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The Army's infrastructure is aging -- much of it is of World War II and Korean War vintage. Resources are diminishing at a time when infrastructure renewal needs are growing. The Army Plan specifies a relatively modest spending "goal" of 1.75% of the total Plant Replacement Value. However, forecasts through FY 1999 reflect a gap between projected funding and the funding required to meet this goal. In order to establish and maintain world class power projection platforms, the Army must coordinate the allocation of resources for facilities revitalization at all levels. In order to determine needs and their relative critically, the Army must have a common system for assessing infrastructure status that is understood by commanders, engineers, and comptrollers alike. Determination of needs must be based on the commander's objective assessment, not on an emotive, subjective appeal. With the infrastructure investment gap, Army leaders must make priority decisions within a structure that ensures consistent application of criteria that support the Army's mission and incorporate well-defined Army installation infrastructure standards. The Army can not afford ad hoc piecemeal fixes with only marginal effects on revitalization. The Army must synchronize its infrastructure renewal efforts through functional, comprehensive planning that yields results with major impact. In short, commanders and facilities planners must operate within a framework that allows them to effectively focus the infrastructure investment.

This report describes the concept for a decision support system that will provide the needed framework. In this system, planners base the planned state for each discrete installation infrastructure system upon defined standards. We propose the development of a clearly defined set of standards for Army facilities. The standards will not replace existing technical engineering standards, but would supplement them with easily understood, yet technically based standards. In order to effectively determine needs, it is imperative that decision makers assess the condition of the various systems in comparison with the appropriate standard.

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Decision Support for Infrastructure Renewal in the United States Army

Major David C. Frye

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

Decision Support for Infrastructure Renewal in the United States Army

by

Major David C. Frye

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Vita

Major David C. Frye was born in Spangler, Pennsylvania in 1957. In 1979 he received his B.A. from Indiana University of Pennsylvania and was commissioned as a Second Lieutenant in the U.S. Army. He has served in a variety of assignments, including tours as a company commander and a battalion executive officer. In 1989, he received his M.S. in Operations Research from Georgia Institute of Technology. As an instructor and assistant professor in the Department of Systems Engineering at U.S.M.A, he has taught courses in Engineering Decision Methods, Production Operations, and Engineering Economy.

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Senior Advisory Group

Ms. Cynthia Baker, Deputy Assistant Secretary of the Army for Resource Analysis and Business Practices, and Mr. Paul Roberts, Director for Investment (Office of the Assistant Secretary of the Army for Financial Management); Mr. James De Wire, Deputy for Programs and Installation Assistance (Office of the Assistant Secretary of the Army for Installations, Logistics, & Environment); Mr. C. Cary Jones, Deputy Assistant Chief of Engineers; Dr. Jules Bellaschi, Deputy Director Program Analysis & Evaluation (Office of the Chief of Staff of the Army).

Project Working Group

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Finally, I thank my wife Linda and my sons Ben and Joe, for their patience, support, and understanding while I worked on this project -- particularly during my many travels to conduct field research.

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Executive Summary

The Army's infrastructure is aging -- much of it is of World War II and Korean War vintage. Resources are diminishing at a time when infrastructure renewal needs are growing. *The Army Plan* specifies a relatively modest spending "goal" of 1.75% of the total Plant Replacement Value. However, forecasts through FY 1999 reflect a gap between projected funding and the funding required to meet this goal. In order to establish and maintain *world class power projection platforms*, the Army must coordinate the allocation of resources for facilities revitalization at all levels. In order to determine needs and their relative criticality, the Army must have a common system for assessing infrastructure status that is understood by commanders, engineers, and comptrollers alike. Determination of needs must be based on the commander's objective assessment, not on an emotive, subjective appeal. With the infrastructure investment gap, Army leaders must make priority decisions within a structure that ensures consistent application of criteria that support the Army's mission and incorporate well-defined Army installation infrastructure standards. The Army can not afford ad hoc piecemeal fixes with only marginal effects on revitalization. The Army must synchronize its infrastructure renewal efforts through functional, comprehensive planning that yields results with major impact. In short, commanders and facilities planners must operate within a framework that allows them to effectively focus the infrastructure investment.

This report describes the concept for a decision support system that will provide the needed framework. In this system, planners base the **planned state** for each discrete installation infrastructure system upon **defined standards**. We propose the development of a clearly defined set of standards for Army facilities. The standards will not replace existing technical engineering standards, but would supplement them with easily understood, yet technically based standards. In order to effectively **determine needs**, it is imperative that decision makers **assess** the **condition** of the various systems in comparison with the appropriate standard. To that end, we propose the development of an *Infrastructure Status Report* that will allow commanders to assess the infrastructure in a manner analogous to the method utilized for assessing the condition of other readiness resources -- the Unit Status Report. Once commanders determine needs and assess conditions, they must **set priorities** in accordance with clear and consistent criteria. We propose the development of a common prioritization methodology that is useful at installation, MACOM, and DA level. This decision support system would also incorporate a mechanism for laying out the **transition states** through which the infrastructure will pass. Such a comprehensive planning system will aid coordination of installation plans with Army-wide functional area plans. Finally, the Army needs to develop the means to **measure progress** toward the planned state. Decision makers can use these measures to monitor the infrastructure to ensure that installation facilities are maintained at the planned state.

The report concludes with suggestions for further research necessary to implement the system. A comprehensive decision support **system** such as the one described in this report will enable the Army to take a more powerful approach to facilities revitalization.

1. Introduction

Concern for the condition of the national infrastructure is increasing. Samuel K. Skinner, then Secretary of Transportation, described the seriousness of the problem stating, "The nation's infrastructure deficit ... represents as much of a threat to America's future as the budget and trade deficits" [Skinner, 1990]. The infrastructure of military installations faces similar difficulties. The military infrastructure deficit degrades our national security posture. With the dramatic developments in eastern Europe, the national military strategy is evolving from forward deployment in overseas bases to power projection from the United States. The Chief of Staff of the United States Army, General Gordon R. Sullivan, stated that in order to execute this strategy "we need to build a trained and ready Army with the infrastructure to support it; ... [the Army] requires *world class power projection platforms*" [Sullivan, 1991].

The U.S. Army Posture Statement for Fiscal Year 1993 states, "Quality Army facilities are the base which provides the infrastructure ... from which landpower is rapidly projected worldwide. Army facilities significantly impact unit readiness by supporting our training and maintenance programs." The posture statement also discusses the impact of facilities on the quality of life before, during, and after deployment and the relationship to attracting and retaining qualified soldiers, their families, and Department of the Army civilians. In response to these concerns the Assistant Secretary of the Army for Financial Management, organized a study group[1] to investigate ways to improve how the Army allocates resources to infrastructure renewal. Based upon our study, we developed a concept for a system to support Army decision makers at all levels in their efforts to focus the infrastructure investment.

1.1. Goal and Objectives

The overall goal for the Army is to achieve Infrastructure Renewal / Facilities Revitalization (IR) through better management of Army resources. The overall objective of this study is to develop a decision support system that will:

- maintain a current *inventory and condition assessment,*
- assimilate *Army infrastructure standards* for installations,
- *predict* IR resource requirements,
- incorporate command *priorities* to *allocate* IR dollars, and
- *measure progress* toward *planned goals.*

This report will relate the problem definition and needs analysis efforts for this study. We will attempt to describe a number of issues and needs concerning infrastructure

[1]The members of the Senior Advisory Group, Project Working Group, and the Operations Research Center.

renewal, to present a concept for addressing these needs, and to suggest areas for future research.

1.2. Definitions[2]

1.2.1. 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.

1.2.2. Renewal

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."

1.3. Field Research

To enhance understanding of the infrastructure renewal challenge, the following organizations were visited.

- Office of the Deputy Assistant Secretary of the Army (Army Budget)
- Office of the Deputy Assistant Secretary of the Army (Installations and Housing)
- Office of the Assistant Chief of Engineers
- Army Engineering and Housing Support Center
- Army Construction Engineering Research Laboratories
- U.S. Forces Command (Office of the Engineer)
- Army Training and Doctrine Command (Office of the Engineer)
- Office of the Civil Engineer, U.S. Air Force
- Air Force Civil Engineering Support Activity
- Navy Facilities Engineering Command (Operations Research Group)

Participation in the following activities further aided understanding.

- Army Worldwide Directorate of Engineering and Housing Training Conference
- Preparation of Army prioritized project submission to DOD Real Property Maintenance Account

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[2]The terms *infrastructure renewal* and *facilities revitalization* are used interchangeably throughout this report. Infrastructure renewal is the term more commonly used in the literature, particularly with regard to the private sector and local government. Facilities Revitalization is the term preferred by the Army engineering community.

2. Background

2.1. Infrastructure Renewal Funding

Funds for infrastructure renewal comes from a variety of sources with differing constraints on usage. The major categories of funding for facilities revitalization include major construction funded by the Military Construction Act for the active Army (MCA), Army Reserve (MCAR), and National Guard (MCNG), as well as Army Family Housing (both Construction and Operations). Funding sources included in the Department of Defense (DOD) Appropriation Act are Real Property Maintenance Activities (RPMA), Environmental Restoration, and other funds, such as Research, Development, Testing, and Evaluation (RDT&E) and Other Procurement, Army (OPA). This report will focus on RPMA and MCA issues since they are the primary source of infrastructure renewal dollars. The basic ideas will still apply regardless of the funding source.

2.1.1. Real Property Maintenance (RPM)

Base Operations (BASOPS) funds are used to support daily activity on an installation[3] and are provided under the Operations & Maintenance, Army (OMA) appropriation. The RPM functional accounts are a subset of the BASOPS funds. These accounts (with letter designation) are:

K) Maintenance and Repair of Real Property
L) Minor Construction.

The purpose of RPM is to maintain Army facilities at a level required to meet mission requirements. Maintenance and Repair of Real Property does not include the operation of utilities or engineering support such as fire prevention and pest control. Minor construction, as of 5 December 1991, is any <u>new</u> construction costing no more than $300,000.

An important factor to consider in the allocation of RPM funds is that as OMA dollars, they may be reprogrammed by the major command (MACOM) or installation commander into other OMA accounts. Thus, even though certain RPM projects may be budgeted for, they may be postponed or deleted for competing non-RPM requirements such as training. This migration of OMA funds is a common practice in the Army. Actions to slow some of the migration are being considered. If implemented, all funding for Major Repair and Minor Construction[4] (MRMC) would be transferred to Major Construction Army (MCA) accounts. Consequently funds budgeted for MRMC projects would not be subject to OMA migration.

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[3]See Appendix A for a listing of BASOPS accounts.

[4]All L account projects and those K account projects costing $50,000 or more are classified Major Repair / Minor Construction (MRMC).

2.1.2. Major Construction Army

Any new construction costing more than $300,000 is submitted as an MCA project and undergoes the Military Construction (MilCon) review process. Installation planners initiate these projects and program them in a standard Department of Defense format (DD Form 1391, *Military Construction Project Data*). Installation committees review and prioritize the projects and forward selected projects to the installation's Major Command (MACOM). Each MACOM in turn reviews the submissions from all of their subordinate installations, prioritizes them, and submits their recommended projects to the Office of the Assistant Chief of Engineers (O/ACE) at Department of the Army. O/ACE consolidates all MACOM submissions for review by the DA Construction Requirements Review Committee that has representatives from the various stakeholders on the Army Staff and Secretariat. DA submits a prioritized listing to DOD for inclusion in the DOD submission to Congress. Congress then selects the projects it wishes to fund through MilCon appropriations.

2.1.3. DOD Real Property Maintenance Account

For fiscal year 1992, Congress appropriated $500 million for RPM projects that were not in the original budget request. $450 million is to be used for major repair and maintenance projects submitted by the Army, Navy and Air Force. The services submitted prioritized listings to compete for the funds. DOD will use the remaining $50 million to initiate a pilot program of facility condition surveys. "The goal of this program is to improve information available on RPM activities and enhance congressional oversight. These surveys will include what are known as fence-to-fence engineering assessments... of all facilities located at a base or shipyard[5]. They will serve as a basis for a maintenance plan for each base, listing projects by priority and including cost estimates" [U.S. Senate Appropriations Committee, September 1991].

2.2. Backlog of Maintenance and Repair (BMAR)

The Army (and the other services) reports the Backlog of Maintenance and Repair each year as a part of the budget submission. BMAR is used as an indicator of the condition of real property assets and 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 [Livingstone, 1991 and Palmer, 1991].

2.2.1. Background

The concept of BMAR began 1 March 1960 when DOD required the services to report on their backlog of essential maintenance deferred at the end of the fiscal year. Essential Maintenance was defined as either routine recurring work or major restoration

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[5]There are eight Army bases designated to undergo the initial assessment: Fort Bragg, Fort Lewis, Fort Polk, Fort Campbell, Fort Stewart, Fort Hood, Fort Knox, and Redstone Arsenal.

actions required to sustain a facility to its intended design or capacity [Price, p. 15]. Over the years, the use and definition of BMAR have evolved considerably, and DOD has seen increasing congressional concern with the level of real property maintenance. Today each of the services defines and forecasts BMAR differently. The Army defines BMAR as "a fiscal year end measurement of [maintenance and repair] work that remains as a firm requirement and was not started during the fiscal year due to a lack of resources" [U.S. Army Regulation 420-16, 1987]. BMAR refers only to RPMA projects that had been submitted on an approved annual work plan.

2.2.2. Reporting Procedures[6]

Army installations annually submit an *Unconstrained Requirements Report* (URR) to their MACOM for consolidation and further reporting to DA. The purpose of this report is to identify the total Real Property Maintenance (RPM) requirements needed to maintain the Army's facilities. The report consists of three parts: Annual Recurring Requirements (ARR)[7], One-time Requirements, and BMAR. ARR includes minor construction, but legislation limits total planned new work (with some exceptions) to 10% of sum of the ARR for Maintenance and Repair (M&R) (the K account) and minor construction (the L account). One-time requirements are those items not covered in the ARR. One-time requirements may be brought on by changes in mission, programs, or operational needs. BMAR consists of the unfunded projects costing more than $10,000 and chargeable to the maintenance and repair of real property account (K account).

The Army uses the URR to develop and present total requirements in the planning phase of the Planning, Programming, Budgeting, and Execution System (PPBES) cycle, in the initial phase of building the Program Objective Memorandum, and subsequently to allocate resources to MACOMs for redistribution to installations. The Army uses URR for RPMA program management, policy development, and for reporting to other authorities such as DOD and Congress.

Analysts make forecasts by carrying over current year BMAR figures and adjusting them for inflation and deterioration to determine Total Growth. ARR forecasts adjust current year figures for inflation and aging of facilities. Total Growth + ARR forecasts + other known requirements comprise Total Requirements. Total Resources are the direct funds projected for RPM. Future BMAR is then calculated as Total Requirements less Total Resources.

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[6]Procedures for preparing and submitting BMAR reports are detailed in Army Regulation 420-16.

[7]AR 420-16 defines ARR as "the level of operations, M&R[maintenance and repair], and services needed to sustain occupant activities, prevent avoidable deterioration of the physical plant, and preserve real property in accordance with established engineering standards while adequately supporting assigned missions." Operations is the level of utility support consistent with the geographical area. M&R is the level of work required to prevent deterioration of the physical plant. Services refer to engineer support such as custodial services.

2.2.3. Issues[8]

The notion of BMAR seems fairly simple and straightforward, yet there are a number of issues that complicate matters. Accuracy 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 also lead to an under allocation of resources. In a 1991 report entitled, *Validation of the Army's Fiscal Year 1989 Reported BMAR*, the U.S. Army Audit Agency (AAA) identified two of the Army's major concerns as the growth of the BMAR and the credibility of the reported amount [U.S. Army Audit Agency, p. 10].

The Army Audit Agency [p. 19] identified two issues which installation engineers blamed for placing little emphasis on BMAR accuracy:

- 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, p. 21]. The agency found that the installations did not receive sufficient funding and were forced to operate under personnel shortages [pp. 29-30].

The FY 89 Continental United States (CONUS) BMAR was reported as $933.8 million. The Army Audit Agency found that although there were a number of inaccuracies[9] at the installation level, MACOM totals reflected valid needs. However, further review of the 27 surveyed installations uncovered $313 million in required work that the command had found and NOT reported. Additionally, AAA performed technical inspections on four installations (Forts Lewis, Polk, Benning, and Lee) to determine the level of work not identified and reported to DA. On these four installations alone, the agency found $1.035 billion in unidentified M&R work [US AAA, pp. 23-24]. Thus, the FY 89 BMAR was under reported by *at least* $1.3 billion or 136% of the reported CONUS BMAR. With the downsizing of the Army and consequent reduction of resources, these issues will add to the decline of BMAR accuracy, credibility, and reliability.

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[8]This report does not address a number of problems due to the differing definitions, forecasting methods, and reporting procedures used by each of the services. See Price for further discussion of these issues.

[9]The AAA attributed many of the inaccuracies to a lack of standard procedures for updating the backlog lists and no Army requirement to report all known M&R work.

The migration of RPM funds to other OMA accounts is an issue that not only contributes to the unreliability of the BMAR, but also contributes to its growth. Many engineers in the field believe that RPM often serves as the billpayer for training and readiness. In FY 88 Congress removed the statutory floor on RPMA spending and larger amounts of funds have migrated out of the program.

M&R Funds	FY 86	FY 87	FY 88	FY 89
Appropriated	$1,320	$1,729	$1,479	$1,485
Migration	$9	$79	$291	$197
Migration %age	0.6%	4.5%	19.6%	13.3%
Backlog Growth	$(116)	$48	$554	$627

Table 2.1 Migration of M&R Funds (in millions) [U.S. Army Audit Agency, p. 30]

Installation commanders will reallocate funds to pay for unfunded training and readiness needs. Often they do this under the assumption that funds will become available at the end of the fiscal year to handle the RPM needs. However, even when such funds are available, there is often little time to adequately plan for the execution of the projects. Thus, the BMAR continues to grow.

Another problem with the 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 the BMAR were accurate, it would not truly represent total infrastructure renewal needs.

2.2.4. Summary

There are many problems with BMAR and many in the Army who question its validity. One assessment of BMAR by a highly placed DA budget official is that "BMAR is bankrupt;" a comment that has received numerous affirmations from the field. In 1984, Mr. Robert Stone, Deputy Assistant Secretary of Defense (Installations) made the following comments to the House Subcommittee on Appropriations:

- The projects contained in the BMAR are valid, but BMAR does not contain all the valid projects.
- BMAR is not an indicator of M&R need and should not be used to justify funding.
- BMAR is not considered a good management indicator for base allocation of resources [U.S. House, 3 May 84, pages 718-719 and 732-735].

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 can not be discerned. The Army needs additional indicators and decision support tools to better focus the investment in the infrastructure.

2.3. Army Infrastructure Planning

2.3.1. The Army Plan

The Army Plan (TAP) [U.S. Army, 1991] provides long and mid-range planning guidance for resource allocation among all Army programs. A summary of the objectives for facility's maintenance, construction, and utilization that are relevant to this report follows.

Support for the Maintenance of a Trained and Ready Army - The Army's infrastructure must support the Army's ability to recruit, train, and sustain a high quality force with facilities that provide excellent living and working conditions. Focus investments on facilities that will remain after force structure reductions.

Facilities Reduction - Wherever possible eliminate unessential facilities and replace obsolete facilities with modern ones where required. The elimination of World War II temporary facilities is a priority.

Power Projection - Plan for facilities that will support the Army's roles in the evolving national military strategy. Army facilities must enhance the capability to project forces around the world. Wherever possible, include facilities in the cost of new initiatives to preclude the decrementing of resources for infrastructure renewal.

Resource Management and Planning - Improve the manner in which the Army plans for and allocates resources to the infrastructure. Support facilities research and development efforts and accomplish technology transfer of these initiatives. Continue to reduce energy use by planning for energy efficiency in construction and repair projects. Sustain automated real property data bases.

Utilities Management - Support regional solutions to provide water and waste treatment with off base plants. Encourage private industry to construct, own, and operate utility plants and systems and other service facilities where more economical than government owned and operated ones.

The programming guidance establishes a goal of investing in infrastructure renewal at a rate of 1.75 % of the Plant Replacement Value[10] (PRV). This equates to a 57 year

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[10]Plant Replacement Value is the estimated cost to rebuild a similar facility in current dollars. To determine the replacement cycle, invert the decimal value for the percent of PRV invested annually. For example, with a 2% investment rate, the decimal value is 0.02 which equates to a 50 year replacement cycle.

replacement cycle. The goal for Army Family Housing (AFH) is 2.86 % of PRV or a 35 year replacement cycle. The aim is to contain the growth of the Army's Backlog of Maintenance and Repair and AFH revitalization backlog. The Army Plan states that these investment rates have not been attained due to increasing facility inventories[11] and decreasing renewal budgets.

2.3.2. Facility Revitalization Strategy

The Army's strategy for infrastructure renewal has two main tenets, the reduction of facilities inventory, and the provision of sufficient resources to revitalize facilities. The Base Realignment and Closures (BRAC) program is one of the more widely recognized efforts to reduce the inventory. Under this program DOD, with congressional approval, has and will continue to close many installations and realign others to consolidate activities. The Army also has a facility reduction plan, the goal of which is to consolidate into the best facilities and close the rest. Additionally, the Army has imposed a requirement on its MACOMs to demolish one square foot of old facilities for each square foot of new construction. The purpose of this policy is to restrain the growth of the inventory.

Consider the resourcing of infrastructure renewal in terms of the amount of funds available and the amount of facilities requiring revitalization. In a mathematical sense then, one can express the infrastructure investment rate (IIR) as follows:

$$\text{IIR} = (\text{Funds for Renewal}) / (\text{Total Facilities})$$

or

$$\text{IIR} = \$\$ / \text{PRV}$$

With this equation it is clear that there are only two ways to improve the investment rate. Either increase the number of dollars earmarked for revitalization or reduce the number of facilities requiring renewal. Given current and projected funding forecasts, the Army is more likely to rely on the latter. Thus with limited resources, reducing the number of facilities concentrates the impact of the renewal dollars; i.e., it *focuses the investment.*

Figure 2.1 depicts the Army's actual and forecasted Plant Replacement Values for fiscal years 1990-1999 [Kraeer, 1992]. There is some decline[12] initially, but forecasts do not reflect a steady decline. In fact, inflation adjustments reveal growth of the total PRV.

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[11]The increase in the inventory has occurred because new facilities have been constructed and the buildings they replaced have been converted to other uses.

[12]A portion of the initial reductions reflect administrative actions. Medical facilities are now considered DOD assets and are no longer included in Army PRV estimates. Because regulations prohibit MRMC on World War II wooden facilities, they have been administratively removed from PRV estimates[Kraeer, 1992].

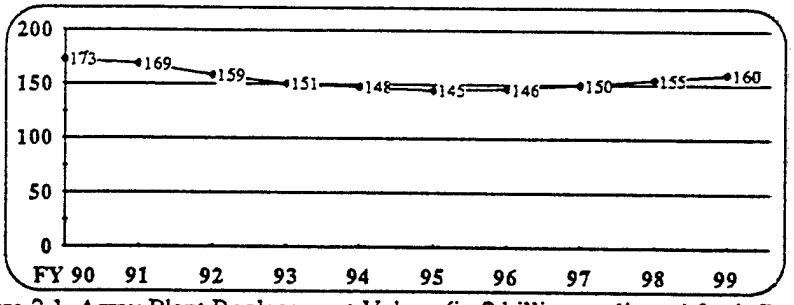

Figure 2.1 Army Plant Replacement Values (in $ billions, adjusted for inflation)

Providing sufficient resources is a more complicated challenge. Generally, the funding for infrastructure renewal is relatively fixed at a certain level within the total Army budget. Infrastructure renewal competes with other needs. Even if they are programmed into the budget, OMA portions often migrate to these other needs. In order to protect the facilities investment, *The Army Plan* establishes the goal of investing at the rate of 1.75% of the PRV to contain the BMAR. It also places the highest priority on meeting legal and environmental requirements followed by those providing quick economic payback and having the greatest impact on unit readiness and quality of life [US Army, 1991, p. 46].

2.4. The Infrastructure Investment Gap

Army planners designed the goal of investing at 1.75% of PRV to provide sufficient resources to contain the BMAR. Note, however, that investment at this rate will not *reduce* the BMAR. Even so, there is a gap between this relatively modest goal and programmed expenditures. Funding plans[13] as percentages of PRV equate to 0.95% in FY 93 and improve to 1.44% in FY 94. However, as depicted in Figure 2.2, the Army will not likely close the gap in this decade [Kraeer, 1992].

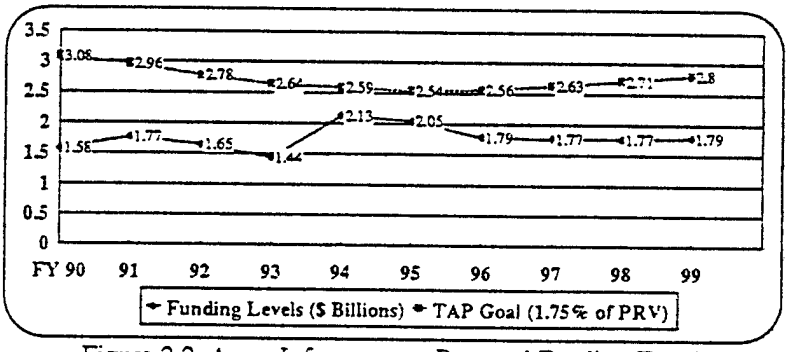

Figure 2.2 Army Infrastructure Renewal Funding Trend

As 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

[13]Primary sources of funding include current mission MCA, BRAC, Major Repair / Minor Construction (i.e., all funds budgeted for L and > $50,000 from K accounts), and residual value from sale of overseas real property assets.

and that this amount must be doubled by the year 2000 in order to meet the needs of the existing infrastructure. The DOD study, *Renewing the Built Environment*, compared DOD investments with those of 6 major colleges and universities, 16 major private organizations, and 23 non-DOD government entities [U.S. Dept. of Def., 1989, p. H-16].

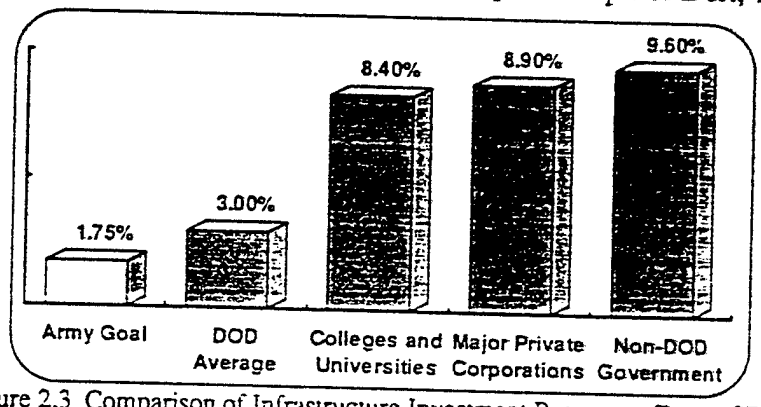

Figure 2.3 Comparison of Infrastructure Investment Rates as a %age of PRV

The comparison shows DOD trailing these groups, with the Army behind even the DOD averages. One can see then, 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. Given the limited availability of funds we explored ways for the Army to get the most out of its revitalization investments.

3. Needs Analysis

The Army has considerably more renewal needs than dollars to fund them. The infrastructure investment gap emphasizes the fact that the Army does not have enough money to pay for all of its renewal needs. Therefore, it is imperative that the Army leadership concentrate available dollars on those facilities investments that yield the largest return. Those leaders who are responsible for allocating resources need improved decision support in order to better focus the investment.

The renewal of infrastructure really evolves to answering a logical, common-sense set of questions. *Where are we now? Where are we going? How do we get there? How are we doing?* [Riordan, et al. 1987, Lamphere, 1986, and more] *What are our priorities?* In order to analyze the Army's needs, we kept these questions in mind.

3.1. Condition Assessment

In order to answer the question, "Where are we now?", planners must have an accurate inventory of all facilities and a description of their condition. The Army utilizes the Headquarters Level Integrated Facilities System (HQIFS) for inventory and resource planning. HQIFS is a family of automated engineering management systems that provides facilities and cost data for MACOM and DA level use. Integrated Facilities System (IFS) is the installation level management system and the feeder for HQIFS [U.S. Army Engineering and Housing Support Center, 1992, pages 34-40]. As with any large database system there are many challenges to maintaining accurate and timely information. Particularly problematic with this system is the reporting of facilities' condition. HQIFS contains a data field for installations to report on the condition of individual facilities. The U.S. Army Engineering and Housing Support Center commissioned an independent study of condition code reporting for HQIFS. Analysts reviewed data as reported by installations in June 1991 and concluded, "The existing database of Facility Condition Codes is worthless for any management purposes." Two major factors leading to this evaluation were inaccurate and incomplete data and inconsistent reporting schemes [R&K, 1991].

The Army Audit Agency described a need to perform periodic technical inspections of real property. Such inspection would provide a more reliable basis for evaluating the condition of real property and for identifying resources needed to bring the real property inventory up to standard [U.S. Army Audit Agency, p, 25]. As related in section 2.1.3, Congress has also identified a need for improving condition assessment. However, these methods are costly and they tax already overburdened engineering personnel. The need for an inexpensive assessment tool exists. Such a tool must provide accurate information to resource planners on a regular and frequent basis. The Army needs to develop inexpensive, yet technically based criteria for assessing the condition of installation infrastructure

3.2. Standards

General Carl E. Vouno, former Chief of Staff of the Army, has said, "A great sergeant major once told me, 'The only time we ever get into trouble is when we don't know the standard or don't enforce it' " [U.S. Army Training and Doctrine Command]. Engineers use detailed technical standards for construction and maintenance of Army facilities. However, these standards are not useful for decision makers who allocate resources at the DA, MACOM, and even installation level. More often than not, these decision makers are not engineers.

The Army needs to develop a set of well-defined standards for all of its facilities. The standards should be easily understood so that they are meaningful to non-engineers as well as engineers. These standards would serve as benchmarks against which the leadership can assess the condition of the infrastructure. They could also serve as a foundation for answering the question, "Where are we going?"

3.3. Prioritization Methodology

In a resource constrained environment, as described by the infrastructure investment gap, establishing priorities is requisite for effective investment of capital. Tough priority decisions must be made to distinguish between desirable improvements and critical needs. All MACOMs and installations have methodologies for prioritizing projects. However, they are all different. The techniques employed vary considerably in the degree of sophistication and level of technology used. More importantly, they use different criteria to rank projects. Following are the factors used by the two largest MACOMs for RPM projects and the factors used by DA to prioritize projects for the DOD RPM Account submission.

FORSCOM	TRADOC	DA
Facility Category	Facility Category	CONUS or OCONUS
Project Purpose	Project Justification	Mission Category
Project Type	Work Description	Facility Group
Condition	Facility Condition	MACOM Priority
Mission	Installation Priority	Cost

Table 3.1 RPM Prioritization Factors

Because nothing existed at DA level, and the MACOM procedures were so dissimilar, the Office of the Assistant Chief of Engineers developed an ad hoc methodology solely for the DOD RPM Account submission. A significant dilemma resulted from the use of different criteria within the DOD RPM Account prioritization process. Frequently, projects submitted high on a MACOM list would drop below lower rated projects after undergoing the DA procedure. Another problem that surfaced during the DOD RPM Account prioritization was that even though MACOMs consider condition when assigning priorities to projects, most of the project submissions contained little if any description of the current state and no mention of the planned state for the facility.

Although many existing methods incorporate the current condition, none of the prioritization methodologies consider the planned condition of the facility. For example, there is no way to distinguish between a project to renovate a barracks building from intolerable to adequate conditions and a project to upgrade adequate barracks to the highest condition. Contributing to the lack of planned conditions is the lack of well-defined standards for the infrastructure.

3.4. Comprehensive Planning

Infrastructure renewal planners need clear answers to know where the Army is going and how it will get there. The revitalization of facilities demands a myriad of resources and years of planning by the many agencies involved at varying levels in the process. A standard method for infrastructure planning will aid in the effective orchestration of these assets.

The DOD study, *Renewing the Built Environment*, recommended instituting five year maintenance planning at each installation. Such planning greatly aids programming and budgeting of RPM and assists with addressing deferred maintenance. The longer planning horizon allows more efficient allocation of resources and coordination of work [U.S. Department of Defense, 1989, p. 30].

Many of the key decision makers spend no more than two years in their assignment. Comprehensive, long-term plans for renewing the infrastructure will help to overcome the learning curves and will provide a target for their efforts.

The Army can not afford extemporaneous band-aid solutions for revitalizing facilities. There are many who plan diligently within in their own domain. However, with such a vast inventory of real property assets, these individual plans must be synchronized across the Army to realize a greater return on investment.

3.5. Link to Readiness

3.5.1. Command Involvement

A traditional command philosophy is that the Army fights from foxholes, not from installations. Consequently, the infrastructure takes a back seat to other readiness resources such as training and maintenance which have a more readily discernible bearing on readiness. The Assistant Secretary of the Army for Installations, Logistics, and Environment and the Assistant Secretary of the Army for Financial Management wrote in a memorandum to the Secretary of the Army, "...a sensitized leadership climate [is an] integral component of a policy that will reverse the steady decline in facilities revitalization." Among the initiatives that they cited for halting the decline were reward for commanders' commitment to quality facilities and the inclusion of attaining facilities quality standards as a measure of performance on commanders' evaluation reports [Livingstone and Brook, 1990].

However, commanders often feel that they are at the mercy of 'bean counters' and engineers and do not have enough influence on the infrastructure renewal process. They need a mechanism to articulate their needs to the Army's prioritizers. They must also be given the latitude to invest in the infrastructure rather than other readiness resources as necessary. Often installation commanders are faced with a 'long-term -- short-term management dilemma'. As the installation commander they are responsible for installation facilities, but as the division or corps commander, they are responsible for unit training and readiness. Facility revitalization has a long-term planning horizon while training management has a relatively short-term outlook. Generally speaking, Army leadership provides incentives and motivation for the training and readiness goals. Hence, the infrastructure becomes a lower priority and frequently pays the bill for other readiness resources.

3.5.2. Infrastructure and the Army Imperatives

The infrastructure is linked to readiness and should also be considered a readiness resource. Though the relationship may not be as apparent as it is for personnel, training, equipment, and maintenance, it does exist. A report prepared by the Office of the Assistant Secretary of Defense for Production and Logistics stated, "All base operating support, either directly or indirectly, contributes to the performance of the mission [U.S. Department of Defense, 1988, p. 3].

The Chief of Staff of the Army has established six imperatives (depicted in Figure 3.1) to "building a trained and ready Army." The roles played by Army facilities are intertwined in most of these imperatives.

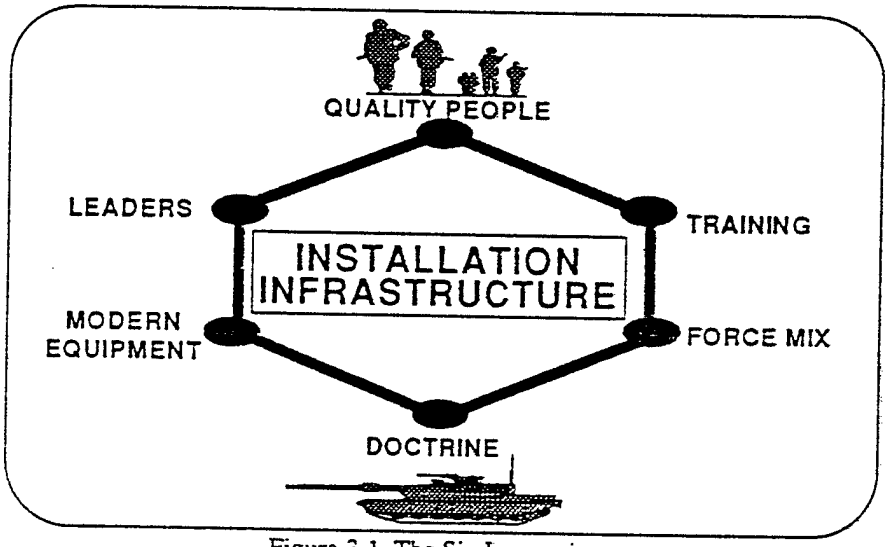

Figure 3.1 The Six Imperatives

The living and working conditions of Army facilities must offer a quality of life that will attract and retain quality soldiers, civilian employees, and their leaders. Obviously, the Army's infrastructure does not go to war, but soldiers are not always deployed and a large part of the Total Army is composed of civilian employees who rarely deploy. Therefore, the Army must invest wisely in its resources that do not deploy but do support the ability to deploy. "Military installations are vital to the nation's security... The

investment that this country makes in its defense facilities is an investment in its military people -- an investment that is repaid in the form of improved pride, greater performance, and better combat readiness" [U.S. Department of Defense, 1988, p. 3].

The Army trains on its installations and training centers. The impact of the quality of facilities on training, whether in the classroom or in the field can not be overstated. Under investment in training infrastructure equates to an under investment in training.

Modern weapon systems and other equipment are vital to sustaining a lethal, agile force that is capable of responding to an array of contingencies all over the world. How long though, can modern equipment operate at its designed effectiveness levels if it is housed and maintained in antiquated facilities? A report for Congress contrasted Army and Air Force attitudes toward weapon systems procurement and related Military Construction investment. The report stated, "Field training is the [Army's] top priority... In contrast to the Air Force, the Army has been willing to take whatever new procurement it can get, even if associated 'new mission' MilCon is not forthcoming" [Cohen and Dogget, 1991, p.40]. The Air Force generally submits infrastructure requirements as a part of the total weapon system procurement package. They perceive the facilities as an integral part of the weapon system and will not accept anything less. In the past, being predominantly *forward-deployed* in potential combat areas, the Army has been willing to accept the weapons without the facilities. Now that the national military strategy requires *CONUS based* power projection platforms, the Army must reconsider its 'foxhole philosophy' towards weapon system procurement.

3.6. Conclusion

The Army's infrastructure is aging -- much of it is of World War II and Korean War vintage. Resources are diminishing at a time when infrastructure renewal needs are growing. In order to establish and maintain *world class power projection platforms*, the Army must coordinate the allocation of resources for facilities revitalization at all levels. In order to determine needs and their relative criticality, the Army must have a common system for assessing infrastructure status that is understood by all, commanders, engineers, and comptrollers alike. Determination of needs must be based on the commander's objective assessment, not on an emotive, subjective appeal. With the infrastructure investment gap, Army leaders must make priority decisions within a structure that ensures consistent application of criteria that support the Army's mission and incorporate well-defined Army installation infrastructure standards. The Army can not afford ad hoc piecemeal fixes with only marginal effects on revitalization. The Army must synchronize its infrastructure renewal efforts through functional, comprehensive planning that yields results with major impact. In short, commanders and facilities planners must operate within a framework that allows them to more profitably invest in the infrastructure.

4. System Framework

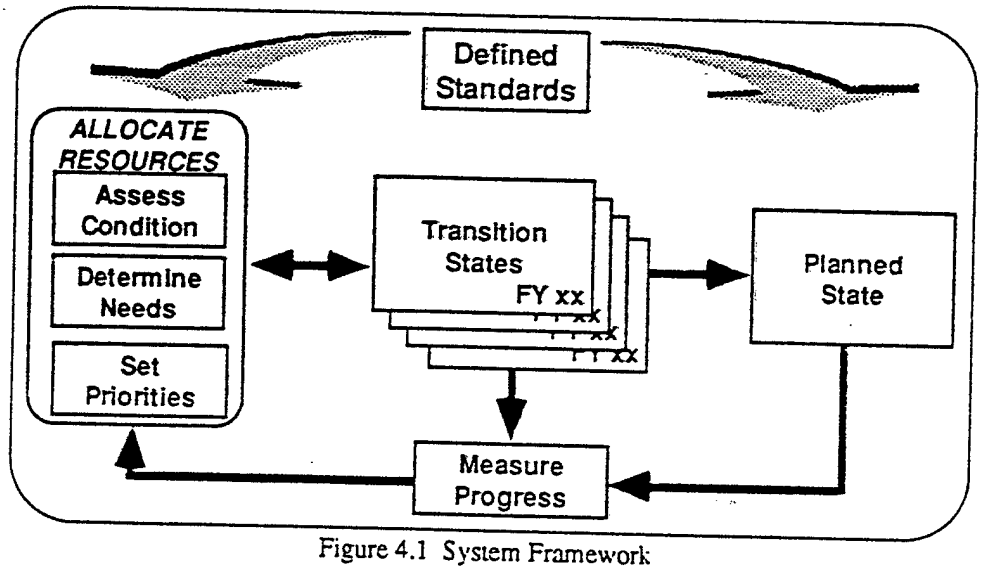

Figure 4.1 System Framework

4.1. System Overview

An effective infrastructure renewal Decision Support System (DSS) will incorporate the components as depicted in figure 4.1. Planners must base the objective or **planned state** for each discrete installation infrastructure category upon clearly **defined standards**. In order to effectively **determine needs**, it is imperative that decision makers be able to **assess the condition** of the facilities in comparison with the appropriate standard for each infrastructure category. Once commanders determine needs and assess conditions, they must set **priorities** in accordance with clear and consistent criteria. Due to resource and other constraints, the infrastructure obviously will not immediately attain the planned state. Therefore, it will be necessary to plan for the intermediate or **transition states** through which the infrastructure must pass. Finally, the Army needs to develop the means to **measure progress** along the path toward the planned state. Decision makers can also use these measures to monitor the infrastructure to ensure that facilities are maintained at the planned state and not allowed to deteriorate.

4.2. System Components

4.2.1. Defined Standards

The system must be based on a well defined and easily understood set of Army standards for installation infrastructure. Though this may be the most controversial component to develop, it is essential to the long term success of infrastructure renewal. These standards will not replace technical engineering standards, but will supplement them and be meaningful to non-engineering personnel as well. The standards must address a number of facility criteria such as function, form, size, quality, appearance, etc... Once developed, the standards serve as the basis for the planned state of the infrastructure.

The standards can allow for different levels of facilities readiness within an infrastructure category. For example, temporary barracks on training ranges or installations are used intermittently and only for short periods of time. The readiness standards for these facilities then might be more austere than permanent barracks serving as homes for soldiers. Another example is that readiness standards for maintenance or training facilities used by rapid deployment forces might be higher than for facilities used by other units.

4.2.2. Resource Allocation

Supporting the effective allocation of increasingly scarce resources is the primary purpose of this system. Accordingly this component is the real driver of the system. The Army must obtain a system-wide determination of infrastructure renewal needs and allot funds to deal with them. Under ideal circumstances of unlimited funding this might be a rather trivial pursuit. However, the more restricted the funding, the more important it becomes to identify not only the needs but also to distinguish between them. Limited dollars also imply a need to prioritize spending opportunities in order to net the best possible return.

An alternative to resource intensive technical engineering inspections is to have commanders make an assessment of the facilities their units live and work in. The commanders' facilities assessment tool that we propose would be analogous to the Unit Status Report which commanders use to assess the condition of their other readiness resources: personnel, training, equipment, and maintenance.[14] The ***Infrastructure Status Report*** (ISR) would be a non-technical, but technically sound set of questions for the various installation infrastructure categories. By answering these questions commanders will have the means to objectively assess their facilities and articulate their needs. As is the case with the Unit Status Report, the ISR should not be used to evaluate commanders. It would serve as a decision support tool for accurately determining and reporting the 'fitness' of Army infrastructure.

Standard criteria for assessing installation infrastructure are essential to ensuring the objectivity of the report. The criteria must provide a simple, yet theoretically sound basis for rating the capability of facilities to satisfy specific requirements for serviceability. These requirements should address a number of factors such as condition, appearance, functionality (suited to current use), the facilities deficit (adequate capacity for mission requirements), reliability, etc... Other condition indicators that have been used by some agencies are divided into four categories [Hatry, 1982]:

1. *Engineering indicators* such as measures of utility capacity or road condition ratings.
2. *Intermediate performance indicators* such as number of sewer line stoppages or roof leaks

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[14]See Army Regulation 220-1, *Unit Status Reporting*, 30 August 1988

3. *Service level / impact indicators* such as number of work orders or additional wear and tear on vehicles due to poor road conditions.
4. *Maintenance unit costs* such as the costs for maintaining roads, segments of water or sewer systems, etc... High or increasing costs indicate a possible need for corrective action.

The overall rating might then be the sum of the scores for the chosen factors for a given infrastructure system. The score would equate to a condition rating such as those used in the Unit Status Report.[15] Use of an Army-wide assessment tool will allow planners to compare infrastructure needs more objectively. As a result, they can get away from 'salami slice advocacy' and apply resources to the most critical needs.

Adoption of the ISR would provide a number of benefits. Its use as a condition assessment tool would truly get commanders involved in the management of infrastructure renewal. It would also provide a more timely and less expensive evaluation of facilities than is possible utilizing more traditional technical inspections. The ISR would also provide assessment information on a more frequent and regular basis than is possible with traditional inspection techniques. The ISR would not replace the technical inspections, but instead would supplement the total inspection process. An unsatisfactory rating could also trigger a more detailed survey of the facilities in question. The ISR then might assist engineering personnel to employ their inspectors more effectively.

Incorporating the ISR into an automated hierarchical reporting system adds more benefits. Consolidating reports at MACOM and DA level would provide better information for those making the resource allocation decisions. An ISR system would greatly aid the preparation of reports on facilities for outside authorities such as Congress or the Office of the Secretary of Defense.

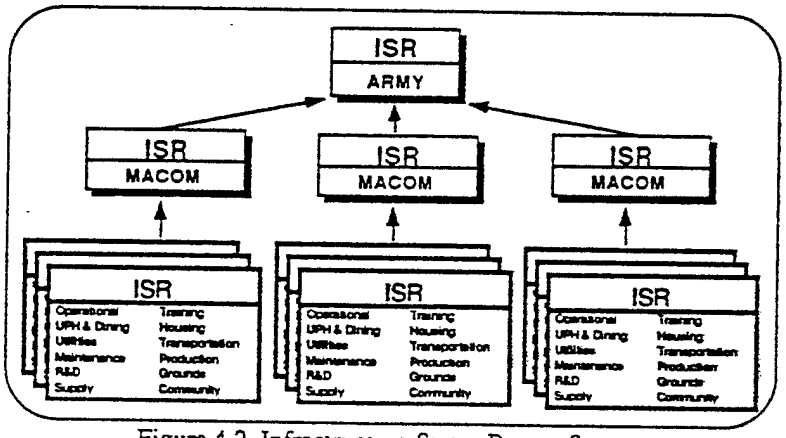

Figure 4.2 Infrastructure Status Report System

The information flow for these reports might be through command channels to the HQDA Deputy Chief of Staff for Operations and Plans (DCSOPS) -- the Army's overall

[15]A level of C-1 is the highest, ratings of C-2 and C-3 indicate less satisfactory levels, and a rating of C-4 indicates a level at which the facility can not provide the needed service.

prioritizer. Engineers and resource managers could also receive the information. However, keeping the reports in command channels allows commanders to surface infrastructure problems to those who set the Army's priorities and makes the facilities resourcing process more responsive to their needs.

As a part of the needs determination actions, planners must predict the required resources. The resource allocation module should be linked to the Capital Investment Strategy program, Maintenance Resource Prediction Models [Neathammer et al. 1991], and other models used by engineers to forecast resource requirements.

Once the condition assessment and needs determination are made prioritization becomes the challenge. As discussed earlier, Army organizations establish infrastructure priorities in different ways with differing factors. The DSS would utilize a consistent set of factors for assigning Army priorities to projects and / or infrastructure investment categories. The factors should include facility category, mission category, readiness impact, and facility condition -- both current and planned. Other important considerations include health, safety, and environment issues and legal obligations.

A priority rating system will not replace sound professional judgment. Instead, it provides a uniform structure for evaluating infrastructure renewal projects consistent with total Army needs. It also requires planners to think about revitalization efforts in a systematic and objective manner. With a thorough, objective condition assessment and needs determination linked to a validated method for assigning priorities the Army will be able to concentrate its infrastructure resources for maximum effect.

4.2.3. Planned State

The planned state is nothing more than the goal for the desired condition for a category of infrastructure on an installation. The planned states are derivatives of the infrastructure standards. When designing this objective state it is useful to consider the ideal state for the facilities. From the ideal state planners can adjust for changing resource constraints. Clear concise descriptions of the desired state of facilities will greatly aid the total planning effort.

4.2.4. Transition States

Thus far, the DSS has addressed the questions -- *Where are we now?* (ISR) What are our priorities? *Where are we going?* (Planned State) Answering the question of how we get there may be the most difficult challenge for the Army. Comprehensive planning across functional areas and installations is needed. Project contingency relationships and funding availability constraints require planning across time as well.

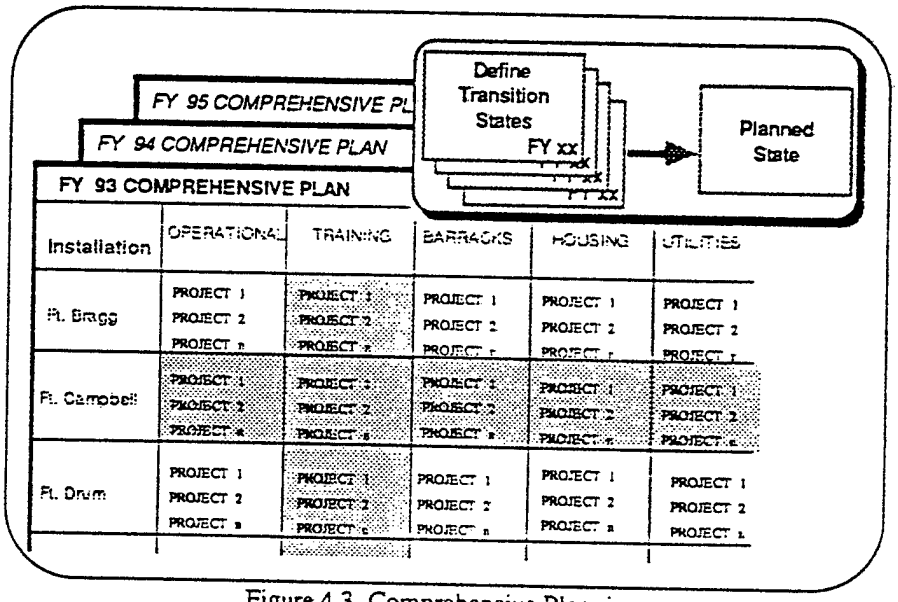

Figure 4.3 Comprehensive Planning

Development and use of long-range plans will also alleviate some of the difficulties posed by the 'long-term -- short-term management dilemma' described earlier. When a new installation commander inherits a comprehensive plan for renewing the infrastructure, they would not have to develop their own new plan. Instead they would have the mission of following through with the existing plan and modifying it only as necessary.

Comprehensive planning might also allow savings due to economies of scale. If many like facilities have similar needs, MACOM and DA staffs can take action to implement larger contracts that will exploit discounts.

There are many other benefits to comprehensive planning. The overall advantage to implementing an Army-wide scheme is that it enables staffers and leaders to take a systems approach to infrastructure renewal. The result will be greater coordination of effort and synchronization of resources

4.2.5. Measures of Progress

As infrastructure renewal proceeds planners must measure the progress. Many of the factors cited for use in the ISR could serve as measures of progress for the various categories of installation infrastructure. The DSS should also use aggregate metrics such as percentage PRV by condition rating to gauge effectiveness at the MACOM or DA level. This measure will also be useful for evaluating the effectiveness of facility reduction

efforts. Hopefully, the largest PRV reductions will be among those facilities with the lowest condition ratings. Whatever measures are employed, they must provide meaningful answers to the question, '*How are we doing?*'.

5. Summary

The limited availability of dollars requires the Army to act to enhance the impact of the funds earmarked for infrastructure renewal. The intent of the needs analysis done for this study was to take a critical look at how the Army does business. There is a great deal of good work being done by individual facilities planners. However, their work is largely restricted to a single installation or MACOM thereby diminishing its effect. A comprehensive decision support system such as the one described in this report will enable the Army to take a more holistic approach to facilities revitalization.

6. Future Research

The scope of this project expanded considerably as the needs analysis progressed. Following are areas of research that will move the project closer to the goal of achieving infrastructure renewal through better management of Army resources.

6.1. Infrastructure Standards

The standards set the stage for what the Army is trying to accomplish with its infrastructure. Without well defined standards it will be difficult to plan objectives for the infrastructure. Condition assessment requires standards to measure the difference between a facility's current and planned state. The DOD Pilot Program for Facility Condition Surveys (FCS)[16] or 'fence-to-fence assessments' will catalog engineering design standards that are based upon industry standards [Scharl, 1992]. The standards for this system should be coordinated with FCS to complement and supplement the more technical standards. However, it is vital that the standards for this DSS have universal utility; i.e., they must be meaningful to users outside of the engineering community.

6.2. Infrastructure Status Report

The ORCEN and the Project Working Group are moving forward with the development of a prototype ISR to serve as a commander's infrastructure assessment tool[17]. We recommend rapid prototype development to exploit the opportunity to compare results with the FCS assessments scheduled to begin in FY 93. By testing the prototype on the FCS installations[18] prior to the technical fence-to-fence assessments, we can validate the ISR's utility as a meaningful assessment tool. Following are issues for consideration in developing the prototype.

Carefully consider the scope of the assessment and the level of detail. Criteria for individual facilities may well bog down the process and make the report too large and too technical. The ISR assessments should probably concentrate more on discrete installation infrastructure systems; i.e., groups of like facilities. A macro approach will aid in the effort to keep it simple and still provide the needed information to those allocating resources for infrastructure renewal.

Define the infrastructure categories to be included in the ISR. The Army Plan suggests some categories of facilities to consider. The FCS will also describe categories. Consider whether or not separate categories are needed for addressing health, safety, environmental, and historical concerns.

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[16]See Section 2.1.3 above.

[17]See Appendix B for a list of questions to consider for ISR development.

[18]The eight Army bases designated to undergo the initial assessment are Fort Bragg, Fort Lewis, Fort Polk, Fort Campbell, Fort Stewart, Fort Hood, Fort Knox, and Redstone Arsenal.

Balance the subjectivity and technicality of the ISR. Design assessment criteria so that the ISR is in fact a commander's tool. It must be simple and not unduly burden commanders. However it must be technical enough to provide objective, meaningful information to decision makers.

Frequency of assessment is an important consideration. The assessments should be conducted often enough to provide timely information but not so often that it becomes unduly burdensome. One alternative is an annual assessment with quarterly exception reports. Another alternative is to assess the one or more category per month so that all are evaluated over a one year period.

Incorporation of the condition codes into the reporting system is another important concern. Consider utilizing the facility condition field in IFS and HQIFS[19] for data collecting, recording, and reporting, etc. However, care must be taken to avoid the problems currently existing in the HQIFS database.

6.3. Prioritization Methodology and Resource Allocation

Any effort to coordinate the methods used by the many agencies who prioritize infrastructure renewal efforts will help to focus the investment. A variety of multiple criteria decision making (MCDM) models exist.[20] There are even decision support techniques for selecting MCDM methods [Ozernoy, 1991, pages 242-257]. The Directorate of Program Analysis and Evaluation, Office of the Chief of Staff of the Army uses the 'Technique for Order Preference by Similarity to Ideal Solution' (TOPSIS) as an MCDM tool [Kloeber, 1991]. Researching the application of an MCDM model for incorporating Army priorities into the resource allocation component of this DSS would be fruitful.

6.4. Comprehensive Planning System

With so much at stake, the Army must coordinate its multi-echelon facilities revitalization planning efforts. Comprehensive, long-range plans are essential to achieving infrastructure renewal through better management of Army resources. The FCS program will develop a multi-year planning system. The FCS plans will utilize the results of the fence-to-fence assessments to develop plans that have a minimum six year horizon. This system should be analyzed for possible integration.

6.5. Measures

Continual evaluation of renewal efforts must be made. Tracking progress via the ISR system will help track effectiveness of investments. Measures incorporating PRV

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[19]Refer to Section 3.1 above.

[20]See Korhonen et al., 1991 or Clemen, 1991.

figures and condition ratings may also gauge the potency of facility revitalization endeavors. Some possible PRV metrics include:

-- Percentage of PRV by condition code

-- PRV rate of change, and

-- PRV rate of change by condition code.

A streamlined BMAR reporting mechanism might prove to be a useful measure of progress. The idea of computing and reporting the BMAR is simple enough, it just seems to bog down in the implementation procedures. The U.S. Army Audit Agency suggests clarifying the guidance in AR 420-16 to require installations to review BMAR projects annually and update cost estimates [U.S. Army Audit Agency, 1991, p. 32].

6.6. System Integration

As much as possible, the DSS should take advantage of existing systems. The potential for coupling with IFS and HQIFS should be examined. The system components also need to be linked together to optimize data collection and information utilization. Though it may not specifically replace any existing reporting requirements, the ISR should allow the elimination of many ad hoc reports now being generated for a variety of reasons.

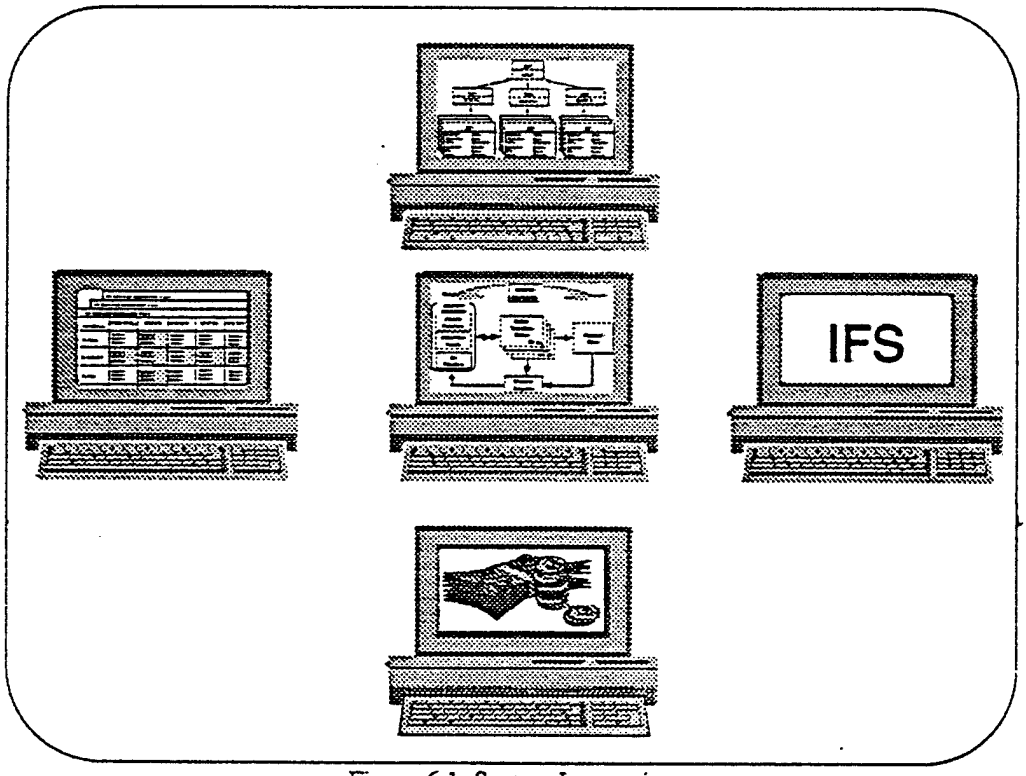

Figure 6.1 System Integration

A thorough investigation of possible linkages to the Program Planning Budget and Execution System (PPBES) will be useful to accentuate the effectiveness of the DSS. It should also be incorporated as far as possible into the installation master planning and

capital investment strategy processes. Finally, proponency for the DSS must be established.

6.7. Policy Considerations

Full implementation of the decision support system outlined in this report will require some corporate culture changes. Several Army leaders, upon receiving briefings about this project have made remarks along the lines of, "We really haven't been doing business like this." They have unanimously commented on the potential for this project to really benefit the Army. However, these benefits won't be fully realized without the support of Army leadership -- from the top down. To that end we recommend consideration of some policies that may be helpful to facilities revitalization.

Commanders must get more involved with infrastructure renewal. One sure way to accomplish this has been recommended by Livingstone and Brook in their memorandum to the Secretary of the Army. Including the attaining of facility quality standards as a major performance objective for their evaluation reports will emphasize the importance of the infrastructure in relation to other readiness resources.

Infrastructure management should also be included as an integral part of their formal mission statement. If the Army is going to overcome the 'long-term -- short-term management dilemma', commanders must understand their role in the long-term infrastructure renewal process.

Certainly commanders are the ones who must make the decisions regarding tradeoffs in the allocation of funds to the various readiness resources. There are plenty of occasions when some facilities revitalization projects must 'pay the bill' for training or other urgent requirements. However, unless commanders are given the needed support, guidance, and incentives they can not be expected to play an active role in infrastructure renewal.

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Appendix A (BASOPS Accounts)

	BASOPS (-)
A	Real Estate Leases
B	Supply Operations
C	Maintenance of Material
D	Transportation Services
E	Laundry and Dry Cleaning
F	Army Food Services
G	Personnel Support
H	Unaccompanied Personnel Housing Operations
J	Utilities
M	Other Engineering Support
N	Administration
P	Automation Activities
Q	Reserve Component Support
S	Community and Morale Support Activities
T	Preservation of Order
U	Directorate of Resource Management
V	Directorate of Plans, Training, and Mobilization
W	Directorate of Contracting
X	Security and Counterintelligence Operations
Y	Records Management and Publications
	RPM
K	**Maintenance and Repair of Real Property**
L	**Minor Construction**
	ENVIRONMENT
	Environmental Programs

Appendix B (ISR Discussion Questions)

1. Can installation infrastructure be adequately defined by the following categories?

- Operations and Training Facilities
- Barracks and Dining Facilities
- Family Housing
- Utility Systems
- Transportation Systems
- Maintenance and Production Facilities
- Research and Development Facilities
- Grounds
- Supply
- Community Facilities

2. What are the sub-categories and components of each of the categories above that need to be addressed?

3. Can some of the categories be consolidated or eliminated?

4. Are separate categories required for environmental, historical, safety, and health considerations or can these types of concerns be addressed in the standards and assessment criteria?

5. Can the categories be consolidated into other more general categories such as Quality of Life, Pre-deployment, Deployment, Post-Deployment, etc...?

6. What are the Army standards for each category in terms of both quantity and quality?

7. How can each category at the installation be assessed in an objective, easily understood manner?

8. What are the condition codes for each category?

9. What systems or reports are already in place for each category?

10. Can existing systems or reports be feeders to each category?

11. Who in the Army is responsible for facilities in each category at installation, DA, and MACOM level?

12. What offices and agencies are responsible for initiating or following through on actions associated with each category?

13. How should information on each category be aggregated so it is useful at each level (installation, MACOM, and DA) and for each office and agency?

14. How should installations articulate their needs in terms of dollars across fiscal years for each category?

15. How can installation commanders prioritize their greatest needs with the ISR? Top five? By Category?

16. What resource allocation decisions and funding actions should be triggered by deficiencies in each category?