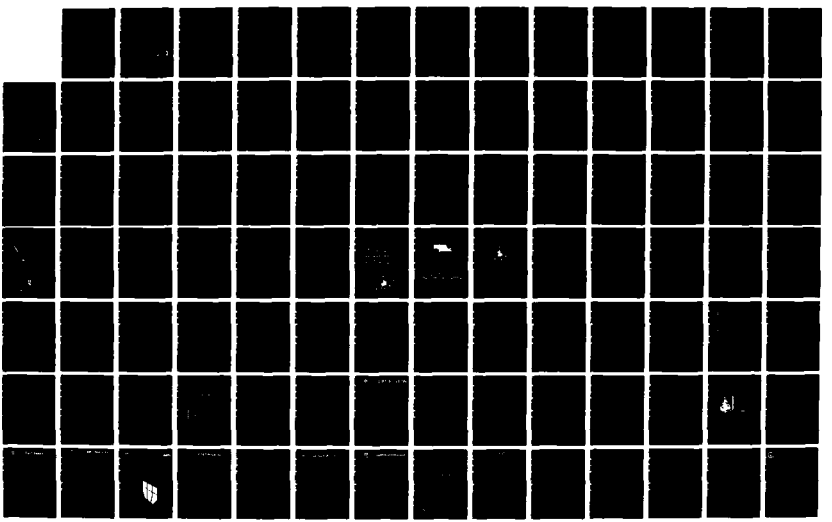
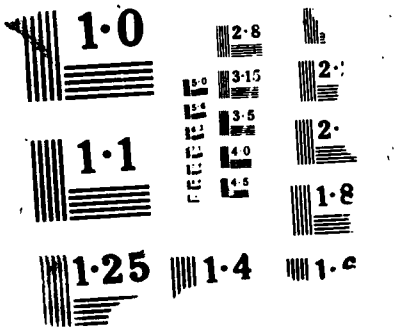
AD-A194 889 PROCEEDINGS: USA-CERL TECHNOLOGY TRANSFER (T2) WORKSHOP HELD IN URBAN IL (U) CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL MAR 88 1/2

UNCLASSIFIED CERL-SP-0-88/01 F/G 5/2 NL




1·0
1·1
1·25
1·4
2·8
3·15
3·5
4·0
4·5
2·
1·8

DTIC FILE COPY

USA-CERL SPECIAL REPORT O-88/01
March 1988

US Army Corps
of Engineers
Construction Engineering
Research Laboratory

AD-A194 889

Proceedings: USA-CERL Technology Transfer (T^2) Workshop

The Technology Transfer (T^2) Workshop was held at the University of Illinois Levis Faculty Center, Urbana, Illinois, on December 15 and 16, 1986. The workshop was intended to establish the first version of an integral T^2 process for the U.S. Army Construction Engineering Research Laboratory (USA-CERL).

The 2-day workshop consisted of a series of persentations on T^2 planning, case studies of successful USA-CERL transfer efforts, and group discussions by participants.

The reports published in these proceedings are those presented at the workshop.

DTIC
ELECTE
MAY 1 1 1988
S D
H

Approved for public release; distribution is unlimited.

88 5 1 131

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official indorsement or approval of the use of such commercial products. The findings of this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

DESTROY THIS REPORT WHEN IT IS NO LONGER NEEDED
DO NOT RETURN IT TO THE ORIGINATOR

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704 0188
Exp Date Jun 30 1986

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) USA-CERL Special Report O-88/01	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION U.S. Army Construction Engr Research Laboratory 6b OFFICE SYMBOL (If applicable) CECER-ZTA	7a NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code) P.O. Box 4005 Champaign, IL 61820-1305	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING/SPONSORING ORGANIZATION USA-CERL 8b OFFICE SYMBOL (If applicable) CECER-ZTA	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code) same as above	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification)
Proceedings: USA-CERL Technology Transfer (T^2) Workshop (Unclassified)

12 PERSONAL AUTHOR(S)

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final	FROM _____ TO _____	March 1988	143

16 SUPPLEMENTARY NOTATION
Copies are available from the National Technical Information Service
Springfield, VA 22161

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Technology transfer T^2
05	02		

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The Technology Transfer (T^2) Workshop was held at the University of Illinois Levis Faculty Center, Urbana, Illinois, on December 15 and 16, 1986. The workshop was intended to establish the first version of an integral T^2 process for the U.S. Army Construction Engineering Research Laboratory (USA-CERL).

The 2-day workshop consisted of a series of presentations on T^2 planning, case studies of successful USA-CERL transfer efforts, and group discussions by participants.

The reports published in these proceedings are those presented at the workshop.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL D. Mann	22b TELEPHONE (Include Area Code) (217)373-7223 / 22c OFFICE SYMBOL CECER-IMT

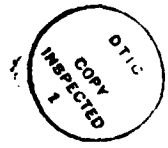
DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

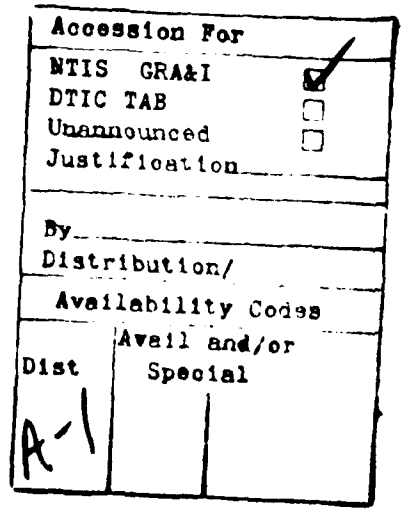
SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

FOREWORD

The U.S. Army Construction Engineering Research Laboratory (USA-CERL) conducted this workshop for its in-house staff to promote effective technology transfer methods that fulfill the responsibilities set forth in Army Regulation (AR) 70-57 and the Stevenson-Wydler Act of 1980. Publication of these proceedings was an initiative of the USA-CERL Commander and Director.

COL N. C. Hintz is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director. Dr. Robert Dinnat, USA-CERL Associate Technical Director, coordinated the workshop and this publication.





TECHNOLOGY TRANSFER TRAINING SESSION FOR THE ENGINEER INSPECTOR GENERAL

by Robert M. Dinnat
Associate Technical Director

1. INTRODUCTION

The Engineer Inspector General (EIG) has been tasked to review the technology transfer operations of the Corps of Engineers in a systems context. USA-CERL was requested to provide the EIG with training assistance on the subject of technology transfer. This presentation does two things: 1) it describes the systems context in which the EIG intends to view technology transfer operations within the Corps, and 2) it describes the systems definitions of technology transfer which were presented to the EIG during the training session.

2. THE EIG VIEW

The systems context to be used by the EIG is the complete life-cycle of an R&D product, starting with the identification of a problem and ending with the utilization of a solution to the identified problem. This single task is considered to be decomposable into smaller connected tasks for which the responsible parties and the items that flow through the connections are known. Their approach is to construct the network of existing (and proposed) subtasks and determine how well the existing system works.

As a starting point, the life-cycle at the highest level has been decomposed into four sequentially connected tasks: Indentify Problem, Acquire Solution, Distribute Solution, and Utilize Solution. Similarly, the responsible parties have been decomposed into six groups: Office of the Chief, USACE R&D Review Board, OCE R&D Directorate, Other OCE Directorates, USACE Laboratories, and All Others. By arranging the tasks and responsible parties into the columns and rows respectively of a matrix, the cells contain those subtasks of each major task for which each party is responsible. Connectivity between parties as well as between tasks and subtasks can be shown using this arrangement. Figs. (1) and (2) show the connectivities between parties, tasks and subtasks constructed by the EIG using existing regulations and drafts of proposed regulations. Fig. (1) shows the connectivities between parties and subtasks within the task: Identify Problem. The parties are indicated by capital letters and the subtasks by numbers. Fig. (2) shows the connectivities between parties and subtasks for the remaining three tasks: Acquire Solution, Distribute Solution and Utilize Solution. The meanings of the letters and numbers are given in the Appendix.

As can be seen in Fig. (2), the regulations produced very few subtasks in the cells under the last two tasks. The

bulk of the technology transfer subtasks should appear in these cells. That the laboratories are expected to effect the transfer is clear in this construction. The intent of the training session was to give the EIG some idea of what the missing subtasks might be by providing them with operational definitions of technology transfer in a systems context.

3. OPERATIONAL DEFINITIONS OF TECHNOLOGY TRANSFER

Continuing the EIG approach of successive decomposition into connected subtasks, let us start with technology transfer as a single subtask having an input and an output connector. As can be seen in Fig. (3), two parties are involved in a transfer operation -- the provider of the technology (in our case a Federal laboratory) and the acquirer of the technology. The important thing to notice is that the transfer operation does not affect the technology per se; it is the possession of the technology that flows through the connectors.

Technology is possessed in at least three ways: 1) as knowledge and skills, 2) as products and equipment, and 3) as property rights. Each form of possession has its own transfer operation, as shown in Fig. (4), and each of these its own suboperations.

Knowledge and skills reside either in people or in those products within which knowledge and skills are described (e.g., books, films, videotapes). Thus, the transfer operation for knowledge and skills has three suboperations: one that transfers between people; one that transfers between people and products; and one that transfers between products and people. These three suboperations are involved in two transfer paths, a direct one between people and an indirect one from people to product to people. The latter path allows knowledge and skills to be possessed and transferred as a product. These two paths are illustrated in Fig. (5).

Products and equipment are possessed either as physical objects or as the knowledge and skills required to produce such objects. The transfer operation for products and equipment moves things from one location to another. Their legal ownership is transferred in the transfer operation for property rights. Transfer occurs in the transfer operation for knowledge and skills when possession is of that form. Also illustrated in Fig. (5) is the transfer operation for products and equipment.

Property rights, like knowledge and skills, reside both in products and in people (or in organizations represented by people). In this case the products are legal documents

which assign property rights to others. This transfer operation is analogus to that of knowledge and skills; simply replace the words "knowledge and skills" with the words "property rights". Most property rights are transferred along the people-to-product-to-people path.

4. ORGANIZING FOR TECHNOLOGY TRANSFER

For transfer purposes, a technology is defined as the knowledge, skills, products, and equipment needed to produce a specified result. For an acquiring organization, the technology transfer objective is accomplished when it is able to produce the specified result. For the providing organization, accomplishment of its technology transfer objective depends upon its mode of operation. In the active mode, its objective is accomplished when the acquiring organization's objective is accomplished. In the passive mode, its objective is accomplished when it has transferred to the acquirer the knowledge, skills, products, and/or equipment that it wishes to transfer.

In the passive mode, shown in Fig. (6), the providing organization needs only a transfer operation. In this mode, the acquirer initiates the transfer, usually by requesting the transfer of a technology described by the providing organization. When the requested technology is described by the acquirer, those technologies which reasonably match the requested knowledge, skills, products and/or equipment are transferred. When operating in the passive mode, the providing organization's objective is simply to make its technology available for transfer. The actual acquirer is irrelevant.

In the active mode, shown in Fig. (7), the providing organization takes actions intended to cause a particular acquirer, or class of acquirers, to initiate a transfer. In the business world, this operation is called marketing. The marketing operation and the transfer operation make up the active mode of technology transfer. When operating in the active mode, the providing organization's objective is to assure that its intended acquirer is capable of utilizing the transferred technology to produce the specified result. That the acquirer will benefit from producing this result is implicit in the objective.

The providing organization need not transfer its technology directly to its intended acquirer. When the transfer occurs as a sequence of intermediate transfers, called a transfer path, the transfer is said to be indirect. Since the knowledge, skills, products and equipment that make up a technology can be transferred separately, an indirect transfer can be a network of transfer paths.

The intermediate acquirers are transfer agents who perform all or some part of the transfer operations including marketing. Transfer agents may be either internal or external agents. The agent is an internal one if his organization and the providing organization belong to the same parent organization, otherwise he is an external agent. Shown in Fig. (8) is an example of an active transfer mode having indirect marketing and training paths each using internal agents. If these agents' operations were performed by contract, they would be external agents. Another example of indirect transfer, this one being in the active mode and using an external agent, is shown in Fig. (9). This example is particularly interesting in that the providing organization is operating only in the passive mode. The active mode of transfer is completely performed by the external agent.

Some indirect paths involve transfer agents who produce and service the technology. In such cases wherein the Government would be competing with the private sector, the agents must be external ones. Such agents are commercial firms who produce, sell and service technology for the purpose of making a profit. The providing organization must either contract with an agent to perform this function or convince the agent that he can make sufficient profit from producing and selling the technology to the public. In performing the latter activity, the Government, in effect, behaves as if it were a private firm selling its technology. Such behavior has been authorized by the Technology Transfer Acts of 1980 and 1986.

SUMMARY AND CONCLUSIONS

Technology transfer transfers the "possession" of technology. Technology is possessed and transferred as knowledge/skills, as products/equipment, and as property rights. These three transfer tasks make up the transfer operation. Knowledge/skills are transferred in two ways: between people and from people to product to people. When in product form, knowledge/skills can be transferred as a product. Property rights are transferred in the same way. Products/equipment are transferred between physical locations and as knowledge/skills.

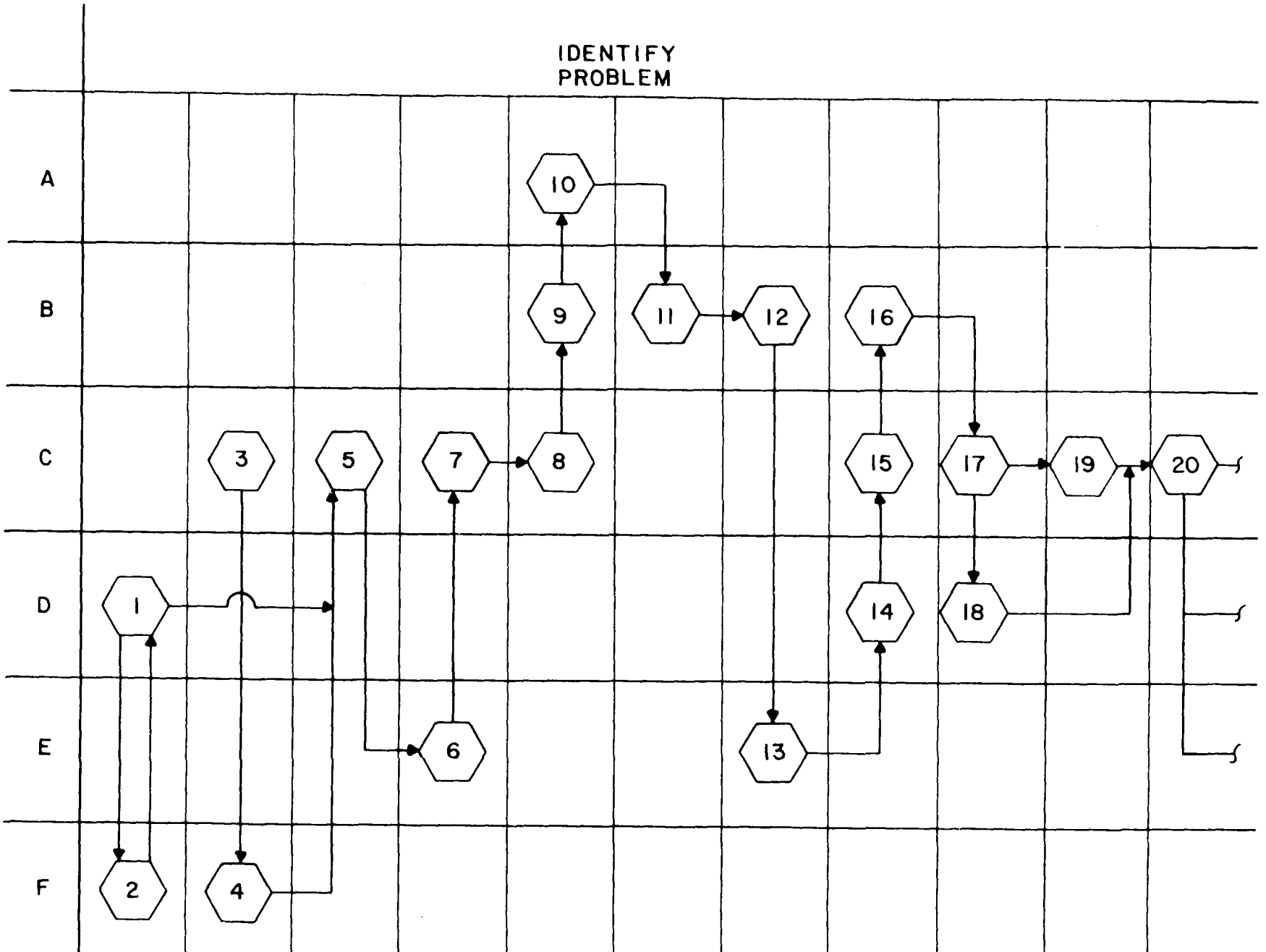
Technology transfer occurs in two modes: passive and active. The passive mode contains only the transfer operation. The active mode contains the transfer operation plus a marketing operation. For the acquirer, the transfer objective is the same in either mode, and that objective is to acquire a desired capability. For the provider, the transfer objective differs with the mode. In the passive mode, the objective is transfer itself. In the active mode, the

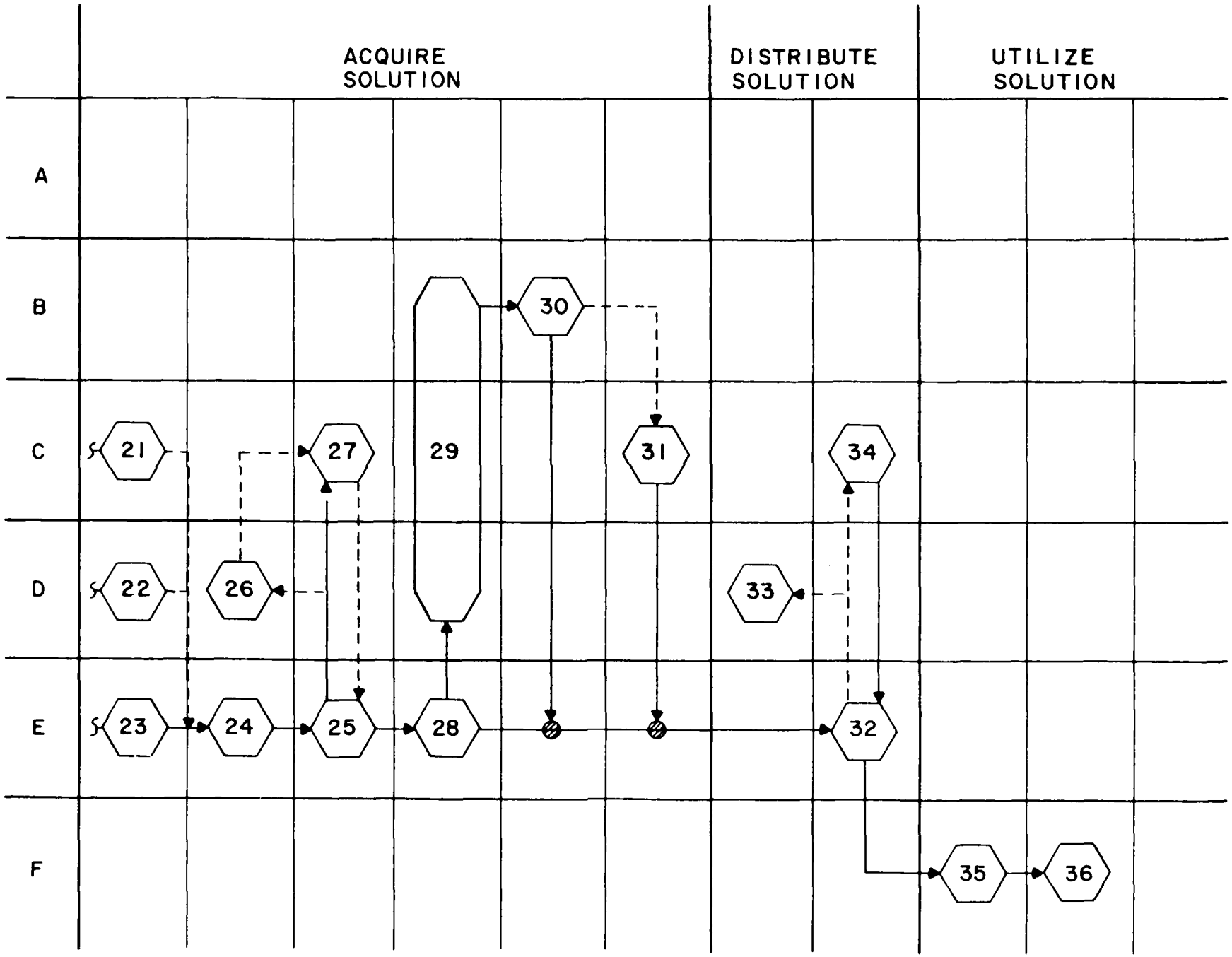
objective is to give the acquirer a capability the provider wishes him to have.

The active mode of transfer can occur indirectly as a network of intermediate transfers performed by transfer agents. An internal agent belongs to the provider's parent organization; otherwise the agent is external. Choosing which functions agents should perform and choosing between internal or external agents are part of structuring an organization for technology transfer.

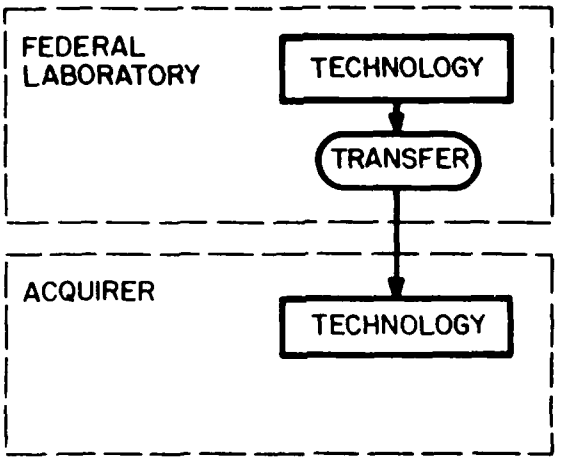
The Technology Transfer Acts of 1980 and 1986 provide government operated laboratories with the opportunity to have commercial firms pay, or at least not charge, to be intermediate transfer agents. Negotiating such arrangements is a completely new role for government operated laboratories.

Given this view of technology transfer, there are two unanticipated subtasks that should appear in the EIG network. The first is the marketing subtask, which includes negotiating with the commercial sector, and the second is the technology making and servicing subtask. The responsible party for the first subtask could be the laboratory, an internal agent or an external agent. The Technology Transfer Act of 1986 says it should be the laboratory when transferring to the commercial sector. The responsible party for the second subtask is the commercial firm(s) making and servicing the technology.

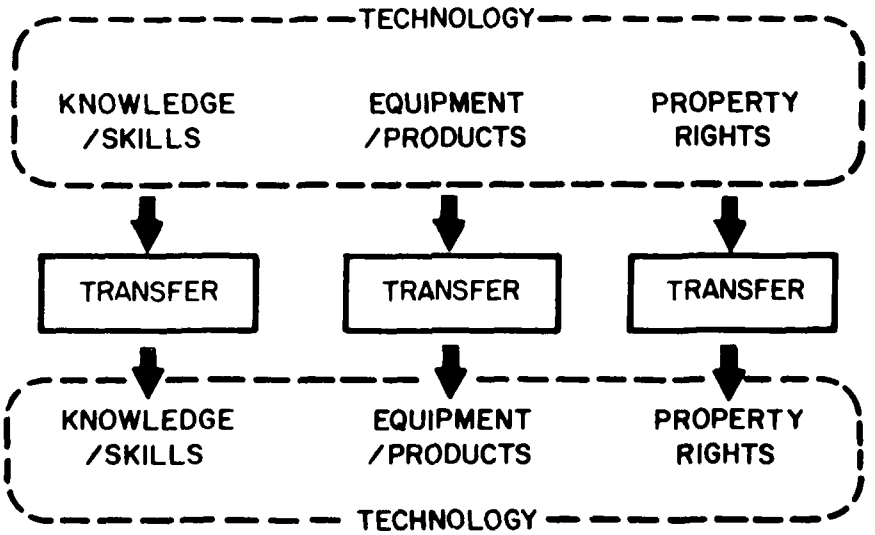

IDENTIFY
PROBLEM
A
B
C
D
E
F
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20


ACQUIRE SOLUTION
DISTRIBUTE SOLUTION
UTILIZE SOLUTION
A
B
C
D
E
F
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

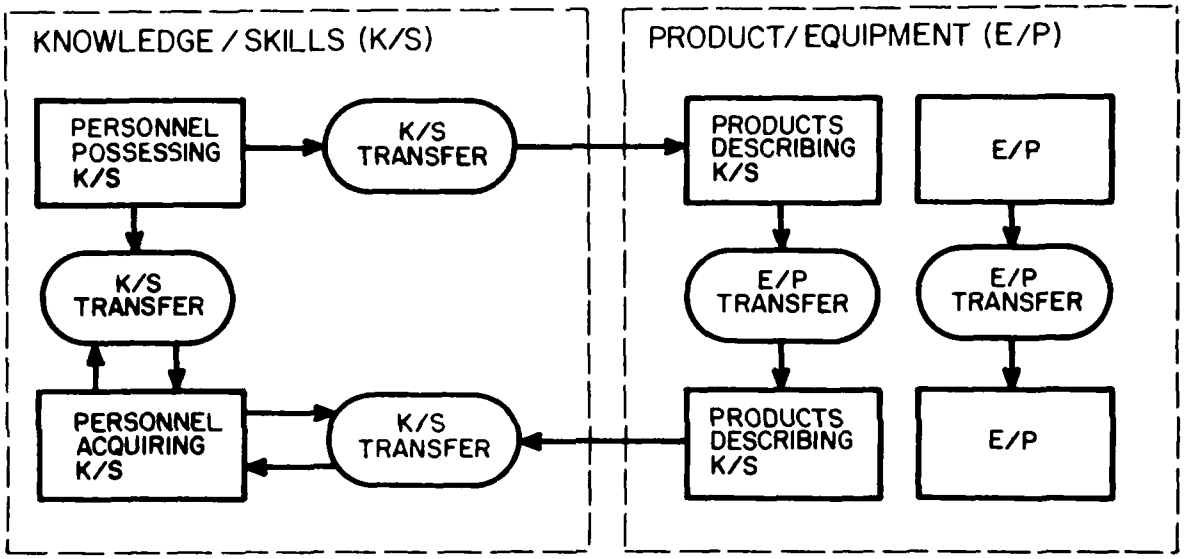
CONTEXT



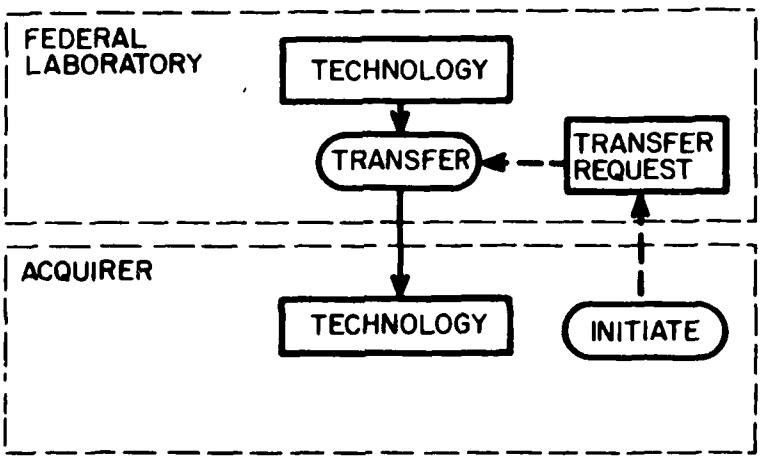
TRANSFER OPERATIONS



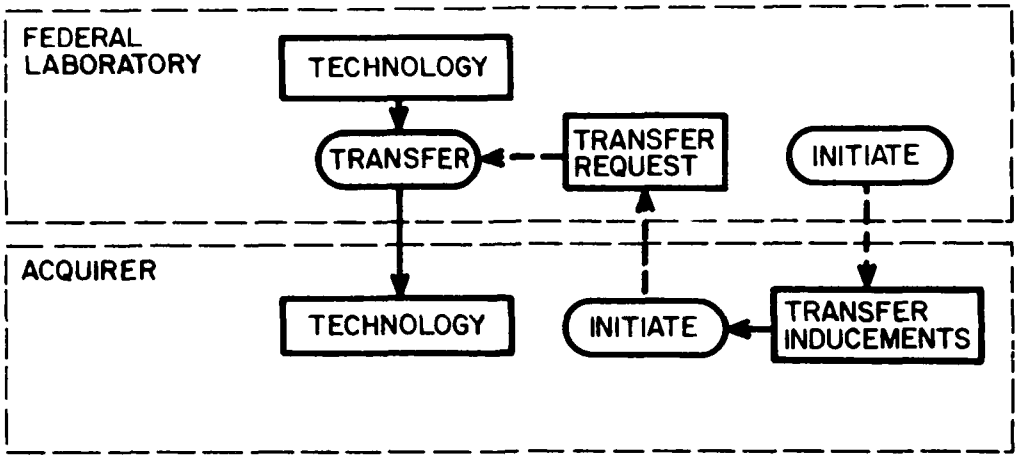
TRANSFER OPERATIONS



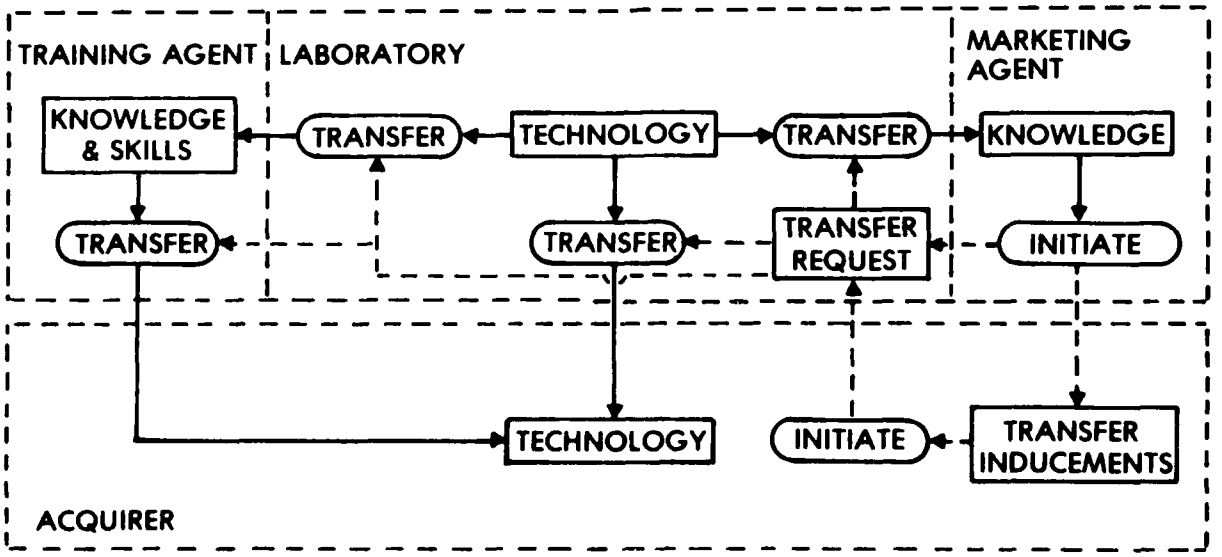
PASSIVE



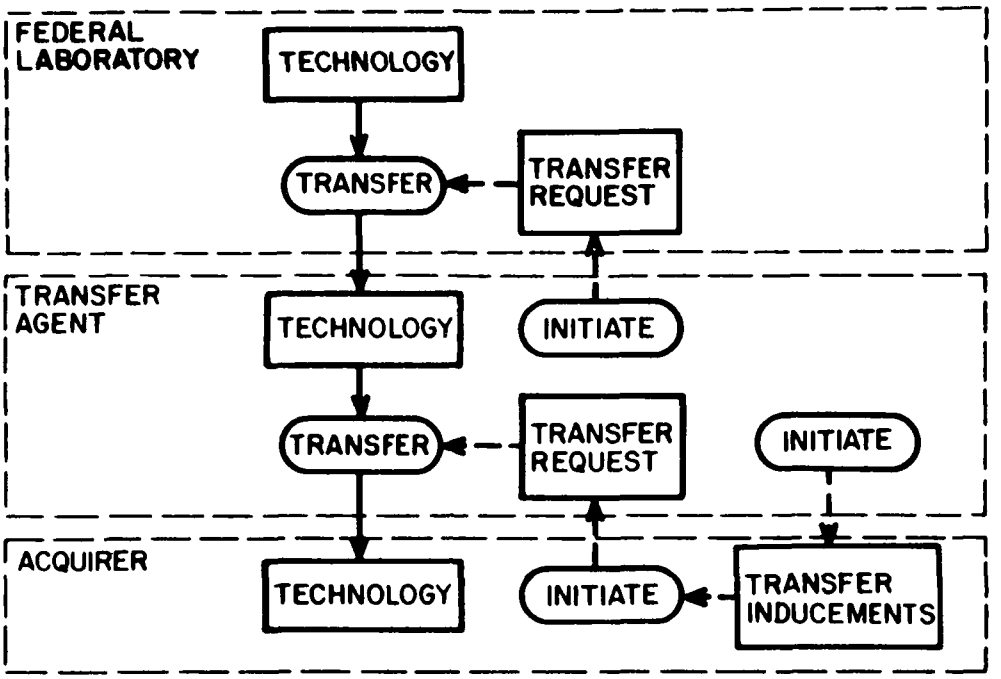
ACTIVE



MULTIPLE INDIRECT TRANSFER PATHS



INDIRECT TRANSFER PATH



COMMUNICATIONS AND MARKETING THEORY ON THE DIFFUSION OF INNOVATIONS--A REVIEW OF THE LITERATURE

by Jeffrey J. Walaszek
Public Affairs Officer

Background

Diffusion is a term used by social scientists to identify the process through which a new idea or technology is transmitted to individuals and organizations and ultimately results in its adoption. Within the context of USA-CERL, diffusion is synonymous with technology transfer.

This paper attempts to identify some of the problems and processes involved in technology transfer. It also examines what is known about the effectiveness and role of marketing and communications activities in support of technology transfer. This paper relies heavily on the work of Everett Rogers of Stanford University who has conducted extensive research on the diffusion of technology. His findings and theories have been published in his book entitled Diffusion of Innovations (1983). Rogers' findings on diffusion and the thoughts of other authors have been explained within the context of the technology transfer activities of USA-CERL.

Technology Transfer: The Marketing/Communications Challenge

Robert J. Betsold of the Federal Highway Administration compares the technology transfer activities of Federal laboratories to the advertising campaigns and other marketing effort in private industry. Both the Federal technology transfer effort and the private sector marketing effort are intended to encourage the use of a product whether it be toothpaste or some research product from a Federal laboratory. As Betsold points out, "...new products and ideas do not sell themselves--they must be brought to the attention of the consumer" (1982, p. 145).

Federal laboratories need to examine and use those marketing and communications techniques which will most efficiently inform users of available technology and assist them in using it.

Obstacles to Technology Transfer

The literature provides a wide offering of reasons for the failure of efforts to transfer technology to potential users. These problem areas typically fall into three general areas: ineffective communication, human resistance to change, and organizational constraints. Many of these same obstacles apply to efforts of USA-CERL to transfer its technology to military and nonmilitary users.

Ineffective Communications

Communications activities in support of technology transfer activities fall short in getting the word out to potential users and in

presenting information of value to users. A study by the U.S. General Accounting Office identified that many home builders were not aware of the results of innovative building technology (GAO, 1982). GAO suggested that use of these technologies by the home builders would result in reduced home costs for the consumer.

Another obstacle is that documentation may not be available at a time and place that is convenient to the users (Sheth, 1979). Army personnel interviewed on technology transfer activities cautioned that even information which does reach a potential user may go unnoticed if the user has no immediate need for the technology. When a problem arises that could be resolved by the technology, the potential user may not remember that the technology exists (Walaszek, 1987).

Another problem is that information on new technologies developed by research personnel may be of little value to users interested in applying the technology. A committee tasked to investigate the application of research findings by the American Association of State Highway Officials (AASHO) reported that researchers do not present their findings in the form or language that can be immediately translated into practice (ASSHO, 1968). This point was restated by Army interviewees who indicated information on technologies directed to users should emphasize the practical applications of the technology over the significance of the research (Walaszek, 1987).

The concept of "semantic noise" suggests that organizations have a language and set of experiences unique to themselves. These experiences and language affect their interpretation of research results causing problems in communication. Allen states, "Engineers in an organization are able to communicate better with their organizational colleagues that with outsiders because there is a shared knowledgy on both ends of the transaction and less chance for misinterpretation" (1979, p.139).

The AASHO committee also reported that researchers do not fully understand the needs of practicing engineers and others whose problems are seldom communicated in terms of research needs. The end result is that the research community may not be studying the problems which would directly assist the practicing engineers. This point was also brought up by Army interviewees who stated that the research effort needs to be closely tied to the needs of the field in order to develop usable products.

Human Resistance to Change

The ultimate goal of technology transfer activities is to produce a behavior change. The user will change his work activities to use a new technology. However, many efforts to implement new ideas and processes fail not because of good technological planning or leadership, but because those promoting change fail to take into consideration the human factor--the resistance to change (Yaeger and Raudsepp, 1983).

Goldhar states that information producers must deal with the fact that more information creates psychological dissonance and users may react defensively to it. More information implies additional work, uncertainty, and the necessity to seek even more information (Goldhar, 1979).

Information received from Army engineers interviewed by Walaszek expands upon this point. Interviewees revealed several reasons why engineers at Army installations may be less willing to try new technologies: problems in learning to use a new technology, risks involved

in trying something new, and logistical problems in obtaining new technologies (Walaszek, 1987).

Learning to use a new technology can be a very time consuming process. The installation engineer is under much pressure to complete a large number of tasks within a limited time frame. As one interviewee mentioned, why should the engineer take the time to draw up new pavement design plans for some new approach, when he can take some older plans off the shelf, make some minor changes, and be done with it.

Army engineers suggested that the reluctance by installation engineers to learn to use new technologies may be due in part to pressures brought on by the commercial activities process. Many installation engineers are currently seeing many of their services and people being replaced by commercial contractors under the Reagan Administration's emphasis on involving the private sector in Government operations. Time spent on learning to use new technologies could be viewed as nonproductive time by installation engineers who are under much pressure to justify their own productivity.

The risk in trying something new may prevent individuals from trying a new technology which may not have a proven track record. Using a new technology requires a financial commitment by the installation engineer. If the technology fails to perform as expected, the installation engineer will have to account for his decision to use the technology and may have to seek additional funding to correct the situation.

Another obstacle which prevents Army personnel from using new technologies is the ability to easily acquire the technology through existing procurement processes. Some technologies are so new that only one contractor can provide the technology or service for it. Government procurement regulations are designed to promote fair competition for Goverment contracts among potential suppliers of a service. Purchasing a service from a single supplier of that service can be done within existing procurement procedures. However, installation engineers may not be aware of these procedures, nor be willing to undertake the additional paperwork required.

Organizational Constraints

Love of the Federal Highway Administration (FHWA) points out that successful technology transfer is a management process which can be successful only if the organization makes a commitment to conducting such activities. This commitment towards technology transfer by the organization must consist of 1) the support of top management, 2) adequate funding, 3) an effective organization supporting transfer activities, and 4) cooperation from all elements involved both at headquarters and in the field (Love, 1978).

The literature suggests that the very effective technology transfer programs of FWHA, National Aeronautics and Space Administration (NASA), and the U.S. Department of Agriculture (USDA) meet the four management criteria proposed by Love. All four programs are all similar in that technology transfer has been given a high priority by the agency. Technology transfer is not the responsibility of the research and development laboratory, but the entire agency which sponsors the research.

Funding has been provided to support the network of regional offices in the case of NASA and FHWA and the extension service offices of USDA. The FHWA uses this network of offices to 1) serve as communications link between the sources of research and potential users, and 2) assist in transferring technology into field use. FHWA spends 15 to 20 percent of its annual research and development administrative contract funds on the implementation of technology (Griffith, 1982). The network of regional offices provide the organization through which technology transfer objectives are met.

Within an organization, the search for scientific and technical information is limited by time, permission requirement, and budgetary constraints on the user (Rothberg, 1979). A user will take much time to search through the large volume of available scientific and technical information. The organization may not have the information resources or financial resources to allow this search to occur efficiently. Engineers at Army installations do not have research and development departments or information specialists to do this type literature searching.

The organization of the Army is not conducive to easy communication and a centralized support for technology transfer activities. Decision making responsibility for using new technologies is fragmented among the major commands (MACOM's) within the Army who have responsibility for engineering operations at installations under their control (Walaszek, 1987). The U.S. Army Corps of Engineers headquarters personnel have no real authority to impose new procedures and technologies among the installations which belong to the MACOM's. Personnel involved in installation activities at Corps headquarters serve as important contacts with the MACOM engineering personnel. However, their efforts to communicate with these individuals is complicated by the number of MACOM's to communicate with.

Even within the Corps of Engineers organization of Divisions and Districts, top-level Corps management has not made technology transfer a high priority. The business of the day at Corps headquarters is dealing with the program management of ongoing contruction projects and the operations and maintenance of existing facilities. Those individuals at Corps headquarters assigned to overseeing research projects are often pulled from these activities for higher priority projects (Walaszek, 1987).

The Innovation Development Process

Rogers defines a six-step process through which an innovation comes into existance and is transferred into the social system. Rogers points out that the diffusion phase is just one component of the innovation-development process. He adds that many of the events leading to the diffusion step will affect the nature of the later diffusion activities. Rogers' six-step innovation-development process consists of the following stages: 1) problem identification, 2) research, 3) development, 4) commercialization, 5) diffusion and adoption, and 6) consequences (1983).

Within the research operation of USA-CERL, this same innovation-development process has been defined somewhat differently by the Laboratory's Technical Director Dr. L. R. Shaffer. The Shaffer model

consists of the following five steps: 1) problem identification, 2) research and development, 3) field demonstration, 4) product/system authorization, and 5) product/system application. The following presentation will explain the Army innovation-development model and outline the distinctions between the two approaches.

The major difference between the two models, and this will come out more clearly in the later paragraphs, is the Shaffer model places more of an emphasis on the diffusion of the innovation. Rogers' model lumps diffusion activities into one step in the overall process. Shaffer's model consists of three diffusion or technology transfer phases--the field demo, the product authorization, and product application.

Problem Identification Phase

Both innovation-development models begin with a problem identification. Problems are identified for USA-CERL in a variety of ways. Personnel at Corps headquarters identify problem areas and provide funding to USA-CERL for research on those problems they have identified through their contacts with the MACOM's and field personnel. Army committees tasked to look at specific problem areas also provide input and set priorities for research activities through personnel at Corps headquarters.

Another major source of research opportunities for USA-CERL are the MACOM's and engineers at Army installations. Both groups will provide funding to USA-CERL to conduct research on problems they are facing. USA-CERL also identifies and recommends potential research areas to Corps headquarters.

Research and Development Phase

Under the Shaffer model the research and development occurs in the second phase of the innovation-development process. Rogers separates the research and development into two separate phases. Under the Shaffer model the second phase also includes a pilot test of the developed technology to ensure it meets the needs of the ultimate user. Findings from the pilot test will be used to modify the technology before its transfer to the field. The pilot test is similar to Rogers' concept of clinical trials. If the technology does not work in the pilot test, this will ultimately result in a decision not to initiate transfer activities.

The research and development phase ends the research segment of the innovation-development process. The following three sections represent the technology transfer segment of the innovation-development process.

Field Demonstration Phase

The field demonstration phase is designed to demonstrate the use and effectiveness of a technology in a wider and more visible application than the pilot test. It is the first step in the transfer of the technology. Unlike the pilot test which is intended to refine and test the application of the innovation, a major purpose of the demonstration is to show all users how the innovation can effectively be used to solve a problem. Another important function of the demonstration is to gain information on operational problems faced by users of the technology at demonstration sites. Finally, the demonstration of the technology may also reveal

additional technological problems which need to be resolved before formal Armywide transfer.

It is at this stage that we see the first major departure in the two models depicting the innovation-diffusion process. Rogers identifies commercialization as the next phase following the development of the technology. Shaffer leaves commercialization considerations for later phases. An examination of the role of commercialization in the two models is necessary to understand this discrepancy.

Rogers defines commercialization as the production, manufacturing, packaging, marketing, and distribution of a product that embodies an innovation. Rogers points out that this packaging of research results is typically done by private industry. In the Army process this may or not be the situation. Many of the innovations developed by USA-CERL consist of new procedures or practices which do not necessarily require hardware items to be manufactured.

However, even procedures need to be packaged in the form of training manuals or mechanisms for obtaining support to use the procedure. The lack of formal support mechanisms for innovations is one of the problems facing the transfer of USA-CERL technology (Shaffer, 1985). USA-CERL often finds itself devoting human resources to provide such support to Army users until formal support mechanisms can be arranged. USA-CERL is currently providing such support to Corps engineers at construction sites who are using microcomputers (Walaszek, 1987).

There are several arguments which could be used to support placing commercialization/support considerations before the field demonstration phase in the Shaffer model. If commercialization/support considerations are developed prior to and incorporated into field demonstrations, the demonstrations would reflect real life situations and pave the way for later transfer activities. Contractors providing support or training packages for use by the field in using the technology would replace laboratory personnel who otherwise would provide such support in field demonstrations. If the demonstrations go well and a decision is made to transfer the technology Armywide, the support mechanism would already be in place.

Another reason for having commercialization/support considerations planned out and available prior to demonstrations is that laboratory personnel could affect the outcome of the demonstration. Laboratory personnel familiar with the technology may inadvertently assume responsibilities which otherwise would result in operational problems for the users. A hypothetical example of this would be the previously mentioned situation of the installation engineer's lack of familiarity with sole source contracting procedures. Perhaps in a previous demonstration of the technology a researcher arranged for the contracted service. While the technology worked well in the demonstration, the demonstration never revealed the potential operational problem caused by an installation engineer's unwillingness to contend with single-source contracting.

The field demonstration is a key element in the overall diffusion of the technology. The field demonstration is the first attempt to show the effectiveness of the technology before Armywide users. A successful demonstration will produce information on real life savings from use of the technology which can be used to convince others to adopt the technology.

Personnel using the technology at the demonstration sites can become valuable spokespersons for the technology during later transfer activities. As previously mentioned, Army personnel cited peers as the primary source for obtaining information for decisions on using a new technology. The role of peers in influencing adoption decisions will be discussed in greater detail later.

Product/System Authorization Phase

Once the technology has reaffirmed its value in the field demonstration phase, a decision has to be made by someone to begin transferring the technology to potential users. In the Shaffer model this occurs at the product authorization phase. Rogers uses the term "technology gatekeeping" to represent those individuals who have the authority to decide what technologies should be transferred and when transfer activities should occur.

In the Army, the technology gatekeepers can be a variety of people or groups. Personnel at Corps headquarters or the MACOM sponsoring the research are potential gatekeepers. Another potential gatekeeper is Army committees, such as the Corps of Engineers Energy Team, which formulate guidance for applying technologies within a technology area.

The decision or authorization to use a technology needs to be transmitted to the field as some form of policy statement. Within the engineer social system, the responsibility for engineering policy and guidance typically lies with personnel at Corps headquarters. Corps headquarters publishes a variety of documents which serve as policy statements to engineers at installations. These documents include technical manuals and engineering regulations. One problem with these types of documents is the long length of time it takes to get them published (Walaszek, 1987). Technical manuals and engineering regulations may take years to publish due to the extensive reviews involved in publishing them.

Some method of providing interim guidance to users needs to be worked out. Engineering Technical Letters are one such interim document. Another potential tool is the technology summaries being considered for use in the Facilities Technology Applications Test Program (Walaszek and Williamson, April 1986). The technology summaries consist of listing of all pertinent information on a technology such as equipment needed, cost of applying it, and the savings from its use. The summaries are provided in a newsletter format and are intended to assist installation engineers in making decisions on using the technology.

The existence of authorization documents alone is insufficient in ensuring the use of technology by installation personnel. A secondary level of authorization to use a technology lies at the MACOM level. The MACOM needs to provide both encouragement and financial support in some cases in order for the technology to be used by installation engineers (Walaszek--April, 1986 and January, 1986). MACOM engineers need to be involved in the overall decision to transfer a technology.

Product/System Application Phase

The product/system application phase is similar to Rogers' diffusion and adoption phase. During this phase the technology begins to be used

outside the field demonstration sites. This phase consists of an extensive information or awareness program to inform potential users of the existence of the technology, its applications, and sources of support. Authorization documents should be heavily referenced in awareness activities. Additional components of this phase include training activities and field support. Commercialization and support mechanisms worked out prior to the field demonstrations are put into place in this phase. The following sections will describe some considerations which need to be addressed to achieve success during this technology transfer phase.

Consequences Phase

One final discrepancy between the two innovation-development models is the addition by Rogers of a consequences stage. Rogers defines this stage as an evaluation of whether the diffusion of the technology actually solved the problem to which it was intended. This evaluation would also attempt to identify if any new problems were created by the use of the technology. The Shaffer model does not address this type of post-diffusion evaluation.

Innovation-Decision Process

The ultimate goal of technology transfer is to have individuals adopt the technology for use. Rogers points out that an individual's decision to adopt a technology is not an instantaneous act, but a process that occurs over time and consists of a series of actions. Rogers proposes the following five-step model to describe the innovation-decision process: 1) knowledge stage, 2) persuasion stage, 3) decision stage, 4) implementation stage, and 5) confirmation stage (1983). Communications activities are present at every step in the innovation-decision process.

Knowledge Stage

At some point a potential user of a technology is exposed to information on the innovation. Rogers raises a point of controversy among diffusion scholars on which comes first--the need for the technology or information on the technology. Some experts say an individual will expose themselves to messages which are supportive of a pressing need or an existing attitude. Army personnel indicated that information on a new technology may go unnoticed by personnel who are not facing a problem which the technology can resolve (Walaszek, 1987).

The other view suggests that information on the existence of an innovation can lead to an individual identifying a need for the technology. Rogers points out that the literature does not provide a clear support for either position. He adds that different situations may exist for different technologies.

Rogers also attempts to define two types of knowledge which an individual uses to make decisions on using new technologies--how-to knowledge and principles knowledge. How-to knowledge consists of information necessary to use the technology properly. Rogers suggests that the lack of adequate how-to knowledge prior to a trial of an innovation will most likely result in a negative decision to use that technology. Principles knowledge consists of information on principles underlying how

the technology works. Rogers points out that it is possible to adopt an innovation without principles knowledge, but that the danger of misusing the innovation is greater.

This initial information on a innovation can come from almost anywhere--mass media channels, contacts with research personnel, or other interpersonal contacts with peers. Rogers summarizes characteristics of early knowers of a technology through generalizations from the research. An early knower typically has more education, more exposure to mass communications channels, more exposure to interpersonal channels of communication, and more exposure to individuals representing new technologies.

Persuasion Stage

Knowledge of an innovation does not necessarily result in the use of the technology. At the persuasion stage an individual forms a favorable or unfavorable attitude towards the innovation. The potential adopter actively seeks out additional information on the attributes of the innovation. The individual is interested in obtaining innovation-evaluation information on the advantages and disadvantages of the innovation within his or her setting. (The specific attributes of innovations will be discussed later.)

Rogers points out that the important communications behaviors occurring at this phase include where he or she seeks out the information, what messages he or she receives, and how this information is interpreted. Rogers points out that peers are a prime source of innovation-evaluation information. A recent study of Army personnel supports this point (Walaszek, 1987). Peers were cited by 54 percent of the respondents as a major source of information on the effectiveness of new technologies. Articles in technical and trade publication received the second highest rating (mentioned by 30 percent) and research staff was ranked as the third most popular source (mentioned by 27 percent).

Rogers points out that even a favorable attitude towards an innovation does not necessarily lead to adoption. Rogers states that sometimes adoption can be prompted by a cue-to-action. A cue-to-action is an event which coverts a favorable attitude into a behavioral change--the adoption of the technology. A corrosion problem may lead an installation engineer to adopt a cathodic protection system. Rogers states that a cue-to-action response can also be induced through incentives to use a technology. The Federal Aviation Administration offered funding support to State Aeronautic Departments which were interested in implementing USA-CERL's Pavement Condition Index as part of their pavement maintenance activities (Walaszek, 1987).

Decision Stage

During the decision stage, potential users either decide to adopt the technology for use or reject the technology for use. Rogers points out that most individuals will use the product on a trial basis before deciding to use the innovation. This is one mechanism for reducing the uncertainty on how well the technology will work. Rogers states that most individuals who try an innovation will decide to use it, if the technology offers at least a certain degree of relative advantage.

The trial of an innovation can be promoted by offering free samples or use of an innovation. Rogers discusses a study by Klonglan which found that the free trial of a new weed spray speeded the innovation-decision by a year. Free passwords and temporary access to an economic analysis computer program provided by USA-CERL to Army personnel allowed people to gain familiarity with the system (Walaszek, 1987).

Rogers points out that for some individuals the trial of a technology by a peer like themselves can substitute for their own trial of an innovation. Demonstrations of a technology by a individual viewed as an opinion leader by potential users can be effective in creating a trial by others effect (Magill, Rogers, and Shanks, 1981). While demonstrations may be an effective tool in creating a trial by others effect, the results of such demonstrations need to be publicized and brought to the attention of other potential users (Walaszek, 1987).

While Rogers points out there is little research on behaviors leading to rejection, he discusses two types of rejection proposed by Eveland--active rejection and passive rejection. Active rejection consists of an individual considering use of an innovation, but results in a decision not to use it. Passive rejection occurs when an individual never really considers use of the innovation.

Implementation Stage

During the implementation stage the individual or organization puts the innovation to use. Rogers points out that prior to the implementation stage, the innovation-decision process has been primarily a mental process. In the implementation phase a behavior change actually occurs.

Rogers points out that the individual seeking to implement the technology will be actively looking for information on obtaining, using, and resolving problems brought on by use of the innovation. The ready availability of this information or sources of assistance can help minimize the confusion brought on by the attempt to use the innovation.

Attempts to implement an innovation within an organization may be more difficult. Rogers points out that within an organizational setting, a number of individuals are usually involved in the innovation-decision process, while another group is responsible for implementing the technology. The adoption of innovations within an organization will be discussed in more detail later.

Sometimes innovations are implemented, but not in the exact form provided by the designers of the innovation. Individuals will occasionally modify a technology to meet local or changing needs. Rogers suggests that this re-invention can be a positive thing resulting in innovations better suited to a local situation and ensuring the innovation's use.

Confirmation Stage

Rogers points out that individuals will continue to seek out information to reinforce his or her decision to implement the technology. On the other hand, an individual may reverse the decision to implement the technology after adoption if confronted with conflicting information about the innovation.

Rogers identifies two types of discontinuance--disenchantment discontinuance and replacement discontinuance. Disenchantment

discontinuance occurs when the user is dissatisfied with its performance. This could occur when the innovation is inappropriate for the individual. Engineers at a small Army installation with a limited road network may find the automated pavement maintenance management system an unnecessary expense when compared to manual methods. Disenchantment can also occur from the misuse of a innovation which otherwise would have worked well for the individual.

A replacement discontinuance is a decision to replace an existing innovation with a better idea. Computer users are taking their programs off large, mainframe computers and running them on microcomputers, which are less costly to operate.

The availability of information and personnel to adequately support the individual in his or her use of the innovation can prevent discontinuance. Change agents or personnel supporting the use of the technology can provide reinforcement to adopters. These individuals can also head off potential problems or misperceptions in the use of innovations.

Rate of Adoption and Adopter Characteristics

The ability of researchers to identify the rate of adoption forms the basis for attempts to classify adopter characteristics. Rogers has identified five categories of adopters: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards (1983).

Rogers states innovators make up the first 2.5 percent of the individuals who adopt an innovation and stand two standard deviations away from the mean adoption time. Early adopters make up 13.5 percent of the adopters. The early majority and late majority each consist of 34 percent of the innovators. The laggards represent 16 percent of the innovators. A more detailed description of each category type follows.

Adopter Types

Rogers describes innovators as venturesome. Innovators are very eager to try new ideas and are comfortable with taking risks. Rogers points out that two prerequisites for innovators is control of substantial financial resources and the ability to understand and apply complex technical knowledge. Innovators are often looked at as eccentrics within a social system. The innovator plays an important role in the diffusion process by launching a new idea into the social system.

Rogers describes early adopters as respectable members of the social system. He adds that this adopter category contains the greatest degree of opinion leadership. Early adopters are the ones potential adopters look to for advice and information. Rogers defines the role of the early adopter as to decrease uncertainty about an innovation and convey this information to near peers through interpersonal contacts.

The early majority adopt an innovation before the majority of adopters. They are willing to make changes, but deliberate some time before deciding to adopt the innovation. Rogers points out that the early majority interact frequently with their peers, but seldom hold leadership positions.

Rogers describes the late majority as the skeptics. Their decision to adopt are often produced by economic necessity and increasing pressure from peers who have adopted. The late majority can be persuaded of the value of the innovation, but the pressure of peers is needed before the decision to adopt is made. Rogers adds that the resources of the late majority are limited. Consequently, almost all of the uncertainty about an innovation must be removed before they adopt.

The laggards are the traditionalists in the social system. They also have the fewest resources available to them for implementing an innovation. This forces them to be very conservative with using innovations.

Characteristics of Adopter Types

A recent survey asked Army engineers to identify when they would try a new technology (Walaszek, 1987). The intent of the question was to determine how much information was needed by respondents before they would decide to use a technology. Respondents were asked whether they would try a technology after initially reading about it, after evaluating additional information on the technology, after the technology was in use for some time and results on its use were available, and after the use of the technology became mandated by some higher authority in the organization.

The responses somewhat parallel the percentages shown in the above adopter categories. About 8 percent mentioned they would try a technology after initially reading about it. Another 8 percent would wait to use the technology after some higher authority made its use a requirement. The most commonly cited response was that they would try a technology after evaluating more information on it (66 percent checked this response) and would try the technology after it was in use for a while and results were available (38 percent).

Multiple answers to the question prevent a clear comparison to the adopter categories. However, one would think the 8 percent who were willing to try the technology after reading about it would belong to the innovator or early adopter categories. The laggards would wait until the technology was mandated for use. The remaining respondents would fall within the early and late adopter categories.

Rogers identified several generalizations about the characteristics of early versus late adopters. These generalizations have been explained under the heading of socioeconomic status, personality variables, and communications behavior.

Under the socioeconomic heading, early adopters typically display the following characteristics over the late adopters:
1) more schooling, 2) higher social status, 3) more favorable attitudes towards borrowing, 4) manage more specialized operations, and 5) manage larger sized organizations.

Under personality variables, differences between early and late adopters include the following characteristics for early adopters: 1) less dogmatic, 2) greater ability to deal with abstractions, 3) more favorable attitude toward change, 4) more able to cope with uncertainty and risk, and 5) higher levels of achievement motivation.

Under communications variables, differences between early and late adopters include the following characteristics for early adopters: 1) more highly interconnected within the social system, 2) have more contacts with

people and places outside the social system, 3) greater exposure to mass media channels, 4) greater exposure to interpersonal communications channels, and 5) more actively seek out information about innovations.

Attributes of Innovations Leading to Adoption

Rogers presents five attributes of innovations which are commonly used by diffusion researchers to characterize successfully adopted innovations. By being able to characterize and compare innovations, one can attempt to predict whether an innovation will be accepted within the social system. These attributes of innovation which lead to their adoption include, 1) relative advantage, 2) compatibility, 3) complexity, 4) trialability, and 5) observability (Rogers, 1983).

Relative advantage is an individual's perception of the innovation being better than the practice it supersedes. The degree of relative advantage is often expressed in profitability, the amount of status it provides to the adopter, or other ways.

Army engineers were asked to rate which benefits of a technology would encourage them to try using it (Walaszek, 1987). The majority of respondents (69 percent) indicated that claims of reduced labor and cost of operations would encourage them to use an innovation. Improved efficiency through timesavings (57 percent) and improved product quality (56 percent) also received high ratings by respondents.

Rogers states that relative advantage is one of the best predictors of rate of adoption. He points out that relative advantage indicates the strength of the reward or punishment from using an innovation.

Incentives are one way to increase the degree of relative advantage and, consequently, increase the rate of adoption. Rogers' experience with family planning innovations led him to draw the following conclusions about the effects of incentives (1983). Incentives increase the rate of adoption of an innovation. Adopter incentives lead to adoption of an innovation by individuals different from those who would otherwise adopt. In the case of family planning innovations, Rogers found incentives worked well in increasing the rate of adopters among individuals of the lowest socioeconomic status. Finally, individuals who adopt an innovation as a result of an incentive may have less motivation to continue the use of the adoption.

Rogers defines compatibility as the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters. Rogers states that the compatibility of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.

Rogers presents the idea of technology clusters as a way of achieving a sense of compatibility. Technology clusters are an approach to package an innovation with other related innovations which are either new or have already been accepted by individuals. Rogers points out that while technology clusters intuitively make sense, little research has been conducted on this approach.

Complexity is the degree to which an innovation is perceived as difficult to understand and use. Rogers suggests that the complexity of an

innovation, as perceived by members of the social system, is negatively related to its rate of adoption. The more difficult an innovation is to understand, the less likely it will be used. The implication here is that there is an increased importance for effective mechanisms for providing support to users for complicated technologies. Such support may be able to offset problems faced by the user in learning to use technology.

Trialability is the degree to which an innovation can be experimented with by users on a limited basis. The practice or experimentation with the technology removes the uncertainty about how the technology will work for the user. Rogers contends that the trialability of an innovation is positively related to its rate of adoption.

Rogers points out that studies suggest that early adopters place a higher importance on trialability than later adopters. These individuals lack the availability of peers who they can rely on for information on the effectiveness of an innovation. Later adopters may be willing to rely on innovation-evaluation information provided by peers who have used the technology.

Observability is the degree to which the results of an innovation are observable or can be communicated to others. Some technologies are easier to describe to others. Software aspects of a technology may be less observable than hardware aspects. Rogers suggests that the observability of an innovation is positively related to its rate of adoption.

The above attributes should be taken into account by communicators or those promoting adoption in their communications efforts in technology transfer. In developing informational materials on new technologies, demonstrations of it, or results from tests, communicators need to emphasize the above attributes of innovations. The relative advantage of an innovation as shown from a demonstration should be a fundamental component of all informational materials. Designers of informational materials and communications activities can also incorporate the concept of trialability into its messages. Articles should carry observations and quotes presenting the views and observations of users of a technology to those peers who may later read the material.

Communications Activities in Support of Technology Transfer

A simple definition of communication is the transfer of information between two individuals or groups. There are four basic components of the communications process: the source or sender of the message, the message itself, the receiver of the message, and the channels linking the sender to the receiver.

Several forces affect the success of the communications process (Cutlip and Center, 1978). The communicator must have adequate and useful information of interest to the receiver. The communicator must have credibility in the eyes of the receiver. The communicator must be able to convey his or her thoughts into a message that can be understood by the receiver. The communicator must select a media channel which will convey the message directly to the desired receiver. The message must be pertinent and contain information of interest to the receiver. Finally, the message must motivate the receiver to respond in some way.

Cutlip and Center point out that a sender can encode a message and a receiver decode it only in terms of his or her own experience and knowledge. This is similar to the concept of "semantic noise" which was discussed earlier. When there is no common experience or knowledge between the sender and receiver, communication becomes virtually impossible. The receiver may filter out and fail to attend to messages that are outside his experiences, values, or knowledge. Cutlip and Center point out that too many practitioners engage in message sending only and fail to adjust their message to ensure it is effectively received and interpreted (1978).

Army personnel interviewed on technology transfer pointed out some shortcomings in attempts by research personnel to transfer information on innovations to users (Walaszek, 1987). These shortcomings included a failure by researchers to understand how installation engineers conduct their business; reports and briefings written in too technical of a language; and technical reports which contain much information which is thought to be irrelevant to the installation engineer's daily activities. Many of these shortcomings can be traced to a lack of understanding of the factors affecting the communications process.

Mass Media Models

Earlier we identified two types of communications channels used to exchange information on a new technology--mass media and interpersonal channels. Rogers points out that the strength of the mass media channels lies in their ability to reach a large number of potential users with information on the technology. Rogers points out that interpersonal channels are more effective in persuading an individual to adopt a new idea, especially if interpersonal channels link two near-peers. The communications channels can originate beyond the social systems called cosmopolite sources, or they can originate within the social system called localite sources. The following sections will examine the role of these communications channels in technology transfer.

Communications scholars have developed two models which identify how mass media contribute to the development of public opinion. These models are the hypodermic needle model and the two-step flow model (Rogers, 1983).

The hypodermic needle model assumes that the mass media have a direct, vertical effect on creating public opinion. This model assumed that individuals would listen to and believe what they learned through the media. Evidence from more sophisticated research studies soon resulted in the two-step flow model.

A 1944 study by Lazerfield attempting to determine the effect of the mass media on the public's decision on who to vote for marked the beginning of the end for the hypodermic needle theory. This study found that almost no voting choices were directly influences by the mass media. As Rogers reports, the findings identified the importance of interpersonal relationships and opinion leaders on forming opinions of others.

The two-step flow theory states the mass media serve to bring information to the attention of the public, particularly influential individuals within the social system. Upon learning of the information, individuals will seek out the opinions of others on the information.

The two-step flow theory appears to apply to diffusion activities within the Army engineer social system. A survey of Army engineers

revealed that while most of them currently learn of new technologies through mass media channels, their preference for receiving information on new technologies lies with interpersonal channels (Walaszek, 1987). A similar survey done with Florida home builders identified trade journals as the most common means of receiving information on new technologies. The home builders then indicated a preference for receiving this information from seminars as well as trade journals (Halperin, 1981).

Role of Communications Channels Within Diffusion

Rogers point out that the mass media can effectively, 1) reach a large audience rapidly, 2) create knowledge and spread information, and 3) lead to changes in weakly held attitudes. Mass media channels are very important at the awareness stage of the innovation-decision process.

His review of the research has led Rogers to develop generalizations on the roles of communications channels within diffusion activities. The first generalization states that the mass media channels are relatively more important at the knowledge stage and interpersonal channels are relatively more important at the persuasion stage in the innovative decision process. This is not to say that either channel could not have an effect at any point throughout the innovation-decision process.

The second generalization states that mass media channels are relatively more important than interpersonal channels for earlier adopters than for later adopters. This is largely due to the limited availability of accessible peers with knowledge of an innovation. Rogers points out that early adopters may not be as reliant on the opinions of other in making innovation-adoption decisions.

Rogers has also proposed two generalizations on the effect of the source of the channel on innovation-decision making. The third generalization states cosmopolite channels are relatively more important at the knowledge stage, and localite channels are relatively more important at the persuasion stage. Many innovations may not originate within the social system so early adopters would need to be exposed to more cosmopolite channels. Also, as Rogers indicated earlier, opinion leaders and near-peers who would influence a innovation-adoption decision would tend to be similar to the adopter and typically be part of the social system.

The final generalization is cosmopolite channels are relatively more important than localite channels for earlier adopters than for later adopters. This refers to the existence of information on innovations which may have been developed outside the social system.

Several mass media channels are available for use in informing Army engineers of the existence of new technologies. Army engineers ranked trade publications (77 percent), technical reports (68 percent), and newsletters (63 percent) as the three top ways they currently receive information on new technologies (Walaszek, 1987). The next cluster of ways Army personnel receive information on innovations were interpersonal channels such as exhibits at conferences (49 percent), workshops (49 percent), and demonstrations and briefings (43 percent).

Of these mass media channels identified by Army personnel, the newsletters had the highest readership ratings among engineer personnel at installations. Walaszek suggested the quick-to-scan, easy-to-read format of these newsletters may have contributed to their popularity among

readers. Readers with busy schedules who do not have a lot of time to read, can simply pick and choose what items they would be interested in reading.

Interpersonal Communications

Rogers points out interpersonal channels have greater effectiveness in changing or creating strongly held attitudes among users. The strength of face-to-face communication is that it provides a two-way exchange of information which can lead to an individual changing his or her attitude or behavior to adopt the technology (Rogers, 1983). Interpersonal communications are very important in the persuasion stage of the innovation-decision process.

Rogers identifies two types of individuals who play major roles in interpersonal relationships related to the diffusion of technology--change agents and opinion leaders.

A change agent is defined by Rogers as, "an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency" (Rogers, 1983, p. 312). Within the USA-CERL technology transfer efforts change agents would primarily consist of research personnel or technology transfer specialists from the laboratory, and could include personnel at Corps headquarters promoting adoption of a new technology among engineers within the other major commands or commercial manufacturers of Corps developed technologies.

Change agents provide a linkage between the change agency and the potential user. The two-way communications between the change agent and user is vital to the success of the diffusion of the innovation. Rogers points out that for the diffusion to be effective, the innovation must be tied to the needs and problems of the user. This point was emphasized repeatedly by Army personnel interview by Walaszek (Walaszek, 1987). The change agent needs to feed information on the needs of the user to the change agency to ensure innovations are responsive to such needs.

The change agent serves to assist the client in identifying existing needs and problems which can be resolved by available technology. Rogers cites the problem of information overload in which a client can be overwhelmed by the excessive amount of information on innovations. Once a need has been identified, the change agent can point out those innovations that are applicable to the problem.

Opinion leaders are those individuals whom people look towards for information and advice on adopting an innovation. Rogers states that change agent success is positively related to the extent that he or she works through opinion leaders. Opinion leaders typically have much credibility in the eyes of their followers. Further, opinion leaders who have used an innovation become a source of knowledge on how the innovation works in real life situations. Within the USA-CERL technology transfer activities, opinion leaders could be engineers at installations who have used a technology or engineers at the major commands who provide direction to installation personnel.

Rogers points out that interpersonnel diffusion networks are mostly homophilous (1983). Homophilous individuals share a common occupation, educational background, or socio-economic status. Army personnel stated they would rely most heavily on peers for information used in decisions on

adopting new technologies. Change agents need to identify who the opinion leaders are and try to foster the exchange of information between such individuals and potential users. Meetings of potential users and those using a technology have been arranged by USA-CERL to promote such an exchange of information on microcomputer technology for construction managers (Walaszek, 1987).

Identifying who the opinion leaders are can be difficult. Rogers has developed the following generalizations used to describe characteristics of opinion leaders (1983). These three generalizations describe the availability and access to information on new technologies by an opinion leader. These generalizations are summarized as opinion leaders have greater exposure to mass media, have greater exposure to change agents, and are more cosmopolite than their followers.

A second generalization states that opinion leaders have greater social participation than their followers. Interpersonal contacts occur through formal and informal gatherings. This access to an opinion leader by others is critical to the exchange of information.

A third generalization states that opinion leaders have higher socio-economic status than their followers. Rogers discusses a study of Brazilian farmers in which the opinion leaders were those having much larger farms than others. A perhaps forced comparison within the Army would be opinion leaders may be found on larger or more prestigious installations.

References

Allen, Thomas J. Allen. Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information Within the R&D Organization. Massachusetts Institute of Technology, 1977.

American Association of State Highway Officials. Special Committee on Utilization of Research Findings, First Interim Report. Washington, D.C., April 1, 1968 (Rev. April 15, 1968).

Betsold, Robert J. "Implementation of Highway Research: Yesterday, Today, and Tomorrow." Public Roads, 1982, Vol. 45, No. 4, pp. 145-152.

Cutlip, Scott and Allen H. Center. Effective Public Relations, Fifth Edition. New Jersey: Prentice-Hall, Inc., 1978.

Goldhar, Joel. "STI Dissemination: Issues and Opportunities." In Marketing Scientific and Technical Information, edited by William R. King and Gerald Zaltman. Boulder, CO: Westview Press, 1979.

Griffith, Ray G. "Field Activities in Technology Transfer." Public Roads, 1982, Vol. 45, No. 4, pp. 138-144.

Halperin, Don A. "Information Dissemination in Construction." Proceedings of the CIB W-65 Third Symposium on Organisation and Management of Construction. Dublin, Ireland, Session B: Education and Training, Volume II, July 1981.

Janus, Dr. Timothy. Presentation at Illinois Exhibition of Science and Technology for Economic Development, Chicago. NASA Indianapolis Center for Advanced Research, February 1986.

Kotler, Philip, Bobby J. Calder, Brian Sternthal, and Alice Tybout. "A Marketing Approach to the Development and Dissemination of Educational Products." In Information Dissemination and Exchange for Educational Innovations, edited by Michael Radnor, Durward Hofler, and Robert Rich. Evanston, IL: Northwestern University, 1977.

Lennon, Bernadine Antoinette. Technology Transfer Agents' Perceptions of the Technology Transfer Process. Monterey, California: Naval Postgraduate School, 1982.

Love, Gerald D. "Getting Research Into Practice." Better Roads, 1978, Vol. 42, No. 2, pp. 41-47.

Magill, Kathleen P., Everett M. Rogers, and Thomas Shanks. Improving the Diffusion of Mass Transportation Innovations. Institute for Communication Research, Stanford University. Sponsored by U.S. Department of Transportation. August 1981.

New, J. Randolf and Daniel D. Singer. "Understanding Why People Reject New Ideas Helps IEs Convert Resistance Into Acceptance." Industrial Engineering, May 1983, Vol. 15, pp. 51-56.

Roberts, Edward B. Roberts and Alan Frohman. "Strategies for Improving Research Utilization." Technology Review.

Rogers, Everett M. Diffusion of Innovations, 3rd Ed. New York: The Free Press, 1983.

Shaffer, L. R. "Product/System Development for Military Facilities." From the Briefing on High Technology Test Bed Concept. U.S. Army Construction Engineering Research Laboratory, Champaign, IL, 1985.

Sheth, Jagdish N. "A Model of User Behavior for Scientific and Technical Information." In Marketing Scientific and Technical Information, edited by William R. King and Gerald Zaltman. Boulder, CO: Westview Press, 1979.

U.S. Congress, House of Representatives, Committee on Science and Technology, Stevenson-Wydler Technology Innovation Act of 1980. House Report No. 96-1199, 96th Congress, July 29, 1980.

U.S. General Accounting Office. Greater Use of Innovative Building Materials and Construction Techniques Could Reduce Housing Costs. Report No. CED-82-35, February 18, 1982.

Walaszek, Jeffrey J. The Role of Communications Within Technology Transfer Activities of the U.S. Army Construction Engineering Research Laboratory. USA-CERL Technical Manuscript 0-87/1, July 1987, Champaign, IL.

Walaszek, Jeffrey J. and Gilbert Williamson. Technology Transfer Plan for the Facilities Technology Applications Test Program. Briefing before Personnel in the Facilities Division, Corps of Engineers Headquarters. U.S. Army Construction Engineering Research Laboratory, Champaign, IL, April 1986.

Yaeger, Joseph and Eugene Raudsepp. "Cope With Resistance to Change." Hydrocarbon Processing, March 1983.

Zaltman, Gerald and William R. King. "Marketing Scientific and Technical Information." In Marketing Scientific and Technical Information, edited by William R. King and Gerald Zaltman. Boulder, CO: Westview Press, 1979.

Zaltman, Gerald and Rohit Deshpande. "Increasing the Utilization of Scientific and Technical Information." In Marketing Scientific and Technical Information, edited by William R. King and Gerald Zaltman. Boulder, CO: Westview Press, 1979.

FACILITY SYSTEMS TECHNOLOGY TRANSFER

by Robert Porter, Janet Spoonamore,
Moonja Kim, and John Williamson
Facility Systems Division

I. General Considerations

For technology transfer to occur, especially in the arena of research efforts for application products, a dynamic approach is needed to assure that the process of change, which is becoming more and more the major part of any dynamic enterprise such as the Corps of Engineers, proceeds with direction and with purpose. The very nature of a professional organization, such as the COE, is its need for continuing education to maintain and advance its position at the forefront of higher technology into the "real world" of daily operations. Accordingly, it is desirable that the developers of new technology assume a leadership role in its transfer to and effective use by its intended user.

This is especially significant given there is presently a change occurring in the location of institutional knowledge. Previously, institutional knowledge has been "individual person-based" with cross-fertilization of ideas limited by logistical and time constraints. With the advent of the technology for "knowledge-based" institutional resources, such as comprehensive expert systems, institutional knowledge becomes universally accessible for anyone trained in the use of such systems. Specific situations encountered by personnel in the operational arena can now be handled by application of generic, universal knowledge collected and integrated from individual "lessons learned," making a significant difference in the effectiveness of total operations. However, the significance of the sharing of these "lessons learned" has become more and more important as systems capable of coordinating the information become available. Accordingly, the "information revolution" requires that personnel be helped in their development of new capabilities to both contribute to and to extract from the pool of institutional knowledge.

The nature of FS Division research (improved process-oriented decision making) requires more and more field-related technology transfer that is contributing to the development of improved decision makers along with the improved decisions. The implications for the research are that it must be not only more routinely relevant to keeping a dynamic enterprise functional with its products applicable to the development of the enterprise, but the research must also contain a conscious early consideration for the eventual training requirements for its transfer. T^2 of FS Division products must be a part of the COE's continuing education process. This early concern for the research product's transfer will not only provide for immediate field implementation when the product is complete, but will also probably improve the "quality" of the research and thus the product itself through a discipline of insisting upon "real world" relevancy.

Researchers, in most cases, cannot depend upon effective automatic technology transfer to occur through a passive presentation of the results of their efforts. Research technical reports, without active interpretation and field implementation through effective training programs, will not alone bridge the knowledge gap between the developer and the user.

II. FS Considerations and Current Status

A. Identified Problems

The major users of FS research products are OCE, ACE, COE Districts and Divisions, MACOM's, DEH offices, Area Engineers, installation Army personnel, and other various DOD agencies. It is now considered important that CECER-FS take a more aggressive approach to the T^2 of FS Division research products with all customer groups. A recent study addressed the current condition of CERL-wide T^2 efforts. The following criticisms and problems were identified by various members of our "customer group":

1. research products encounter T^2 difficulties mainly due to being only marginally relevant to the conditions in the field,

2. incomplete (or premature) research products that have not had adequate testing generate field resistance,

3. technical reports about products are many times "too technical" and not "application apparent" (A^2),

4. "time sensitive" products need to be introduced in a more timely way (possibly even sequentially), instead of waiting to research "everything" first,

5. field personnel must be more informed about the total research program--not just the individual products as they appear,

6. the field personnel are sometimes so far "behind" they can't try or resist trying a new way if the risk of the product not working will put them further behind,

7. the lack of T^2 support funding beyond initial research-oriented field tests constrains wide distribution of many products,

8. sometimes the "right" field personnel (application users) are not in a position to get "the word" about a improved product, because the T^2 communications now used are "stopped" by administrative "disconnections,"

9. research information per se that is sent to the field needs to be more concise and to the point,

10. the contractors who do projects for the field agencies (especially DEH offices) are not included nor considered in the research decisions and thus the research products are less applicable.

11. the field agencies have procurement constraints that must be accommodated if the research product required "special" procurement actions, such as sole source on contracts.

B. Pull of Technology

The advancing technology readily pulls society forward into using new products, e.g., PC, electronic sound and video. Similarly, the attitude of

the Corps of Engineers towards protessional growth has assured their interest in learning and adopting new technologies.

To transfer the FS Division research products/systems, efficient and effective methods for application of these products must be developed. The method must address the presentation form to assure that the application of the technology is readily apparent to the user and not cluttered with unnecessary details. Highly complicated, technical information can be simplified by breaking it up into small, acceptable lesson modules.

The researcher should prepare attractive, inviting T^2 introductory packages to communicate the information to the appropriate field personnel assuring that the information is noticed and passed on throughout the field organization. The researchers should include background information on their experience and credentials to give more personal information and assure acceptance by the future users. Caution must be advised, however, to assure that the product performance is not overstated in introductory materials, and limitations and ranges of uses are clearly understood.

Researchers should be encouraged to explore new techniques for T^2 and employ creative, innovative methods in their T^2 activities and thereby stimulating the creative energies of the product/system users. This can result in "leveraged T^2" - maximizing the resources and the energy of the user groups in bringing their vast resources into the implementation effort willingly. Further, use of innovative tools, e.g., PC's, video, electronic mail, etc., will assure efficient T^2 activities.

C. Conclusions

Analysis of the intrinsic nature of the technology transfer of application research products and of problems identified by major users of CERL research indicates that the researcher cannot assume that automatic technology transfer of his/her research product will occur with the issuance of a technical report. Instead, the researcher must, near the start of the research, consider the transfer of the product to its intended user through an effective training program. Review of the policy provisions for typical development and/or procurement of training devices such as in AR 71-9, Chapter 8, 15 August 1984, is recommended for the researcher. This policy statement may or may not be applicable for FS research product T^2 training.

The remainder of this report provides information and guidance for selection, development, and formatting of training materials.

III. Management and Control of Research T^2

A. Researcher Actions

The researcher should recognize that the T^2, just as the research, is an important part of product development. The researcher needs to control and manage the product development process. At the beginning of development of the product, the researcher spends the major effort in research, but as the product matures, the researcher will need to focus much more attention to the technical transfer aspects. The researcher plays different roles in various stages of product development. When the product is being developed, one must

consider the incorporation of the T^2 aspects into the product. Refer to Figure 1, "Research/Technology Transfer Interface," showing the relative balance of research vs. technology transfer activities during the research/T^2 life cycle. The T^2 periods require separate plans by the PI for the initiation, field test, authorization and application (refer to Figure 2, "FS T^2"). The principal investigator roles and activities during each period of the T^2 process are shown. The responsibilities/actions for the field administrator/operators role in the T^2 of the research product are also shown. The role of FS PI evolves during the T^2 process, for example when the product is ready to be distributed, the PI plays the role of translator, explaining the relation of the product to the potential user's work. Then, after the product is distributed, the researcher becomes the teacher of the initial training until some of the users become capable teachers themselves who can stimulate and lead more potential users. When there are enough capable users who can lead the user group, the researcher will play the role of supporter only when needed. The figure shows the breakout by typical product types and user types, and the introduction of Support Center assistance during the T^2 of certain research products is also shown.

For a T^2 development process to be successful, it is absolutely necessary to have a cooperating partnership between the researcher and the user. The researcher should understand that the interconnectivity of each user is important for efficient T^2 of the product, recognizing that each user will become multiple activators of the user group and eventually generate into self-sufficient user groups. As the number of users of the product increase, T^2 needs to be synchronized for many participants; developer, translator, teacher, and user. The researcher must play the proper role depending on the level of user (sophisticated vs. novice).

B. User Involvement in T^2

FS Division product systems are oriented to "change"--doing things a new way, a different way, a better way. These changes, to be implemented, require the user's recognition of the "old way" being unsatisfactory and acceptance of change for the "better." It is the user's responsibility to change and progress. However, the researcher must instill within the user an awareness of the need and necessity to change. There are several approaches which may be employed. Formal authority and/or endorsement concurring with the T^2 implementation are very important to give the product a <u>push</u>. Public relations approaches should also be employed to assure exposure to the concepts and benefits of the product/system and the problems with doing things the old way. The researcher and product/system champions must push the product to the user.

The partnership described earlier in the discussion of T^2 control is again illustrated in the specific user involvement in T^2. The user is recognized as a responsible partner in the T^2 process, understanding the importance of the product benefits and attending to its application.

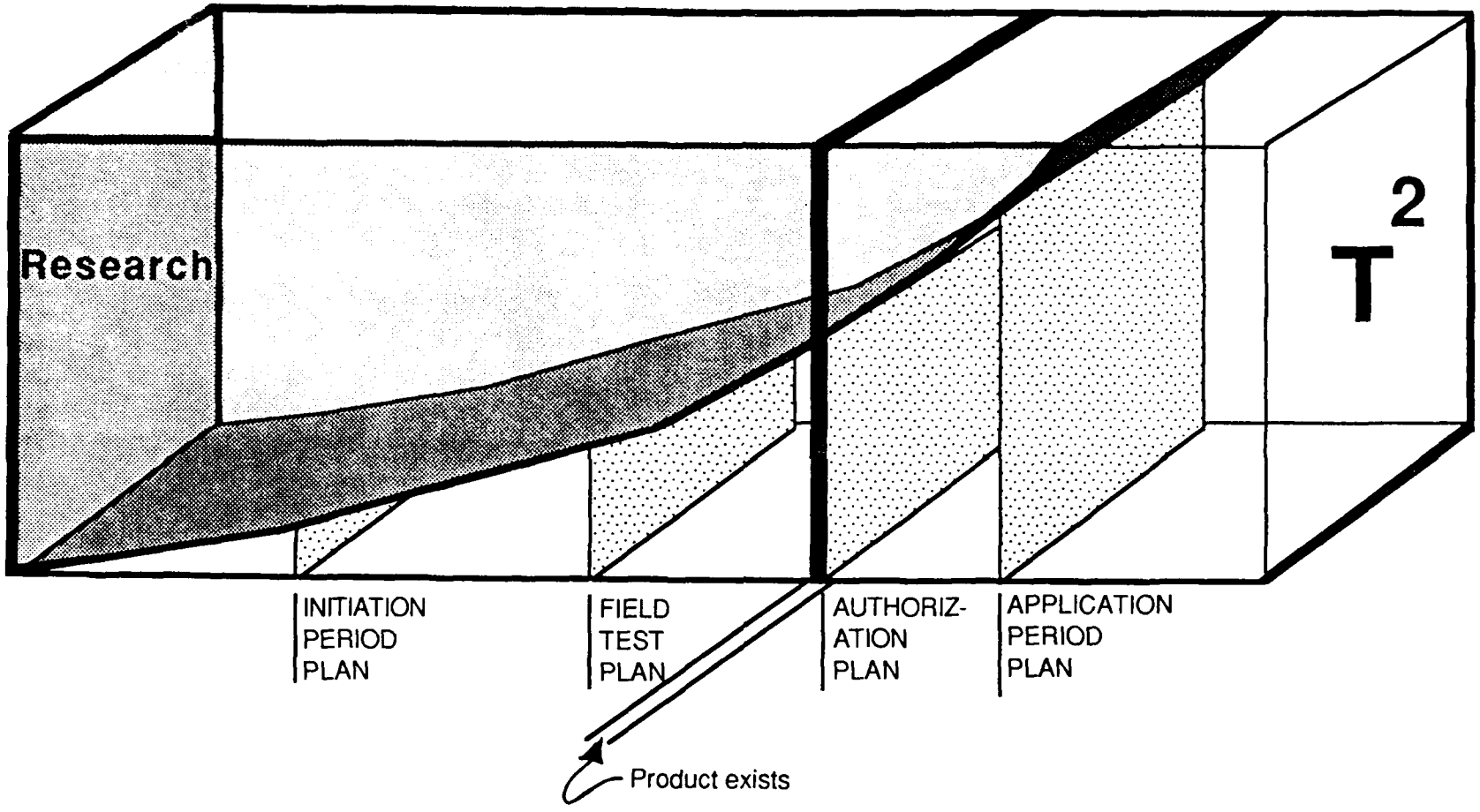


Figure 1. Research / Technology Transfer Interface

INFORMATION INPUT/ DECISION MAKING PRODUCTS	Maintenance Management Method Facility Information Documents FRG Processor (for PDB info.)		MCA/CW CYCLE OPERATIONAL CAPABILITY PRODUCTS	CAEDS 1391 processor	PROPONENTS MONITORS	FS / T 2		
CERL / FS PI'S	DEH Offices Area Engineers Army Occupants Military Engineers	SUPPORT CENTER (CONTRACT)	CERL / FS PI'S	DISTRICTS/ DIVISIONS	OCE MACOM			
• Begins Technology Transfer planning as research effort clarifies possible Product type. • Begins nuturing of "champions."	Tech Monitors give leads for contacts.		• Begins Technology Transfer planning as research effort clarifies Product type. • Begins nuturing of "champions."	Tech Monitors establish contacts.	Tech Monitors establish contacts.	coord-ination	administrators	INITIATION
	Installation management "allows" for volunteer operator to assist in the initial Technology Transfer planning.			Upper management "allows" a volunteer operator to assist in the Technology Transfer planning.	MACOM POC provides liason and encouragement	enabling		
	Volunteer Installation operators provide insights into the eventual T2 of the required improvement and serve as field "champions."			Volunteer operators provide insights and serve as field "champions."		T2 assistance	operators	
• Reviews field test site possibilities and recommends "best" to MACOM for approval. • "Demonstrates" the Product and shows Installation Personnel how to use it. • Develops "enhancements" of the Product to incorporate Installation feedback.	Installation requests to be a participant in the field test.		• Reviews field test site possibilities and recommends "best" to OCE/DRD for approval. • "Demonstrates" the Product and shows volunteer how to use it. • Develops "enhancements" of the Product to incorporate feedback. • Catalyzes "User's Group" from end-user organizations.	Upper management makes request to be a field test participant.		initiation	administrators	T2 FIELD TEST
					DRD approves field test sites. MACOM approves test participation	concur-rence		
	Personnel try Product in "real world" exercises. (ALPHA tests)			Personnel "share" operation of field test. (ALPHA tests)		develop. testing	operators	
	Personnel provide feedback on ability of Product to meet their needs.			Personnel provide feedback on Product inadequacies.		evalu-ation		

Figure 2 (part 1). Personnel responsibilities for the various participants in the Technology Transfer activities.

INFORMATION INPUT/ DECISION MAKING PRODUCTS	Maintenance Management Method Facility Information Documents FRG Processor (for PDB into)	MCA/CW CYCLE OPERATIONAL CAPABILITY PRODUCTS	CAEDS 1391 processor	PROPONENTS MONITORS	FS / T^2		
CERL / FS PI'S	DEH Offices Area Engineers Army Occupants Military Engineers	SUPPORT CENTER (CONTRACT)	CERL / FS PI'S	DISTRICTS/ DIVISIONS	OCE MACOM		
• Finds willing, realistic Installation personnel to carry out operational test. • Develops Prototype T^2 Training Program. • Uses Installation personnel feedback for final Product "enhancements." • Uses Installation personnel feedback for developing T^2 Training program.	Installation agrees to be part of the test and modifies their SOP to integrate the Product into their system.	Start-up personnel selected and organized.	• Develops Prototype T^2 Training program for User Group operators at "expanded" sites. • Develop "contract" to establish Training Support Center. • User Group operator feedback used to develop the T^2 Training Program. • Monitors Support Center development into a training organization.	"National Team" advocates use of the Product to selected Dist/Div for operational testing (BETA tests) as T^3B effort.	Initiates POLICY modifications so the "system" can accomodate the Product improvements. Approve need to establish Support Group. Approve T^2 training prototype. MACOM selects additional Installations to participate in the operational test and integrates the Product into their operational system, and funds Product publication costs, if any.	authorization fiscal implementation operational testing training development	administrators operators operators
	Product hardware/software costs paid by Installation. Personnel costs at Installation paid by FTAT funds.	Start-up costs funded by T^3B and FTAT funds		Product hardware/software costs paid by Dist/Div. T^2 prototype T^2 Training Program costs paid by research. Personnel costs at Dist/Div paid by T^3B funds.			
	Installation personnel use the Product in their "normal" SOP. (BETA test)	Respond to User Group requests with training sessions. Provide "Technical Support" for Training.		Personnel operate the Product in a "normal use" mode. (BETA tests)			
	Installation personnel evaluate the Product as an "improvement" to the SOP of their system, and provides input to the PI on training methods.			Personnel evaluate the "refined" Product and the prototype T^2 Training Program methods, and provides feedback for further improvements in both.			AUTHORIZATION
• "On-call" to respond to user comments and inquiries (by being listed in the Product ID text.)	Installation management mekes appropriate plans to integrate the Product into their system. (If there is management resistance, call MACOM to advocate.		• Assists the User Group in becoming "self sustaining" and possibly subdividing into geographic of "special interest groups.	Upper management makes appropriate plans to integrate the Product into their specific organization. (If there is management resistance, call the "Support Center"	Establishes POLICY that accommodates the potential improvements of the Product in the System.	authorization fiscal implementation product integration training	administrators administrators operators operators
	Product hardware/software costs paid by Installation funds.			Product hardware/software costs paid by Dist/Div funds.			
	Installation personnel assist in developing the "application management plan" to integrate the Product into their specific tasks.			Personnel assist in developing the application management plan to integrate the Product into their specific tasks.			
	Appropriate training for all Installation personnel doing their asswignments- either on a routine basis (GS 3 to 9), or as military personnel (that rotate every 3 years) doing a special task.			Appropriate training for all Dist/Div personnel doing their daily tasks on a basically routine basis (Probably at a GS9 to GS14 range)			APPLICATION

Figure 2. (part 2) Personnel responsibilities for the various participants in the Technology Transfer activities.

IV. Training as T^2

A. General Consideration

Given the timely nature of today's information age technology, the "moving target" of operational technology transfer is particularly difficult using previously accepted modes of T^2: technical reports, guide specifications, and regulations. Training, as technology transfer, is the only effective mode to assure currency and relevancy in the application of these types of product/system, especially those of FS Division. For the researcher to accomplish training, the researcher must have a "tool box" of training mechanisms which become the basis for evolutionary change. These include the devices of training; e.g., books or instructional manuals, computer-assisted instruction, and teaching (classroom style). The training must be staged in a manageable process involving the user as a partner in the T^2 process.

B. Training Devices

In training, as a mode of T^2, several methods or modes are available to the researcher for incorporating instruction into the T^2 activities. The researcher may select:

- book (instructional manual or documents)
- computer (computer-assisted instruction)
- teacher (teacher/student instruction).

Instructional manuals or books differ from research technical reports in that technical reports document the research findings for the research community and the training manual translate the findings into "how to" apply the product.

These media may be combined to offer the appropriate instruction for the product application.

Characteristics of each mode are important to the specific instructional needs of the students. For example, the book approach is applicable to the widest group of students. Computer equipment, available as part of the product system, is potentially useful in computer-aided instruction of the product. The teacher-student approach offers specific interaction not available in the other two approaches. Practical consideration for the choices of training modes is given in the following sections.

C. Training Considerations

When considering the development of training packages, the researcher should keep in mind the following factors:

1. Technology transfer training "closes the loop" of the research and development cycle and thereby maintains contact between the user, procurement and developer of new technology.

2. T^2 training should generate the motivating factors which will "turn on" the student to use the research product and thereby realize its fullest possibilities.

3. T^2 training should concentrate on decision knowledge (that which makes a difference, is relevant and acceptable) and thereby assure continuing stimulation and staying power throughout the training process.

4. T^2 training should incorporate management overviews which convince senior management of the need for the research product and demonstrate clearly how the need is satisfied.

5. T^2 training should address "real life" situations that are directly applicable. It should clearly define its objectives and then maintain a logical consistency to that end.

6. T^2 training should demonstrate and effect a smooth transition from old methods to new methods (transformation vs. discardation), thereby promoting a "yearning" within the student to become up-to-date.

D. Training Attributes

An effective training program must exhibit certain characteristics which promote the learning process. The training program should:

1. assure distribution method/media is chosen so that training is interactive, personalized, convenient, flexible (based on need for depth), and gives feedback on results.

2. contain a scheduled sequence of "bite-sized" chunks

3. allow for individual differences in student experience and knowledge

4. contain creative and imaginative presentations

5. contain challenging participatory exercises which build upon the expertise of the students

6. maintain a focus/concentration on critical issues

7. foster participant enthusiasm (peer group cooperation, competition)

8. maintain a palatable, comfortable, non-threatening atmosphere

9. provide methods and preparation for progressive field transfer (student to become teacher)

10. include a methodology for evaluating the training program's effectiveness

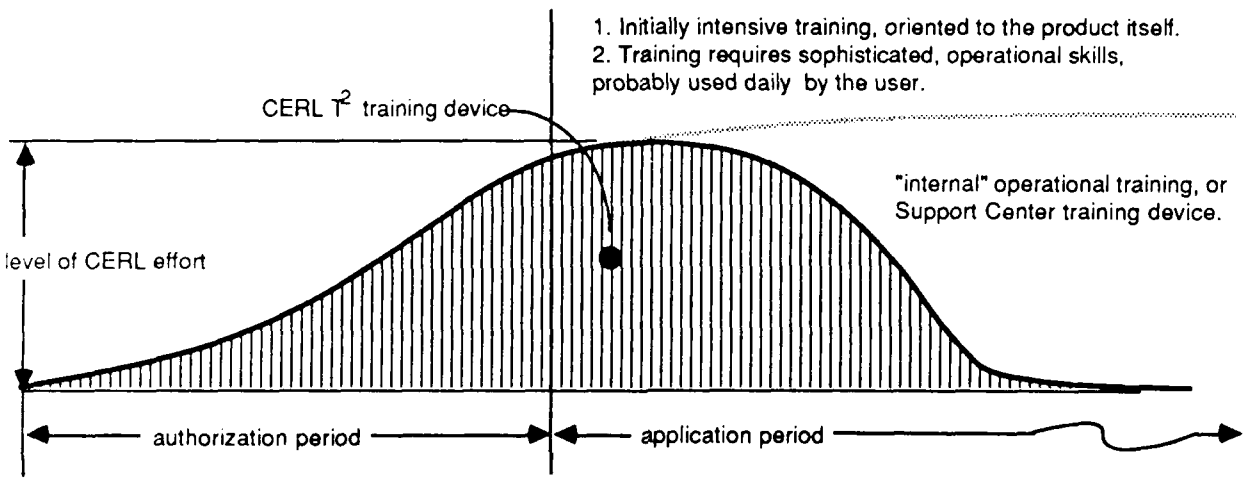
E. Training Development

When selecting an appropriate training mode for technology transfer, the researcher must consider both the type of audience and type of product. The

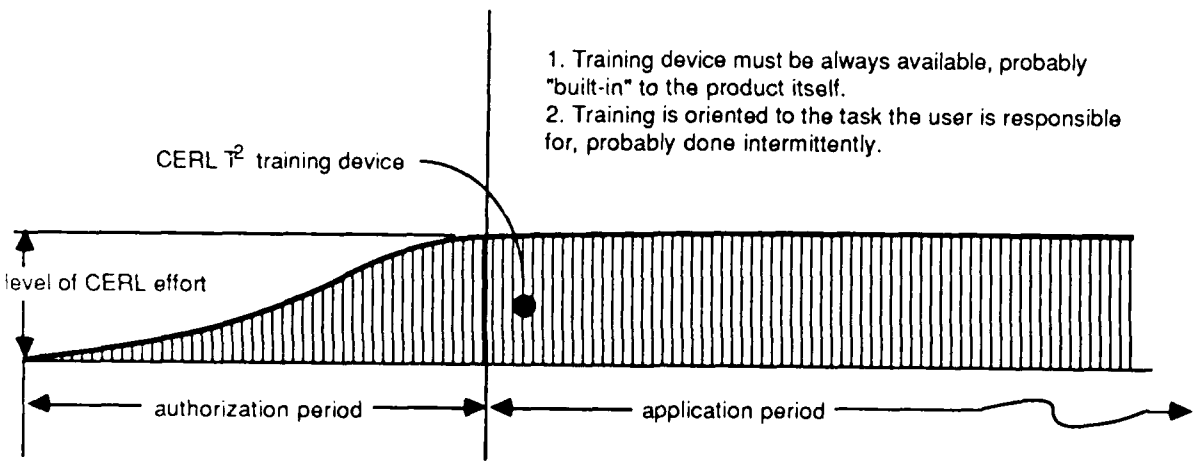
following discussions and illustrations are intended to define the typical audience and product types encountered by FS researchers and to present suggestions for the development of appropriate training.

1. Personnel/Organization Considerations

a. Corps of Engineers District/Division Personnel - Recognizing that the training environment at District/Division Offices is largely that of long-term permanent, professional (GS 9-12) personnel whose use of a research product is of a continuous nature, the following diagram illustrates the characteristics which reflect these conditions:



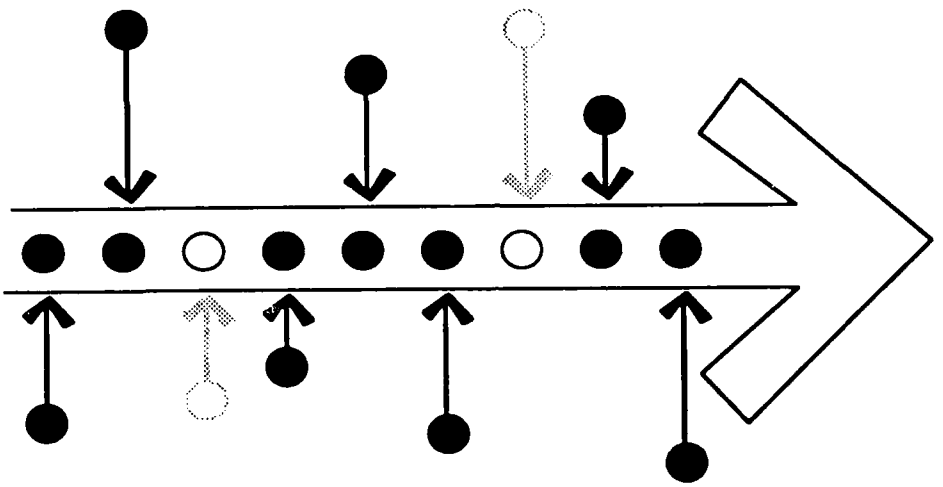
b. Installation/Army Personnel - Recognizing that the training environment at Army installations is largely that of short-term, rotating Army personnel or Civilian GS and WG 3-9 personnel whose use of a research product is intermittent or cyclic within the context of daily operations, the following diagram illustrates the characteristics which reflect these conditions:



2. Product Type Considerations

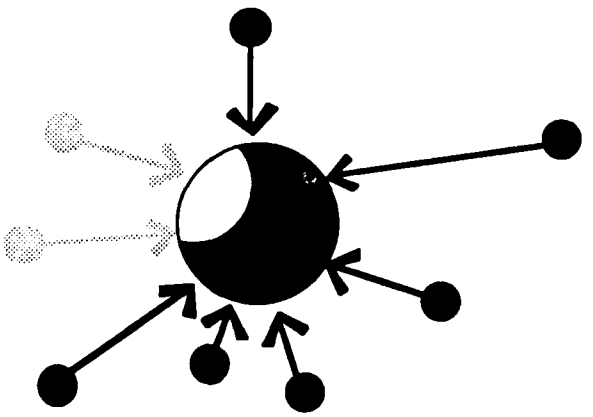
The following descriptions and accompanying illustrations of FS research products that require technology transfer training are included as a point of reference for the detailed analysis of the appropriate training mode configurations which occur later in this paper.

Process Management products (1391 processor, CAMS, ARMS, for example) assist in the integration of input information or review responses in order to allow multi-users organizations to keep track of their particular input and the completeness of the total effort.



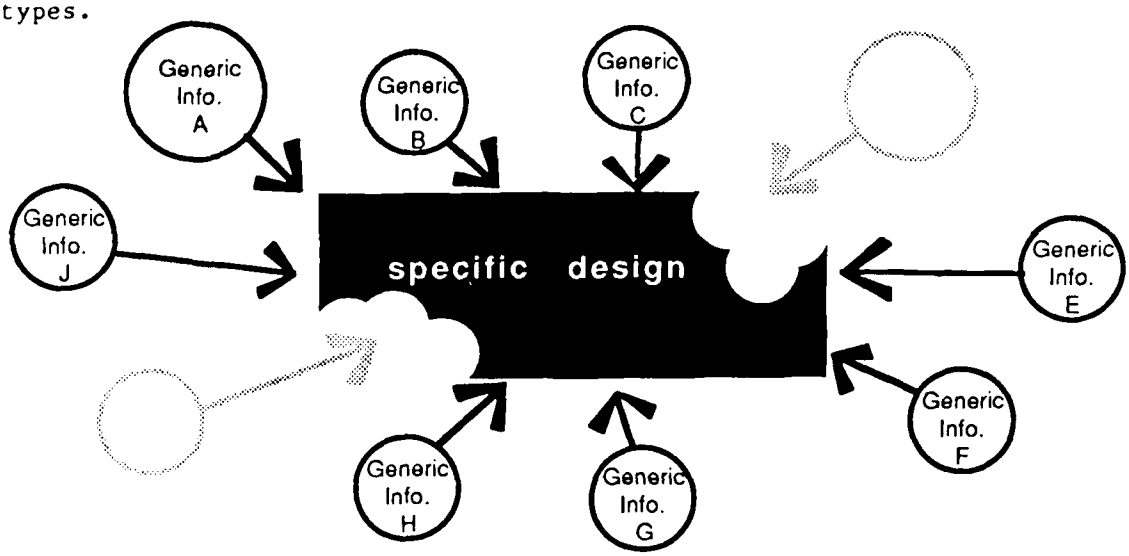
Assists multiple user organizations by organizing their individual input

Decision-Making products (AEDSS, DEH DSS, D/DDSS, ACCESS, CAEADS, for example) assist in making faster and better decisions about documents, usually parts of the MC/CW facility delivery process by "collecting" all relevant data in a timely way and arranging it in a "clarifying" format.



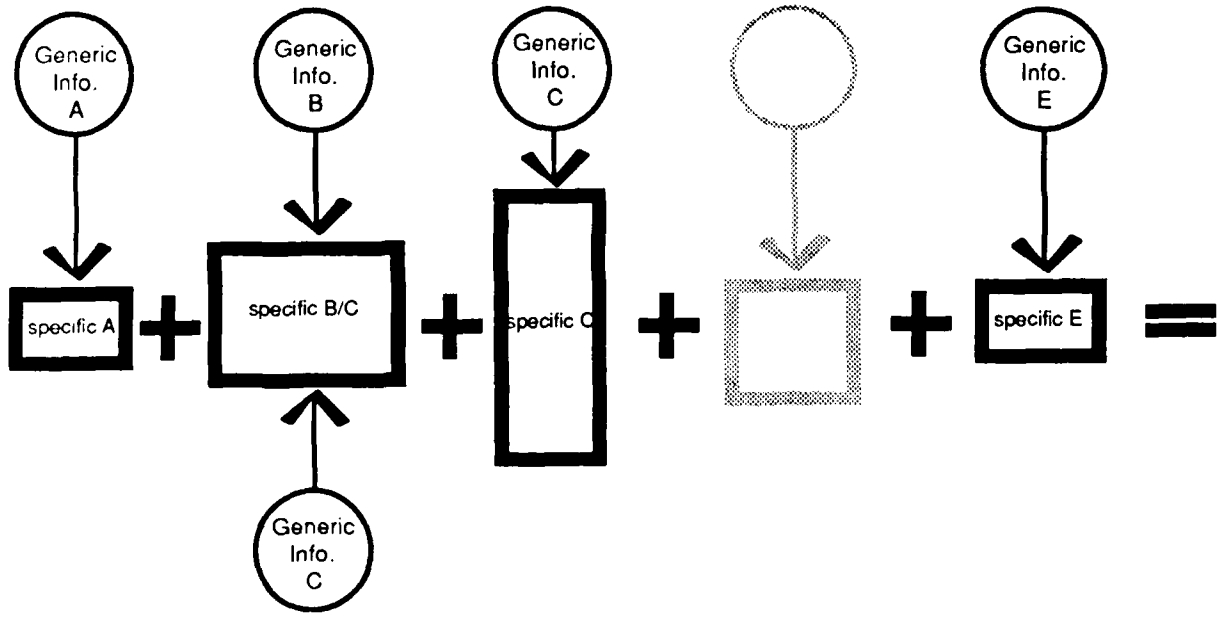
Assists an individual user in focusing extensive input that must be complete, prioritized, and current for decision making.

Facility Design products (Facility Information, Expert System (AI), Office Workstations, for example) assist in designing MC/CW facility projects (both new construction and retrofits) by presenting generic design guidance information for prototype modules (and some total buildings) of various building types.



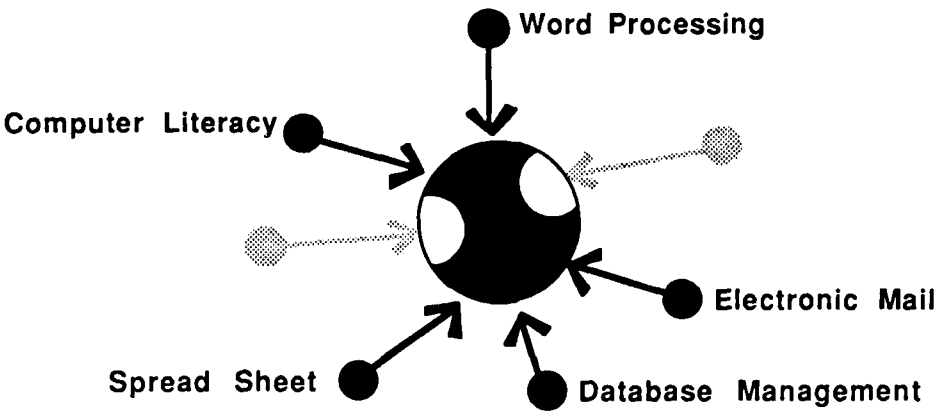
Assists an individual participant in synthesizing extensive amounts of diverse, generic information for the "design act."

Problem Solving products (FRG processor (PDB), Facility Information, for example) assist in solving facility development problems by presenting generic information and processes that can be used for developing functional input on various specific MC/CW and OMA projects (mainly assistance for military personnel).



Assists multiple participants in applying focused pre-collected, complete, generic information to their specific problem.

Productivity Skill Enhancement products (specific assistance to the user in increasing his productivity on-the-job). These tools include office automation capabilities: electronic mail, word processing, spread sheet, etc. Productivity skill enhancements can be included as a part of the other product/system types: DDS, Process Management, etc. These enhancements can result as a side-benefit of other product/system types. Other skill enhancements include skills in developing input information, skills in using background information design, and also working group skills.



Individual participant improvements:

- faster communications
- increased output
- time savings

V. Specific Training Elements by Product Type

Investigations into the methods for use of the three most common training devices (books/manuals, computer, teacher/student) has shown some significant differences in applying these devices for technology transfer training depending on whether the research product is either a process management, decision-making, design, or problem-solving type product.

The following sections present recommendations for training materials development (both in terms of the substance of the training as well as the format) sorted by research product/training device type.

A. PROCESS MANAGEMENT PRODUCTS

BOOK (for process management products)

Steps to be considered (Substantive)

1. Use a comparison of "old" process to the new process showing where the new process actually manages better.

2. Present lesson sequences that include the necessary information about the "old" way that lead to an awareness by the user that the new way is better. (The timing of convincing the student is critical to his accepting the change.)

3. The completeness and uniform consistency of the data entered into the process should be shown in the training examples, as well as the imbalance which results from incomplete, spotty data.

4. Use simulation exercises which are sensitive to the student's learning level and role the student plays; e.g., cost estimate in 1391 vs. environmental impact implications. Structure the training lessons so that the student understands the interdependency of the multi-person input.

5. Maintain a central focus perspective on the product in the modules such that the diverse details do not obscure the purpose of the training (improved process management). These can be done both by graphics and periodic summary statements.

6. Develop exercises that are part of the current workload, assuring efficiency of the training process with short-term payoffs.

7. Consider the residual benefit of the users group network potential that can occur beyond the benefits of the process management product per se, and encourage that networking as part of training manual.

8. In developing T^2 lessons, consider emphasizing the mutual support of users from which the process will now benefit that probably was not part of the "old" way.

9. Consider including a POC reference to CERL for possible continuing support to the product users.

10. Have T^2 training lessons recognize the product's "limitation potential" as well as its potential potential (P^2); i.e., other applications.

11. Integrate the requirement for and the confidence in the product in the T^2 text, so that the "student" (user) of the T^2 becomes a believer in the product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

12. Establish T^2 mechanisms for "launching" of the product--to gain initial broad exposure and concentrated focus. All students should have the proper equipment, etc. There should be a higher authority "release" of the product (breaking the bottle over the bow).

Steps to be considered (Formatting):

1. Translate arbitrary listings of data into "managed" categories through outlines, diagrams, tables, etc., through an example diagram.

2. Include calendar of events that is reproducible. Blank forms as well as filled-out examples are useful, so the students can apply this to their own sequence of rigorously developed input information.

3. Training modules should be organized to present small "chunks" for each participant e.g., 1391 has a DEH user part, MACOM part, District part, etc. Each module internally complete.

4. Format the user's manual so that text/examples occur on facing pages.

5 The ruggedness of user's manuals is important for maintaining the sequences and facing pages. Use multiple ring loose-leaf binders that stay open and use heavy duty paper with card-stock dividers.

6. Use color and graphics to add interest and to differentiate modules and to identify repeating elements within several modules (Both ink and paper color.)

7. Highlight critical operational steps for easy reference by using reference cards, boldface type, boxing, tabs.

8. Training materials need to focus on each student-type's "need-to-know." especially if materials get too voluminous--a manual should be limited to 50-80 pages or so. Don't confuse the students with extraneous material.

9. Maintain a consistent parallel referencing between the components of the T^2 modes, i.e., a manual that has an accompanying PC disk for data exercises.

COMPUTER (for process management products)

Steps to be considered (Substantive):

1. Use a CAI tutorial comparison of "old" process to new process showing where the new process manages better.

2. Use a dynamic sequence of animated diagrams showing that the growth of usage is critical to the management potential of the product type (a management critical mass is achieved when 80-90% are using system).

3. Use the available PC-based tools to bridge the user-unfriendliness of "process management" products, e.g., WordPerfect to develop 1391 text unloading to host computer.

4. Use simulation exercises on the computer which are sensitive to the student's learning level and role the student plays.

5. Use computer graphics diagrams to illustrate the interdependency of the multi-person input.

6. Maintain a central focus perspective on the product in the modules such that the diverse details do not obscure the purpose of the training (improved process management). This can be done both by graphics and periodic summary statements.

7. Develop training exercises that are part of current workload, assuring efficiency of the training process with short-term payoff.

8. Establish electronic mail, electronic bulletin board as part of the network (established by process management product) to form user group networks in administrative and technical areas.

9. In developing T^2 lessons, consider emphasizing the mutual support of users from which the product will now benefit that probably was not a part of the "old" way.

10. Consider including a POC reference to CERL for possible continuing support to the product users.

11. Have T^2 training lessons recognize the products "limitation potential" as well as its potential potential (P^2), i.e., other applications.

12. Integrate the requirement for and confidence in the product in the T^2 lessons, so that the "student" (user) of the T^2 becomes a believer in the product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

13. Establish T^2 mechanisms for "launching" of the product--to gain initial broad exposure and concentrated focus. All students should have the proper equipment. There should be higher authority "release" of the product (break bottle over bow).

Steps to be considered (Formatting):

1. Translate data into graphs, pie-charts, tables, diagrams to enhance understanding the managing process.

2. Training modules should be organized to present small "chunks" for each participant; e.g., 1391 has a DEH part, MACOM part, District part, etc. Each module internally complete.

3. For those "busy" people, provide more flexibility in the lengths of training sessions, so trainee can start/stop easily and fragment the training into chunks.

4. Critical commands (most important) should be easily referenced and help provided by including reference cards,, boldface type, flashing, key templates, etc.

5. Maintain a consistent parallel referencing between the components of the T^2 modes--the computer lessons and the training manual and the product's written text, if any.

TEACHER (for process management products)

Steps to be considered (Substantive):

1. Teacher should include good use of anecdotes for "failure" analysis; e.g., past experiences of "disasters." Point out how the new methods obviate these pitfalls.

2. Teacher should incorporate proven pedagogical techniques (emphasis, repetition, asking questions) rather than only demonstrating the product.

3. Teacher should exude and thus transmit to the students the requirement for and confidence in the product, so that the users become believers in the product as well as users of the product. (The user truly feels that they "can't do without" the product).

Steps to be considered (Formatting):

1. Teacher should transform listings of data to meet the specific needs of students in a more flexible way, based on the teacher's exper.ence (the use of real world anecdotal information in both convincing and instructing students).

PRODUCTIVITY SKILL ENHANCEMENT: Develop skills to rigorously generate input information. Because of the high visibility of this users' input, the user will be careful to provide complete and accurate information.

B. DECISION MAKING PRODUCTS

BOOK (for decision making products)

Steps to be considered (Substantive):

1. Show how the product integrates the necessary incoming information through a prioritized sorting process to constructively array the decision making factors conducive to making a decision.

2. Present lesson sequences that include the necessary information about the "old" way that lead to an awareness by the user that the new way is better. (The timing of convincing the student is critical to his accepting the change.)

3. Show that the data contained in the prioritized array is valid for decision making and that the product gives a warning of imbalanced or incomplete data.

4. Use simulation exercises which are sensitive to the student's learning level and role the student plays

5. Maintain a central focus perspective on the product in the modules such that the diverse details do not obscure the purpose of the training (improved

decision making). This can be done both by graphics and periodic summary statements.

6. Develop exercises that are part of current workload. assuring efficiency of the training process with short-term payoffs.

7. Encourage the formation of user groups (e.g., Area Engineer or DEH).

8. In developing T^2 lessons, consider emphasizing the mutual support of users from which the product will benefit from field generated improvements.

9. Consider including a POC reference to CERL for possible continuing support to the product users.

10. Have T^2 training lessons recognize the products "limitation potential" as well as its potential potential (P^2); i.e., other applications.

11. Integrate the endorsement of and confidence in the product in the T^2 text, so that the "student" (user) of the T^2 becomes a believer in the product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

12. Establish T^2 mechanisms for "launching" of the product--gain initial broad exposure and concentrated focus. All students should have the proper equipment. There should be a higher authority "release" of the product (breaking the bottle over the bow).

13. Demonstrate how decision making uses statistically valid samples of desirable arrays of the critical information. Show that it is unnecessary to have all data available to make decisions, pointing out where increased accuracy, etc. is unnecessary. (Highlight the importance of the critical information and that delaying decision making is warranted if it is missing.)

14. Select the most commonly encountered decision-type examples for illustration since the entire range of type of decision possibilities is extensive.

Steps to be considered (Formatting):

1. Training modules should be organized to present small "chunks for each participant; e.g., submittal register and modification status modules in AEDSS). (Each module internally complete.)

2. Format the user's manual so that text/examples occur on facing pages.

3. The ruggedness of user's manuals is important for maintaining the sequences and facing pages. Use multiple ring loose-leaf binders that stay open and heavy duty paper

4. Use color and graphics to add interest and to differentiate modules and to identify repeating elements within several modules (both ink and paper color).

5. Highlight critical operational steps for easy reference by using reference cards, boldface type, boxing, tabs.

6. Training materials need to focus on each student-type's "need-to-know," especially if materials get too voluminous--a manual should be limited to 50-80 pages or so. Don't confuse the students with extraneous material.

7. Maintain a consistent parallel referencing between the components of the T^2 modes, i.e., if a manual has an accompanying PC disk for data exercises.

8. Format training manual so that modifications generated from within or imposed from outside can be incorporated easily.

COMPUTER (for decision making products)

Steps to be considered (Substantive):

1. Use a CAI tutorial comparison of "old" ways to the new way showing where the new way promotes faster and better decision making.

2. Use simulation exercises on the computer which are sensitive to the student's learning level and role the student plays

3. Develop training exercises that are part of current workload, assuring efficiency of the training process with short-term payoff.

4. Encourage the formation of user groups (e.g., Area Engineer or DEH).

5. In developing T^2 lessons, consider emphasizing the mutual support of users from which the process will now benefit that probably was not part of the "old" way.

6. Consider including a POC reference to CERL for possible continuing support to the product users.

7. Have T^2 training lessons recognize the products "limitation potential" as well as its potential potential (P^2), i.e., other applications.

8. Integrate the endorsement of and confidence in the product in the T^2 text, so that the "student" (user) of the T^2 becomes a believer in the product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

9. Establish T^2 mechanisms for "launching" the product--gain initial broad exposure and concentrated focus. All students should have the proper equipment. There should be a higher authority "release" of the product (breaking the bottle over the bow).

10. Demonstrate how decision making uses statistically valid samples of desirable arrays of the critical information. Show that it is unnecessary to have all data available to make decisions, pointing out where increased accuracy, etc. is unnecessary. (Highlight the importance of the critical information and that delaying decision making is warranted if it is missing.)

11. Select the most commonly encountered decision-type examples for illustration since the entire range of type of decision possibilities is extensive.

Steps to be considered (Formatting)

1. Translate data into graphs, piecharts, tables, diagrams for decision making.

2. Training modules should be organized to present small "chunks" for each participant; e.g., submittal register and modification status modules in AEDSS. (Each module internally complete)

3. Use computer color and graphics to add interest and to differentiate modules and identify repeating elements within several modules.

4. For those "busy" people, provide more flexibility in the lengths of training sessions, so trainee can start/stop easily and fragment the training into chunks.

5. Critical commands (most important) should be easily referenced and help provided by including reference cards, boldface type, flashing, key templates, etc.

6. Maintain a consistent parallel referencing between the components of the T^2 modes, i.e., if a manual has an accompanying PC disk.

7. Develop CAI such that lesson modules can be modified separately when modifications are warranted from within or imposed from outside.

TEACHER (for decision making products)

Steps to be considered (Substantive):

1. Teacher should transform listings of data to meet the specific needs of students in a more flexible way, based on the teacher's experience (the use of real world anecdotal information in both convincing and instructing students).

2. Teacher should include good use of anecdotes for "failure" analysis; e.g., past experiences of "disasters." Point out how the new methods obviate these pitfalls.

3. Teacher should incorporate proven pedagogical techniques (emphasis, repetition, asking questions) rather than only demonstrating the product.

4. Teacher should exude and thus transmit to the students the endorsement of and confidence in the product, so that the users become believers in the product as well as users of the product. (The user truly feels that they "can't do without" the product.)

PRODUCTIVITY SKILL ENHANCEMENT: Develop skills for using PC-level computers and additional skills to incorporate necessary commercially available software that interfaces with the product.

C. FACILITY DESIGN PRODUCTS

BOOK (for facility design products)

Steps to be considered (Substantive):

1. To demonstrate the credibility of the product, show how the product assists in synthesizing available generic information developed by integrating input from several current operators with many years of experience in similar operating spaces.

2. Use a comparison between the existing facility layout and the improved facility layout that shows the use of the generic information for specific applications (real world case study comparison).

3. The completeness and uniform consistency of the data entered into the facility information should be shown in the training examples; as well as the imbalance which results from incomplete, spotty data.

4. Use simulation exercises which are sensitive to the student's learning level and role the student plays.

5. Maintain a central focus perspective on the product in the modules such that the diverse details do not obscure the purpose of the training (improved facility design). This can be done both by graphics and periodic summary statements.

6. Develop exercises that are part of current workload, assuring efficiency of the training process with short-term payoffs.

7. Encourage the formation of user groups (e.g., district and MACOM facility design review groups).

8. In developing T^2 lessons' consider emphasizing the mutual support of users from which the product will benefit from field generated improvements.

9. Consider including a POC reference to CERL for possible continuing support to the product users.

10. Have T^2 training lessons recognize the products "limitation potential" as well as its potential potential (P^2) i.e., other applications.

11. Integrate endorsement of and confidence in the product in the T^2 text, so that the "student" (user) of the T^2 becomes a believer in the product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

12. Establish T^2 mechanisms for "launching" the product--to gain initial broad exposure and concentrated focus. All students should have the proper equipment. There should be a higher authority "release" of the product (breaking the bottle over the bow).

13. Select the most commonly encountered facility design type examples for illustration since the entire range of type of facility design possibilities is extensive.

14. Demonstrate that project-specific design solutions can be found within the extensive scope of generic design information.

15. Demonstrate through a case study that the evolving history of a mission-responsive facility can be accommodated by an equally evolving facility design.

Steps to be considered (Formatting):

1. Training modules should be organized to present small "chunks" for each participant; e.g., case study examples should be focused on a limited aspect of either mission-responsiveness or quality-of-life.

2. Format the user's manual so that text/examples occur on facing pages.

3. The ruggedness of user's manuals is important for maintaining the sequences and facing pages. Use multiple ring loose-leaf binders that stay open and heavy duty paper.

4. Use color and graphics to add interest and to differentiate modules and to identify repeating elements with several modules (both ink and paper color).

5. Highlight critical operational steps for easy reference by using reference cards. boldface type, boxing, tabs.

6. Training materials need to focus on each student-type's "need-to-know," especially if materials get too voluminous--a manual should be limited to 50-80 pages or so. Don't confuse the students with extraneous material.

7. Maintain a consistent parallel referencing between the components of the T^2 modes; i.e., if a manual has an accompanying PC disk for data exercises.

8. Format training manual so that modifications generated from within or imposed from outside can be incorporated easily.

COMPUTER (for facility design products)

Steps to be considered (Substantive):

1. Use CAI tutorial comparison of old criteria information to new generic information emphasizing that the new includes prototype design guidance.

2. Use simulation exercises on the computer which are sensitive to the student's learning level and role the student plays.

3. Use computer graphic diagrams to illustrate the interdependency of the multi-domain generic information for the synthesizing design process.

4. Maintain a central focus perspective on the product in the modules such that the diverse details do not obscure the purpose of the training (improved

facility design). This can be done both by graphics and periodic summary statements.

5. Develop training exercises that are part of current MCA emphasis on facility type. assuring efficiency of the training process with short-term payoff.

6. Establish electronic mail, electronic bulletin board as part of the user network (established by process management product) to form user group networks in administrative and technical areas

7. In developing T^2 lessons, consider emphasizing the mutual support of users from which the product will now benefit that probably was not a part of the "old" way.

8. Consider including a POC reference to CERL for possible continuing support to the product users.

9. Have T^2 training lessons recognize the products "limitation potential" as well as its potential potential (P^2); i.e., other applications.

10. Integrate the endorsement of and confidence in the product in the T^2 lessons, so that the "student" (user) of the T^2 becomes a believer in the product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

11. Establish T^2 mechanisms for "launching" the product--gain initial broad exposure and concentrated focus. All students should have the proper equipment. There should be a higher authority "release" of the product (break bottle over bow).

12. Select the most commonly encountered facility design type examples for illustration since the entire range of type of facility design possibilities is extensive.

13. Demonstrate that project-specific design solutions can be found within the extensive scope of generic design information.

14. Demonstrate through a case study that the evolving history of a mission-responsive facility can be accommodated by an equally evolving facility design.

Steps to be considered (Formatting):

1. Training modules should be organized to present small "chunks" for each participant; e.g., case study examples should be focused on a limited aspect of either mission-responsiveness or quality of life.

2. Critical commands (most important) should be easily referenced and help provided, by including reference cards, boldface type, flashing, key templates, etc.

3. Maintain a consistent parallel referencing between the components of the T^2 modes--the computer lessons and the training manual and the product's written text (if any).

4. Develop CAI such that lesson modules can be modified separately when modifications are warranted from within or imposed from outside.

TEACHER (for facility design products)

Steps to be considered (Substantive):

1. Teacher should present space and system information in a flexible way related to the specific diverse needs of students, based on teacher's experience.

2. Teacher should incorporate proven pedagogical techniques (emphasis, repetition, asking questions) rather than only demonstrating the product.

3. Teacher should exude and thus transmit to the students the endorsement of and confidence in the product, so that they become believers in the product as well as users of the product. (The user truly feels that they "can't do without" the product.)

PRODUCTIVITY SKILL ENHANCEMENT: Develop skills to perform design synthesis by using extensive generic information.

D. PROBLEM SOLVING PRODUCTS T^2

BOOK (for problem solving products)

Steps to be considered (substantive):

1. Show how the product assists in solving specific problems by extracting input from several current operators with many years of experience in similar operating spaces or operational environments to demonstrate the credibility of the product.

2. Use a comparison between the existing facility information and the improved functional requirements that shows the use of the generic information for specific applications (real world case study comparison).

3. Include calendar of events that is reproducible (blank forms as well as filled-out examples) so the students can apply this to their own sequence of rigorously developed input information.

4. The completeness and uniform consistency of the data entered into the facility information should be shown in the training examples as well as the imbalance which results from incomplete, spotty data.

5. Use simulation exercises which are sensitive to the student's learning level and role the student plays; e.g., the various spaces involved in the functional requirements generation process structure. Structure training lessons so that student understands the interdependency of the multi-person input.

6. Maintain a central focus perspective on the product in the modules such that the diverse details do not obscure the purpose of the training (improved problem solving). This can be done both by graphics and periodic summary statements.

7. Develop exercises that are part of current workload, assuring efficiency of the training process with short-term payoffs.

8. Highlight critical operational steps for easy reference by using reference cards, boldface type, boxing, tabs.

9. Training materials need to focus on each student-type's "need-to-know," especially if materials get too voluminous--a manual should be limited to 50-80 pages or so. Don't confuse the students with extraneous material.

10. In developing T^2 lessons, consider emphasizing the mutual support of users from which the process will now benefit that probably was not part of the "old" way.

11. Consider including a POC reference to CERL for possible continuing support to the product users.

12. Integrate the endorsement of and confidence in the product in the T^2 text, so that the "student" (user) of the T^2 becomes a believer in the product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

13. Select the most commonly encountered functional requirement examples for illustration since the entire range of type of functional requirement possibilities is extensive.

14. Demonstrate that the project-specific functional requirements solutions can be found within the extensive scope of generic functional requirements information.

15. Demonstrate through a case study how the evolving mission-responsive facility can be described by functional requirements that include information about future expectations.

16. Develop training exercises that emphasize the importance of this lay person group input toward the success of achieving a mission-responsive optimum quality-of-life facility or other project types. (Assure lay person participants that the project can't "get along without them".)

Steps to be considered (Formatting):

1. Training modules should be organized to present small "chunks" for each participant; e.g., case study examples should be focused on a limited aspect of either mission-responsiveness or quality of life.

2. Format user's manual so that text/examples occur on facing pages.

3. The ruggedness of user's manuals is important for maintaining the sequences and facing pages. Use multiple ring loose-leaf binders that stay open and heavy duty paper.

4. Use color and graphics to add interest and to differentiate modules and or identify repeating elements with several modules (both ink and paper color).

5. Maintain a consistent parallel referencing between the components of the T^2 modes, i.e., if a manual has an accompanying PC disk for data exercises.

COMPUTER (for problem solving products)

Steps to be considered (Substantive):

1. Use CAI tutorial comparisons of old criteria information to new generic information emphasizing that the new includes prototype functional requirements.

2. Use simulation exercises on the computer which are sensitive to the student level and role the student plays.

3. Use computer graphic diagrams to illustrate the interdependency of the multi-person input.

4. Develop training exercises that are part of current workload, assuring efficiency of the training process with short-term payoff.

5. Develop training exercises that emphasize the importance of this lay-person group input toward the success of achieving a mission-responsive optimum quality-of-life facility or other project types. (Assure lay person participants that the project "can't get along without them".)

6. Critical commands (most important) should be easily referenced and help provided by including reference cards, boldface type, flashing, key templates, etc.

7. In developing T^2 lessons, consider emphasizing the mutual support of user from which the product will now benefit that probably was not a part of the "old way."

8. Consider including a POC reference to CERL for possible continuing support to the product users.

9. Integrate the endorsement of and confidence in the product in the T^2 lessons, so that the "student" (user) of the T^2 becomes a believer in the

product as well as a user of the product. (The user truly feels that they "can't do without" the product.)

10. Select the most commonly encountered problem-solving (functional requirements examples for illustration since the entire range of functional requirements possibilities is extensive.

Steps to be considered (Formatting):

1. Training modules should be organized to present small "chunks" for each participant; e.g., case study examples should be focused on a limited aspect of either mission-responsiveness or quality-of-life.

2. For those "busy" people, provide more flexibility in the lengths of training sessions' so trainees can start/stop easily and fragment the training into chunks.

3. Maintain a consistent parallel referencing between the components of the T^2 modes--the computer lessons and the training manual and the product's written text (if any).

TEACHER (for problem solving products)

Steps to be considered (Substantive):

1. Teacher should present the requirements & criteria part of the facility space and system information in a flexible way related to the specific diverse needs of students. based on teacher's experience.

2. Teacher should include good use of anecdotes for "failure" analysis; e.g., past experiences of "disasters." Point out how new methods obviate these pitfalls.

3. Teacher should incorporate proven pedagogical techniques (emphasis, repetition, asking questions) rather than only demonstrating the product.

4. Teacher should exude and thus transmit to the students the endorsement of and confidence in the product, so that they become believers in the product as well as users of the product. (The user truly feels that they "can't do without" the product.)

Steps to be considered (Formatting):

1. Teacher should use extracts from the book for specific lessons; e.g., reproduced pages from the book.

PRODUCTIVITY SKILL ENHANCEMENT:

Develop skills in contributing to group input efforts which includes respecting input of others regardless of rank, position (the importance of good, valid requirements information leading to improved facilities is paramount--not the origin of an idea).

TECHNOLOGY TRANSFER IN THE U.S. ARMY CORPS OF ENGINEERS

by L. R. Shaffer, Technical Director

USA Corps of Engineers: The Chief of Engineers of the US Army Corps of Engineers has three missions. He serves as the Engineer Adviser to the Army Chief of Staff for Combat Engineering; he is responsible for the construction, operations and maintenance of navigable waterways and for flood control, hydroelectric power, hurricane/shoreline protection and recreation, i.e. water resources for the nation. He is responsible for the acquisition, maintenance and repair of the physical plant for the US Army. The technology transfer mechanism in this presentation will address the Chief's mission involving the Army physical plant--the primary interests of the CII membership.

Army Physical Plant: The Army physical plant is an essential resource for providing for the national defense. The quality of soldier's family life; the efficiency and effectiveness of the Army's training; the responsiveness of the logistic base of equipment, supplies and soldierpower for Army readiness; and the take-off point for mobilization all depend upon a responsive physical plant. And the physical plant required is huge consisting of over 190,000 buildings, 48,000 miles of utilities, 560 million square yards of surfaced areas, 4,200 miles of railroads, and 11.7 million acres of real estate located in 300 sites worldwide. It has a replacement value of $175 billion. And it is a physical plant wherein the average age of a building is 38 years, i.e. at two-thirds of its economic life.

The Chief of Engineers performs these missions with an organization of 900 military officers and soldiers, 31,500 civilians organized into 14 divisions commanded by General Officers, 38 districts commanded by Colonels and 4 laboratories, also commanded by Colonels.

New Construction: A major function of the Chief of Engineers is to plan, design and construct the new military facilities authorized by the Congress for the Army and for the USAF--the USAF market shared with the USN. For the Army the Congress has authorized $1.2 billion per year in the recent past and projections for the near future maintain this figure.

These funds provide not only for the design and construction of the new facilities but also for the development of criteria that insures that the quality of the facility is that required in the Army environment at an affordable cost. It is important to note that only 35% of the architect/engineer function is done by

Army A/E's, i.e. government employees; 65% is done by A/E's in private practice. And 100% of the construction is done by civilian contractors. This use of the private sector impacts the USACE T^2 program.

Leverage Required from Advanced Technology: Each year the Army physical plant obsoletes at a rate which exceeds the productivity of funds provided by the Congress for new construction by $700 million. With the Congress not being able to provide the funds necessary to meet the optimum requirements for the Army physical plant, the Chief of Engineers must seek resource multipliers. Among the most promising of these is advanced technology. His policy is to exploit technology for increasing the productivity of the resources made available by the Congress for new construction. In other words, the policy is to exploit technology to stretch the military construction dollar.

Technology Transfer Test Bed T^3B Process: For advanced technology to be a resource multiplier it must be incorporated into the design and construction of the new facilities. With 14 divisions and 38 districts being the pressure points and with 65% of the design and 100% of the construction performed by the private sector a process has been established which facilitates the participation of all of the elements in the Army and in the private sector for incorporating advanced technology into new facilities. This process, i.e. the Technology Transfer Test Bed process consists of the 5 steps shown in Table 1.

The process begins with a definition of a technology advancement, i.e. a product/system, which addresses a specific Army need which if successful will stretch the military construction dollar. This is done by a team of P/S users, researchers, criteria writers and owners. The R&D of the product is Step No. 2. The research is primarily innovative R&D, i.e. smart-buyer and adaptive R&D. Inventive R&D is the last resort. The R&D is completed when the P/S is pilot tested. T^3B then involves facilitating the incorporating of the P/S into the design and construction procedures of the Army. First, a demonstration of the P/S is in Step No. 3; the authorization in Step No. 4; and the training, technical support, and generic project documentation in Step No. 5. The incorporation of a P/S into a specific project is done via application of authorization documents of Step #4 by staff aware of the P/S who has sufficient time to incorporate it. This is the ultimate of Step #5. Each step requires resources; specific programs exist to accomplish each step. These are identified in Table 2, i.e. the National Team in Step 1, User Groups in Step 2, etc.

Vertical/Horizontal Integration: T^3B facilitates on the vertical integration of technology advancement into a project by having the horizontal integration being done by the "same" professionals

from the military and private sector communities who design and construct specific projects. This horizontal integration institutionalizes the P/S in a generic way which includes the requirements of each facet of the military construction process. Each participant plays a role in shaping the P/S so that when it is available it will be practical to his/her peers. The participant can also notify his peers as to its availability.

The translation of the generic information into a specific project depends in large measure on the enthusiasm in the organization to foster the use of advanced technology.

Results: The T^3B process has been in application in successive forms of maturization for several years. It is not yet fully matured. But even the results of the process applied to date are interesting. First, the length of time after a P/S has been commercially demonstrated to when it is spec'd and available to be a P/S incorporated into an Army project is 1/8 that in the private sector, i.e. 2.2 years versus 17 years. Second, the average return of the research investment is 34:1, i.e. for each research dollar invested in R&D the cost avoidance $34.00 has been realized. No comparable figure available for the private sector.

Comment: Advanced Technology processed via T^3B is serving the US Army as an exceptional resource multiplier. It may be that advanced technology process via a civilianized CII T^3B will become equally as effective as a resource multiplier to the US construction industry.

Acknowledgement: The record of the T^3B process to date is the result of the cooperative efforts of many professionals in the Army in shaping this process. Principal among these are Mr. L. Duscha, Mr. W. McCormack, Mr. D. Dressler, Mr. J. McCarty, Mr. C. Smith, Mr. B. Wasserman, Dr. D. Leverenz and Dr. L. Schindler of Office of Chief of Engineers; Ms. L. Lawrie, Dr. M. O'Connor, Ms. J. Spoonamore, Dr. P. Howdyshell of USA-CERL; Dr. G. Marvin of Cold Regions Research & Engineering Laboratory; Mr. D. Beranek of the Missouri River Division; Mr. W. Day of the South Pacific Division and Mr. G. Dunnivant, Forces Command.

References:

1. "History of the US Army Corps of Engineers," EP360-1-21, January 1986.

2. "Transfer of USACE Research & Technology Development: Engineering and Construction," ER70-1-XX (draft), Jan. 87

PRODUCT / SYSTEM DEVELOPMENT FOR MILITARY FACILITIES

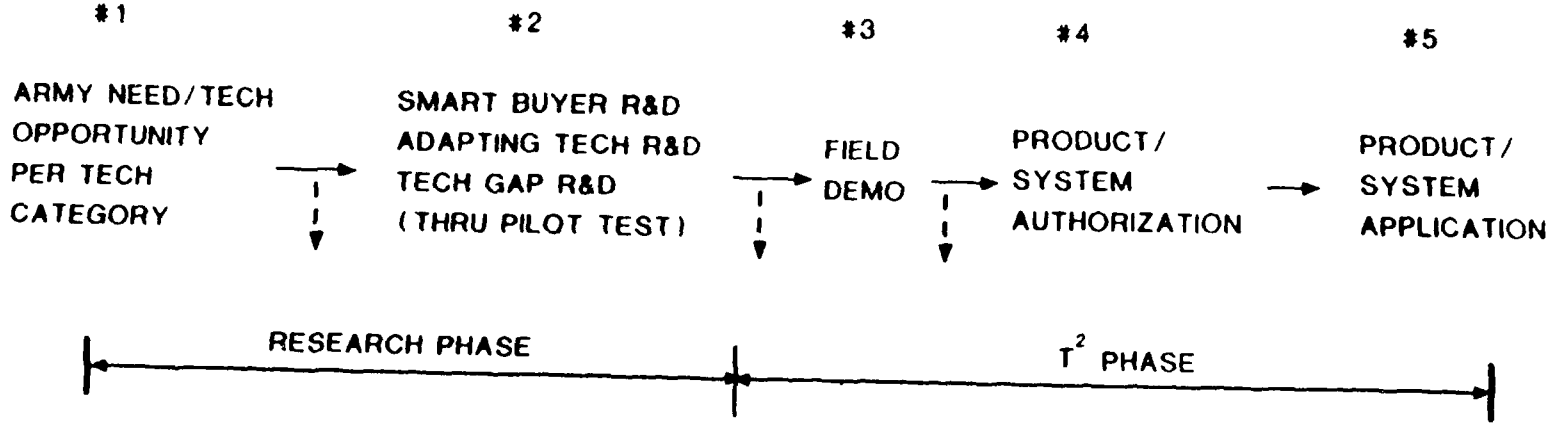
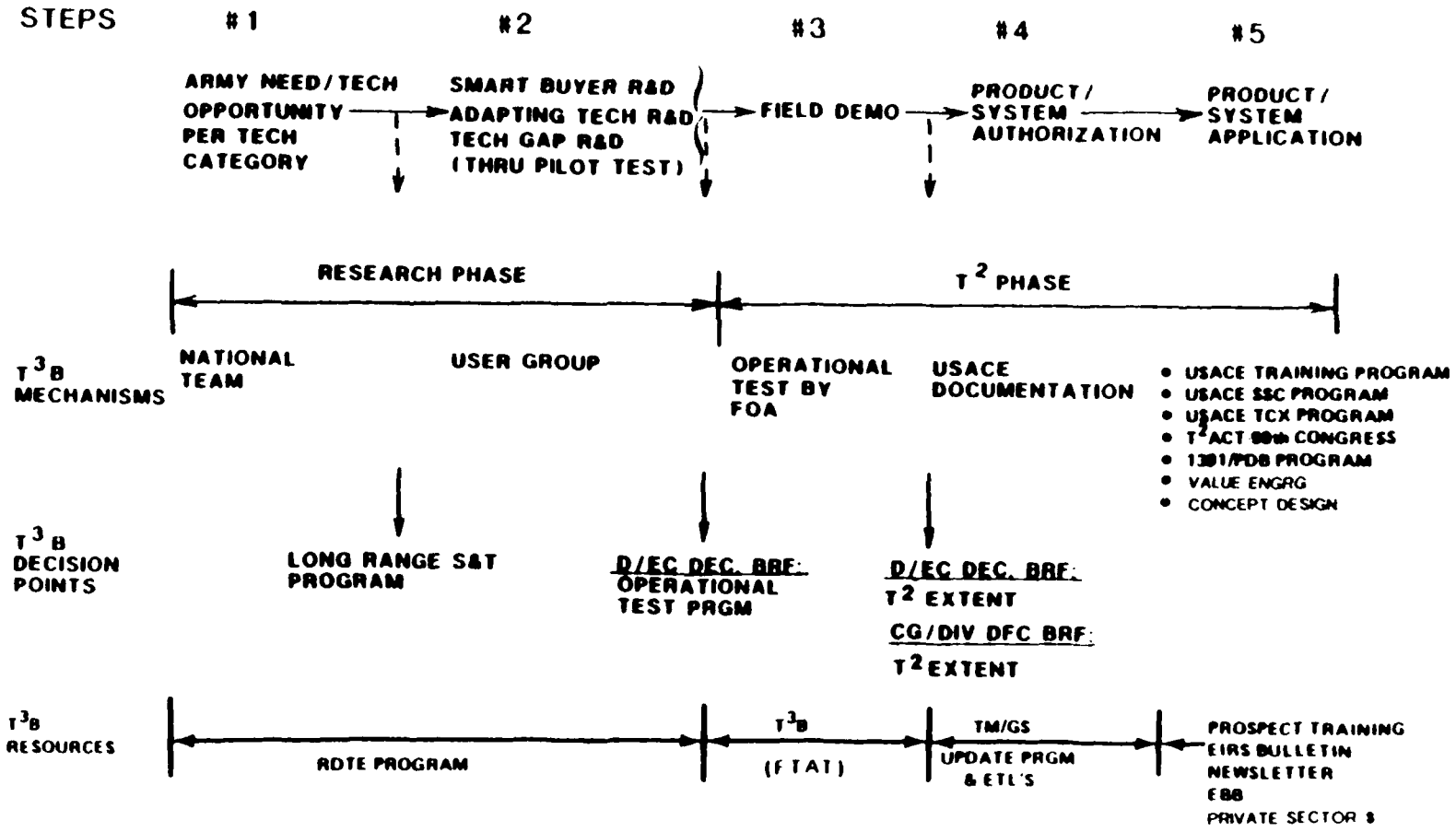


TABLE 1

PRODUCT/SYSTEM DEVELOPMENT FOR MILITARY FACILITIES

TABLE 2



TECHNOLOGY TRANSFER ACTIVITIES ASSOCIATED WITH USA-CERL REMOTE SITE WASTE TREATMENT PRODUCTS

by Ed Smith and Richard Scholze
Environmental Division

Virtually every Army installation has some remote site waste management responsibilities. Such sites, firing ranges, ceremonial grounds, guard stations, or recreation areas, traditionally use pit latrines, chemical latrines or unaerated vault latrines. However, problems and dissatisfactions generated by current systems include: offensive odors, potential health hazards, and potential groundwater and soil contamination, among others, often resulting in misuse or nonuse of the facilities.

USA-CERL researchers surveyed state-of-the-art technologies for addressing remote site waste management and selected two alternatives as being appropriate for upgrade and new construction at Army remote sites: aerated vault latrines and composting latrines (toilets). These technologies provide high user acceptance, effective process operation, acceptable health considerations, and avoidance of environmental contamination.

Aeration of vault latrines by means of bubble aeration units is applicable for both new construction and retrofit conditions. The technology consists of a motor/blower unit which is connected to a perforated pipe which rests slightly above the vault floor in the longitudinal direction. Air continuously supplied to the waste supports the growth of aerobic organisms, which break down the wastes into carbon dioxide and water. Aerobic decomposition is about four times faster than the anaerobic decomposition which occurs in vaults which function as holding tanks. Foul odors are eliminated or greatly reduced. Some minimal mechanical maintenance is required.

Composting latrines are large chambers in which wastes and organic bulking agents are placed for biological and physical breakdown into humus-like material by aerobic decomposition and dehydration. Breakdown of this waste occurs naturally, without the addition of water or chemicals, by aeration using a series of channels and baffles, and a continuously operating low wattage fan. Regular addition of bulking agent, occasional raking, periodic inspection, and semi-annual removal of the finished end product are the only additional operation and maintenance besides routine maintenance.

USA-CERL research addressed a variety of aspects of these technologies: O&M, health considerations, economics, basic and applied research and demonstration of the technologies as Army-applicable with complete documentation and technology transfer along the route to implementation. Selected facets of this technology transfer program are presented in this paper.

Existing USA-CERL FTAT planning documents (Attachment 1) were instrumental in the successful technology transfer (T2) of the two products. That is, the T2 Program (Attachment 1) served as an excellent checklist. However, it should be emphasized that another complementary planning mechanism would enhance the T2 of USA-CERL developed products. For instance, a planning mechanism is needed which serves as a blueprint to assist the PI, Team Leader, and Division Chief to visualize the T2 process. This type of planning construct becomes a defendable/definable/action-oriented hard copy "road map" which emphasizes T2 from day-one of the project. Because each project is dynamic by nature, this approach serves the function of providing a written/documented "institutional knowledge" unique to each project. The format allows all the players (instrumental to the ultimate T2 of the proposed product) to be identified. In addition, the plan allows the details of necessary T2 action-items to be articulated and the status of the

project can easily be updated. This type of tool (if institutionalized) would provide the PI (and management) a tool to measure/facilitate (and hopefully ensure) that the unique activities necessary to effectively T2 each product/system have been throughly thought out, defined, continously reassessed and implemented. The requirement of this type of process mandates a change in the USA-CERL existing modus operandi and forces USA-CERL to make T2 of our products a number one priority. It is recommended that USA-CERL consider adopting this type of concept as a tenet to its evolving T2 process. Each PI, Team Leader, and Division Chief have their own version of such a plan (See Attachment 2 for an excellent example of a T2 plan dedicated to one of the FS Division projects). However, it makes sense to aggregate the best features of each Division's particular version of the plan into a USA-CERL standard format.

T2 is as much an art as it is a science. The following actions were associated with successful T2 remote site waste treatment project products:

A. The first phase of the project was characterized by an "Awareness Campaign" to alert OCE and the field that the Army's remote site waste management scenario had been recognized as a shortfall and that steps were being taken by the R&D community to find or develop technology to remedy the situation. (Refer to Attachments 3 through 6.)

B. Once the problem had been adequately defined and 6.1/6.2 research had been performed, preliminary guidance was issued. (Refer to Attachments 7 through 10.)

C. An FTAT project resulted in a CEGS (Attachment 11) on one of the technologies and final guidance (in the form of a video tape and USA-CERL Technical Report, (Attachment 12) Engineer Technical Note, etc.

D. One aspect critical to the technology being embraced by the Army (especially HQ, TRADOC, Attachment 13), was the education of the private sector (especially the A/E and academic community and the environmental/sanitary engineering profession, in general), regarding the science/technology associated with the USA-CERL products. This was accomplished, in part, via conference presentations and papers in refereed and trade journals.

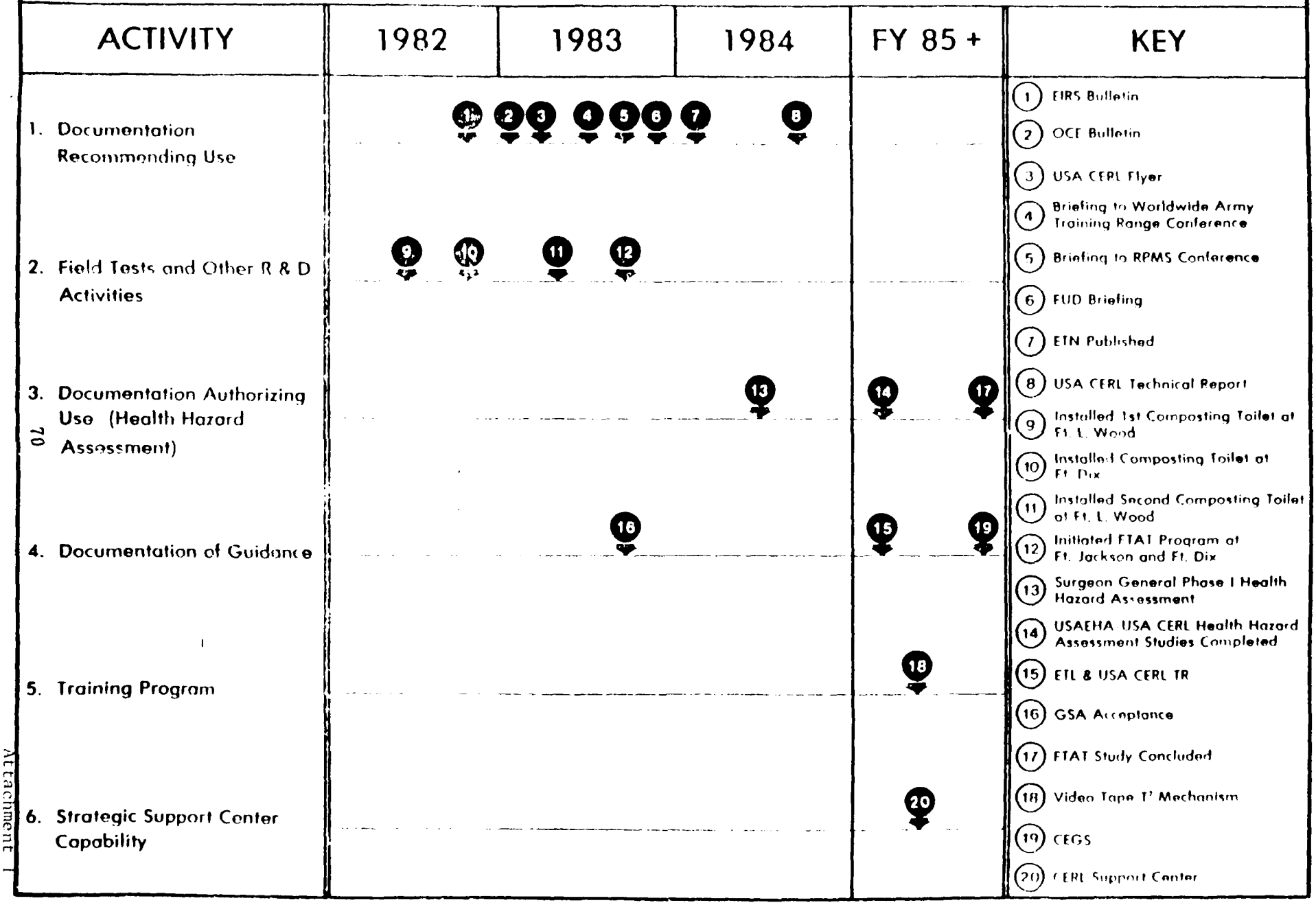
E. Many products which may impact the health of the Soldier require a form of a Health Hazard Assessment by the Army's Office of the Surgeon General) before the technology is approved for Army wide use.

F. The proprietors of an off-the-shelf technology (which USA-CERL has evaluated and modified to meet Army requirements) play a significant role in the T2 process. The proprietors' resources, marketing, and expertise should be utilized where appropriate during the USA-CERL T2 program. The role and importance of USER groups needs to be expanded. For certain products it may be difficult to organize a formal group (traditionally called a user group). Do not underestimate the influence and role which a loosely knit group of supporters and champions can exert and play, respectively, on the T2 of a product.

Another important "lesson-learned" which several USA-CERL researchers have mentioned as a short fall to T2 is related to follow up monitoring of the product's implementation. That is, once the R&D has been performed and the product has been demonstrated in the field (and adopted by the Army), resources continue to be required to monitor and obtain feedback regarding the success/shortcomings of the T2 and the technology itself. Unfortunately as the process exists today, a "clear-cut" mechanism does not exist to continue to interact technically or to transfer this monitoring function to

Army service organizations (such as FESA), or a mission funded organization (such as the Army Environmental Hygiene Agency). Consequently, the concept/mechanism of USA-CERL as a "Center of Competence" for our products needs to be explored further and implemented more often.

T² Program: Composting Latrines



Attachment 1

INFORMATION INPUT/ DECISION MAKING PRODUCTS	Maintenance Management Method Facility Information Documents FRG Processor (for PDB info.)		MCA/CW CYCLE OPERATIONAL CAPABILITY PRODUCTS	CAEDS 1391 processor	PROPONENTS MONITORS			
CERL / FS PI'S	DEH Offices Area Engineers Army Occupants Military Engineers	SUPPORT CENTER (CONTRACT)	CERL / FS PI'S	DISTRICTS/ DIVISIONS	OCE MACOM	FS / T^2		
• Begins Technology Transfer planning as research effort clarifies possible Product type. • Begins nuturing of "champions."	Tech Monitors give leads for contacts.		• Begins Technology Transfer planning as research effort clarifies Product type. • Begins nuturing of "champions."	Tech Monitors establish contacts.	Tech Monitors establish contacts.	coord-ination	administrators	INITIATION
	Installation management "allows" for volunteer operator to assist in the initial Technology Transfer planning.			Upper management "allows" a volunteer operator to assist in the Technology Transfer planning.	MACOM POC provides liason and encouragement	enabling		
	Volunteer Installation operators provide insights into the eventual T^2 of the required improvement and serve as field "champions."			Volunteer operators provide insights and serve as field "champions."		T^2 assistance	operators	
• Reviews field test site possibilities and recommends "best" to MACOM for approval. • "Demonstrates" the Product and shows Installation Personnel how to use it. • Develops "enhancements" of the Product to incorporate Installation feedback.	Installation requests to be a participant in the field test.		• Reviews field test site possibilities and recommends "best" to OCE/DRD for approval. • "Demonstrates" the Product and shows volunteer how to use it. • Develops "enhancements" of the Product to incorporate feedback. • Catalyzes "User's Group" from end-user organizations.	Upper management makes request to be a field test participant.		initiation	administrators	T^2 FIELD TEST
					DRD approves field test sites. MACOM approves test participation	concur-rence		
	Personnel try Product in "real world" exercises. (ALPHA tests)			Personnel "share" operation of field test. (ALPHA tests)		develop. testing	operators	
	Personnel provide feedback on ability of Product to meet their needs.			Personnel provide feedback on Product inadequacies.		evalu-ation		

Figure 2 (part 1). Personnel responsibilities for the various participants in the Technology Transfer activities.

INFORMATION INPUT/ DECISION MAKING PRODUCTS			MCA/CW CYCLE OPERATIONAL CAPABILITY PRODUCTS		PROPONENTS MONITORS	FS / T^2		
Maintenance Management Method Facility Information Documents FRG Processor (for PDB info.)			CAEDS 1391 processor					
CERL / FS PI'S	DEH Offices Area Engineers Army Occupants Military Engineers	SUPPORT CENTER (CONTRACT)	CERL / FS PI'S	DISTRICTS/ DIVISIONS	OCE MACOM			
• Finds willing, realistic Installation personnel to carry out operational test • Develops Prototype T^2 Training Program • Uses Installation personnel feedback for final Product "enhancements" • Uses Installation personnel feedback for developing T^2 Training program	Installation agrees to be part of the test and modifies their SOP to integrate the Product into their system	Start-up personnel selected and organized.	• Develops Prototype T^2 Training program for User Group operators at "expanded" sites • Develop "contract" to establish Training Support Center. • User Group operator feedback used to develop the T^2 Training Program. • Monitors Support Center development into a training organization.	"National Team" advocates use of the Product to selected Dist/Div for operational testing (BETA tests) as T^3B effort	Initiates POLICY modifications so the "system" can accomodate the Product improvements. Approve need to establish Support Group. Approve T^2 training prototype. MACOM selects additional Installations to participate in the operational test and integrates the Product into their operational system, and funds Product publication costs, if any.	authorization	administrators	AUTHORIZATION
	Product hardware/software costs paid by Installation. Personnel costs at Installation paid by FTAT funds	Start-up costs funded by T^3B and FTAT funds		Product hardware/software costs paid by Dist/Div. T^2 prototype T^2 Training Program costs paid by research. Personnel costs at Dist/Div paid by T^3B funds		fiscal implementation		
	Installation personnel use the Product in their "normal" SOP. (BETA test)	Respond to User Group requests with training sessions. Provide "Technical Support" for Training.		Personnel operate the Product in a "normal use" mode. (BETA tests)		operational testing	operators	
	Installation personnel evaluate the Product as an "improvement" to the SOP of their system, and provides input to the PI on training methods.			Personnel evaluate the "refined" Product and the prototype T^2 Training Program methods, and provides feedback for further improvements in both.		training development		
• "On-call" to respond to user comments and inquiries (by being listed in the Product ID text.)	Installation management mekes appropriate plans to integrate the Product into their system. (If there is management resistance, call MACOM to advocate.		• Assists the User Group in becoming "self sustaining" and possibly subdividing into geographic of "special interest groups.	Upper management makes appropriate plans to integrate the Product into their specific organization. (If there is management resistance, call the "Support Center"	Establishes POLICY that accommodates the potential improvements of the Product in the System.	authorization	administrators	APPLICATION
	Product hardware/software costs paid by Installation funds			Product hardware/software costs paid by Dist/Div funds.		fiscal implementation		
	Installation personnel assist in developing the "application management plan" to integrate the Product into their specific tasks			Personnel assist in developing the application management plan to integrate the Product into their specific tasks		product integration	operators	
	Appropriate training for all Installation personnel doing their asswignments- either on a routine basis (GS 3 to 9), or as military personnel (that rotate every 3 years) doing a special task			Appropriate training for all Dist/Div personnel doing their daily tasks on a basically routine basis (Probably at a GS9 to GS14 range)		training		

Figure 2. (part 2) Personnel responsibilities for the various participants in the Technology Transfer activities.

US Army Corps of Engineers
Office of the Chief of Engineers

EIRS BULLETIN

Engineering Improvement Recommendation System

82-03 (No)

30 September 1982 (Date)

Engineering Improvement Recommendation System Bulletins are part of a system for implementation of recommendations from information feedback sources, and are used in the military construction program to facilitate expedited dissemination of information regarding problems. The probable solutions included in EIRS Bulletins have not been thoroughly explored or staffed. As such, these probable solutions will not represent a final OCE position, and their use will not be mandatory. Probable solutions are considered as informational in nature and for the purpose of permitting prompt consideration by the field. EIRS Bulletin recipients are encouraged to comment on the probable solutions presented so that other viewpoints can be considered in the development of the final OCE position. Since changes to guide specifications issued in EIRS Bulletins are expected to remain firm, they are identified as solutions--rather than as probable solutions--and should be used in current design. This issue of the EIRS Bulletin contains 6 inclosures as follows:

INCL 1: ENGINEERING AND DESIGN - Human Waste Disposal at Remote Army Sites
INCL 2: ENGINEERING AND DESIGN - Exhaust Systems for Ethylene Oxide Sterilizers
INCL 3: ENGINEERING AND DESIGN - Showers for Brigade and Battalion HQ Buildings
INCL 4: ENGINEERING AND DESIGN - Grading for Typical POV Parking Areas
INCL 5: CURRENT DESIGN CRITERIA - Recently Issued Criteria
INCL 6: GUIDE SPECIFICATIONS - Drafts of Changes

FOR THE COMMANDER:

6 Incl
as

WILLIAM N. McCORMICK, JR.
Chief, Engineering Division
Military Programs

Attachment 3

ENGINEERING AND DESIGN

Human Waste Disposal at Remote Army Sites:

a. Problem: The Army has for many years experienced difficulties in treating and disposing of human waste at remote sites such as firing ranges, bivouac areas, vehicle training areas, guard stations and etc. These facilities have no water or sewer systems available. Current Army practice utilizes four basic treatments and/or disposal methods consisting of (1) trenching and catholing; (2) pit latrines; (3) vault toilets; and (4) chemical toilets. Each of these methods has certain problems, difficulties, or limitations associated with its use as described in the attached report.

b. Probable Solution: Recent research efforts conducted by CERL to identify and to formulate alternative treatment systems and to appropriate upgrade technologies for Army remote sites indicated that composting may be a viable alternative. Composting toilet technology (attached) as developed in Sweden (similar to the Clivus Multrum System) appears to have many advantages for Army use. The benefits of composting toilets include simple installation, low maintenance requirements, odorless operation, waterless system requiring no sewer, vandal proof construction, and no adverse environmental affects.

Composting - A Method for Human Waste Treatment at Army Remote Training Sites

Introduction

Upgrading human waste treatment facilities at Army remote sites is necessary according to several Army installation representatives. The Construction Engineering Research Laboratory is currently investigating inexpensive methods to accomplish this objective. One such method, composting takes advantage of natural biological decomposition to treat human wastes.

Background

Presently, the Army is experiencing many difficulties with human waste disposal at remote sites without water and sewerage facilities. Remote sites may be defined as essentially permanent areas designated for a specific operation or exercise distant from the contonment area of the installation. Yet, due to high costs of utility connection, sewage collection and water supply are not provided.

Each type of remote site has a unique use pattern. Probably the largest number of these areas are firing ranges. During normal training exercises at a firing range a company (160-180 soldiers) is given a 15 minute break to use latrine facilities. The average number of units available for use at this type of site is 10 toilets and 10 urinals. Estimates indicate this is approximately half of the capacity which would be sufficient for the number of people who must use the facilities in the time period designated. Because firing ranges provide facilities for several hundred soldiers a week, the lack of adequate waste handling facilities (a basic need) at these sites could severely impact their well being. The Army must take steps to accommodate the needs of these men and women.

One of the notable characteristics of the waste generated at training areas is the high urine content. This characteristic is the result of primarily daylight hour use. Vehicle and other heavy equipment training areas are similar in use. Occasionally, intensively used bivouac areas require a waste handling system. If these areas are not located on Army owned land (many installations rent forest service land) traditional Army practices (trenching) are prohibited (AR 200-1). Waste collected at bivouac areas is both liquid and solid, therefore, these sites require a system which is able to treat both types which are produced in large quantity spordically, throughout the year. Additionally, this system must prevent contamination of the environment which is a primary concern for forests and parks.

Other sites having unique waste handling characteristics include: a) distant installation gates and guard stations where a small number (1-5) people are posted 24 hours a day, year round; b) ceremonial grounds with extremely high usage periodically throughout the year; c) parks and recreational areas used primarily during warmer months; and d) U.S. Army installations and remote sites overseas (OCONUS). Each of these sites presents a different type of waste handling problem. Many of the systems currently

Attachment 3 (Cont'd)

available at the sites are not adequately managing the use patterns they are presented with.

CURRENT METHODS

Presently, the Army utilizes four waste treatment "technologies" at remote sites. They are: 1) trenching and cat holing as defined by AR 200-1. This method involves digging a hole into which waste is deposited and covering the waste with soil. Trenching and cat holing is restricted to Army owned land as mentioned previously. For sites used over and over by hundreds of men and women weekly it is obvious that sufficient land would not be available to maintain sanitary conditions in the area. 2) Pit latrines are a large hole over which an outhouse is constructed. When the hole reaches capacity, the hole is covered and the structure is moved to a new location. Due to their dependence on available land, pit latrines have hazards similar to cat holes and trenching associated with them. The most recent restrictions on the use of these units has been made to prevent ground water contamination. These units are also banned from non-Army owned lands. Odors usually accompany these units due to decomposition of waste. The structure associated with these units are similar to that used for vault toilets and is discussed below. 3) Vault toilets consist of a concrete chamber overlaid by an outhouse structure. When filled to capacity, the waste in this unit must be pumped out and transported to an appropriate disposal point. This technology is one of the most widely applied forms remote site treatment at Army installations. Experience with operating vault toilet systems has indicated several major problems are associated with them. First, since the system is primarily a storage of waste in a concrete basin, odors due to anaerobic decomposition are constantly emmitted, especially during warm weather. Odors are excessive where cracked vaults allow the waste to migrate into the soil surrounding the vault or overflows occur. These odors at vault toilets are not merely offensive but nauseating to those exposed to them. This inhibits the use of these facilities and forces the soldiers to search out undesignated areas. Overflows of vault toilets are common in areas where rainfall runoff or soil moisture enters the vault through cracks or improper sealing. The dispersion of the waste in the area surrounding the vault toilet produces a health hazard to those who use them. To counter this problem, one installation is spreading lime on the contaminated soil surrounding their vault toilets to aid in sanitation of the area and hinder some of the odor. Overflow occurs where maintenance schedules do not provide for removal of waste commensurate with the use of the facility. Often an extra phone call to notify responsible personnel of the problem is not adequate to insure alleviation of the overloading at a particular site. Several weeks may elapse between recognition of the overflow, notification of the responsible authorities, and the dispatch of maintenance personnel and equipment. By this time, facilities are usually overloaded and require extensive "cleanup" than might have not been required if immediate action was taken. However, immediate action is not always possible because at many installations latrine maintenance is handled on a contract basis. Even at sites where good operation and maintenance is conscientiously practiced, "clean up" is expensive and collection and disposal are often difficult. The average vault toilet has a 3000 gallon capacity and costs $150-225 per unit per month to pump out. Depending upon usage, units require pumping anywhere from one to several times a month. Collection is accomplished by pumping waste from the vaults into a transport truck. Cans, bottles, ammunition and

other obstacles often clog hoses and pumps and must be manually removed before or during the pumping process. A final problem which must be addressed concerning vault toilet maintenance is the discharge of the waste collected. At most installations this material is fed into the sewage treatment plant or other waste treatment operation, with the potential to overload the facility and increase operation and maintenance costs. In any case, disposal is a problem. Insects too can become a problem. Flies are attracted to odors, wasps find nesting areas, and poisonous spiders congregate in the damp darkness under seats. At many installations, these seats are no more than holes cut in a plywood board making sanitation more difficult. As one can assess from the above description (or perhaps a personal experience) vault toilets can hardly be considered aesthetic from a users point of view. 4) Chemical toilets are a portable waste collection system. The outhouse and waste collection chamber are constructed as a single unit. Chemical toilets have a much smaller capacity and employ chemicals to mitigate some of the odor generated from the stored waste. This technology is also widely used at Army installations waste treatment systems. This system is very similar to the vault toilet in the expense incurred and problems encountered for maintenance. One problem unique to chemical toilets is their susceptability to vandalism due to its fiberglass construction. Because odors are again a problem even with chemical additives, units are often damaged. When filled they are commonly and easily overturned by dissatisfied "customers" allowing waste to contaminate the units and flow onto the surrounding ground. Chemical toilets must also be periodically pumped and cleaned at costs of $150-225 per unit per year. Each unit usually requires emptying one to two times a week according to use. Additional charges are made for relocation of these units.

These cost figures may not seem extreme until one considers the number of vault toilets and chemical toilets to meet an installation's requirements. One installation estimated that approximately $60,000 yearly is spent on 155 vaults' and 125 chemical toilets' operation, maintenance, and relocation.

COMPOSTING

CERL researchers have been made aware of these problems through site visits and a recent survey. A research effort has been initiated to determine appropriate upgrade techniques/technologies for both remote site and other non-sewered installation sites which require waste management. As part of this effort, a preliminary survey of available remote site treatment system has been made to identify alternatives which are conducive to Army use. The alternative must be "Army proof" and applicable to the Army's site-specific requirements, capabilities, and restrictions. This survey has revealed that composting toilet technology should be considered as an alternative for many remote sites. Acclaimed as a waterless, odorless, low maintenance waste treatment system, composting toilets require no chemicals and create no polluting discharge. Composting toilet technology initially developed in Sweden has been used successfully throughout the world. Adaptable to most climates there are now in excess of 10,000 units in public and private use throughout the world including every state in the U.S. and most provinces in Canada. Among those who have implemented composting toilet technology are the U.S. Forest Service; national; state, and local parks; the Corps of Engineers (Civil Works); the Audubon Society; schools and universities, and the Girl

Scouts. Systems are successfully functioning in temperature extremes which can reach -40o to 150oF.

The composting unit operates on the principle of aerobic biological decomposition. A schematic of a composting toilet system is shown in Figure 1. The composting toilet consist of a modification of the conventional toilet and/or urinal which overlays a composting chamber. The wastes drops into the composting chamber where it comes in contact with the pile which initially consists of peat moss and a layer of soil (which provides biological population). Wastes mix naturally in the compost chamber. Internal vents, baffles, air channels, and a vent stack control air flow through and around accumulating organic material maintaining the oxygen rich environment. Waste decomposes on the pile. Both air flow and pile temperature are often aided by solar energy applications. The principal by-products generated are water vapor and carbon dioxide which usually escape from the vent stack by a natural draft. The ventilation system prevents odors by drawing air into the chamber through the toilet seat when it is open. During decomposition, total waste volume is decreased by 90 percent. The final product is a fertile organic compost similar to normal garden soil which is safe to handle and easy to remove. The average large composting toilet unit is capable of treating the waste generated by 50,000 human uses per year. One or two toilets and/or urinals may be attached to a single tank to accommodate various use patterns or separate facilities for the sexes. A specific units capacity will vary with the prevailing conditions such as temperature, humidity, draft, and type of waste. Design guidance is available to insure appropriate systems are chosen.

First compost removal is usually after three to five years. The composting toilet requires little maintenance other than that required for sanitation of the building. It is suggested that a regular inspection maintenance is practiced to guarantee the existence of optimum conditions for decomposition. Inspection and maintenance would include regular visual inspection of the pile for moisture content and aeration, regular removal of any accumulating liquid, regular addition of a bulking agent (organic materials such as peat moss, shredded bark, lawn clippings, leaves, kitchen wastes) to maintain aeration, and occasionally turning the pile (in most cases this is not necessary). These maintenance procedures may be accomplished, quickly, easily and inoffensively in a minimal amount of time. It should be mentioned that this system can tolerate misuse such as dropping trash or other objects on to the pile. These objects may be removed if desired but in most cases will not appreciably affect the operation of the unit. Due to the simple efficient design of the system very little other maintenance is required and subsequently O&M costs are low. This low cost makes composting toilet technology a competitive option to present remote site treatment and future plans considering sewerage.

Composting toilet technology is also simple to install. Available as a preconstructed unit or easily built, the composting toilet may be established at a variety of locations. The preconstructed unit components can be transported by helicopter, boat, or land vehicle allowing access to even the hardest to reach areas. Several vendors around the world manufacture preconstructed composting toilets and the plans to "build your own" are available.

Attachment 3 (Cont'd)

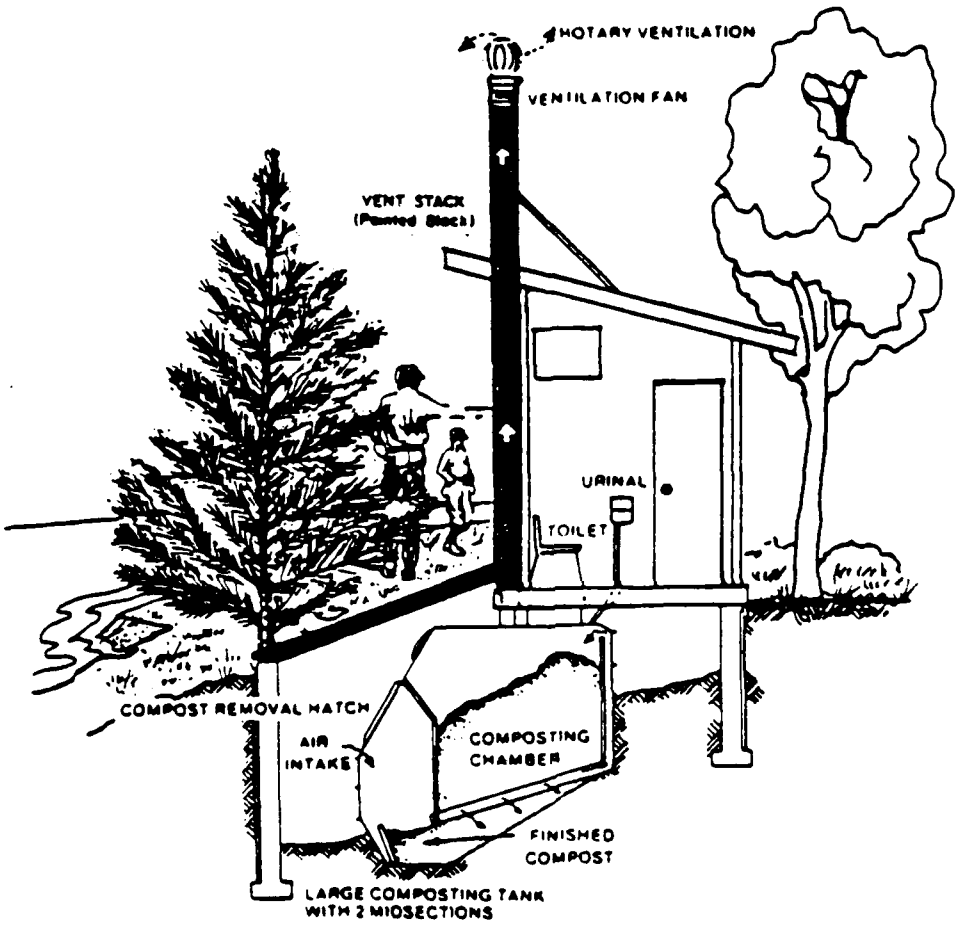


Figure 1

Attachment 3 (Cont'd)

SUMMARY

Due to the presence of women in today's Army, a new awareness of the quality of Army life has been generated. Along with this awareness has been the stark realization of deficiencies in quality which exist in some areas. Remote site treatment is one such area demanding attention. Many installations have master plans which include plans to upgrade these facilities. Others do not. Where one such plan exists the approach defined in 1970 was to sewer all remote sites at the installation by the year 1990. This would include supplying each of these sites with water, sewerage, electricity, and a new building. It is estimated, if accomplished, this venture will cost approximately 6.4 million dollars (1985 dollars). This does not include the cost of the water, electricity, or treating the sewage which will be generated. Obviously, a more cost effective lower O&M, environmentally safe, aesthetically appealing system is being sought. Perhaps composting toilets would provide a favorable option. To reiterate, composting toilet technology has many advantages including:

(1) low maintenance requirement and subsequently low maintenance costs

(2) pleasant to use because there is no odor due to aerobic decomposition and a well-designed ventilation system

(3) can accommodate variable use

(4) easily adapts to climatic conditions

(5) it is a self-contained unit requiring no water, electricity, or sewage collection system

(6) not affected by foreign matter such as cans and bottles

(7) virtually vandal-proof

(8) produces no adverse environmental affects

(9) easily installed or built

US Army Corps
of Engineers
Construction Engineering
Research Laboratory

P.O. Box 4005
Champaign, IL 61820

Public Affairs Office
Phone (217) 352-6511
Toll Free 800-USA-CERL

Fact Sheet

September 1986

REMOTE SITE WASTE TREATMENT

The Problem

Virtually every Army installation has some remote site waste management responsibilities. Problems and dissatisfactions generated by current systems include 1) crude construction, insect infestation, and offensive odors; 2) ground water and soil contamination resulting from improper privy location and vault overflows; 3) creation of potential health hazards; 4) excessive maintenance costs and requirements; and 5) adverse impacts on wastewater treatment plants when vault contents are emptied. The bottom line is that oftentimes the troops will not use these systems because of odors and rumors that use of the systems may cause skin diseases.

The Technology

After a survey of state-of-the-art techniques for remote site waste treatment, two alternatives were chosen as having the most promise of meeting Army needs and requirements--the composting latrine and the aerated vault latrine. Both eliminate odor by aerobically breaking down the waste.

A composting latrine is a large chamber into which wastes and organic bulking agents are placed for biological and physical breakdown into humus material by aerobic decomposition. Breakdown (or treatment) of the wastes occurs naturally, without additional water or chemicals, by aeration, using a series of air channels and baffles and a continually operating fan.

Retrofitting a vault latrine with a bubble aeration system is another option. The Corps of Engineers Fort Worth District has used this concept successfully at Ben Brook Reservoir, Fort Worth, TX, since 1976. This modification simply involves installing a motor/blower unit and connecting it to a perforated pipe which is attached to the vault floor. Air continuously supplied to the waste supports the growth of aerobic organisms, which break down the wastes into carbon dioxide and water. Aerobic decomposition is about four times faster than anaerobic decomposition, so pumping costs are reduced. Preventing anaerobic decay also greatly reduces the odor in the latrine.

Benefits/Savings

The aerated vault toilet system requires no daily maintenance. The latrine is used just as it was before; no chemicals or additives are needed. The aeration system is a mechanical device, however, and as such requires some minimum service. Weekly checks are recommended to ensure system operation.

US Army Corps of Engineers
Construction Engineering Research Laboratory

CERL Reports

Information Exchange Bulletin

Vol. 8 Date: August 1982

No. 3

Composting Toilets Offer Economical Alternative

Composting toilets offer the Army a simple, efficient, economical alternative to conventional methods of treating human wastes at remote sites such as firing ranges, guard stations, and training and recreational areas.

Research by CERL's Environmental Division (EN) has shown that these toilets are more sanitary and less offensive than the four technologies now used for waste treatment at areas without water or sewage facilities: trenches and cat holes, pit latrines, vault toilets, and chemical toilets.

For example, with trenching and cat holing, used when troops are on bivouac, waste is deposited in a small hole and covered with soil. However, other waste-handling systems must be installed when troops train on land that is not owned by the Army and when training areas are heavily used. Pit latrines can pollute groundwater and produce foul odors. With vault and chemical toilets, operation, maintenance, and waste disposal can be time consuming and expensive—over $2400 per year for each unit.

CERL's evaluation of alternatives to these treatment methods indicates that composting toilets are effective, economical, low-maintenance systems applicable to the Army's site-specific requirements (Table 1). These toilets have no odors; do not use water, chemicals, or electricity; and create no polluting discharge. The average unit can treat the waste generated by 50,000 uses per year and for only $60 per year maintenance per unit.

Operating on the principle of aerobic biological decomposition, the composting toilet is a modification of a conventional toilet or urinal over a composting chamber (Figure 4). The waste drops into the compost pile, which provides a biological population—peat moss under a layer of soil in a new unit. The wastes mix naturally and decompose in the pile. Internal vents, baffles, air channels, and a vent stack maintain the oxygen-rich environment by controlling the air flow through and around the accumulating organic material. Both air flow and pile temperature can be increased by solar-energy applications. The ventilation system prevents odors by drawing air into the chamber when the toilet seat is open.

Composting toilets are simple to install. Available as preconstructed units or easily built, they can set up quickly on a variety of sites. The preconstructed unit components can be taken even to the most remote areas by helicopter, boat, or truck.

Because of the system's simple, efficient design, the little maintenance needed can be done quickly and easily: regular disinfection of the facilities, visual inspection of the pile for moisture content and aeration, and addition of a bulking agent for aeration—peat moss or lawn clippings, for example. The compost is usually removed for the first time about 3 to 5 years after installation of a unit. This final product is a fertile, organic material similar to normal garden soil; it is safe to handle and easy to remove.

CERL is conducting a field test of composting toilets at a firing range on Fort Leonard Wood. This study is designed to collect information about:

- Operation, maintenance, and design
- The handling of the extra urine loading typical at remote sites
- The units' durability
- Users' acceptance of the units.

Research is also underway on the amount of money that can be saved by installing the toilets, rather than other systems. For example, composting toilets could readily replace one installation's plan to supply all remote sites with water and electrical lines, sewers, and new waste-handling facilities. The projected cost for this extensive system is over $6 million (1985 dollars), not including expenses for water, electricity, and sewage treatment; composting toilets could be constructed and at a small fraction of this cost.

For more information about composting toilets, contact Dr. E. D. Smith, CERL-EN.

U.S. Army Corps of Engineers
Construction Engineering Research Lab
P.O. Box 4005, Champaign, Illinois 61820
Off. 217/352-6511

Table 1
Treatment Alternatives

Conventional Methods	Composting Toilets
• Trenching and cat holing 1. Can be unsanitary 2. Are restricted to use on Army-owned land	• Have low operation and maintenance costs • Are easy to build • Have no adverse effects on environment • Are self-contained—unit needs no water, electricity, or sewage collection system • Are unaffected by foreign matter, e.g., cans, bottles • Are virtually vandal-proof • Are odorless • Are adaptable to varying climates, locations, and amounts of use
• Pit latrines 1. Can pollute groundwater 2. Produce foul odors	
• Vault toilets 1. Produce foul odors; attract insects 2. Tend to overflow and contaminate surrounding area 3. Have high operation and maintenance costs	
• Chemical toilets 1. Are susceptible to vandalism 2. Require costly and time-consuming maintenance	

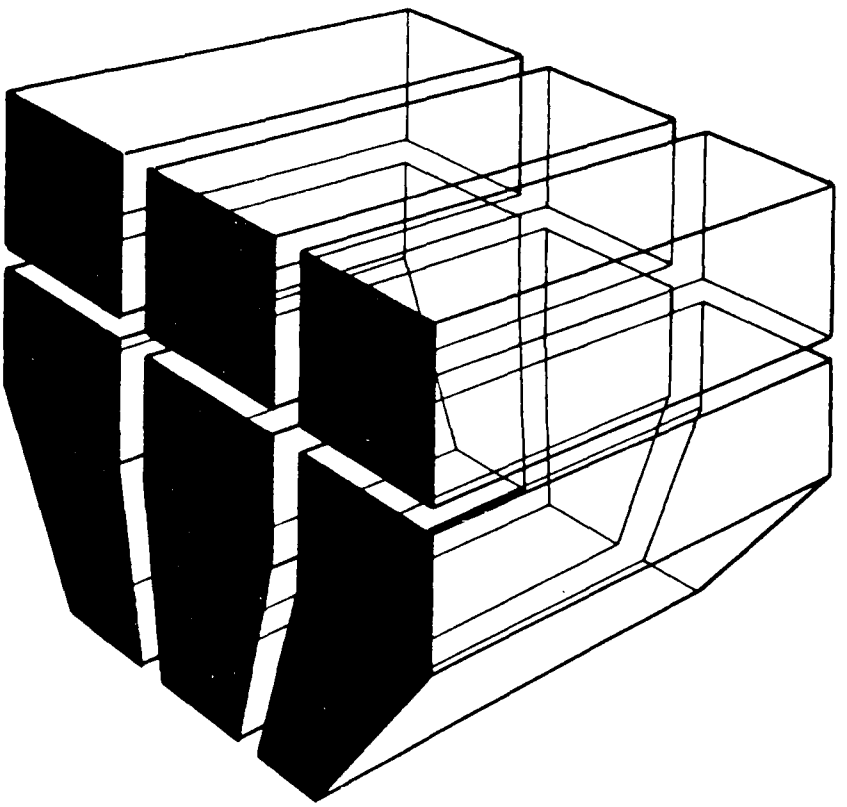
Attachment 5

US Army Corps
of Engineers
Construction Engineering
Research Laboratory

TECHNICAL REPORT N-160
April 1984

APPROPRIATE TECHNOLOGY FOR TREATING WASTEWATER AT REMOTE SITES ON ARMY INSTALLATIONS: PRELIMINARY FINDINGS

by
E. D. Smith
C. P. C. Poon
S. R. Struss
J. T. Bandy
R. J. Scholze



Approved for public release; distribution unlimited.

Attachment 6

US Army Corps
of Engineers

Office of the Chief
of Engineers

FTAT Projects

For Information on FTAT Projects
Contact Dr. Gil Williamson,
FTAT Information Manager,
USA-CERL, P.O. Box 4005,
Champaign, Il. 61820-1305 217-373-7206

October 1986

INNOVATIVE WASTE TREATMENT AT REMOTE SITES
COMPOSTING LATRINES AND AERATED VAULT LATRINES

Description of Technology. Nearly every Army installation contains remote sites such as firing ranges, ceremonial grounds, guard stations, and recreational areas. Pit latrines, vault latrines, and portable or fixed chemical latrines are typically used to treat human wastes at these sites. Each of these systems are subject to a variety of problems.

USA-CERL researchers have identified aeration of vault latrines and composting latrines as being appropriate for upgrade and new construction at Army remote sites. These technologies provide high user acceptance, effective process operation, acceptable health considerations, and avoidance of environmental contamination. Aeration of vault latrines by means of bubble aeration units is applicable for both new construction and retrofit conditions. The technology consists of a motor/blower unit which is connected to a perforated pipe which rests slightly above the vault floor in the longitudinal direction. Air continuously supplied to the waste supports the growth of aerobic organisms, which break down the wastes into carbon dioxide and water. Aerobic decomposition is about four times faster than the anaerobic decomposition which occurs in vaults which function as holding tanks. Foul odors are eliminated or greatly reduced. Some minimal mechanical maintenance is required.

Composting latrines are large chambers in which wastes and organic bulking agents are placed for biological and physical breakdown into humus material by aerobic decomposition. Breakdown of this waste occurs naturally, without the addition of water or chemicals, by aeration using a series of air channels and baffles, and a continuously operating low wattage fan. Regular addition of bulking agent, occasional raking, periodic inspection, and semi-annual removal of the finished end product are the only additional operation and maintenance besides routine latrine maintenance.

Status of Demonstration. All hardware installation is currently in place. Fort Jackson, South Carolina, was selected as the primary demonstration site for evaluating these two technologies for Army use. At five locations on post firing ranges, vault latrines were retrofit with aeration units. These vault latrines varied from some in excellent, new condition to some which were decrepit. Ten composting latrines housed in five buildings were also installed at two training ranges on the installation. One composting latrine was installed under the demonstration program at Fort Dix, New Jersey.

During FY85 the effectiveness of the units at Fort Jackson were monitored. Army guidance such as a videotape, Environmental Technical Letter, and Technical Report have been developed to assist the Army in implementing these technologies.

Benefits of Technology. The use of these technologies provides today's soldiers and today's Army with acceptable alternatives to the problems and inadequate solutions which have existed in the past and currently still operate at remote sites. They offer high user acceptance, effective process operation, improved sanitary conditions, and avoidance of environmental contamination.

Return on investment studies show that for a typical Army firing range, given that it will be upgraded, construction of new aerated vault latrines will save $700 per year per range over chemical toilets on an annualized basis. Given 20 ranges and a 20-year life-cycle, that is a savings of hundreds of thousands of dollars per installation. This example equates one aerated vault latrine with six chemical toilets, a typical situation.

In the majority of situations, aerated vault latrines will be the option of choice. They can easily be used for retrofit or new construction, and they are far more economical than compositng latrines in captial costs and require less operation and maintenance. In some cases, particularly where electricity is unavailable, a composting latrine may be considered. However, a site-specific cost/benefit analysis should be performed to ensure selection of the most appropriate alternative.

Points of Contact. Mr. Richard Scholze, U.S. Army Construction Engineering Research Laboratory, P.O. Box 4005, Champaign, IL 61820-1305, COMM 217-373-6743, FTS 958-7743, AV 862-1110 (ask for commercial number), or toll-free 800-USA-CERL (Outside Illinois), 800-252-7122 (Within Illinois).

Attachment 7 (Cont'd)

Technology Application Tests

Innovative waste treatment at remote sites

Remote site waste handling responsibilities exist at nearly every Army installation. Pit latrines, vault latrines, and portable or fixed chemical latrines are typically used at such sites. Unpleasant odors, pollution of nearby groundwater, high maintenance costs, and user dissatisfaction are some of the problems experienced.

The U.S. Army Construction Engineering Research Laboratory (CERL) is demonstrating the use of composting toilets and aeration of vault latrines as alternatives to currently used waste treatment technologies for remote sites.

Composting latrines are large chambers in which wastes and organic bulking agents are aerobically treated. No water or chemicals are needed. Air supplied through a low wattage fan assists in breaking down the wastes. Bubble aeration units also can be added to new and existing vault latrines to treat wastes. Air continuously supplied to the waste through these techniques promotes the growth of aerobic organisms which break down the wastes into carbon dioxide and water.

Previous research on use of these technologies indicated high user acceptance, effective process operation, acceptable health considerations, and avoidance of environmental contamination.

The FEAT demonstrations are being conducted at Fort Jackson, SC, and Fort Dix, NJ. Five vault latrines on firing ranges at Fort Jackson were retrofitted with aeration units. The conditions of the vault latrines varied from "brand new" to very run down. Ten composting latrines housed in free buildings were also installed at two training ranges at Fort Jackson. One composting latrine was installed under the FEAT program at Fort Dix, NJ. The units will be monitored on a regular basis to determine system performance and suitability for Army use. Point of contact is Rick Scholze, CERL-EN, P.O. Box 4005, Champaign, IL 61820-1305, Commercial (217) 352-6511 EXT 470 or FTS 958-7410.

Railroad Maintenance—hot-mix asphaltic concrete for underlayment

Water intrusion into low strength and swelling subgrade soils results in the need for continuous maintenance of railroad track structures to avoid railroad traffic operating problems. The U.S. Army Engineer Waterways Experiment Station (WES) will demonstrate the use of hot mix asphaltic concrete to construct an underlayment section, a technique developed to repair unstable track over a prepared subgrade at the Red River Army Depot, Texarkana, Texas.

The underlayment, coupled with adequate drainage of surface water, will prevent water from reaching the subgrade soil directly beneath the track structure. A 4-inch underlayment section will not only improve operating conditions of the track, but will reduce the thickness of the ballast from 15 inches to 8 inches. The underlayment will prevent ballast fouling, or migration of soil particles into the ballast. This decreases the need for periodic resurfacing.

Soils testing and underlayment design has been completed at the Red River Army Depot site. Project plans and specifications are finished and awaiting approval. The contract award is tentatively scheduled for mid May with construction of the demonstration section to begin in mid June. Point of contact is David Coleman, WESGP-IP, P.O. Box 631, Vicksburg, MS 39180-0631, Commercial (601) 634-2223 or FTS 542-2223.

Noise warning system alerts residents

Military installations emit unique types of noise that may disturb both residents of nearby communities and military personnel living onpost. The Army's major noise problems stem from low frequency impulse noise from tanks, guns, and artillery, demolition activities, and helicopters. At many installations noise disturbances occur only during several days of the year, when weather conditions are favorable for carrying the noise into the community.

The U.S. Army Construction Engineering Research Laboratory (CERL) installed a noise warning system at Fort Richardson, Alaska, to alert excessive range noise to the range office. Once alerted, training installations can adjust their activities to prevent noise from disturbing the community.

The system consists of a microphone and "smart" monitor located outside the training area. These devices pick up and monitor existing noise levels which are accessed and analyzed in the range office using a microcomputer.

CERL built the noise warning system using self built and commercially available components. The software for the monitor and the microcomputer was developed by CERL. The noise warning system will be tested during FY85.

Point of contact is Dr. Paul Schomer, CERL-EN, P.O. Box 4005, Champaign, IL 61820-1305, Commercial (217) 373-7229 or FTS 958-7229.

Attachment 8

US Army Corps of Engineers
Office of the Chief of Engineers

Facilities Engineering

Items of Interest

Information Exchange Bulletin

4	1	MARCH 1985
Vol	No	Date

HIGHLIGHTS: COMMERCIAL ACTIVITIES ARTICLES

ROUTE TO:

Introductory Note

This publication is intended to report on matters of interest and importance and to keep you abreast of developments in the facilities engineering field. The contents can be considered authoritative but are neither directive nor official in nature. Please do not quote the **Items of Interest** in formal justification of any type.

CONTENTS

		PAGE
Section I	BUILDINGS AND GROUNDS	
	Revised AR 420-90, "Fire Protection".....	1
	Fire Sprinkler Seminar.....	1
	Ladder Truck Hazard.....	1
	Federal Fire Service Task Group (FFSTG) Meetings.....	2
	Fast Response Sprinkler System Project.....	2
	PAVER Pavement Management Courses.....	3
Section II	UTILITIES	
	HVAC Controls.....	4
	On-Site Utility Systems and Services.....	5
	Boiler Water Training Workshops.....	5

Prepared IAW AR 310-2.

Attachment 9

ISSUED BY: FACILITIES ENGINEERING DIVISION, OFFICE OF THE ASSISTANT CHIEF OF ENGINEERS, WASH DC 20314

Briefing to: **Major General Ames S. Albro, Jr.**

Subject: **"Appropriate Waste Management Technology for Army Remote Sites"**

Presenter: Dr. Ed D. Smith

Date: 3 April 1984

US Army Corps
of Engineers
Construction Engineering
Research Laboratory

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS

DRAFT

CEGS-....
July 1985

CORPS OF ENGINEERS GUIDE SPECIFICATION
MILITARY AND CIVIL WORKS CONSTRUCTION"

SECTION..... (A)

COMPOSTING TOILET (B)

TABLE OF CONTENTS

	PART 1 - GENERAL	Page
1.	APPLICABLE PUBLICATIONS	1
1.1	Federal Specifications (Fed. Spec.)	
1.2	Military (Army) Specifications (Mil. Spec.)	
2.	DESCRIPTION	1
3.	DESIGN	1
4.	PERFORMANCE	2
5.	QUALITY CONTROL	2
6.	SUBMITTALS	2
6.1	Shop Drawings	2
6.2	Spare Parts Data	2
6.3	Operating and Maintenance Instructions	3
7.	DELIVERY, STORAGE, AND HANDLING	3
8.	ALTERNATIVES	3
9.	WARRANTY	3
10.	MATERIALS/EQUIPMENT	4
10.1	Compost Tank	4
10.2	Compost Tank Access Door	4
10.3	Compost Tank Inspection Door	4
10.4	Toilet, Chute, Seat, and Lid	5
10.5	Composting Ventilation System	5
10.6	Urinals	6
10.7	Compost Baffles	7
10.8	Liquid baffles, Drain Ports, and Screens	7
10.9	Liquid Drain Fittings	7

Page

10.10 Air Ducts..... 7
10.11 Air Intakes..... 7
10.12 Joint Sealants..... 7
10.13 Lumber..... 7
10.14 Signs..... 7
10.15 Fire Extinguisher..... 7
10.16 Compost Rake..... 7

PART 3 - EXECUTION

11. INSPECTION/TESTING..... 8

12. PREPARATION/DELIVERY..... 8

13. INSTALLATION..... 8

14. ADJUSTMENTS AND CLEANING..... 8

15. SCHEDULES..... 8

GENERAL NOTES..... 9

TECHNICAL NOTES..... 9

Attachment 11 (Cont'd)

TECHNICAL REPORT N-86/20
December 1986

EXCERPT FROM:

Technology for Waste Treatment at Remote Army Sites

by
Richard J. Scholze
James E. Alleman
Steve R. Struss
Ed D. Smith

This report examines the problems associated with traditional methods for disposing of human wastes at remote Army sites. Two alternative technologies—aerated vault latrines and composting latrines—offer substantial advantages over traditional methods such as pit latrines, unaerated vault latrines, and chemical latrines. These two technologies are analyzed in terms of their costs, operation and maintenance requirements, Army applicability, and user acceptability. Based on the information obtained from the research, recommendations are made regarding applications of these technologies to use at remote Army sites. Information is provided on selection, design, operation, and maintenance of the recommended technologies.

Approved for public release; distribution unlimited.

Attachment 12

CONTENTS

		Page
	DD FORM 1473 -	1
	FOREWORD	3
	LIST OF FIGURES AND TABLES	6
1	INTRODUCTION	9
	Background	9
	Objective	10
	Approach	10
	Mode of Technology Transfer	10
2	TRADITIONAL WASTE DISPOSAL METHODS AT REMOTE SITES	11
3	DESCRIPTION AND RECOMMENDED APPLICATIONS OF COMPOSTING LATRINES AND AERATED VAULT LATRINES	15
	Composting Latrines	15
	Vault Aeration	24
	Technology Recommendations	28
4	AERATED VAULT LATRINES	30
	Aerated Vault Design Criteria	30
	Field Installations	35
5	COMPOSTING LATRINES	38
	Design	38
	Operational Concepts	41
	Operations Concerns	44
	Pile Moisture	50
	Installation	51
	Ventilation	53
	Solar Glazing	53
	Startup	55
	Service and Management of Composting Latrines	55
	Handling and Disposal of Compost	58
	Selection and Cost Estimates of Composting Latrines for U.S. Army Installations	59
	New Developments in Composting Latrines	62
6	COMPOSTING LATRINE DEMONSTRATIONS AND O & M SURVEY	63
	Survey Approach	63
	Results	66
	Data Analysis	69
7	HEALTH CONSIDERATIONS	78
8	CONCLUSIONS AND RECOMMENDATIONS	81
	METRIC CONVERSION FACTORS	82
	REFERENCES	82

Attachment 12 (Cont'd)

CONTENTS (Cont'd)

		Page
APPENDIX A:	Shasta Latrines	97
APPENDIX B:	Survey of Remote Site Waste Treatment Practices at U.S. Army TRADOC and FORSCOM Installations	104
APPENDIX C:	Vault Latrines: Design and Maintenance Considerations	123
APPENDIX D:	Aerated Vault Construction and Installation	130
APPENDIX E:	Laboratory Research of Vault Aeration	136
APPENDIX F:	Laboratory Research on Composting Latrines	139
APPENDIX G:	O&M Survey Questionnaire	160
APPENDIX H:	O&M Survey Scoring Method	162
APPENDIX I:	Health Hazards of Remote Site Waste Treatment Technologies	166
APPENDIX J:	Input Waste Characterization	172
APPENDIX K:	Suggested Scope of Work for Contractor O & M of Composting Latrines	175

DISTRIBUTION

DEPARTMENT OF THE ARMY

HEADQUARTERS UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
FORT MONROE VIRGINIA 23651-5000

REPLY TO ATTENTION OF

S: 28 Feb 86

ATEN-FN

29 Oct 85

SUBJECT: Elimination of Portable Chemical Toilets

Commanders, TRADOC Installations, ATTN: DEH
Commander, New York Area Command & Fort Hamilton, ATTN: DEH, Brooklyn, NY 11252
Commander, Fort Chaffee, ATTN: DEH, Fort Chaffee, AR 72905

1. The need to provide acceptable sanitary facilities at training ranges and other outlying areas has caused many installations to resort to service contracts for portable chemical toilets. In recent years the number of chemical toilets procured in this manner has increased to the point that the cost has become excessive. The Construction Engineering Research Laboratory (CERL) has tested other methods of handling waste disposal at remote sites and has found the aerated vault latrine and the composting toilet to be both technically and aesthetically acceptable as a substitute for chemical toilets. A CERL fact sheet explaining details of these units is attached.

2. In view of the adequacy of these two systems, all installations will immediately take action to phase out the use of portable chemical toilets and replace them with either aerated vault latrines or composting toilets. Specifically, where there are vault latrines already constructed and electricity is available the existing vaults will be retrofitted with aerating equipment. If electricity is not available, an analysis will be made to determine the economic feasibility of installing electricity and aerating equipment versus a solar powered composting toilet.

3. Installations should submit proposed plans for funding and accomplishing the subject action to this headquarters, ATTN: ATEN-FN, NLT 28 Feb 86.

FOR THE COMMANDER:

Encl

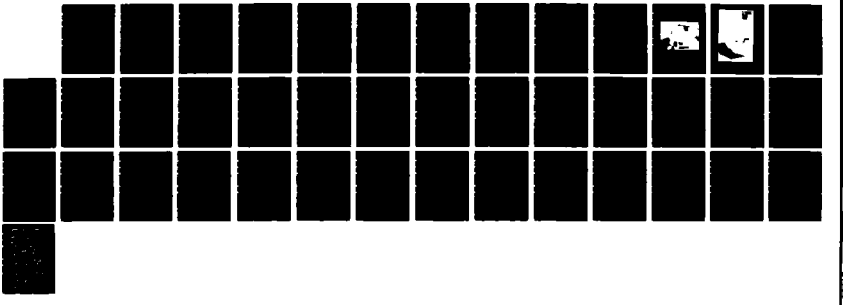
GERALD C. BROWN
Colonel, GS
Deputy Chief of Staff, Engineer

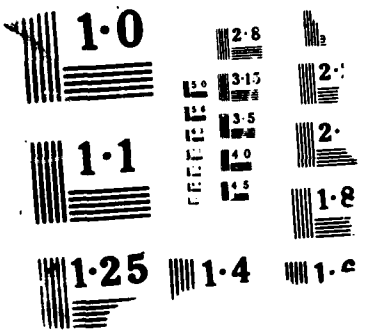
CF:
(over)

Attachment 13

AD-A194 889 PROCEEDINGS: USA-CERL TECHNOLOGY TRANSFER (T2) WORKSHOP 2/2
HELD IN URBANA IL (U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL MAR 88

UNCLASSIFIED CERL-SP-0-88/01 F/G 5/2 NL




1·0
1·1
1·25
1·4
2·8
3·15
3·5
4·0
2·
1·8

TECHNOLOGY TRANSFER OF THE WQM

by Frank W. Kearney
Engineering and Materials Division

ABSTRACT

The Weld Quality Monitor (WQM) is a non-contact weld quality control system capable of automatic correction or adaptive control of welding conditions in real time.

The need for real time weld quality control was recognized by the Corps of Engineers while constructing the anti-ballistic missile system in North Dakota in the 1960s and early 1970s. CERL developed and tested prototype WQM systems and obtained three patents associated with this work. CERL transferred the technology to National Standard Company as the first Corps developed technology to be licensed by a private firm.

This paper traces the development of the WQM through three principal T^2 stages: 1) research and development phase, 2) product engineering phase and 3) manufacturing engineering phase.

I INTRODUCTION

During the welding process, changes in arc voltage, travel speed, and heat input can occur without the operator's knowledge. These changes can cause defects such as porosity, slag inclusions, incomplete fusion and undercut in the deposited weld metal. The cost of locating and repairing these defects can be a major portion of Army construction costs; welding inspection can constitute 25 to 40 percent of the total weld fabrication costs.

Consequently, it is desirable to monitor the welding parameters to detect, identify and locate possible defects. These needs became saliently apparent during the construction of the anti-ballistic missile safeguard system in the 1960s and 1970s. This construction involved 1100 linear miles

of welds that joined liner plates which were used to shield the computer facilities and other electronics from electromagnetic pulse (EMP) disturbances. Because of the sensitive and critical requirements imposed on these EMP shields, the welds had to undergo 100 percent inspection. Shortly after the formation of CERL with its unique metallurgical capabilities the concept of real time weld quality control was studied. These studies led to a configuration concept for a real time system which was breadboarded in 1974.

Two separate systems comprised the Weld Quality Monitor: 1) a process data system and 2) an opto-electronic data system. The process data system (PDS) utilizes information from the weld process such as current, voltage, travel speed, wire feed speed, etc. and computes weld quality based on models developed through experimental work. The PDS identifies when the data from the weld in process falls below the normal acceptable limitations based on the model and stored data base in the system. The block diagram is given in Figure 1.

The opto-electronic data system (ODS) analyzes the spectral radiation from the weld process; the various components of the radiated spectra are correlated to normal weld conditions and flaw inducing conditions. The ODS is shown diagramatically in Figure 2.

The PDS was funded in the AT-41 program from its inception, whereas the ODS was initially funded by an ILIR. Starting in FY 79, both systems were funded under AT-41.

II CERL RESEARCH AND DEVELOPMENT ON WELD QUALITY MONITOR AND PRELIMINARY PRODUCT ENGINEERING

The R & D phase of the WQM was fraught with ponderous complexities because two new technologies were being combined - Microelectronics and Real Time Process Sensors. Microprocessors only months out of development were

used for data processing and there was no data base for welding processes developed using the sensors invented in the WQM program. The welding profession was unfamiliar with the concept of real time weld quality control and were adamant that conventional "after the fact" nondestructive testing was the only acceptable control. As will be seen, these factors magnified the problem of technology transfer for this system.

Breadboards for the configuration concepts developed in 1974 (PDS) and 1976 (ODS) were substantially completed in the 1977 to 1978 timeframe. As mentioned there was no experimental data base extant to correlate WQM sensor information with weld quality; consequently, an intensive, concurrent effort to obtain this data base was initiated and continued through the breadboarding period. The prototype system for field testing was fabricated in 1977 and tested at Ozark Power Plant on a turbine shaft repair job in the Little Rock District. In 1979 after successful testing, patents were applied for. The three patents were 1) PDS system, 2) ODS system and 3) an opto-electronic weld travel speed system. During this time presentations were made at various professional societies such as American Welding Society and American Society for Nondestructive Testing. As a result of these presentations the need for the WQM grew in crescendo fashion; similarly, test sites were suggested for field testing the WQM. From 1979 to 1981 rudimentary product engineering was required to produce a unit rugged enough for field testing. The first field test unit is shown in Figure 3. Six of these units were produced and tested at Lima Army Tank Plant, Alliss-Chalmers, Vandenberg Air Force Base and Waterways Experiment Station. It was this phase of the work, i.e. this preliminary tech transfer activity that engendered an onorous aspect of T^2- fifty percent of the R & D funds were expended in support of these field activities. Resource problems grew geometrically. Permutations of three

facets contributed to this: support of software for the system, upgrading the micro-electronics system to meet changing field conditions and the geographical dispersion of the test sites. It was in this tenuous state of affairs that it became obvious that a laboratory would not perform this phase of T^2 and a suitable producer was needed.

III TRANSFERRING THE TECHNOLOGY TRANSFER TO NATIONAL STANDARD

As early as 1980 it appeared that T^2 to the private sector would be a relatively straightforward task. Several manufacturers of electronic equipment approached CERL to produce the WQM. However, in all cases the potential vendors did not have the resources or experience to produce the WQM such that the Army and the general public could obtain the systems and equally important could not provide field support for the systems. Consequently, three criteria were developed for choosing a candidate producer: 1) sufficient background and knowledge to appreciate the concept and the technical ability to fully develop the technology (ideally the producer should be in a field related to welding technology), 2) sufficient stature such as size, financial strength, and demonstrable business and professional acumen and 3) a field engineering group capable to support the system, i.e. "service after sale."

In July, 1983, National Standard Company of Niles, Michigan, became aware of the WQM through an article describing the Weld Quality Monitor in the Welding Journal. They immediately contacted CERL and visited the laboratory in December 1983; impressed with what they saw, corporate headquarters sent a letter to CERL requesting the right of first refusal for the WQM technology. At this time CERL and the Corps legal groupwere in the position of the dog that chased cars and caught one - what to do now. The Stevenson-Wydler Act of 1980 conveyed the congressional intent for federal laboratory technology

transfer to industry but lacked specifics regarding implementations. As a first course of action COE Counsel referred CERL to the Judge Advocate General. Following the practice used in licensing pharmaceuticals. The JAG announced the availability of the WQM technology and intended award of an exclusive license to National Standard in the Federal Register. With this requirement satisfied, negotiations began on a license agreement; but since this was the first instance of the Corps transferring technology via a license, there was no precedent for the terms and conditions of such a license. The JAG composed a draft which was modified by National Standard and subsequently agreed to by CERL. The joint signing of the license occurred May 24, 1984 at CERL.

The license runs for a period of seven years with an option for renewal; CERL reserves the right to revoke the license if appreciable effort is not shown within two years to bring the WQM to the market place. National Standard may grant sublicenses subject to approval by CERL. National Standard is to submit annual reports to CERL and a royalty of five percent of gross sales to non-military users is charged. There is also a general article pertaining to a mutual research and development program.

IV. TECHNOLOGY TRANSFER TO NATIONAL STANDARD AND MANUFACTURING ENGINEERING

The rationale for the criteria mentioned in Section III regarding sufficient stature and financial strength was certainly validated by the resource committment made by National Standard to produce the first production model for the general market. Although exact figures for this effort are proprietary and unavailable to CERL, it is estimated that this cost was approximately $1 million. This is understandable because the WQM is a complex, multi-faceted system involving sophisticated sensors and hardware, and associated applications software. Also a lesson learned in this T^2

activity was that the transfer did not mitigate the level of effort required by CERL resources; for the first year the CERL involvement equalled that of the years prior to the agreement. Approximately one-half man year is continuing to be expended in support of applications engineering and data base development for shielded metal arc welding (SMAW) applications.

The stages of manufacturing engineering as performed by National Standard with CERL participation are as follows:

Jan 85 - Jun 85	Developed functional specifications for WQM system; re-evaluated systems specifications; established pilot laboratory and procured prototype hardware components; developed software utilizing both the CERL data base and the National Standard rudimentary data base.
Jul 85 - Dec 85	Built/tested/approved production prototype.
Jan 86 - Sep 86	Installed/field tested first production prototype.
Jul 86 - Oct 86	Finalized production procedures and installed tooling and set up production line.

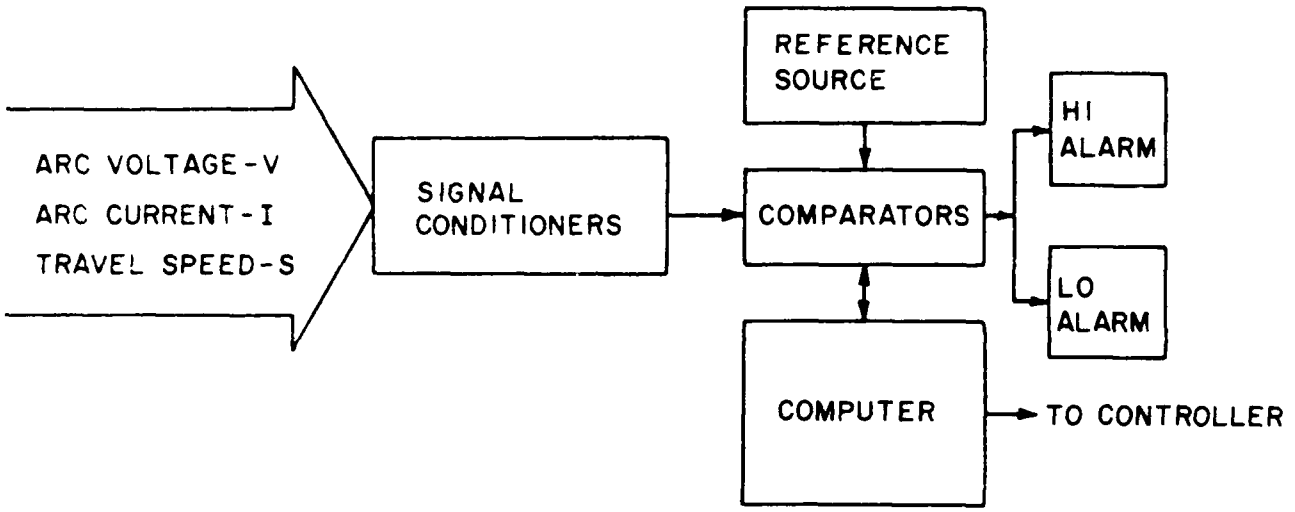
The first production run was started October 9, 1986. The unit as it is now marketed is shown in Figure 4.

V. CONCLUSIONS

The primary lesson to be learned from this T^2 case study is that the limitations of the natal laboratory in bringing a particular product/system to market must be recognized! Too much effort in product engineering will be detrimental to the laboratory's prime mission - R&D. The expenditures made by National Standard to produce a robust WQM could not have been made by CERL - yet, anything short of the NS commitment would have been futile. This is not

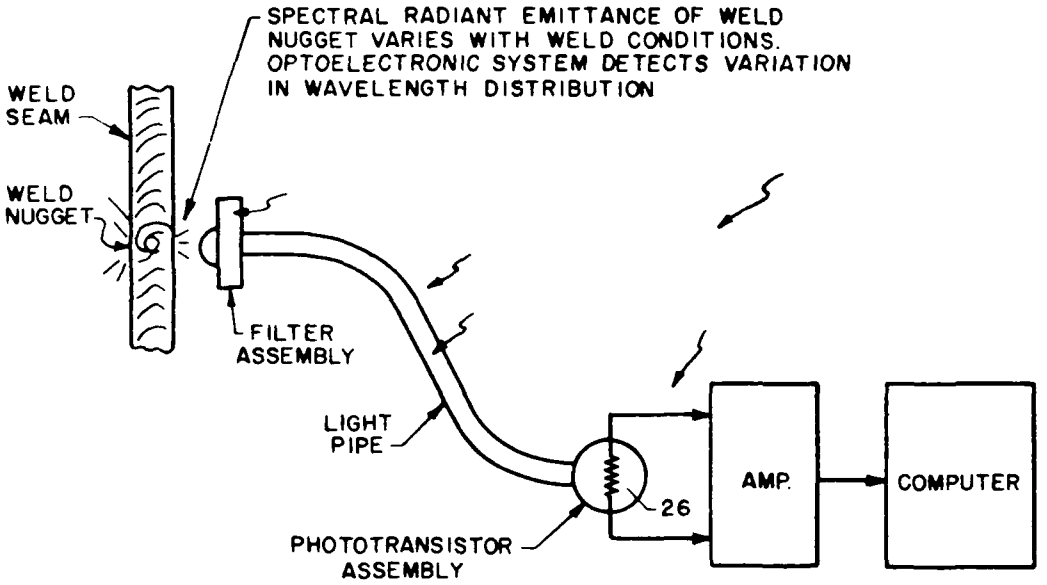
a unique situation. The Voice Operated Inspection System was recently transferred to a private company; the first technical activity was to scrap the CERL hardware/software and upgrade at a cost of $200,000.

These are hard economic facts that might be blurred by the brilliance of the technical accomplishment, but are pertinent if an idea is to be taken beyond the repose of a library shelf.



WELD QUALITY MONITOR
PROCESS DATA SYSTEM (PDS)

FIGURE 1



WELD QUALITY MONITOR
OPTOELECTRONIC DATA SYSTEM (ODS)

FIGURE 2

FIGURE 3

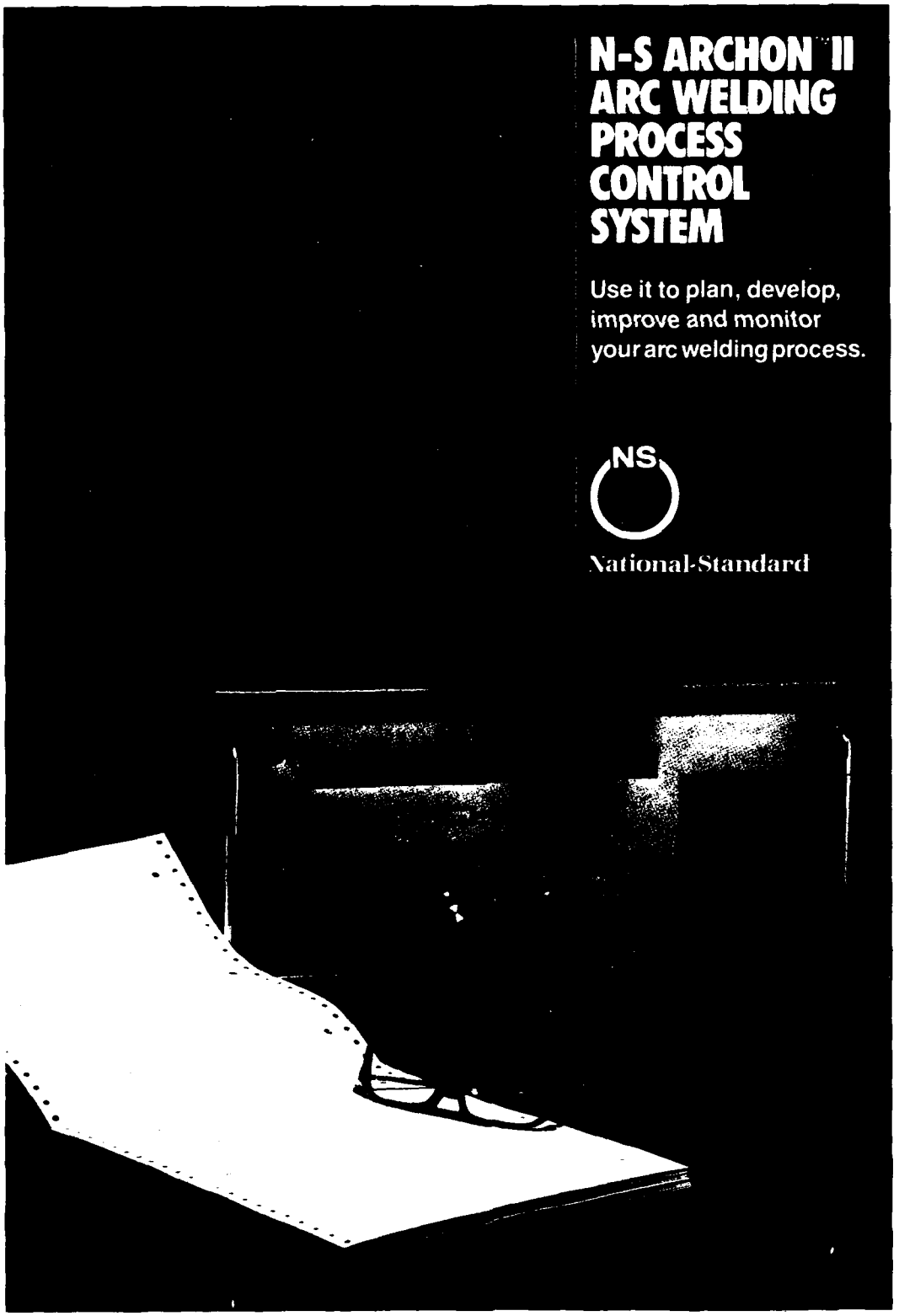

N-S ARCHON II
ARC WELDING
PROCESS
CONTROL
SYSTEM
Use it to plan, develop,
improve and monitor
your arc welding process.
NS
National-Standard

FIGURE 4

TECHNOLOGY TRANSFER OF HVAC CONTROL PANELS

by Dale L. Herron
Energy Systems Division

Introduction

The control systems used with heating, ventilating, and air-conditioning (HVAC) systems in Army and Air Force facilities are typically pneumatic systems which are designed and fabricated individually for each facility by a control hardware supplier. As a result of the increasing emphasis on energy conservation in these facilities, the control systems are becoming complex and difficult to maintain.

USA-CERL research has developed new standardized control systems based on the use of state-of-the-art electronic control components in a standard control panel configuration. These control systems significantly improve energy efficiency and maintainability of HVAC systems by standardizing the control system design and the hardware used to implement the design in a standard panel.

Because the new control panel concept used existing components, the panels are not a patentable device. Thus the final products of this research are the standardized control panel designs and the guidance documents required to implement the use of the panels in new and retrofit applications in Army and Air Force facilities.

Research process

The development of the new control panels included three major thrusts: research to evaluate HVAC control hardware, development of the control panel design, and development of the design documentation. The chronology of the development is as follows:

1978-1983: In-lab research of HVAC control components determined that existing pneumatic control systems typically did not perform adequately and had excessive maintenance requirements. Research also showed that electronic analog control components (developed by the control industry in the early 70's) did have high accuracy and low maintenance requirements.

1979-1983: Field investigations of HVAC control systems indicated that most pneumatic systems were not functioning as designed and could not be adequately maintained by the Army and Air Force maintenance staffs.

1983: The concept for standardized HVAC system designs implemented by standardized control panels using electronic analog control hardware was developed. A prototype panel was constructed in-house.

1983: The first commercial prototype panel was developed for the laboratory by a small control manufacturer (TSI) in November 1983. The panel was constructed from designs provided by the laboratory. Funding for the panel construction was provided by USA-CERL.

1983: First HVAC controls user's group meeting was held in November 1983. The Army and Air Force attendees were supportive of the panel concept and agreed that documentation describing the panel should be produced. Panel concept would then be implemented by Army and Air Force Engineering Technical Letters (ETLs).

1983-1984: The commercial prototype panel was testing in actual operation on HVAC systems at USA-CERL.

1983-1984: Other control panel manufacturers were solicited to produce the panel. Only one additional manufacturer (Johnson Controls) agreed to construct the panel. Several panels were procured from both manufacturers (TSI and Johnson).

1984: OCE decision was made in January 1984 to develop a completely new guide specification and technical manual for HVAC controls based on the USA-CERL standard panel concept.

1985: First draft of a technical specification for the standardized control systems and panels and the design instructions for their use were completed and forwarded to the Army and Air Force for review in January 1985.

1985: First electronic analog control panels were installed at an Air Force field site in January 1985.

1985: Panels were displayed at an international exhibit by a manufacturer in January 1985.

1985-1987: The electronic analog panels were evaluated via an FTAT project at three Army installations.

1986: OCE (through Huntsville Division) awards contract to develop the new controls guide specification and technical manual based on the draft USA-CERL technical specifications and design instructions.

1986-1987: Pilot projects using electronic analog panels are initiated by the Army and Air Force. Two additional manufacturers begin to produce electronic analog panels.

1986-1987: Research by USA-CERL and others indicates that single loop digital controllers are now more cost effective to use in the panels than electronic analog controllers. Panel design concept was changed to incorporate these controllers.

1986: OCE decision was made to develop the HVAC controls guide specification and technical manual based on the use of the single loop digital panel instead of the electronic analog panel.

1987: Air Force decides to implement the use of electronic analog panels since the technology is proven to be effective while the development of the single loop digital panels and the associated documentation is being completed. ETL is released in June 1987 mandating the use of the analog panels for new and retrofit Air Force projects and provided the USA-CERL produced technical specifications and design instructions as supporting documentation.

1987: First in-lab prototype single loop digital panel is completed in May 1987 and in-lab testing initiated.

Projected future efforts:

1988: First single loop digital panel provided by a control manufacturer.

1988-1989: FTAT project to field validate use of single loop digital panels.

1989: Guide specifications and technical manual on HVAC controls will be completed by the Army. Army and Air Force will adopt the use of standardized control systems implemented by single loop digital control panels.

Lessons Learned:

While the research process to develop the standardized control systems and panels was relatively straightforward, the technology transfer process was not. Because the final product was non-patentable hardware, both the users (in this case the Army and Air Force) and the suppliers (in this case the control manufacturers) had to be convinced that the product was viable.

The time required to implement the use of the panels after the first prototype panel was developed was four years for the Air Force and will probably be six years for the Army. During that time, the state-of-the-art in control hardware changed such that the panel had to be completely redesigned even before panel use was mandated.

The Army HVAC guide specification and technical manual development process has/will take at least three years to complete even though technical specifications and design instructions for the control panels were completed prior to the start of the guide specification development process.

PAVER TECHNOLOGY TRANSFER

by M. Y. Shahin
Engineering and Materials Division

The Technology Transfer T^2 process of the PAVER Pavement Management System began at the outset of system developed by following the steps shown in figure 1. Following is a description of each of these steps:

I. IDENTIFYING THE INITIAL AND ONGOING NEEDS

1. Various user levels, were visited to discuss current pavement management procedures and to identify needs for improvement.

2. A literature search was conducted to find out how the identified problems were currently being handled by other organizations.

3. As a PI began to develop champions with all possible pertinent organizations which can be the source of fund and have the need for pavement management.

II. DEVELOPMENT

1. Identified a team consisting of both researchers and field experts in the area of pavement maintenance and management.

2. Defined existing technology that can be modified for the problem at hand as well as technology gaps. It was identified that the most important technology gap was a rational method for measuring pavement condition. This method was referred to as the Pavement Condition Index (PCI). The requirements for the PCI were to; agree with the collective judgement of experienced pavement engineers, repeatable, and relate to needed maintenance and repair.

3. Initiated a user group to insure the usefulness of the final product.

4. Began planning for the application phase (training, Strategic Support Center (SSC)).

5. Identified all potential users with interest in PAVER e.g., USAF, FAA, Army, NAVY, etc., and kept them informed of the progress in development.

6. Conducted pilot test for the purpose of software debugging and improving user friendliness prior to initial release.

7. Began development of guidelines for expected use of the product in the various phases of planning/design/construction/ and O&M as applicable.

III. FIELD DEMO

1. Conducted a field demo at Ft. Eustis supervised by over 20 pavement engineers.

2. Identified an Assigned Responsible Agency (ARA) for overseeing the demo and making the system available if demo is successful.

3. Insured continuing support from the user committee.

4. Insured continuing support by the CERL top management.

5. Made other potential users and agencies aware of the field demo, and results.

6. Based on the field demo, developed package for the product use in planning/design/construction/ and O&M as applicable.

IV. SYSTEM AUTHORIZATION

1. Worked with USAF and Army to facilitate initiation of System full or partial authorization. For example, prepared Air Force regulation, Army technical manual, and assisted in developing project approval steps based on PAVER.

2. Worked with in accordance with Army regulations to make PAVER Standard system.

3. The system was accepted and implemented on a voluntary basis which proved to be best.

V. APPLICATION

1. Made the system available to the military users through the U.S. Army Facilities Engineering Support Agency (FESA) and to Civilian users through the American Public Works Association (APWA).

2. Published articles in trade and technical journals for technology acceptability and feedback.

3. Attended symposium/workshops to take advantage of outside technology that can be adopted or incorporated into product.

4. Assisted in coordination meetings and development of association among using agencies.

VI. SYSTEM UPDATE

It should be recognized that PAVER is a living system that needs continuous update as technology is improved as illustrated in Figure 1.

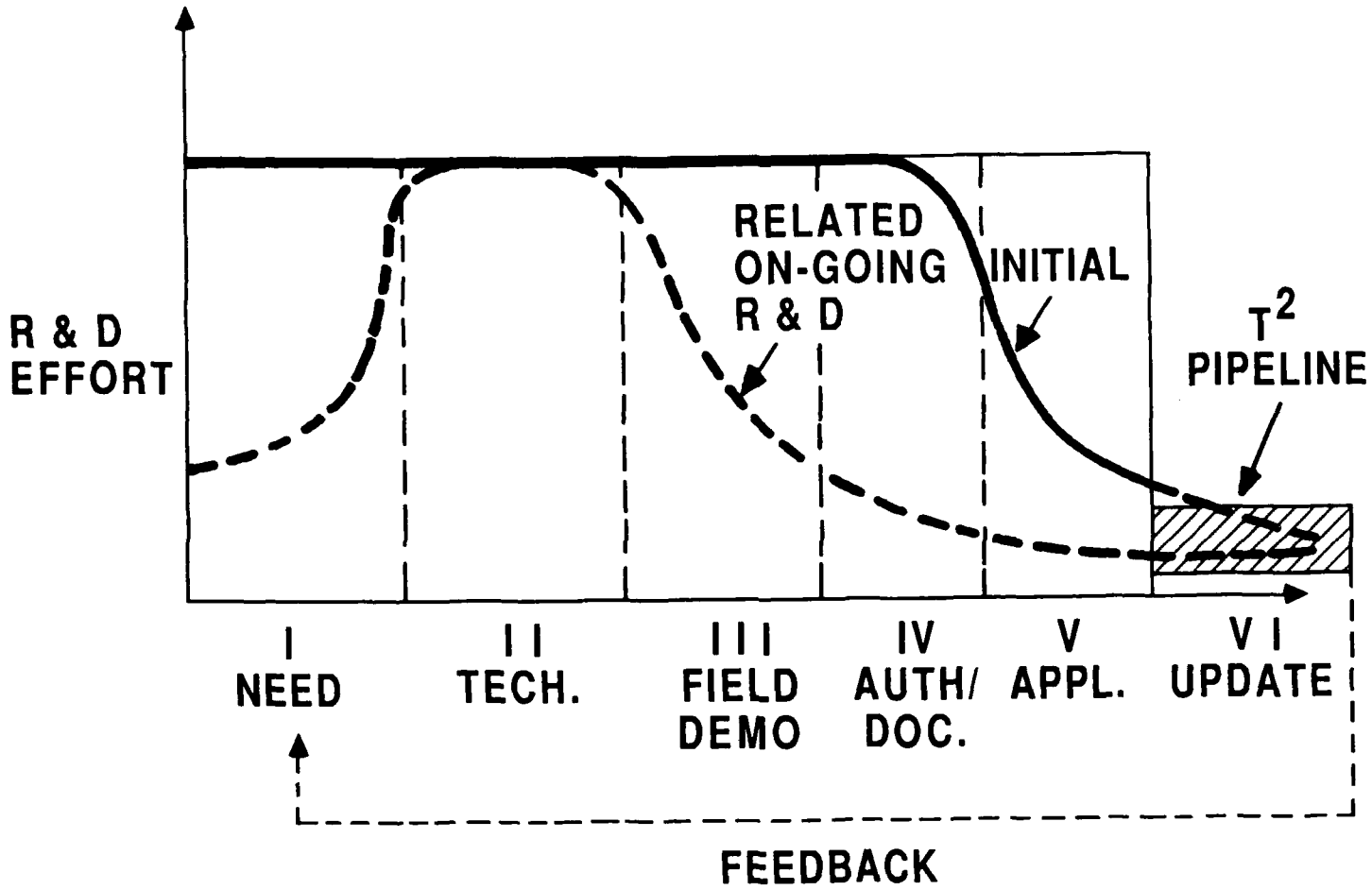


Figure 1. Technology Transfer (T^2) Cycle for the PAVER Pavement Management System

APPENDIX: KEY TO FIGURES 1 AND 2

RESPONSIBLE PARTIES:

A. Chief of Engineers
B. USACE R&D Review Board
C. Directorate of Research and Development
D. Other USACE Directorates
E. USACE Labs
F. Others

SUBTASKS:

1. Solicit, receive, consolidate, evaluate in relation to USACE major themes. Define basic mission problems and assign directorate priorities.

2. Divisions, districts and MACOMs: Submit user problem statements.

3. Solicit user problem statements

4. All others: Submit user problem statements.

5. Consolidate problems, coordinate with directorates, transmit to labs for assessment.

6. Develop preliminary assessment of feasibility of problem solutions, including estimate of time and cost.

7. Consolidate, review lab assessments and estimates, introducing USACE and national considerations.

8. In coordination with directorates, recommend total USACE priorities.

9. Review, validate user problems and lab assessments; make adjustments when recommended total USACE priorities conflict with existing capabilities. Recommend priorities and thresholds below which R&D efforts should be deferred or disapproved.

10. Approve priorities and thresholds.

11. Publish priorities and thresholds.

12. In coordination with directorates, develop and issue program guidance within approved priorities and funding guidance from DA, OSD, OMB.

13. Formulate lab programs consistent with objectives, priorities, and guidance, assuring balance with commitments to other "customers" and maintaining sound in-house/out-of-house ratio.

14. Review lab programs and provide comments and recommended changes.

15. Review, modify, consolidate, and coordinate programs into a recommended total USACE program.

16. Approve USACE program.

17. Develop program justification in coordination with directorates and labs.

18. D/CW: Defend civil works program with directorates SPT and follow through.

19. Defend RDTE program and follow through.

20. Review program in terms of resources actually authorized and adjust in coordiation with directorates.

21. Exercise staff supervision to assure effective use of resources.

22. Monitor on-going research and final results to assure consistency with user requests, themes, objectives, priorities.

23. Adjust lab program.

24. Execute assigned programs.

25. Submit quarterly R&A reports.

26. Review and recommend directive action(s)

27. Review and Redirect as necessary.

28. Present summary of accomplishments, shortfalls, problems, and resource status. (Semi-annual corps lab program review system).

29. Review lab program.

30. Provide guidance and program direction

31. Follow-up

32. Complete and publish or otherwise communicate results of research in form specified by user.

33. Review research results to assure effective communication and transfer of results.

34. Monitor and assure transfer of results to all applicable users.

35. Receive research results (answers to problems).

36. Use research results.

TECH TRANSFER CONSIDERATIONS

by R. D. Webster
Environmental Division

1. A STEP-BY-STEP PROCESS

It is unlikely that ONE step-by-step technology transfer process will ever suffice for all types of products and systems. The Environmental Modeling and Simulation (EM&S) Team within USA-CERL has developed what would appear to be a software project development process which stimulates and facilitates tech transfer. Based upon the "prototyping" approach to software development, as opposed to the traditional "stovepipe" type of system development, this approach has proven to be very effective in developing products which are readily tech transferred. At the "end" of the development cycle, in fact, the systems are readily used by a community of user's who are familiar with the systems and have a vested interest in system success. The level of effort spent on each phase of this process varies from project to project, but each phase adds essential elements to eventual tech transfer phase which are important. The phases of the development process can be represented as follows:

Idea Formulation

Prototype Development

Prototype Enhancement

User Evaluation

User Group Synthesis

As shown, the last three phases are continuing iterations as the product evolves toward some optimum. It should be noted that there is no clear point at which this iteration process is complete. In fact, as long as the users are active (i.e., using the system), there is always a need for modification, improvement, or enhancement. Any system which does not exhibit this iterative need for improvement may not be undergoing robust usage by an active, contributing user community. Additionally, as long as the users will financially support this iterative process, it should be encouraged - a type of free market determination. Often, this type of support is accomplished with O&M money after the original work has been leveraged through the appropriate use of R&D funds (principally during the first two phases of the process). For clarification purposes, each phase of this process can be characterized as follows:

IDEA FORMULATION - This phase involves both technical AND user inputs. In some cases, one person can provide both viewpoints, but it is essential, at this phase, that the two distinct viewpoints be formulated. The technical view is often based in the recognition of technological opportunity, and the user view is often based upon an appreciation of the cultural and practical environment in which this innovation must be fostered. Either view, in the absence of the other, will insure tech transfer difficulties. If the technical participants on the development teams need input from a user perspective, it is possible to "select" a "representative" user. This can be difficult and holds considerable risk in the determination of the "typical user view." However, getting one voice (or, at least, a small number of them) is essential at this phase. Else, the project can suffer from too many inputs, too early. Often users can argue about the trivial aspects of a system (to the point of condemning other views) and never see the fruition of the effort because of these disagreements ("Too many cooks spoil the broth"?). Recognizing this aspect of human behavior, the project leader is often required to "synthesize" those elements of the discussion which appear to be a common user requirements; thus arbitrating disparate views in the interest of system progress.

Sometimes the user representatives appoint themselves. Whether responding to a technical proposal or concept, or even being the source of the original idea, this enthusiasm deserves appreciation. If such enthusiasm does represent a broader user view, the product/system stands to be very successful. Some evaluation of this "universality" is essential, and must be periodically performed, but emergence of an "enthusiastic user" has considerable impact on both product quality and tech transfer.

PROTOTYPE DEVELOPMENT - This part of the process is almost entirely left to the technical development team. Here, a synthesis of views and discussions must occur. On larger products/systems, it may be necessary to see that interfaces between tasks (often different teams or elements) are carefully coordinated. (As one software expert aptly noted, "The bugs occur at the interfaces.") On smaller systems, the importance of this coordination diminishes; allowing more individual technical creativity without unnecessary administrative constraint.

USER EVALUATION - During this phase, the size and importance of the user input increases. This is a very critical time in the phase of a project. The technical staff (including the user representa-

tive involved in the first phase) must respond favorably to user commentary. This can be particularly difficult where "pride of authorship" is involved. This "pride" is a very commendable staff attribute and should be encouraged in the technical staff, but, at this phase, the technical staff must "listen" to the user. At this point, the user is seeing the first version and will provide considerable input into the process (continuing into the future and during tech transfer) unless alienation occurs. The technical staff can pass judgement upon user suggestions (and even have open confrontation), but this must only be allowed later in the process, after user comments have been tempered with the time necessary to provide truly objective review and analysis

USER GROUP SYNTHESIS - At this point, true "users" will become apparent. A true "user group" must consist of people who use the product/system. In the case of an interactive computer system, these are the people who actually "interact" with the system. While many people may interpret or use system outputs, they cannot provide the same insight to the system design as the person who actually interrogates and flexes the software. Therefore, in this context, the user group definition is very narrow. With the term "user group" becoming more popular, their is a tendency to arbitrary define a "user group" too early in the process. This can, in fact, keep actual users out of the development process; and with predictable results regarding tech transfer. While many systems have user groups, fewer systems have both user groups AND users.

The true user group can now provide a much needed role in the process. Trivial modifications will tend to be minimized while modifications and augmentations which improve the prototype system will be the more usual result. At the same time, the system (still in R&D) will be developing a user clientele with an appreciation for its benefits, and hence, some programs for O&M support, funding, etc. This appreciation can certainly streamline any tech transfer by creating "pull" for the product (by real users) and negating the often adverse effects of R&D "pushing" the system toward a reluctant or unfamiliar user community. The EM&S Team has noted that its systems are more likely to gain acceptance as "non-mandated" systems, as a result of the natural psychological tendency of users. If users are free to choose approaches and elect to use these particular products/systems because of their perceived benefits, there is a direct empirical verification of the systems' success. If the system is "mandated," usage is harder to evaluate as a measure of system success. "True" usage (iterative interrogation

and use of the system) as approved to "token" usage (clipping system output to the back of the study) is hard to distinguish.

The user group concept can streamline this user acceptance through both peer communication and a true appreciation for user requirements. A considerable amount of work is necessary, however, to insure successful transition across the interface between Prototype Development and User Evaluation phases.

PROTOTYPE ENHANCEMENT - This is the phase during which the system really manifests itself. Here, user supplied suggestions are implemented through major rewrites or minor modifications - whichever is necessary. At this point, MEANINGFUL dialogue is exchanged between the elements which know what is technically feasible and elements which know what is needed. In the absence of the first "prototype," it is considerably more difficult to reach this phase of the process. If the first phases are accomplished with proper professional attitudes (on the part of ALL concerned), this phase can be very exciting from a technological standpoint and very productive from an economic or user standpoint.

It is possible that one iterative cycle back through the user will suffice. This however, is not always the case. This is not even desirable in some cases and the number of iterations is often based on system performance/requirements, financial support by the user community, changing agency guidelines, and many other exogenous factors independent of the R&D team or the user groups. Again, successive iterations should not be discouraged, as long as a user product (the optimum result) is being approached. The only real danger in cases where the development has numerous iterations is a system losing modularity while, at the same time, it is expected to do more. As a system gets larger, modularity becomes more essential. It is also important that, at some point, users pick up the O&M burden of the system (When it provides enough tangible benefits, this becomes practical), leaving R&D funds free for appropriate other uses.

2. MILITARY PLAYERS

Within USA-CERL, the obvious military player is the Commander/Director. Having direct contact with the management and executive players (the bosses of our users) he can provide several

needed functions. These include the resolution of conflicts, communication of R&D needs, identification of financial support, support of both the user and the R&D team in appropriate forums, and other activities which play an important role in tech transfer. EM&S Team experience with the military outside USA-CERL has been generally positive, except in cases where normal officer rotation played havoc with long-term plans. However, the military players have proven to be technically sound and, more importantly, "action-oriented." As the heads of different user organizations, these players can expedite progress in many cases where civilian initiative (or decision-making) was often slower in coming. This has been observed at a number of offices at higher levels as well. By and large, these players form influential catalysts for change and should be encouraged to participate in the R&D effort. Because of their temporal nature in organizations, however; they cannot provide sustainable, long-term support. This almost always comes from the civilian-dominated "institutional memory" of DA agencies. They often represent the long-term users and are essential to success.

Productive involvement of military players in the R&D effort becomes difficult to achieve. USA-CERL has benefitted from a reputation for providing the much-needed "new idea." USA-CERL, through its affiliation with universities and, to some extent, industry, provides a more distant and often focused view of the overall technological or process picture. This is particularly true where the composition of a given office is predominantly military officers - often with similar or identical training. It is in such an environment that "decision making from a cubicle" runs the real danger of reaching a "consensus" too early in the evaluative process, before many alternatives to given actions have been evaluated. This consensus can develop a false sense of "doing the right thing" although it can be based upon a sterility instead the robust evaluation required in an R&D community and useful in policy evaluation. Several recent project sponsors have identified this problem and solicited USA-CERL support to provide a different view from the R&D community in evaluating technical and policy issues. These divergent views can provide much-needed insights into approaches and policy decisions which have often been unavailable. If this capability were marketed as an R&D type of service of value to higher-level decision-makers in HQDA (and the injection of new viewpoints is a legitimate tech transfer activity), this would naturally involve more military players in our research program. It is also important to note that, (as a result of the officer rotation program) the Major or Captain obtaining assistance

from USA-CERL can become a vocal product/system sponsor as a Colonel or even the Commander/Director. In such cases, we have achieved considerable positive military involvement.

It is also important to note that military sponsor involvement has assisted the EM&S Team at all phases of product/system development. The major proponents of this work have become dependent upon the team to assist in the development of policies and procedures, allowing the necessary tools to be developed in concert. A very open dialogue has always been available and useful for these development efforts. This military input has always been a respected contributor to these systems and their design, development, utilization, and tech transfer.

3. COMMUNICATIONS AND MARKETING TOOLS

This category of discussion must be tempered with a large dose of reality. While open, constructive communications is an important part of almost any project and, in fact, an important historical source of problems for technologists (and can profoundly affect tech transfer), marketing is often overemphasized. No tool will work unless the developers of a product/system are committed to three objectives:

(1) the system to be used,

(2) the user to obtain some benefit,

(3) to expend the energy necessary for tech transfer.

If all three of these elements are not part of the development process and the development team is not sufficiently committed, no amount of marketing will accomplish tech transfer. To a large extent, the ease of tech transfer depends upon the perception users receive as they hear or investigate the product/system at all or different phases of the developmental process. Several perceptions can hinder tech transfer in this regard and many of them are related to the traditional communication problem of the technologist in dealing with the layman:

(1) The developers are too busy to talk.

(2) The developers are too educated/sophisticated to deal with.

(3) The design of the system is beyond the ability of the user to change.

(4) The interface is too complicated.

Users tend to categorize product systems based upon their exposure at different phases. If misperceptions occur, considerable effort is required to cure them, and, in many cases, these negative connotations can never be changed. If positive perceptions (on the part of as many users as possible) are achieved during the development process, tech transfer almost drives itself. The EM&S Team has experienced both extremes in the development of systems.

Again, communications is critical to the success of the system. Peer recognition and communication among users is the most effective means of tech transfer. These users like to share successes and any product/system which achieves a level of positive notoriety among users and their peers will be successfully tech transferred (even if the users have to support it.) Means of stimulating positive peer communications among systems users should, therefore, be encouraged.

Other tools to stimulate transfer include formal DA documents - DA PAM'S, ETL'S, etc; and CERL outputs - technical reports, newsletters, fact sheets, etc. All of these achieve the same purpose if placed in the right hands. This is, however, very difficult to achieve. Mailing lists and other means of mass mailing do not insure the successful supply of technical material (at any level) to the right personnel. EM&S Team experience has indicated that users become acquainted with systems and request technical material and assistance, after first hearing about the product/system through other means.

In addition to peer interchange; USA-CERL visits, and personal marketing are very important to the tech transfer of R&D products. Many times, a trip to Washington, DC (or some other office) can obtain additional marginal benefit by just "touching base" with potential sponsors. This same concept of personal touch is particularly valuable at the MACOM and installation level where demonstrated interest in their problems are appreciated. While travel can be expensive and often frustrating, it is an essential ingredient of tech transfer (Knowing the users).

Seminars and conferences can be effective means of initiating tech transfer with new users. The success is very difficult to predict, however, and these mechanisms do take considerable time and resources. Again, the users exposed at these seminars and conferences must come away with positive perceptions of both the technical aspects of the system and the personal commitments on the part of

participating researchers. There is, perhaps, a sizable role for PAO in this area, and, in fact, recent PAO support has been very effective. A workable program could be developed which would accomplish more in this area and require less researcher time in the more time-consumptive portion of this effort.

4. INDUSTRY AND ITS ROLE

Before industry is specifically analyzed, it should be noted that four types of players are commonly required in the technology transfer of technologically advanced product/systems: R&D staff (USA-CERL), users, university representatives, and industry. If all these players are in evidence, there is strong reason to suspect a high degree of technological opportunity. An example of this could be built around the GRASS development - where all elements are active and supportive. It is indeed likely that USA-CERL will form the critical mass of this system, the universities will provide the long-term supply of talent, industry will adapt and market (in the interest of hardware sales), and the user will reap the benefit.

Industry does play an important role in tech transfer. USA-CERL must keep abreast of industrial trends (for example, automation) in order to insure the technical content of its product/systems and the ability of industry to supply necessary product/system components. In some cases, USA-CERL has had to wait for this industrial capability (UNIX/C) and, in some cases, USA-CERL has created the capability (Ceramic Anode). In both extremes, industrial ability to supply the appropriate technology has a significant effect on tech transfer.

Industry can provide a catalyst for tech transfer in cases where analogous requirements exist. This has been true in the tech transfer of PAVER (for example) and for GRASS, in the future. In some cases, this industrial acceptance lends legitimacy to the product/system in the eyes of the target DA user (although it is unfortunate that this is necessary).

Industry can provide meaningful input to the R&D effort at all phases. The EM&S Team has used interactions with Bell Labs to obtain insight into the future direction of some technical areas. These interactions have taken the form of formal Beta-site type program and informal exchanges on a personal/technical basis. In both cases, the exchange often led to design modifications of USA-CERL product/systems to account for recognized trends (approaches to software modularity, etc.).

To stimulate interaction with industry, steps must be taken to get the appropriate exposure AND interchange. Exposure is best initiated through laboratory management. Interchange will be the responsibility of researchers and technical personnel in each agency. This will be more difficult to achieve without appropriate incentives. In the development of such incentives, the desirable outcome would be an environment where joint side-by-side research occurs on a natural day-to-day basis with as little formality as possible in management.

5. CONCLUSION

This paper has attempted to tie tech transfer considerations through the life cycle of system development, as observed through the development of a family of systems by the USA-CERL Environmental Modelling and Simulation (EM&S) Team. Sensitivity to eventual tech transfer is essential during all phases of system development, and development staff must constantly be aware of the interface to users (on a personal basis) and its importance in assuring eventual user acceptance of the system. Users must form an integral part in the development of systems and an iterative, interactive process brings about a better product.

The role of the military, universities, and industry in the development of USA-CERL systems has been critical, although a concentration and dependence on one (to the detriment of others) is ill-advised. All have a role to play.

The best marketing strategy revolves around the development of a quality product which represents user needs, provides payback to the user, and has a staff committed to the tech transfer process.

CASE STUDY REVIEW:
CONSTRUCTION MANAGEMENT MICROCOMPUTERS

by Jeffery J. Walaszek
Public Affairs Officer

Description of Technology

The use of microcomputers at construction sites can assist U.S. Army Corps of Engineers personnel in more efficiently managing the construction effort. The U.S. Army Construction Engineering Research Laboratory (USA-CERL) introduced the use of microcomputers at Corps offices at construction sites. USA-CERL currently assists Corps personnel in fielding and using microcomputers, and in evaluating commercially available construction management software applications.

Timetable of Activities

USA-CERL began its research in 1978 at a time before the microcomputers had been fully developed. Field tests of software applications for construction activities were initiated in 1981 at Wright-Patterson Air Force Base in Dayton, OH. These initial applications were run on

minicomputers. Transfer of the minicomputer systems began shortly afterwards when seven additional systems were installed at separate Corps construction field offices. During this time the microcomputer technology was advancing to a point which made the minicomputer systems somewhat obsolete. A decision was made at USA-CERL to go ahead with the transfer efforts despite the systems already being on the verge of obsolescence.

During this time, USA-CERL began research on using its software applications on the newer microcomputers. The many advances in microcomputer technology redefined the research role of USA-CERL. It was no longer necessary for USA-CERL to develop software applications as several construction management applications were now commercially available. USA-CERL become a microcomputer information broker of sorts and advised Corps personnel on the benefits and disadvantages of the new technology. Lab staff evaluated available microcomputer systems and software programs to assess their usefulness to the Corps and then transferred this information onto the field. Transfer of the microcomputer-based construction management systems began with the publication of the "Microcomputer Selection Guide" in June 1983.

Technology Transfer Approach

Informing the Field

USA-CERL's efforts to inform the field of the microcomputer technology consisted of the following activities:

* Publication of "The Microcomputer Selection Guide for Construction Management at Corps Field Offices," June 1983. The quide was designed to introduce Corps personnel on how microcomputers could be used in the field office, explained microcomputer terminology, identified hardware systems and software applications commercially available, and identified how one goes about procuring a microcomputer within the Corps. A second edition of the Selection Guide was published in 1985.

* The "Micro Notes" newsletter is published by USA-CERL three times a year. It contains articles written by field users on how they are using microcomputers, new software applications for construction management, and listings of Corps-developed applications available from USA-CERL.

* The Microcomputer Users Group was started as a way to exchange information among Corps users of microcomputers. The group typically meets twice a year.

Implementation Strategies

The interviewee pointed out two things which are required for successful technology transfer: 1) a product which is of

value to the user, and 2) having spokespeople for the technology who have credibility in the eyes of the users.

The value of the product was demonstrated to a few individuals through the actual use of the product in the field. USA-CERL funded the purchase and installation of the minicomputers and software in field offices at construction sites. Many of the software applications demonstrated on the minicomputers were incorported for use on microcomputers. This demonstration approach resulted in the user becoming a spokesperson for the technology. Typically, the field user has a higher degree of credibility among his/her peers than does a researcher. The users group furthered this exchange of information from "credible experts" as Corps personnel spoke to one another on their use of the technology.

Researchers also need to have credibility in the eyes of the users. The interviewee stated researchers gain credibility by listening to field and learning about their problems and their business. USA-CERL researchers have long been involved with construction managers and felt they had that type of credibility.

The field's eagerness to use the microcomputer technology in construction offices attracted the attention of Corps headquarters personnel. USA-CERL staff had solicited the headquarters support for field use of the technology. Headquarters recognition for the technology would make it

easier for the field to procure microcomputers within their own organizations. The groundswell of support from users in the field prompted Corps headquarters to publish an Engineering Regulation in June 1984 which authorized the use of microcomputers at construction sites.

Effectiveness of Transfer Activities

Informing the Field

The Selection Guide was step one in the education of potential users on the technology. Both the first and second editions of the Selection Guide had to go into second printings due to the numerous additional requests for it. The newsletters were perceived to be very valuable in keeping the users up to date on new applications in the technology.

Information dissemination activities were well received and probably benefitted from an overall increased awareness of microcomputers within society. Microcomputer advertisements on television and school children using computers and talking about them at home have raised the awareness of computers by adults. Society has become computer oriented.

In the cases of both the newsletter and the selection guide, extensive mailing lists were developed. The publications were sent to those individuals who were perceived by USA-CERL to be able to benefit from the technology and those individuals who requested them.

Implementation Strategies

The overwhelming use of the technology within the Corps legitimized its use throughout the Corps and probably encouraged others to use them. The newsletters and users group conveyed the notion that microcomputers are needed and accepted for use in the Corps--a corporate recognition of the need for the technology.

This corporate recognition idea was very strongly emphasized in the users group meetings. USA-CERL specifically tried to make the users group meetings an avenue for the users to step up and exchange ideas about what they did with microcomputers. The agenda for typical users group meetings consisted of two users speaking before the group to every one technical person speaking from the lab. The idea was to create this corporate recognition for the meetings--that these were Corps users group meetings, not USA-CERL users group meetings.

The users group work well within a decentralized organization such as the Corps. Decentralized organizations leave the decision making to its subunits--such as Districts and Divisions in the Corps. The users groups provide a mechanism for exchange of information among peers which allows the individual decision makers to make well informed decisions from credible information.

The authorization for the use of microcomputers at construction offices provided by the Engineering Regulation was effective in allowing Corps personnel to seek funding for procurement of systems. The benefits of the technology sold the technology on its own merits. Demonstrated savings from peers using the microcomputers was a major motivation behind the adoption of the systems.

Expected or Encountered Problems

The decision to go ahead with the implementation of the minicomputers created some minor credibility problems as suddenly the lab was seen as shifting gears on its own technology when it went to microcomputers. USA-CERL found itself having to defend its decision to go with microcomputers every time a presentation was made on the topic.

In May 1985 the Corps headquarters requested USA-CERL to cancel the scheduled users group meeting until a clarification could be made on the distinction between a users group meeting and a professional conference. Under existing Army guidelines conferences have to be initiated by a headquarters office and follow specific procedures on the makeup and number of attendees.

Prior to this time attendees of users group meetings received a special invitation from USA-CERL. Those invited were typically daily users of the microcomputers known to USA-

CERL personnel. A decision was made that the meetings were in fact conferences and that each Corps District and Division would send one representative to the meeting.

Nonusers often cite the time needed to learn the system as a reason why they do not use microcomputers. "People are so busy trying to get their heads above water, they don't have the time to reach for the lifesaver." The managers typically do not give their employees the time to learn the system. Some employees also think that time spent learning how to use a computer is wasted time that does not result in any noticeable output. Computer adoption is also restricted by computer phobia--the fear people have of using computers.

The interviewee raised the issue of when does technology transfer stop. In the case of microcomputers, the technology will continue to change. The Corps risks falling behind the technology unless technology support activities are maintained after the research staff moves onto different research missions. The users groups concept and newsletters need to be maintained somehow by the Corps. Until the mechanism to do this is established, the research organization needs to maintain it.

Some users stated they did not receive copies of the newsletter when it was sent through normal mail distribution channels. USA-CERL discovered that occasionally individuals would keep issues of the newsletter for their own reference

purposes and not pass them on to the remaining individuals on the mail routing slip.

Improving the Transfer Process

Overall, the interviewee thought technology transfer activities were very effective. Some scheduling problems did result in missed opportunities to make presentations to higher level personnel such as conferences of Engineering Division chiefs. In addition to selling the technology to those individuals who will be using it, it is also necessary to sell the technology to those individuals who make decisions on whether their people should buy microcomputer systems or should be using the technology.

The problem of hording the newsletters could be resolved by sending a supply of copies to the appropriate office chief with a cover letter asking him or her to disseminate them to microcomputer users in the office.

It was also suggested to get training classes on microcomputer applications for construction managers incorporated into the Corps training program at the Huntsville Division office. Giving individuals time to learn to use microcomputers outside the office would relieve some of the computer fear and lack of time obstacles.

Using Outside Experts

The interviewee did not think outside experts were appropriate in this situation. A Madison Avenue approach to communications activities would have been too slick for this audience and would not have contained any credibility in the eyes of the users.

DISTRIBUTION

Federal Laboratory Consortium Representatives
(142)

Defense Logistics Agency
Defense Technical Information Center
Cameron Station
Alexandria, VA 22304-6145
(2)

END
DATED
FILM
8—88
DTIC