United States Military Academy
West Point, New York 10996

Installation Efficiency Analysis

OPERATIONS RESEARCH CENTER
TECHNICAL REPORT NO. FY93/93-2

1 June 1993

The Operations Research Center is supported by the Assistant Secretary of the Army for Financial Management.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	1 JUNE 1993	TECHNICAL REPORT

4. TITLE AND SUBTITLE

INSTALLATION EFFICIENCY ANALYSIS

5. FUNDING NUMBERS

6. AUTHOR(S)

MAJ WILLIAM P. NANRY

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

USMA OPERATIONS RESEARCH CENTER
WEST POINT, NEW YORK 10996-1779

8. PERFORMING ORGANIZATION REPORT NUMBER

TECH RPT #: FY93/93-2

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A.
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

THE CURRENT INSTALLATION STRUCTURE WAS SHAPED PRIMARILY BY THE DEMANDS OF WWII AND THE KOREAN WAR. TECHNOLOGY HAS INCREASED THE LETHALITY OF MODERN WEAPONS SYSTEMS AND HAS ALTERED THE WAY WE FIGHT BATTLES. THE INFRASTRUCTURE OF INDIVIDUAL INSTALLATIONS HAS NOT EVOLVED TO SUPPORT THE NEW FORCE STRUCTURE, WEAPONS TECHNOLOGY AND TACTICS. THE ARMY MUST KEEP THE INSTALLATIONS THAT BEST CONTRIBUTE TO TRAINING, FORCE PROJECTION AND SUPPORT OF PROBABLE FUTURE CONTINGENCIES AND PRIORITIZE ITS SPENDING TO REVITALIZE THE EXISTING INFRASTRUCTURE TO ENSURE WE ATTRACT, TRAIN AND RETAIN QUALITY PEOPLE.

14. SUBJECT TERMS

INSTALLATION EFFICIENCY ANALYSIS

15. NUMBER OF PAGES
62

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	

Installation Efficiency Analysis

Major William P. Nanry

A TECHNICAL REPORT
OF THE
OPERATIONS RESEARCH CENTER
UNITED STATES MILITARY ACADEMY

Directed by
Lieutenant Colonel James E. Armstrong, Jr. Ph.D.
Director, Operations Research Center

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

1 June 1993

The Operations Research Center is supported by the Assistant Secretary of the Army for Financial Management.

Vita

Major William P. Nanry was born in Patchogue, New York in 1957. In 1979, he received his B.S. from the United States Military Academy at West Point in Applied Sciences and Engineering and was commissioned a Second Lieutenant in the U.S. Army Corps of Engineers. He served eight years in a variety of engineering assignments before attending graduate school at the University of Texas at Austin. He received an M.A. in Mathematics in preparation for teaching undergraduate mathematics in the Department of Mathematical Sciences, USMA. After teaching courses in Calculus, Differential Equations and Discrete Dynamical Systems and being the Course Director for Numerical Analysis, Numerical Solutions to Ordinary Differential Equations and the Capstone Research Program in Applied Mathematics, he was selected to serve as an analyst for the Operations Research Center, USMA.

Acknowledgments

This project is sponsored by Ms. Sharon Weinhold from the Office of the Assistant Secretary of the Army for Financial Management.

Colonel Frank Giordano, Professor and Head of the Department of Mathematical Sciences, Lieutenant Colonel David C. Arney, Professor and Deputy Head of the Department of Mathematical Sciences and Lieutenant Colonel Richard West, Permanent Associate Professor in the Department of Mathematical Sciences, gave me the opportunity to serve as an analyst this semester. They counseled me on the benefits of pursuing the opportunity to conduct research during my final semester at USMA.

Colonel James Kays, Professor and Head of the Department of Systems Engineering and Lieutenant Colonel James Armstrong, Director of the Operations Research Center, USMA, accepted me as a member of their team and provided the guidance, expertise and necessary patience in establishing the prototype for this project. They provided me with the latitude to work on my vision for the prototype and reviewed my design and directed my efforts to create a truly worthwhile prototype. A special note of appreciation goes to Dr. Donald Barr for his critique of the project and the information he provided on installation capacities.

Major Joseph Waldron, Major William Harmon, Major James Watson and Captain Steven Strukel, fellow analysts at the Operations Research Center, USMA, for their tremendous help during the inception and presentation phases of the project.

Finally, I would like to thank my wife, Dori, and my sons, Chris and Bill, for their patience, support and understanding while I worked on the project.

Table of Contents

List of Tables

List of Figures

Executive Summary

Quality facilities and services attract, motivate, and aid in recruiting, training and retaining good people. To provide the facilities and services required to meet the needs of our units, soldiers, their families and the civilian work force, we must find more *efficient* ways of managing our diminishing resources and *optimize* the use of and *revitalize* the aged infrastructure of our installations. We are in a transition period during which our management policies, practices, and systems are changing in response to new fiscal realities and a new national military strategy. This strategy relies heavily on contingency forces based in the United States. CONUS installations must be world class *power projection platforms* at which soldiers and units organize and train, are sustained, and from which they mobilize and deploy for combat.

The leadership of the Army is committed to protecting and enhancing the quality of life on its installations in order to retain these trained soldiers, to care for their families, and to provide a suitable working environment for the military force and their civilian counterparts. Numerous directives and management studies have been initiated that focus on both improving the quality and efficiency of services and the revitalizing and/or replacement the facilities. The Army realizes that it can not afford to mismanage its limited resources. An analysis and management tool is needed that will assist commanders and facilities planners with identifying and evaluating efficiencies on installations, other federal facilities or adjacent civilian communities.

This report describes the concept for a decision support system that will provide this necessary analysis and planning tool and discusses the prototype developed to rapidly demonstrate its capabilities. The second iteration of the prototype is being developed. This enhancement keeps pace with the Installation Status Report, a major information source for this decision support system.

There are four components in the prototype. The prototype provides a user-friendly and interactive direct manipulation interface that permits the user/analyst to quickly obtain the necessary information contained in the knowledge base in a usable form. The graphical interface provides menus, help windows and easy-to-use graphics that will guide the user to the information desired. These menus and graphics are *linked* to the information contained in the knowledge base tables that are transparent to the user. This knowledge base contains current, accurate information from several different data sources on installation facilities, their capacities and respective services. The analyst is able to browse through information contained solely on one installation or select several installations related by their location in a common state or region or by MACOM. The analyst can compare and contrast related information from one or several categories of the Installation Status Report. Once the analyst determines what information is desired, the next requirement to be completed for the prototype will be to provide a suitable graphical representation

Much work still needs to be completed to provide an effective decision support system. The first major area to be worked on is model bases. These model bases will be critical in manipulating the information so that the leaders of the Army can make sound recommendations. A machine interface will be required to periodically access information contained in different data sources with distinct data structures and translate the information into a compatible data structure for use with the IEA project. A search will have to be conducted to ascertain usage and cost factors to evaluate installation efficiency and potential areas for savings in overlapping functions between installations and the surrounding

communities. The last area of concern is the geographical information system. It would be beneficial to provide commanders current pictorial information about the facilities and/or ranges in cooperation with information resulting from queries. Commanders would know explicitly what the shortcomings are concerning their installations infrastructure.

The final decision support package described in this report will provide commanders a powerful, flexible and necessary analytical tool to monitor and evaluate existing programs and forecast the Army's infrastructure requirements as we progress towards the 21st century.

1. Introduction

The current installation structure was shaped primarily by the demands of W.W.II and the Korean War. Technology has increased the lethality of modern weapons systems and has altered the way we fight battles. The infrastructure of individual installations has not evolved to support the new force structure, weapons technology and tactics. The Chief of Staff of the United States Army, General Gordon R. Sullivan, along with the Secretary of the Army, the Honorable M.P.W. Stone, wrote

> We have become accustomed to the tradition of self-sufficiency. Now the realities of the times demand that we closely reexamine how best to operate and maintain our installations. In terms of changes to our national spending priorities, the increased cost of doing business, the availability of like services in nearby communities, and the ever changing expectations of our more diversified and educated Army, we must critically analyze which services we should continue to provide, which ones we should divest, which ones should be contracted or consolidated, and how to better afford and support those we retain. And yet, in changing we must not lose sight of the heritage and culture that under girds the Army family and our way of life.
>
> We are certain of two things: *Our enduring installations must be world class power projection platforms* from which we successfully project and sustain our trained and ready Total Force to support the National Military Strategy; and they must provide a top-qualify environment in which our people live, work, and train. [Sullivan and Stone, 1991]

The Army must keep the installations that best contribute to training, force projection and support of probable future contingencies and prioritize its spending to revitalize the existing infrastructure to ensure we attract, train and retain quality people.

1.1. Installation Management Goals

The Army has clearly outlined its strategy for installation management and the revitalization of its infrastructure. Six of the eight goals directly impact on the importance of creating this decision support system. Those goals are specified below:

- Reshape installations to meet power projection specifications.

- Formulate soldier and civilian employee programs to enhance Quality of Life, and improve the living and working environment for soldiers, families and civilians.

- Establish and resource an "Investment Plan" for our enduring installations to revitalize or replace installation infrastructure facilities.

- Complete installation-level business process and functional redesign to off-set impact of downsizing and continuing resource constraints, improve service, and reduce costs of running installations; incorporate modernized telecommunications network to support voice, data, and image services.

- Achieve community, interservice, and interagency partnerships for facilities and services to *improve operations*, *customer service*, and *fiscal effectiveness* and *efficiency*.

- Attain resource management flexibility for the Garrison Commander through policy, procedures, and systems changes that will enable installations to operate as business activities and maximize the effectiveness and efficiency of resources. [*Army BASOPS Primer*, pages 7-8]

1.2. Installation Efficiency Analysis Objectives

Several objectives has been directed for the design and implementation of the decision support system. Those objectives are

- To capture, manipulate and display ISR data and other data related to installation management.

- To find or identify potential efficiencies (cost savings) across and with Army installations.

- To monitor the success of installation policies and programs.

- To compare the cost-effectiveness of installations across and within functional areas.

- To facilitate exploration and discovery of costs and benefits of Army installations.

- To portray the capabilities and limitations of Army installations in terms of:

  - power projection issues and

  - quality of life issues.

- identify shortcomings in facilities utilization and determine the respective capacities of facilities. This would assist in optimizing the use of facilities. Plus, it would help determine excess capacity which the Army/installation could use to generate additional money.

- analyze overlapping functions to determine if functions can be realigned without sacrificing support to the soldier and the mission.

- quantify financial impacts of proposed changes

- evaluate alternatives

- recommend realignments

This report will outline how the prototype complies with the above objectives and how the decision support system will be a useful management tool to support the revitalization of the Army's infrastructure and evaluate installation efficiency.

1.3. Key Definitions

1.3.1. Installation

An aggregation of contiguous or near contiguous, common mission-supporting real property holdings under the jurisdiction of the Department of Defense controlled by and at which an Active Army unit activity is permanently assigned. [*Army BASOPS Primer,* page 103]

1.3.2. Infrastructure

Infrastructure encompasses all of the facilities that are improvements to the real estate of the installation. Infrastructure includes all buildings, utilities, training ranges and transportation facilities such as roads, airfields, railroads and docks. It is all of the real property assets that support actual deployment and remain behind when the combat forces and equipment are gone. [Frye, page 2]

1.3.3. Renewal or Revitalization

Renewal or revitalization refers to all efforts undertaken to improve the condition of the infrastructure. Renewal does not include routine or regularly recurring maintenance activities. *The Army Plan* defines revitalization as "the systematic replacement or renovation of Army real property with the goal of modernizing it to current standards." [Frye, page 2]

1.3.4. Installation Efficiency

Installation efficiency measures how well installations utilize their resources and facilities. Armed with this information, commanders will be able to develop priorities in accordance with established guidelines for apportioning the limited resources to meet the demands. Determining facility utilization will assist commanders in realigning units to optimize use of the best permanent facilities; realignment will aid in making facilities available for revitalization; inadequate and temporary facilities will be earmarked for replacement. Evaluating utilities usage and comparing that to alternate sources for providing the service, may identify potential savings for the installation. Finally, determining installation efficiency will help commanders monitor the programs outlined below.

1.3.5. BASOPS

Base Operations, or BASOPS, refers to the resources involved with operating and maintaining Army installations, both active and reserve. BASOPS provides for the facilities and services at the installations supporting the combat forces, the training base and the industrial base. [*Army BASOPS Primer*, page 1]

2. Background

2.1. Facility Reduction Program

Facilities maintenance requirements are growing and the resources for repair are diminishing. The Army has initiated a facility reduction program to reduce our facility base to improve funding of installation facilities maintenance requirements. The goal of this program is to consolidate units into the best facilities available and close/eliminate the rest. In one part of the program, MACOMs are required to demolish one-square foot of old, temporary facilities for each square-foot of new construction. This requirement began in FY92 and attempts to prevent the facilities inventory from growing.

There are three additional elements of the Facility Reduction Program:

- to improve utilization of permanent facilities;
- consolidation into the best facilities; and
- disposal of the worst facilities.

The VCSA has formally established reduction goals for the U.S. facilities inventory. These reduction targets have been disseminated to each of the MACOMs with major land holdings . This program will dispose of 33.8 million square feet during FY92-FY96. [*Army BASOPS Primer*, pages 10-11]

2.2. Revitalization

We must apply revitalization in a *systematic* rather than *incremental* way to repair, upgrade, or replace our infrastructure to modern standards. Goals are expressed as a percent of Plant Replacement Value (PRV) to occur over a revitalization cycle measured in years. The modest goals established in *The Army Plan* (TAP), FY1994-2009 are less than adequate to counteract the impact of expenditures in the current highly constrained environment. These goals are provided below:

- Fund 1.75% of the Army's PRV (57-year replacement cycle); and
- Fund 2.86% of all Army Family Housing (AFH) PRV (35-year replacement cycle).

The actual funding for the goals outlined above were only partially met under the current POM. The current funding calls for the Army to fund 1.63% of the Army's PRV (61-year replacement cycle); and concentrate 2.86% AFH PRV (35-year replacement cycle) only on CONUS housing. Army planners designed the goal of investing at 1.75% to provide sufficient resources to contain the backlog of maintenance and repair (BMAR). Note, however, that investment at this rate will not *reduce* the BMAR. It is not foreseeable that the Army will close this gap between this relatively modest goal and programmed expenditures during the remainder of this decade.

And if this gap were not bad enough, a comparison with other organizations reveals the significance of the Army's facility investment gap. In its February 1988 report, *Fragile Foundations: A Report on Americas Public Works*, the National Council on Public Works, determined that the total public sector infrastructure investment is 4.5% of PRV and that this amount must be doubled by the year 2000 in order to meet the existing infrastructure. The DOD study, *Renewing the Built Environment* , compares DOD investments with those of 6 major colleges and universities, 16 major private organizations and 23 non-DOD government entities [US Department of Defense, 1989, page H-16]

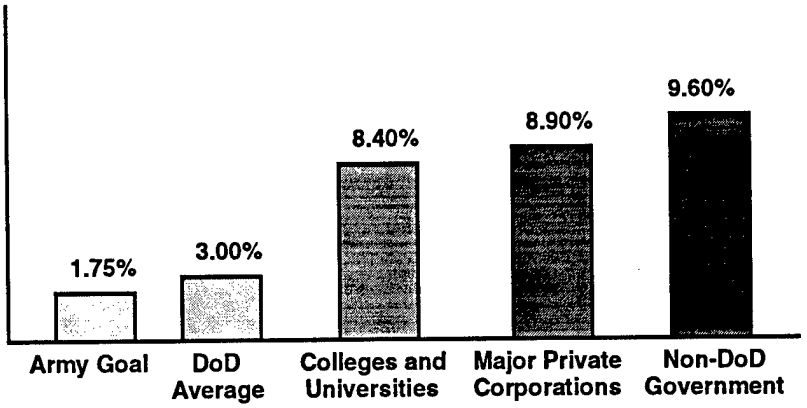


Figure 2.2.1 - Comparison of Infrastructure Investment Rates as a %age of PRV

The comparison shows DOD trailing these groups, with the Army even behind the DOD averages. One can see that the Army's "goal" of investing at 1.75% of PRV is not truly a goal, but rather an upper bound on spending in a highly constrained environment. Merely establishing a goal to spend money, at rates that are less than adequate, is not enough to maximize the impact of the expenditures. Goals for effective distribution of infrastructure renewal resources are needed. The Army needs to explore ways and establish priorities to get the most out of its revitalization efforts given the limited availability of funds. [*Army BASOPS Primer*, pages 10-11, Frye, pages 10-11]

2.3. Whole Barracks Renewal Program

The Whole Barracks Renewal Program is designed to upgrade unaccompanied personnel housing (UPH) standards. This program, set to commence in FY 94, is resourced to revitalize 167,500 spaces over 15 years in CONUS, 19,500 spaces in Korea, and 22,000 spaces over 6 years in Europe. [*Army BASOPS Primer*, page 12]

2.4. Whole Neighborhood Revitalization Program

The Whole Neighborhood Revitalization Program takes a holistic approach to renewing whole neighborhoods and includes revitalization of dwelling units, neighborhood support infrastructure, and neighborhood amenities accomplished at one time, thereby, eliminating the piece-meal approach. [*Army BASOPS Primer*, page 13]

2.5. Installation Status Report (ISR)

The ISR is a reporting system that identifies and documents critical infrastructure conditions and needs and, more broadly, evaluates both facilities and services at an installation. This reporting system will assist the Army in managing its diminishing resources so it can obtain its goals for infrastructure renewal / facilities revitalization. This reporting system is sponsored by ASA(FM) and was developed by the ORCEN. [Harmon, 1993] The project objectives for this decision support system are

- maintain a current inventory and condition assessment on the Army's facilities
- incorporate and validate installation infrastructure standards

- articulate the commander's needs
- measure progress towards planned goals
- prioritize infrastructure renewal projects
- predict infrastructure renewal resource requirements
- allocate available infrastructure renewal dollars

The ISR is projected to be field tested with ten installations in July-August 1993. The other services have similar initiatives. For example, the Air Force is presently field testing its facility assessment tool, "Commander Facility Assessment".

2.6. Making Money

The Army must be innovative in setting new standards for financial management, in implementing good business practices, and in seeking every opportunity to "make money" for the Army in an effort to provide quality base services. Normally, the Army is precluded by law from using those assets - which are supported with appropriated funds - to generate revenues to offset costs. However, recently Congress has demonstrated some willingness to consider limited, amendatory legislation to use the proceeds from sale or outlease of property for the specific purposes of maintenance and repair and environmental restoration.

2.6.1. Excess Property Outlease

The FY 1991 National Defense Authorization Act included two new authorities that were initially authored by the Army. Sections 2805 and 2806 of P.L. 101-510, National Defense Authorization Act for FY 1991, provide DOD the authority to retain revenues generated from the sale or transfer of excess non-base realignment and closure (BRAC) real property and the outlease of non-excess real and personal property, respectively...Proceeds are to be split 50%-50% by the generating installation and the Service headquarters...On 30 September 1992, the Secretary of the Army approved a modified distribution plan for the HQDA share of the proceeds. The HQDA share will be returned to the parent MACOMs of the generating installations. The MACOMs must distribute this money based upon a prioritization of requirements of installations under its command...On 9 October 1992, the VCSA signed a memorandum establishing an Army policy that any funds earned by an installation through these authorities would not be off-set by a reduction elsewhere in an installation's budget. This policy provides additional incentives to encourage installation commanders to actively review utilization of their installation's assets and generate revenues to improve the post. [*Army BASOPS Primer*, pages 16-17]

2.7. Army Communities of Excellence (ACOE)

Today's soldiers deserve to live and work in quality facilities commensurate with that of the society that they have sworn to defend. The spartan environment they are exposed to in the field should not be extended to include their living in the barracks. The Army must provide excellent facilities and services for our young men and women at all installations. Dilapidated, antiquated facilities decrease productivity, erode morale, and insult the dignity and worth of our people.

The ACOE process is being used to compliment existing programs so that our soldiers and civilians are guaranteed the necessary quality of life to retain them. By providing our soldiers better facilities, we are demonstrating to them that we care about them, their families, and the civilian work force. This, in turn, will increase the morale and productivity of our soldiers. ACOE employs the principle of Total Army Quality to achieve its goal of providing quality facilities and services. The ultimate objective of ACOE is to make our installations the finest small towns in the world in terms of excellent management of services, facilities and environment.

2.8. The Army Plan, FY 1994-2009

The Army Plan provides the necessary planning and programming guidance for resource allocation among all Army programs. A summary of those objectives that pertain to this project follows.

● Revitalize Facilities: The Army will focus facilities resources on revitalization of the infrastructure that will remain after force structure reductions and base closures. Inherent in this objective are the Revitalization, Whole Barracks Renewal and Whole Neighborhood Revitalization programs (described above) that will modernize the facilities and eliminate family and unaccompanied personnel housing (UPH) deficits.

● Reduce Facilities: The Army needs to divest itself of facilities that no longer contribute the sustainment of a smaller, CONUS based Army that will remain after force structure reductions and base closures. The Army is identifying and disposing of the old, obsolete WW II facilities and programming new replacement facilities. The Army will continue to reduce the facilities base through

- space utilization improvements

- consolidation into the best facilities

- renovation to improve available space

- dispose of one square foot of unneeded permanent or temporary square footage for every square foot of programmed new construction.

- relocation of Reserve units now in leased facilities to government-owned permanent facilities where possible or cost effective.

● Power Projection Platform: Provide a modernized facilities base for training and supporting power projection of our forces. Army facilities must enhance the capability of our Army to project our forces around the world in response to any contingency.

● Better Management Practices: Strengthen master-planning and land use management and make Installation Real Property Master and DEH Resource Management Plans the basis for RPMA, MCA, AFH, and other appropriation revitalization funding. This plan should form the basis for analyzing and allocating maintenance and repair resources and serves as the justification for future new construction. Additionally, support facilities research and development efforts to identify more efficient construction, operation, maintenance and repair techniques. Finally, new construction and repair efforts must capitalize on new energy efficient measures to reduce energy consumption.

- New Fiscal Opportunities: The Army will allocate the funds gained from closing overseas facilities and apply them to CONUS infrastructure repair needs. The Army will also survey and identify any *under-utilized* property used by AC or RC units via special legislation (noted above) with proceeds to be used to meet infrastructure repair and replacement needs.

- Utility Efficiency: The Army will support regional solutions around its installations to provide water and sewage treatment and solid waste disposal facilities to reduce future costs and lessen future environmental liabilities. It will also look to develop cooperative partnerships with local communities and organizations to avoid duplication of programs, facilities and services. Finally, the Army needs to encourage private industry to construct, own and operate utility plants and systems and other service facilities where more economical than government owned plants. [*Army BASOPS Primer*, pages 89-99 and Frye, pages 8-9]

2.9. Backlog of Maintenance and Repair (BMAR)

The Army, along with its sister services, reports the Backlog of Maintenance and Repair each year as a part of their budget requirements. BMAR is a collection of those maintenance and repair projects that were planned for accomplishment in previous fiscal years and continue to be valid requirements. BMAR is an indicator of the deterioration of real property assets and is used as a guide for allocating infrastructure renewal resources. The Army BMAR for fiscal year 1991 (in constant FY 92 dollars) was $2.867 billion and the projected amount for FY 92 and 93 is approximately $3 billion and $4 billion respectively

The notion of BMAR seems fairly simple and straightforward, however there are many problems with this program and many in the Army question its validity. Accuracy in reporting maintenance and repair (M&R) requirements is crucial. An understated BMAR can result in an under allocation of resources leading to further deterioration of the infrastructure. An overstated BMAR can result in a *loss of credibility* that can lead to an under allocation of resources. Installation engineers place little emphasis on BMAR accuracy because of the following two issues:

- continuous resource constraints placed on installation DEHs, and

- the belief that resources would not be adequate to reduce existing backlogs.

A significant factor in BMAR reporting is that it is seen as a time and resource consuming effort at the installation level, thus it tends to be a product of *expectations.* A 1989 DOD report to Congress on RPMA, *Renewing the Built Environment*, stated "If the funding climate is favorable, expectations increase, and the field does a better job on facility inspections used to identify requirements and the [reported] backlog grows. When the funding climate is poor, expectations decrease and the [reported] backlog decreases or grows at a slower rate over time." [US Department of Defense, 1989, page 21] In 1989, the Army Audit Agency (AAA) performed a technical inspection on Forts Lewis, Polk, Benning and Lee to determine the level of work *not identified* and reported to DA. The agency discovered $1.35 billion in unidentified M&R work for these four installations alone [US AAA, pages 23-24]. Thus, BMAR is not an indicator of M&R need and should not be used to justify funding.

The projects that are listed in the BMAR are valid, but BMAR does not contain all the valid projects. 1989, AAA's review of 27 surveyed installations uncovered $313 million in

required work that the command had found and **not** reported. With the downsizing of the Army and consequent reduction in resources, these issues will add to the decline of BMAR accuracy, credibility and reliability.

The migration of Real Property and Maintenance (RPM) funds to other Operations and Maintenance Appropriation (OMA) accounts contributes not only to the unreliability of the BMAR, but also to its growth. Installation commanders often reallocate funds to pay for unfunded training and readiness needs under the guise that funds will become available at the end of the fiscal year to handle RPM needs. Even if the end-of-year funds are available, there is often little time to adequately plan for the execution of the projects. Thus, BMAR continues to grow.

Another problem with BMAR is that it does not include new construction requirements. Many infrastructure renewal needs require major construction, yet the BMAR does not reflect these needs. A significant finding reported to the House Committee on Appropriations was that the Operations and Maintenance Appropriation BMAR addresses only about 58% of the total maintenance and repair problem [House Surveys and Investigations Staff, 1984, pages 49-57]. Even if BMAR were accurate, it would not truly represent total infrastructure needs. Thus, BMAR is not a good management indicator for base allocation of resources.

Even an accurate BMAR report is only a gross indicator of a part of the Army's total revitalization needs. The information is not particularly useful for making planning and resource allocation decisions except those of the most general nature. When installation and MACOM engineers discuss infrastructure needs, they generally do so by referring to specific projects or to discrete installation infrastructure systems. However, above installation level BMAR figures are aggregated such that *criticality of need* cannot be discerned. The Army needs additional indicators and decision support tools to better focus the investment in the infrastructure. [Frye, pages 4-9].

2.10. Base Realignment and Closure (BRAC) Program

BRAC is another program, along with the Facilities Reduction Program, designed to reduce the inventory. The Department of Defense (DOD) is closing many installations and consolidating remaining forces to optimize use of the best, most efficient facilities. One of the underlying principles of this program is to secure our ability to project our combat power to meet worldwide military contingencies. As the force decreases, DOD will continue to reshape the base structure and reevaluate installation requirements overseas in a continued effort to reduce the inventory.

3. Installation Efficiency Analysis

3.1. Needs Analysis

The Army's infrastructure renewal needs remain critical to support and sustain today's modern Army. We have soldiers living in substandard housing. Deployment and transportation systems are inadequate and crumbling. Financial resources are diminishing. Priorities have to be established to concentrate the limited dollars the Army has on the key facilities it needs to sustain its power projection platforms. Forecasts through FY 99 reflect an ever growing gap between the money projected for infrastructure renewal and required

funding. Additionally, financial constraints will also impact on the ever-increasing BMAR list. The Army leaders have a strategy for allocating the resources and implementing the revitalization program. The leaders need a decision support system that will enable them to prioritize the resources to monitor infrastructure renewal implementation.

The project of analyzing duplicative, on-post functions offers significant potential fiscal payoffs. Why should an installation continue to produce its own electricity or water when it can lease it for less from the surrounding community? A methodology needs to be developed to identify, quantify and evaluate overlapping functions on installations, other federal facilities, or with nearby communities.

3.2. Capabilities

To meet these needs, the system must have these capabilities and features that are outlined below. It is important to note that this decision support system is being designed for the personal computer. This consideration will minimize the overall cost of this project. This enables a greater number of analysts at installation and MACOM level access to a powerful, analytical management tool to study the progress of current policies and programs, propose revisions to these programs and make recommendations for alternative programs.

- Integrate with the Installation Status Report.
- Problem solving tool used to analyze the effects of resource constraints.
- Common, compatible software and hardware. System is being designed for use on a personal computer (PC).
- Dynamic and flexible data base management system.
- Responsive user interface that is interactive and user friendly.

This decision support system will have a **knowledge base** that integrates information from numerous data sources and efficiently tabulates the data in an acceptable format for quick querying and analysis. In the prototype, a relational model for the knowledge base will be used. Searches are more efficient in a relational model. It limits the amount of redundant fields in associated tables. This lessens the effort required to update and make changes in the knowledge base and minimizes the computational effort required to conduct searches. Finally, the relational model readily permits the user to add new fields or specify additional key indices without the necessity to recreate the knowledge base. Other HQDA decision support systems, the Installation Status Report and data bases such as HQRPLANS will be used to supply the information for the knowledge base (see section 6 for a complete description).

Paradox is a powerful *relational* data base management system (DBMS) that permits the user to ask complex questions about several interrelated tables of data without any programming. This is the software chosen to manage the knowledge base. It is an extremely flexible program, giving the user virtually unlimited options for storing and managing information. Historically, DBMSs have been programming language oriented and thus best used as tools by programmers and sophisticated computer users. *Paradox* frees the user from having to memorize complex commands. *Paradox* permits you to access information from separate tables and provide graphs or reports of the results. *Paradox* offers the ability to develop custom applications. Applications let you reduce

complex tasks to simple menu options, allowing you to automate virtually all the tasks involved in managing the knowledge base.

Paradox was also chosen for the knowledge base because it automatically checks the validity of the data that you enter into the tables. This will help keep erroneous data from being stored in a table (especially when the tables are being translated from other databases). It also permits you to specify a range of values for specific fields, for example, the c-ratings for the different ISR areas are limited to C1-C4.

Paradox can also provide customized graphs and reports. To be able to access this power and keep the design "user-friendly", it will be important to pre-define several *scripts* that will enable the user to graph and/or printout the desired data.

The **user interface management system** (UIMS) must be an interactive, user friendly display that enables the user/analyst to

- access the desired information
- maintain the knowledge base
- perform computations and other manipulations on the data

The UIMS must provide a graphical interface that enables the user to access the information through physical actions, such as pressing a button and moving a mouse. This *direct manipulation interface* does not require the analyst to be a programmer or a sophisticated computer user. The UIMS must enable the analyst to move about the knowledge base accessing information quickly from numerous tables. The two objectives of the UIMS will be to

- make the system commands and mechanisms match the thoughts and goals of the user/analyst as much as possible.
- make the output displayed present a conceptual model of the system that is easily perceived and evaluated. [Sage, page 137]

Interoperability enables *Paradox* to share its file with other Borland products, specifically, the user interface, *Object Vision. Paradox* operates as the engine, handling all the input and output to the knowledge base files and lets *Object Vision* access and display the data.

Object Vision uses forms to gather, display, calculate, edit and print values. Several forms can be stacked together in an application just as paper forms might be stacked or stapled together. The application is easy to create and provides the ease for the user to access the necessary information. This will be demonstrated in the next section as the prototype is explained.

The purpose of the **model base** will be to manipulate the data from the knowledge base into information that is useful in decision making. The final design for the model base must make use of algorithmic procedures, for example, linear programming models, and model subroutines that might be established through the use of *scripts*. Regardless, the design will have to incorporate several models and/or subroutines to accommodate decision makers' need for flexibility. Once these models are established, it should be possible to perform a *sensitivity analysis on* the results of the model. The model should also be able to respond to a variety of "what if" queries.

3.3. Prototype

When you start the IEA application in *Object Vision*, you are greeted with a form that provides you several alternatives:

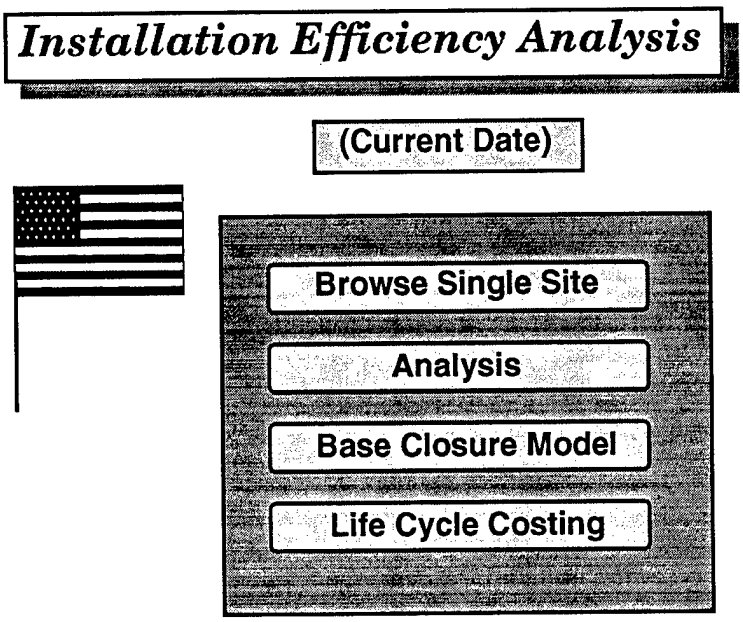


Figure 3.3.1 - IEA Initial Screen

Clicking on the first alternative allows you to select a site location from a map of the United States. This enables to you to scan data from the knowledge base solely on the installation that you select. The follow-on screen is depicted below in figure 3.3.2.

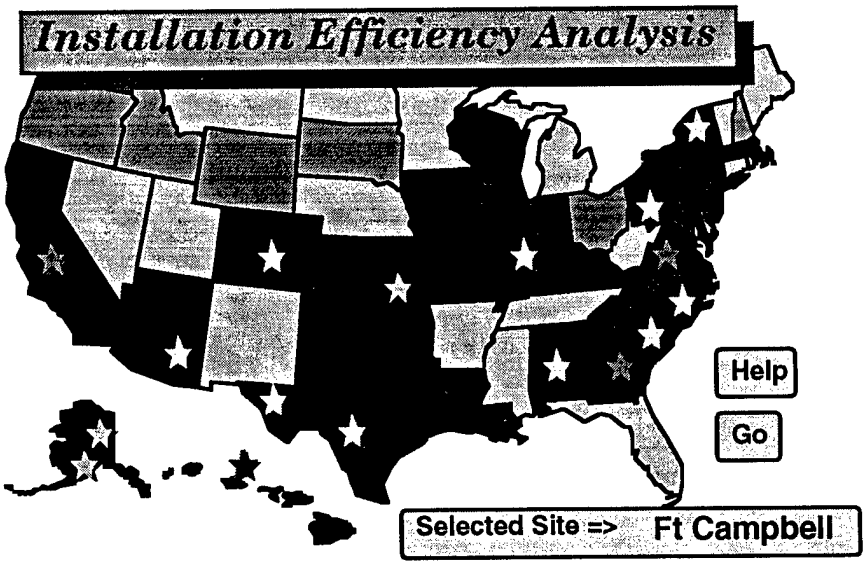


Figure 3.3.2 - Coded Map

The map consists of two different forms of color coding. The color of the respective states provides information on the types of installations located in the state.

- Blue is used to indicate the presence of AC Army installations.
- Dark Gray is used to indicate the presence of RC Army installations.
- Light Gray indicates that no Army installations are located in that state.

Clicking on the help button provides the user/analyst an explanation of the other form of color coding - the stars.

- Yellow stars indicate the location of any Army installation
- Red stars indicate the presence of several installations in a congested area.

Clicking on a red star will call up a form with an enlarged picture of the state and all the installations within that state.

- Green stars are used to indicate that the presence of an installation currently not contained in the prototype. This will permit quick inclusion of this installation when the final system based on all installations is fielded.

Once you have found the desired installation, you click on "Go" to access information from the knowledge base on the overall **areas** of the ISR. The form is located in the next figure.

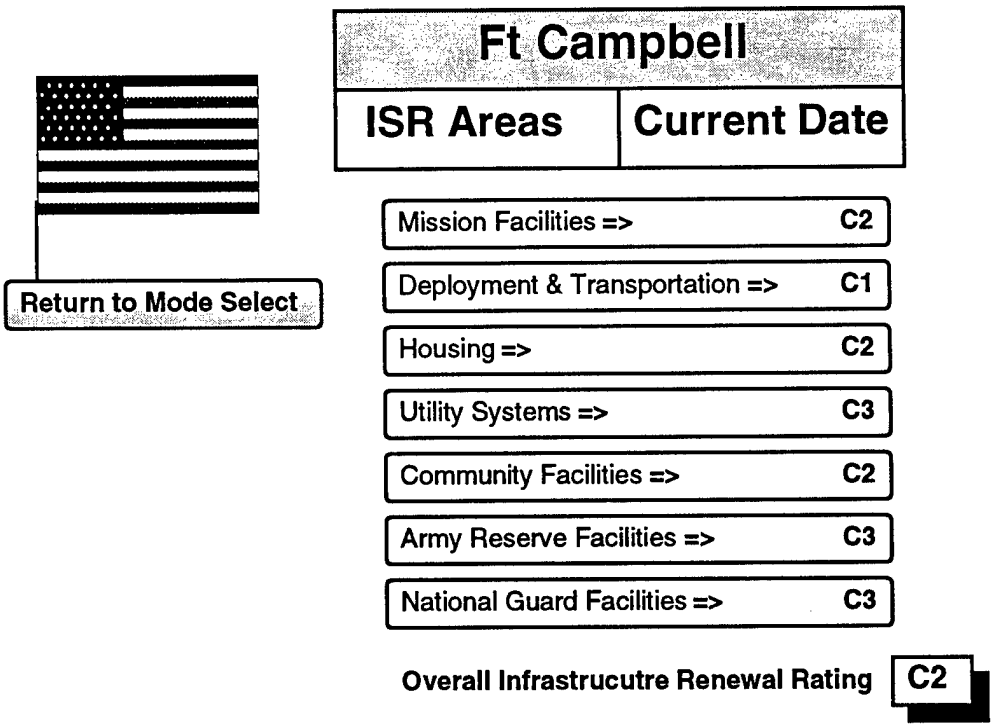


Figure 3.3.3 - ISR Areas

This form gives the user/analyst the overall rating for the respective areas of the ISR. The overall infrastructure renewal rating is determined by averaging the seven ratings and rounding to the nearer value. A button is included in all the forms to enable the user to reverse his direction if the user has made the wrong choice. Now, the user wants to learn more information about, say, Mission Facilities. Any field name with the "=>" symbol

after it indicates that there is more information on that field. The user clicks on the field name Mission Facilities to access the **categories** depicted in the next figure.

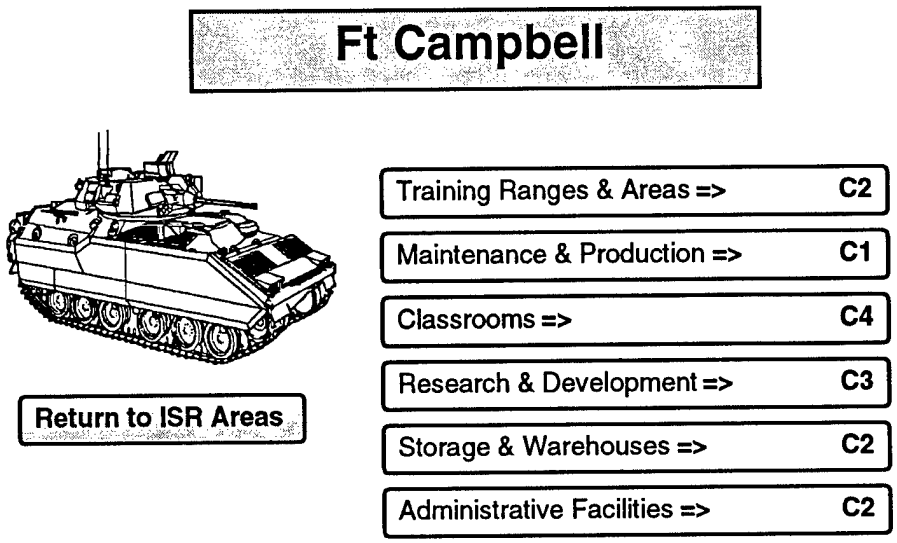


Figure 3.3.4 - Mission Facilities Category

The categories of the ISR report c-ratings. The c-rating has two components:

- Quantity - this is a factor of the actual amount of say, classroom space in ft^2 (or whatever applicable unit of measure), divided by the amount required.

- Quality - this component measures the conditions of the facilities against a set of standards. As seen in the next figure, this component is divided into three color coded schemes. The meaning of the color coding is intuitively obvious.

A concern is raised as the analyst scrutinizes the c-ratings. The analyst clicks on the field name "Classrooms" to determine why classrooms are rated C4.

Ft Campbell

Quantity		Quality			C-rating
Existing Required	Number of Facilities	% Green	% Amber	% Red	
.80	12,450	0	0.4	0.6	C4

Comments: All of the general purpose classroom facilities at Ft Campbell are the old WWII temporary facilities. These facilities are earmarked for replacement in FY98.

Applied Instruction Facilities **Return to Mission Facilities**

Figure 3.3.5 - Classroom Sub-category

Now the analyst has information that is useful. From this form, the analyst is able to determine why this installation has received such a poor c-rating. Additionally, a help window will be provided to explain to the analyst how the quantity and quality components were combined to determine the overall c-rating. A button or several buttons will be provided indicating the presence of additional sub-category listings.

The next feature of the prototype is its ability to perform the analysis functions. If you click on the next button in figure 3.3.1 you will access another menu with several options.

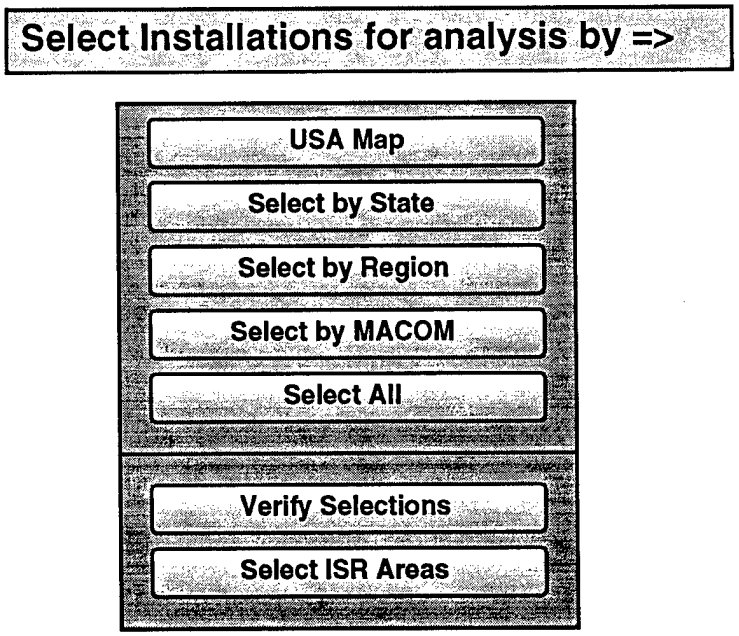


Figure 3.3.6 - Analysis Menu

This portion of the design will enable the analyst to effect the analysis functions that are described in section 4.4 later on in this report. When you select either State, Region or MACOM button, another form will open enabling you to select your respective area for analysis. The first button enables you to select several installations that are not related by either state, region or MACOM by returning you to a form similar to that depicted in figure 3.3.2. You click on the stars representing the installations while verifying your selections in the selection box in the lower right corner until you have selected all the installations required in your query/problem. The installations and ISR Area/Categories/Sub-categories you select will be forwarded to a table for analysis.

The final feature of IEA is to execute model bases to provide useful information for the analyst. The models depicted will be developed next year.

4. Future Requirements

4.1. Installation Efficiencies

A critical area for potential financial savings will be in the area of overlapping utility functions. A search will have to be conducted to determine where information can be obtained on utility utilization and respective cost factors for the surrounding communities for installations. There are numerous civilian organizations whose sole purpose is to conduct surveys. Future analysts working on this project will have to identify these organizations to obtain the data and, more importantly, how often the data is updated. The following example is provided to show the benefits of a simple comparative analysis. The table shows the excess capacity/shortfall an installation possesses and the potential savings (or loses) that can be made through the leasing or selling of the storage or service.

Category	Installation		Cost		Potential Savings/yr (lose)
	Usage	Excess (shortfall)	Installation	Community	
Storage	406 k-ft²	(200 k-ft²)	1,412 $ / k-ft² / year	2,000 $ / k-ft² / yr	($400,000)
Admin Facilities	559 k-ft²	611 k-ft²	1,412 $ / k-ft² / year	2,250 $ / k-ft² / yr	$1,374,750
Water	3.771 MGD	1.217 MGD	1,250.46 $ / MG	1,137 $ / MG	$156,170 $505,060*1
Wastewater Treatment	1.909 MGD	0.059 MGD	3,058.25 $ / MG	2,775 $ / MG	$197,365 $59,760*1
Electricity	31,500 KVA	(5,250 KVA)	0.3788 $ / KVA / day	0.35 $ / KVA / day	$289,820 ($670,687*2)

***1 - First figure represents savings by having the Community provide the entire service. The second figure indicates the sale of excess at the Community rate.**

***2 - First figure represents the savings by having the Community provide the entire service. The second figure indicates the lose by having the Community provide the additional electricity required.**

Figure 4.1.1 - Sample Comparative Analysis

4.2. Machine Interface

A machine interface program will have to be developed that will enable the analyst to update the knowledge base with current information from the numerous data sources. The program will be using a modem to connect to the different data sources, for example, HQRPLANS. Once logged on, the program will have to access the updated information in its current format, download the information and translate it for use in the IEA data structure.

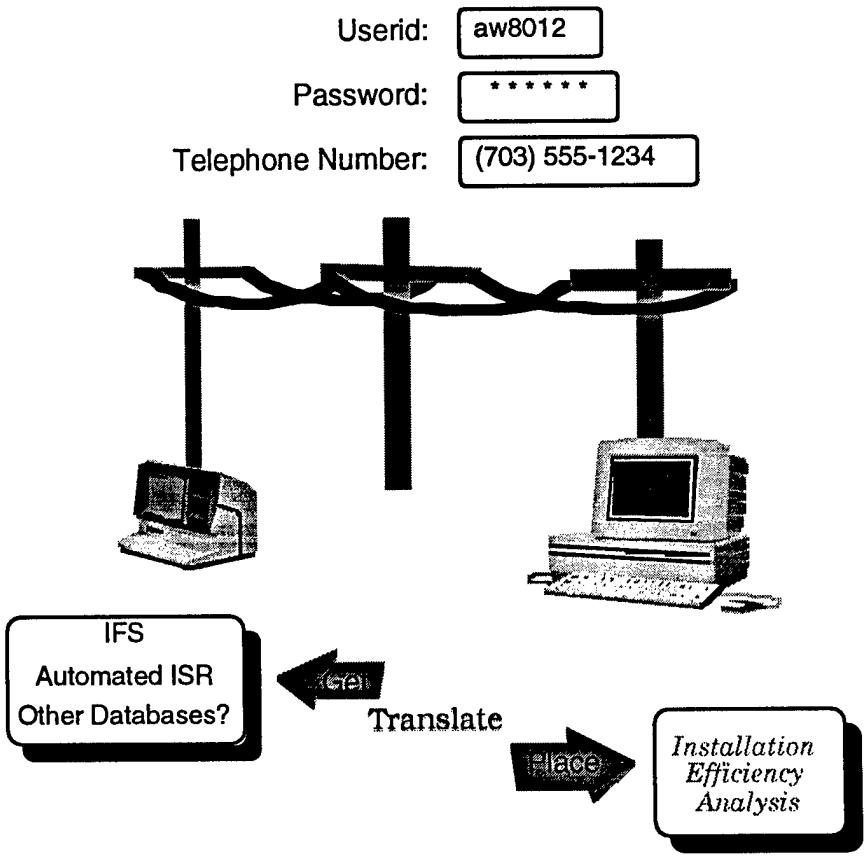


Figure 4.2.1 - Machine Interface

4.3. Model Bases

Presently, we are looking to implement two models with IEA. The first program being considered is an adaptation of the base closure linear program developed by CPT Greg Singleton. His model looks at stationing units to ensure that they would be able to train effectively to complete their respective missions while minimizing the cost involved. This program may be adapted to constrain the stationing of units based upon facilities utilization or other functions. The other model being considered is the Life-Cycle Costing model. We want to be able to use the model to determine how much money is needed to upgrade marginal c-ratings to a C1 rating. We want to be able to project how long it will also take in order to obtain this rating. Other models to investigate are

● Interaction matrices - this will be useful for initial, comprehensive exploration of data.

● Mathematical Programming Models - these models are useful for resource allocation under constraints, planning, scheduling and similar applications. Other models can be considered in addition to the base closure model.

● Optimum Systems Control Models - a routine could be developed that evaluates the optimum use of facilities at an installation given either financial constraints and/or realignment of forces.

● Decision Models - to assist the commander in choosing the alternative course of action that best satisfies the objectives or to assist in prioritizing tasks. [Sage, pages 85-93]

4.4. Analysis Functions

Presently, we have encountered some difficulty in using *Object Vision* to perform the analysis functions desired for the IEA project. It will take some considerable effort to work through these difficulties. These functions are described below:

● Comparisons: The desire is to be able to select several installations - at random, by region, or MACOM - and compare data on different ISR areas, categories and/or sub-categories. The intention here is to look at the c-ratings for the different installations and what the critical factors were for determining that rating. Was it the quantity factor or the quality factor that drove the overall rating? It would also be desirable to do a "red rollup" to identify installations that were deficient (red) in a specific sub-category. This would assist leaders in determining what installations need priority on resources to correct the shortcoming.

● Cost: Again, the desire is to be able to select one or several installations and be able to apply cost factors to examine the projected costs required to change an installations c-rating from C3 to C2, for example, or change the percent of "amber" facilities to "green".

4.5. Geographic Information System

A tremendous asset for the IEA project will be the eventual development of its geographic information system (GIS). GIS have been developed for the PC. This concept is best illustrated via the use of an example. Lets suppose that a leader is interested in the condition of the tank gunnery ranges at Fort Hood. The leader would be able to access this information using the GIS section of IEA. The leader would be able to gain current pictorial information on the tank gunnery ranges at Fort Hood. This asset would also be useful to validate shortcomings depicted in the ISR. The GIS is not essential to have fully prepared for implementation when the IEA is fielded.

4.6. Final Design

I have already mentioned that the infrastructure has been designed for the final design of the IEA project. The ISR is experiencing numerous changes as the project gets closer to its field testing. The current infrastructure should provide the necessary flexibility to account

for the changes to the ISR and, also, allow for additional critical data requirements identified for further analysis.

5. Recommendations

Flexibility will be a major concern for the IEA project as it is being developed. The format and design of the Installation Status Report is changing while this report is being written. Once the ISR is finalized, it will be staffed for further revision. The ISR will be field tested beginning the summer of 1993. Many more revisions can be expected prior to the full implementation of the ISR.

5.1. Paradox for Windows

I would recommend that we upgrade the "engine" for this project from *Paradox* to *Paradox for Windows*. To conduct queries of the knowledge base, the analyst will have to access *Paradox* to complete the queries. This program, by itself, is a simple data base program which eliminates the complexities of having to write programs to perform your queries. Everything is menu driven. However, it does not meet the "user-friendly" design criteria for the project.

5.2. FST Program

LTC Richbourg of the Artificial Intelligence cell at West Point has prepared an FST program which performs a lot of the functions desired for the IEA project. LTC Richbourg adapted the project for inclusion of the ISR areas. The FST program is a stand alone program written in C that enables the user to select several installations and compare data in different categories. The project will also project status of facilities in the outyears and provide a graphical representation of the results. The FST program was written for OCONUS installations. The FST program needs to be evaluated for inclusion into the IEA project and adapted to CONUS installations. The evaluation needs to focus on what parts of the program will benefit/support the IEA project. A hard look needs to be given to that data structure for the project to see if it can be modified to use the existing data structure in *Paradox* or have to provide a totally separate data structure. The FST program is a software package that already works, may be adaptable and could provide a boost in accelerating the completion of the IEA project so it can be implemented concurrently with the ISR project.

5.3. Machine Interface

One of the difficult and time consuming, but technically solvable aspects of the IEA project will be to translate data from, for example, *Oracle*, the data base used for HQRPLANS, into the format used in the *Paradox* tables. This process will have to be done for all data bases providing information for IEA. This area is critical to fielding of the IEA thus enabling analysts to begin searching for potential cost saving measures and better utilization of facilities.

6. Data Sources

Numerous data sources are available which provide information concerning the installation's infrastructure. A list of the data sources that have been used for the knowledge base are provided with brief explanations of the information contained in the source and points of contact, if applicable, for accessing the information.

● Army Stationing and Installation Plan *(ASIP)* User Interface, version 2.0. The *ASIP* database is an unclassified database that reflects the **planned populations** of all tenants at Army installations and all Army units over the two year budget period and the five year Program Objective Memorandum (POM) period. This vehicle will assist the user in identifying, planning for and programming future real property support requirements, e.g. amount of facilities space for administrative, maintenance and quarters, at Army installations. This database is updated semiannually in July and January. The January 1993 version is currently loaded on the Toshiba 4400C laptop computer. This version was provided by the USA AI Center at the Pentagon. Other information that could become necessary to use are the Unit Identification Codes (UIC) and the Station Codes (STACO). These codes are widely used in other databases to access information about installations.

● Real Property Planning and Analysis System (RPLANS) contains current data on the different types of facilities at installations which enables Army planners and programmers to compare unit requirements against real property assets of the installation. RPLANS is a software package that runs on a VAX computer. Headquarters, RPLAN (HQRPLANS) is a remote-user version of the main software package. The DEH at West Point is expected to have this remote-user version and access to this database in the very near future. Point of contact for gaining access to this database is Ms. Maureen Wylie, Installation Planning Division, Office Assistant Chief of Engineers. Her address is

HQDA, DAEN-ZCI-A
Room 1E671, Pentagon
Washington, DC 20310-2600
DSN: 224-3986

This database provides a listing of all the permanent, semi-permanent and temporary assets on the installation, some information, e.g. on housing, on the surrounding community and the amount of assets the installation actually requires. It also computes factors on how much of what is required is satisfied solely by permanent assets and by all assets on the installation.

● The Army Times publishes a yearly reference guide on many of the major installations in the U.S. It provides current information on the major units at the installation, the make up of its population, housing, temporary lodging, the commissary, exchange and services it provides, schools, child and health care and the projected changes facing that installation. The section on upcoming changes discusses if the installation is closing or what units and missions the installation will be gaining or losing.

● The *Automated ISR* is a vehicle that is currently being designed by R & K Engineering of Roanoke, Virginia that will forward the results of the ISR reports generated at installation level up to the MACOM and HQDA level. It will be important to tie into this data source because of the strong correlation between this decision support system and the ISR.

- Last summer, Headquarters, FORSCOM published a memorandum on the installation capacities on CONUS installations that are programmed for mobilization stationing. It contains data on the permanent and temporary facilities at an installation. The point of contact for this is Mr. Jerry Harbison, Operations Research/Systems Analyst. His address is

Forces Command
ATTN.: FCJ5-PM
Ft McPherson, GA 30330-6000
DSN: 367-7438

- The final data source that was used was a Master's Thesis written by CPT Greg Singleton on base closure. He lists the several sources where he gained his information from and lists the data used in his model. This data was suitable for the initial development of the prototype.

6.1. Data

Provided on the subsequent pages is a reference guide to the current *Paradox* files used in the prototype and where the data is found. The *Paradox* files are also provided on floppy disks.

Database Information

ISR Area	Category	Sub category	Paradox File	Data Source	UM	Description
Mission Facilities			Mission	ISR		C-ratings
	Training Ranges & Areas		Trgr&a	ISR		C-ratings
		Individual Weapon Qualification Range	Indwpns	FORSCOM		Type of ranges and # of firing points
				HQ RPLANS	EA	17901 - Bsc 25M Fire Rg
					EA	17902 - Fld Firing Rg
					EA	17903 - Record Fire Rg
					EA	17907 - Sniper Trng Fld
					EA	17909 - Machgun 10M Rg
					EA	17910 - Machgun Tran Rg
					EA	17917 - Gr Launcher Rg
					EA	17929 - Combat Pistol
		Major Weapon System Range	Majwpns	FORSCOM		Types of ranges and # of firing points
				HQ RPLANS	EA	17930 - TK Gun 1:30&60
					EA	17931 - TK Gun 1:5&1:10
					EA	17932 - TK Gun Statnry
					EA	17933 - TK Crw Cbt Fire
					EA	17937 - Aerial Gunry Rg
					EA	17942 - Fld Art Indr Rg
					EA	17943 - Airdef Fire Rg
		Training Areas	Trngarea	FORSCOM	SZ	Size unit training areas
					AC	supports/maneuver acres
				HQ RPLANS	AC	17986 - maneuver acres
	Maintenance & Production Facilities					C-ratings
		Maintenance Facilities	Maintfac	HQ RPLANS	SF	21410 - Veh Mnt Sh Org
					SF	21420 - Veh Mnt Sh DS
					SF	21435 - Veh Rebuild Fac
					SF	21800 - Sp Purp Mnt Shop
					SF	21900 - Mnt Inst O&R
		Ammunition Plant	Amoplant			

ISR Area	Category	Sub category	Paradox File	Data Source	UM	Description
		Production Facilities	Prodfac	HQ RPLANS	SF	22110 - AC Prod Bldg
					SF	22210 - GM Prod Bldg
					SF	22310 - Ship Prod Bldg
					SF	22410 - Tank./Auto Prod
					SF	22510 - Weapon Prod Bld
					SF	22610 - Explosive e Prod
					SF	22710 - Commo Prod
	Classrooms	General Purpose Instruction Facilities	Gpfac	HQ RPLANS	SF	17120 - Gen Inst Bldgs
		Applied Instruction Facilities	Applfac	HQ RPLANS	SF	17130 - Appl Inst Bldg
	Research & Development Facilities		Res_dev	HQ RPLANS	SF	31010 - RDT&E Labs
					SF	31110 - AC RDT&E
					SF	31210 - Msl Space RDE
					SF	31310 - Mar RDT&E
					SF	31410 - Tank/Auto RD
					SF	31510 - Weapon RDT&E
					SF	31610 - Explosive RD
					SF	31710 - Elec RDT&E
					SF	31810 - Prop RDT&E
					SF	31910 - Non-metal RD
					SF	32010 - Und-Wat RDT&E
					EA	37110 - RDT&E Rng Fac
					EA	39010 - Other FDT&E Fac
	Storage & Warehouses	Conventional Ammo Supply Facilities	Convammo	HQ RPLANS	SF	42100 - Ammo Stor-Dep
					SF	42200 - Ammo Stor-Inst
		Supply Facilities	Supfac	HQ RPLANS	SF	43200 - Cold Stor-Dep
					SF	44100 - Gen P Wh-Dep
					SF	44200 - Gen P Wh-Inst
					SF	44230 - Cont Hum Wh
					SF	44240 - Infl Matls Wh
					SF	44260 - Veh Stor Shed
	Administrative Facilities		Adminmf			C-ratings

ISR Area	Category	Sub category	Paradox File	Data Source	UM	Description
		Admin Facilities	Adminfac	HQ RPLANS	SF	61050 - Gen Purp Admin
		CID Facilities	Cid			
		Correctional/ Confinement Facilities	Confine	HQ RPLANS	SF	73015 - Confinement Fac
		Finance Facilities	Finance			
		Military Police Station	Mp			
		Postal Facilities	Postofc	HQ RPLANS	SF	73073 - Post Office
		Operations Buildings	Opnsbldg	HQ RPLANS	SF	14110 - AF Ops Bldg
					SF	14112 - AV unit Ops Bldg
					SF	14182 - Bde HQ Bldg
					SF	14183 - Bn HQ Bldg
					SF	14185 - Co HQ Bldg
Deploy and Transportation Systems			Deploy			C-ratings
	Road & Trail Network					
		Road Network	Road	ISR		
		Trail Network	Trail	ISR		
	Railroads		Railroad	HQ RPLANS	MI	86010 - railroads
	Airfield					
		Air Traffic Control Facilities	Airtraff	ISR		
		Airfield Facilities	Airfield	HQ RPLANS	SY	11110 - FW Runways
					SY	11120 - RW Runways
					SY	11210 - Std Twy
		Airport Maintenance	Airmaint	HQ RPLANS	SF	21110 - Mnt Hangr Avum
					SF	21111 - Mnt Hangr Avim
					SF	21120 - Misc Acft Maint

ISR Area	Category	Sub category	Paradox File	Data Source	UM	Description
	Ports		Port	Inst Mob Plans		
Housing						C-ratings
	Family Housing		Famhsg	Army Times HQ RPLANS	 SF FA	Number of houses 71100 - Family housing 7110F - Family housing
	UPH	Bachelor Enlisted Quarters	Beq	HQ RPLANS	SF PN	72170 - Sr Enl Qtrs 7217P - Sr Enl Qtrs
		Bachelor Officer Quarters	Boq	HQ RPLANS	SF PN	72400 - Officer UPH 7240P - Officer UPH
		Guest Houses	Guest	Army Times		Number of quarters
		Transient Quarters	Tranqtrs	Army Times HQ RPLANS	 SF	Number of qtrs - by type 74032 - Trans Hsg Fac
	Dining Facilities		Dinefac	HQ RPLANS	SF	72200 - UPH Din Fac
Community Facilities	Post Exchange		Px	Army Times		Service; size; # shoppettes
	Commissaries		Commisary	Army Times HQ RPLANS	 SF	Size description 74021 - Commissary
	Hospital and Medical Facilities					
		Dental Clinics	Dental	HQ RPLANS	SF	54010 - Dental Clinic
		Hospitals	Hospital	Army Times		Number of Beds Description of Services
				HQ RPLANS	SF	51010 - Hospital
		Troop Medical Clinic	TMC	HQ RPLANS	SF	55010 - Health Clinic
	Child Care Facilities		Kidcare	Army Times		# Child Spt at Center # available for home care
				HQ RPLANS	SF	74014 - Child Spt Ctr
	Community Support	Arts & Crafts	Artcraft	HQ RPLANS	SF	74022 - Skill Dev Ctr

ISR Area	Category	Sub category	Paradox File	Data Source	UM	Description
		ACS	Acs	Army Times		if available
		Audio-Visual	Avit	HQ RPLANS	SF	17160 - Tasc
		Automotive Skills	Auto	HQ RPLANS	SF	74024 - Skill Ctr Auto
		Club Facilities	Club			
		Education	Ed	Army Times		Type School/grade avail
				HQ RPLANS	SF	73048 - Depn Grade Sch
					SF	73049 - Depn High Sch
		Fire Station	Fire	HQ RPLANS	SF	73010 - Fire Station
		Libraries	Library	HQ RPLANS	SF	74041 - Library Ctr
		Museums	Museum	HQ RPLANS	SF	76010 - Museum
		Music & Theater	Theater	HQ RPLANS	SF	74010 - Auditorium GP
		Outdoor Playing Fields & Courts	Outplay	HQ RPLANS	EA	75010 - Tennis Courts
					EA	75011 - Multiple Courts
					EA	75020 - Baseball Fields
					EA	75021 - Softball Fields
					EA	75022 - Football/Soccer
		Outdoor Rec Center	Outrec			
		Physical Fitness Center	Fitctr	HQ RPLANS	SF	74028 - Phys Fit Ctr
		Publication Facilities	Pubfac			
		Recreation Center	Reccentr	HQ RPLANS	SF	74069 - Rec Center
		Religious Facilities	Religion	HQ RPLANS	SF	73020 - Chapel Ctr Fac
		Swimming Pools	Swimpool	HQ RPLANS	EA	75030 - Outdoor pools
		Youth Centers	Youthctr	HQ RPLANS	SF	74066 - Youth center

ISR Area	Category	Sub category	Paradox File	Data Source	UM	Description
Utility Systems			Utility			C-ratings
	Heat/AC	Boiler Plant & Heat Distribution System	Heat_ac	HQ RPLANS	MB LF	82100 - Heat Source 82200 - Heat Dist Ln
	Electric/Gas	Electric	Electric	HQ RPLANS	KV LF KV	81100 - Elec Pwr Source 81200 - Elec Pwr Dist 81300 - Elec Pwr Substa
		Gas System	Gas			
	Water	Drinking Water Plant & Water Distribution	Water	HQ RPLANS	KG KG LF	84100 - W S Trmt 84120 - W S Stor 84200 - Water Distr
	Sewer	Waste water Treatment & Sewage Collection	Wastewtr	HQ RPLANS	KG LF	83100 - Sew/Trmt & Dsp 83200 - Wstwtr Coll Sys
	Communications	Cable	Cable		ISR	
		CUITN	CUITN		ISR	
		Gateway	Gateway		ISR	
		Telephone Switch	Teleswit		ISR	
		Telecommunications Building	Telecomm		ISR	
Army Reserve Facilities			Arf	HQ RPLANS	SF SF	17140 - AR Center 21409 - AR Maint Fac
National Guard Facilities			Ngf	HQ RPLANS	SF SF	17142 - NG Center 21407 - NG Maint Fac

Additional Database Information

Name	Fields	Paradox File	Data Source	UM	Description
General Information		Insteam1			
	Installation Name				
	City				
	State				
	Zip Code				
	Region				
	MACOM				
Population		Theforce	Army Times		
	Active Duty			EA	
	Civilian			EA	Civilian Work Force
	Dependents			EA	
	Reserve/NG			EA	Reserve/NG Supported
Cost Factors		Costfact	TBD		
	Utilities				
	- Water			$/person/year	includes only military
	- Electric			$/person/year	and civilian
	- Sewer			$/person/year	
	- Gas			$/person/year	
	Construction				
	- New			$/ft-sq	multiply by local cost factor
	- repair & maintenance			$/k-ft^2	

6.2. Sample Data Structure for a Sub Category

The majority of the database files follow the same format. This format is used primarily to record the information from the sub categories of the ISR. The format follows:

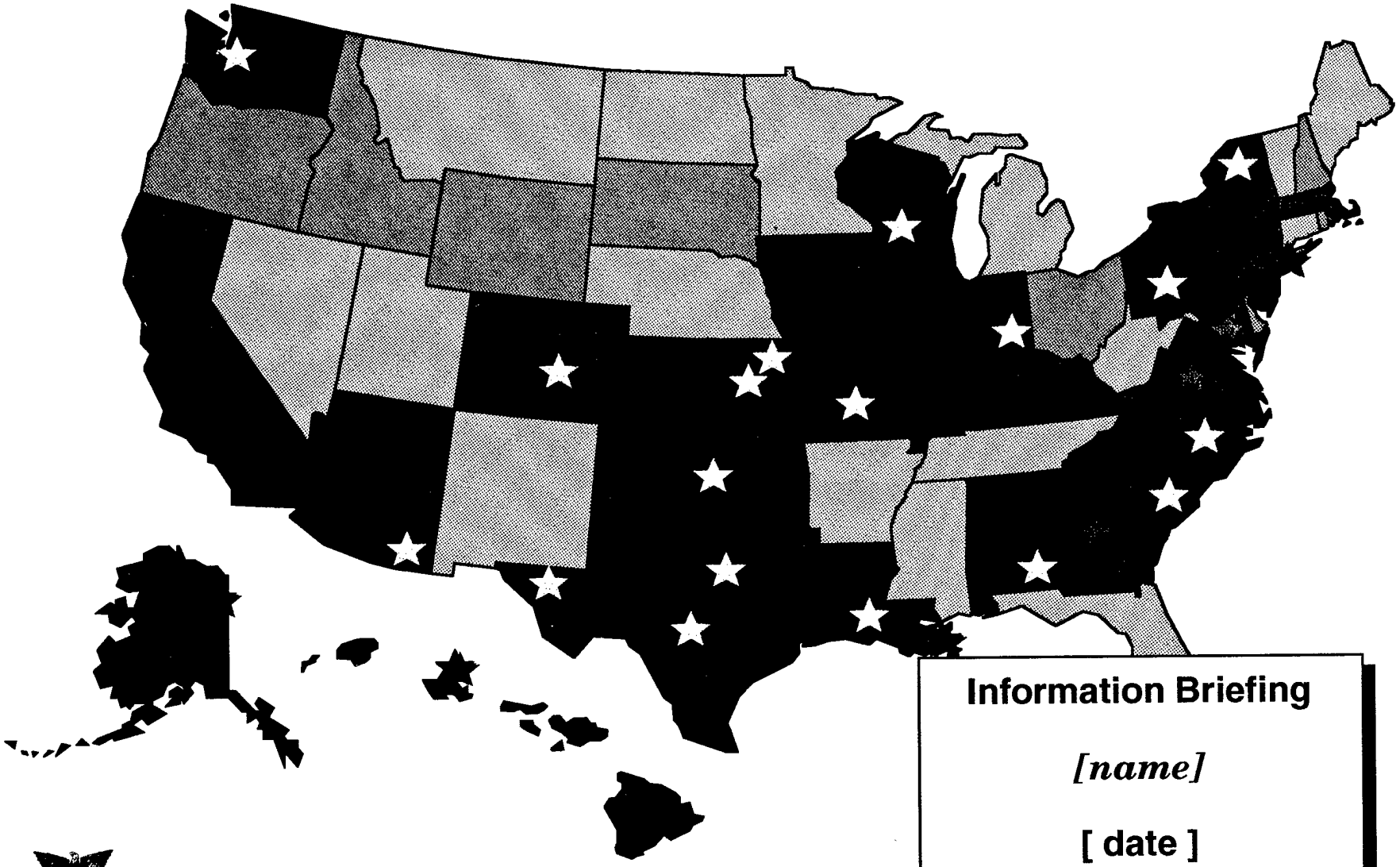
Field Name	Field Type
Installation	Alpha-numeric - 20 characters; key field
Existing	Numeric (ratio of actual/required)
Actual	Numeric (actual amount on hand)
% Green	Numeric (% of facilities in excellent shape)
% Amber	Numeric (% of facilities in adequate shape)
% Red	Numeric (% of facilities in poor shape)
Comments	Memo (Provides comments on environmental, safety, health, location considerations and explanation of services)

Briefing slides 11-15 provide the overall structure of the knowledge base. Slide 13 gives an example of the information indicated above.

6.3. Briefing Slides

A copy of the final briefing slides has also been included on the following pages. The slides were created in Microsoft PowerPoint. A disk copy of the slides is also provided.

Portfolio Analysis



Information Briefing

[name]

[date]

Operations Research Center

PURPOSE

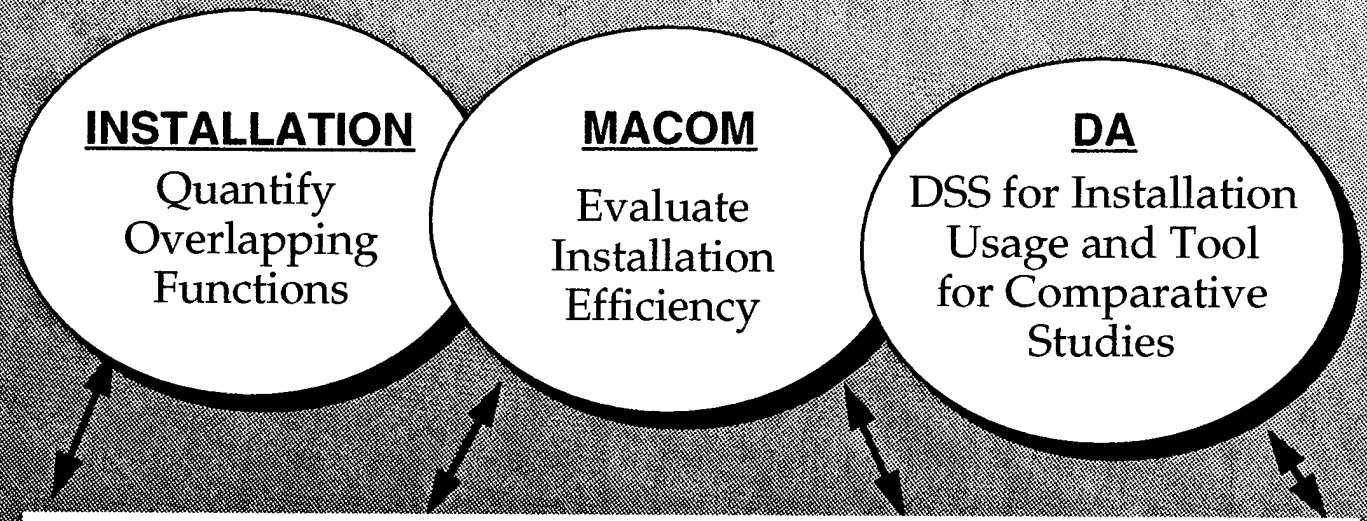
Installation Efficiency Analysis

SPONSOR
ASA (FM)

ANALYSTS
MAJ NANRY
LTC ARMSTRONG
CPT HULL

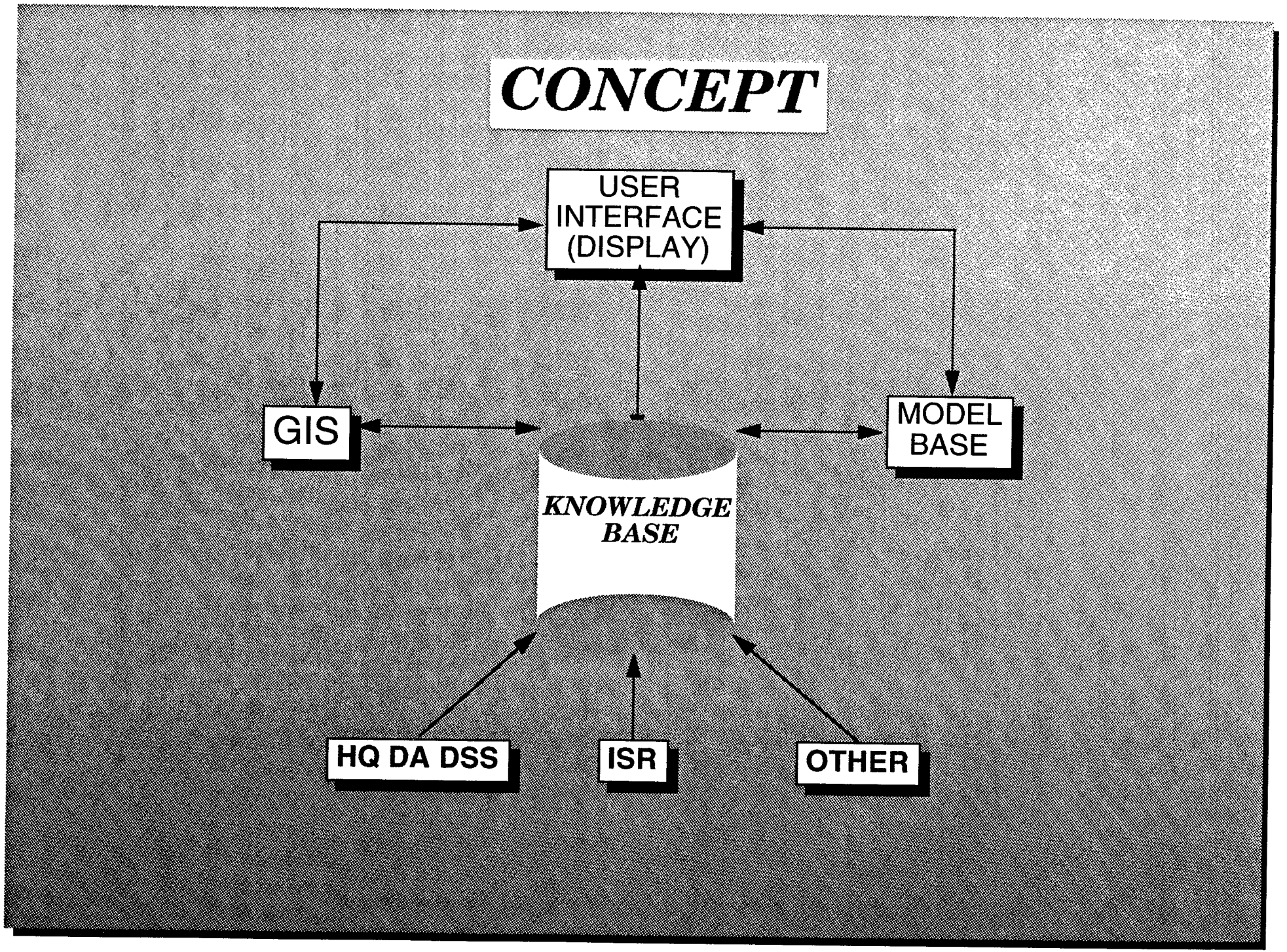
TO IDENTIFY AND EVALUATE EFFICIENCIES ON INSTALLATIONS, OTHER FEDERAL FACILITIES, OR ADJACENT CIVILIAN COMMUNITIES.

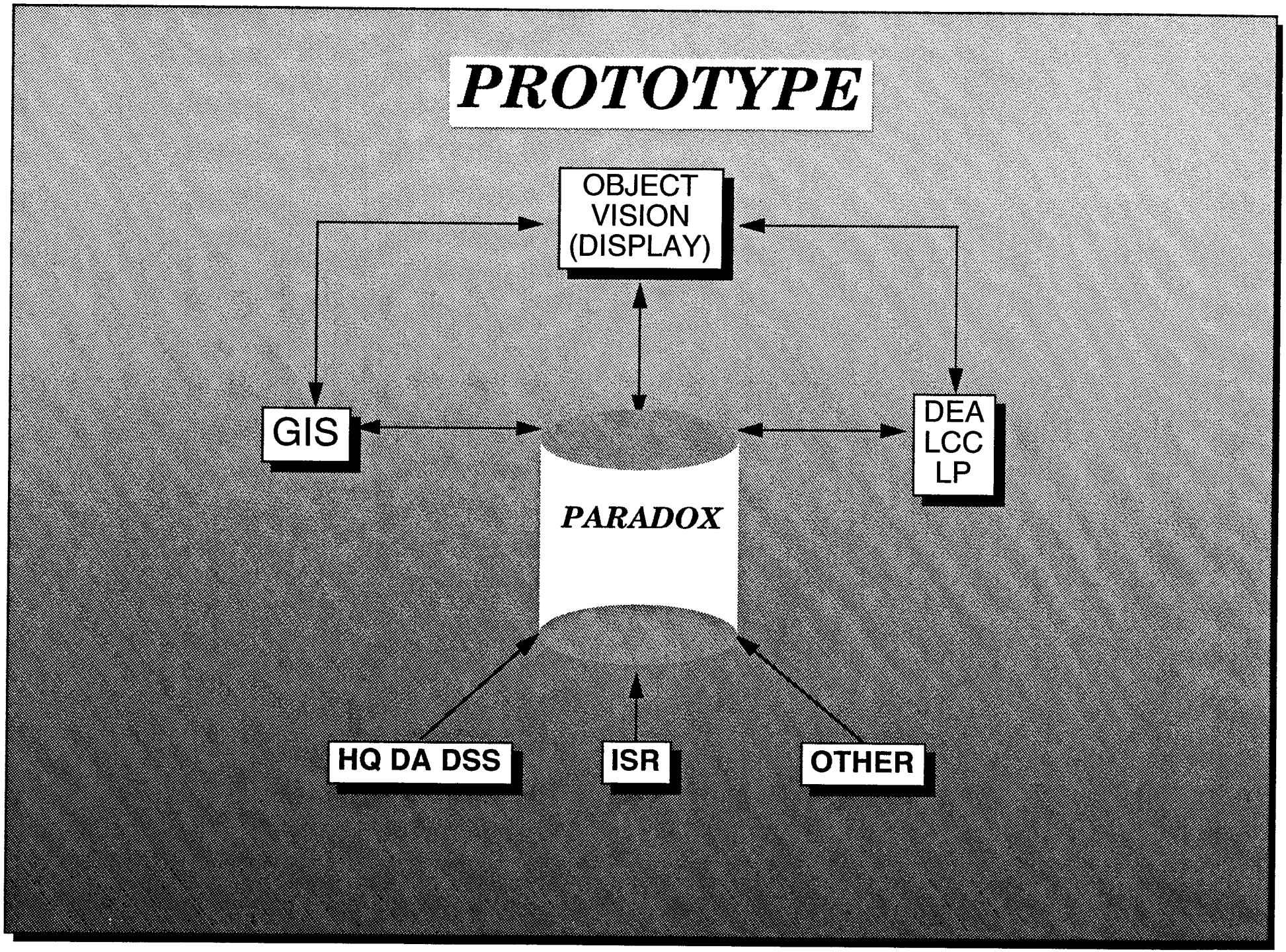
NEEDS



OBJECTIVES AND FEATURES

- Integrated with the **I**nstallation **S**tatus **R**eport
- Problem Solving vs Resource Constraining
- Common / Compatible Software/Hardware (PC)
- Dynamic and Flexible Data Base Management System
- Responsive User Interface - Interactive, User Friendly


CONCEPT
USER INTERFACE (DISPLAY)
GIS
MODEL BASE
KNOWLEDGE BASE
HQ DA DSS
ISR
OTHER


PROTOTYPE
OBJECT VISION (DISPLAY)
GIS
DEA LCC LP
PARADOX
HQ DA DSS
ISR
OTHER

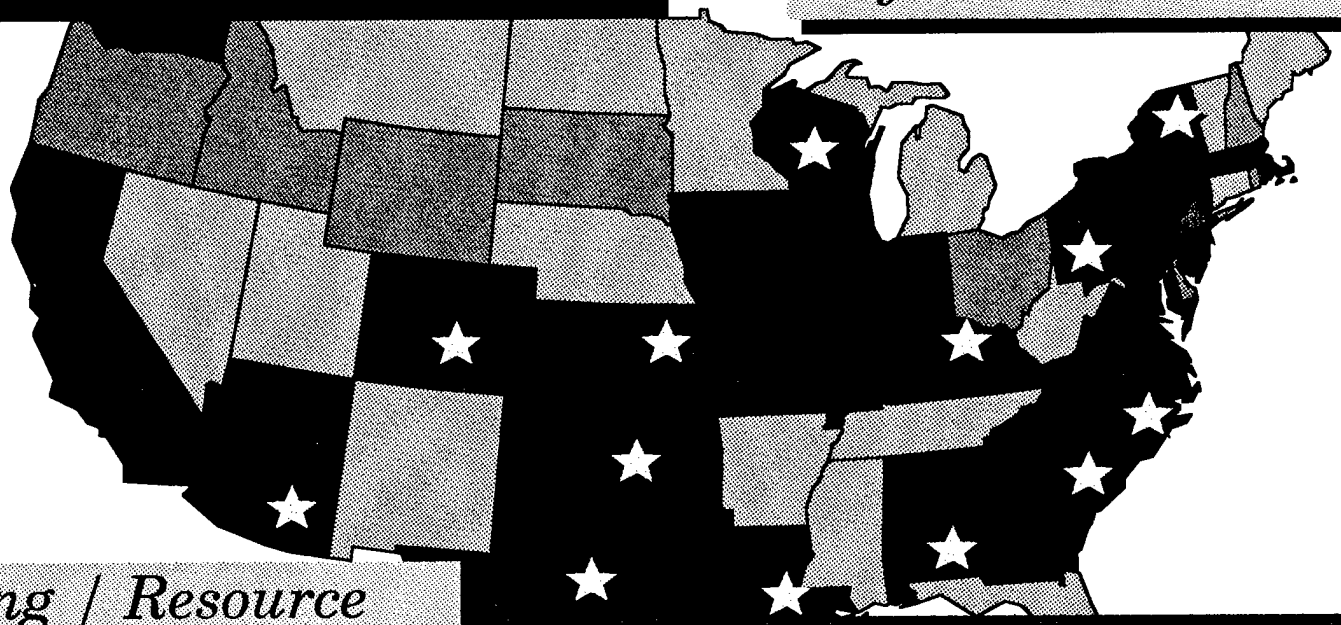
Model Base

Linear Programming Models

Base Closure Model

Life-Cycle Model

Object Oriented Model



Costing / Resource Prediction

? $ C2 to C1 $?

Simple comparisons using cost factors Installation vs Surrounding Community

Analysis Functions 1

- **Compare**
  - Select Installations *&/or*
  - ISR Area(s)
  - Category
  - Sub-category
  - Facility

Look at

- C-ratings
- Quantity
  - Existing
  - Required
  - Capacity

  } Per Population Basis
- Qualtiy
  - Green
  - Amber
  - Red

  } Rollups

Analysis Functions 2

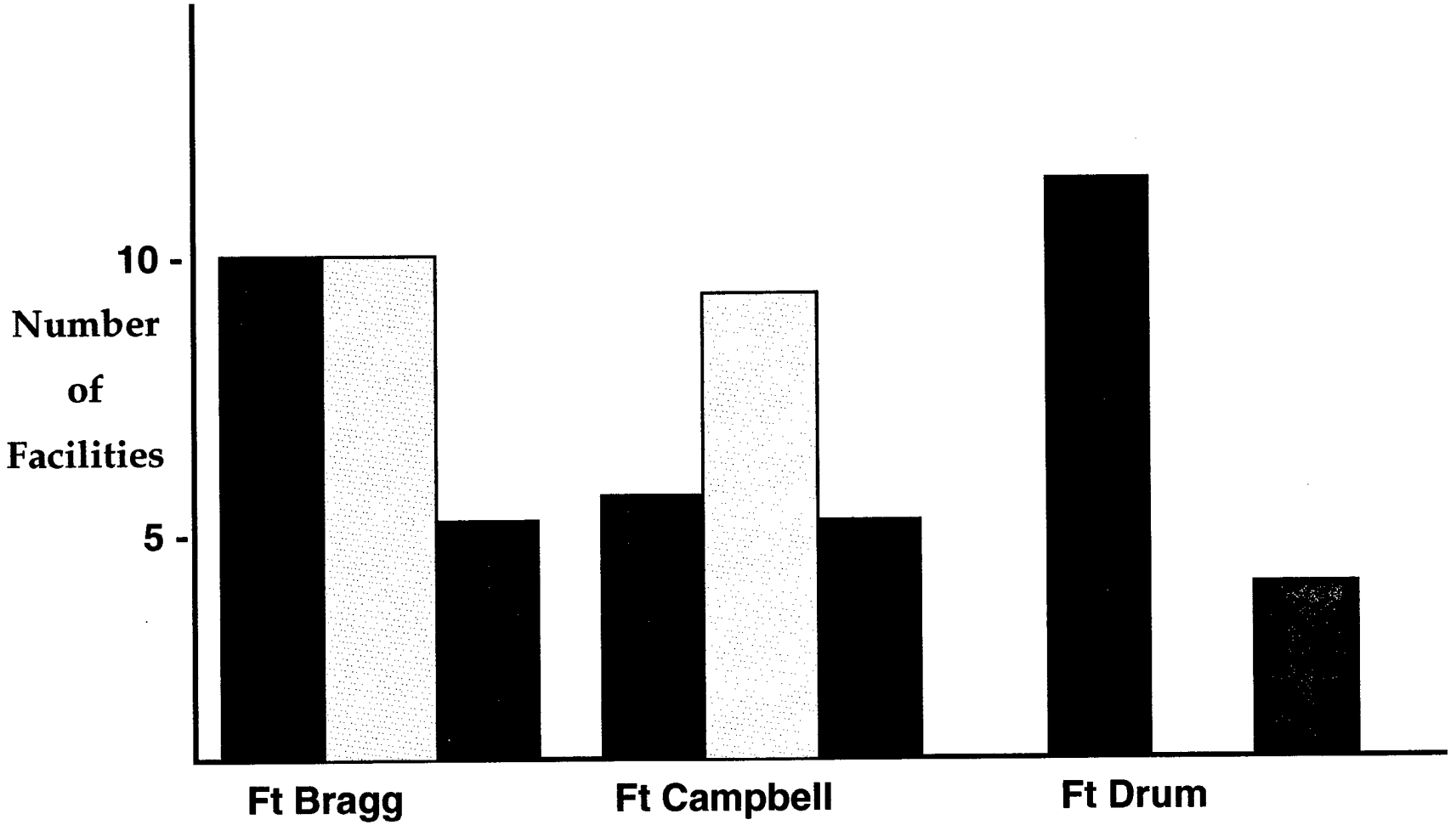
- **Cost**
  - Selection Options
  - Apply Cost Factors
  - Examine Costs to Change
    - C-rating
    - Quantity
      - Existing
      - Required
      - Capacity

      } Per Population Basis
    - Quality
      - Green
      - Amber
      - Red
- **Models**
  - Predictions / Forecasting

Dining Facilities

Installation	Quantity		Quality		
	Existing Required	Number of Facilities	[redacted]	%	[redacted]
Ft Bragg	25	25	40%	40%	20%
Ft Campbell	20	20	30%	45%	25%
Ft Drum	20	15	80%		20%

Dining Facilities



INSTALLATIONS

Data Base Structure

Installation				
Name*	Location	Region	MACOM	Overall Rating
Ft Harmon	Muncy, ND	MidWest	FORSCOM	C3

ISR Areas							
Name*	Mission Facilities	DTS	Housing	Community Facilities	Utility System	ARF	NGF
Ft Harmon	C3	C2	C2	C3	C2	C4	C4

Data Base Structure

ISR Area - Mission Facilities

Name*	Training Ranges	Maintenance & Production	Classrooms	Research & Development	Storage & Warehouses	Administrative Facilities
Ft Harmon		C2	C2	C3	C3	C3

Category - Training Ranges & Areas

Name*	Individual Weapon System Range	Major Weapon System Range	Maneuver Areas
Ft Harmon		C3	C3

Operations Research Center

Data Base Structure

Individual Weapon System Range
Ft Harmon

Quantity		Quality			C Rating
Existing / Required	Number of Ranges	Green	Amber	Red	
0.75	30	0.5	0.2	0.3	C3

Comments

The zero and basic marksmanship ranges for the M16 and M203 Grenade Launcher are in poor condition. The remote target systems are inoperable. The available amount is inadequate to handle total personnel at the installation.

Data Base Structure

Population				
Name*	Active Duty	Family	Civilian	Reserve/NG
Ft Rucker	6,798	16,090	7,356	14,891
Ft Sam Houston	11,055	15,125	5,826	15,018
Ft Sill	19,887	21,681	6,820	795
Ft Stewart	16,594	23,444	3763	250

Data Base Structure

Cost Factors

Location	Utilities*				Construction	Repair & Maintenance
	Water	Sewer	Electric	Gas	LCF	
Ft Harmon	82	41	187	63	.94	$6,010 / k-ft^2

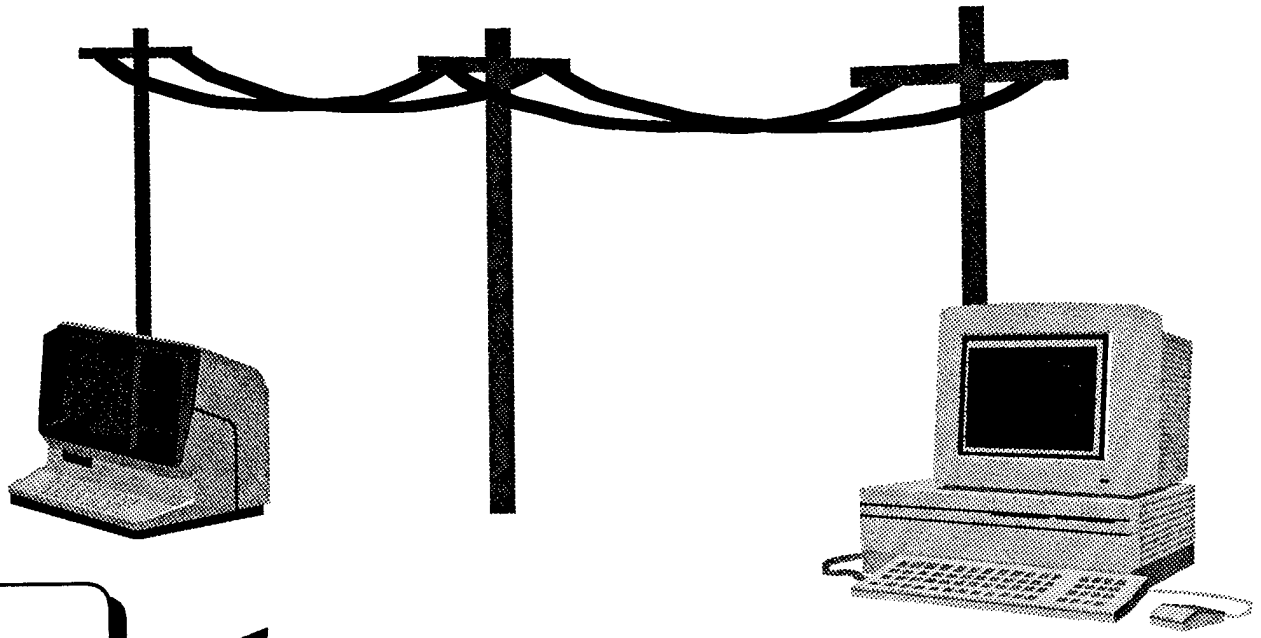
* Utilities Cost Factors are based on $ / person (Military & Civilian) / year

Machine Interface

Userid: aw8012

Password: * * * * * *

Telephone Number: (703) 555-1234



IFS
Automated ISR
Other Databases?

Translate

Installation Efficiency Analysis

7. References

Base Operations Program Evaluation Group. Army BASOPS Primer. Installation Management Division, Directorate of Management, Office of the Chief of Staff. Headquarters, Department of the Army, Washington, D.C.

Davis, Gordon B. and Olson, Margrethe H. Management Information Systems, 2nd Ed. McGraw Hill, 1985.

Frye, David C.. Decision Support for Infrastructure Renewal in the United States Army. Operations Research Center Technical Report 91-1, United States Military Academy, June 1992.

House Surveys and Investigation Staff, US House of Representatives, *Maintenance of Real Property in the Department of Defense*, 25 April 1984.

Sage, Andrew P. Decision Support Systems Engineering. John Wiley & Sons, Inc., 1991.

Singleton, James G.. "Stationing United States Army Units to Bases: A Bi-criteria Mixed Integer Programming Approach." Masters Theses. Naval Postgraduate School, Monterey, California, June 1991.

U.S. Army, *Trained and Ready*, the United States Army Posture Statement, FY 93, Washington, DC, 1992.

U.S. Army Audit Agency, *Validation of the Army's FY 1989 Reported Backlog of Maintenance and Repair*, Alexandria, VA, 31 January 1991.

U.S. Department of Defense, *Renewing the Built Environment*, a DOD report to Congress, March, 1989.

Williams, Arthur, E. Lieutenant General, USA Chief of Engineers. Memorandum on "Installation Status Report" dated 29 December 1992.