Selecting an In-Service Engineering Agent for Material Handling Equipment

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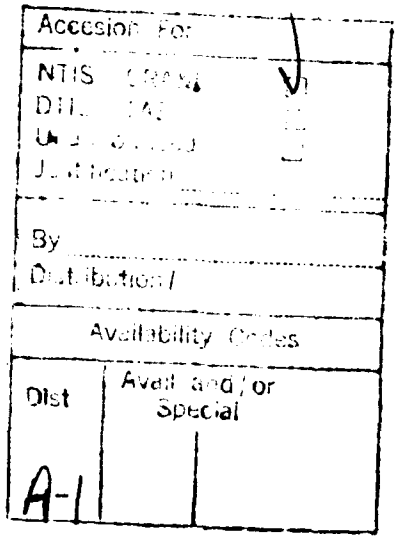

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INTRODUCTION

Material handling equipment (MHE) (i.e., forklifts, pallet trucks, etc.) is an essential component of the logistics system that supports the Navy's mission. It is used to move supplies and ordnance through shore stations, through Naval magazines, and within ships. Without MHE, the Navy could not sustain itself at sea, nor could it deliver payloads to the targets.

The Fleet's view of MHE functionality and performance — although largely anecdotal — is a bleak one. In many instances, the equipment does not meet basic requirements; e.g., it is too heavy for ship elevators, it does not fit in passageways, it ruins deck plating, and it cannot climb the grades between deck ramps. MHE is unsuitable for the job; e.g., a new missile can be moved only under tight operational restraints because of MHE lifting capacity limitations. MHE is unreliable; e.g., ships carry an extra allowance of MHE on deployments for spares or cannibalization. Finally, MHE technical logistics information is out of date or nonexistent, and data on performance are not available.

In contrast to Fleet problems, shore-based MHE seems to perform satisfactorily because it is operated in a commercial-like environment, an impression we were unable to fully investigate.

The Naval Supply Systems Command (NAVSUP) Program Manager (PM) for MHE is searching for ways to resolve shipboard MHE problems and to improve its support overall. As a result of recommendations by a NAVSUP-sponsored Quality Management Board, the PM intends to establish an in-service engineering agent (ISEA) whose sole responsibility will be to improve the operations and maintenance phase of the MHE life cycle.

The NAVSUP PM asked the Logistics Management Institute (LMI) to assist with selecting an ISEA from the following four candidates that have submitted proposals:

- The Ships Parts Control Center (SPCC), Mechanicsburg, Pa.
- The Naval Air Warfare Center, Aircraft Division Lakehurst, (NAVAWCADLKE) Lakehurst, N.J.
- The Naval Packaging, Handling, Storage, and Transportation (PHST) Center, Earl, N.J.

- The Naval Surface Warfare Center, Carderock Division (NSWCCD) Philadelphia Station, Philadelphia, Pa.

In assisting NAVSUP, we have:

- Defined a goal for MHE life-cycle management
- Produced a functional description or charter for the MHE ISEA
- Developed weighted criteria for evaluating the four candidates
- Recommended which candidate should be the MHE ISEA
- Recommended actions the Navy should take to manage MHE over its entire life cycle.

In the sections that follow, we discuss our recommended MHE management goal and present a process model that an MHE life cycle management team can use to achieve that goal. Appendix A is the charter that we recommend the Navy adopt for MHE management. Appendix B contains our weighted selection and the results of applying those criteria to the candidates through the use of a decision-support model named BestChoice.

Life-Cycle Management for MHE

Goal for MHE Life-Cycle Management

Before preparing a charter for the new ISEA, we found it necessary to define a goal for its management activities. We formulated the following goal:

> Navy MHE life-cycle management will meet user community operational requirements for MHE capability, capacity, and availability while providing interoperability with other packaging, handling, storage, transportation, and weapon systems. MHE must comply with appropriate explosive and ordinance safety and occupational safety requirements as specified by standards organizations and regulatory agencies. While MHE life-cycle management strives to meet these goals, it must also strive to minimize life-cycle costs.

Definitions of the component parts of our recommended goal are as follows:

- The user community includes the shore establishment (e.g., MHE users in warehouses, Naval Stations, and magazines) and the Fleet.
- Capability refers to the ability of MHE to perform its basic functions (e.g., lift and reach).
- Capacity is the ability of the MHE to deliver the required materiel throughput safely.

- Availability is the capability of the MHE to meet the minimum number of hours of use required by the users. That availability can only be attained if the fielded MHE meets the following conditions:
  - Has sufficient reliability and maintainability
  - Is used by trained operators
  - Is maintained by adequate numbers of skilled technicians with access to appropriate technical manuals and adequate spares.
- Interoperability means that the MHE works seamlessly with other acquisition programs and ISEAs. The life-cycle management team must participate actively to ensure that the Navy's logistics systems work seamlessly. PMs for new Navy weapon systems and other projects are responsible for ensuring that the capability, capacity, and configuration of fielded and planned MHE is interoperable with their systems.
- Compliance with appropriate explosive and ordinance safety and occupational safety means that requirements of outside interested parties must be included in the design of MHE and its interfaces. Those outside parties include such organizations as other DoD Components, the General Services Administration, Underwriters Laboratories, the Occupational Health and Safety Administration, and other standards organizations and regulatory agencies.
- Minimum life-cycle cost means that MHE is designed and fielded in numbers that meet all other goals so that the acquired equipment and its anticipated lifetime logistics support provide the greatest return on investment.

An Integrated Approach to Life-Cycle Management

Commercial MHE provides the basic functionality (i.e., capability and capacity) for Navy MHE. The Navy acquires commercial MHE as a nondevelopmental item, using performance specifications that include additional requirements to accommodate ordnance safely and shipboard use (i.e., requirements for explosive and ordnance safety, electromagnetic interference control, four-wheel brakes, etc.).

Even though MHE is acquired as a nondevelopmental item, its design and application in the Navy is a complex systems engineering process since it must be integrated with many parts of the logistics system. The design of MHE, includes, for example, detailed interfaces with transportation equipment, warehouse and magazine storage systems, and shipboard systems and the packaging of commodities and specific ordnance items. The systems engineering process takes place in an environment that continually evolves as the Navy adapts its

systems and operations to meet new requirements. Thus, the Navy must continually and intensively manage its MHE over its entire life cycle.

Figure 1 depicts a recommended life cycle management process for Navy MHE. It includes the key participants of the MHE life-cycle management team: the PM, the Acquisition Engineering Agent (AEA), and the ISEA. The MHE user community and its requirements, although not shown, are the reason for the team's existence. The team must work together smoothly and effectively to meet the requirements of a large community of users, acquisition managers, in-service engineering managers, and outside interested parties — all with diverse and often conflicting interests.

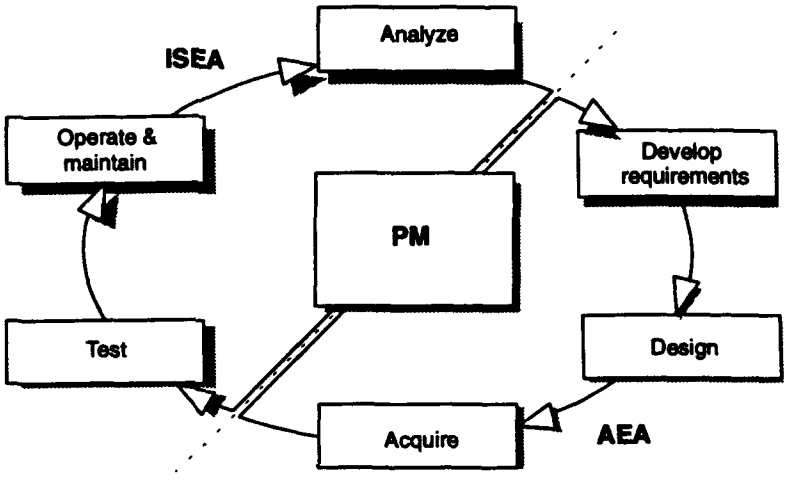

Figure 1.
The Navy MHE Life-Cycle Management Process

Management Team

The Program Manager for MHE has overall responsibility for the acquisition, logistics support design, and initial logistics support of MHE. The PM plans, programs, and budgets acquisition and operations and maintenance dollars for this purpose. The PM uses estimates from the AEA and the ISEA to develop those plans, programs, and budgets.

As depicted in Figure 1, we have divided the roles of the AEA and ISEA to provide a system of checks and balances in the life-cycle management process. The AEA is responsible for assembling the requirements for future MHE, and the ISEA assists in that process as the user community's representative. The AEA is also responsible for the design of MHE that meets approved requirements, and the ISEA is responsible for developing the logistics support concept and the maintenance plans that support that design. The ISEA prepares engineering changes for MHE based on its analysis of fielded MHE performance and associated logistics support, and the AEA must acquire MHE that meets those

specifications. The ISEA manages acceptance testing to ensure that the MHE acquired by the AEA complies with its design and can satisfy the user community's requirements.

Throughout the operational life of a piece of MHE, the ISEA collects performance and logistics support data on it. By assisting users with operations, maintenance, and training, the ISEA acquires valuable experience and expertise that it uses to evaluate equipment performance and to prepare corrective engineering changes. It also uses that experience to help the AEA update requirements for future acquisitions. Thus, the teamwork of the PM, the AEA, and the ISEA represents a continuous life-cycle management process that ensures that MHE will be an effective part of the Navy logistics system in the future.

In summary, the AEA and the ISEA have different but complementary roles. The AEA focuses on the equipment needs of future users; the ISEA focuses on current fielded equipment.

Specific Responsibilities of the ISEA

The ISEA represents the MHE user community in the life-cycle management process in the following ways:

- Assisting the AEA in developing MHE requirements
- Supporting the AEA in designing MHE
- Managing MHE acceptance in the field
- Helping the user community in the operations and maintenance of MHE
- Analyzing MHE and logistics support performance
- In addition to the above responsibilities, the ISEA assists the Fleet and shore establishment in planning, programming, and budgeting MHE logistics resources (i.e., operations, training, maintenance, and supply support) for fielded MHE.

Appendix A presents the ISEA's charter, which defines the above responsibilities in detail.

Criteria for Selecting an ISEA

From the list of responsibilities of an ISEA, we developed the following criteria for evaluating the four candidate organizations:

- Interface with the worldwide MHE community

- Experience with MHE life-cycle support
- Experience as an ISEA
- Technical staffing qualifications
- Capability to manage logistics technical information
- Interface with other organizations with responsibilities for MHE.

The above criteria represent necessary conditions for an ISEA to manage the MHE life-cycle process successfully.[1] We describe each in the following subsections.

Interface with the Worldwide MHE Community

Many of the problems with MHE — shipboard MHE in particular — imply that the customer is ignored in the current MHE acquisition process. Thus, if the customers' needs are to be met, the MHE ISEA must bring the customer into the process. To do so requires the ISEA to have a strong working relationship and "on-the-deck" experience with the MHE user community. The candidates varied in this area, with PHST having the closest relationship with customers and SPCC the most remote.

Experience with MHE Life-Cycle Support

Managing a nondevelopmental item such as MHE may at first appear to be a simple process for any organization with a systems engineering background. MHE's operating environment and its interface requirements, however, are complex, and that complexity mandates that the ISEA have specific experience with MHE and its interface environment.

The candidates varied in this area, with SPCC, NAVAWCADLKE, and PHST having stronger capabilities than NSWCCD. The experience of NAVAWCADLKE with MHE is concentrated in the specialized area of aircraft support equipment. We felt that the demands of this aviation environment and their experience supporting expensive aircraft would make it difficult for NAVAWCADLKE to live with the very tight budgets that MHE is likely to experience.

[1] Appendix B specifies the weights given to each criterion and describes how we applied them in a decision support model to develop our recommendation for the MHE ISEA.

Experience as an ISEA and Experienced Technical Staffing

These experience criteria are used in a assessing the ability of the ISEA to apply systems engineering to MHE life-cycle management. All the candidates were basically qualified in this area. PHST's staff had the most relevant experience for MHE because of its work in testing and integrating the packaging, handling, storage, and transportation aspects of MHE with Navy weapon systems.

Capability to Manage Technical Logistics Information

The current acquisition and support process has not assembled and maintained even the minimal set of essential technical logistics information (i.e., technical data packages and maintenance-and-logistics-support performance information). Until it does so, no ISEA will be able to bring MHE into a controlled process.

The MHE ISEA, however, must work effectively with logistics technical data. Increasingly, that task will require the use of Continuous Acquisition and Life-Cycle Support[2] -compliant information as the rule rather than the exception. Only if it has the ability to handle digital technical logistics information can the ISEA acquire, maintain, use, and distribute the information needed to support MHE cost-effectively.

All candidates were capable when it came to working with paper-based technical logistics information. NAVAWCADLKE and PHST, however, were the strongest candidates for working with digital data.

Interface with Other Organizations That Also Have MHE Responsibilities

Other user communities also dictate requirements for MHE (e.g., the explosive and ordnance safety community). An effective MHE ISEA must have a working relationship with those other communities. PHST has the most effective cross-functional working relationships because of its extensive work with weapon systems and other programs.

Combining Responsibilities with Selection Criteria

Table 1 cross-references ISEA responsibilities with the selection criteria described in Appendix A. Each responsibility will depend on the ISEA's capabilities in a number of areas, and the applicable selection criteria can be associated with the responsibilities as shown in Table 1.

[2] Formerly, Computer-aided Acquisition and Logistics Support.

Table 1.
Relationship Between ISEA Responsibilities and Selection Criteria

ISEA responsibilities	ISEA selection criteria
Assisting the AEA in developing MHE requirements	Interface with the worldwide MHE community Experience with MHE life-cycle support Interface with other organizations with responsibilities for MHE
Supporting the AEA in designing MHE	Experience with MHE life-cycle support Experience as an ISEA Experience with technical staffing Interface with other organizations with responsibilities for MHE
Managing MHE acceptance in the field	Interface with the worldwide MHE community Experience with MHE life-cycle support Experienced technical staffing
Helping the user community in operations and maintenance of MHE Assisting the Fleet and shore establishment to plan, program, and budget MHE logistics resources	Interface with worldwide MHE community Experience with MHE life-cycle support Experienced technical staffing Experience as an ISEA
Analyzing MHE and logistics support performance	Experience with MHE life-cycle support Experience as an ISEA Experience with technical staffing Ability to manage logistics technical information

RECOMMENDATIONS

In this section, we present our recommendations on how the Navy can manage its MHE better. The recommendations are based on our

- In-depth understanding of Navy logistics processes
- Extensive experience with integrated logistics support
- Visits to each candidate organization
- Evaluation of each concept of operations proposal

- Comparison of each proposal and data gained from our site visits to the Naval Surface Warfare Center in Port Hueneme, Cal., an acknowledged expert ISEA for combat support equipment

- Interviews with Naval Sea Systems Command and Commander Air Forces Atlantic customer representative groups

- Definition of the MHE ISEA's functional responsibilities (charter)

- Development and application of weighted selection criteria to candidate organizations.

1. ***We recommend that the NAVSUP MHE Program Manager select the Naval PHST Center as the ISEA for MHE.***

From the data we collected, we concluded that the Naval PHST Center is the best qualified candidate to perform as the Navy's ISEA for MHE. In arriving at that conclusion, we considered the costs of each concept of operations submitted by candidate organizations and thought them reasonable based on our perception of the Navy's MHE problems. We discarded cost as a criteria, however, since each candidate's costs were approximately the same. Thus, we based our decision on the nonfinancial factors identified in Table 1.

We used a decision support tool called BestChoice to help us evaluate data collected and to numerically select an MHE ISEA. BestChoice allows users to formulate problems by simply and methodically inputting choices and weighted criteria. It then mathematically computes the BestChoice from the answers to a series of paired comparisons where each person involved in making a comparison must always pick the better of two choices. As an example, BestChoice asked evaluators to compare SPCC relative to PHST, SPCC relative to NAVAWCADLKE, SPCC relative to NSWCCD and so on for the factor, interface with the worldwide MHE community. It then asked evaluators to do the same for our other selection factors. The total of all numeric weights from those comparisons determined our recommended candidate. Details of that process are contained in Appendix B. We have found this methodology to be extremely effective in making optimal choices. It is based on years of research in the area of management science and mathematical optimization.

1. ***We recommend that the Navy retain NAVSUP as the PM for the MHE and the SPCC as the AEA.***

The general consensus of all user groups and candidates we talked with was that NAVSUP and SPCC were the appropriate organizations to serve as PM and AEA, respectively, but that their effectiveness suffered by not having an ISEA in the field that was responsible for post acquisition issues. We believe NAVSUP, SPCC, and PHST will form an effective, counterbalanced team that will achieve the management goal we defined above.

1. ***We recommend the Navy provide the same integrated logistics support for shipboard MHE as that provided for other mission-essential systems.***

As a mission-essential component of the Navy's logistics system, MHE, especially shipboard MHE, must be acquired and supported such that it can perform its mission cost-effectively. The historical laissez faire, nonintegrated approaches to shipboard logistic support have not worked. The Navy must acquire MHE and centrally manage it to bring shipboard MHE support under a controlled process. Centralized integrated logistics support will inevitably improve support for all MHE — ashore and afloat.

APPENDIX A

Charter for the Material Handling Equipment In-Service Engineering Agent

GOAL FOR MATERIAL HANDLING EQUIPMENT LIFE-CYCLE MANAGEMENT

The goal of the Navy's life-cycle management process for material handling equipment (MHE) is as follows:

> . . . [to] meet user community operational requirements for MHE capability, capacity, and availability while providing interoperability with other packaging, handling, storage, transportation and weapon systems. MHE must comply with appropriate explosive and ordinance safety and occupational safety requirements as specified by standards organizations and regulatory agencies. While MHE Life Cycle Management strives to meet these goals, it must also strive to minimize life cycle costs.

THE IN-SERVICE ENGINEERING AGENT'S ROLE IN MHE LIFE-CYCLE MANAGEMENT

The in-service engineering agent (ISEA) represents the MHE user community in the MHE life-cycle management process in the following ways:

- Assisting the Acquisition Engineering Agent (AEA) in developing MHE requirements
- Supporting the AEA in designing MHE
- Managing MHE acceptance in the field
- Helping the user community with the operations and maintenance of MHE
- Analyzing MHE and logistics support performance
- Assisting the Fleet and shore establishment to plan, program, and budget logistics resources (i.e., operations, training, maintenance, and supply support) for fielded MHE.

The following discusses specific responsibilities of the Navy's ISEA for MHE.

Assist the AEA in Developing MHE Requirements

The ISEA will coordinate the establishment of a logistics support philosophy for each type of MHE and identify the level at which maintenance should be performed throughout the entire life cycle of the equipment based on Naval Operations (OPNAV) guidance and operational environments.

Assist the AEA in Designing MHE

Conduct Technical Evaluations

The ISEA will evaluate the suitability of new or existing MHE to specific operational environments and recommend changes.

Develop Maintenance Plans

The ISEA will review and maintain all technical data that prescribe the scope, depth, and frequency of maintenance throughout the life cycle of the equipment, and will ensure detailed procedures are provided through the technical manual, maintenance requirement cards (MRCs), repair standards, etc., to effect economical beneficial repairs.

Review Provisioning

The ISEA will review the logistics support analysis and provisioning parts lists (PPLs) to assist the AEA in developing the allowance parts list (APL). The ISEA will also develop and maintain lead allowance parts lists (LAPLs) with military-essentiality codes, source, maintenance and recoverability codes, and on-board allowances, and will monitor the maintenance data system/casualty report (MDS/CASREP), coordinated shipboard allowance list (COSAL) and consolidated shore-based allowance list (COSBAL) feedback to determine whether equipment is properly supported. The ISEA will recommend changes to the APL to produce more effective support., and will provide technical support to identify interchangeability and substitutability of spare parts.

Develop Shipboard Stowage Procedures and Regulations

The ISEA will provide assistance and recommendations on the packaging, handling, storage, and transportability (PHST) issues of MHE consistent with the requirements of the weapon systems that MHE supports.

Manage MHE Acceptance

The ISEA will provide for first article testing prior to introducing MHE to the field and will evaluate any changes or modifications to equipment for impact on specific operational environments. In addition, the ISEA will maintain appropriate instructions and standards for testing and verifying equipment worthiness.

Assist the User Community in the Operation and Maintenance of MHE

Provide Fleet Engineering Support

The ISEA will provide support to the Fleet and shore establishment to evaluate reliability, maintainability, availability, and logistics support performance for MHE and will provide technical assistance on MHE issues and on-site operational and ordnance safety training as required.

Maintain MHE Logistics Technical Data

The ISEA will maintain all logistics technical data at a central location, will review and maintain drawings and logistics support analyses/records, and will develop and maintain technical manuals and repair standards, and for shipboard equipment, MRCs and maintenance index pages (MIPs).

Investigate User Feedback

The ISEA will review and evaluate documentation and/or defective or improperly designed equipment and recommend corrective actions based on user feedback, and will also work to correct current problems in the field and prevent those problems in the future by working with the AEA to improve acquisition specification.

Monitor Maintenance and Test Facilities

The ISEA will review maintenance and test facilities to assist the user community in verifying the accuracy and completeness of repairs, ensure accurate complete testing, verify qualifications of repair facility personnel, and ensure proper training is provided for all aspects of equipment repair and maintenance.

Analyze MHE and Logistics Support Performance

Collect and Analyze Operation and Maintenance Data

The ISEA will review data from the 3-M data system, parts usage, and other sources to identify problems with a particular type or manufacturer of equipment and will recommend corrective actions including necessary modifications.

Investigate MHE Safety Problems

The ISEA will review the safety of proposed changes or modifications to equipment and operating procedures and will evaluate user feedback about deficiencies to identify safety concerns and recommend corrective action.

Evaluate Training Effectiveness

The ISEA will monitor the training conducted by Navy training activities and will conduct systematic audits of training courses and provide needed input or assistance.

APPENDIX B

Material Handling Equipment In-Service Engineering Agent Selection Criteria

We used a decision-support tool called BestChoice to help us select a material handling equipment (MHE) in-service engineering agent (ISEA). To resolve weighted problems with BestChoice, the analyst simply and methodically inputs choices and criteria. BestChoice then mathematically computes the best choice from the answers to a series of paired comparisons where each pair is involved in making a comparison. It must always pick the better of two choices. This methodology is extremely effective in making optimal choices and is based on years of research in the area of management science and mathematical optimization.

We evaluated the following organizational choices (listed in the order of our visits):

- The Naval Packaging, Handling, Storage, and Transportation (PHST) Center, Earl, N.J.
- The Naval Surface Warfare Center, Carderock Division (NSWCCD) Philadelphia Station, Philadelphia, Pa.
- The Naval Surface Warfare Center (NSWC) Port Hueneme Division (PHD) Port Hueneme, Calif.
- The Naval Air Warfare Center, Aircraft Division, Lakehurst (NAVAWCADLKE) Lakehurst, N.J.
- The Ships Parts Control Center (SPCC).

To allow BestChoice to create paired comparisons, we programmed it to use the weighted criteria contained in Table B-1. When we ran BestChoice, it then tabulated the results of paired comparisons made by each of our three team members between SPCC and PHST, SPCC and NSWC, PHST and NSWCCD, etc., for each of the criteria in Table B-1. Figure B-1 is the result of that tabulation and clearly shows PHST as the best qualified candidate.

While the mathematical optimization of BestChoice quantified our recommendation of an ISEA, its results were based on our team's subjective formulation of weighted selection criteria in Table B-1. We ranked the interface with the worldwide MHE community highest. The ISEA's primary responsibility for

managing the post acquisition life-cycle phases of MHE will be to work with user groups to solve current problems, analyze data, and monitor training. When we found an organization had strong and effective relationships with the Fleet, we rated that organization higher in our paired comparisons than another organization (SPCC, for example, primarily interfaces with the Fleet through correspondence).

Table B-1.
Criteria for the Selection and Their Weights

Criteria	Weights (%)
Interface with the worldwide MHE community	30
Experience with MHE life-cycle support	20
Experience as an ISEA	20
Experienced technical staffing	10
Capability to manage logistics technical information	10
Interface with other organizations with MHE interests	10

We considered experience with MHE and current experience as an ISEA for other equipment of equal but lesser weight than user group interface. We were impressed with the caliber of the personnel at all of the organizations we visited. We felt those who were already doing the same or similar functions as required of the MHE ISEA would require a shorter learning period. Thus, organizations with current, applicable experience received a higher ranking in each paired BestChoice comparison.

Finally, we judged the capability to manage logistics technical information and the interface with other organizations that had MHE interests as important but assigned it the lowest weight. In the very near future, the ability to manage technical information digitally will increasingly become more important as DoD implements Joint Continuous Acquisition and Life-Cycle Support (JCALS) to specify its technical information on equipment. None of the organizations we interviewed had fully implemented JCALS. NSWC Port Hueneme was clearly the leader, however, since it uses JCALS for several new weapon systems that it manages. It is also converting other older systems where that conversion is economical.

The results of combining the choices and weighted criteria in the decision support model by three experts (LMI's John Handy, Program Director; Richard Nolan, Project Leader; and James Giles, Research Fellow) are shown in Figure B-1.

As seen in Figure B-1, the Naval PHST Center is the appropriate choice as the MHE ISEA given the weighted criteria used.

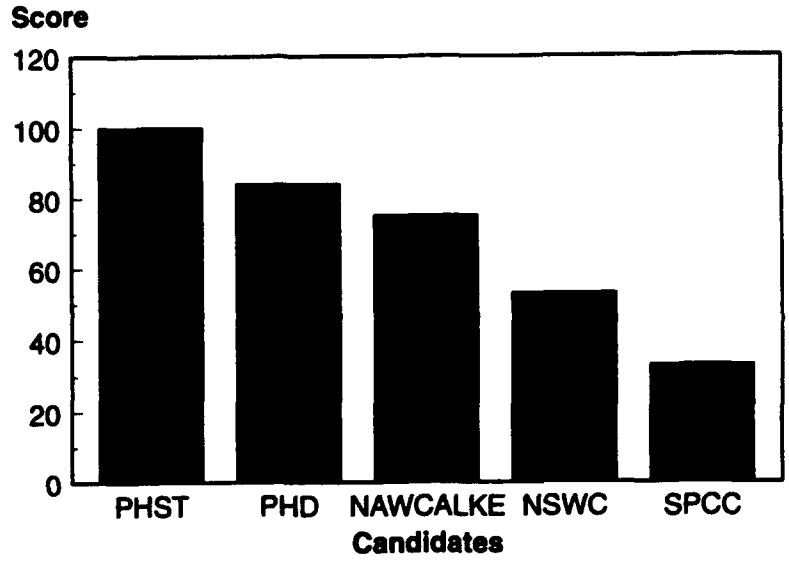

Figure B-1.
Results of the Application of Weighted Criteria to MHE ISEA Choices

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The Navy needs an improved process for managing its material handling equipment (MHE) that provides equipment in the future that better meets user needs, extends the useful life of existing equipment, and improves the Navy's return on its substantial investment in MHE. Historically, Navy MHE has fallen considerably short of meeting user requirements, particularly users in the Fleet.

This task recommends a process for managing MHE over its entire life cycle. It provides a charter for a new in-service engineering agent (ISEA) to manage MHE in its postacquisition life-cycle phase, and it specifically recommends that the Navy select the Naval Packaging, Handling, Storage, and Transportation Center (PHST) as its new ISEA. The recommendation to select PHST resulted from our years of experience with integrated logistics support, our extensive, on-site interviews with four organizations that the Navy nominated, the application of weighted selection criteria that the Navy asked us to create, and the use of a decision-support package named BestChoice.

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