidence in the priority listing produced.

Another potential source for cost data is to have the installations input installation specific cost data estimates for each project. This approach would be unacceptable to the installation because it would require the installations to conduct detailed inspections of each of their non-Green facilities. The additional manhours required to do this makes this approach unfeasible.

We therefore decided to base our Prioritization Module on commander's priorities versus cost effectiveness. Eventually we see this prioritization as a two step operation. The first step is to rank order the projects based on commander's priorities. The second step would be to collect the accurate cost data for the top priority projects and then rerun the model to incorporate cost effectiveness into the ranking. This method would require detailed cost estimates on a much small subset of all renovation project than the full cost effectiveness method would. (Just collecting estimates on the top ranking projects as opposed to all the projects.) Our prototype will focus on the first step only.

5.2.3.3 *Implementation.* The prioritization model rank orders the FCGs based on installation levels inputs of target C-Ratings, current facility conditions, and relative FCG importance (See Figure 8).

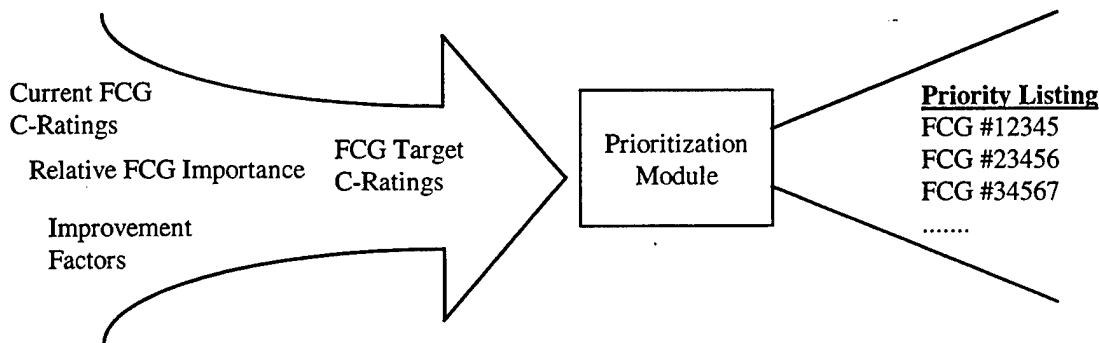


Figure 8. Prioritization Module Schematic

5.2.3.4 *Target C-Ratings.* Installations will be given the opportunity to input target C-Ratings for each Area, Category, Sub-Category and FCG. This target is the desired rating that the installation commander has established for each ISR grouping. Realistically, these targets should not all be C1. The commander should determine those facilities that are truly mission essential and set their targets higher, while non mission essential facilities could be given a lower target. Those projects with higher targets will be higher on the priority listing.

The user will have three options for setting target ratings:

Option 1. The user to input the target C-Ratings for the five ISR areas and have the model set all subordinate C-Ratings equal to the area rating. For example, the user could input C-2 as the target rating for Housing and the model would set the targets for Family Housing, Unaccompanied Personnel Housing and Dining Facilities and all their subordinate sub-categories and FCG to C-2 as well.

Option 2. The user would be allowed to drill all the way down to specific FCGs to set FCG specific targets. Using the same Housing example, the user would be able to set the target for FCG# F7210P, Enlisted Unaccompanied Personnel Housing (Barracks), to C-1 even though the Housing area as a whole is C-2.

Option 3. Accept system defaults which are C-1 for all Mission and Strategic Mobility facilities and C-2 for all Housing, Community Facilities and Utilities.

5.2.3.5 *Current FCG ratings.* These are the current FCG ratings directly out of the ISR export files. The IDSM Viewer that R & K Engineering developed has an import function that pulls the current C-ratings directly off of the ISR export disk. The Prioritization Module links into the tables that the IDSM Viewer builds to hold this data.

The Prioritization Module gives the user the option to use either the quality, quantity or overall C-ratings to develop the priority listing. Using the quality ratings will allow the user to produce a FCG listing that will assist in prioritizing repair and maintenance projects. Using the quantity ratings will do the same for new construction projects. Using

the overall rating with help produce a general prioritization listing for all infrastructure expenditures on the installation.

5.2.3.6 *Relative FCG Importance Factors (RFIF)*. These values are numbers between (0, 10) which show the relative importance of each element within a grouping. The comparison is not being made across groupings, it is restricted to within the same grouping. For example, the user could set the RFIF for Family Housing = 10, Unaccompanied Personnel Housing = 8 and Dining Facilities = 6. All of these are categories within the Housing area. The user isn't comparing Family Housing to Training Ranges & Areas which is a category within the Mission Facilities area.

The user will need to input relative importance factors for each level of ISR groups, i.e., for areas, categories, sub-categories and FCGs. The user can also choose to use the system defaults. These values were established based on input received from the Ft. Bragg DPWE. Additional surveying of more installations is needed to establish a more generic default set.

The model uses the RFIFs to calculate global weights that can be used to compare FCGs across ISR groups. The following example is used to show how the global weights are calculated:

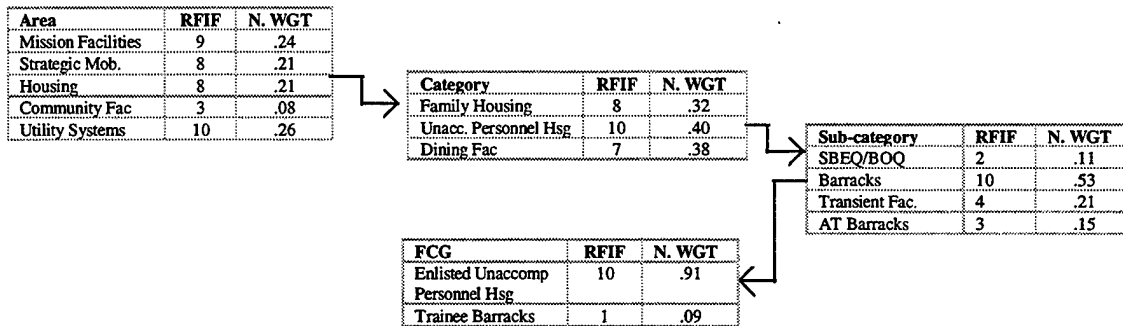


Figure 9. Global Weights Example

The first step is to normalize the RFIFs for each level (area, Category, sub-category and FCG). This normalized weight (NW(i)) is calculated using the following formula:

$$NW(i) = RFIF(i) / \sum RFIF \forall i \text{ in grouping} \quad (1)$$

For example, $NW(\text{Mission Fac}) = 9 / (9 + 8 + 8 + 3 + 10) = .24$

Global weights (GW) are then calculated for each FCG using the following formula:

$$GW = NW(\text{Area}) * NW(\text{Category}) * NW(\text{Sub-category}) * NW(\text{FCG}). \quad (2)$$

Using the example from Figure 9,

$$\begin{aligned} \text{GW(Enlisted Unacc Personnel Hsg)} &= \text{NW(Housing)} * \text{NW(Unacc Personnel Hsg)} \\ &\quad * \text{NW(Barracks)} * \text{NW(Enlisted Unacc} \\ &\quad \text{Personnel Hsg)} \\ &= .21 * .40 * .53 * .91 = .04 \end{aligned}$$

Similar global weights are calculated for each FCG.

5.2.3.7 Improvement Factors. The Improvement Factor establishes a linkage between current FCG ratings and target ratings. They assign a numeric value to reflect the improvement associated with changing the current C-rating to the target C-Rating. If a FCG is currently at or above its target rating, then its Improvement Factor is 0. Table 2 shows the default values for the Improvement Factors. The user also has the ability to change these to any value they from within the model.

Current Rating	To C1	To C2	To C3	To C4
C1	0	0	0	0
C2	1	0	0	0
C3	2	1	0	0
C4	4	2	1	0

Table 2. Improvement Factors Matrix

5.2.3.8 Priority Score Calculation. The priority score(PS) for each FCG is calculated by multiplying the global weight (GW) of the FCG by its associated improvement score (IS(current, target)) which is a function of the current and target FCG ratings. Therefore:

$$\text{PS(FCG)} = \text{GW(FCG)} * \text{IS(current, target)} \quad (3)$$

Again using the example from Figure 9 and assuming that the current C-rating for Enlisted Unaccompanied Personnel Housing is C-4, we can see that:

$$\begin{aligned} \text{PS(Enlisted Unacc. Personnel Hsg)} &= \text{GW(Enlisted Unacc. Personnel Hsg)} * \\ &\quad \text{IS(current=C-4, target=C-2)} \\ &= .04 * 2 = .08 \end{aligned}$$

The model calculates the priority score for each FCG and then sorts them in descending order to produce the priority listing that is outputted by the model.

5.2.3.9 Alternative Comparison. Each time the user asks the model to calculate the priority listing, the user is asked if they want to save their FCG listing. If the user opts to save, the FCG listing is dumped to the Alternatives table in the database. The user can then go back into the model and conduct some basic "What-If?" drills such as adjusting target ratings or varying whether the quality, quantity or overall C-Rating is used. If the user saves each of these "alternatives", the model will allow him/her to compare the rank orderings of the various alternatives on the screen. This capability allows the user to see the impact of changing the target ratings, etc.

5.2.4 Software Interface Module

5.2.4.1 General Concept. The IDSM needs to be able to link into existing infrastructure management software. Primarily this is referring to the ISR software, but also could apply to other software packages such as IFS-M, the USACERL Engineering Management Systems (EMSs) such as ROOFER and BUILDER, as well as other locally developed software packages. The prototype will include linkage to ISR Part 1 and to the ISREditor, the software package developed to populate the expanded ISR database needed for the ISR

5.2.4.2 Feasibility Screening. This module is written in Visual Basic in order to be consistent with the other modules of the IDSM. No other alternative methods of building this linkage were evaluated.

5.2.4.3 Implementation. The Software Interface Module is nothing more than a switchboard which starts the various software packages. By clicking a button on the Visual Basic form, the user can start either ISR Part 1 software or the ISREditor. The user will then have access to all the feature of the software package they have chosen. After existing out of either ISR Part 1 or the ISREditor, the control of the model is returned to the IDSM's Visual Basic shell.

5.3 Hardware/software requirements

The IDSM will run on any IBM compatible computer with a 486 or better processor and at least 8 MB of RAM. If the Overview Map module is used, then the computer will have to meet the minimum requirements of Intergraph's VistaMap software package which is also a 486 with 8 MB of RAM. For improved performance, Intergraph recommends 16 MBs of RAM and a Pentium processor for VistaMap.

The IDSM interface and software is written in Visual Basic and will be distributed in a runtime executable. Again, if VistaMap is used, that package will need to be purchased separately from Intergraph and installed on each workstation. Users will also have to have access via LAN to a GIS database.

6. Future Work

The prototype of the IDSM adequately demonstrates the capabilities outlined in the initial vision for the model. As a prototype, the model still has areas that can, and need to be, refined before the IDSM will be ready for fielding. These areas can be organized into two main groupings: model expansion and software enhancements.

6.1 Model Expansion

Additional research needs to be conducted in order to expand the IDSM. The primary area needing additional research is the "What-If?" module. The majority of the work on this module was planned to be conducted during Phase II of the model development in FY 97.

The prototype includes a very basic prioritization tool. This tool prioritizes down to the FCG level. It also does not include any aspects of cost effectiveness in its algorithm. One major area of additional research should focus on establishing if this FCG based prioritization is adequate. If it is not, are installations interested in a tool that will help them prioritize individual projects within an FCG, or across FCGs? If the answer to this question is yes, then the model should be expanded to include a method of establishing a project based priority listing.

The prioritization algorithm should also address a longer planning horizon than the one year used in the prototype. 3, 5, or 7 year planning cycles should be considered. Adequate planning is not conducted on a year to year basis. Long term vision and direction need to be built into the prioritization process.

Once the model begin looking out to future years, facility degradation and penalties associated with delaying maintenance become critical. Degadation curves should be built into any expanded prioritization module that considers long term investment strategies. ACSIM, USACERL and R&K Engineering are currently doing work in this area that may be able to be applied to the IDSM.

Another area of further research is how to incorporate project costs into the prioritization process. There is a need to incorporate these costs into the model. The source of the cost data is the primary area of disagreement. The ISR produces generic cost factors for sustainment and new construction at the FCG level and renovation at the facility level. In general, installations do not have problems with sustainment and new construction cost. On the other hand, installations normally do not agree with the renovation costs generated by the ISR. These factors are adequate at DA level, but lose credibility when applied to specific installations. This is the reason why ISR cost data was not included in the prototype.

The issue then becomes where to get accurate cost estimates for inclusion in this process. Several possible sources include locally generated engineer estimates on the high priority projects (as discussed in Section 5.2.3.2), other existing software such as ROOFER, BUILDER , etc from USACERL, or other project estimation systems currently being used by installations. Further work is needed to determine how to link this cost data to the IDSM in such a way as to minimize the additional workload on the instaltion staff.

Finally, additional research needs to be conducted to determine how to expand the IDSM to include Environmental and Services related data. Ultimately, the IDSM was designed to integrate all three parts of the ISR as well as all other installation management tools such as IFS-M. The prototype focuses solely on ISR, Part I and its associated data. Further work is needed to expand the model to its full scope.

6.2 Software Enhancements

The prototype software was written using Visual Basic 4.0, MicroSoft Access 2.0 and Intergraph's VistaMap GIS viewer. All the components are functional, but the source code will need optimization and refinement before it is ready for fielding.

7. Conclusion

The IDSM was developed to provide installation commanders and their staffs with a set of tools to help make sound business decisions dealing with installation management issues. The focus of the development effort was on the installations and their needs. Considerable effort was exerted to get the installation perspective on all phases of the model development. The installation visits conducted during the needs analysis phase showed that the installations were interested in a low cost, user friendly interface with existing data. The prototype was developed to provide this interface in the form of the Database and Mapping modules. The prototype also allows the installation to establish a basic priority listing based on locally determined commander's inputs. This prioritization algorithm allows the commander to establish funding alternatives based on how well the FCG support his/her overall priorities for the installation.

The IDSM prototype serves as a good starting point for further development effort in the area of installation management tools. With expansion and continued coordination with the system users, i.e., installation commanders and their staffs, the IDSM will develop into a valuable tool for installation commanders in the area of installation management.

References

- [1] Trainor, T., Decision Support for Installations of the United States Army: The Installation Status Report Part I - Infrastructure, United States Military Academy, ORCEN Technical Report, June 1995.
- [2] Plummer, R. and J. Kays, Installation Status Report Part II - Environment, United States Military Academy, ORCEN Technical Report, January 1996.
- [3] Trainor, T., Installation Status Report Part I - Infrastructure Field Test After Action Report, United States Military Academy, ORCEN Report, November 1993.
- [4] Graham, L., Ft. Bragg ISR POC, August 1995.

Appendix A: Needs Analysis briefing to installation staffs

This briefing was given to representatives from all the major staff elements at the following installations: Ft. Bragg, Ft. Benning, Ft. Detrick, Aberdeen Proving Ground, Ft. Benning, Fort Belvoir, Ft. Hood and Ft. Riley.

Assistant Secretary of the Army (Financial Management)
Assistant Chief of Staff for Installation Management
&
Operations Research Center
United States Military Academy

**Installation Decision Support Model
(IDSM)**

Installation Visits Briefing
October 1995

Agenda

- Review of ISR
 - ISR Concept
 - Overview of Part I
 - ISR Report Flow
- Installation Decision Support Model (IDSM)
 - Model Concept
 - IDSM Schematic
 - Timelines
- Potential IDSM Capabilities
 - Installation Overview Map
 - Comparison Charts
 - What If Analysis
- Discussion Questions

USMA Operations Research Center

IDS2

ISR Concept

What is the ISR?

- "A decision support system to improve management of limited resources for installations."
- Designed --
 - Similar to Unit Status Report (USR)
 - A Commander's tool
 - As an Integrator of "Stovepipe" Reports
 - To be user friendly
- Three Parts
 - Infrastructure
 - Environmental
 - Services
- Identifies problems and resource needs
- Serves needs of different customers --
 - Installation Commander
 - MACOMs
 - HQDA
- Does not contain --
 - Engineering language
 - Detailed information

USMA Operations Research Center

DSM 3

Part I - Infrastructure

GOAL: Achieve Installation Renewal (IR)/ Facilities Revitalization through improved justification and prioritization of limited Army resources.

Project Objectives

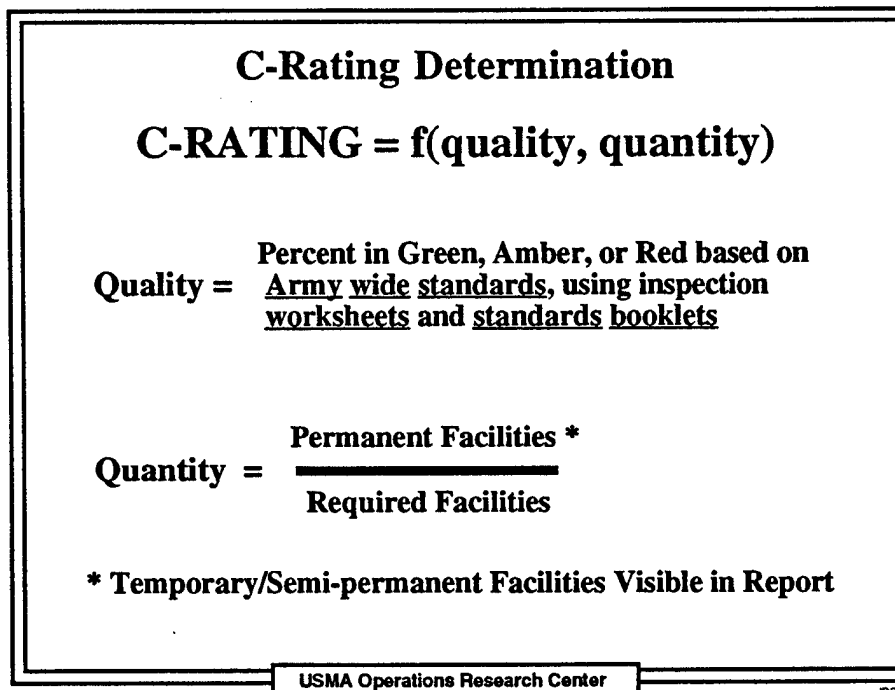
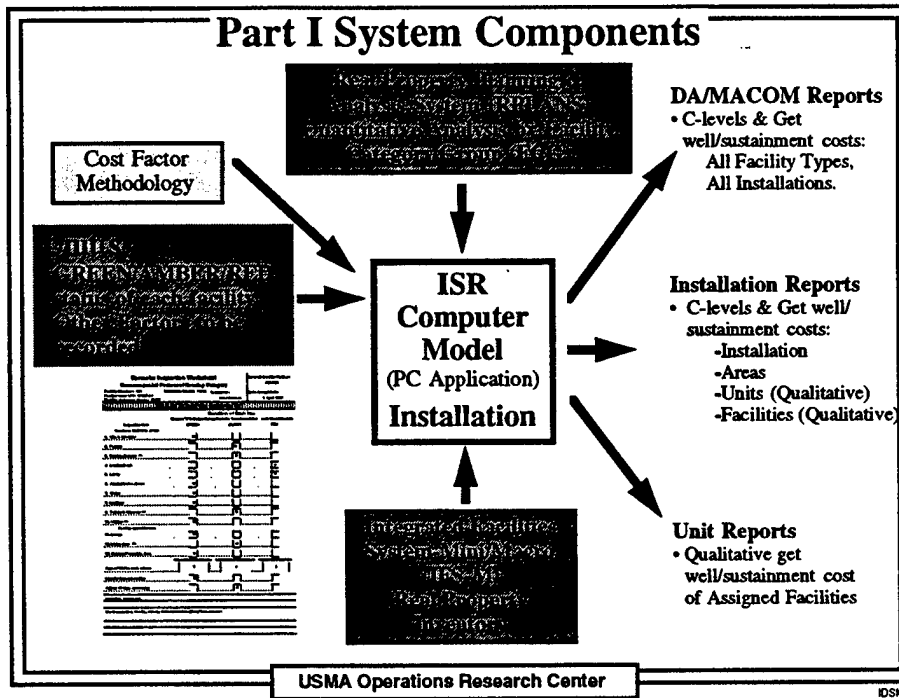
To develop a Commander's decision support system that:

- assesses installation *conditions*
- uses established Army-wide *standards*
- articulates *installation* and *Army needs*
- estimates IR resource *requirements*
- assists in *prioritizing* programs, projects
- assists in *allocation* of resources
- measures *progress*

USMA Operations Research Center

DSM 4

Appendix A (continued)



Part I - Infrastructure ISR

INSTALLATION STATUS REPORT			
PART ONE - INFRASTRUCTURE			
Installation: Fort Harenc	As Of Date: 1 April 03	C-2	
Mission Facilities			
Training Ranges & Areas	C-3	C-2	
Maintenance & Production Facilities	C-2		
Classrooms	C-1		
Research & Development	C-2		
Supply & Storage Facilities	C-2		
Conventional Ammunition Facilities	C-2		
Administrative Facilities	C-1		
Warehouses Management	C-2		
Storage Stability Facilities			
Road & Trail Network	C-2		C-2
Railroad	C-3		
Airfield	C-1		
Ports	C-3		
Housing			
Family Housing	C-3	C-2	
Unaccompanied Personnel Housing	C-1		
Dining Facilities	C-1		
Community Facilities			
Post Exchange	C-1	C-1	
Commissary	C-1		
Hospital & Medical Facilities	C-1		
Child Development Centers	C-1		
Community Support	C-2		
Utility Systems			
Heat/AC	C-1	C-1	
Electro/Gas	C-1		
Water	C-2		
Power	C-1		
Army Reserve Facilities		NR	
National Guard Facilities		NR	
Installation Commander's Signature: John Henry, MG, USA			

USMA Operations Research Center

IDSM 7

Cost Factors Overview

- **New Construction Cost Factors:**
 ~ estimates costs to improve FCG quantity
 C-ratings to C-1.

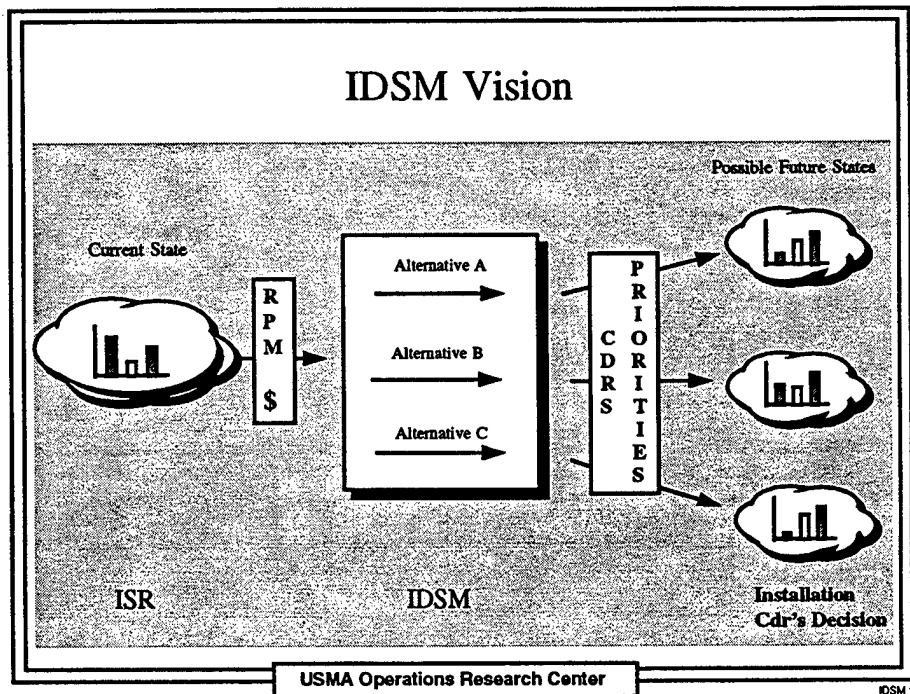
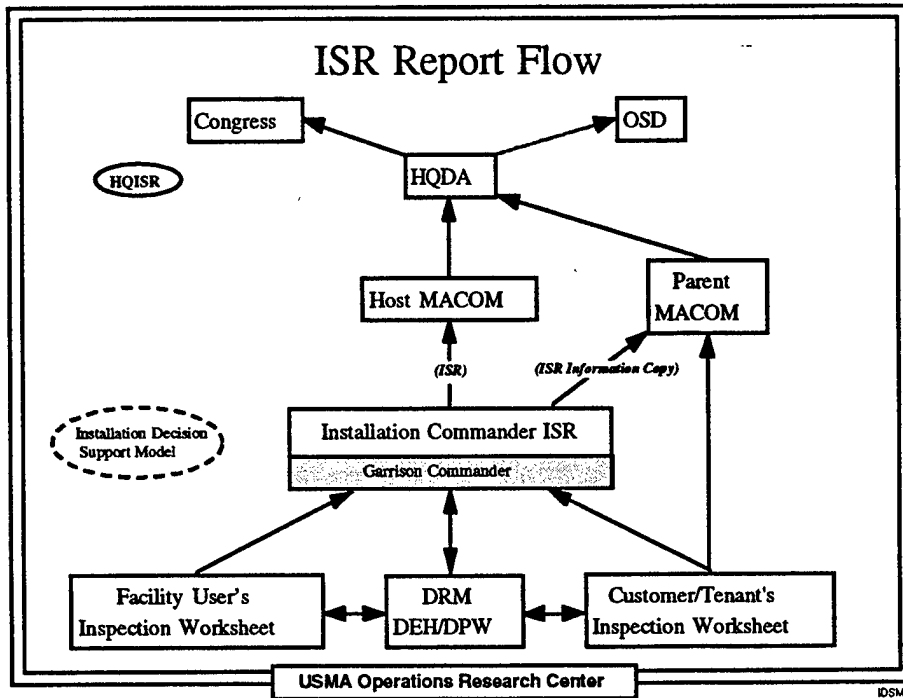
- **Renovation Cost Factors:**
 ~ estimates costs at the FCG level to upgrade
 AMBER & RED facilities to GREEN.

- **Sustainment Cost Factors:**
 ~ estimates annual costs at the FCG level
 to maintain facilities (both permanent
 and non-perm) at the current Quality C-rating.

USMA Operations Research Center

IDSM 8

Appendix A (continued)



Installation Decision Support Model (IDSM) Concept

Purpose: To give the installation commander a tool to help make sound business decisions dealing with the allocation of Repair and Maintenance funds.

Capabilities:

- Enable installation staff to construct various infrastructure investment alternatives
- Conduct What If Analysis to evaluate the future effects of the different alternatives
- View and analyze ISR and other existing data
- Measure progress toward infrastructure goals

USMA Operations Research Center

IDSM 11

Installation Decision Support Model (IDSM) Concept

Characteristics

- user friendly
- cost effective
- driven by commander's priorities
- links investment strategies with installation readiness

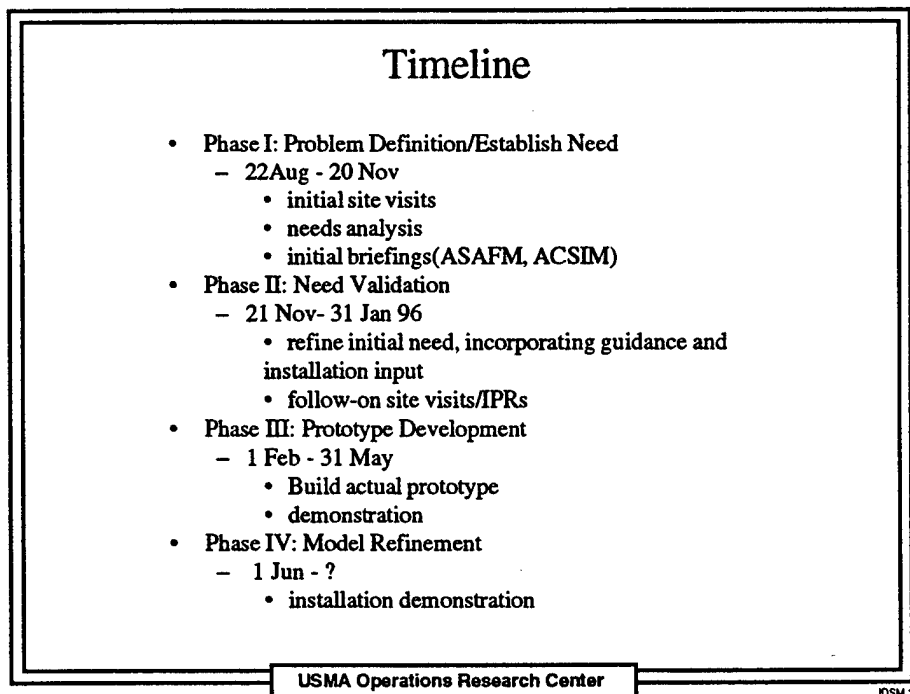
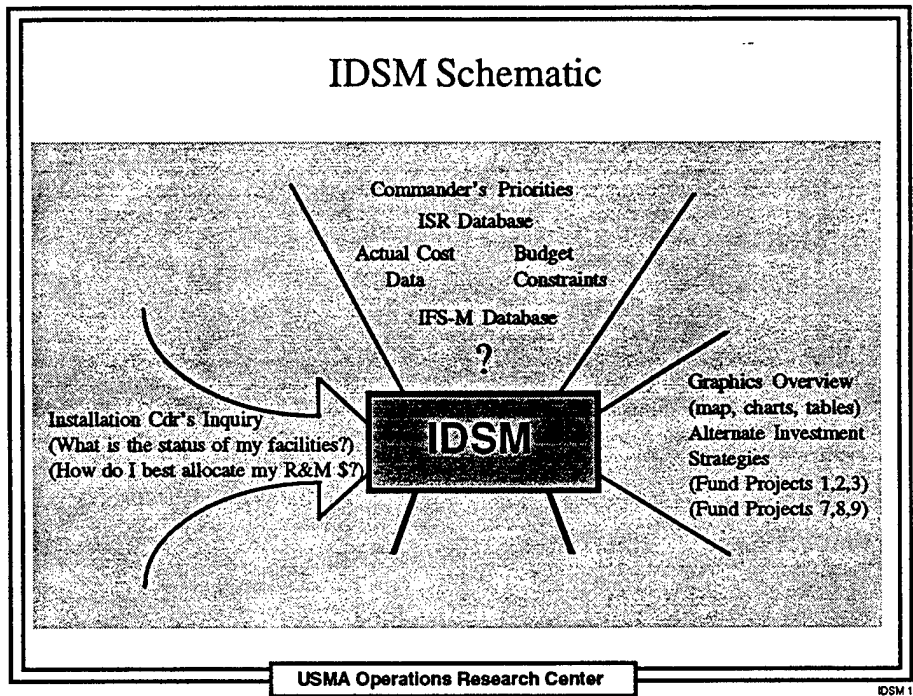
Benefits

- Provides commander a quick overview of infrastructure status
- Assists commander in evaluating the impacts of various infrastructure investment strategies
- Gives commander the ability to articulate the installation's funding requirements to the MACOM

USMA Operations Research Center

IDSM 12

Appendix A (continued)



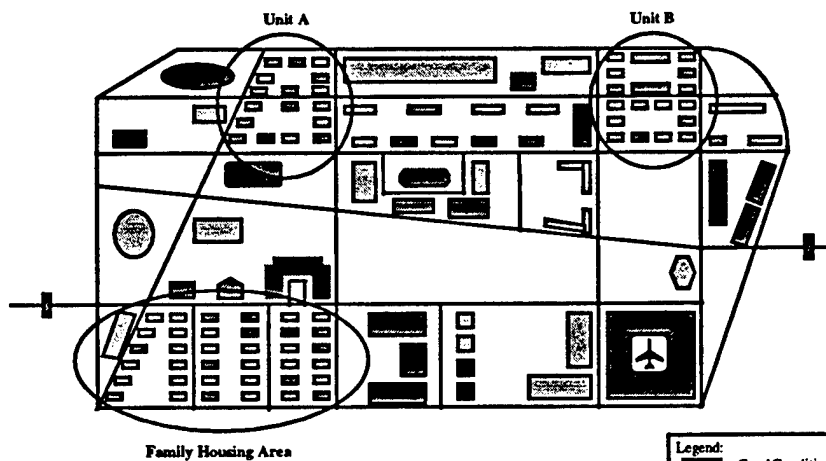
Potential IDSM Capabilities

- Installation Overview Map with condition ratings
- Comparison Charts
- What If Analysis

USMA Operations Research Center

IDSM 15

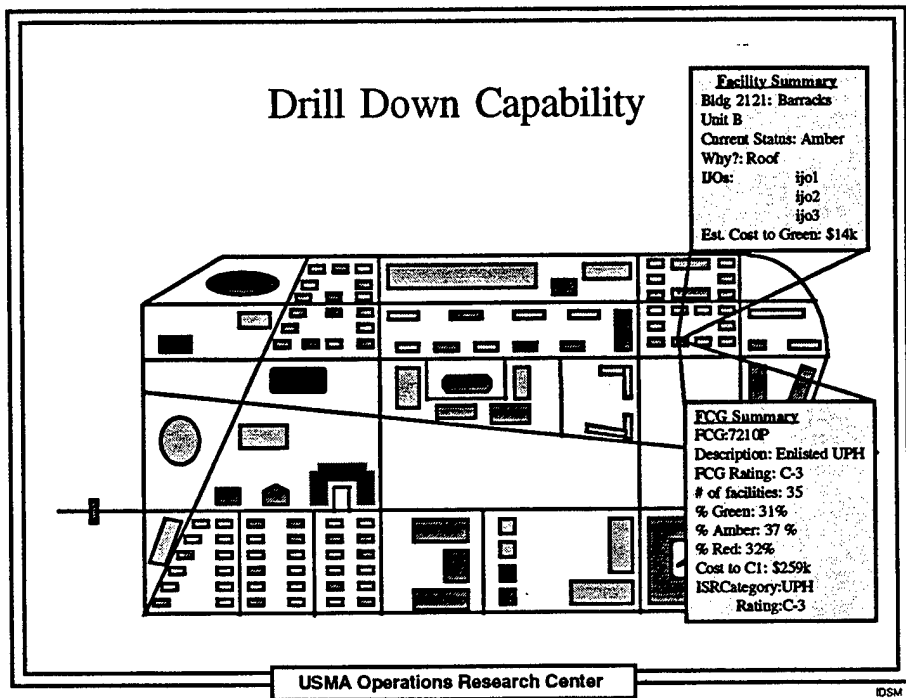
Installation Overview Map



USMA Operations Research Center

IDSM 16

Appendix A (continued)



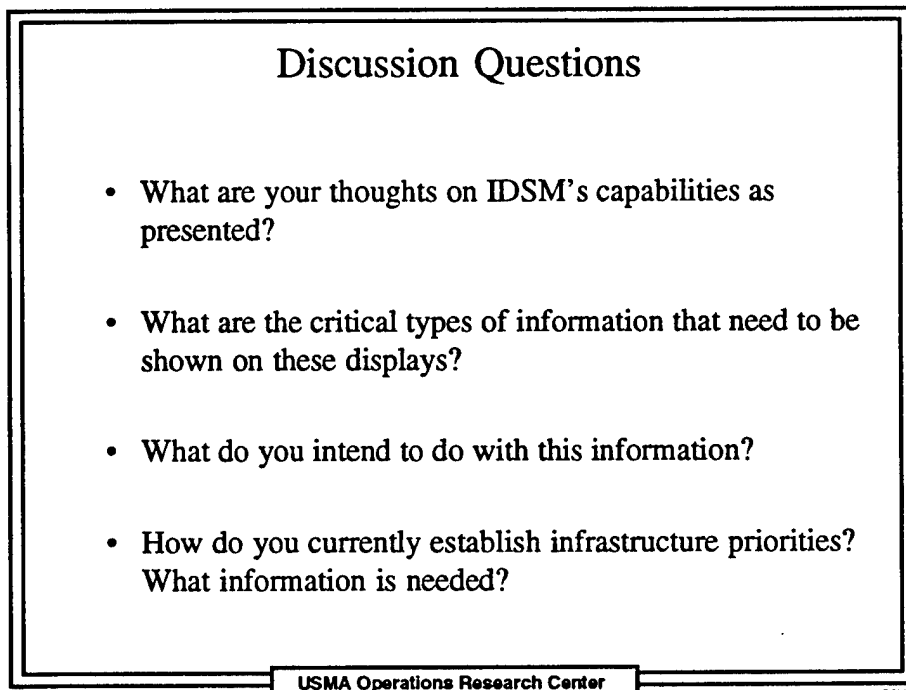
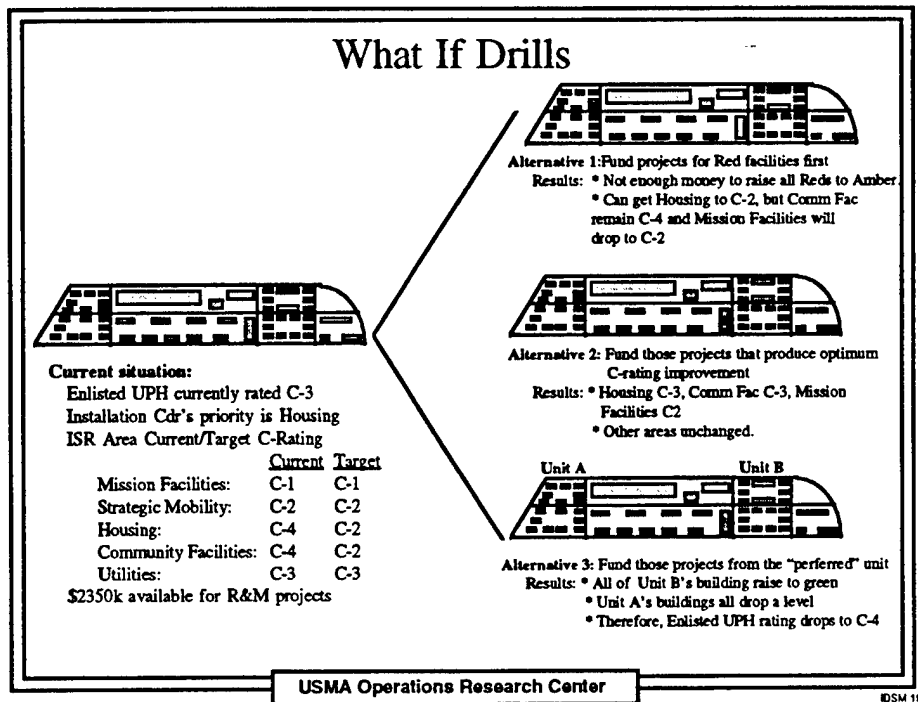
Comparison Charts (Installation Rollup)

	Mission Facilities	Strategic Mobility	Housing	Community Facilities	Utility Systems
Unit A	█	NA	█	NA	NA
Unit B	█	NA	█	NA	NA
Unit C	█ C3	NA	█	NA	NA
Other Units	█	NA	█ C3	█	NA
DPW	█	█ C2	█	█	█ C3
DPT	█ C2	█	NA	NA	NA
DOL	█	█ C2	NA	█	NA
DCA	█	NA	NA	█ C3	NA
Other Directorates	█	█ C2	NA	█ C3	NA

USMA Operations Research Center

DSM 16

Appendix A (continued)



Discussion Questions(cont)

- What essential elements of information are necessary for funding decisions?
- What features should IDSM have to interface with current and projected automation systems? What systems need interface?
- What format should be used to display alternatives for allocating funds? What are some of the “what if” scenarios you can anticipate?
- What graphical displays are desired?

USMA Operations Research Center

DSM 21

Appendix B: Related Computer Automation Management Systems

The following section describes some of the existing and planned computer automation systems that could interface with the IDSM.

Integrated Facilities System, Mini/Micro (IFS-M)

IFS-M is the central automated system supporting the DPW's RPMA and AFH missions. Its main strengths are interactive processing, its query capability, and its report flexibility. IFS-M provides information on all aspects of DPW activities and is the single-source database for facility-related and budget-supportive information that assists managers at all levels of Army command. The IFS-M package presently supports real property accounting, DPW customer coordination (work reception), job cost accounting, work estimating, supply management, property book and contract administration. DPW activities have real time access to IFS-M through a network, so they no longer need to coordinate data requests with the DPW's Management Engineering Systems activity.

Proponent: Directorate of Facilities Management, Center for Public Works (CPW)

Headquarters Level Integrated Facilities System (HQIFS)

HQIFS has two modules that use data collected from IFS-M, and other sources to meet facilities data reporting and analysis needs at the MACOM and HQDA levels and above. The two modules are Inventory and Resource Planning (Assets), and the Technical Data Reporting System. HQIFS also serves as the source for data that support other Army and DoD information needs including HQRPLANS.

Proponent: Directorate of Facilities Management, Center for Public Works (CPW)

Real Property Planning and Analysis System (RPLANS)

RPLANS is an installation level, integrated, automated master planning tool that allows planners and programmers to efficiently calculate peacetime facility space allowances and to compare them to available real property assets for a wide range of facility types. The RPLANS is a multi-level system and is a dependent module of IFS-M. The system uses installation specific data from CAPCES and the Army Stationing and Installation Plan (ASIP). The installation assets data are extracted from HQIFS. This system is a vital tool for "what if" analysis of force structure and stationing decisions. The installation DPW uses a micro computer-based system that periodically exchanges data with a central data base on the central computer.

Major installation planning functions supported by RPLANS include preparation of the tabulation of Existing and Required Facilities (TAB), construction program development, facility requirements, stationing analysis, base realignment and closure analysis, MCA program validation, RPMA Analysis, facilities revitalization forecasting, review of assets and allowances, and facilities utilization analysis.

Proponent: DAIM-FDP-P / CECPW-FM, Center for Public Works (CPW)

Appendix B (continued)

Headquarters Real Property Planning and Analysis System (HQRPLANS)

HQRPLANS is an automated system to analyze, program, and plan for the future size and stationing of U.S. Army Forces. It provides MACOMs and the HQDA with an automated master planning and programming tool and it helps them perform a number of analytical functions, e.g., stationing analysis, base realignment and closure analysis, MCA program validation, RPMA Analysis, facilities revitalization forecasting, review of assets and allowances, and facilities utilization analysis. Data are extracted from CAPCES, ASIP, and HQIFS.

Proponent: DAIM-FDP-P / CECPW-FM, Center for Public Works (CPW)

Real Property Management Tool (RMAT)

RMAT is a decision support system that will provide installation decision makers a tool to better evaluate alternative for the management of real property and the investment of limited resources. It integrates real property and environmental data to provide analyses of installation carrying capacity and development of investment strategies. RMAT is still in its initial fielding stages and has only been fielded at a limited number of installations.

RMAT will establish standards for installation map overlays and data definitions for real property management. It will provide installation users dynamic query capability of real property and environmental data through the use of Geographic Information Systems (GIS) technology.

Part of RMAT is the fielding of equipment necessary to run GIS. This fielding is done in conjunction with the Sustaining Base Information Services (SBIS) Program. The SBIS Program is a ten year contract to develop and deploy standardized software applications which perform the business functions at the installation or garrison level.

RMAT's major benefits are seen as:

- Site analyses can be done quickly and include environmental searches to improve and shorten the planning process.
- Utilization studies will be accomplished more quickly and efficiently enabling more responsive and accurate determinations.
- Elimination of redundant databases, systems, and files which generate excessive cost and provide conflicting information.

Proponents: Greg Brewer, ACSIM and Leo Oswalt, CPW

Appendix B (continued)

Headquarters and MACOM level Executive Information System (HQ-MACOM EIS)

This system provides a user friendly method to access current facility information from IFS-M and other existing databases. HQ-MACOM EIS allows users easy access to data without knowledge of Structured Query Language (SQL) or other specialized computer skills. HQ-MACOM EIS displays management information related to the Real Property Inventory (RPI) and real Property Maintenance Activity (RPMA) costs in graphical and tabular reports by Fiscal Year (FY) and quarter. Real Property data is updated quarterly and cost data is updated annually. HQ-MACOM EIS is a multidimensional database. Summarized data at the Headquarters, Department of the Army (HQDA) level can be displayed at the underlying levels for further analysis (e.g. MACOM, Base Code, Primary Installation, Subordinate Installation). The system can display, organize, and analyze data that a manager would otherwise be required to collect separately from other systems and manually integrate into additional presentation software. This provides users with a single source for facility data. The system can be used for planning, decision making, problem solving, and preparing briefings and reports.

Proponent: Linda Smith, Center for Public Works (CPW)

Headquarters Installation Status Report (HQISR)

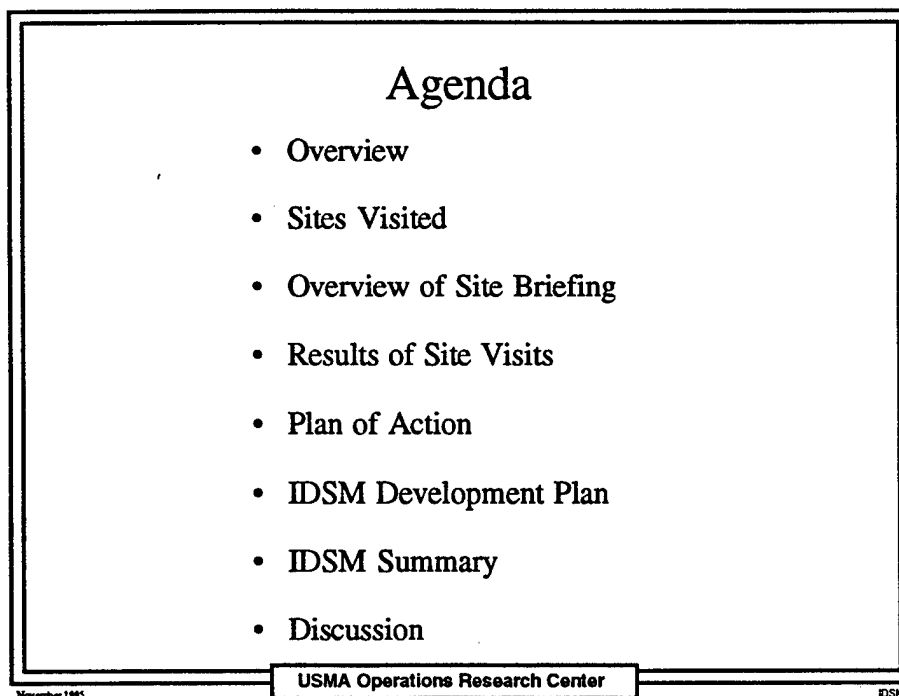
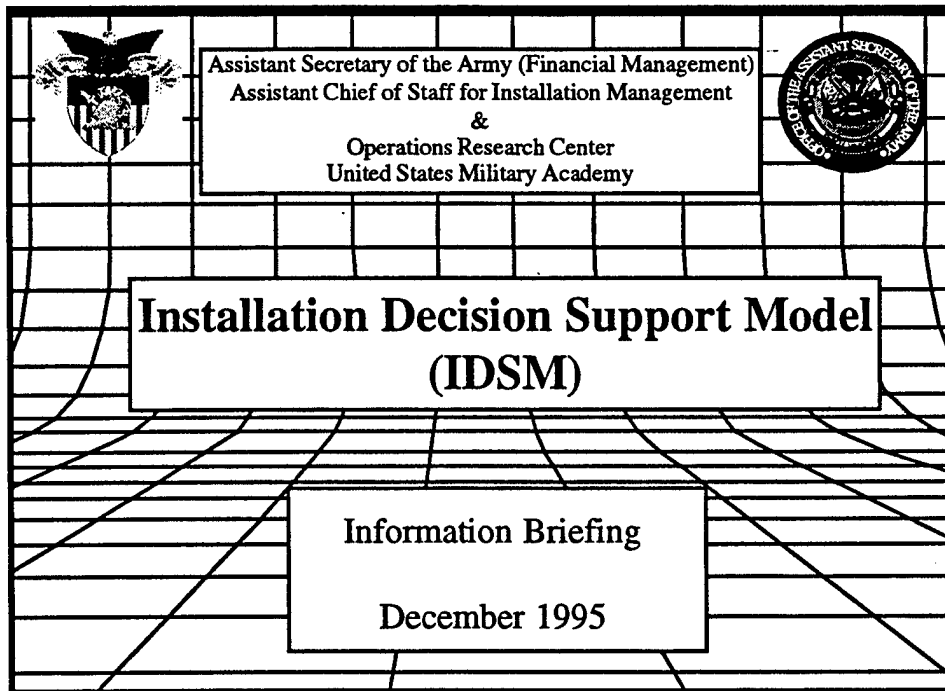
HQISR is the software package that was developed to assist MACOMs and DA view and analyze installation level ISR data. It has built in viewing and query abilities. HQISR is a windows based, user-friendly package that has been used effectively at the DA level to articulate Army requirements to Congress.

Condition Assessment Survey (CAS)

CAS was a program funded by DoD to do a "fence to fence" inspection of selected installations. These inspections were very detailed and thorough. The aim was to produce an accurate listing of all the repair and maintenance projects on the given installation. This listing could then be prioritized to develop a long term plan for how to improve the installation's readiness. The draw back of CAS was that it was very labor intensive and expensive. As a result of this expense, the CAS program has been terminated.

Appendix C: Initial Project Briefing for MG Howard and MG Miller

This briefing was given to MG Howard, ASA-FM, on 14 Nov 95 and MG Miller, ACSIM, on 8 Dec 95. Both individuals strongly supported the model development after the briefing.



Overview

- Initial direction was to build infrastructure investment alternatives based on commander's priorities.
- Recent site visits identified more timely need to enhance installation use of ISR output.
- Adjusted IDSM focus responds to installation requests.
- IDSM:
 - enhances the use of ISR output at installation level.
 - responds to requests from the field.
 - is being developed in coordination with ACSIM, in concert with other ISR enhancements.

USMA Operations Research Center

November 1995

IDSM 3

Sites Visited

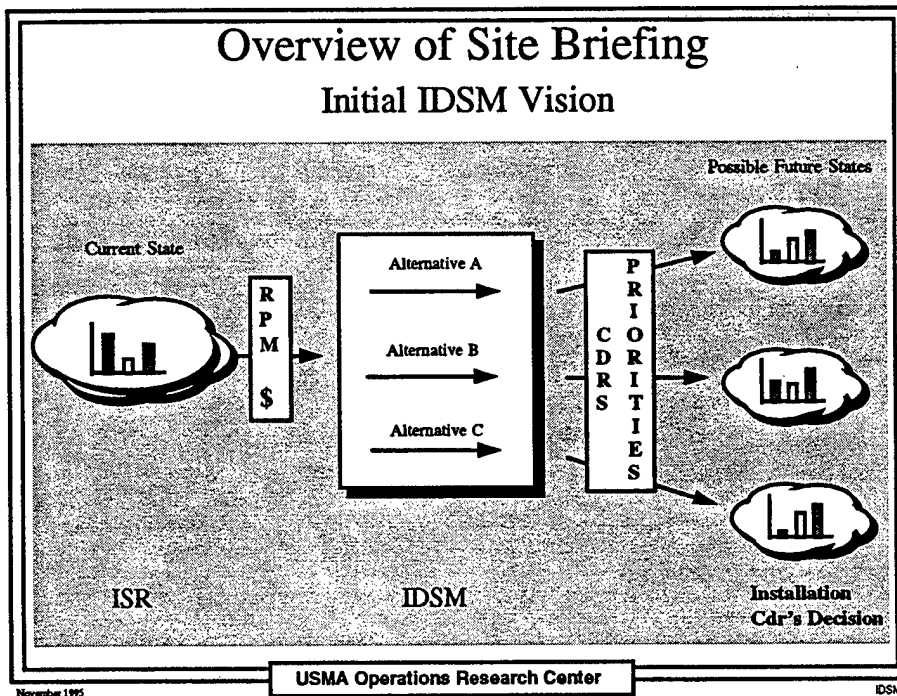
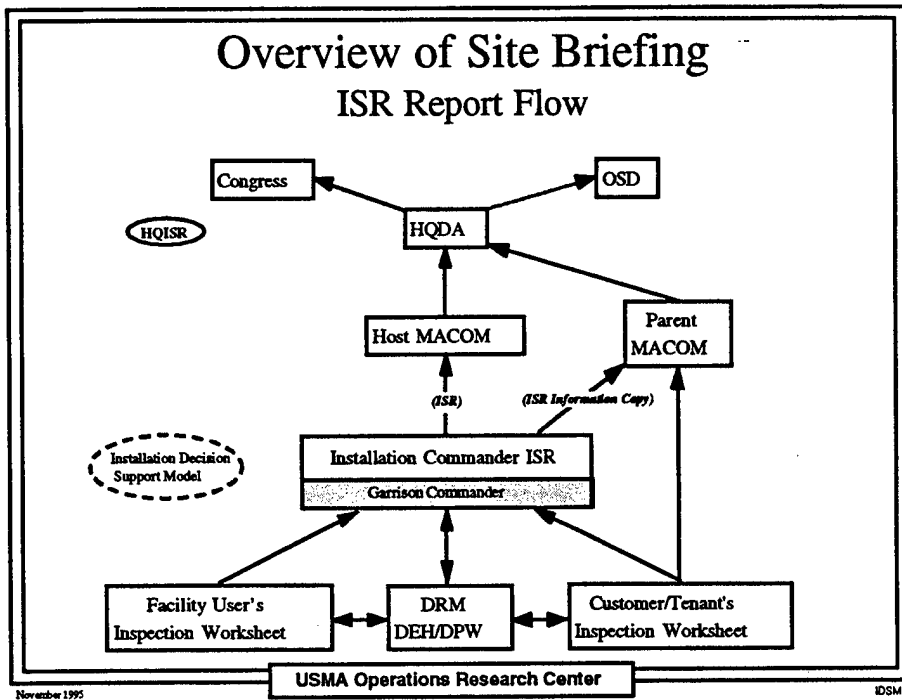
- Ft. Hood
- Ft. Riley
- Ft. Benning
- Redstone Arsenal
- Ft. Bragg
- Ft. Belvoir
- Ft. Detrick
- Aberdeen Proving Ground

USMA Operations Research Center

November 1995

IDSM 4

Appendix C (continued)



Appendix C (continued)

Results of Site Visits

(What the installations said they wanted)

- No additional workload
- Return on investment from the ISR
- Improve the utility of ISR data
 - track trends
 - An "honest broker" tool, discourages "pet rocks"
 - More micro view of problems
- Usable common language to describe needs to MACOM

Bottom Line -- ISR is difficult to use at the installation level.

USMA Operations Research Center

November 1995 DSM 7

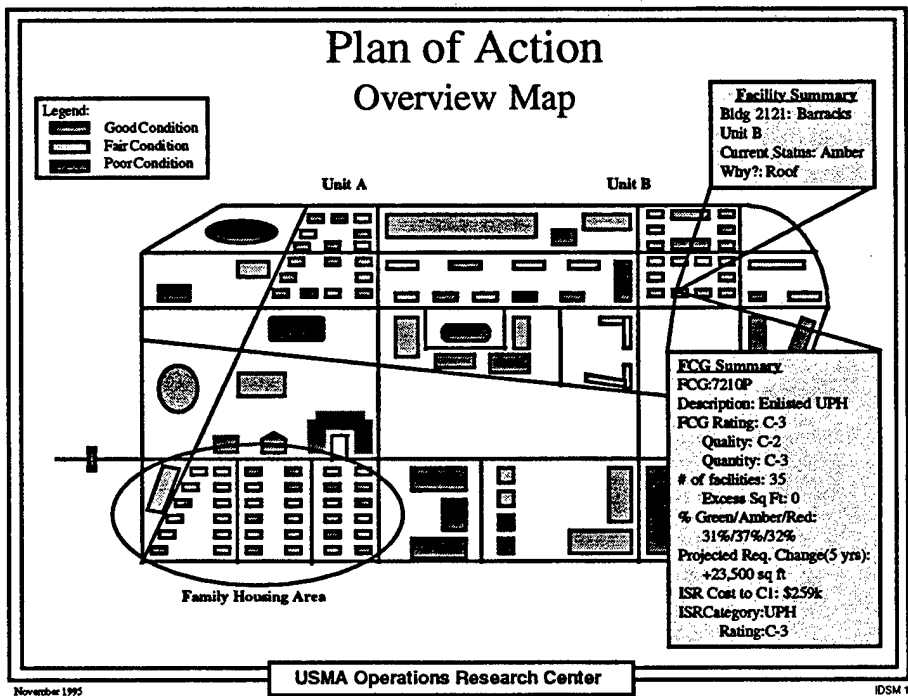
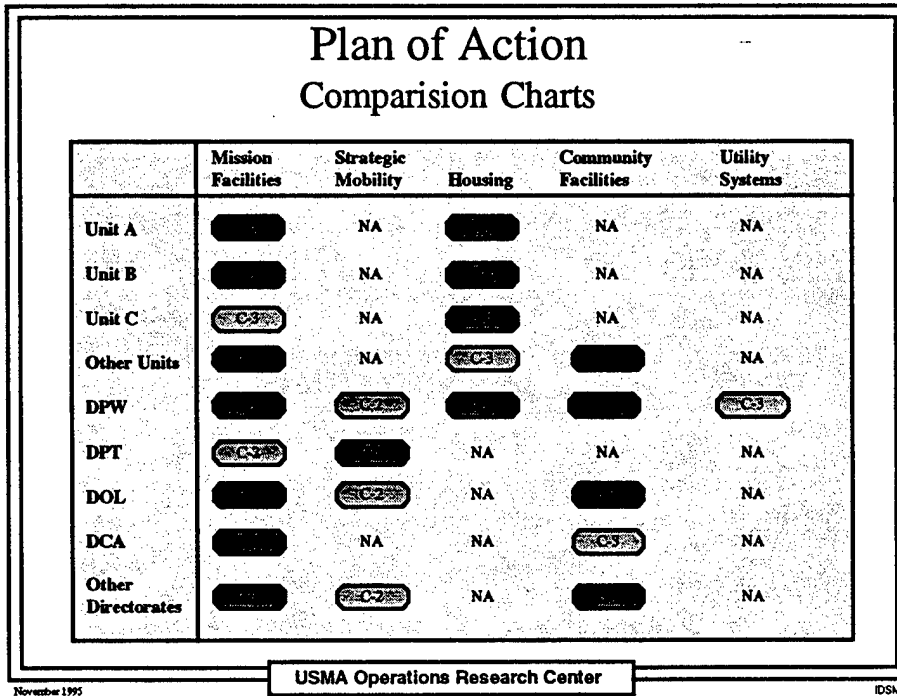
Plan of Action

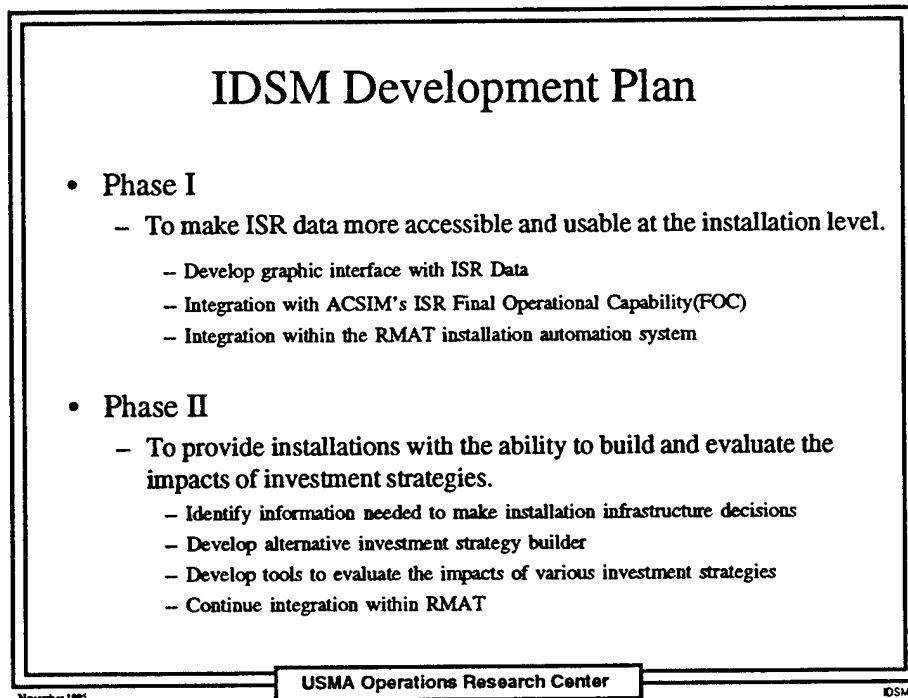
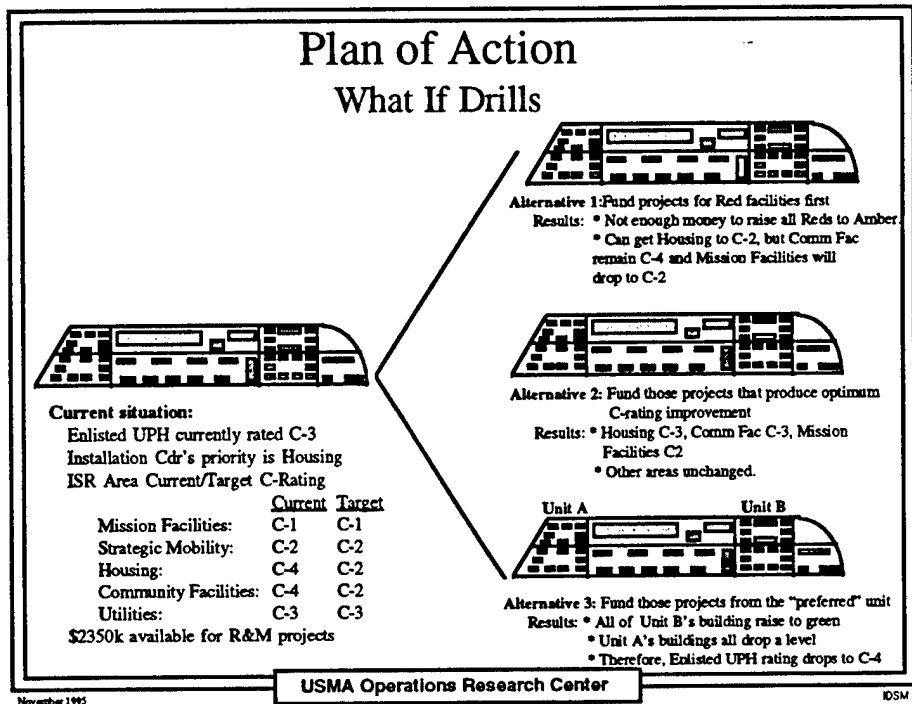
<u>Installation Needs</u>	<u>Action</u>	<u>Responsibility</u>
Workload	← ISR FOC Marksense Forms	ACSIM
Return on Investment	← ISR DB interface (Comparison Charts)	ORCEN
Utility	← Overview Map (GIS)	ORCEN/ ACSIM
Common Language	← "What-If" Analysis	ORCEN

USMA Operations Research Center

November 1995 DSM 8

Appendix C (continued)





IDS M Summary

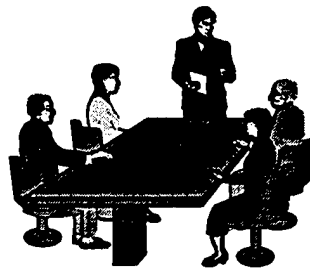
- Timely, responsive, promotes ISR utility
- Inexpensive, avoids additional workloads
- Improve situational awareness of installation commanders
- Interfaces with current, future systems
- Addresses current installation needs
- Doesn't duplicate existing or planned systems
- Partnered with ACSIM initiatives

USMA Operations Research Center

November 1995

IDS M 13

Discussion



USMA Operations Research Center

November 1995

IDS M 14

Appendix D: ISR C-Rating Calculation

The following is an extract from *Installation Status Report - Part I, Infrastructure FY96 Implementation Instructions* that describes how ISR calculates Quality C-Ratings.

Detailed Quality C-Rating Explanation

A Quality C-Rating is automatically calculated for each Facility Category Group (FCG) which comprises a Sub-Category. The example presented in this Appendix is for the Barracks SubCategory. The FCGs which comprise this Sub-Category are: Enlisted Unaccompanied Personnel Housing (UPH) and Enlisted Barracks, Trainee. The unit of measure for both of these FCGs is the number of sleeping spaces (Persons) in the facility.

The color condition of each permanent/semi-permanent facility on an installation has to be entered into the ISR software. The ISR software will then determine the amount of the FCG which is GREEN, AMBER, and RED. The following example demonstrates the calculation.

The facility number and the facility color condition rating have been collected for the Enlisted UPH FCG (F7210P) and listed in the table below. These data are entered into the ISR software. The ISR software then links the condition information with a database which contains the size (capacity) of each facility.

Facility Number (Contained in the ISR Software)	Color Rating (Entered into the ISR Software)	Facility Capacity (Contained in the ISR Software)
2402	AMBER	24 SPACES
2403	GREEN	24 SPACES
2404	AMBER	24 SPACES
2409	AMBER	24 SPACES
2410	AMBER	145 SPACES
2411	AMBER	145 SPACES
2414	GREEN	145 SPACES
2415	AMBER	110 SPACES
2416	RED	110 SPACES

The ISR software will then determine the amount of Enlisted UPH which is GREEN, AMBER, and RED. The software does the following calculations:

Amount of Enlisted UPH GREEN 24 spaces + 145 spaces = 169 spaces.

Amount of Enlisted UPH AMBER 24 spaces + 24 spaces + 24 spaces + 145 spaces +
145 spaces + 110 spaces = 472 spaces.

Appendix D (continued)

Amount of Enlisted UPH RED = 110 spaces.

Total Enlisted UPH spaces = 169 spaces + 472 spaces + 110 spaces = 751 spaces.

Percent of Enlisted UPH GREEN 169 spaces/751 spaces x 100 = 23%.

Percent of Enlisted UPH AMBER 472 spaces/751 spaces x 100 = 63%.

Percent of Enlisted UPH RED = 110 spaces/751 spaces x 100 = 14%.

Table C-1 below provides the Quality C-Rating cut-off values.

Table C-1 Quality Algorithm Cut-Off Values	
Condition:	Percent of facilities GREEN ≥ 90%
Rating:	C-1
Condition:	Percent of facilities GREEN & AMBER ≥ 90%
Rating-	C-2
Condition:	Percent of facilities GREEN & AMBER ≥ 50%
Rating:	C-3
Condition:	Percent of facilities RED ≥ 50
Rating:	C-4

From the example: Percent of facilities GREEN = 23%
 Percent of facilities AMBER = 63%
 Percent of facilities RED = 14%

The ISR software calculates the following:

$$\text{Percent of facilities GREEN} = \text{AMBER} = 23\% + 63\% = 86\%$$

By using Table C-1, the ISR software determines the Quality C-Rating for Enlisted UPH is C-3. The software computes Quality C-Ratings for all FCGs that comprise a Sub-Category. The table below shows the Quality C-Ratings for all FCGs which comprise the Barracks Sub-Category.

<u>Facility Category Group</u>	<u>Quality C-Rating</u>
Enlisted UPH	C-4
Enlisted Barracks, Trainee	C-4

Appendix D (continued)

The Quality C-Rating of the Sub-Category is a weighted average of the Quality C-Ratings of all FCGs that comprise the Sub-Category. Each FCG is first weighted by the relative value of the onhand permanent/semi-permanent assets (cost to construct these assets).

Relative Value of On-Hand Assets for the FCG

Relative Value of On-Hand Assets for the Sub-Category = Weight for FCG

The weight for each FCG in this example is determined as follows.

Enlisted UPH Relative Value/Barracks Relative Value = $\$36M/\$50M = 0.72$

Enlisted Barracks, Trainee Relative Value/Barracks Relative Value = $\$14M/\$50M = 0.28$

The calculations below show how the average Quality C-Rating is determined.

FCGs C-1:	0
FCGs C-2:	0
FCGs C-3:	1 (Enlisted UPH)
FCGs C-4:	1 (Enlisted Barracks, Trainee)

Determine the Quality C-Rating for the Sub-Category in this example.

Each C-1 FCG x Weight x 1	$= 0 \times 1 = 0$
Each C-2 FCG x Weight x 2	$= 0 \times 2 = 0$
Each C-3 FCG x Weight x 3	$= 0.72 \times 3 = 2.16$
Each C-4 FCG x Weight x 4	$= 0.28 \times 4 = 1.12$

Weighted average Sub-Category Quality C-Rating = $2.16 + 1.12 = 3.28$

The following table summarizes the rounding rules for C-Rating roll-ups above the FCG level.

C-1	if the average C-rating calculated is less than 1.5
C-2	if the average C-rating calculated is less than 2.5
C-3	if the average C-rating calculated is less than 3.5
C-4	if the average C-rating calculated is 3.5 or greater

The Quality C-Rating for the Barracks Sub-Category in this example is then C-3.

The Quality C-Rating for any Category is the simple average of the Quality C-Ratings of each of its component Sub-Categories.

The Quality C-Rating for any Area is the simple average of the Quality C-Ratings of each of its component Categories.

Appendix E: GIS Tables

The following is a listing of all the tables in Ft. Bragg's GIS database. They show the variety of information that can be consolidated and displayed graphically using GIS.

Table Name
afd_airfield_surf
als_cable
als_cable_pairs
als_capacitor
als_duct
als_ductbank
als_generator
als_handhole
als_light
als_manhole
als_meter
als_pole
als_switch
als_transformer
asf_aircraft_ops
asf_flight_track
asf_noise_zone
asf_safety
bio_fish_habitat
bio_fish_samp_site
bio_wild_habitat
bio_wild_samp_comp
bio_wild_samp_site
bot_forest_stand
bot_planting
bot_shrub
bot_tree
bot_vege_samp_comp
bot_vege_sample
bot_vegetation
com_cable
com_cable_pairs
com_central_office
com_device
com_duct
com_ductbank
com_handhole
com_manhole
com_pole
ctv_cable
ctv_cable_pairs
ctv_device
ctv_pole
curve_display
curve_index
dbrelations
deviation_index

Appendix E (continued)

drawings
Table Name
ele_cable_pairs
ele_capacitor
ele_device
ele_duct
ele_ductbank
ele_generator
ele_handhole
ele_junction_box
ele_manhole
ele_meter
ele_motor
ele_pole
ele_substation
ele_switch
ele_transformer
els_cable
els_cable_pairs
els_device
els_duct
els_ductbank
els_handhole
els_light
els_manhole
els_meter
els_pole
els_switch
els_transformer
env_air_poll_srce
env_permit
env_pollut_contam
env_pollut_extent
env_pollut_release
env_pollut_source
fault
fault_pen
feature
fluid
fluid_pen
ful_hydrant
ful_manhole
ful_meter
ful_pipe
ful_pipe_invert
ful_plug
ful_pump_station
ful_reducer
ful_regulator
ful_separator
ful_tank

Appendix E (continued)

ful_valve
ful_valve_pit
Table Name
gas_hydrant
gas_manhole
gas_meter
gas_pipe
gas_pipe_invert
gas_plug
gas_pump_station
gas_reducer
gas_regulator
gas_separator
gas_tank
gas_valve
gas_valve_pit
geo_borehole
geo_mine
geo_soil
hcs_air_cond
hcs_chill_plant
hcs_furnace
hcs_heat_plant
hcs_manhole
hcs_meter
hcs_pipe
hcs_pipe_invert
hcs_plug
hcs_pump
hcs_reducer
hcs_regulator
hcs_tank
hcs_valve
hcs_valve_pit
hyd_flood_zone
hyd_surface_hydro
hyd_watershed
icc_cable
icc_device
int_features
int_hazard_sample
int_mineral_sample
int_room
iws_cleanout
iws_grit_chamber
iws_manhole
iws_pipe
iws_pipe_invert
iws_plug
iws_pump_station
iws_separator

Appendix E (continued)

iws_valve
lithology
lnd_land
Table Name
log_curve
lsc_planting
lsc_shrub
lsc_tree
lsc_vegetation
maps
nat_wetland
petro_params
pole
prj_project
prj_study_area
rsf_aircraft_ops
rsf_flight_track
rsf_range
rsf_safety
rsf_target
saf_safety
san_cleanout
san_grit_chamber
san_manhole
san_pipe
san_pipe_invert
san_plug
san_pump_station
san_separator
san_septic_tank
san_treatment_plnt
san_valve
san_valve_pit
sect_line
sect_vert
sto_cleanout
sto_culvert
sto_headwall
sto_inlet
sto_junction_box
sto_manhole
sto_open_channel
sto_pipe
sto_pipe_invert
sto_plug
sto_separator
sto_stilling_well
str_bldg_mgr
str_real_property
str_structure
strat_pen

Appendix E (continued)

strat_unit
sub_interval
swm_landfill
swm_landfill_feat
Table Name
top_gps_dma
top_slope
trn_bridge
trn_parking_area
trn_railroad
trn_road
ucs_cable
ucs_cable_pairs
ucs_device
ucs_pole
unconf_pen
unconformity
vendor_well_id
wat_booster_sta
wat_hydrant
wat_manhole
wat_meter
wat_pipe
wat_pipe_invert
wat_plug
wat_press_red_sta
wat_pump
wat_pump_station
wat_reducer
wat_regulator
wat_tank
wat_treatment_plnt
wat_valve
wat_valve_pit
working_int