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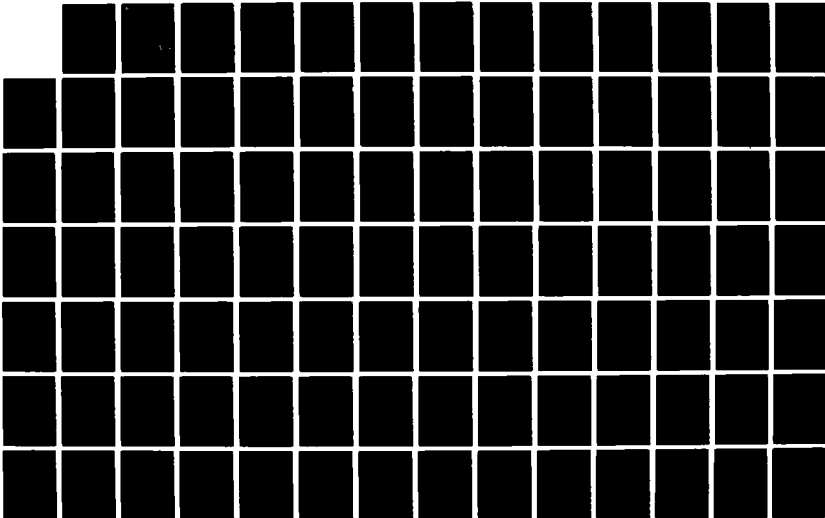
THE ROLE OF COMMUNICATIONS WITHIN TECHNOLOGY TRANSFER
ACTIVITIES OF THE U. S. (U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL J J WALASZEK JUL 87
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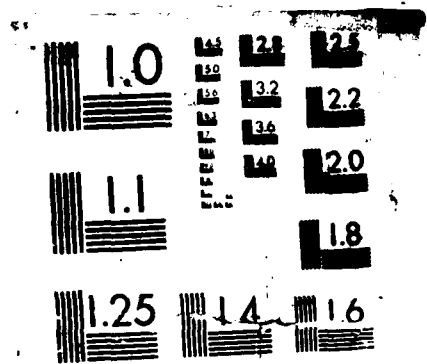
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USA-CERL TECHNICAL MANUSCRIPT O-87/1

July 1987

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US Army Corps
of Engineers

Construction Engineering
Research Laboratory

AD-A184 334

The Role of Communications Within Technology Transfer Activities of the U.S. Army Construction Engineering Research Laboratory

by
Jeffrey J. Walaszek

This study was undertaken to obtain a greater understanding of the communications activities involved in the technology transfer effort at the U.S. Army Construction Engineering Research Laboratory (USA-CERL). This study was conducted through the University of Illinois at Chicago in cooperation with USA-CERL.

This project consists of a series of investigations into the communication aspects of the overall technology transfer process at USA-CERL. The ultimate purpose of the study was the development of a communications strategy to support technology transfer efforts at USA-CERL. However, each chapter provides valuable information on specific aspects of the technology transfer effort at USA-CERL.

Chapter II presents a case study of communications strategies used and the problems encountered in the transfer of eight technologies from USA-CERL. Chapter III presents the views of high-ranking Army personnel on the process and problems with current technology transfer activities. Chapter IV consists of a survey of public relations organizations at government and nongovernment research laboratories, their possible role in support of technology transfer efforts, and the views of technology transfer specialists towards current communications efforts. Chapter V summarizes the findings of a survey of users of USA-CERL technology. Chapter VI applies findings from the numerous diffusion studies found in the literature towards the technology transfer activities at USA-CERL. Chapter VII presents a communication strategy in support of technology transfer.

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87 9 8 043

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

A184334

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) CERL-TM-0-87/1		5 MONITORING ORGANIZATION REPORT NUMBER(S)	
6a NAME OF PERFORMING ORGANIZATION U.S. Army Construction Engr Research Laboratory	6b OFFICE SYMBOL (If applicable) CECER-ZP	7a NAME OF MONITORING ORGANIZATION	
6c ADDRESS (City, State, and ZIP Code) P.O. Box 4005 Champaign, IL 61820		7b ADDRESS (City, State, and ZIP Code)	
8a NAME OF FUNDING / SPONSORING ORGANIZATION USA-CERL	8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c ADDRESS (City, State, and ZIP Code)		10 SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO	PROJECT NO
		TASK NO	WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification)
The Role of Communications Within Technology Transfer Activities of the U.S. Army Construction Engineering Research Laboratory (Unclassified)

12 PERSONAL AUTHOR(S)
Walaszek, Jeffrey J.

13a TYPE OF REPORT final	13b TIME COVERED FROM _____ TO _____	14 DATE OF REPORT (Year Month, Day) 1987, July	15 PAGE COUNT 345
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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) technology transfer communications Army construction engineering research laboratory
FIELD	GROUP	SUB-GROUP	
05	02		

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

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(Cont'd)

20 DISTRIBUTION AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS		21 ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a NAME OF RESPONSIBLE INDIVIDUAL D. P. Mann		22b TELEPHONE (include Area Code) (217) 373-7223	22c OFFICE SYMBOL CERL-INT

Block 19. (Cont'd)

This project consists of a series of investigations into the communication aspects of the overall technology transfer process at USA-CERL. The report consists of seven chapters-- each chapter documenting a separate and complete investigation of some aspect of the topic. The ultimate purpose of the study was the development of a communications strategy to support technology transfer efforts at USA-CERL. However, each chapter provides valuable information on specific aspects of the technology transfer effort at USA-CERL.

Chapter II presents a case study of communications strategies used and the problems encountered in the transfer of eight technologies from USA-CERL. Chapter III presents the views of high-ranking Army personnel on the process and problems with current technology transfer activities. Chapter IV consists of a survey of public relations organizations at government and nongovernment research laboratories, their possible role in support of technology transfer efforts, and the views of technology transfer specialists towards current communications efforts. Chapter V summarizes the findings of a survey of users of USA-CERL technology. The survey identified how users were obtaining information on new technologies, their preferences for receiving future information, and how the source and content of this information affects the decision to use a technology. Chapter VI applies findings from the numerous diffusion studies found in the literature towards the technology transfer activities at USA-CERL. Chapter VII presents a communications strategy in support of technology transfer.

FOREWORD

This project was conducted through the Department of Communications and Theater in the University of Illinois at Chicago (UIC) with the cooperation and support of the U.S. Army Construction Engineering Research Laboratory (USA-CERL) in Champaign, Illinois.

The author would like to recognize several individuals for their assistance and support in the writing and production of this report. Dr. L.R. Shaffer, Technical Director, and Dr. Gil Williamson, Technology Transfer Specialist at USA-CERL provided many valuable comments in reviewing drafts of each of the chapters of this report. Similarly, Dr. James Danowski and Dr. Betsey Blosser of the Department of Communications and Theater at UIC were of great help in providing direction to this project. I'd like to thank Paul J. Theuer, former Commander and Director of USA-CERL, for his support and encouragement on this project, and his belief in my ability to provide a different perspective on the process of technology transfer. I'd like to specially recognize the guidance and encouragement provided by Dr. Barb Wood, my thesis advisor at UIC. Without her support--and her patience--over the past two years, it would have been difficult to get this somewhat ambitious effort off the ground and into print.



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CONTENTS

<u>Title</u>	Page
ABSTRACT.....	iii
Chapter I: Introduction	
Background.....	1
Purpose of this Project.....	2
Methodology.....	3
Technology Transfer at USA-CERL.....	5
Chapter II: A Discussion of Eight Case Studies	
Purpose of Study and Discussion of Approach.....	12
Descriptions of the Technologies.....	13
Summary of Case Study Findings.....	19
Discussion.....	45
Chapter III: Summary of Interviews with High-Level Army Personnel on Technology Transfer Activities of U.S. Army Corps of Engineers Research Laboratories	
Purpose of the Study.....	56
Impressions of DRD/Labs and Technology Transfer.....	58
Impression of Technology Transfer Communications Media.....	66
Suggestions for Improvement.....	71
Discussion.....	77
Chapter IV: An Assessment of Public Relations Organizations and Technology Transfer Activities at Research Organizations	
Background.....	84
Purpose of the Study.....	85
Methodology.....	86
Results.....	88
Discussion.....	98
Bibliography.....	101
Chapter V: How Do Potential Users Learn of New Technologies--A Survey of the U.S. Army Corps of Engineers	
Purpose of the Study.....	102
Methodology.....	103
Results.....	104
Discussion.....	121

Chapter VI: The Process of Diffusion of Innovations--A Review of the Literature	
Purpose.....	127
Technology Transfer: The Marketing/Communications Challenge.....	127
Obstacles to Technology Transfer.....	130
The Four Elements of Diffusion.....	139
The Innovation Development Process.....	145
Innovation-Decision Process.....	154
Rate of Adoption and Adopter Characteristics.....	161
Attributes of Innovations Leading to Adoption.....	167
Communication Activities in Support of Technology Transfer.....	171
Diffusion Networks.....	186
Innovation in Organizations.....	190
Future Research Needs.....	192
Bibliography.....	193
Chapter VII: A Communications Strategy	
Scope of this Communications Strategy.....	196
Research and Development/Technology Transfer Process.....	197
Role of Communications in Technology Transfer.....	203
Communications Strategy for Technology Transfer.....	220
Bibliography.....	242

LIST OF APPENDICES

Appendix A	Listing of Interview Questions for Case Studies.....	243
Appendix B	Case Study Review: Portawasher.....	247
Appendix C	Case Study Review: Concrete Quality Monitor.....	256
Appendix D	Case Study Review: Weld Quality Monitor.....	265
Appendix E	Case Study Review: Ceramic Anode.....	274
Appendix F	Case Study Review: Solar Energy Feasibility System.....	284
Appendix G	Case Study Review: Pavement Maintenance Management System.....	291
Appendix H	Case Study Review: Environmental Technical Information System.....	301
Appendix I	Case Study Review: Construction Management Microcomputers.....	312
Appendix J	Listing of Interview Questions for Army Personnel.....	323
Appendix K	Copy of Survey for Public Relations Professionals.....	326
Appendix L	Cover Letters for Public Relations Survey.....	332
Appendix M	Survey on Communications of New Research and Development Technologies.....	334
Appendix N	List of Survey Recipients and Survey Correspondence.....	338

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
1	Tally of Communications Activities in Support of Technology Transfer.....	23
2	Responses to Survey Sections.....	88
3	Response by Organizations.....	88
4	Source of Public Relations Support.....	89
5	Size of In-House Public Relations Staffs.....	90
6	Titles of Public Relations Offices.....	90
7	Budgets of In-House Public Relations Staffs.....	90
8	Who Public Relations Chiefs Report To.....	91
9	Importance of Public Relations Activities to the Research Organization.....	92
10	Amount of Time Spent on Public Relations Activities.....	93
11	Breakdown of Responses by Organizations.....	93
12	Responsibility for Technology Transfer.....	94
13	Backgrounds of Technology Transfer Agents.....	94
14	Value of Different Approaches to Informing Users of New Technologies.....	96
15	Value of Different Approaches to Assisting Users in Implementing New Technologies.....	96
16	Potential Roles of Public Relations Personnel in Technology Transfer.....	97
17	Identified Backgrounds of Respondents.....	105
18	How Respondents Learn of New Technologies.....	106
19	How Respondents Prefer to Receive Information on New Technologies.....	107
20	Access to Media Equipment/Facilities.....	108
21	Readership Habits--All Respondents.....	110
22	Readership Habits--DEH Respondents.....	111
23	Readership Habits--Corps Respondents.....	112
24	Persuasiveness of Product Claims.....	116
25	When Would Users Try a New Technology.....	117
26	Sources of Information to Assist in Decisions On Using a New Technology.....	118
27	How Respondents Learned of USA-CERL Technologies.....	119
28	Familiarity of USA-CERL Technologies by Technical Backgrounds.....	120
29	Characteristics of Centralized and Decentralized Diffusion Systems.....	188

Chapter I: Introduction

Background

Technology transfer can be simply defined as all activities of a research organization directed towards making its research products available to potential users. The author serves as a Public Affairs Officer at the U.S. Army Construction Engineering Research Laboratory (USA-CERL) in Champaign, Illinois. To truly support the laboratory, the author believed it is necessary to design a Public Affairs program which supports the lab's mission to transfer its technology to both potential military and nonmilitary users.

Technology transfer activities can be grouped into two categories. The first category consists largely of communications activities designed to create awareness of a laboratory technology among potential users. Inherent in these efforts are the identification of who are those potential users, what are the best media to reach those users, and devising a message suited to both the media and the users. The second category consists of those activities designed to assist the user in applying the technology in his or her particular work environment. These activities include making the research product physically available for use and then training the individual in properly using it. The former

requires the technical and often marketing and business skills of research personnel; the latter requires a combination of both technical and communications skills.

The above description suggests a major role for communications specialists in the technology transfer process. While the need for effective communications in technology transfer activities is obvious, what is not so obvious is the best way to transmit this information to engineers involved in military and nonmilitary construction activities.

The contention of this project is that communications activities are a vital component of both planning and carrying out technology transfer activities.

Purpose of this Project

The purpose of this project was threefold. The first objective was to develop an understanding of the role of communications in technology transfer activities at USA-CERL. The second objective was to determine which communications media are effective in informing potential users about research technologies. The final objective was to develop a communications strategy which could be used by USA-CERL research personnel responsible for transferring their technologies to potential Army users.

Methodology

A variety of activities were conducted to meet the above objectives. Each of these activities is described in the following chapters. The first two activities were designed to develop an understanding of the current efforts of USA-CERL to transfer technologies to potential users. The first activity was to conduct a case study of eight technologies developed and transferred by USA-CERL. The intent of this effort was to determine what communications media and marketing approaches were used to transfer the technologies. The author interviewed the leader of the research team at USA-CERL responsible for developing the technology and transferring it to potential users.

The second activity consisted of obtaining the opinions of high level Army personnel on the technology transfer activities of USA-CERL. The interviews were conducted in Washington, D.C, as part of a three-month, work-related assignment of the author. Personnel were interviewed in the headquarters of the U.S. Army Corps of Engineers, the U.S. Army Training and Doctrine Command, and the U.S. Army Materiels Command. Interviewees oversee the operations of Army personnel who are potential users of USA-CERL technologies. The results of these interviews are discussed in Chapter III.

The next two activities were designed primarily to identify what communications media are effective in informing users on new technologies. Two surveys were developed in support of this effort. The first survey was sent to public relations personnel and technology transfer specialists at research organizations within the Federal government, universities, and corporations. The intent of this survey was to obtain information about public relations staffs at research organizations and their potential support of technology transfer activities. Technology transfer specialists at these organizations also were asked to identify which communications media they believed to be effective in their technology transfer activities. The results of this survey are discussed in Chapter IV.

The second survey was designed to identify how users of USA-CERL technologies actually find out about the technologies and to identify what factors affect their decision to try a new technology. The survey was sent to engineers and other scientists working at Army installations and at Corps of Engineers offices worldwide. The results of this survey are discussed in Chapter V.

The fifth activity consisted of a literature review on government technology transfer efforts and diffusion studies conducted by corporations and universities. Chapter VI is intended to serve as a handbook which introduces the reader to

the various components affecting the transfer of technology as described in the literature and this project.

The final activity in the project was the development of a communications strategy for technology transfer to be used by USA-CERL personnel. The strategy uses the findings from the earlier activities in this project and ties it all together into a step-by-step framework. The strategy incorporates a wide variety of communications activities which includes publicity for new technology; training materials for users; and interpersonal contacts between research staff, users, and decision makers.

Technology Transfer at USA-CERL

The U.S. Army Construction Engineering Research Laboratory (USA-CERL) in Champaign, Illinois, has been very actively involved in technology transfer activities. Part of the U.S. Army Corps of Engineers, USA-CERL conducts research in support of the construction and engineering activities of the military. Many of its products are being used by the military and other agencies in the Federal government. In addition, USA-CERL products are increasingly being used by State and municipal governments and private industry.

USA-CERL conducts research at the request of engineers at Army installations, personnel in the headquarters of the various Major Commands (MACOM's) within the Army, or personnel

at Corps of Engineers headquarters. USA-CERL reports directly to Corps headquarters. A technical monitor is an individual at Corps headquarters who is assigned to oversee a particular research project at USA-CERL. The technical monitor works closely with personnel at the MACOM headquarters to determine what types of research need to be conducted.

Up until a few years ago, technology transfer was assumed by USA-CERL to be the responsibility of Corps of Engineers headquarters. Heavy workloads and reductions in personnel have limited the amount of time which headquarters personnel have been able to devote to technology transfer activities. This has prompted USA-CERL to assume more responsibility in technology transfer efforts in support of Corps headquarters.

U.S. Army Corps of Engineers Research Laboratories

USA-CERL is one of four research laboratories run by the U.S. Army Corps of Engineers. The other three laboratories are the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH; the Engineer Topographic Laboratories (ETL) at Fort Belvoir, VA; and the Waterways Experiment Station (WES) in Vicksburg, MS.

USA-CERL conducts research on the life-cycle requirements of facilities from design through construction, operation, and maintenance to eventual replacement. This area of research is typically labeled as base support. This involves research and

development studies in materials, energy, construction management, and environmental quality.

CRREL supports civil and military construction, and combat engineering through research investigations and engineering studies pertinent to cold environments. Its mission includes research on general materials, techniques, and equipment design for cold regions.

The Engineer Topographic Laboratories (ETL) at Fort Belvoir conducts research to support the geodetic, topographic, and geographic information needs of the combat Army.

The research emphasis of WES lies in the area of civil works activities and combat engineering activities, with a smaller amount directed towards base support. The expertise at WES lies in the areas of structures, hydraulic modeling, geotechnical studies, coastal engineering, and the environment.

Military Users of Technologies from Corps Laboratories

There are several potential users within the military of technologies from the Corps laboratories. The Army is divided into several organizations called Major Commands (MACOM's). The larger MACOM's are the U.S. Army Forces Command (FORSCOM), U.S. Army Training and Doctrine Command (TRADOC), U.S. Army Materiel Command (AMC), and the U.S. Army Corps of Engineers.

Each MACOM has a mission to perform. FORSCOM is responsible for ensuring the availability of the Army's fighting forces. FORSCOM maintains military installations at key locations across the country and overseas which house the Army's full time, professional soldiers. TRADOC has the responsibility for training new recruits to be soldiers and for deciding Army doctrine--how the Army will fight its battles. TRADOC operates and maintains numerous training installations across the country and overseas. AMC runs the industrial plants for the Army which manufacture ammunition, and some weapons and vehicles not manufactured by private industry.

The installations of TRADOC and FORSCOM, and the industrial facilities of AMC consist of numerous buildings, roads, and other structures such as underground piping and water towers. The Army needs to keep its property in top working condition. Within each MACOM, the responsibility for operating and maintaining such facilities lies with the Directorate of Engineering and Housing (DEH). Each installation and industrial plant has a DEH office onsite. Personnel in the DEH at installations are a major user of technologies from the Corps laboratories.

The last MACOM to be discussed is the U.S. Army Corps of Engineers. The Corps is the construction agent for the Army. The Corps manages the construction of all buildings and

facilities at Army installations worldwide. The Corps is divided into over 38 District offices which have responsibility for construction activities within a geographic area. These District offices are then grouped under any one of 12 Division offices which oversee the activities of the Districts under its jurisdiction.

The Corps works with DEH personnel at installations in designing and building new buildings and structures. Once a building is constructed, the responsibility for operating and maintaining that building lies with the DEH at the installation. The Corps also manages much of the construction at Air Force installations.

In addition to its construction responsibilities at military installations, the Corps also has a civil works mission. The civil works mission consists of a variety of nonmilitary-related peacetime construction activities. Civil works activities include the construction, operation, and maintenance of a large number of locks and dams on our nation's rivers; disaster relief activities during major floods; and the cleanup of hazardous waste sites under the direction of the U.S. Environmental Protection Agency.

The Navy and Air Force also operate numerous installations across the country and overseas. They also have engineer offices similar to the DEH at Army installations that are responsible for operating and maintaining the buildings

and structures at their installations. These individuals are also potential users of USA-CERL technology.

Potential Nonmilitary Users of USA-CERL Technologies

There exist two general groups of nonmilitary potential users of USA-CERL technology. One group consists of architect-engineering firms who assist the Corps and the Army in constructing and maintaining its facilities at installations. The other general group consists of those individuals within other Federal, State, or municipal government agencies and private industry who also are responsible for operating and maintaining buildings and structures.

Public works personnel in cities and counties are a large group of potential users of USA-CERL technology. DEH personnel at military installations face many of the same problems as public works personnel at cities and counties. The American Public Works Association (APWA) has worked closely with USA-CERL in making the lab's technology available to its members in cities and counties across the nation.

Some government agencies are also potential users of some USA-CERL technology. The Federal Aviation Administration (FAA) offices are responsible for overseeing the maintenance of airport runways. USA-CERL's Pavement Maintenance Management System (PAVER) was initially developed to assist

the Air Force in maintaining runways at its installations.
The FAA is now requiring commercial airports to use PAVER in
maintaining their runways.

Chapter II: A Discussion of Eight Case Studies

Purpose of Study and Discussion of Approach

This study was conducted in an effort to obtain a greater understanding of the technology transfer process. Eight USA-CERL research products were selected for a case study analysis. The selected products have met varying degrees of success in being transferred to users. Information on technology transfer activities were obtained through interviews with the leader of the research team at USA-CERL which developed the technology. The interviewees were asked the questions listed in Appendix A. This approach is limited by the memory of the interviewee. However, the interviewees were asked to review a draft copy of the case study summary and add any relevant information they may have failed to mention during the interview. These summaries are provided as Appendices B through I.

The primary emphasis of these case studies centered on the role of the various communications media used in technology transfer. However, the study also attempted to identify all aspects of the technology transfer process that may be influenced by communications efforts.

Descriptions of Technologies

This section describes the USA-CERL technologies examined through the case studies. More detailed information on each technology and activities to transfer it to potential users is contained in the interview summaries presented as appendices.

Portawasher

The Portawasher was developed by USA-CERL to clean large trash dumpsters located at Army installations. Prior to its development, dumpsters would have to be emptied and transported to a central cleaning area. The Portawasher sits on a trailer and is driven to the location of the dumpster which needs to be cleaned.

The Portawasher consists of a high pressure hot water nozzle which sprays water onto the dumpster. The heat of the water and the force of the spray cleans the dumpster. A vacuum system built into the Portawasher removes the washwater from the inside of the dumpster and stores it in the Portawasher for later disposal.

Field tests of the Portawasher at Fort Leonard Wood, Mo, revealed that its use would enable three times as many dumpsters to be cleaned in one day as the previous method and at half the cost. The intended user of the Portawasher was D&D personnel at Army installations.

Concrete Quality Monitor

The Concrete Quality Monitor (CQM) was developed by USA-CERL to determine the strength of concrete as it is being placed. The CQM assists the user in determining the mixture of cement and water which makes up the concrete. This information enables the user to then calculate the strength of the concrete. The CQM is a procedure which uses commercially available test equipment such as a centrifuge and a chloride meter. The tests can be quickly conducted at the construction site.

Prior to its development, industry would use a 28-day compression test to determine the strength of the concrete. This procedure consisted of taking a sample of the wet concrete, letting it harden for 28 days, and then running compression tests on the sample in a testing laboratory. The results of the CQM procedure were determined to be within 10 to 15 percent of the accuracy of the 28-day test. The CQM offers timely and accurate information to construction managers. The intended user of the CQM was personnel in the U.S. Army Corps of Engineers responsible for overseeing concrete construction activities.

Weld Quality Monitor

The Weld Quality Monitor (WQM) was developed by USA-CERL to assist the Army in facilities construction and in its tank production effort. The WQM identifies defective welds as they are being placed. The WQM is an improvement over existing technologies to determine weld quality such as dye penetrants, x-rays, and other nondestructive tests. These technologies are all used after the weld has been placed.

The problem with these after-the-fact tests is that reworking a defective weld can be five times as expensive as initially placing it. The WQM enables the user to shut down the weld at the first indication that it is faulty. Tests of the WQM at a Army tank plant resulted in an average savings of \$4,500 per tank in preventing defective welds.

Ceramic Anode

The ceramic anode was developed by USA-CERL as an alternative to the old silicon iron anode used on lock gates maintained by the U.S. Army Corps of Engineers. Both anodes are a vital part of cathodic protection systems which prevent rusting of buried or submerged steel structures such as underground piping, water towers, or lock gates. The cathodic protection system reverses the rusting process whereby the anode wears away instead of the steel. If properly

maintained, a cathodic protection system could in theory keep a steel structure free from rust forever.

The ceramic anode improves upon the silicon iron anode in its smaller size and reduced manufacturing and installation cost. The ceramic anode is 1/500th the weight of the older anode and can be manufactured and installed at half the cost. Yet, the ceramic anode has the same life expectancy and provides the same degree of cathodic protection.

Solar Energy Feasibility System

The Solar Energy Feasibility System (SOLFEAS) was developed by the USA-CERL to assist the Army in determining whether solar energy was cost-effective for new buildings proposed for Army installations. A feasibility study of the the use of solar energy for all proposed new construction by Federal agencies is required by law. SOLFEAS is a computer program which uses solar energy information on building types similar to the one under consideration, existing climatic information, and energy cost data for the area. The SOLFEAS program performs calculations using this information to determine whether the construction and later operation of a solar energy system is cost-effective for the building under consideration.

Significant savings were shown by the use of SOLFEAS in a test comparing its data against the data of a solar

feasibility study performed by a contractor using traditional approaches. SOLFEAS produced estimates to within five percent accuracy of the results from the conventional study. Results were obtained within 15 minutes at a cost of \$50 worth of computer time. The conventional study took three weeks at a cost of approximately \$20,000.

Pavement Maintenance Management System

The Pavement Maintenance Management System (PAVER) is a computer program developed by USA-CERL to assist personnel at military installations in managing repair activities for roads and airplane runways. Information provided by PAVER can be used by the DEH to identify which parts of the road need repair, schedule pavement repairs, and identify the amount of money which will be needed to perform those repairs.

Before PAVER can be used, the user needs to enter into the computer a variety of data on the pavement such as traffic surveys, types of construction materials used to build the road, and results of visual inspections of the pavement. Using this information PAVER calculates the Pavement Condition Index (PCI) which is a rating of the condition of the pavement on a scale of 1 to 100. Once the computer has the above information and a PCI has been determined, the user can then play "what if" games to assist him in his pavement maintenance planning. The user can ask PAVER to identify the cost of

improving the road from a 55 PCI to a 70 PCI. Or the user can ask PAVER to predict the future condition of the road in three years if no repairs are made this year.

Environmental Technical Information System

The Environmental Technical Information System (ETIS) was developed by USA-CERL to assist Army personnel in putting together Environmental Impact Statements. ETIS is a computer-based information retrieval system which consists of three subprograms. The Environmental Impact Computer System (EICS) identifies possible environmental impacts of a variety of military construction activities. The Computer Evaluation of Legislative Data System (CELDS) contains abstracts of Federal and State environmental legislation throughout the country. The third and most often used subprogram is the Economic Impact Forecast System (EIFS) which enables the user to perform an economic analysis of the impact of military activities.

ETIS is currently made available to users through the ETIS Support Center at the University of Illinois at Urbana-Champaign (UIUC). The support center updates the ETIS data files, assists users over the phone with the system, and offers training courses twice a year on the system. In addition to the three subprograms related to developing Environmental Impact Statements, ETIS also contains about

another 30 programs developed by USA-CERL for dealing with a variety of environmental issues. These programs are also accessible to users of ETIS.

Construction Management Microcomputers

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. The microcomputers can be used to manage information on a variety of activities such as scheduling of work, payments of fees, and submittals of supplies and materials. USA-CERL currently assists Corps personnel in fielding and using microcomputers, and in evaluating commercially available construction management software applications. USA-CERL also maintains a library of microcomputer programs designed for managing a variety of construction activities. USA-CERL makes copies of these programs available to any Corps of Engineers personnel who request them.

Summary of Case Study Findings

The following is a summary of the comments obtained from the interviewees. This summary attempts to highlight

activities which were thought to have made a significant impact on either the successful or unsuccessful transfer of the technology. Common activities or observations from the various interviews are also noted.

Timetable

The majority of technology transfer activities began with or shortly after pilot testing of the technology. Transfer activities often continued throughout the development of the technology following field testing and often long after project funding was no longer available to the research staff.

The question arose of when is a product ready for technology transfer. Some interviewees cited the harmful effects of encouraging the use of a product before it is ready. Premature selling of a product before all the technical problems have been resolved can lead to a loss of credibility for both the product and the research organization. One interviewee believed problems in gaining acceptance of the CQM by the industry were due in part to lack of enough field data to convince its critics.

Often decisions or efforts to push a technology among users are made by higher level lab management. One interviewee expressed a concern that the current emphasis on technology transfer could result in products being forced to the field before they are ready. He added that technology

transfer should be the normal culmination of the research process; it should not be overemphasized as an end in itself. Several interviewees stated the technical staff involved in the product development is in the best position to make the decision on when a technology is ready for transfer.

Technology Transfer Approach

No formal technology transfer plan was developed for any of the technologies. Technology transfer activities were conducted as a normal part of the research process. Technical reports, draft rewrites of Army regulations or procedural guidance to include a technology, and briefings to technical monitors and lab visitors are routine duties for researchers. These duties are requested of researchers by headquarters personnel or sponsors of the research.

Outside of these routine responsibilities, technology transfer activities are largely left to the ingenuity of the researcher as very little guidance is available. Additional technology transfer opportunities, such as presenting a paper at a conference, were seized upon by the research staff as they appeared. In the case of the Pavement Maintenance Management System (PAVER), USA-CERL was asked by the American Public Works Association (APWA) to review a research proposal on developing a computerized pavement maintenance system. APWA was not aware of USA-CERL's PAVER system. USA-CERL took

this opportunity to inform APWA of the existence of PAVER. This led APWA's sponsorship of PAVER--a very successful technology transfer venture.

For discussion purposes, communications/marketing activities associated with technology transfer will be divided into those activities intended to create awareness of a new technology and those intended to encourage its use. The latter activities will be identified as implementation strategies.

Informing the Field.

A variety of communications and marketing activities designed to increase the awareness of a technology among potential users were conducted for the eight technologies. These activities are listed in table 1. As identified in the table, much has been done in the way of publishing information on the technologies. In the case of all eight technologies, technical reports were written and distributed to potential Army users. Articles published in military and commercial/trade publications were another vehicle commonly used. Information was not readily available on how many articles were published and in what publications. However, a greater number of articles seemed to have appeared on PAVER, the Weld Quality Monitor (WQM), and the Ceramic Anode as opposed to the other technologies. Presentations made at

Table 1 Tally of Communications Activities in Support of Technology Transfer

Activity	Portawasher	CQM	WQM	Ceramic Anode	SOLPEAS	Micros	PAVER	ETIS
Technical Reports	X	X	X	X	X	X	X	X
Demonstrations* in Field	X			X		X		X
Flyers, Brochures	X		X*					
Papers Presented at Conferences	X	X	X	X	X		X	X
Articles in Trade Magazines	X	X	X	X	X		X	
Army/Industry Guidance Documents	X	O	O	O	O	X	O	X
Audio-Visual Presentations	X							
Articles in Military Publications	X	X	X	X	X	X	X	X
Personal Contacts*				X	X		X	X
Special Briefings to Decision Makers				X	X			
Presentations at Workshops, Training Courses, etc.				X	X		X	X
Newsletters						X		X
Users Groups for Technology						X		X

Notes:

* Demonstrations are not to be confused with field testing or those given to visitors at the lab. Demonstrations as defined here are part of some active effort to show the applicability of a developed technology at an installation or other site outside the lab where the technology would be used under realistic conditions.

* The WQM brochure was done by an outside organization promoting the transfer of Federal laboratory technology.

* Personal contacts as defined here are those actively initiated in support of technology transfer efforts. This includes letters or phone calls to potential users to encourage the use of the technology.

technical and professional conferences were another commonly used method to inform others of the technology.

Less commonly used information approaches were the use of brochures and flyers, audio-visual presentations, and newsletters devoted to a technology. An electronic mail system set up on the Environmental Technical Information System (ETIS) was used to disseminate new information on the system to existing users.

Interviewees indicated that the purpose of publishing articles and reports was primarily was one of peer review--a standard practice resulting from the academic orientation of researchers. It was perceived to be a way to facilitate comments on the research by other experts. Technical reports, while disseminated throughout the Army, are primarily a source of documentation for the research. Papers presented at conferences and articles placed in academic oriented publications were cited as one way of obtaining this peer review.

Some researchers did use articles to meet very definite technology transfer objectives. Articles on the WQM were placed in trade publications with the intention of attracting the interest of a potential manufacturer. A specific emphasis was made to publish articles on PAVER in nonmilitary publications to attract the interest and support of

professional organizations in using the technology. News-type articles were written by the lab's public affairs office for publication in the Corps commandwide newspaper. These articles were intended to inform readers on the availability of microcomputer support for construction management and the ETIS Support Center.

Very little had been done with the use of flyers and brochures, and audio-visual presentations as part of information activities. Information activities for the Portawasher used both items; however, the flyers were handed out primarily on request and the slide presentation was shown primarily at conferences and trade shows. Little thought had been given on what would be the best way to distribute these materials.

Implementation Strategies.

One interviewee stated that different approaches are needed for transferring technology to military users and nonmilitary users. Technology transfer to military users first requires that you gain the support of high-level military personnel overseeing a specific engineering activity. These individuals can then require or encourage the use of the technology among those individuals they oversee. Transferring technologies to nonmilitary users requires that you first inform them of the benefits of using the technology. Once the

users have the information, they will then make decisions on whether to use the technology.

Successful technology transfer to the military depends largely upon obtaining the cooperation of a variety of military organizations. One researcher identified these players as the USA-CERL management, the Corps of Engineers headquarters, and the headquarters office of the Major Command (MACOM) which oversees the installations. Each organization would need to throw its support behind the technology in order for the system to be transferred to the ultimate users. The researcher's role in technology transfer was defined as gaining the support and coordination of the lab management and higher-level headquarters personnel.

A variety of activities was conducted in support of encouraging use of the technology in the field as shown in table 1. Much emphasis was placed on getting the technology written into Army guidance documents such as Engineering Regulations, Technical Manuals, or Guide Specifications. Interviewees believed that use of these documents would legitimize and encourage the use of the technology among field personnel.

Demonstrations of a final version of the technology to potential users and decision makers were another activity commonly used. Special technology transfer briefings to high level military officials were conducted for the Solar Energy

Feasibility System (SOLFEAS) and the Ceramic Anode. These briefings were given to Major General Albro, Chief of the Directorate of Engineering and Construction at Corps headquarters, in an effort to obtain his support for implementing the technology Corpswide.

Other activities encouraging the use of a technology were directed more towards the user than higher level officials. The ETIS Support Center was established at the University of Illinois to specifically assist military personnel in using the system. The support center personnel answer phone requests, offer training courses, and publish a newsletter.

A users group was established for the construction management microcomputer technology. This group meets regularly to exchange information on new software programs and problems experienced in the field, and to provide direction to the lab's research on these systems. Members of the users group also serve as a reference source to new users of the technology.

Briefings on the technologies have been incorporated into the Army's training courses and technology workshops, some of which are conducted at USA-CERL. A one-week course on PAVER is offered by both the University of Illinois and the APWA.

As suggested earlier, a different approach was suggested as being necessary to encourage the use of a technology among the nonmilitary community. There rarely exists a central

organization that can require its members to use a new technology as in the military. The emphasis is on providing information to convince potential nonmilitary users of the value of the technology. Due to the profit orientation of the private sector, you need to show these users that the system will work and save them money.

Many of the same activities described above for the military were also used for nonmilitary. In efforts to transfer technology to nonmilitary users, credibility plays a much bigger role. Claims of product benefits and savings need to be documented by actual field use of the technology or come from a reputable source. Professional organizations and societies played a valuable role in spreading the word and encouraging use of the some of the technologies.

In the case of the Concrete Quality Monitor (CQM) and PAVER, special emphasis was made to get outside organizations to test, evaluate, and endorse the system. Independent contractors were asked by USA-CERL to evaluate the CQM. The APWA sponsorship of PAVER led to its use in numerous counties and municipalities. Prior to sponsoring the system, APWA conducted its own study comparing PAVER to other available pavement maintenance systems.

The construction industry and engineering societies also publish standards for their members to follow. These standards are similar to guidance documents within the

military. The evaluation of the independent contractor and lab studies on the CQM were submitted to the American Society of Testing and Materials (ASTM) for consideration in making the CQM a standard procedure for industry to follow.

It was cited that papers presented at conferences and articles published in technical publications typically are reviewed by experts in the field. This lends an added level of credibility to the contents of the paper or article which then reflects on the technology.

Personal contacts were cited as being a major approach in the technology transfer of SOLFEAS, ETIS, and the Ceramic Anode. USA-CERL sent out a letter accompanying a technical report which served as a users manual for SOLFEAS. The letter encouraged the recipient to use the SOLFEAS program. The same approach was used for PAVER. When Army personnel call the lab to seek solutions to their corrosion problems, researchers use that as an opportunity to encourage the use of the ceramic anode.

Effectiveness of Transfer Activities

In determining the effectiveness of technology transfer activities, the interviewees generally had some difficulty specifying which activities directly led to the successful transfer of the technology. Some activities were easy to identify as having a direct impact on initiating the use of a

technology. The workshop/demonstration of PAVER before a gathering of Air Force engineers resulted in a decision to test PAVER at installations for one year and its eventual required use. Identifying which efforts to inform the field of a technology were more successful than others was not so easily determined. Researchers typically do not ask people requesting information on a technology where they first heard about it.

Informing the Field.

Conflicting views were expressed on the value of technical reports as a way to inform potential users of the existence of a technology. Technical reports were not perceived to be read by the field according to the majority of interviewees. Technical reports were criticized as being too long and people do not have the time or interest to read them. One interviewee stated, "All the guy in the field wants are specs and drawings on installing the anode." Yet, in the case of ETIS, technical reports were cited as being the one item which prompted many of the calls requesting information on the system.

Papers presented at conferences and articles published in commercial and trade publications were cited as resulting in many inquiries from nonmilitary users. These approaches were not thought to be good for reaching military users. Interviewees felt few military personnel participate in

professional conferences and they do not regularly read the commercial trade publications.

Newsletters and short items such as Engineer Technical Notes seemed to work well in prompting the inquiries from military users. The Engineer Technical Note is a short two or three page item which explains the application of a new technology or procedure. It is used by Corps of Engineers headquarters as an informal way of providing guidance to installation personnel. The technical note, in the case of the Portawasher, was cited as a good way to get a message before users in a format that is easy to read.

Moderate success at attracting inquiries was attributed to articles placed in military-oriented publications such as Military Engineer. News story type articles on the WQM (an Associated Press story) and the Construction Microcomputers (published in Engineer Update) did result in several requests for information. The AP story attracted inquiries from nonmilitary users and the Update story attracted inquiries from primarily Corps personnel.

The "Construction Micro-Notes" newsletter was well received by military personnel. However, the interviewee received comments that some individuals were not receiving copies even though listed on the distribution list. Evidently, some personnel would keep copies for themselves as reference without passing them along to others in the office.

Very little information was available on the effectiveness of the flyers and formal audio-visual presentations.

Implementation Strategies.

Demonstrations were perceived to be a valuable way to convince individuals of the value of a technology. Demonstrations were conducted for a variety of audiences for the technologies under study. PAVER and the Portawasher were demonstrated to groups of high-level engineers at the headquarters of the MACOMs. Demonstrations of ETIS and the Construction Microcomputers were conducted before user groups and before selected individuals. Demonstrations of the Ceramic Anode were just initiated as part of a formal, large-scale program to demonstrate new technologies at Army installations. Only the demonstration of the Portawasher to high-level MACOM engineers seemed to fall short of the expectations. The interviewee felt the demonstration failed to encourage the MACOM personnel to pass the word on the Portawasher to the engineers at the installations.

Guidance documents are viewed as one way to encourage, almost mandate, the use of a technology within the Army. Lab personnel will rewrite portions of these documents for the headquarters personnel responsible for publishing them. It was stated that unless the product appears in these guidance documents, potential users will be less willing to stick their

necks out and use the product. Guidance documents such as guide specifications, technical manuals, and others take a long time to be published. Efforts to develop inserts on the technology into guidance documents were made for all eight technologies. However, only three of the technologies have had these documents published within the Army. In the case of PAVER, the Federal Aviation Administration and the Air Force published their guidance documents much more quickly than the Army.

User groups were used for both the Construction Microcomputer initiative and ETIS. Users groups are simply a collection of individuals who are interested in or are actually using a technology. Both groups were established with different main goals in mind. The microcomputer user groups were established primarily as way to exchange information among existing users and also provide direction to the research effort. The ETIS group was established primarily for gaining users' opinions on the technology for purposes of fine tuning it to better serve the field's needs.

A benefit of the users groups was that their participants began to feel a personal involvement and commitment to the technology. In fact, many of the participants became spokespersons for the technology and advocated its use among their peers and subordinates. In the case of the microcomputers, it was cited that these spokespersons had a

higher degree of credibility among other potential users than did lab personnel. The difference was that the spokespersons could speak of the technology in the context of solving real life problems.

Personal contacts, such as site visits or phone contacts, were also looked upon highly as a way to encourage an individual to use a technology. The advantage is that the researcher can specifically address the application of the technology to the individual's needs. As a follow-up to the personal contacts, researchers involved with ETIS gave potential users free passwords. This worked well in allowing potential users to experiment with the system and learn its capabilities at their own pace. Giving a potential user free access to the system also prevented him or her having to go through the paperwork drill of submitting purchase orders to pay for the trial use. The bureaucracy involved in submitting purchase orders when only a minor amount of money is involved may have discouraged a potential user from getting involved.

Personal letters attached to technical reports worked well in highlighting the significance of the report to the potential users. This approach was used to highlight the transmittal of users manuals for SOLFEAS and PAVER. These manuals were to be used as interim guidance until a formal guidance document could be published.

One interviewee brought up the point of why some people adopt new technologies when others do not. With no real force mandating the use of the Portawasher, he suggested the motivation for considering use of the technology must have come from within the individual. The interviewee characterized those individuals who requested information on the Portawasher as being, "Motivated enough to look for better ways of doing their job."

The special briefings on SOLFEAS and the Ceramic Anode to Major General (MG) Albro worked well in convincing him of the merits of these technologies. MG Albro stated his willingness to mandate the use of these systems throughout the Army once USA-CERL completed some follow-up work prior to transfer. Within the year following the briefings, MG Albro retired before he had the opportunity to mandate the use of these technologies. Military personnel are transferred to new positions every two to three years which poses a problems with conducting these special briefings.

Expected or Encountered Problems

It was evident from the interviews that the success of technology transfer activities are affected by a variety of external and internal circumstances. Even the best communications and marketing efforts may fall short in achieving desired technology transfer goals due to such

circumstances. The next two sections present some of the obstacles encountered by researchers in transferring the technologies.

Problems Outside the Military System.

As the development of Portawasher was underway, the Reagan Administration directed government agencies to contract with private industry for services in an effort to reduce the Federal workforce. The potential user in this case shifted from installation personnel to private contractors in the waste disposal business. Private contractors are under no obligation to clean trash dumpsters unless it is written into their contract.

During the development of EIFS the military was studying the realignment of its installations and offices. The proposed closure of military offices and the shifting of military responsibilities from one geographic area to another were big concerns among local politicians and businessmen. Many military organizations were involved in lawsuits concerning the realignment effort. The military was in a position where they had to come up with a realistic assessment of what the impact of these realignment activities would have on the local economy.

Under these conditions, the EIFS system essentially sold itself and ETIS. Both the Air Force and the Army began using EIFS as it provided a way to provide an answer to the

realignment questions with some degree of credibility. Having obtained numbers on the economic impact from a computer program was viewed much more credibly by critics of realignment activities than the "seat-of-the-pants" approach previously used. Because EIFS provided a solution to a very real problem at the time, that program and ETIS in general received extensive use in the field. Use of ETIS was never made mandatory; the interviewee stated people used it because they wanted to.

Technology transfer efforts for PAVER and the microcomputer initiative also benefitted from external situations according to the interviewees. PAVER became accessible to users at a time when the country was extremely concerned with its infrastructure problems--the deterioration of its physical resources such as streets and structures. PAVER provided a usable approach to dealing with the deterioration of streets and became one solution to a very large problem.

The microcomputer initiative came at a time when microcomputers were being heavily publicized by industry and being used at home, work, and school. The interviewee suggested that Corps personnel may have been embarrassed into trying the microcomputers by their children who were now using them at school.

The CQM received much publicity outside the Government, but still is not being regularly used by industry or the Corps. The Corps of Engineers serves as a manager of construction activities. The actual construction work is carried out by the construction industry. The Corps cannot require contractors to use the CQM as the approach does not have the approval of the construction industry.

USA-CERL submitted the CQM procedure before the American Society of Testing and Materials (ASTM) for approval as an industry standard. However, this approval process is very time-consuming and problems have been encountered in convincing ASTM members of the merits of the technology.

Private interest groups and other professional trade associations may be an obstacle or not overwhelmingly support the adoption of a technology. In situations where the technology will be used by industry in support of Army construction efforts, the support of these special groups must be carefully solicited. USA-CERL anticipated a negative reaction to the CQM from the Ready-Mix Concrete Association. In an effort to solicit their support, USA-CERL asked the Ready-Mix Concrete Association to evaluate the procedure. The Association validated the procedure with certain restrictions placed on its use.

Problems Within the Military System.

Another problem to technology transfer cited by virtually all of interviewees is the lack of funding to conduct technology transfer. Technology transfer efforts within the military are conducted with research funds. After the research projects were completed and funding was no longer available, active efforts in support of technology transfer initiatives were severely impaired. The CQM is still under review by ASTM, yet USA-CERL has no funding to devote personnel to this effort.

Researchers were hard pressed to justify other project funds in support of continuing transfer activities on an older technology. Furthermore, researchers pointed out that continuing efforts in support of technology transfer initiatives prevented progress on new research activities.

In the case of hardware products, there is insufficient funding to complete the research on the technology and advance it to final product stage. The government needs to rely on industry to provide this additional research and development effort. This was a problem for the WQM, Ceramic Anode, and the Portawasher.

The lack of money to conduct technology transfer activities is even a bigger problem when the lab tries to transfer products outside the military. The Stevenson-Wydler Technology Innovation Act which authorizes Federal research

laboratories to make their technology available to non-Federal users authorizes only very minimal funding to carry this task out. Assisting nonmilitary users in acquiring technology consumes both financial and personnel resources.

The ETIS Support Center concept resolves some of these problems. The support center also requires nonmilitary users to pay user fees to help pay for the cost of its operation. The support center staff answers most of the questions which come in; however, the more technical questions are still referred to USA-CERL staff.

The military purchasing system is very time consuming and may create another obstacle for people to purchase new technology. The Army's Quick Return on Investment Program (QRIP) is designed to speed up the purchasing process for those items which have shown to provide a quick return on investment. Some installations purchased Portawashers through this program. However, funding for the QRIP purchases is limited at each installation and program money is usually used up quickly.

The purchase of hardware items such as microcomputers, terminals, and computer time for PAVER and ETIS usually requires permission from several people. While support for such technologies was obtained from potential users, these users still had to convince their supervisors on the value and cost benefits of the technologies to obtain permission to

purchase them. A section of the PAVER training course, is devoted to training attendees on how to brief their bosses on PAVER when asking for funding. The Microcomputer Selection Guide contains information on how to fill out the forms needed to procure a microcomputer within the Army.

Premature or overzealous claims can hurt the credibility of a product and impair subsequent technology transfer efforts. The CQM and the construction microcomputers were identified as case in points. One interviewee stated that as a result of information received from the lab, some construction personnel were led to believe the CQM was the cure-all for quality control of all concrete work. In reality, the CQM works very well in some applications--i.e. roller compacted concrete--and just as well as other techniques in other applications. The emphasis on microcomputers for construction was begun by the lab just as they were field testing the older minicomputers. For a time, lab personnel had to begin their briefings on the microcomputers by first retracting everything they had been saying about the minicomputers.

Information needs to be accurate and supported by evidence. A common source of this misinformation is lab personnel not technically familiar with the product who have discussed or briefed potential users on the technology. One interviewee made the point, "The cost of bad publicity is

extremely expensive and time consuming. You can correct a bad technology, but it is much more difficult to change misperceptions of the field."

Improving the Transfer Process

The interviewees offered several suggestions for ways to make future technology transfer activities easier. These suggestions are summarized below.

Researchers need to be aware of the administrative problems with procurement of new technology--especially hardware items. Efforts need be made to make it easier for installation personnel to purchase these technologies within the Army's procurement process.

Cofunding and cooperative research projects with other military services would increase their stake in the technology. This involvement would encourage these individuals to take a more active role in transferring the technology within their own services.

If a product is perceived to be needed by the field, then the likelihood that the technology will be used will be greater. Before a research is begun, an effort must be made to ensure the ultimate technology is really needed by the user. The technology then needs to be developed with the needs of the user in mind.

The timing of transfer activities is critical. The technology needs to be field tested and potential problems uncovered prior to efforts to transfer the technology Armywide.

The question of when does the transfer process end was raised. Some technologies such as PAVER and microcomputers will be continually evolving. Continued research and support to the field is necessary to keep the Army abreast of the new developments in the technology. Mechanisms need to be developed to provide this support to the Army. It was stated that until such a support is arranged, it should be the lab's responsibility to provide it.

Using Outside Experts

The overall perception was that selling of a technology requires someone technically competent to explain the technology. Users of much of the lab technology typically are engineers or scientists who are used to dealing with facts and figures, and then using this information to make a decision. One interviewee stated that a "Madison Avenue approach would have been too slick for this audience and would not have contained any credibility in the eyes of the users." Consequently, interviewees believed the research staff needs to be actively involved in transfer efforts with minimal outside assistance.

Several interviewees stated that good communications skills within technical people are necessary in obtaining and encouraging individuals to use a technology. One interviewee stated that in hiring people, he looks for individuals with good communications skills to assist in the marketing of the technologies.

One interviewee thought his demonstration could have benefitted from a "showier" presenter. Also, the same interviewee indicated he would obtain the services of a scriptwriter or a producer next time he is required to put together an audio-visual presentation due to frustrations with his one effort.

Endorsements of a technology from technical personnel outside the research organization were believed to enhance the credibility of the product both within the military and, especially, with nonmilitary users. Typically, trade associations or recognized experts can be asked to evaluate a technology for the lab. Their report, assuming it is positive, then becomes an unbiased reference.

To encourage private sector involvement in manufacturing a product, it is necessary to demonstrate a market exists for the product. The company which received rights to manufacture the WQM hired a marketing firm to determine the extent of the market for the product. One interviewee suggested the lab could hire a marketing firm to determine the market potential

for a technology. This information could be used to attract potential investors in manufacturing or selling the technology.

Discussion

The Technology Transfer Approach

The decision on when to begin and how to conduct technology transfer for a product needs to be thought out carefully. A serious effort should be made to think out how the technology should be transferred at the inception of the research project. Decisions should be made on how and when to publicize the technology, identify what command level or industry support is needed to transfer the technology, and determine how the technology will be provided to the users. A technology transfer plan should be developed and approved by the technical monitor as a way of strengthening his or her commitment to the transfer activities. The plan should be reviewed and modified throughout the development of the technology to reflect changes which may occur.

In developing a technology transfer plan, several considerations should be included pertaining to the timing of communications/marketing activities. Information on demonstrated benefits should be available before a product is aggressively transferred. Data from field tests and modifications to improve the technology following such tests

are valuable in convincing users of the value of the technology. Product claims not supported by later field use can reduce the credibility of the technology.

Publicity during the development of a technology is beneficial in creating user awareness of a future technology prior to its transfer. Much publicity on a developing technology is being generated through articles and conference presentations. However, once the technology has been developed, the funding and the resulting effort on publicity type activities typically falls off. This was the case for the Portawasher, CQM, and Ceramic Anode.

While potential users may have a passing interest in a technology under development, they may have a more active interest in a technology that is developed and obtainable. The majority of communications/marketing activities should be timed to occur after product development. These activities need to be continued well after the funding life of the research project.

The question was raised as to who is responsible for marketing the product if a commercial manufacturer is involved. One interviewee stated that the responsibility for transfer/marketing activities should belong to the manufacturer of the item. USA-CERL needs to define its role in supporting transfer/marketing efforts of manufacturers of lab technologies.

The interaction with the field and their use of ETIS led to a sizeable inflow of research dollars into USA-CERL to develop specific applications. The interviewee commented that a sign that technology transfer is working is that users come back to you to modify the technology to meet additional specific needs they have. As many of these modifications may have applications elsewhere, researchers need to be on the lookout for additional technology transfer opportunities.

Several interviewees stated that technology transfer will go fairly smoothly if the technology meets a real need of the user. The WQM was the only solution to a critical construction and manufacturing problem. The interviewee stated that, once a production model of the WQM becomes available, it will not take long before it is being used by industry. Another interviewee stated that SOLFEAS simply sold itself due to the savings it produced and the legislative requirement to perform such studies. PAVER was developed at a time when the nation's infrastructure problem was a pressing concern.

Prior to initiating research on a technology and throughout its development, researchers need to make sure the technology will be responsive to real needs of the users and not just the perceived needs of the users as envisioned through the technical monitor. As the case studies suggest, USA-CERL generally does a good job at providing technologies

which meet the needs of the user. Yet, closer contact with the users will help keep the research staff abreast of external changes which would impact the use of the technology. Technology transfer efforts may need to be modified to reflect these changes.

As an example, the Portawasher was the 10-year-old brain child of the technical monitor. While the initial idea behind the development of the Portawasher may have been valid at one time, the changing commercial activities requirements affected the transfer of the technology. Closer contacts with the field could have identified these changing requirements. The emphasis of transfer activities for the Portawasher could have been changed from "you can use the Portawasher" to "you can write the use of the Portawasher into your trash collection contract."

Communications Activities

Very little is done to find out how people do find out about a technology. The researchers do not typically ask users how they found out about the technology. Researchers only have gut feelings and limited responses from the field personnel who may mention where they heard about a technology. The majority of interviewees believed that the massive distribution of technical reports--a commonly used technology

transfer mechanism--has only marginal value in informing potential users about a technology.

Two approaches were cited as working well in transferring technologies to military users--personal contacts and command emphasis. Personal contacts are time consuming and are dependent on the credibility and salesmanship of the researcher. The support of high-level command personnel is difficult to obtain.

Magazine articles are a key to attracting interest in a technology by potential users outside the military. Specific audiences can be reached by carefully selecting publications with the desired readership. Efforts to obtain a manufacturer for the WQM consisted of carefully selecting the appropriate magazines and submitting articles to them.

It cannot be assumed that all potential users attended the conference presentation or read the issue of the trade magazine that contained the article. Repeat publicity through the appropriate media channels is needed to increase the likelihood of reaching the maximum number possible users.

Newsletters and articles can be a cost-effective way to reach a large portion of potential users. The "Construction Micro-Notes" newsletter was believed to be well read by users of the technology in the Corps. However, determining which medium to use which will be read by the appropriate military user is unclear. One interviewee stated that military

personnel do not have time to read long technical reports or articles.

Communications activities ought to describe the benefits and use of the technology accurately. If the product works particularly well under situations that similar technologies fail, these points should be emphasized. The CQM works very well with roller compacted concrete--a point just recently discovered. Yet, this point has not received emphasis in communications activities.

Misinformation or overzealous claims create wrong expectations by users of the technology. These wrong expectations are then difficult to correct and hurt the credibility of the product and the research organization. Part of this problem is related to the timing of communications activities. Expected benefits from a technology may not materialize in field tests. Efforts to emphasize the tenuous status of expected benefits in a briefing may be lost over time as a briefee remembers only what the technology was supposed to do, not the status of the technology. Part of the problem lies with individuals not intimately familiar with the technology discussing it with potential users.

Problems with misleading information could be avoided by scheduling major communications activities after the technology is developed. At this time results from the field

tests would be documented and become convincing arguments for use of the technology.

Implementation Strategies

The case studies revealed that encouraging individuals to use a technology often required the support and assistance of individuals outside the research organization. High level officials in the MACOM's or Corps headquarters were contacted in an effort to encourage or, in some cases, to require the use of the technology. Corps personnel using microcomputers in managing construction activities became spokespersons for the technology among their peers. Professional associations such as APWA and ASTM became the link between the labs and the nonmilitary users. Each technology will require a different approach and communications strategy to encourage the use of the technology in the field.

The decentralized structure of the Army somewhat impairs the transfer of technology through a command emphasis-type approach. The Corps of Engineers headquarters oversees the engineering program for all of the Army. Yet each of the three major commands (FORSCOM, TRADOC, AMC) are responsible for the operation of the engineering activity at installations within the MACOM. To transfer technology throughout the Army, the cooperation of the MACOMs must be obtained in addition to personnel at Corps headquarters.

Unlike the Army, the Air Force has a more centralized organization and consequently can make decisions and implement technologies much more rapidly than the Army. The Air Force was quick to require the use of the pavement condition index (PCI) portion of PAVER. The PCI was demonstrated at a meeting of Air Force engineers. A decision was made at the meeting to test the system at selected Air Force installations for one year. The results were discussed at a meeting the following year and within one week a letter was sent out to all installation engineers requiring the use of the PCI until the guidance document formalizing its use could be prepared. Similarly, the Air Force moved equally quickly in requiring the use of the Economic Impact Forecast System (EIFS) within ETIS.

Encouraging the use of a technology within the Army through a command emphasis approach can be greatly facilitated by an effective technical monitor. The technical monitor at Corps headquarters is in a better position than lab personnel to obtain the cooperation and support of MACOM engineers. The technical monitor also provides guidance to engineer personnel within Corps Districts and Divisions. One interviewee stated a good technical monitor can make or break the transfer of a technology to the field.

A command emphasis-type approach may also be applicable in transferring technologies to nonmilitary users. The Corps

of Engineers cannot require contractors to use some technologies or procedures unless they are an accepted practice within the industry. The CQM procedure was submitted to ASTM with the intention of it becoming an accepted procedure by industry. The APWA support for PAVER is another form of a higher level organization taking an active role in transfer of technology among its members.

The command emphasis-type approach in both the military and nonmilitary allows the higher level organization to become spokespersons for the technology. Potential users will become users because higher level officials say it is all right to use the technology. These high level spokespersons legitimize the use of the technology. In many cases these high level people will legitimize the use of the technology by making funding available to the field to purchase equipment or computer time.

The problem with the command emphasis approach is identifying and obtaining the support of those individuals who could become spokespersons for a technology. Demonstrations and special briefings work well to convince these potential spokespersons of the merit of a technology. Demonstrations before high level engineers with the Air Force and FORSCOM led to the decisions to require the use of PAVER.

Users of the technology also can become very effective spokespersons for the technology as was shown with the

construction microcomputer initiative. These individuals can explain to other users how the technology works in a real world environment. Their comments can be much more convincing than statements of researchers who may not have the same credibility with potential users.

Demonstrations of technologies at an installation is one way of developing a user spokesperson for a technology. Assuming the demonstration works well, installation personnel will now be available to act as a reference or point of contact on the technology for other installation personnel. Users group meetings and newsletters are other ways to develop and foster this group of peer experts. Users group meetings allow for the exchange of information on actual applications of a technology. Articles written by users published in a newsletter or other publication help convey the idea that the technology really does work.

In promoting a peer-spokespersons approach to transfer technology, efforts should be made to disassociate the technology from the lab and associate it with the Army. As one interviewee put it, "You need to develop a corporate identity for the technology." Communications messages should emphasize this is an Army technology and not a USA-CERL technology.

The biggest problem with the peer-spokespersons approach is identifying who would be a good spokespersons for the

technology within the user community. Another problem with this approach is the limited range of contacts a spokesperson may have. There needs to be some mechanism for disseminating information on the demonstration results or the views of the spokespersons on the technology.

Use of outside experts and associations to evaluate a technology also provides a valuable endorsement for the product. As in the case of the peer-spokesperson approach, the findings and reports of these outside experts needs to be disseminated to potential users.

Chapter III: Summary of Interviews with High-Level Army Personnel on Technology Transfer Activities of U.S. Army Corps of Engineers Research Laboratories

Purpose of the Study

During the time frame of 1 October 1986 through 15 December 1986, several interviews were conducted with high-level officials in the Army. The purpose of the interviews was to determine interviewees' perceptions of the technology transfer activities of the four research laboratories within the U.S. Army Corps of Engineers (USACE).

The interviews were conducted in conjunction with an eleven-week assignment of the author to the Directorate of Research and Development (DRD) within USACE. The intent of the assignment was to gather information to identify the role of communications activities in technology transfer and determine what could be done to improve the awareness of DRD and lab activities among high-level Army personnel.

Interviewees were asked a set of questions which are provided as an Appendix J. The questions were designed to determine the effectiveness of the Corps laboratories' existing technology transfer efforts, the obstacles to technology transfer, what communications media work well in informing users of new technologies, and what could be done to improve technology transfer. For the purpose of the

interviews, technology transfer was defined in the following manner:

Technology transfer consists of two general activities: (1) Informing potential users of the existence of an available technology and its applications, and (2) getting the technology into the hands of the users in a usable form with the appropriate technical support.

The major users of the technologies developed by the Corps labs are the Corps districts and divisions (civil works and some base support technologies), the Engineering School (combat engineering technologies), and the Directorate of Engineering and Housing at Army installations (base support technologies). Interviews were conducted with the following individuals:

Headquarters, U.S. Army Corps of Engineers (USACE)
 Assistant Chief of Engineers, Facilities Division
 Mr. Ed Watling, Chief
 Mr. Homer Musselman, Assistant Chief
 Mr. Bernie Wasserman, Division Contact for Labs
 Directorate of Engineering and Construction
 Mr. Bill McCormack, Chief, Engineering Division
 Mr. Lloyd Duscha, Deputy Director
 Directorate of Civil Works
 Mr. Cecil Goad, Chief, Operations and Readiness Division
 Mr. John Mikel, Division Contact for Labs
 Mr. Tom Whitman and others, Planning Division
 Engineer School, Directorate of Combat Developments
 COL Parker, Director
 LTC Corbin, Assistant to the Director
 Headquarters, U.S. Army Training and Doctrine Command (TRADOC)
 Mr. Dave Stoakley, Facilities Engineering Office
 Mr. Lee Aiken, Chief, Environmental Branch
 Headquarters, U.S. Army Materiel Command (AMC)

COL Simoneaux, Chief, Engineering Branch for Installation Support

Time did not allow for additional interviews to be held with personnel from the Engineering staff at Headquarters U.S. Army Forces Command at Fort McPherson, GA; the Environmental Office with HQ AMC; or the Installation Support Activity Office within AMC at Rock Island, IL.

Impressions of DRD/Labs and Technology Transfer

Overall, most interviewees thought technology transfer is moving along well, but almost all noted room for improvement. Within Corps headquarters, personnel from both the Directorate of Engineering and Construction (E&C) and the Directorate of Civil Works (CW) were content with the existing effort of the Corps labs in technology transfer. Interviewees indicated that the transfer of technology to the field should be conducted cautiously to ensure the readiness of a technology before it is transferred.

Personnel in the Facilities Division in the Office of the Assistant Chief of Engineers (ACE) took a different view and stated that the labs need to do more in the area of technology transfer. They stressed the need for the labs to take a more aggressive approach to informing installation personnel about

new technologies and to assist the field in using the technology at the installation.

Outside the Corps of Engineers, interviewees believed that overall technology transfer efforts were working well and could be improved with changes.

Several interviewees raised the question of who is responsible for technology transfer. Personnel within E&C and CW stated they have a better overall view of the consequences of new technologies and they should have a main role in technology transfer decisions. Lab efforts in technology transfer should be in support of directives from Corps headquarters. Personnel in the Engineer School were a little more emphatic and stated that technology transfer is their responsibility, not the labs.

Personnel in ACE, U.S. Army Materiel Command (AMC), and U.S. Army Training and Doctrine Command (TRADOC) defined their role as primarily encouraging the use of "good" technologies among the field through their contacts. These interviewees added that their support may be a requirement to technology transfer as without it the field may not be able to acquire funds to purchase new technologies.

A key concern in technology transfer is making sure of the appropriateness and readiness of a technology before it is used in the field. One interviewee stated that the acceptability and readiness of a technology for transfer is a

judgment call. He added that that question becomes, "Who is in the best position to make that decision--lab personnel or headquarters personnel?"

Another interviewee stated that lab personnel probably do not know enough about the daily operations of the field to really understand the possible applications or ramifications of a new technology. In the area of construction, it is important that the technology be accepted by the construction industry. Corps headquarters personnel believe they are in a better position to assess the ramifications of a technology than the labs.

Interviewees supporting the headquarters as having the key role in technology transfer decisions claim lab efforts to transfer technologies cause confusion in the field as to what is official guidance and what is just advice from the labs. With the exception of the ACE's office, the majority of interviewees tend to take a more conservative "wait and see" approach. They prefer to have the labs gather field data on a technology which will validate its use before a decision is made on transferring it to the field.

Personnel in ACE claimed lab personnel were too conservative in releasing information on developing technologies. They believed the field could benefit from information on many lab technologies before the field tests were completed.

Criticisms of the Lab Technology Transfer Efforts

The following items were frequently cited by interviewees as problems which hinder the transfer of technology to the field.

A common complaint directed towards the Corps labs is that in the past they have not been as responsive to the needs of the field as they should be. The majority of interviewees stated that the labs have been improving in this area. Personnel from both the Engineer School and TRADOC noted a decrease in the frequency of discussions between them and the labs on identifying the pressing research needs of the major command (MACOM).

One interviewee stated that if the technology truly meets needs of the field, technology transfer would not be a problem. The implication was that the labs will encounter difficulties in transferring technologies which provide only marginal benefits or do not solve the problems of the users.

Overzealous selling of products by labs is a problem on occasion. Sometimes the labs push technologies which have not received adequate testing. The ceramic anode was cited as an example by two interviewees who referred to problems which surfaced with its use on a lock gate. E&C claims to have told the labs that some of their products are not worth the push, but labs still continue to push the technologies. A third

interviewee stated that the problem may not be in the lack of testing, but in the technology itself. He said, "Sometimes the labs push technologies which aren't so good."

A complaint from almost all interviewees was that information coming out of the lab is too technical for some administrators at USACE and personnel in the field. Information needs to be directed to the information the user needs to make a decision--typically how the technology will improve his operation and what the costs are of learning and using a technology. One interviewee stated the DEH is not interested in the 25 pages of methodology and analysis which leads to a conclusion--he just wants the one sentence which says the technology is good or bad.

The same problem also applies to briefings. Another interviewee stated lab personnel assume that everyone in the audience is familiar with the topic. Even technical people may not be able to understand some briefings if the subject falls outside of their area of expertise.

Another criticism was the length of time it took the labs to develop a product and transfer it to the field. Personnel in both TRADOC and CW suggested the labs spend too much time to uncover answers and are continually finding new things to research on a topic. The Environmental Early Warning System and the dredging research program were cited as examples. Interviewees stated the labs periodically need to take a look

at what they learned from the the research and make this information available to the field.

The Engineer School identified two potential problems unique to combat engineer research which ultimately affect technology transfer. The first is a hesitancy by the labs to keep the Engineer School informed on current research for fear of the School reassigning that research to a lab with more expertise on the topic. The second is the failure of the labs to tie their research into the Army's concept base requirements and the materiel acquisition process. The recently conducted Engineer Equipment Review was viewed as one way to overcome both obstacles.

Problems in Implementing Technologies in Field

The interviewees identified several obstacles and potential problems which have hindered the transfer of technology to the field.

Army personnel may not be overly responsive to trying new technologies for a number of reasons. One interviewee pointed out the risk of being the first to use a technology which has not been proven over a long period of time. If the technology does not work, that individual will still be accountable to users of the service for correcting the problem. A new epoxy material was used to fill voids on a lock gate. Placing the material required shutting the lock down to commercial barge

traffic for 30 days. When the material failed, the lock gate had to be shut down an additional 30 days for repair under conventional methods.

Another interviewee indicated that Army personnel in the Directorate of Engineering and Housing (DEH) at Army installations rarely have the time to try something new. Under the rush of things to get done, the DEH will prefer to go with whatever approach he or she is familiar with. The interviewee pointed out that the DEH is less inclined to learn a new approach to pavement repair and develop new pavement designs than to take the old plans off the shelf and modify them to meet the existing need.

The CW planning staff made the point that research funding for a technology often stops after pilot testing. Little or no funding is available to transfer technologies out to other Districts or installations that could also benefit from the technology following the pilot tests.

A similar point was also raised about the lack of funding to modify a technology to meet specific needs of each District. When such modifications to a technology do occur, these modifications rarely are transferred back out to the field.

Several interviewees cited the lack of information about available technologies among Army personnel as a problem. Information sent out by the labs may reach the users at a time

when they do not have a need for the technology. When a situation arises in which the user could benefit from the technology, he or she will not remember the technology.

The question was raised as to how aggressive the labs are in going out to Districts and Divisions and telling the users about their technologies. Interviewees also questioned whether lab personnel are talking to the right people.

Several interviewees stated that the field is too busy to read information sent out to them by the labs. Information that is sent out needs to be concise and to the point.

Many contractors assisting the DEH consist of small businesses which do not use the newer technology; they are not familiar with it, or they have no motivation to learn to use it. Lab personnel need to direct some of their attention to informing the suppliers of engineering services of the existence of new technology.

Another problem with acquiring the new technologies lies with the Army procurement process. Procurement procedures make it difficult for the field to provide a sole source contract and obtain the services of a particular contractor. One interviewee stated this becomes a problem when lab personnel specify only one contractor with the expertise to provide a particular service using a new technology or approach.

Impression of Technology Transfer Communications Media

Interviewees were asked to comment on the effectiveness of several communications and marketing tools used to transfer technologies to the field. A list of these tools is provided in Appendix J. The comments are summarized in the following paragraphs.

Large-Scale Technology Transfer Programs

Interviewees thought demonstrations of technologies, such as those conducted under the Facilities Technology Applications Tests (FTAT) program, were a good way to show the usefulness of a technology in the field. One interviewee stated that FTAT brings lab and field personnel together to work through field applications of technology. A criticism of the demonstration approach was that it focuses only on transferring information to personnel viewing the demonstration. Some effort needs to be made to get information from the demonstration out to non-demo sites. The Repair, Evaluation, Maintenance, and Rehabilitation (REMR) program was also spoken highly of by interviewees, but was said to face the same challenges as FTAT in getting the word out.

The Technology Transfer Test Bed (TTTB) was thought to be a good program in concept, but interviewees had some reservations about assigning one or two Corps Districts sole

responsibility in assisting other District personnel in using the new technology. Another interviewee said another potential problem with the TTB program is poor communication between Districts.

The Air-Land Battlefield Environment (ALBE) program was cited as a good approach for demonstrating technologies in support of combat activities. However, the Engineer School stated the technologies demonstrated under ALBE need to be broken down and sold to the different Army Schools which have jurisdiction over the training doctrine that technology supports.

Technical Reports

Interviewees almost unanimously complained of technical reports being too long and too technical for benefit of the user. The consensus was that busy schedules do not leave much time for the reading of technical reports. Another criticism of technical reports was that the significance of research for most readers is either buried or lost in the technical language of the report.

Newsletters

All interviewees thought newsletters were a good way to inform the field about new technologies. Short articles on a technology with a point of contact listed can be quickly

reviewed by an individual. Several interviewees cited "Facilities Engineering (FE) Items of Interest", which is published by the ACE's office, as a good format. The ACE's office thought the labs should submit more information to "FE Items of Interest" as a way of getting information on technologies to the installation personnel.

According to interviewees, the big problem with newsletters and all printed material is making sure the right people see and read them. Distribution lists ideally need to contain the name of the person to receive the publication and be updated regularly.

Articles in Technical Magazines

The majority of interviewees believed the publication of articles in trade publications is a good way to inform potential users of new technologies--especially with individuals outside the military. The effectiveness of this approach in reaching military users is limited to what publications pass through the office.

Publishing articles on lab technologies in trade publications has caused problems for the Corps. One interviewee stated that overstated claims in these articles give contractors and Corps personnel misleading impressions of readiness and acceptance by Corps headquarters for new technologies.

Authorization Documents

Guidance documents provide a good reference to the military user and also give some credibility for the use of a technology. The consensus was that it takes too long to get these documents approved and published.

Workshops, Training Classes, Briefings

USA-CERL's quarterly briefings on specific technologies ready for transfer were cited by E&C personnel as a good way to keep Corps headquarters informed on such technologies. However, time is a problem in carrying out actions on briefings. Interviewees saw little value in general briefings on lab research programs.

Presenting information on new technologies through workshops and training courses was perceived to be valuable, but limited by the number of people that can be reached at one time.

Interviewees indicated that the labs should get more involved in presentations at the DEH and other specialty conferences attended by Corps personnel. Presentations at these conferences need to be oriented to the field applications of the technology and avoid getting too technical.

Audiovisual Presentations

Videotapes were described as a good way to brief individuals on a technology. Videotapes can be viewed at the leisure of the individual, and the visual impact of seeing the technology applied to real life situations is much more informative than reading about the same technology.

Personal Contacts

Both the Engineer School and TRADOC were in favor of regular visits from lab personnel as a way to exchange information on current lab research and the changing needs of the field. Both the Engineer School and TRADOC stated the Corps labs used to do this regularly, but the effort has fallen off in recent years. Liaison officers are currently employed by AMC labs to maintain such contacts with the Engineer School.

The Engineer Equipment Review is a good way to keep the Engineer School informed of lab research activities and to tie those activities into the Army's concept base requirements. The Engineer Equipment Review is a yearly meeting between lab personnel and the Engineer School officials to review existing research activities and identify future research needs.

Personnel in the Directorate of Civil Works spoke very highly of the hotline service provided by the labs to District and Division personnel.

Suggestions for Improvement

Interviewees, in addition to citing problems with technology transfer activities, also made some suggestions for how improving upon the deficiencies.

The Research Process and Technology Transfer Efforts

Almost all interviewees questioned whether lab technologies are meeting real needs of the field. Several suggestions were made for ensuring that lab research will meet such needs. These suggestions all centered around increased coordination between lab personnel and MACOM personnel.

Both the Engineer School and TRADOC noted a decrease in the number of visits by lab personnel to discuss current problems and perceived needs of the field. Both groups suggested these efforts should be picked up. The Engineer School has formalized this type of interaction through the Engineer Equipment Review. Similarly, TRADOC has a yearly review with lab personnel on ongoing research programs. However, both groups stated these formal meetings contain packed agendas which often do not allow in-depth discussions tying needs and future research efforts together. The additional contacts would allow for more detailed discussion on the topic.

Other interviewees stated that technical monitors need to play a bigger role in setting priorities for the research efforts of the labs. More active participation by technical monitors will ensure the research effort produces products of value to field. One interviewee mentioned that recent personnel cuts are limiting an expansion of this role.

Several interviewees believed that the technical monitors need to take a more active role in technology transfer activities. One interviewee stated the technical monitor should be making decisions on technology transfer efforts and assigning lab personnel tasks in support of these efforts. He stated that labs are currently spending research dollars on transfer activities which are the responsibility of Corps headquarters, but headquarters personnel do not have the time to carry such activities out. He suggested that headquarters personnel could hire consulting firms using nonresearch funds to do rewrites of technical manuals and engineering regulations to incorporate new technologies. Contracting out may be another option for other technology transfer activities.

Another suggestion to tie the research effort more closely into the needs of the field was to find ways to increase the awareness by research staff of how installation engineers in the Directorate of Engineering and Housing (DEH) conduct their business and the problems they face. One

interviewee suggested the labs should send new employees out with veteran lab personnel to installations to see how the DEH conducts business. Another option would be to send lab personnel to the Facilities Engineer management course.

Many interviewees pointed out that, while it is valuable to gain support of the field in using a technology, lab personnel need to gain support of MACOM level decision makers. MACOM personnel make decisions, not the field, on Armywide use of the technology. Often, MACOM personnel also control fundings sources which are needed to purchase equipment needed to implement technologies.

In many cases, the labs need to make a conscious effort to sell appropriate technologies to industry as well as the MACOM's. Industry will be the users of many of the technologies in support of Corps activities. Industry support for a technology may also be a prerequisite to gaining the support of Corps headquarters. One interviewee in E&C stated they will sign off on new technologies if (1) the technology was well conceived, tested, and proven to work; and (2) technology has been accepted for use by industry.

Communications Activities

All communications activities need to concentrate on explaining the significance of the research or technology as it pertains to the user. A common complaint was that

briefings and articles presented to potential users or decision makers tend to be too technical. Information contained in communications activities needs to be presented in a manner that will be understood by the particular audience.

Communications efforts should emphasize the information a user needs to make a decision on using the technology. This was a common complaint of communications activities directed towards DEH personnel at installations. Interviewees stated that articles and other communications activities need to spell out the significance of the technology for the DEH. Installation personnel want to know information of a more practical nature such as how the technology will benefit him or her, what the cost will be of using it, where has it been used before, and how does one go about obtaining it.

In providing information to the field, the lack of time to read lengthy reports was commonly cited as a big problem. Newsletters were repeatedly offered as a good medium to inform users on new technologies. Newsletters are viewed as being easy to read and they do not take a lot of time to scan. Interviewees in the ACE's office stated the labs should make more use of existing newsletters such as "Facilities Engineers Items of Interest."

Several interviewees suggested executive summaries be written summarizing the findings of technical reports. The

summaries should be nontechnical and should highlight the research results and their significance to the reader. One interviewee stated the DEH is only interested in the one or two sentences which say the technology is good or bad, not the 25 pages which explain how that conclusion was reached. These summaries could accompany the technical report or possibly be sent out instead of the technical report.

Several interviewees stated a big problem with mailing executive summaries and newsletters is ensuring they get to the right people. One interviewee suggested including the name of the person or position within the organization who should receive the publication onto the distribution list. These distribution lists would need to be updated regularly.

Another suggestion for getting information out to the field personnel was making presentations on technologies ready to be fielded at the many specialty conferences--such as the annual meeting of the Chiefs of Engineering Divisions at Corps Districts and Divisions or the DEH conference. One interviewee stated lab personnel should go to the field more often to conduct presentations or more formal technology workshops. Personnel in the field often have a difficult time obtaining travel money.

Interviewees also identified several activities which could improve the effectiveness of videotapes. Videotapes distributed through the mail need to be publicized by the labs

or promoted by the MACOM's to encourage people to view them. The viewing of videotapes can be achieved by using them in a controlled environment such as a workshop or training session. Another interviewee stated videotapes should be accompanied by speaker who can answer questions. The ACE's office mentioned videotapes should to be more how-to-do oriented than publicity oriented.

OCE and TRADOC stated some indexing system needs to be made available to the field to identify available technical reports and lab resources. Resources branch in CW is developing a bulletin board upon which this information could be made available. A similar effort for installation personnel is currently being developed by USA-CERL for the ACE.

Corps headquarters and the other MACOM's have many contacts with field. Labs need to keep them informed on new technologies. Interviewees stated that the field will initially contact the MACOM with a problem. If the lab had a technology which may help resolve the problem, MACOM personnel could pass the information on the technology or a lab point of contact to the individual with the problem.

Another way to keep MACOM personnel informed of new technologies or current programs is to invite them to lab-sponsored technology conferences. One interviewee attended a technology conference at CRREL. He stated although he did not

have much to contribute to the conference, he did find it valuable in finding out what was new in roofing research.

Discussion

The interviews were valuable in two ways. One, they provided a rough picture of how personnel at Corps headquarters and some MACOM's view the Corps laboratories and technology transfer activities. Second, the interviewees provided their insight into problems with the technology transfer process and offered some suggestions on improving it.

As an interviewer, my impressions were that many of the interviewees were not really all that familiar with the operations of the Corps labs. Many of the criticisms directed towards the labs and technology transfer activities seemed to be based on incomplete information. As an example, the labs were commonly criticized for their technologies not being responsive to the problems facing the field. As an employee of a lab I see the opposite--a fairly large emphasis placed on working with the field and headquarters personnel to ensure the technologies are developed to meet the needs of the field.

The discrepancy may be one of degree. Perhaps the labs are being unjustly criticized for not doing things they are indeed doing--they may just not be doing enough of them. The discrepancy also may be caused by not keeping the higher level officials informed of things the labs are doing in support of

them. Lab personnel may work closely with a technical monitor or middle-management level official at the MACOM. However, this interaction may not get to the attention of the individual at the level which was interviewed.

The source of this discrepancy also may be a result of incomplete information which is received by headquarters personnel. The ACE's office criticized the reports provided by USA-CERL's Pavement Maintenance Management System (PAVER) as not being compatible with the reports engineers at Army installations are required to keep. They cited this as an example of a technology which was developed without taking into account how the field conducts its business. As the development of PAVER received much funding from the Air Force, it is only natural that its reports would not be tied to the Army's reporting requirements--yet, the technology may be just as applicable.

This lack of awareness of laboratory operations by MACOM personnel is further aggravated--especially at Corps headquarters--by the low profile of the research community. The business of the day at Corps headquarters is dealing with the program management of ongoing construction projects and the operations and maintenance of existing facilities. The role of technical monitor for research projects is often another duty as assigned to headquarters personnel. One interviewee at Corps headquarters indicated that he would like

to see his technical monitors spend more time on lab activities, but more pressing priorities prevent this.

The laboratories seem to be viewed as being off on their own from the rest of the Corps. Indeed much of the research conducted by the four labs, such as combat engineering research, has little direct relevance to the construction mission of the Corps. Information efforts which emphasize combat engineering activities may be well received within the Engineer School or TRADOC. An emphasis on combat engineering activities within Corps headquarters, through "Daily Staff Journal" items and articles in Engineer Update, may only reinforce the notion that the laboratories are an isolated segment of the Corps of Engineers.

In summary, a common underlying point which was suggested in all of the interviews is increased communication between the laboratories and the MACOM's. This is extremely important to successful technology transfer and improved awareness of laboratory activities. MACOM support for a technology can make or break the success of the labs to transfer it to users. All interviewees expressed a willingness to support and encourage the use in the field of those technologies which they thought were beneficial. This is the minimum amount of MACOM involvement in technology transfer.

In many situations MACOM support may be a prerequisite to ensure funds are made available to procure equipment needed

for the technology. Within Corps headquarters, decisions on technology transfer is viewed to be the responsibility of personnel in the Directorates and not the research community. Consequently, personnel at Corps headquarters become a very important cog in the technology transfer process. Communications efforts need to be specifically directed to enlisting the support of personnel at Corps headquarters and the MACOM's. While technology transfer decisions may ultimately be the responsibility of MACOM personnel, the laboratories need to take an aggressive role and assume responsibility for encouraging the appropriate people to make the decisions.

On the subject of technology transfer, an overall concern of interviewees was the lack of usable information on laboratory technologies for use by the field. Technical reports were too lengthy and too technical for use in the field. Workshops, briefings, and conference presentations were thought to be valuable, but limited in how many people can be reached at one time. Videotapes were viewed to have much potential for providing information, but more thought needs to be given on the role of videotapes and how to ensure such tapes will be viewed by the field.

Newsletters were well received as a way to provide information to a large number of people without taking up a lot of their time. Some noted traits of successful

newsletters include the use of short articles which can be easily reviewed, carefully grouping these articles into subject areas of interest to readers, and emphasizing in these articles only that information which would assist a reader in deciding whether he or she could benefit from using the technology.

Another key factor in the effectiveness of newsletters is identifying who should be receiving the publication and ensuring the distribution list accurately reflect that audience. "FESA Briefs" and "FE Items of Interest" are two newsletters which apparently are well read by the field. These newsletters are specifically designed to be read by installation engineers and contain little information not related to installation activities. Laboratories could make greater use of these publications to disseminate information on base support technologies. Perhaps a newsletter could be developed to transfer information on combat engineering technologies to that very specific audience.

A common point made by interviewees was that lab publicity efforts on a particular technology may go by unnoticed by the user unless he or she is in need of that technology. When a problem arises that could be resolved by the technology, the potential user may not remember that the technology exists. This point underscores the need for

repeating efforts to publicize technologies to remind users of their availability.

As a solution to this problem, several interviewees pointed out the need for some indexing system for obtaining information on available technologies and publications on the technology. Such a system would enable users to seek out available technologies for solving problems when the problem occurs. The computer-based electronic bulletin board system under development by USA-CERL is expected to incorporate such an indexing system.

Other major problems in technology transfer center around the reluctance of the field in trying something new. People do not like to change their ways of doing business. Change requires individuals to learn to do something differently--an educational process of sorts. One interviewee asked why should an installation engineer draw up new pavement plans using a new technology, when he can just make some minor modifications to previously used plans.

Perhaps the laboratories need to work with the MACOM's in developing ways to minimize the time requirements of the learning curve. If laboratory or MACOM personnel are not available to support the field in using a new technology, perhaps a self-help, "how to do" training package needs to be developed which would minimize the effort required to use a

new technology. In the example of the pavement technology, this package could include a standard pavement design plan.

A related educational problem is assisting users in working through existing procurement regulations to acquire a technology which is available from a single supplier. One interviewee pointed out the difficulties of obtaining such services within procurement regulations which severely restrict sole-source acquisition. Obtaining such services can be done, but potential users may not be willing to take the time to learn how to do it. The labs or the MACOM's--at the urgings of the labs--may need to provide this information.

Finally, another major obstacle to technology transfer is ensuring the industry is going to provide the service or technology developed by the laboratories. Although no suggestions were offered by interviewees on how to do this, this nevertheless poses a large problem with those technologies developed by the labs without any assistance from industry.

Chapter IV: An Assessment of Public Relations Organizations and Technology Transfer Activities at Research Organizations

Background

Expenditures for research and development among U.S. corporations have steadily increased over the past few years (Business Week, July 9, 1984). Over 300 research laboratories within the Federal Government conduct several billion dollars worth of research every year. In addition to corporate and government research centers, much additional research is conducted by universities and a variety of nonprofit organizations.

A very large concern of the research community is the transfer of technology to potential users. On the corporate side, research organizations typically exist to develop or improve products for the parent company. Technology transfer activities often are the responsibility of the parent company's marketing department or consultant.

Technology transfer activities are less structured at Federal laboratories and universities in terms of staffing and funding levels (Lennon, 1982). One potential source of additional support for technology transfer specialists at Federal labs and universities is public relations professionals assigned to the lab.

Very little is known about the activities and organization of public relations personnel at research organizations. A review of three journals devoted to public relations activities (Public Relations Quarterly, Public Relations Review, and Public Relations Journal) revealed no information on the structure or roles of public relations programs at research organizations.

Purpose of the Study

This study was undertaken to obtain a greater understanding of the role of the public relations professional in government and nongovernment research organizations and determine how such professionals could assist the organization in technology transfer.

The study was designed to obtain the following information:

- 1) Organization of public relations programs at government and private research organizations in areas of source of such support, staffing levels, and budgets;
- 2) Importance of various communications tasks to the public relations practitioner at research organizations; and
- 3) Tools and media used by research organizations in transferring technology to potential users.

Methodology

A survey was developed to obtain the information described above. The survey consisted of two parts. One part was directed towards obtaining information on public relations staffing and its activities at the organization. The second part was directed towards obtaining information on the technology transfer activities of the organization. A copy of the survey is provided as Appendix K.

The survey was developed using multiple choice answers. A total of 254 surveys was mailed out to 115 Federal laboratories, 95 corporate research centers, and 44 nonprofit and university research centers. Copies of the cover letters are enclosed as Appendix L.

The Federal Laboratory Consortium (FLC) provided its mailing list of members for use in distributing the survey to Federal laboratories. The FLC is an organization, with Federal labs as members, devoted to transferring Federal technology to State, county, and municipal users and to private industry. The surveys were sent to the FLC representative at each laboratory. The FLC representative was asked to complete the technology transfer questions and then forward the survey to the public relations practitioner.

Corporate research organizations which received the survey were randomly selected from a list of such organizations which was published in the July 9, 1984, issue

of Business Week. The article discussed research expenditures by publicly held corporations with sales of \$35 million that spend at least \$1 million or 1 percent of sales on research and development. The article grouped these companies into 32 fields of research. Research organizations were selected from only engineering-related fields--a specific area of interest for this study. For every five research organizations listed in each category, one was selected to receive the survey. The organizations were randomly selected within each category. The surveys were sent to the public relations director at each organization. The names of these individuals were obtained from O'Dwyer's Directory of Corporate Communications.

University and nonprofit research organizations were selected from a list of such organizations provided in the Research Centers Directory by Gale Research Company. An initial review revealed that most of these centers had small staffs and budgets--the majority of them were affiliated with universities. A list of potential recipients of the survey was developed using the following criteria for selecting organizations:

- a) a minimum of 40 full-time research professionals, and
- b) a minimum budget of 1.5 million dollars.

Due to the vast number of these organizations, selection was limited to nonprofit research organizations in the fields of engineering, medicine, and industrial subjects. A total of 44

nonprofit and university research organizations were selected from this list using random sample techniques and the above criteria. The surveys were sent to the public relations practitioner at these organizations, when identified, or to the chief executive of the organization.

A total of 97 surveys or 38 percent of the 254 surveys was returned. The data were analyzed using the dBASE III data base management program running on AT&T 6300 microcomputer.

Results

Some of the surveys came back with only one of the two sections completed. Below is a tabulation of the number of respondents who filled out the two sections.

Table 2: Responses to Survey Sections

Number completing the public relations part	=	76
Number completing the technology transfer part	=	92
Total number of surveys returned	=	97

The types of organizations which responded to the survey are listed below:

Table 3: Response by Organizations

Organization	Sent	Received	Percent
Corporations	95	20	21
Federal Labs	115	56	49
Nonprofit and Universities	44	21	48

Survey, Part 1--The Public Relations Function

Source of Public Relations Support.

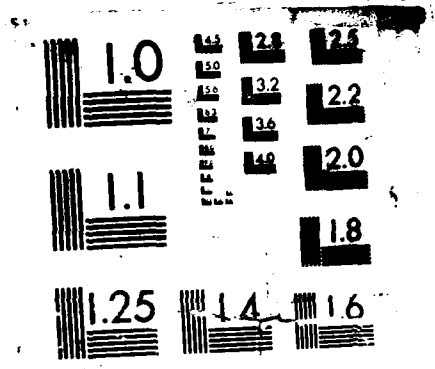
As shown by table 4, the majority of the respondents had public relations staffs in-house or available from a parent organization. Those respondents who marked the response category "others" usually commented the public relations responsibilities were an additional duty assigned to an individual.

Table 4: Source of Public Relations Support

Source	Gov't	Corp.	Nonprof.	Total	Percent
In-house Staff	31	8	10	49	50
Parent Organization	14	9	5	28	29
Consultant	0	0	0	0	0
No PR Activities Conducted	5	3	4	12	12
Other	6	0	2	8	8
Totals	56	20	21	97	100

Profile of the Public Relations Staff.

The in-house public relations staffs at research organizations are listed below. The larger staffs within the Federal government belonged to research organizations at the National Aeronautics Space Administration. One corporate respondent listed a staff of over 75.



MICROCOPY RESOLUTION TEST CHART

Table 5: Size of In-House Public Relations Staffs

Size	Gov't	Corp.	Nonprof.	Total	Percent
Under 4	14	6	6	26	53
4 to 8	7	1	2	10	21
9 to 15	7	-	1	8	16
Over 15	3	1	1	5	10
Total	31	8	10	49	100

The most popular title of the public relations office was public affairs--the large majority of these being the Federal government respondents. The total breakdown is listed below.

Table 6: Titles of Public Relations Staffs

Title	Responses	Percent
Public Relations	5	11
Public Affairs	22	45
Public Information	6	12
Communications	4	8
Other	12	24
Total	49	100

The large majority of in-house public relations staffs operated with a budget of under \$250,000. The information is described in more detail below.

Table 7: Budgets of In-House Public Relations Staffs

Budget	Gov't	Corp.	Nonprof.	Total	%
Less 100,000	13	2	2	17	36
100,000-250,000	6	3	5	13	28
250,000-500,000	4	1	1	6	13
500,000-750,000	5	1	0	6	13
Over 750,000	2	1	1	5	10
Total	30	8	9	47	100

Almost two-thirds (61%) of the in-house public relations chiefs report to the number one or two person in the organization as shown by the following table.

Table 8: Who Public Relations Chiefs Report To

Position	Gov't	Corp.	Nonprof.	Total	%
Chief Exec.					
Officer	14	0	5	19	39
No. 2 Exec	7	4	0	11	22
Administrative					
Staff Officer	2	2	1	5	11
Department Head	7	2	2	11	22
Other	1	0	2	3	6
Totals	31	8	10	49	100

Importance of Public Relations Tasks.

High priority was placed on information dissemination activities for public relations offices at research organizations. Media relations with technical publications was rated high in value by respondents. The following table shows the number of responses identifying the value or importance of various public relations activities. The information consists of the views of public relations practitioners from both in-house staffs and external locations.

Table 9: Importance of Public Relations Activities to the Research Organization

Activities	High Value	Moderate Value	Little Value	No Answer
Media Relations, Technical Publications	41	5	1	1
Media Relations, General Publications	38	7	2	1
Answer Requests for Information	34	3	4	7
Writing/Editing Articles	34	3	4	7
Counseling Chief Exec.	32	8	6	2
Employee Relations	26	5	6	11
Publications	28	3	6	11
Design Displays	26	5	9	8
Community Relations	20	12	2	14
Tours	25	6	6	11
Open Houses	15	6	12	15
Speakers Bureau	14	8	13	13
Tracking New Technology	18	5	14	11
Recruiting Personnel	18	9	15	6
Speechwriting	16	4	16	12
Attend Trade Shows	12	6	23	7
Product Publicity	12	5	20	11
Identifying Public Issues	11	8	19	10
Fundraising	7	3	27	11

Respondents were then asked to identify what percentage of their time is spent on the various categories of activities. Media relations take up the largest percentage of time as the previous table suggests it would. Employee relations follows close behind. The following table summarizes the responses by presenting an average of the percents indicated for each category by respondents. Only 37 respondents indicated that they were involved in technology transfer.

Table 10: Amount of Time Spent on Public Relations Activities

Activity	Average Percent of Time	No. of Respondents
Media Relations, Technical	20.11	71
Media Relations, General	19.38	72
Employee Relations	18.47	62
Community Relations	12.27	62
Assistance to Organization	13.51	57
Technology Transfer	14.76	37
Other	23.52	29

Survey, Part Two--The Technology Transfer Function

The following information provides an overview on technology transfer efforts at the research organizations. The breakdown of the number of respondents among the various type of research organizations who completed the technology transfer section of the survey is shown below.

Table 11: Breakdown of Responses by Organizations

Federal Laboratories	= 58
Corporate Laboratories	= 16
Nonprofit Organizations	= 18
Total	92

Who's Responsible for Technology Transfer?

Respondents identified who are responsible for technology transfer in their organizations oftentimes marking multiple answers. The table below ranks the frequency of responses in the various categories. In all organization types, the research team was most frequently identified as having responsibility for technology transfer.

Table 12: Responsibility for Technology Transfer

<u>Transfer Agent</u>	<u>Gov't</u>	<u>Corp.</u>	<u>Nonprof.</u>	<u>Total</u>
Research Team	26	7	11	44
Technology Transfer Officer	35	1	3	39
Other	11	2	2	15
Assistant to Chief Executive	9	2	3	14
Marketing Dept.	0	8	0	8
Public Relations Chief	4	1	2	7

Background of Technology Transfer Participants.

Respondents were asked to estimate what percent of the people involved in technology transfer had the following educational and professional backgrounds. This category also resulted in multiple responses from many respondents. The following table lists the frequency of responses marked for the various background categories and the average of the percentages identified by respondents.

Table 13: Backgrounds of Technology Transfer Agents

	<u>No. of Responses</u>	<u>Average of Percent With Background</u>
Technical	89	83
Marketing/Business	16	30
Communications	31	27
Law	3	21
Other	2	15

Technical backgrounds were most often cited for personnel involved in technology transfer activities. Of the 89 respondents who checked the technical background category, 34

of them indicated that 100 percent of those people involved in technology transfer had technical backgrounds.

Media Used to Transmit Information on New Technology.

Personal contacts with the technical staff through individual conversations and workshops and briefings, and articles placed in technical and business publications received the highest rankings from respondents as techniques for informing users of new technologies. Table 14 identifies the value placed by respondents on different approaches to informing users of new technologies.

Personal contacts with technical people through users groups or individual phone contacts were most often cited as being a good way to assist users in using technologies. The rating by respondents of the value of these and other techniques is shown in table 15.

The last question asked respondents to identify what role might a public relations office play in supporting technology transfer activities. Over a third of the respondents replied to the question indicating a variety of potential activities. The frequency of identified responses for each activity is listed in table 16.

Table 14: Value of Different Approaches to Informing Users of New Technologies

Medium	High Value	Moderate Value	Little Value	No Answer	Total
Contacts by Researchers	78	5	7	2	92
Articles in Technical/ Business Publications	73	8	8	3	92
Demonstrations/Briefings	64	13	8	7	92
Articles in Newspapers/ General Audience Publ.	30	27	28	7	92
Newsletters	29	20	31	12	92
Trade Show Exhibits	18	20	42	12	92
Videotapes	17	17	44	14	92
Technology Open Houses	12	16	48	16	92
Contacts by Sales People	8	4	56	24	92
Advertisements	8	6	54	24	92
Videoconferencing	4	2	66	20	92
Cable Television	0	1	68	23	92
Others	5	1	1	--	--

Table 15: Value of Different Approaches to Assisting Users in Implementing New Technologies

Medium	High Value	Moderate Value	Little Value	No Answer	Total
Users Groups	65	14	5	7	91
Phone Contacts With Research Staff	61	16	9	5	91
Users Manuals	37	21	17	16	91
Service Staff Onsite	37	15	22	17	91
Training Classes	34	13	28	16	91
Support From Technology Manufacturer	28	13	29	21	91
Support Centers	25	9	42	15	91
Videotapes	18	18	40	15	91
Videoconferences	3	8	59	21	91
Others	--	--	1	--	1

Table 16: Potential Roles of Public Relations Personnel in Technology Transfer

<u>Activity</u>	<u>Frequency of Response</u>
Media Relations/Publicity	27
Very Little Possible Activity	12
Publication Preparations	9
Conducts Tour/Arrange Workshops	8
Communications Planning	4
Presentation Quality	2
Provide Videotape Production Support	2

The most frequently cited role for public relations practitioner was that of media relations and publicity. Many respondents indicated such activities should include not only news releases and articles on technologies, but also publicity on technology transfer effort itself. Public relations staffs were often cited for their ability to translate the technical language of the scientist into general lay terms for nontechnical audiences.

Newsletters, brochures, and other publications supporting technology transfer activities were commonly being prepared by public relations personnel according to some respondents. Conducting tours and arranging for visitor briefings and conferences were cited as other areas of support from public relations personnel.

Some respondents (12) indicated that transfer activities are best handled by the technical staff.

Discussion

Although the number of respondents was small and scattered among the three organization types, the information provided above does provide insight into the organization and activities of public relations staffs at research organizations.

A little over half of the total respondents stated they had in-house public relations staffs. The percentage was a little higher for Federal research organizations at 57 percent. These in-house staffs are relatively small with 53 percent of them having fewer than four people. Consequently, very little specialization is likely to exist within public relations staffs; practitioners are most likely to be jack-of-all trades.

Media relations activities for both technical and general interest media ranked highest in value to the organization. Answering requests for information and writing and editing articles were a close second. Consequently, media relations activities were ranked highest in the amount of time devoted to it by practitioners. Media relations takes up over a third of the time spent by practitioners.

Only 37 public relations practitioners indicated that they are involved in technology transfer activities. They indicated these activities take up an average of 14 percent of their time. Thirty-one of the 92 respondents to the

technology transfer section (about one-third) identified communications personnel as assisting them in technology transfer activities. Individuals with communications background on the average make up 29 percent of the staff support for technology transfer activities at these 31 organizations.

Individuals with a communications background are already providing much support to technology transfer efforts. Many respondents to the technology transfer section identified news releases, articles, and other publicity activities as key responsibilities for public relations personnel.

As a large part of technology transfer is "getting the word out" on new technologies, research organizations should look towards communications professionals to play a greater role in both planning and conducting strategies for technology transfer.

Communications professionals are available to many research organizations through in-house public relations and publications offices. Yet, only one-third of the respondents identified communications specialists as being involved in transfer activities.

The use of articles and other media such as newsletters, brochures, and training materials are more cost-effective media for reaching a greater number of individuals with information on a new technology. Articles in technical

publications were also highly regarded as an existing method for informing users of new technologies.

Just as a research organization would not expect a communications professional to conduct its technical research, that same organization should not expect technical people to plan out and conduct its communications or marketing activities which make up technology transfer activities.

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Chapter V: How Do Potential Users Learn of New Technologies--A
Survey of the U.S. Army Corps of Engineers

Purpose of the Study

USA-CERL and the other Corps labs conduct an intensive effort in publicizing the results and products of its research. However, little has been done to determine the effectiveness of the various media used and the preferences of users for receiving information on lab technologies. This study was conducted to achieve the following objectives:

- 1) identify how Army personnel find out about new technologies;
- 2) determine users' preferences for receiving this information;
- 3) determine the availability to users of hardware items to support receiving information through nonprint media such as videotapes, video- and teleconferencing, and electronic mail; and
- 4) determine what types of informational messages and which sources of information are considered in the decision to use a technology.

Methodology

A survey was developed to obtain information in support of the previously stated objectives. A copy of the survey is provided in Appendix M.

A total of 229 surveys were sent to District and Division offices of the Corps of Engineers, the Directorate of Engineering and Housing (DEH) at Army installations, and to DEH offices at the headquarters of four Major Commands (MACOM) overseeing the activities of the DEH at installations. A good response was received from the mailings--155 surveys for a 68 percent return.

Twelve Corps of Engineer District and Division offices were randomly selected for the survey. Nine copies of the survey were sent to the commander of each office with instructions for internal distribution. Of the 108 surveys sent to Corps offices, 73 (68 percent) were returned. Only one District located overseas failed to return any surveys--probably due to overseas mailing problems.

The selection of installations to participate in the survey was the decision of the MACOM. As DEH personnel report to the MACOM and not the Corps headquarters, permission to send out the survey and nominations of installations was requested from the MACOM. Each of the four MACOM's nominated five installations to participate in the survey. Five copies of the survey were sent to the Director of the DEH office with

instructions for internal distribution. Five copies of the survey were also sent to the four MACOM's. Of this mailing, only one MACOM failed to return any surveys--again probably due to overseas mailing problems. A list of survey recipients and correspondence for the surveys are provided in Appendix N.

Instructions for internal distribution of the surveys identified which subunits in the organization should receive the survey. As information shown in the following section suggests, a wide variety of individuals with varying technical backgrounds completed the survey.

In addition to the mailed surveys, another 30 surveys were completed by DEH personnel at a conference of Army engineers held December 1985 in Cincinnati, Ohio. The surveys were distributed during a workshop on a technology transfer program. Approximately 75 people attended the two sessions. Between the mailings and the workshop, 91 DEH personnel and 21 MACOM personnel responded to the survey .

Results

Respondents to the survey represent a variety of technical backgrounds. Many respondents identified their titles and offices in an optional question asking for that information. In some cases it was relatively easy to identify what type of position or office respondents held based on the types of specialty publications they listed under the other

category in question 5. Below is a breakdown of the number of respondents who could be identified with a technical expertise or an office within the organization.

Table 17: Identified Backgrounds of Respondents

<u>Area of Expertise or Office</u>	<u>No. of Respondents</u>
Corps of Engineers	
Operations and Maintenance	9
Planning Division	2
Engineering Division	17
Environmental Office	9
Construction	9
District Engineer/Deputy	3
DEH (including MACOM's)	
Energy and Utilities	12
Environment	10
Building and Grounds	15
Engineering Plans and Services	26
DEH/Assistant DEH	31
Others	11
No Answers	31

How Do Users Learn of New Technologies

Respondents were provided a list of communications media currently used by USA-CERL to inform users of new technologies. Respondents were asked to check off those media through which they learn about new technologies. The question did not attempt to specify just USA-CERL technologies. Below is a ranking of media by responding groups. The percentages represent the number of positive responses against potential responses within the group.

Table 18: How Respondents Learn of New Technologies

Media	Percent of Positive Responses			
	DEH	Corps	MACOM	Total
Trade Publications	77	75	81	77
Technical Reports	59	74	81	68
Newsletters	58	70	57	63
Exhibits at Conferences	52	38	48	49
Guidance Documents	55	42	57	49
Workshops	45	49	62	49
Demonstrations/Briefings	42	44	43	43
Army Magazines/Newspapers	35	26	57	34
Newspapers	30	27	33	29
Personal Contacts	16	29	43	24
Textbooks	25	15	2	21
Audio-Visual Materials	8	15	29	13
Video-Teleconferencing	7	1	3	5

All three groups of respondents were uniform in their ranking of the top three media. Respondents rely heavily on the conventional print sources of information. The next cluster of media consisted of the one-on-one contacts between researchers and users through briefings or exhibits. At the bottom of the scale were the electronic media of videotapes and video and teleconferencing activities. Other sources of information on new technologies mentioned by respondents in the other category included suppliers, peers, advertisements, and catalogs of services.

Preference for Receiving Information on New Technologies

Respondents were provided the same list of communications media used to provide information on new technologies. This time they were asked to identify the three media through which

they would prefer to receive information. Some respondents marked off more than three answers. Below is a ranking of media by responding groups. The percentages represent the number of positive responses against potential responses within the group.

Table 19: How Respondents Prefer to Receive Information on New Technologies

Media	Percent of Positive Responses			
	DEH	Corps	MACOM	Total
Technical Reports	51	64	48	56
Workshops	44	47	57	46
Newsletters	38	51	29	42
Demonstrations/Briefings	40	44	2	42
Trade Publications	36	37	1	34
Guidance Documents	31	18	48	28
Personal Contacts	21	30	24	25
Audio-Visual Materials	22	25	2	23
Exhibits at Conferences	32	11	2	22
Army Magazines/Newspapers	18	8	14	14
Video-Teleconferencing	10	8	1	9
Textbooks	7	3	0	4
Newspapers	1	6	1	3

The greatest number of DEH and Corps personnel identified technical reports as a preferred way of receiving information. While the print media is the most currently used channel for receiving information, it appears that respondents would like to see more one-on-one explanations of technologies. Newsletters and trade publications dropped in the rankings as workshops and demonstrations ranked higher as a preferred way to receive information. Additional preferred sources of information mentioned by respondents in the other category

included fact sheets and information provided by suppliers of the technology such as a catalog of products.

Access to Nonprint Media

Videotape training aids and electronic mail are increasingly being considered by USA-CERL as ways to provide users with information on new technologies. Similarly, videoconferences and teleconferences are technologies already being used in the private sector to avoid travel costs from meetings and conferences. Some hotel chains in larger cities, such as Holiday Inns, are offering these services to their corporate clients.

The ability of the respondents to participate in these nonprint media was the subject of the next question. Respondents were asked if they had access to 3/4" videotape playback equipment, a slide projector cued by an audio tape, a teleconferencing facility, a videoconferencing facility, and electronic mail. Responses are in percentages of positive responses within that group category.

Table 20: Access to Media Equipment/Facilities

Media	Percent of Positive Responses			
	DEH	Corps	MACOM	Total
Video Playback Equip.	75	90	71	81
Slide Projector/Audio	66	75	71	70
Teleconferencing Fac.	11	25	33	14
Videoconferencing Fac.	11	8	81	11
Electronic Mail	62	86	81	74

Many respondents failed to mark either a positive or negative response to the teleconferencing and videoconferencing item. This could have been due to a lack of familiarity with the medium or a lack of awareness of the local availability of these services.

Respondents were also asked to identify what electronic mail system they were using. A poor response was obtained on this part of the question. Respondents who did answer mentioned a variety of electronic mail systems, and hardware used to access unidentified electronic mail systems. The more frequently mentioned systems and the number of responses are: Paxmail--23, Ontyme--7, 1391 Processor--8, IBM Micros--9, ETIS--4, Unix--4, Optimis--2, Harris--2, and seven other items each with one response.

Readership Survey

The next part of the survey asked respondents to identify how often did they read several military and nonmilitary publications which carry information on new technologies. The responses have been separated into three tables (tables 21-23) to summarize those of all respondents, those of the DEH, and those of the Corps. The publications are ranked according to the total percentage of respondents who stated they either read every issue or read the publication occasionally.

Table 21: Readership Habits--All Respondents

Publication	Tot. %	Percentage of Positive Responses				
		Every Issue	Read Sometimes	Read Never	Do Not Receive	No Reply
CERL Technical Reports	83	12	71	3	7	7
CERL Reports	80	17	63	3	7	10
Engineer Update	74	39	35	2	10	14
FE Items of Interest	66	39	27	5	17	12
FESA Briefs Engineering	65	28	37	6	17	12
News-Record	65	22	43	3	19	13
SAME-Military Engineer	59	22	37	10	17	14
ASCE-Civil Engineering	37	11	26	6	36	21
REMR Bulletin	31	6	25	8	37	24
Benchnotes-CRREL	29	3	26	9	38	24
Army RD&A	24	2	22	14	37	25

Table 22: Readership Habits--DEH Respondents

Publication	Tot. %	Percentage of Positive Responses				
		Every Issue	Read Sometimes	Read Never	Do Not Receive	No Reply
FESA Briefs	86	48	38	-	8	6
FE Items of Interest	85	64	21	1	5	9
CERL Technical Reports	79	15	64	4	8	9
CERL Reports	78	18	60	3	7	12
Engineer Update Engineering	64	31	33	2	13	21
News-Record	52	14	38	3	25	20
SAME-Military Engineer	49	19	27	11	23	20
Benchnotes-CRREL	19	1	18	9	45	27
Army RD&A	19	1	18	13	38	30
ASCE-Civil Engineering	19	3	16	7	46	27
REMR Bulletin	11	1	10	9	49	31

Table 23: Readership Habits--Corps Respondents

Publication	Tot. %	Percentage of Positive Responses				
		Every Issue	Read Sometimes	Read Never	Do Not Receive	No Reply
Engineer Update	88	48	40	3	4	5
CERL Technical Reports	86	5	81	3	8	3
CERL Reports Engineering	84	18	66	3	8	5
News-Record	76	27	49	3	14	7
SAME-Military Engineer	72	25	47	11	7	10
ASCE-Civil Engineering	61	19	42	4	21	14
REMR Bulletin	61	14	47	5	18	16
Benchnotes-CRREL	44	7	37	10	29	17
FE Items of Interest	37	4	33	10	36	17
FESA Briefs	30	1	29	15	33	22
Army RD&A	24	1	23	16	37	23

The readership percentages listed in table 21 with the total responses may be a little misleading as many of these publications are directed more towards one group as opposed to the other. For example "FESA Briefs" and "FE Items of Interest" are directed towards the DEH audience. Tables 22 and 23 bring this point out.

Also, some publications have a limited distribution which may not include the survey audience. Military Engineer and Civil Engineering magazines are available only if an individual belongs to the professional organization that publishes it. "Benchnotes," a newsletter from the U.S. Army Cold Regions Research Engineering Laboratory, discusses findings on the effects of cold and ice on a variety of activities. This newsletter may not be sent to installations and Corps offices in warm climates.

The tables listing the responses of the DEH and the Corps identify some publications which have fairly high readership. "FE Items of Interest" and "FESA Briefs" are two newsletters which reach a large percentage of the DEH community. Of particular interest is the consistency in which they are read. Both publications have a high percentage of people who read every issue (FESA Briefs--48%; FE Items of Interest--64%). The high consistency of readership is probably a result of their newsletter style which consists of well marked subject areas and short articles. Another publication with a high consistency of readership by Corps personnel is Engineer Update. Update, a newspaper, features short articles well identified by informative headings.

Another newsletter, "CERL Reports," fared high in total readership for both the DEH and the Corps, but not very high in consistency of readership. One possible explanation for

this could be its irregular publication schedule which may lead respondents to believe they are overlooking some issues. "CERL Reports" also uses a different format which includes fewer and longer articles. This particular format may not be as appealing to read as that followed by "FE Items of Interest" and the other two publications. It is interesting to note that "Benchnotes" and "REMR Bulletins"--two newsletters which are similar in style and publishing schedule to "CERL Reports"--also had low consistency of readership scores.

On the Corps side of the house, Engineer Update has not only the highest readership percentage, but more importantly the highest consistency percentage. The Corps also has high readership of professional and trade publications such as Engineering News-Record, Military Engineering, and Civil Engineering. These nonmilitary publications also have fairly high consistency of readership scores for Corps personnel.

CERL technical reports and "CERL Reports" received high total readership scores for both the Corps and the DEH. The high readership scores for the technical reports somewhat contradicts information obtained from earlier interviews with high level Army personnel (See Chapter III). One possible explanation could be that those interviewed at a headquarters level received a wide variety of technical reports and could not possibly read all of them. The distribution of technical

reports to the Corps and DEH offices may be more restrictive in sending only those reports of interest to particular offices.

The last column in the above readership tables identifies the number of respondents who failed to respond to a publication. This column was included to draw a distinction between publications which were identified by respondents as not being received and no responses at all. One possible reason for a lack of a response for a particular publication could be the respondent's lack of familiarity with it. Almost all respondents checked off some publications and many of them checked off Engineering News-Record which was at the end of the list.

Factors Affecting Decisions to Use a New Technology

Respondents were asked to identify which of the following product claims or benefits would encourage them to try using a new technology. Many respondents checked off multiple answers. The percentages of respondents who answered positively to a claim or benefit are listed below.

Table 24: Persuasiveness of Product Claims

Claim/Benefit	Percent of Positive Responses			
	DEH	Corps	MACOM	Total
Reduced Labor and Cost of Operations	69	66	76	69
Improved Efficiency by Timesavings	60	52	57	57
Improved Product Quality	49	60	66	56

Due to the multiple answers by many respondents, the numbers are relatively close. One respondent said it was difficult to distinguish one claim from another as they are all interrelated. However, reduced labor and costs of operations were responded to by a somewhat larger percentage of respondents.

Other claims or benefits cited by respondents which would encourage them to try a new technology included increased durability and reliability, improved customer quality of life, and reduced paperwork.

The next question asked respondents to identify when they would try a new technology. The intent of the question was to determine how much information was needed by respondents before they would decide to use a technology. The percentages of responses to the listed options are provided below.

Table 25: When Would Users Try a New Technology

Options	Percent of Positive Responses			
	DEH	Corps	MACOM	Total
After Initially Reading About It	12	4	1	8
After Evaluating More Information	65	67	71	66
After Technology In Use and Results Available	36	42	29	38
After Use Became Mandated by Organization	4	11	1	8

The results suggest that the great majority of respondents would take it upon themselves to evaluate additional information on the technology and make their own decision on whether to use it. The second most frequently cited option was to wait until the technology was in use by others. Very few individuals would consider using a technology after initially reading of it, nor would they wait until some higher authority made it a requirement.

Respondents also identified available funds and the need to gain a supervisor's approval as conditions for trying a technology.

The final question in this part was intended to determine what sources of information a user would depend upon to assist him or her in making a decision on using a new technology. The percentage of respondents who responded positively to the source options are provided below.

Table 26: Sources of Information to Assist in Decisions On
Using a New Technology

Source Options	Percent of Positive Responses			
	DEH	Corps	MACOM	Total
Peers	48	61	48	54
Articles in Publications	36	25	23	30
Research Staff	21	29	48	27
Higher Authority	23	18	28	22
Architect/Engineering Firm	14	10	19	13

The majority of respondents identified peers as the prime source of information in helping them make a decision on using a new technology. Articles in publications and the research staff were ranked next in the frequency of responses.

Learning About USA-CERL Technologies

The last question asked respondents to identify as best as they could remember how they found out about the listed USA-CERL technologies. The technologies listed were either currently in use by the Army or were technologies which had been heavily publicized. The technologies are listed below in order of the most frequently recognized by respondents. The percentages listed under the three sources of information reflect the number of respondents who checked that source divided by the number of respondents who recognized the technology.

Table 27: How Respondents Learned of USA-CERL Technologies

Technology	% Respond. Recognized	Learn by Reading	Learn by Briefing	Learn by Word of Mouth
Pavement Maintenance System (PAVER)	74	62	39	21
Computer Aided Eng. & Arch. Des. (CAEADS)	71	53	39	34
1391 Processor	66	49	40	38
Building Loads Energy Analysis (BLAST)	56	57	27	32
Environmental Tech. Info. Sys. (ETIS)	48	53	31	25
Construction Manage. Software	46	48	38	27
Voice Activated Inspection System	45	50	44	16
Ceramic Anode	38	59	34	14
Concrete Quality Monitor	27	56	24	32
Portawasher	24	66	28	17

The above USA-CERL products received a fairly high percentage of respondents who recognized the product and identified how they learned of it. This high percentage is interesting when one considers that it is unlikely that all respondents would actually be users of the technology.

For all of the above technologies, the majority of respondents identified print material as the major source of information. This is not that surprising when one considers the variety of technical backgrounds for respondents. Respondents normally would not be in a position to receive briefings or attend workshops on technologies outside their technical expertise.

Familiarity of USA-CERL Products by Technical Group

A quick check was made comparing the number of positive responses to a USA-CERL technology against the respondents with a technical expertise that could use the technology. This information is summarized below.

Table 28: Familiarity of USA-CERL Technologies by Technical Backgrounds

USA-CERL Product	No. Identifying a Source	Not Familiar With Tech.	No Answer
Construction Respondents (Corps)--9 total			
Microcomputer Software	7	1	1
Voice Inspection	6	1	2
Concrete Monitor	4	3	2
Environmental Respondents (DEH & Corps)--19 total			
ETIS	18	0	1
Engineering Respondents (Corps)--17 total			
CAEADS	14	2	1
Building And Grounds (DEH)--15 total			
Portawasher	3	9	2

Although the numbers are too small to make any generalizations, technologies such as CAEADS and ETIS, which had a high recognition percentage by all survey respondents, had even higher recognition rates among the technical groups which would use them. Respondents within the appropriate technical group also cited printed materials as the major source of obtaining information on the technology. Technologies such as the Concrete Quality Monitor and the Portawasher, which had lower recognition percentages among all

survey respondents, also had low recognition rates among the technical groups which would use them.

Discussion

Printed materials currently are a prime source of information on new technologies. Respondents identified trade publications, technical reports, and newsletters as the major sources of information. Efforts to inform potential users of new technologies should concentrate on these media. Trade publications and newsletters typically consist of short, easy-to-read articles which effectively highlight important aspects of a technology. Technical Reports offer a much more detailed description of the technology for the interested reader. Articles placed in trade publications also add credibility to the technology of having been recognized by the editors as being significant enough to include in the magazine. These media are probably the most cost-effective means for reaching a large number of interested individuals. The key to success here is to ensure the distribution of these publications reaches the appropriate audience.

While print media currently serves as the prime source of information on new technologies, respondents indicated a preference for more one-on-one sessions with research personnel. Respondents still identified technical reports as a prime source of information on new technologies. However,

workshops and demonstrations were ranked high as preferred ways of receiving information. These activities provide more hands-on experience in using a technology and make experts available to answer questions. Even with the increased emphasis on one-on-one sessions, newsletters and trade publications still ranked high as preferred ways of receiving information.

In developing a communications strategy for informing potential users of new technologies, one needs to look at how best to use the various media. Newsletters and trade publications should be used primarily to create the initial awareness of a new technology. These publications contain short articles which are easy to read and do not often get too bogged down in technical information. Respondents indicated they rely heavily on these media for information.

The indicated preference for workshops and demonstrations suggests the respondents want more detailed information on a technology. Workshops and demonstrations are costly and usually only a selected few users can participate in such activities. If individuals can not participate in such activities, technical reports are the only other alternative for receiving this information. Yet, technical reports do not offer the freeflowing exchange of information between researcher and user.

As mentioned earlier the popularity of technical reports, as repeatedly shown throughout this survey, is somewhat surprising as it contradicts previous information. Criticisms of technical reports largely revolve around the length of the document and the cumbersome language of the research approach. Critics argued that nobody reads these reports. Yet, the survey shows technical reports are a primary source of information, a preferred source, and the majority of them are at least scanned by users.

Technical reports obviously serve a very important function. Technical reports appear to be a primary--if not only--source of detailed information on a technology for a user. Yet, not everyone who receives a technical report will be in the market for that amount of detail. Hence, we get the criticisms described earlier. Perhaps we need to rethink both the role of technical reports in technology transfer and the current distribution practices.

Another surprise from the survey was the relatively low preference by respondents for audio-visual materials as a means for obtaining information on new technologies. The availability of videotape playback equipment apparently is not an obstacle to the use of this medium. Over 80 percent of the respondents stated such equipment was available. The often cited concern on videotapes was how users can be encouraged to

view a videotape. The survey results suggest that the field is not too eager to look at videotapes.

Approximately 74 percent of the respondents use some type of electronic mail system. The big problem here is the wide number of electronic mail systems that are available. Respondents identified several systems that are currently being used.

The readership findings identified a high consistency of readership for newsletters and newspapers such as "FESA Briefs," "FE Items of Interest," and Engineer Update. These publications consist of short articles grouped together under subject headings or identified by informative titles. These publications can be easily and quickly scanned by readers for items of interest to them. This appears to be a good format for publications of this nature.

Nonmilitary magazines such as Engineering News-Record, Military Engineer, and Civil Engineering appear to be good publications in which to get articles on new technologies placed. These publications combine a high total readership of Corps personnel with also providing information on a technology to potential nongovernment users. As the readership survey shows, no single publication is guaranteed to reach all of the potential audience. Consequently, opportunities for repetitive placement of articles in different publications needs to be continuously sought out.

Efforts to inform potential users of new technologies should always try to identify the benefits of using the technology. A large concern of Corps and DEH personnel is reducing the costs of their operations. Respondents seem willing to evaluate information on a technology and decide for themselves whether that technology will improve the way they do business. Researchers and communicators need to become more aware of the types of information users need to help them make a decision on using a new technology.

Respondents indicated a highly credible source of information on new technologies is peers who have used the technology. Such individuals can provide their experiences of applying the technology in a real world environment. This exchange of information among peers can be fostered through laboratory-initiated users group meetings or the use of electronic mail systems which tie together individuals with similar responsibilities.

Finally, USA-CERL technologies received a fairly high recognition rates by survey respondents who may or may not use the technology. Those technologies which are in widespread use were recognized by a large majority of respondents. One final comment pertains to the lower percentage of respondents for the concrete quality monitor and the portawasher. Good publicity is an important ingredient to successful technology transfer, but it is only one ingredient. Both the CQM and the

Portawasher were well publicized, but external factors prevented their acceptance by users. There is a lot more to technology transfer than just getting the word out.

Chapter VI: The Process of Diffusion of Innovations--A Review of the Literature

Purpose

This literature review 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).

Within the Federal laboratory system, technology products consist of a wide variety of items. These items include information on research findings, information on new procedures or techniques, computer software programs, and hardware products (Hintz, 1986). This all implies an exchange of information on the product between researchers and users. Zaltman and Deshpande define information utilization as, "The process by which users' needs are determined and communicated to producers (researchers), leading to information designed to meet these needs, and eventually to new knowledge based on information that is passed on to users who apply it to answer their needs" (1979, p. 94).

A marketing orientation towards the use of technology and scientific information can increase the value of that information. As Goldhar states, "...information is a commodity in which marketing can create a much larger proportion of the value of the product than with most other products" (1979, p.27).

Kotler points out that a marketing orientation takes the focus off the product and puts it on the user needs. Products should be developed from a user's point of view, not the

producers' (Kotler, 1977). Goldhar says that such a marketing approach will require developers of information to identify the users, segment the market, learn about user behavior, and design information services that fit users' needs (1979).

Encouraging individuals to use products requires an active marketing plan to transfer the product to the potential users. The Office of Development and Implementation Division was established in 1970 by the Federal Highway Administration with the intention of transforming technology transfer from a "hit-or-miss" basis into a more planned and logical approach (Love, 1978).

This marketing orientation has affected the way commercial research laboratories conduct business. In the late 1970's, industrial labs restructured and restaffed themselves to accommodate a changing emphasis from furthering scientific goals to satisfying market needs. Research became oriented to developing new products and starting new businesses. Labs began hiring marketing-oriented people to supplement the skills of their technical personnel (Roberts and Frohman).

Several Federal organizations have formal marketing programs. The Department of Agriculture (Rogers, 1983, p.159), National Space and Aeronautics Agency (Janus, 1986), and the Federal Highway Administration (Griffith, 1982) have

established regional offices to support technology transfer efforts. However, the majority of Federal laboratories have neither an established network of field offices available to them nor adequate inhouse personnel to support extensive technology transfer activities (Lennon, 1982).

Federal laboratories face even more pressure to market their products as a result of the Stevenson-Wydler Technology Innovation Act of 1980. This law requires Federal laboratories to take a more active approach to transfer its technology to potential users at State and municipal governments and private industry (U.S. Congress). In addition these laboratories still need to ensure their technology is delivered to potential users within the Federal government.

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 (US 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 (See Chapter III).

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 (See Chapter III).

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 than with outsiders because there is a shared knowledge on both ends of the transaction and less chance for misinterpretation" (1977, 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 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 (See Chapter III).

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 Government 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.

New and Singer attempted to explain the human resistance to change by examining psychological and motivational constraints. They identified five causes of why people resist change: threatened self-interest, distorted perception of the intended change, objective disagreement with the change, psychological reactance, and low tolerance for change (1983).

Threatened self-interest consists of a concern by the technology user on how the technology will affect his or her job duties. Individuals may resist the introduction of microcomputers for fear their use may result in changes in their duties or even eliminate the need for their position. New and Singer point out that, "There is a tendency to camouflage the real reasons for resistance with other reasons the change should not be made" (1983, p. 52).

Resistance to change may also be a result of individuals not understanding the nature and implications of a change. In the microcomputer example, efforts to indoctrinate users should have emphasized the computers would eliminate the

repetitive tasks and result in more creative and challenging work.

Resistance as a result of objective disagreement arises when the goals of the individual and organization are the same, but the individual feels the change will not lead towards that goal. New and Singer point out that this can be a positive force in ensuring the change is properly done. Individuals opposing the change may have information which outlines problems which proponents of the change may not have considered.

New and Singer describe psychological reactance as resistance to change caused by the realization by individuals that their freedom to engage in desired behaviors has been threatened or eliminated by the change. The use of a technology being required from some higher authority could produce this type of reaction.

Finally, some individuals resist change purely because of inertia. This low tolerance of change may result from a particularly strong desire to avoid taking risks. New and Singer point out such resistance is purely emotional and often without a logical, rational, or intellectual basis.

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 FHWA, 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 (See Chapter III). 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 construction 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 (See Chapter III).

The Four Elements of Diffusion

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. Everett Rogers of Stanford University has conducted extensive research on diffusion activities. The findings of his research and those of other scholars have been summarized in Rogers' book, Diffusion of Innovations (1983). The following sections consist of the applications of these findings to the technology transfer activities of USA-CERL.

Rogers defines diffusion as the process by which an innovation is communicated through certain channels over time among members of a social system. This definition identifies four distinct elements in the diffusion process: 1) an innovation, 2) communications channels, 3) time, and 4) a social system (Rogers, 1983). These elements are described briefly here.

The Innovation

Rogers defines innovation as any idea, practice, or object that is perceived as new by an individual or unit of adoption. Time is not a factor in determining whether an innovation is new. If the idea is new to a potential user, it is an innovation.

Rogers further explains a technology or innovation in terms of it having two components--a hardware aspect and a software aspect. The hardware aspect consists of any material or physical objects which comprise the innovation. The software aspect of the technology consists of the information base for the innovation. The Concrete Quality Monitor developed by USA-CERL is a good example of this. The hardware items used to run the tests for analyzing the strength of concrete are one aspect of the innovation. The knowledge of the procedure to run the test is the software component of the innovation. Rogers points out that many technologies consist

of a mixture of hardware and software components. One component may be more noticeable than the other for some innovations. However, a technology can also consist of entirely information.

Communications Channels

Rogers points out the essence of the diffusion process is the exchange of information on an innovation from one person to another or group of others. The information is exchanged through the communications channels which are available to tie the two individuals together.

Both mass media and interpersonal communications channels are used to exchange information on a new technology. 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. The mass media channels available to USA-CERL consist largely of Army-published magazines and newsletters, letters, videotapes and films, electronic mail systems, and a limited number of commercially produced trade and professional publications (See Chapter V).

Interpersonal channels involve a face-to-face exchange between two or more individuals. These channels include briefings, workshops, visits by research staff to installations, and conferences. 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. In a recent study, Army personnel most frequently identified peers as a primary source of information for making decisions on using new technologies (See Chapter V).

Etgar identifies four channels typically used to transmit scientific and technical information from producers to customers (1979). These channels are shown in figure 1.

The Zero-Level Channel conveys information on an interpersonal basis directly from the producer to user. This is the quickest way to transfer information. This approach requires that the customer be personally known to the researcher.

The One-Level Channel consists of producers writing up research findings into books, journal articles, or newsletters. These publications are then sent directly to the users and are easily accessible. Some of these publications, such as journals, provide quality control service to users. Materials submitted to such publications have complex acceptance procedures to ensure certain standards.

The Two-Level Channel results in published materials such as books and journal articles being sent to a library where users can obtain such materials. The shipping of materials to libraries lengthens the delivery time of the information.

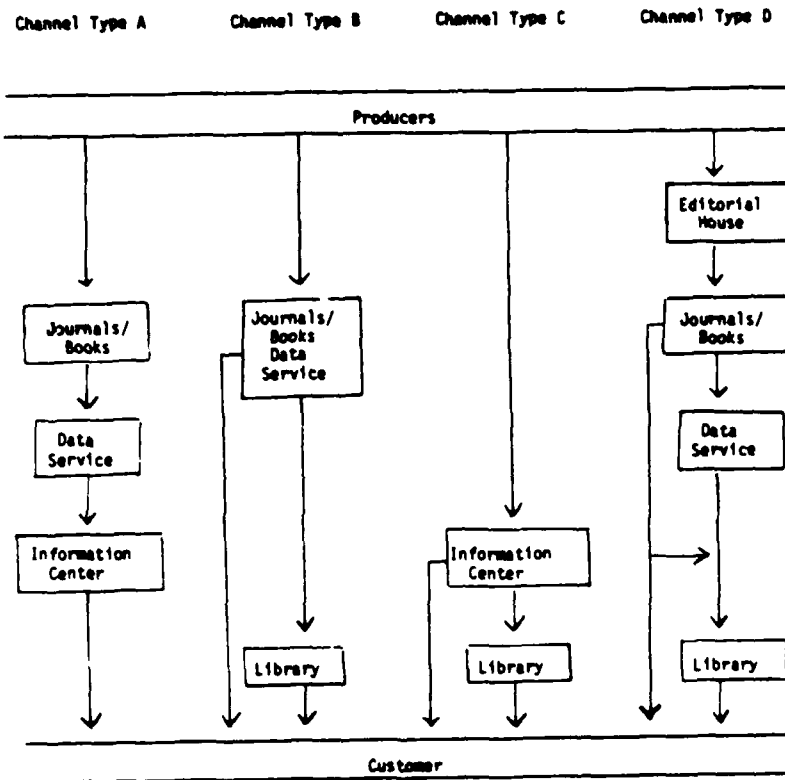


Figure 1 Distribution channels. (Source: Marketing Scientific and Technical Information, Zaltman and King, Westview Press, 1979. Used with permission.)

However, the library provides a large number of information materials and provides assistance in searching through the available information.

The Three-Level Channel adds another information intermediary in the form of a data base provider. Computer-based search systems will collect information on recently published material, code it into their computer service, and make the service available to libraries. Such computer services reduce the time of the search for information.

Time

Time is an important element which is valuable in understanding the diffusion process. Time provides the background upon which decisions are made on accepting or rejecting an innovation, in identifying the characteristics of those individuals who adopt early as opposed to later, and comparing the rate of adoption for one innovation as opposed to another.

A Social System

A social system is a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. Rogers points out the social system affects the diffusion of the innovation through existing norms on using innovations, roles of opinion leaders and change agents, decisions made on

diffusion activities within the system, and the social/communications structure within the system.

The social system for USA-CERL is the engineering community within the Army. As mentioned earlier, the diffusion of technology within this social system is complicated by several independent lines of authority. Engineers at Army installations are directly responsible to the Major Command (MACOM) overseeing their operation. USA-CERL and other Corps labs which produce technology designed for use at installations are responsible to another MACOM--the Corps of Engineers. Personnel at Corps headquarters provide guidance to installation engineers, yet lack complete authority to implement new procedures. The Corps of Engineers as a MACOM consists of numerous Division and District offices which provide engineering services to installation engineers. Engineers at Corps Divisions and Districts are also potential users of USA-CERL technology. A by-product of this social system is the lack of a clearly defined organization responsible for the diffusion of engineering-related innovations.

The Innovation Development Process

Rogers defines a six-step process through which an innovation comes into existence 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 (1985). 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 (See Chapter II).

There are several arguments which could be used to support placing commercializational/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 (See Chapter III). 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 (See Chapters II & III). 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 (See Chapter III).

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 (See Chapter V). 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 converts 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 (See Chapter II).

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 (See Chapter II).

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 (See Chapter III).

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

Rogers' examination of diffusion studies showed they generally agree that the rate of adoption for most innovations follows a similar pattern. The distribution of the rate of

adoption follows a normal bell-shaped curve when plotted over time on a frequency basis. The distribution over time on a cumulative basis takes the shape of an S-curve. Both of these curves are illustrated in the figure 2.

The S-shaped adopter curve rises slowly as only a few individuals initially use the innovation. Rogers suggests that once interpersonal networks begin spreading information on the innovation from peer to peer the S-shaped curve of adoption takes off. Rogers adds that the area of the diffusion curve after the 10 percent adoption and up to the 20 to 25 percent adoption is the heart of the diffusion process. After that point, it is probably impossible to stop the diffusion process.

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

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.

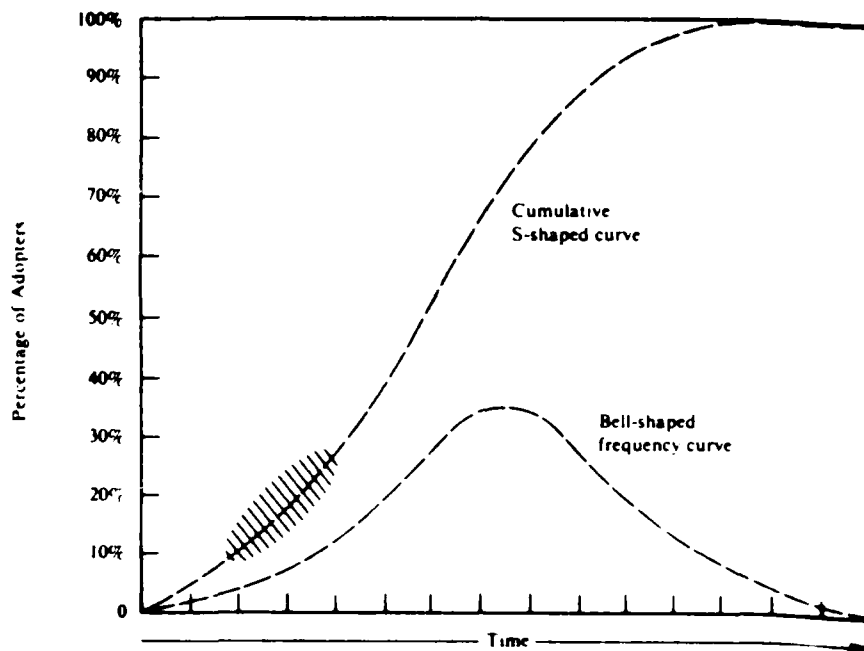


Figure 2 The bell-shaped frequency curve and the s-shaped cumulative curve for an adopter category. (Source: Diffusion of Innovations, Third Edition, by Everett M. Rogers. Copyright c 1962, 1971, 1983 by the Free Press, a Division of Macmillan, Inc. Reproduced by permission of the publisher.)

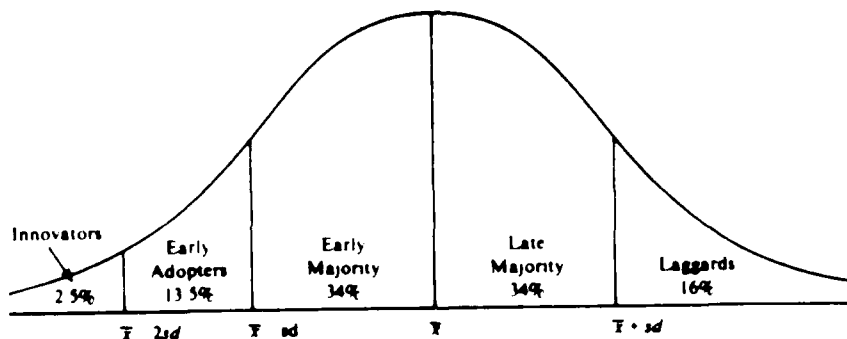


Figure 3 Adopter categorization on the basis of innovativeness. (Source: Diffusion of Innovations, Third Edition, by Everett M. Rogers. Copyright c 1962, 1971, 1983 by the Free Press, a Division of Macmillan, Inc. Reproduced by permission of the publisher.)

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.

Late Majority

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 (See Chapter V). 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 (See Chapter V). 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 find the following conclusions about the effects of incentives: 1) Incentives increase the rate of adoption of a technology. 2) At present, incentives are not used to the

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 increasing 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 adopted by individuals. Rogers points out that while technology clusters do not necessarily make sense, all research conducted in support of this approach

has indicated that the degree to which a technology cluster is perceived as compatible with the existing values, past experiences and needs of potential adopters is positively related to its rate of adoption. Rogers also states that technology clusters are most effective when they are perceived as being compatible with the existing values, past experiences and needs of potential adopters.

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 of 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 and his co-researchers suggest that certain characteristics of an innovation, such as its trialability, are related to its rate of adoption. The more trialable an innovation is, the more likely it is to be adopted. This is because the more trialable an innovation is, the more likely it is to be used by a larger number of users. This is because the more trialable an innovation is, the more likely it is to be used by a larger number of users. This is because the more trialable an innovation is, the more likely it is to be used by a larger number of users.

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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.

3.1.2.1.3. Activities in Support of Technology Transfer

A basic definition of communication is the transfer of information between two individuals or groups. There are four 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.

As illustrated in figure 4.

For the communication process of the communications process to be successful, as shown in figure 5, the communicator must have a message of interest to the receiver. The message must be presented in the eyes of the receiver.

The communication process

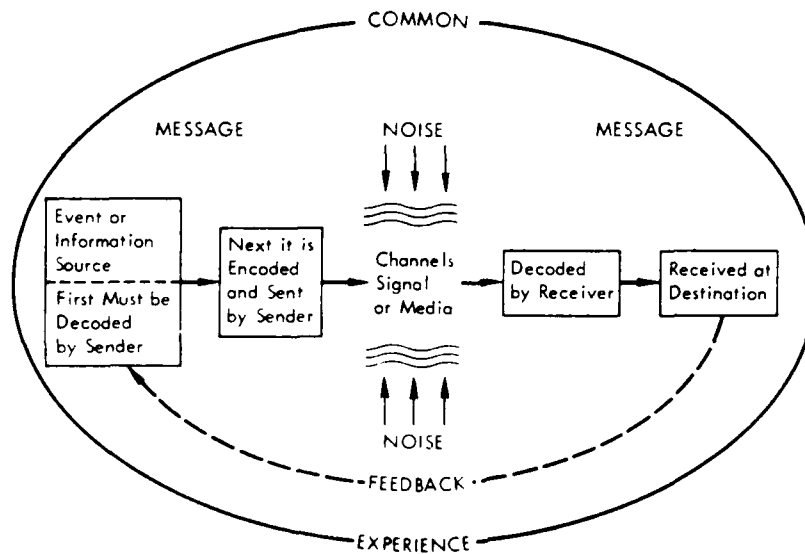


Figure 4 The communication process. (Source: Cutlip/Center/Broom, *EFFECTIVE PUBLIC RELATIONS*, 6/E, ©1985, p. 262. Reprinted by permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.)

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 (See Chapter III). 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 influenced 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 (See Chapter V). 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 (See Chapter V). 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. 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.

Sheth identifies four product-related factors that produce differences in how users perceive the utility of one information source from another. These factors are product content and design, dissemination efforts, past experiences, and professional-informal communications (Sheth, 1979).

Sheth points out that the content design of informational materials affects how customers will use them. Newsletters and technical manuals will be useful in different ways to users. Etgar reports that a researcher may be very interested in receiving information in different formats at the different stages of the research process (1979). References and citations are useful to the researcher in the literature review stage, abstracts are of value in the problem

formulation stage, and full texts of articles are of value in the research design stage.

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 (See Chapter III). 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.

Rogers identifies a sequence of roles a change agent must assume in introducing a technology to potential users (1983). First, the change agent identifies the need for a change in the mind of the user by providing information on the benefits of the innovation. Second, the change agent establishes an information-exchange relationship whereby he or she becomes a credible source of information and assistance to the user. Third, the change agent assists the user in diagnosing the

client's particular problem to determine why existing approaches fail to meet the user's need. Fourth, the change agent seeks to motivate the individual to change a behavior or attitude and attempts to create an interest in the innovation. In steps three and four, the actions of the change agent must be client-centered and focused on the situation surrounding the client and the problem situation which needs to be altered. Fifth, the change agent assists the client in translating intent to action by influencing the client's behavior. The change agent can only work indirectly here by activating peer networks to provide support in the decision process. Sixth, the change agent seeks to stabilize the decision to adopt an innovation by providing reinforcement to the client. Finally, the change agent terminates the relationship once the client is self-sufficient in using innovation.

The success of a change agent depends upon a variety of variables. Rogers has made the following generalizations on factors behind successful change agent activities. The first generalization is change agent success is positively related to the extent of change agent effort in contacting clients. Rogers warns that sheer amount of client contact is not the sole reason for success.

The next four generalizations emphasize the importance of the change agent being accepted by the client and being

perceived as a credible source of assistance. The second generalization states change agent success is positively related to client orientation, rather than a change agent orientation. The agent must be perceived as serving the user as opposed to someone trying to peddle an innovation.

The third generalization states change agent success is positively related to the degree to which the diffusion program is compatible with clients' needs. The agent needs to be able to identify user needs and provide assistance that meets those needs.

The fourth generalization states change agent success is positively related to empathy with clients. If change agents understand the problems and needs of the clients, he or she will be in a better position to assist them. The Army interviewee suggested that research personnel should spend some time with installation engineers in an effort to gain a much better understanding of the way they operate.

Finally, the fifth generalization states change agent success is positively related to homophily with clients. Rogers suggests that change agents should be as much like their clients as possible in terms of educational and socio-economic background.

Rogers points out that paraprofessional aides may serve effectively as change agents for a variety of reasons. Paraprofessionals lack the technical expertise of a

professional but still function much as a professional. Change agent would be paraprofessionals. They help to employ the professional. They handle the majority of the work and are in contact with situations needing more technical expertise than the professional.

Rogers points out that technical expertise may not be the most important quality of a change agent in the eyes of the audience. Personal acceptability of the agent may be as important, if not more so, than technical expertise. He also states that paraprofessionals often make up for their lower degree of technical expertise through their greater social expertise (1983).

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.

The first 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.

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A third generalization states that opinion leaders have a higher economic status than their followers. Rogers presents a study of Brazilian farmers in which the opinion leaders were those having much larger farms than others. A similar comparison within the Army would be opinion leaders who are found on larger or more prestigious assignments.

The last two generalizations to be presented identify the innovativeness of the opinion leader. The fourth generalization states that opinion leaders are more innovative than their followers. Rogers warns that the research does not indicate that opinion leaders are innovators. Often, innovators are viewed with suspicion by peers. A related generalization is when a social system's norms favor change, opinion leaders are more innovative; but when the norms do not favor change, opinion leaders are not especially innovative.

Rogers presents four techniques for use in identifying opinion leaders. These techniques include social network measuring, informant ratings, self-designation, and observations. A detailed explanation of these techniques is beyond the scope of this paper; the appropriate techniques are as possible tools for use in identifying opinion leaders.

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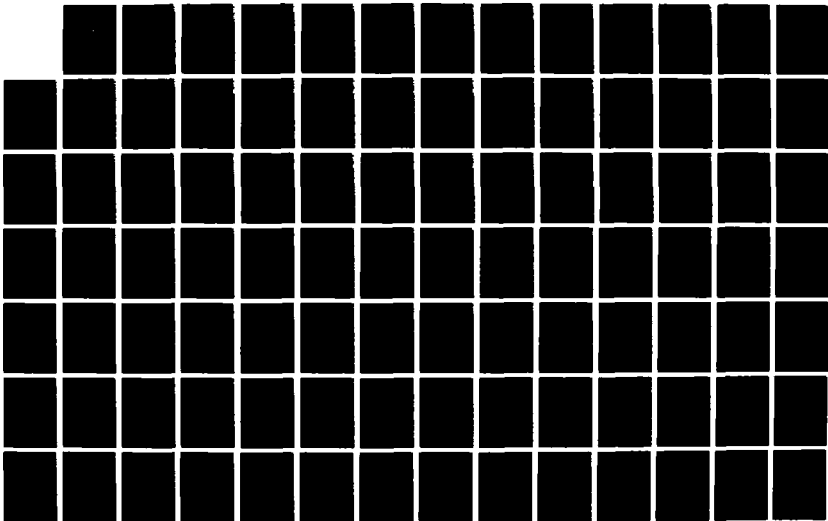
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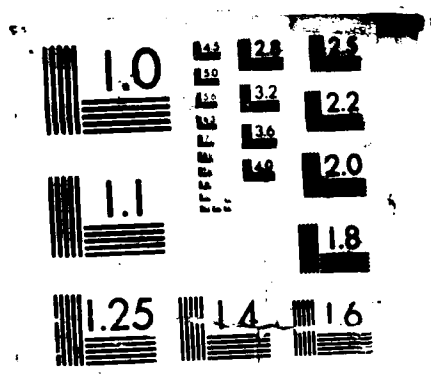
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Diffusion Networks

Rogers points out that, for the longest time, the one diffusion model dominated the thinking of diffusion research and practice. In this classical model, an innovation is developed by a research organization. The innovation is packaged and disseminated through change agents to potential users. These users act as a passive acceptor of the innovation and decide either to accept or reject it. The decision on which technologies to diffuse is determined by a small number of technical experts (Rogers, 1983).

This centralized diffusion model occurs within the military for some technologies. The Pavement Maintenance Management System (PAVER) was diffused this way by the Air Force. High ranking engineers within the Air Force tested PAVER and made its use a requirement by engineers at all its installations (See Chapter II).

But as Rogers points out, more attention is being devoted to the decentralized diffusion of innovations (1983). Under the decentralized diffusion model, innovations develop at operational levels of an organization and spread horizontally through peer networks. Under this approach, much reinvention of the innovation occurs as users modify the technology to suit their particular situation. Adopters often serve as their own change agents and decision makers on diffusion decisions.

The transfer of microcomputer software and technology for construction field offices is an example of a type of decentralized transfer. The decentralized transfer of the technology occurred after USA-CERL initiated some demonstrations of a few software programs and hardware systems. The transfer was facilitated by USA-CERL with the establishment of users groups and a newsletter for exchanging information on the microcomputer technology (See Chapter II). Similarly the transfer of USA-CERL's Environmental Technical Information System (ETIS) followed a horizontal or decentralized transfer model. No central body of experts mandated the use of ETIS. User interest in the system was essentially generated by word of mouth. The transfer of ETIS was aided by the existence of an electronic mail system which assisted in the exchange of information between users, and the users and the research staff (See Chapter II).

The following table developed by Rogers depicts the differences between centralized and decentralized diffusion systems. Rogers points out that the table suggests a dichotomy between the two approaches, when in reality some combination of both approaches occurs in diffusion (1983).

Rogers identifies some advantages and disadvantages to the decentralized diffusion system (1983). Decentralized diffusion systems produce innovations which are very responsive to user needs as much reinvention goes on. The

Characteristics of Centralized and Decentralized Diffusion Systems

CHARACTERISTICS OF DIFFUSION SYSTEMS	CENTRALIZED DIFFUSION SYSTEMS	DECENTRALIZED DIFFUSION SYSTEMS
1. The degree of centralization in decision making and power.	Overall control of decisions by national government administrators and technical subject-matter experts	Wide sharing of power and control among the members of the diffusion system; client control by local community officials/leaders.
2. Direction of diffusion.	Top-down diffusion from experts to local users of innovations.	Peer diffusion of innovations through horizontal networks.
3. Sources of innovations.	Innovations come from formal R&D conducted by technical experts.	Innovations come from local experimentation by nonexperts, who often are users.
4. Who decides which innovations to diffuse?	Decisions about which innovations should be diffused are made by top administrators and technical subject-matter experts.	Local units decide which innovations should diffuse on the basis of their informal evaluations of the innovations.
5. How important are clients' needs in driving the diffusion process?	An innovation-centered approach; technology-push, emphasizing needs created by the availability of the innovation.	A problem-centered approach; technology-pull, created by locally perceived needs and problems.
6. Amount of re-invention?	A low degree of local adaptation and re-invention of the innovations as they diffuse among adopters.	A high degree of local adaptation and re-invention of the innovations as they diffuse among adopters.

Table 29 Characteristics of Centralized and Decentralized Diffusion Systems. (Source: Diffusion of Innovations, Third Edition, by Everett M. Rogers. Copyright c 1962, 1971, 1983 by the Free Press, a Division of Macmillan, Inc. Reproduced by permission of the publisher.)

involvement by the users in learning about, developing, and acquiring the technology increases their sense of control and their willingness to adopt an innovation. The user participation in the decentralized diffusion network creates a self-sufficiency among the user and reduces the need for a change agent.

On the negative side, Rogers points out that technical expertise is not readily accessible under a decentralized system. Without the easy input or direction of technical experts, it is possible for bad innovations to be diffused. Second, completely decentralized systems lack a coordinating role or big picture of the problem. There is little guarantee that complete information on all aspects of the problem and the various alternatives will be passed along to everyone within the diffusion network. Finally, an innovation that some higher authority wants transferred may not be of interest to those communicating within the decentralized system and the technology may be ignored.

Rogers suggests decentralized systems may be appropriate for diffusing technology that does not require a high level of technical expertise to use. He adds that certain elements of centralized and decentralized systems can be combined to transfer a technology.

Innovation in Organizations

Earlier in the paper several obstacle to adoption technologies within an organization were presented. These included the emphasis by an organization on technology transfer and the effect of the human factor on adopting innovations. Rogers identifies several structural characteristics of organizations that also affect their ability to adopt innovations. These include centralization, complexity, formalization, interconnectedness, and organizational slack (1983).

Centralization is the degree to which power and control within a system is in the control of a relatively few people. Centralization inhibits the initiation of new technologies. However, a centralized system does serve to encourage and implement new innovations once a decision is made to adopt. As mentioned earlier, the decentralized nature of the Army can result in communications and coordination problems regarding technology transfer activities.

Complexity is the degree to which an organization's members have much expertise as evidenced by type of occupations and formal education. Complexity results in members suggesting innovations for adoption, but also makes it difficult for members to reach a consensus on the decision to adopt.

Formalization is the emphasis by the organization to adhere to rules and regulations. An emphasis on rules and regulations inhibits the consideration of innovations unless such innovations become part of the rules and regulations. The emphasis within the Army engineering community on rules and regulations materializes in the form of Army and Engineering Regulations. These documents provide guidance to installation engineers on how to conduct business and legitimize the use of the innovation. The long time required for gaining approval for new regulations impedes the technology transfer process (See Chapter II).

Interconnectedness is the degree to which units within a social system are linked together by interpersonal networks. A highly interconnected organization will allow for the exchange of information among peers which is critical to the innovation-decision process. The degree of interconnectedness within the Army is unclear at this time, although it does not appear to be high. Technology transfer activities need to foster such communications.

Finally, organizational slack is the degree to which uncommitted resources are available to implement an innovation. The more uncommitted resources available, the greater the opportunity to adopt new technologies. Within the Army, installation personnel would typically need to solicit funding from higher authorities at the major command

headquarters to purchase equipment for adopting new hardware technologies (See Chapter III).

Future Research Needs

In support of a marketing orientation, Zaltman lists numerous research opportunity areas which should be undertaken in the future (1979). Those areas of research opportunities of primary importance to the technology transfer activities of U.S. Army Construction Engineering Research Laboratory include the following:

1. Product redesign to achieve greater utility from research findings,

2. Improved systems for selective information dissemination to use users profiles so relevant information can be automatically and selectively provided,

3. Examine users' needs for information as opposed to providing information as a form of research documentation.

Sheth states that there exists an inadequate emphasis of the design and content of information products (1979). His concept of design includes format, writing style, medium of representation such as language vs. pictures, and packaging. He suggests that producers of scientific and technical information can learn a great deal on improving content and design from advertising agencies and commercial publication houses.

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Chapter VII: A Communications Strategy

Scope of this Communications Strategy

This report identifies a communications strategy in support of technology transfer activities. Communications activities relating to technology transfer enter into every phase of the research and development cycle. This strategy attempts to do two things. First, it identifies the various communications media available for use in developing a technology transfer plan. These media are discussed within the context of three general communications tasks: creating awareness, providing usable information to receivers of the technology, and creating mechanisms for exchanging information among users of the technology. Second, this strategy identifies the various communications activities that occur within each phase of the research and development process.

The strategy is designed for use in transferring technology to military users of USA-CERL technology. The strategy does not address technology transfer activities directed to potential nonmilitary users. However, the strategy described here could be used equally well for transferring users to nonmilitary users. The only difference would be in identifying and substituting those individuals and organizations in the private sector that could encourage the

use of a technology among a group of potential users. An example would be the American Public Works Association which has sponsored the use of USA-CERL Pavement Maintenance Management System among its members (See Chapter II).

The strategy identifies the communications objectives, tasks, and available media which should be considered for use at the various stages of the research and development cycle. This cycle was defined by Dr. Louis R. Shaffer, Technical Director of USA-CERL, and is described later in this report. Since this cycle currently represents the way USA-CERL conducts its research and technology transfer activities, any communications strategy needs to tie into the existing practice. The strategy incorporates the findings of previous reports in this series that have identified problems, processes, and strategies pertaining to technology transfer.

Research and Development/Technology Transfer Process

Within the research operation of USA-CERL, the innovation-development process has been defined by the laboratory's Technical Director, Dr. L. R. Shaffer (1985). The process consists of the following five phases: 1) problem identification, 2) research and development, 3) field demonstration, 4) product/system authorization, and 5) product/system application.

The process described in the following sections divides the research and development phase from the Shaffer model into two separate components--a research phase and a development phase. This was done to highlight the need to develop a packaging and distribution strategy early in the research, development, and transfer cycle. The development of the packaging and distribution strategy occurs in the development phase.

The innovation-development-transfer model can be divided into a development segment and a technology transfer segment. The first three phases--problem identification, research, and development--make up the research segment. The technology transfer segment consists of the last three phases--the field demonstration, the product authorization, and product application.

Problem Identification Phase

The innovation-development-transfer model begins with the identification of a problem or Army need. 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 responsible for looking 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 Phase

The research on how to solve the problem occurs in the second phase of the research, development, and transfer process. 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 it is transferred to the field. If the technology does not work in the pilot test, additional research and development work will be conducted or a decision may be made to cancel the project.

Development Phase

During the development phase, additional refinements to the technology are made based on the findings of the pilot test. In conjunction with this activity is the development of

a strategy on how to package the technology and transfer it to potential users.

One of the goals of the technology transfer process is to make users self-sufficient in the use of the technology. New users need to be trained on the use of the technology and mechanisms need to be established for providing follow-up support. The research community typically is not staffed to provide follow-up support. Training manuals and other support mechanisms should be thought out prior to the field demonstrations and incorporated into the demonstrations.

If commercialization/support considerations are developed prior to and incorporated into field demonstrations, the demonstrations will reflect real life situations and pave the way for later transfer activities. In situations where a patented product needs to be commercially manufactured, commercialization agreements should be completed before field demonstrations begin. Contractors providing support or training packages for use by the field in using the technology would replace laboratory personnel who typically provide such support in field tests. If the demonstrations go well and a decision is made to transfer the technology Armywide, the support mechanism would already be identified.

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 have users demonstrate how the innovation can effectively be used in the field. Another important function of the demonstration is to gain information on operational problems faced by users of the technology at demonstration sites. Insight can also be obtained on the effectiveness of training and support mechanisms. Finally, the demonstration will identify the benefit of using the technology, whether it be improved quality, time savings, or cost savings.

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 cost savings and other benefits 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.

Product/System Authorization Phase

Once the value of the technology has been proven in the field demonstration phase, a decision has to be made by someone to begin transferring the technology to potential users. In the Army, the decision to transfer a technology can be a variety of people or groups. Personnel at Corps headquarters or the MACOM sponsoring the research are potential decision makers. The packaging and distribution strategy will be finalized and approved by decision makers within Corps headquarters and the MACOM's receiving the technology.

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 and MACOM headquarters. Authorization documents should be developed and disseminated to users during this phase.

Product/System Application Phase

During this phase the technology begins to be used outside the field demonstration sites. The packaging and distribution strategy is put into effect in this phase. This strategy consists of an extensive information or awareness program to inform potential users of the existence of the

technology, its applications, and sources of support. 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 to assist users in implementing and reinforcing the use of the innovation.

Role of Communications in Technology Transfer

Communications activities are evident in every phase of the research, development, and transfer process. Inherent in these efforts are the identification of who those potential users are, the selection of the best media to reach those users, and the creation of a message suited to both the media and the users. Knowing who communicate with and the best way to communicate with them is critical to technology transfer.

Communications activities in support of technology transfer will require proponents of a technology and laboratory personnel to get involved with many different people for a variety of purposes. Some of these activities include surveying users to obtain information required for developing a product responsive to their needs, briefing decision makers on the status of the development of an innovation, or developing training packages to assist potential or existing users of the technology. These

communications activities will be identified later for each phase in the research, development, and transfer process.

The Two-Step Flow Theory

The two-step flow theory of communication has been used to describe how potential users of innovations use information in making decisions on adopting technologies (Rogers, 1983). This theory states individuals will first learn about innovations through messages provided through the mass media or personal contacts. This initial exposure to information serves to create awareness of the innovation by individuals.

Upon learning of a new technology, individuals will then seek out the opinions of peers or superiors on the innovation. Based on the feedback received from these individuals, a potential user will make a decision on trying or using the innovation. The strategy described later relies heavily on fostering the exchange of information among peer users of the technology.

Channels of Communications

The two-step flow theory identifies two types of communications channels used to exchange information on a new technology--mass media and interpersonal channels (Rogers, 1983). The strength of the mass media channels lies in their ability to 1) reach a large audience rapidly, 2) create

knowledge and spread information, and 3) lead to changes in weakly held attitudes. Interpersonal channels are face-to-face interactions between individuals with the purpose of exchanging information. Interpersonal channels are more effective in persuading an individual to adopt a new idea, especially if interpersonal channels link two near-peers.

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 (See Chapter V).

Interpersonal channels would typically bring a user into contact with either change agents or opinion leaders. A change agent is usually a representative of an agency promoting the use of an innovation. The change agent attempts to encourage potential users in adopting an innovation. Change agents provide a linkage between the change agency and the potential user. The two-way communication between the change agent and user is vital to the success of the diffusion of the innovation.

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.

Opinion leaders are those individuals to whom people look for information and advice on adopting an innovation. Opinion leaders typically have much credibility in the eyes of their followers. Peers of individuals also serve as a valuable reference for potential users of technologies. Both opinion leaders and peers 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, these influential individuals could be engineers at installations who have used a technology or engineers at the MACOM's who provide direction to installation personnel.

Change agents need to identify the opinion leaders and try to foster the exchange of information between such individuals and potential users.

Media to Support Communications Activities

Numerous media exist for increasing the awareness of new technologies and also for providing users with information for implementing the technology. These media are described below along with some comments from Army personnel on the effectiveness of the media. These comments were obtained from interviews with Army personnel at Corps headquarters and MACOM's (See Chapter III).

Demonstrations.

Demonstrations of technologies such as those conducted under the Facilities Technology Applications Tests (FTAT) program are a good way to show the usefulness of a technology in the field. Demonstrations as defined here are usually sponsored and funded by the research organization or agency promoting the use of the technology.

Demonstrations bring lab and field personnel together to work through field applications of technology. Demonstrations can be designed to increase awareness of a technology or provide hands-on knowledge to users.

A criticism of the demonstration approach was that it focuses only on transferring information to personnel viewing the demonstration. Some effort needs to be made to get information from the demonstration out to non-demonstration sites. Personnel involved in using the technology at the demonstration site can become valuable spokespersons for the technology among later users. These individuals should be involved in later information exchange activities among users.

Technical Reports.

Interviewees almost unanimously complained of technical reports being too long and too technical for benefit of users. The consensus was that busy schedules do not leave much time for the reading of technical reports. Another criticism of technical reports was that, for most readers, the significance

of the research is either buried or lost in the technical language of the report.

Two alternatives to technical reports currently being considered for use by Corps headquarters are executive summaries and technology notebooks. Executive summaries are condensed versions of technical reports which highlight the significant findings or observations. Such summaries are intended to create awareness of research findings without making it necessary to read an entire technical report.

Technology notebooks are four- to five-page summaries of research products in a newsletter format. Each notebook provides information pertaining to the application of a particular technology such as the cost of materials, type of materials needed, its applications, and savings. The intent of the notebooks is to provide the user with some practical information to assist in applying the technology.

Newsletters.

All interviewees thought newsletters were a good way to inform the field about new technologies. Short articles on a technology with a point of contact listed can be quickly reviewed by an individual. Newsletters are most effective when they have a narrow focus that defines a specific audience and subject content. "FESA Briefs" and "FE Items of Interest" are well read due to their narrow focus and easy-to-read format (See Chapter V).

Several newsletters are currently being published. Personnel at Corps headquarters thought the labs should submit more information to "FESA Briefs" and "FE Items of Interest" as a way of getting information on technologies out to installation engineers.

According to interviewees, the big problem with newsletters and all printed material is making sure the right people see and read them. Distribution lists ideally need to contain the name of the person to receive the publication and be updated regularly.

Articles in Technical and Army Publications.

The majority of interviewees believed the publication of articles in trade publications is a good way to inform potential users of new technologies--especially with individuals outside the military. The effectiveness of this approach in reaching military users is limited to what publications pass through the office.

Authorization Documents.

Guidance documents, such as engineering regulations and technical manuals, provide a good reference to the military user and also give some credibility for the use of a technology. The consensus was that it takes too long to get these documents approved and published. Interim alternatives to such documents, such as technical reports or users manuals, can be developed if approved by technical monitors of research

projects. Technical notebooks are being sent out to the field with the caveat that the information contained within the document does not represent official policy, but can be used by field personnel.

Workshops and Training Classes.

Presenting information on new technologies through workshops and training courses is a valuable way to assist users in implementing a technology. These activities allow for the two-way exchange of information on a technology between the expert and the novice.

Such activities are limited by the availability of travel funds and number of people who can be reached at one time. In some situations it may be possible to provide travel funds to installation engineers to enable them to attend these activities.

Presentations and Exhibits.

Presentations at Army Engineer conferences and other specialty conferences attended by Corps personnel are a good way to address a specialized audience all at once. Presentations at these conferences provide a good way of creating awareness of new technologies among attendees. Presentations at such conferences should be informational in nature, should be oriented to the field applications of the technology, and should avoid getting too technical.

Exhibits at such conferences may be effective in attracting attention to a technology. Handouts or staffing of the exhibit are a requirement to provide additional information to attendees expressing interest in the technology.

Audiovisual Presentations.

Videotapes were viewed to be a good way to brief individuals on a technology. Videotapes can be viewed at the leisure of the individual and the visual impact of seeing the technology applied to real life situations is much more informative than reading about the same technology. Slide presentations, which include an audio cued to forward the slides in conjunction with the presentation, can also be developed.

Videotapes are expensive to produce and may not be the most cost-effective way to create awareness of an innovation. A more effective use of the videotape would be to tie its use into some training activity. Videotapes can be effectively used in showing a viewer how to apply a technology and can serve as a substitute for sending a user to a training class.

Problems with mailing videotapes and slide presentations out to users include ensuring that the presentations are actually viewed and that equipment is available at the receiving end for viewing.

Electronic Mail and Bulletin Board Systems.

With the steadily increasing use of computers, electronic mail and bulletin board systems are available for sending information on new technologies out to potential users. From a communications standpoint, these systems would function much like a newsletter in increasing awareness of technologies with some additional benefits. The electronic systems would provide immediate access to small pieces of information at the push of a button. These systems improve upon the newsletter in that they allow for a two-way exchange of information. A user with a question on something he or she read through this medium can send an electronic message to an expert requesting additional information.

A problem with the electronic mail system is finding one which reaches the user community that would be interested in the technology. This problem is complicated by the numerous electronic mail systems available.

Hotline Services.

Some laboratories have established formal hotline or phone services for dealing with questions on the use of a technology. Users can dial a phone number to obtain answers to their questions on the use of a specific technology or to learn of other options for resolving a technical problem.

Types of Communications Activities

Creating awareness of a technology among potential users or decision makers is just one type of communications activity involved in technology transfer. Another communications activity involves disseminating information designed to assist the user in applying the technology in his or her particular work environment. An example of this is the development of training manuals or sponsorship of training workshops. A third communications activity which occurs is the provision of information on new applications of the technology or the availability of support to users in applying the technology. This continual updating and exchange of information can be promoted through the establishment of meetings of users to discuss the technology, or the use of newsletters or electronic bulletin board systems. A more detailed discussion of these three activities and the applicable media for use in conducting these activities follows.

Awareness Activities.

These activities are designed to inform potential users of the availability of the technology. One commonly used action is a direct letter from the MACOM to field personnel supporting the use of a technology. This support would consist of encouragement to use the technology, general guidance on how to go about implementing the technology, and

approval authority to purchase any equipment needed to use the technology.

This action could be backed up or replaced by placing articles on a technology in newsletters distributed to potential users. Articles should also be sent to electronic mail or bulletin board systems to inform users on the availability of new technology. Short articles emphasizing the applications and benefits of the technology with a point of contact listed are more likely to be read than some lengthy technical article, although longer articles are also effective in creating awareness of a technology. The key consideration with articles is to make sure the articles appear in publications which will be read by potential users.

Awareness activities could also consist of briefings and presentations at conferences attended by users. The Army conducts annual conferences for several specialty groups such as the DEH Conference, MACOM level engineer conferences, or Chief of Engineering Divisions within the Corps. Lists of dates and participants in these conferences are available for use in identifying potential meetings.

These briefings should emphasize the applications and benefits of the technology with only a minor emphasis on the technical aspect of the technology. More technical information of a how-to-do variety can best be provided by training manuals and training workshops.

Provisions should be made to provide follow-up information to individuals who may request such information after reading about the technology. Fact sheets, brochures, or other information summarizing the technology should be made available to individuals upon request. Technical reports can be sent to individuals to provide more detailed information on the innovation.

The above communications activities can also be directed towards obtaining the participation of a commercial firm in manufacturing the technology or some organization to provide user support for the technology.

Providing Usable Information.

Training packages need to be developed to assist the user in applying the technology in his or her environment. Training manuals or instruction sheets should be developed for all technologies. Videotapes showing step-by-step procedures for using a technology or installing equipment can effectively supplement such training materials.

Army guidance documents, such as Technical Manuals, Engineering Regulations, and Engineering Technical Letters, are official documents used in providing guidance to the field. These documents need to be incorporated into distribution strategies. These documents are subject to a long review process which may prevent their timely distribution to the field. Technology notebooks, if approved

and distributed by MACOM personnel or sponsors, could serve as interim guidance until formal documents are finalized.

Training workshops can be used to assist users in the application and use of the technology. Such workshops are costly in terms of travel and manpower. However, more complicated technologies may require such training for users. Formal training programs, such as through the Corps Huntsville Division, could be established. Similar technologies could be grouped together under one training program. The workshops could be conducted initially by research or support personnel.

Support Activities.

Once a technology is in use by a large majority of potential users, an information exchange network among users needs to be developed. Such a network will facilitate the exchange of information on new applications of the technology developed by users, problems encountered in applying the technology, and modifications to the technology by users to make it more responsive to local needs. This network will also be instrumental in providing information to support new users of the technology.

This information exchange network needs to be maintained by someone. Ideally, support personnel tasked with providing assistance to users should have the lead responsibility for this. But, the key to the success of the network depends on the participation and input of the user. This participation

and input will direct the activities of support personnel towards problem areas in using the technology. This participation and input will also foster new applications and the re-invention of the technology, whether it be done by research personnel, the user, or support personnel.

Several mechanisms exist for fostering this exchange of information. The newsletters should have a narrow focus in both subject matter and audience. Newsletters should be designed for the technology or technology area only and be distributed to existing users or Army personnel responsible for activities which could be resolved by the technology. A large portion of the articles and informational materials for the newsletters should come from the users. To get the newsletter started, articles should be solicited from those users involved in the field demonstrations. Support personnel should write up material pertinent to their activities. Support personnel should be responsible for soliciting such articles, editing them, printing, and distributing the newsletter.

In conjunction with the newsletter, an electronic mail or bulletin board system could be established to provide an interactive exchange of information among users of the technology. Through these electronic mail systems, support personnel and users could answer questions raised by other users. The bulletin board system could be used to post

information with the idea of initiating an electronic discussion on the topic which can be viewed by all users. Newsletter articles could be the spark that fosters discussions over the electronic systems.

Another key item to be included in the electronic bulletin board system is a library of points of contacts, published materials on a technology or problem area, or information on suppliers or contractors providing technology services. Those individuals involved with the technology during the demonstrations should be identified as points of contacts to new users.

Initially these electronic systems should be used to supplement a newsletter. Some electronic bulletin board systems already exist that reach out to users of energy and environmental technologies. Additional systems may need to be developed for other technology areas. Once these electronic systems have gained acceptance and widespread use by the field, the entire newsletter could be published electronically.

Regular meetings of all or a select group of users could be initiated by support personnel or sponsor of initial research to promote more detailed discussions on the technology and its use. Participants in these meetings could provide direction to future research activities and the operations of the support personnel. Personnel from the

demonstration sites should be involved in the initial meetings of users. Their experience and knowledge of the technology will be of great assistance to first time users. Eventually, new users will surface as additional opinion leaders as more people adopt and become familiar with the technology.

The availability of the information exchange network needs to be publicized during its initial establishment and throughout its existence to draw new users into the network and reinforce its continued use among current members. Articles in Army publications, general topic newsletters such as "FESA Briefs" or other MACOM publications, letters direct to potential users, and informational briefings at conferences are some of the mechanisms for accomplishing this publicity. Support personnel should take the lead on these activities.

Once the technology was in use for some time, additional training workshops may need to be conducted by the support staff to train users in new applications of technology. Revisions to the training material may be necessary as the technology evolves through use due to modifications to it by users. The availability of workshops and revisions to training documents could be publicized through the information exchange network. The support staff should also take the lead on these activities in conjunction with the sponsor or research organization.

Communications Strategy for Technology Transfer

The following sections describes the various communications activities pertaining to each phase within the research, development, and transfer process. The communications activities are defined in terms of the communications objectives, tasks, target audience for communications activities, and media used in conducting communications activities.

Problem Identification Phase

Technology Transfer Goal.

To identify the problem/need which needs to be resolved and the requirements of the ultimate user.

Communications Objectives.

1. Identify the specific details of the problems or needs which need to be resolved by the development of the technology.
2. Identify the individuals or groups of individuals who will be using the technology.
3. Identify the environment in which the technology will be applied, specifically looking for potential operational problems which need to be considered in developing the technology.

Communications Tasks.

In support of objectives 1 and 2, it is necessary to discuss the problem with those individuals sponsoring the research to develop a thorough understanding of the problems and issues to be resolved, and who will be using the technology.

In support of objective 3, once the problem has been defined by the sponsor, additional information on particulars of the problem should be obtained from potential users of the to-be-developed solution to the problem. Special attention should be directed to the environment in which the problem is occurring which may affect the development of the technology.

It may be advantageous to publicize the initiation of the research at this phase with the intention to obtain additional input on particulars of the problem from unknown potential users. Once additional input has been gathered on the problem or need, the research sponsor should be briefed on the findings before proceeding to the next phase.

Target Audience.

In this phase, the primary audiences are the sponsor of the research and potential users of the to-be-developed innovation. The sponsor could consist of a technical monitor, a MACOM providing reimbursable funding, or a technology steering group. A sponsor should be in a position to approve the use of a technology.

The key audience here is the potential users. While the sponsor may have a good overall understanding of the problems of the user, he or she may lack specific information on the ramifications of the problem as it occurs for the user. The potential user is also in a better position to identify operational difficulties surrounding the problem.

Potential users can be obtained from the sponsor or by randomly contacting individuals involved in activities affected by the problem. Unknown users can also be solicited to comment on the problem through publicity activities or surveys.

Supporting Media.

Most of the communications activities at this point are designed to obtain information. Person to person meetings or phone conversations can be used to discuss the problem with both the sponsor and the users.

Additional input from a larger number of users can be obtained through informal surveys sent by mail. Requests for input could be made through short articles published in appropriate publications, electronic mail messages, or by direct letter. Requests made through mass media channels should specify particular information needed to fill in knowledge gaps pertaining to the problem.

Keys to Success.

It is important to contact the potential users of the to-be-developed innovation in order to understand how they operate and how the problem affects their activities. If the problem only affects a few individuals, it should be relatively easy to contact most of these individuals and obtain an accurate and thorough understanding of the problem and operational factors surrounding the problem. If the problem affects a large number of individuals, it may be more difficult to identify all possible ramifications of the problem for the large number of different individuals and operations. A broad range of users from different types of operations should be contacted.

Research Phase

Technology Transfer Goal.

To develop an innovative product or procedure which effectively resolves the problem and meets the needs of the user.

Communications Objectives.

1. Keep the sponsor informed of the activities involved in the development of a solution to the problem.
2. Obtain user input into the development of the solutions to the problem.

3. Create initial awareness of the developed technology among potential users both at the pilot test site and Armywide.

Communications Tasks.

Many of the communications activities in this phase center around obtaining input to the development of the alternatives and final solution to the problem.

In support of objective 1, the sponsor of the research needs to be kept informed on progress of the research and development activities.

In support of objective 2, input on alternate solutions to the problem leading to the final solution needs to be solicited from the sponsor and selected users throughout the development process. The sponsor and selected users should also provide input to the site for the pilot test.

In support of objective 3, personnel at the pilot test site need to be briefed on the activities surrounding the pilot test. Informational materials may need to be developed to assist site personnel in using the technology during the pilot test.

If the pilot tests prove successful, the findings should be publicized as a way of introducing potential users to the existence of the innovation.

Target Audience.

The audience for the above communications activities are the sponsor, selected users asked to provide input to the development of alternative solutions, and decision makers and users at the pilot test site.

In this phase, the first effort is made to publicize the innovation to users and decision makers not previously involved in the development process.

Supporting Media.

Briefings or informal discussions with the sponsor should be used to inform him or her of research progress and to obtain input. Meetings of users should be conducted at key points in the research and development process to obtain their input. Once a site for the pilot test has been identified, the research staff and the sponsor should brief key personnel at the site on the pilot test activities. Depending on the way the test will be conducted, the research staff may need to train site personnel on use of the technology. Written materials may need to be developed to assist site personnel in using the technology during the pilot test.

Short articles on the successful completion of the pilot test should be placed in appropriate publications, such as the "Daily Staff Journal" at Corps headquarters or newsletters such as "FE Items of Interest," which are read by the target audience.

Keys to Success.

One key is the continued input from users throughout the development of the solution. Another key is the continued coordination between the research staff and the sponsor. The response by site personnel to materials developed to assist them in using the technology during the pilot test will be useful in determining future training packages.

Development Phase

During the Development Phase, final refinements to the technology should be made. The development of the packaging and distribution strategy also occurs during this phase. This strategy is necessary to provide training information and support to users of the technology during both the field demonstrations and later on during Armywide implementation.

It is important that the packaging and distribution strategy be thought out prior to the Field Demonstration Phase. Elements of this strategy should be incorporated into the demonstrations and decision briefings during the Field Demonstration Phase.

Another key consideration in this phase is the identification of potential support groups to assist users with the technology during the field demonstrations and, later, during transfer efforts. In the case of hardware items, commercial firms may need to be identified and

consulted. These firms may assist in the development of a production model of the technology. These firms will ultimately manufacture the technology and provide follow-up support to users.

Technology Transfer Goal.

To develop an approach for distributing the technology to users which includes training materials, a deliverable hardware product when applicable, and follow-up support with the end goal of having a self-sufficient user applying the technology with minimal support from laboratory personnel.

Communications Objectives.

1. Provide instructional/training materials to assist the user in applying the technology onsite during the operational tests. These materials can serve as interim documentation until more formal Technical Manuals or Engineering Regulations can be published.

2. Develop a strategy for later (a) informing users of the availability of the technology, (b) distributing the technology to Armywide users following the operational tests, and (c) providing follow-up support to users.

3. Obtain support for the distribution strategy from key Army personnel within the MACOM's who will be involved in transferring the technology following its approval for Armywide transfer.

Communications Tasks.

In support of objective 1, it will be necessary to produce training materials or instructions which will assist the user in implementing the technology. Test the usefulness of the training materials during operational tests and modify materials as appropriate.

In support of objective 2, communications media and distribution mechanisms that will be used in making the technology available to potential users need to be identified.

Another task is to solicit and obtain agreements from military or nonmilitary sources who will be able to provide follow-up support to the field users during the later Armywide implementation of the technology. If possible, support personnel should be asked to participate in the field demonstrations.

In support of objective 3, key decision makers need to be identified within the MACOM to receive the technology and solicit their input and support for the distribution strategy.

Target Audience.

Training materials will be designed for the intended user as defined earlier in the problem identifications phase.

Support personnel consist of those persons who will be responding to questions from Army personnel on the use of the technology. This assistance will be provided to users during both the operational tests and once the technology is

implemented Armywide. Sources of such support are the Facilities Engineering Support Agency (FESA), commercial firms providing such services, support center personnel established at universities or professional associations, Corps of Engineers Districts assigned such responsibilities, or research laboratory personnel.

Someone will need to be identified to oversee the operations of the support personnel. This could be the research staff working with the sponsor of the technology, the sponsor, or a committee of Army personnel responsible for decisions on the use of new technologies over a given subject area.

The distribution strategy should be discussed and approved by the sponsor of the research and decision makers at the various MACOM's who will be involved in implementing it. The briefings to MACOM personnel on the distribution strategy could occur during the briefings on the field demonstrations.

Supporting Media.

Detailed sets of printed instructions or training manuals will provide both instructions in the use of a technology and also serve as a handy reference for the user.

In some cases, videotapes showing a step-by-step application of the technology may be developed to support the training materials. The training materials in 1a and 1b should be designed for the user who will have no knowledge of

the technology. The training materials should be designed to be the sole source of information for users on learning to use the technology.

More complicated technologies may require the use of formal training workshops led by research staff or support personnel. The developed training materials would become the handout material for the workshops.

The communications activities within the distribution strategy will consist of a variety of mechanisms which can be grouped into the three types of communications activities discussed earlier: awareness activities, the provision of usable information on technology to users, and support activities. The available media for use in these activities were previously discussed in the section entitled, "Role of Communications in Technology Transfer."

Keys to Success.

Effective training packages are a key to minimizing the amount of follow-up support needed by field personnel. For technologies which contain difficult procedures, it may be a good idea to solicit the help of outside contractors with experience in developing training materials. Bringing in an outsider is valuable for two reasons. One, engineers typically are not educators; specialists in developing training materials, such as industrial education personnel, are perhaps better suited for such tasks and should be

consulted in designing such materials. Two, the familiarity of the engineers with the technology can make it difficult for him or her to step back from the technology and identify potential problem areas for learners. At bare minimum the instructional or training materials should at least be edited by inhouse editorial staff for readability and tested on other individuals not familiar with the technology prior to the operational tests.

Another key to the distribution strategy is the involvement and support of the research sponsor and decision makers at the MACOM. Their active support in approving and encouraging the use of a technology is a critical first step in the acceptance of the innovation by users. MACOM personnel have more contacts and direct lines of communications with engineering personnel at installations under their purview. MACOM personnel are often looked to by the field for guidance and support.

Field Demonstration Phase

Technology Transfer Goal.

To demonstrate the technology in real life settings to show its effectiveness, determine operational difficulties encountered by users of the technology, and make further refinements to the technology. The findings from the demonstration will be used to obtain support for the

technology by Army decision makers and later from users during Armywide implementation.

Communications Objectives.

1. Obtain support for operational tests, and packaging and distribution strategy from key Army decision makers within OCE and the MACOM's, and from personnel at the demonstration site.

2. Develop the initial group of users who will later serve as spokespersons or peer experts during Armywide implementation of the technology.

3. Finalize training packages for later use in Armywide transfer of the technology.

4. Create awareness of the results from the demonstrations of the technology throughout the potential user community.

Communications Tasks.

In support of objective 1, obtain support and approval for the demonstrations from key Army decision makers within OCE and the MACOM's. During this time, support should also be solicited from key Army decision makers on the proposed packaging and distribution approach.

In support of objective 2, solicit the assistance of users from the field demonstrations in Armywide transfer activities. Identify users at the demonstration sites who

will later serve as spokespersons for the technology during Armywide implementation.

In support of objective 3, obtain input on the effectiveness of the training materials from the users at the demonstration sites. Modify the training materials as appropriate. If videotapes are to be used as a supplement to the training package, videotape footage should be shot on location at demonstration sites.

In support of objective 4, publicize the technology to create awareness of both the technology and the demonstrations among the user community.

Target Audience.

Key personnel at OCE and the MACOM's include those individuals with decision making responsibility in areas affecting the use of the technology. The sponsor can assist in identifying these individuals who may exist at several levels of the organization's hierarchy. It may be necessary to contact people at several levels of the organization before contacting the one individual who has the ultimate authority to approve the use of the technology. Each MACOM slated for a demonstration or the future use of the technology needs to be contacted at this time.

Typical decision makers for technologies to be used by installations include branch chiefs within the Facilities Engineering Division at OCE, and later the division chief;

branch chiefs within the Engineering Division at the MACOM and later the chief of the Engineering Division; and in cases where Corps personnel will be involved in supporting installations in use of the technology, the chief of the branch at OCE which is responsible for providing that support, and if necessary, the chief of the directorate.

At the demonstration site, the audience consists of the section chief responsible for the staff who will be using the technology, and the staff itself, and the high ranking individual responsible for the organization on some occasions.

Personnel at field demonstration sites can become valuable spokespersons for the technology among other peers. Considerations for selecting demonstration sites should include the ability and willingness of the users to later serve as spokespersons for the technology. These individuals and potential sites for the demonstrations could be solicited from branch chiefs at the MACOM level. The decision on demonstration sites should be made in conjunction with the branch chief at the MACOM, the sponsor, and administrators at the proposed site.

The modifications to the training materials will require input from the users at the demonstration sites.

Once the demonstrations are underway and look successful, the overall user community should be informed. The user community will consist of both Army users as defined in the

problem identification phase and, in some cases, commercial organizations that will be involved in providing the service to the Army users.

Supporting Media.

Decision makers should be contacted directly through formal briefings, which would describe the technology, the demonstration activities, and the packaging and distribution strategy. The sponsor of the research should take the lead in the briefings with assistance from research personnel. Once the briefings reach the level of the ultimate decision maker at the MACOM, the branch chief or his alternate should be involved in the briefing--hopefully as an active proponent of the technology.

Users at the demonstration sites should be asked whether they would be willing to write articles and participate in later information exchange activities, such as user groups meetings or briefings.

Training materials consist of those previously determined of value for the particular technology. These materials can include written instructions and manuals, how-to-do videotapes, and workshop presentations.

Mass media channels should be used to create awareness of the demonstrations and the technology at this phase. These channels include articles in newsletters and publications, existing electronic mail and bulletin board systems. The

demonstrations could also be a presentation topic for specialty conferences attended by potential user groups.

Keys to Success.

The key goal in this phase is to obtain the support and commitment of someone in the MACOM who is willing to become an active proponent of the technology. Someone at the MACOM level has to get involved in seeing that the technology is eventually made available to users within that MACOM.

Product/System Authorization Phase

Technology Transfer Goal.

To obtain the commitment and approval of decision makers authorizing the use of the technology and initiate activities in preparation for the transfer of that technology to users.

Communications Objectives.

1. Obtain the commitment of decision makers within OCE and the MACOM's to actively transfer the technology to users.
2. Initiate preparations in support of implementing the packaging and distribution strategy.

Communications Tasks.

Inform decision makers on the findings of the field demonstrations. Obtain a commitment by the decision makers to authorize the use of the technology among their personnel and to actively involve themselves in such activities. This commitment may include funding assistance for the activities

of the support personnel or to assist users in purchasing needed equipment for the technology, or ensuring that the necessary guidance documents will be authorized and distributed to the users.

Obtain input from decision makers to finalize the packaging and distribution strategy for the technology to include a timetable of activities and identification of those responsible for the actions.

Prepare materials for use in creating the awareness of the technology and available sources of support among potential users per the packaging and distribution strategy.

Prepare interim guidance for transmittal to the field instructing users on implementing the technology. The interim guidance will be in effect until formal guidance documents can be prepared. Initiate preparation of formal guidance documents authorizing the use of the technology.

Ensure supplies of training materials, hardware items, and other pertinent items are available for distribution to the field.

Ensure support mechanisms are ready to be put into operation in place and adequate support personnel are available and trained.

Target Audience.

The decision makers contacted should be the same individuals briefed prior to the operational tests. Decisions

on finalizing the packaging and distribution strategy should be worked out with the appropriate branch chief at OCE and the MACOM prior to the briefing before the ultimate decision maker. The preparations for packaging and distributing the technology should be conducted in coordination with the OCE and MACOM proponent.

Formal guidance documents will need to be coordinated with the appropriate individuals at OCE following the decision briefing. These individuals should also be informed of the interim guidance being sent out by the MACOM.

Support personnel identified in the packaging and distribution strategy should be briefed on the decisions pertaining to them and preparations made for formal operations.

Supporting Media.

The majority of activities at this phase will center on interpersonal communications activities such as briefings and follow-up phone contacts.

Considerations should be made to provide interim guidance to users on implementing the technology while formal guidance documents are being prepared, reviewed, approved, and published. The training package accompanied by a letter from the MACOM official authorizing its use could be used as interim guidance.

Keys to Success.

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.

The existence of authorization documents alone is insufficient in ensuring the use of technology by installation personnel. The MACOM needs to take an active role in advocating the use of the technology. The MACOM must provide both encouragement and financial support in some cases in order for the technology to be used by installation engineers.

Mandating the use of a technology may not always be the best way to go. Some technologies may not be applicable to all installations. Forcing the use of the the technology where it may not be effectively used may create a hostile attitude towards the technology, its developer, and the MACOM.

An alternative to requiring the use of a technology would be for the MACOM to first request installation personnel to consider the use of the technology and ramifications of its applications. Their findings should be reported back to the MACOM. The MACOM can then consider the findings and work with research personnel or support personnel to make adjustments in the technology or funding to enable the technology to be used.

Product/System Application Phase

Technology Transfer Goal.

To distribute the technology to users Armywide and provide assistance to users in its implementation.

Communications Objectives.

Implement the packaging and distribution strategy defined earlier in the process.

Communications Tasks.

Create awareness of the existence of the technology and the availability of assistance to the field in using the technology.

Training materials should be distributed through the MACOM's. The MACOM's should also sponsor the training workshops to assist users in the initial implementation of the technology.

Selected support personnel should implement and maintain information exchange network activities among users.

Target Audience.

The key audience during this phase is the actual users as defined in the problem identification phase. The majority of the communications activities during this phase will be directed towards them.

It may be necessary to direct some of the information awareness activities towards the supervisors of the people who will be using the technology. Their support for the

technology will be a prerequisite for the users to implement the technology.

Finally, the peer spokespersons for the technology--those individuals who used the technology during the field demonstrations--need to be identified and brought into the information exchange network activities.

Supporting Media.

(See discussion on media in section entitled, "Types of Communications Activities.")

Keys to Success.

The keys to success at this phase consist of the visible support for the technology by the MACOM's, effective training materials, the existence of a responsive support staff to assist users with questions during the implementation, and the active involvement of opinion leaders drawn from the ranks of users from the demonstration sites in the activities of the information exchange network.

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The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix A
Listing of Interview Questions for Case Studies

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Questions for Case Study Interviews
3 September 1985

- * Timetable of research project?
 - begun research
 - completed research
 - initiated tech transfer efforts
 - product successfully transferred
- * Who were the targeted users for the T2 efforts?
- * What did you hope to accomplish with your T2 efforts?
- * What hurdles did you think you'd have to overcome in order to successfully transfer the technology?
- * What was your approach to T2 and what did you specifically do to overcome those predictable hurdles/problems?
- * What was the chronological order in which you implemented the various elements of your T2 approach?
- * What was your approach to informing potential users of the availability of the technology?

Which of the following communications media did you use in support of your technology transfer efforts?

- technical reports
- Army guidance documents
- technical articles in Army publications
- technical articles in non-Government publications
- articles written by PAO for Army publications
- articles written by PAO for non-Government publications
- fact sheets
- users groups
- exhibits at conferences
- demonstrations/briefings
- workshops
- personal contacts
- audiovisual materials
- CERL Reports

* In reality, how did users find out about the technology? Why do you think these efforts worked?

* Why didn't the other things you tried work as well in getting the word out?

* What could you have done differently to better inform the field about the technology?

* Making people aware of a technology is one thing, but getting them to use the technology is often much more difficult. What was it that convinced the users to implement the technology?

* What prevented others from adopting the technology?

* In retrospect, what could you do to help turn these nonadopters into adopters?

* To what do you attribute the successful/unsuccessful transfer of your technology to the field?

* Do you think you could have benefitted from the use of outside experts in your technology transfer activities?

- If so, what kind of experts would have been helpful?

* What recommendations would you make to individuals trying to successfully transfer R&D products?

* Obtain communications documents

- published materials
- T2 plan or 1498's
- materials used in communications efforts
- correspondence files

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix B
Case Study Review: Portawasher

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: The Portawasher
Date: 5 October 1985, Revised 17 December 1985

Description of Technology

The Portawasher was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to clean in-place large trash dumpsters located at Army installations. Prior to its development, dumpsters would have to be emptied and transported to a central cleaning area. Field tests of the Portawasher at Fort Leonard Wood, MO, revealed that its use would enable three times as many dumpsters to be cleaned in one day as the previous method and at half the cost. The Portawasher was designed for use by those individuals at Army installations responsible for maintenance activities.

The Portawasher is currently manufactured and sold by four companies. The first company to produce the Portawasher did so under contract with the lab to put together the prototype. That company took the final plans and began selling the system through advertising and trade show

displays. The additional companies began manufacturing similar versions of the Portawasher after finding out about the system through these efforts and an article published in Waste Age magazine.

Timetable of Activities

Research began on the Portawasher about 1979 with funding ending about 1983. The Portawasher was the 10-year-old idea of a Technical Monitor at the Office of the Chief of Engineers (OCE). Technical Monitors sponsor the development of new technologies at USA-CERL. Technology transfer activities began with the development of a prototype and testing of the Portawasher at Fort Lewis, WA, in August 1979.

Technology Transfer Approach

Informing the Field

No formal technology transfer plan was developed. Technology transfer activities were just conducted as an expected part of the research process. As opportunities arose, such as to present a paper at a conference, the research staff took advantage of them. Little formal thought was given as to what might be the best way to inform military users as opposed to nonmilitary users.

The following communications activities were conducted in support of technology transfer:

* A technical report published in June 1983 was the first effort to inform users of the technology.

* Lab personnel conducted four demonstrations before high level engineer personnel at major commands (MACOMs) and the Engineer School.

* A color flyer was prepared by in-house editorial staff on the Portawasher.

* A paper on the Portawasher was presented at a trade conference consisting of individuals involved in waste management.

* The content of the conference paper was used by an editor of Waste Age magazine who published an article on the Portawasher in the May 1982 issue.

* An Engineer Technical Note was prepared by USA-CERL and published in April 1982 by the U.S. Army Corps of Engineers headquarters office responsible for overseeing installation management activities. The Portawasher is also referred to in Army Regulation 420-47 dated January 1985.

* A slide presentation with audio and 8mm film were developed. The slide presentation was taken out and displayed at conferences for installation managers. The film copy was sent out to installations upon request.

* An article on the Portawasher was published in "CERL Reports"--a newsletter published by USA-CERL and sent out to installation personnel.

Implementation Strategies

The field's first experience with the Portawasher was the testing of a prototype out at Fort Lewis, WA. Fort Lewis personnel made recommendations on improving the system by making it more heavy duty and trailer mounted. The final version was tested out at Fort Leonard Wood, MO. The communications activities involved in technology transfer began following the Leonard Wood tests.

The demonstrations before the MACOM engineers were intended to solicit their support for encouraging the use of the Portawasher among engineers at installations under their commands.

An Engineer Technical Note was published as a formal Army guidance document to field personnel. These documents do not mandate the use of a technology, but merely provide interim guidance on its use until more formal regulations or technical manuals describing the use of a technology can be developed.

Effectiveness of Transfer Activities

Informing the Field

The conferences and article in Waste Age generated the most inquiries from nonmilitary users. The Engineer Technical Note seemed to prompt the most inquiries from military users. The technical note was cited as a good way to get a message

before users in a format that is easy to read. Technical reports were criticized as being too long and people do not have time to read them.

Implementation Strategies

The demonstrations did not seem to have the impact lab personnel had hoped to achieve. The demonstrations were given to the high level engineers in the MACOMs. These people did not seem to want to pass the word on the Portawasher to the engineers at the installations.

The Engineer Technical Note did prompt some installation personnel to use the Portawasher technology. Several installations did write the use of the Portawasher into their refuse collection contracts. The system is currently being used by a contractor at Fort Leonard Wood, MO, where the system was field tested.

With no real force mandating the use of the Portawasher, the motivation for considering use of the technology came from within the individual. The interviewee commented that the installation people he spoke with were, "Motivated enough to look for better ways of doing their job and were more receptive to using the Portawasher."

Expected or Encountered Problems

At the beginning of the research effort much of the refuse collection at installations was conducted by base personnel. As the development of Portawasher was underway, the Reagan Administration directed government agencies to contract with private industry for services in an effort to reduce the Federal workforce. The requirement to contract out refuse collection resulted in the limited need for installations to use the Portawasher. The potential user in this case shifted from installation personnel to private contractors in the waste disposal business. Private contractors are under no obligation to clean trash dumpsters unless it is written into their contract.

The military purchasing system is very time consuming and may create another obstacle for people to purchase the system. The Army's Quick Return on Investment Program (QRIP) is designed to speed up the purchasing process for those items which have shown to provide a quick return on investment. Some installations purchased Portawashers through this program. However, funding for the QRIP purchases is limited at each installation and program money is usually used up quickly.

Improving the Transfer Process

The end goal of the technology transfer activities was to get as many installations using the Portawasher as possible. The interviewee offered these insights:

- * If a product is perceived to be needed by the field, then the likelihood that the technology will be used will be greater.

- * When conducting demonstrations, make sure you show it to the people who really need to use it and would appreciate its benefits. Also, the way you present it will have an impact on the response of the viewers. The interviewee felt the demonstration could have benefitted from a showier presenter.

- * The transfer of new technologies has to gain the support of individuals outside the laboratory environment. The demonstrations failed to gain the support of the MACOM engineers for reasons not clear to the interviewee. The changing commercial activities climate may have had a role in this.

- * Need to hash out administrative problems with procurement to make it easier for installation personnel to purchase equipment.

- * Lack of money to continue technology transfer. Portawasher funding ended in 1983 and resources are no longer available to really push the transfer of it anymore.

* Also, additional applications of Portawasher could be developed (i.e., spill cleanup) which would enhance its usability at installations as well as make it easier for installation personnel to justify the purchase of the system.

* Cofunding and cooperation of research projects with other military services would increase their stake in the technology and prompt them in transferring the technology within their own services.

Using Outside Experts

The interviewee thought he could have benefitted from a scriptwriter on the slide presentation. Personnel used in demonstrating Portawasher could have been flashier and showier, and more experienced at making presentations. However, such an individual would have to need to be very knowledgeable about the technology.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix C
Case Study Review: Concrete Quality Monitor

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: Concrete Quality Monitor
Date: 11 October 1985, Revised 18 December 1985

Description of Technology

The Concrete Quality Monitor (CQM) was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to determine the cement-water ratio of concrete as it is being poured. This information enables the user to then calculate the strength of the concrete. The CQM is a procedure which uses commercially available test equipment such as a centrifuge and a chloride meter. The tests can be quickly conducted at the construction site.

Prior to its development, industry would use a 28-day compression test to determine the strength of the concrete. This procedure consisted of taking a sample of the wet concrete, let it harden for 28 days, and then run compression tests on the sample in a testing laboratory. The results of the CQM procedure were determined to be within 10 to 15 percent accuracy of the 28-day test. The CQM offers timely and accurate information to construction managers. The

intended user of the CQM was personnel in the U.S. Army Corps of Engineers responsible for quality control of construction activities. Other rapid analysis test procedures are also in development outside of USA-CERL.

Timetable of Activities

Three generations of the CQM evolved during the research. Research began on generation 1 in 1971 and on generation 2 in 1976. Research on generation 3 began in the Summer of 1979 and went through Summer of 1980. Technology transfer of generation 2 was actually occurring concurrently with the development of generation 3. Generation 3 was an automated version of generation 2, but essentially the same in principle.

Technology Transfer Approach

Informing the Field

Several communications activities were conducted in support of technology transfer activities.

* Over the last 10 years there were numerous articles on the CQM published in trade and professional publications such as Concrete Construction, Military Engineer, Civil Engineering (ASCE), and Cement and Concrete Journal (ASTM).

* Several presentations were made at conferences such as the Concrete Show. Presentations were also made before

committees of professional organizations such as the American Society of Testing and Materials and the Ready-Mix Concrete Association. These presentations were made both by USA-CERL personnel and individuals outside the lab who had reviewed the procedure.

* Several technical reports describing the CQM procedure and its applications were published and distributed to the field.

* The CQM was used at various Corps of Engineers construction sites with assistance from USA-CERL personnel. These applications of the CQM formed the basis of the field data gathering efforts.

Implementation Strategies

The end goal of transfer activities was to have the CQM recognized as an accepted procedure by the construction industry. The American Society of Testing and Materials (ASTM) is one organization which evaluates such procedures and determines whether they should become an industry standard. Another outlet for recognizing the acceptance of the procedure was to get it written into the Corps of Engineers Concrete Specification Manual. However, unless the procedure was accepted as a standard practice by industry, the Corps of Engineers could not require commercial contractors to use it on Corps construction jobs.

The rationale behind this approach was that if the field data showed the system works effectively, the product will sell itself to ASTM and the industry in general. USA-CERL funded the University of West Virginia to run tests of the CQM and present those results to ASTM. USA-CERL also asked the Ready-Mix Concrete Association to evaluate the procedure and they validated the CQM within certain restrictions. Other organizations which tested and evaluated the CQM included the Associated General Contractors of America and the U.S. Army Engineer Waterways Experiment Station.

Effectiveness of Transfer Activities

Informing the Field

The interviewee believed that there had been a more than adequate effort to inform the field of the existence of the CQM. However, over the last five years, the CQM has received little funding and consequently technology transfer activities have been limited. The interviewee stated that the CQM was not marketed as strongly as some of the other products in the lab.

Information efforts suffered from overzealous claims or a lack of complete information on the technology. Information presented through presentations and articles made it sound as if the CQM was the cure-all for all evils.

Incomplete information made in presentations can lead to misconceptions by potential users. A common point made by USA-CERL personnel presenting the CQM system to users is that the test only takes 15 minutes. Where the actual test does only take 15 minutes, this does not include time to set up for the tests and the clean up afterwards. Out in the field, the user will soon discover that he or she will be able to conduct only one test an hour as opposed to the four tests per hour that was suggested in the presentation.

Differences between actual field experiences and information presented in informational activities reduce the credibility of both the technology and the laboratory. The interviewee stated, "The cost of bad publicity is extremely expensive and time-consuming. You can correct a bad technology, but it is much more difficult to change misperceptions of the field."

A common source of this misinformation is lab personnel not technically familiar with the product who have discussed the technology with potential users. Technical personnel familiar with the technology will then have to tell users that what they heard before is not totally accurate or is missing some information.

Implementation Strategies

Use of the CQM is expected to increase if and when ASTM recommends it as an industry standard. The procedure is currently under review by ASTM; this process is typically very slow. The interviewee also suggested that less than conclusive field data to support the effectiveness of the CQM may be hindering its acceptance by ASTM.

There is currently limited use by the field of the CQM. Much of it is by State and Federal organizations. In half of these situations USA-CERL personnel served as the hands-on technicians in its use. Use of the CQM procedure without USA-CERL assistance has not really materialized.

The use of the CQM is gaining support in specialty concrete construction activities where it is the only thing that can do the job--i.e. roller-compacted concrete, stabilized soils, mixer efficiency tests. The Corps is using the CQM in these applications primarily because there is no other way to perform a rapid analysis of concrete. The field tests of the CQM for use in these specialty applications conducted by USA-CERL demonstrated the procedure does work and validated the system.

Expected or Encountered Problems

USA-CERL expected resistance from a variety of organizations in their technology transfer efforts for the

CQM. They expected resistance from the ready mix concrete industry who would object to having a closer monitoring of their product. They also expected resistance from the Waterways Experiment Station--another Corps of Engineers laboratory who has the assigned mission of conducting research on portland cement concrete as it is used in pavements and roads. Both organizations did evaluate the CQM and provided qualified acceptance of it for some concrete construction applications.

The transfer of the CQM was hindered by questions on whether the system was really needed or would work in a field environment. The ASTM committee and industry still questions whether the criteria for rapid test of concrete is met by CQM as opposed to other techniques. The interviewee believes more field data is necessary to conclusively answer this question and convince the skeptics.

Improving the Transfer Process

The interviewee cited several things that could have been done to improve the transfer of the CQM. More field data could have been obtained on the application of the system in conventional concrete construction activities. Demonstrated use of the product with supporting data would be effective in convincing skeptics on the usefulness of the system. However,

obtaining additional data on a technology would require more funding.

Use of the CQM is expected to increase in conventional concrete construction activities if and when ASTM recognizes it as an accepted procedure. Additional use of the CQM could occur as more people use it in nonconventional concrete construction and become familiar with it. Once comfortable with the procedure, these people may apply it to conventional uses. The interviewee stated more marketing of the nonconventional uses of the CQM could be done which may lead to overall greater acceptance.

Using Outside Experts

USA-CERL used outside experts to test and evaluate the CQM, and then to use their recommendations to validate the effectiveness of the procedure. These outside experts included the Associated General Contractors of America, Oregon State University's Construction Education Research Foundation, the National Ready Mix Concrete Association, and the U.S. Army Engineer Waterways Experiment Station.

USA-CERL is currently looking into obtaining some entrepreneur to package the CQM and make it commercially available to both the Corps and industry. Such a company could provide necessary training support for users and also conduct more intensive marketing activities.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix D
Case Study Review: Weld Quality Monitor

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: Weld Quality Monitor
Date: 13 October 1985, Revised 18 December 1985

Description of Technology

The Weld Quality Monitor (WQM) was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to assist the Army in facilities construction and in its tank production effort. The WQM identifies defective welds as they are being placed. All existing technologies to determine weld quality, such as dye penetrants, x-rays, and other nondestructive tests, are used after the weld has been placed. The problem with these after-the-fact tests is that reworking a defective weld can be five times as expensive as initially placing it. The WQM enables the user to shut down the weld at the first indication that it is faulty. Tests of the WQM at an Army tank plant resulted in an average savings of \$4,500 per tank in preventing defective welds.

The WQM consists of two components: the process data system (PDS) and the optoelectronic system (OES). The PDS is a computer-based system which compares data on the weld being

examined against stored data on a normal weld. The PDS identifies when the data on the weld in question falls far enough below the data on the normal weld to indicate a faulty weld. The OES is a system for receiving optical information on the characteristics of the weld. The OES uses fiber optics and an oscilloscope to monitor information such as the presence of hydrogen gas in the weld arc--too much of which is symptomatic of a faulty weld. The OES feeds this information into the PDS.

Timetable of Activities

Research on the PDS began in 1975. About 1978, following some field tests, a first cut prototype was ready for some initial technology transfer. Research on the OES system was begun in 1976 with a prototype available in 1980. Patents on these two systems and a third minor component of the WQM were received between late 1983 and early 1984.

In May 1984, exclusive licensing rights to the WQM were given to the National Standard Company of Niles, Michigan. National Standard was allowed to use the USA-CERL patents on the WQM for purposes of further refining the product, and manufacturing and marketing it. National Standard is currently in the process of developing the production capabilities to produce the product.

Technology Transfer Approach

No structured technology transfer plan was used to transfer the technology. Communications activities were begun after the prototypes had been developed.

Informing the Field

The WQM was very well publicized both through the efforts of USA-CERL and the media who picked up on the significance of the technology. Some of the more notable communications activities are listed below:

- * USA-CERL personnel gave presentations at professional conferences on welding about three times a year.

- * Numerous articles were published in professional and trade journals such as Assembly Engineering, Military Engineer, Civil Engineering, and the Welding Journal.

- * Articles also appeared in general media publications. The New York Times carried an article on the WQM in 1981. An Associated Press article on the WQM was published by several newspapers across the country just prior to the license signing. The AP story also ended up on several network radio news broadcasts. An article on the WQM also appeared in 1981 in Engineer Update--the U.S. Army Corps of Engineers newspaper.

- * Fact sheets and technical reports on the WQM were used to supplement the publicity on the system. These publications

were provided to individuals who requested information on the WQM after hearing about it from other sources.

Implementation Strategies

The WQM was demonstrated and used in field tests on a variety of applications within the Army. The system was installed into the production activities at the Lima, Ohio, tank plant facility. The WQM was also used by a contractor who was under contract with the Corps of Engineers to construct turbine shaft chambers on a hydroelectric power project.

The availability of the WQM for purchase is a key factor in the transfer of this product to potential users. The WQM is a hardware item which needs to be manufactured and sold on the commercial market before anyone can buy the product. Federal research laboratories such as USA-CERL are funded to conduct research and not manufacture products. Therefore it was necessary for USA-CERL to find a commercial company to continue development of the WQM, manufacture it, and sell it.

A decision was made to publish articles in trade journals to try to attract interest in the WQM by potential manufacturers.

Effectiveness of Transfer Activities

Informing the Field

Information activities on the WQM generated a lot of interest in the system both within the Army and the private sector. These activities also generated a lot of interest by manufacturers who were interested in producing and marketing the system. National Standard Company learned about the WQM through the article published in the Welding Journal in 1983. The significance of the technology generated a lot of continued publicity for it from the media. Interest in the WQM resulted in many invitations to submit articles in several of these publications.

Published articles drew a response from a surprisingly different group of individuals. The New York Times story drew numerous requests from high-level management people within corporations. Articles in trade publications attracted inquiries from technical people involved in quality control work in welding operations. USA-CERL received several hundred inquiries as a result of the articles published in the national media.

Implementation Strategies

There are no users of the WQM as the first production model is yet to be delivered. Some prototypes developed by USA-CERL are still being used at sites where the system was

field tested. One commercial company worked with USA-CERL to get a prototype into their daily operation. It is expected that once the production model becomes a reality, the system will be quickly picked up and used by both the public and private sector. One Corps of Engineers office attempted to write the WQM into a contract specification. The clause was thrown out because of the lack of an available production model.

The reason for its expected success lies in the serious nature of the problem which the technology solves. The problem is perceived to be a critical one and interest in the system is high as evidenced by the hundreds of requests for information following the published articles.

Expected or Encountered Problems

The problem with Federal Government research laboratories, in the case of hardware developments, is that they lack funding to conduct necessary research to debug the system, package it, and market it out to users. The problem encountered by USA-CERL was that they had a product people wanted, but there was no way to deliver the product into their hands. The Stevenson-Wydler Technology Innovation Act, which authorizes Federal research laboratories to make their technology available to non-Federal users, carries insufficient funds to do that.

Furthermore, getting a commercial firm involved in manufacturing a technology developed by a Government laboratory is hindered by the financial risk involved in developing a production capability. Most Government technologies fall within public domain and are available to any company that would be interested in them. The exclusive licensing arrangement, even though limited to only five years, nevertheless allows the commercial firm of operating for awhile without the risk of losing its investment. However, the exclusive licensing arrangement is only possible on items that can be protected by a patent.

USA-CERL also needed to be careful in selecting the right company to manufacture and market the WQM. In order for the Army to benefit from the WQM, a manufacturer would have to be selected which would provide the necessary support to users and continue the development of the system. USA-CERL received numerous requests by companies who were interested in picking up and manufacturing the WQM. One of the reasons USA-CERL selected National Standard as the manufacturer was their proposal to conduct further developmental research on the WQM in conjunction with USA-CERL.

Improving the Transfer Process

Overall, the transfer activities which did occur were thought to be adequate. Once a production model is available,

a couple of success stories on how the WQM is saving organizations money will be all that is needed to convince others, who already know about the system, that it does indeed work and convince them to buy it. At this point, the technology transfer efforts will benefit from the professional marketing skills of National Standard.

Using Outside Experts

The interviewee indicated it may be beneficial for USA-CERL to hire a marketing firm to determine the needs of potential users of products under development. National Standard hired a marketing firm to do an assessment of the users to determine both interest in the product and to identify areas of need for the research and production activities to follow. This is especially important for hardware items which are more cost-intensive to develop and have potential application in the private sector. Such outside experts could identify how the product needs to be configured to solve real needs of users.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix E
Case Study Review: Ceramic Anode

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: Ceramic Anode
Date: 14 October 1985, Revised 18 December 1985

Description of Technology

The ceramic anode was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) as an alternative to the old silicon iron anode used on lock gates maintained by the U.S. Army Corps of Engineers. Both anodes are a vital part of cathodic protection systems which prevent rusting of buried or submerged steel structures such as underground piping, water towers, or lock gates. The cathodic protection system reverses the rusting process whereby the anode wears away instead of the steel.

The ceramic anode improves upon the silicon iron anode in its smaller size and reduced manufacturing and installation cost. The ceramic anode is 1/500th the weight of the older anode and can be manufactured and installed at half the cost. Yet, the ceramic anode has the same life expectancy and provides the same degree of cathodic protection.

In May 1984, exclusive licensing rights were awarded to APS Materials, Inc., of Dayton, Ohio, to manufacture and market the ceramic anode. APS Materials was selected because of its expertise with the plasma spraying technique needed to manufacture the anode.

Timetable of Activities

Research began on the anode about 1979 with the initial paperwork for the patent application being filed in 1981. Technology transfer activities began shortly afterward.

Technology Transfer Approach

Technology transfer was defined by the interviewee as having the technology available for users. The technology should be accepted and recognized as a usable item by the users and be written into Army guidance documents such as Guidance Specifications and Technical Manuals. The intended users of the anode were Corps personnel responsible for maintenance activities on lock gates, and personnel responsible for maintenance of steel structures at Army installations.

Informing the Field

Several vehicles were used to inform potential users about the technology:

* Personal contacts, usually by phone, were heavily used to make people aware of the anode. USA-CERL would receive numerous calls from Corps and Army personnel about corrosion problems through the lab's Small Problems Program. In discussing the corrosion problem, USA-CERL staff would mention the merits of the anode as a possible solution to the problem.

* Several papers on the anode were presented at corrosion conferences before military and nonmilitary audiences. USA-CERL or its consultants speak at about two to three conferences a year on the anode.

* In 1983, briefings on the anode were given to Major General Albro--a two-star general in the Corps of Engineers responsible for engineering and construction activities on military installations.

* USA-CERL runs two corrosion courses each year for Corps and Army personnel. USA-CERL provides presentations on the anode and cathodic protection systems during these courses.

* Technical Reports are published by USA-CERL to document the results of the research. Fact sheets and technical reports are provided to people who make initial requests for information.

* Articles published as a result of conference proceedings and in trade and professional journals were also used to inform potential users of the technology. Articles on the anode were published in Corrosion, Military Engineer,

Engineer Update, and other publications. Magazine articles are perceived as an important way of reaching selected audiences.

Implementation Strategies

Efforts have been made to get information on the anode written into formal Army guidance documents on cathodic protection systems such as Guide Specifications and Technical Manuals. The briefing of Major General Albro was also intended to develop some headquarters support for the use of the anode in the field.

The personal contacts between USA-CERL staff and potential users through the Small Problems Program and Corrosion Courses were also used to encourage people to use the anode as a solution to the corrosion when applicable

The anode is currently being demonstrated at installations through the Facilities Technology Applications Test (FTAT) Program. FTAT is a large scale \$29 million program designed to demonstrate several new technologies at Army installations. The anode is also being demonstrated through a similar demonstration effort called the Rehabilitation, Evaluation, Maintenance, and Repair (REMR) program. The REMR program is designed to demonstrate new technologies for use on civil works structures (i.e., lock gates, dams, buildings at recreational areas) maintained by

the Corps. The anode demonstrations for both programs are just getting underway.

Effectiveness of Transfer Activities

Informing the Field

Papers presented at professional conferences are viewed as an excellent way to inform the private sector on the development of a technology. These presentations are also a good mechanism for obtaining feedback on the research work from your peers. Conferences are not perceived to be of real value in reaching the military users, unless the conferences are sponsored and attended by the military.

Technical reports and fact sheets are useful primarily in providing information to users upon request. The mass distribution of technical reports is perceived to be of little value; the reports are not perceived to be read by the field. The interviewee stated, "All the guy in the field wants are specs and drawings on installing the anode."

Personal contacts through the Small Problems Program and the corrosion courses are viewed as very valuable ways of informing the field. These contacts are carried out by both USA-CERL staff and the many corrosion consultants the lab employs.

Articles published in magazines were moderately effective in soliciting inquiries on the technology from individuals

both within the military and private sector. A recent article in Military Engineer magazine prompted some inquiries. A value of these articles is that they are quick to read as opposed to the longer technical reports.

Implementation Strategies

There currently exists only two or three users of the anode. Typically, these users were involved in the field tests conducted by USA-CERL. The anode has been written into drafts of revised guide specifications for cathodic protection systems which should be formally published within two years. The documentation is still being prepared for adding the anode into the Technical Manuals. The responsibility for publishing these documents lies not with the lab, but the headquarters office.

USA-CERL does a good job of maintaining its contacts with the field on corrosion problems. These contacts are recognized as a good way of explaining the use of a technology to users and actually convincing them of the merits of the approach.

The Major General Albro briefings worked well in convincing him of the merits of the anode. His comments after the briefing were, "Find a manufacturer and I'll see to it that anodes are used at every installation." The licensing ceremony occurred a year later; somewhere around that time

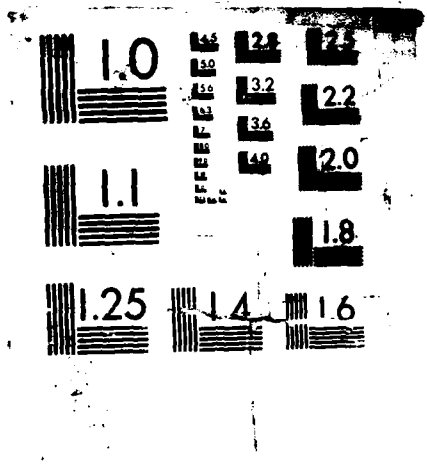
Major General Albro retired and with him the Army mandate to use the anode.

Another company based in Italy is currently marketing a anode similar to the USA-CERL version. This anode is gaining acceptance in industry. The ceramic anode technology, whether it be the Italian version or the USA-CERL version is beginning to be accepted outside the military.

Expected or Encountered Problems

One concern was raised on the level of funding available to truly develop and test a product to the production model level. USA-CERL typically takes a technology being developed commercially, modifies it to suit the Army's particular problem, tests it, and then puts it out into the field. The field testing that USA-CERL does is limited by the available funding and pressures to get a product into the field. Just recently the ceramic anode has undergone some modifications by USA-CERL and APS Materials as a result of some problems encountered in ongoing field tests.

Guide Specifications and Technical Manuals are published by Corps headquarters. The civilian personnel at headquarters responsible for these publications are very conservative. Consequently, it takes a lot of convincing with demonstrated results to convince them to modify Army guidance documents to reflect new technologies. According to the interview



MICROCOPY RESOLUTION TEST CHART

guide specs for the Corps are typically ten years behind new technologies. The interviewee pointed out that you can find vinyl-coated fences in Sears catalog, but they have yet to appear in the Army's guide specifications.

Unless the product appears in the guide specs, potential users will be less willing to stick their necks out and use the product. Because the anode is only an alternative to an existing approach, people are more content to use what they know works and not try something they are not familiar with.

Users of the anode typically tend to be innovators who are willing to take the risk of being the first user of the technology, even though the technology has not received the blessing of the Corps headquarters. These champions could then play a role in convincing others to use the technology.

Improving the Transfer Process

Additional funding for continued field tests of the technology in real world situations would help in transfer efforts. Additional use of the technology will provide documented proof on its effectiveness. This data can be used to convince headquarters personnel to support the technology and incorporate it into guidance documents. The Technology Transfer Test Bed program and other large scale demonstration programs such as FTAT and REMR are perceived to be a good way to show the effectiveness of the technology in the field.

The interviewee suggested that the responsibility to continue the technology transfer effort is really in the hands of APS Materials. The interviewee suggested that APS could be more aggressive in its marketing approach.

USA-CERL no longer is funded to continue in technology transfer activities on the anode. Despite this lack of funding, technology transfer activities are still a large part of the current workload. Transfer activities are disrupting research activities on newer research efforts.

Using Outside Experts

USA-CERL uses consultants having expertise in corrosion to teach sections of the corrosion course and to perform technical work in support of requests for assistance. Consultants are hired for both their technical expertise and the ability to work with people. Good communications skills are important in dealing with people and in obtaining their trust.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix F
Case Study Review: Solar Energy Feasibility System

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: Solar Energy Feasibility System (SOLFEAS)
Date: 20 October 1985

Description of Technology

The Solar Energy Feasibility System (SOLFEAS) was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to assist the Army in determining whether solar energy was cost-effective for new buildings proposed for Army installations. A feasibility study of the use of solar energy for all proposed new construction by Federal agencies is required by law. SOLFEAS is a computer program which uses information such as the solar energy output on building types similar to the one under consideration, existing climatic information, and energy costs for the area.

Significant savings were shown by the use of SOLFEAS in a test comparing its data against the data of a solar feasibility study performed by a contractor using traditional approaches. SOLFEAS produced estimates to within five percent accuracy of the results from the conventional study. Results were obtained within 15 minutes at a cost of \$50 worth of

computer time. The conventional study took three weeks at a cost of approximately \$20,000.

Timetable of Activities

The SOLFEAS program was originally developed by the Fort Worth District of the U.S. Army Corps of Engineers. USA-CERL began modifying the program in November of 1980. The modifications were designed to simplify the use of the program for users who did not have a programming background. A version of the program was running on a Boeing Computer Service computer by February 1981. Further revisions to the program were completed by May 1982.

The targeted users of SOLFEAS were personnel at Corps district and division offices responsible for designing buildings. The program is also flexible enough to be used by architect/engineering firms in the designs for nonmilitary buildings. Most of the design work on military structures is done by architect/engineering firms for the Corps.

Technology Transfer Approach

Informing the Field

The following approaches were used to inform potential users of the availability of SOLFEAS:

* A technical report describing the development of SOLFEAS was combined with a users manual and published in August 1982.

* A Engineer Technical Letter (ETL), with the users manual as an attachment, was to be published in August 1983 by the Corps of Engineers headquarters office.

* A copy of the users manual was sent with a cover letter to each Corps of Engineers Division and District office by USA-CERL in January 1983.

* In 1983-84, USA-CERL conducted workshops at seven district and division offices instructing personnel in the use of SOLFEAS.

* Phone contacts with Corps personnel and private architect/engineering firms were used to inform them of the availability of SOLFEAS and how to use the program.

* Articles on SOLFEAS were published in Engineer Update--the newspaper put out by Corps headquarters, "CERL Reports"--a quarterly newsletter put out by USA-CERL, and Construction Specifier magazine--a trade journal.

* A paper was presented at the 1982 American Society of Mechanical Engineers (ASME) Winter Annual Meeting.

* Presentations on SOLFEAS were made at USA-CERL's solar energy users group meetings.

Implementation Strategies

Several activities were conducted to encourage the use of SOLFEAS by Corps personnel. The ETL would require the use of SOLFEAS by all Corps design personnel at District and Division offices.

In another effort to get both the ETL published and obtain high level support for the program, Major General Albro was briefed on SOLFEAS in late 1983. Major General Albro was the individual at Corps headquarters responsible for overseeing all engineering and construction activities for the Army. He agreed that SOLFEAS should be used by the Army.

Effectiveness of Transfer Activities

Informing the Field

The letter and user manual sent to districts and divisions and the site visits were cited as the most effective methods for informing the field about SOLFEAS. In addition, USA-CERL contacted several districts by phone to determine if they knew about SOLFEAS as a followup to the mailing of the users manual.

The conference presentation and the article in Construction Specifier prompted several requests for information on SOLFEAS by private industry and other government agencies.

Implementation Strategies

Even without the ETL being published which would require the use of the program, SOLFEAS is being used by several districts. USA-CERL has been in contact by phone with almost every district regarding use of the program. According to the interviewee, SOLFEAS simply sold itself due to both the savings it produced and the legislative requirement to perform such studies. Another factor contributing to the successful acceptance of SOLFEAS by the field is the ease in which the user can check the program for accuracy. All one has to do is compare the results of the SOLFEAS computer run against the results of existing studies.

The trips and the phone calls worked well in assisting users with the program. The program is simple enough that USA-CERL personnel can walk the user through the program in a ten-minute phone conversation.

Expected or Encountered Problems

No real problems in transferring the SOLFEAS technology were anticipated by USA-CERL staff. The Fort Worth version was already in use at Fort Worth. It was anticipated that if the program was simplified, other Corps personnel would be eager to use it. Essentially, SOLFEAS was a research product that met a real need of the field, and the technology sold itself.

The ETL has yet to be published due to a variety of external factors. The results of solar energy studies currently underway will also be incorporated into the revised ETL. In response to the delay, USA-CERL initiated the mailing of the users manual to make the technology available to the field in advance of the ETL.

Improving the Transfer Process

The technology transfer efforts were thought to be adequate. Follow-up phone calls were thought to be a good way to double check the accuracy of the communications activities and make sure the field was aware of the technology.

Using Outside Experts

Due to the nature of the technology, it is felt that the technical folks need to be involved in the transfer efforts. A potential problem is the overinvolvement of research staff in transfer activities to the point of preventing new research from being conducted. A suggestion was made that after the initial thrust of getting users comfortable with the system is completed, a contractor could be hired to provide whatever follow-up assistance may be required.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix G
Case Study Review: Pavement Maintenance Management System

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: Pavement Maintenance Management System
Date: 27 October 1985

Description of Technology

The Pavement Maintenance Management System (PAVER) is a computer program developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to assist personnel at military installations in managing repair activities for roads and airplane runways. Data on the pavement such as traffic surveys, types of construction materials used to build the road, and results of visual inspections of the pavement is fed into the computer. Using this information PAVER calculates the Pavement Condition Index (PCI) which is a rating of the condition of the pavement on a scale of 1 to 100. The PCI is used within PAVER to assist the user in planning out and prioritizing pavement repair activities. PAVER will allow the user to develop long-range plans and cost estimates for maintenance activities.

Use of the PCI is currently standard practice for the Air Force and the Federal Aviation Administration (FAA). The PCI

is also being used at installations overseas in Saudi Arabia and Europe. Just recently, the FAA sent a memorandum to State Aeronautic Departments stating if they are interested in using the PCI at State airports the FAA would fund its use. PAVER itself is in use on several military installations. The U.S. Army Forces Command (FORSCOM) is in the process of implementing PAVER at all their installations. Through the sponsorship of the American Public Works Administration (APWA), PAVER is currently being used in over 40 cities and counties throughout the country.

Timetable of Activities

Research on the PCI and PAVER began in 1974. Prototype testing of PAVER at Fort Eustis began in 1979. Technology transfer efforts began in 1980 following the tests.

Technology Transfer Approach

The interviewee stated that you need to take an aggressive approach to technology transfer. No formal technology transfer plan was developed, but USA-CERL staff did think out ways to create interest and involve specific nonmilitary agencies in the PAVER technology. These efforts were directed to obtaining the support and sponsorship of professional organizations in making the technology available to potential nonmilitary users. The interviewee also credited

USA-CERL management for being supportive of technology transfer initiatives outside the military.

Technology transfer was also viewed to be a crucial part of the development of the technology. Feedback from users is necessary in the continual evolution of the PAVER system. The interviewee stressed you need to get a workable system out in the field as it becomes ready and not try to refine it to perfection. The technology will be continually refined through the input of users. However, potential users have to be reassured that technical support of research staff will be there to assist them with changes of the technology as it is refined.

Informing the Field

A variety of approaches were used to inform potential users about the availability of PAVER.

* Papers presented at conferences of professional groups such as the American Society of Civil Engineers, and the Transportation Research Board.

* Articles published in professional journals such as Better Roads, Cities and Counties, Public Works, American Concrete Institute Journal. These articles were initiated through both the efforts of USA-CERL and APWA.

* Technical Reports were published to document the research efforts and to provide information to the user. A users manual was published as a technical report.

* Workshops were conducted for high level military personnel to both inform them on the usefulness of the system and to obtain their support for implementing the system within the services.

Implementation Strategies

Initial transfer efforts were directed to getting PAVER accepted by the Army as a standard system for doing business. Without such acceptance, installation personnel would not be able to procure computer terminals or microcomputers to access PAVER. This was at a time when computer terminals were not as readily available in the Army as they are now.

USA-CERL provided users with assistance in developing guidance documents for the field. The FAA used advisory circulars, Air Force used Air Force Regulation, Army used technical manuals.

It was recognized early that successful technology transfer to the military would depend upon obtaining the support of USA-CERL management, the Corps of Engineers headquarters, and the headquarters office of the Major Command (MACOM) which oversees the installations. Each level would need to throw their support behind the technology in order for the system to be transferred. The lab has the primary responsibility for gaining the support of the headquarters personnel.

A different approach was determined necessary for the civilian audience. You need to show the civilians that the system will work and save them money. Getting support of professional organizations and societies that can assist you in spreading the word on the technology and throw their support behind it was perceived to be another key to successful technology transfer.

Effectiveness of Transfer Activities

Informing the Field

The technical reports were perceived as being forerunners of user manuals and other authority documents. The reports were accompanied by a letter from the Corps of Engineers headquarters stating the technical report should be used in lieu of a technical manual which was under preparation.

Presentations at conferences of professional organizations and the publishing of articles were perceived to be effective in reaching out to nonmilitary audiences. Both the articles and presentations have to be either approved or requested from other professionals. Therefore, these media were perceived to result in a high degree of credibility for the technology among potential users.

Implementation Strategies

A good technical monitor at Corps headquarters was perceived to be very useful in gaining Army support for PAVER. The technical monitor, in addition to providing direction for the research effort, also has valuable connections with decision makers within the other MACOMs. The technical monitor for PAVER suggested that USA-CERL run a three-day workshop for MACOM engineers. The workshop was conducted in summer of 1985. This led to the initiative by FORSCOM to implement the system commandwide.

The workshop held for the Air Force resulted in a decision that each command engineer select one installation to test PAVER. Each command engineer made a presentation on the use of the PCI at a conference held the following year. At the second conference the individual in charge stated the PCI would be mandatory for use by the Air Force and that a letter would be sent out the following week confirming this to all installation engineers.

The Air Force has been using the PCI since 1976. The Air Force initially funded the research on PAVER. Upon the completion of the research, the Air Force made its use mandatory in order to get funding for maintenance and repair projects. The Air Force recently made the use of PAVER mandatory for airfields beginning in 1986. Several Air Force installations are already using it. The Air Force has a much

more centralized command structure than the Army which is largely decentralized. Consequently, it is easier for them to require the use of new technologies.

USA-CERL's involvement with APWA began when they were asked to review a research proposal submitted by APWA to develop a pavement maintenance program similar to PAVER. USA-CERL made a presentation to APWA on PAVER which led to a decision by APWA to use the research money to field test the USA-CERL system. APWA tested PAVER in six cities. APWA also funded the Corps Waterways Experiment Station (WES) to compare PAVER against other pavement management systems. The resulting WES study showed PAVER to be less expensive to use and provides better information than other available systems.

Training is a vital ingredient to getting people to use a new technology. USA-CERL worked with the continuing education department of the College of Engineering at UIUC to develop a training class on PAVER. The APWA also developed its own training class as did the Air Force. The Air Force expanded its pavement school to include sessions on PAVER. Convincing organizations to conduct training is a big sales job due to the investment required to do it well.

The success of technology transfer activities for PAVER was attributed to three things. The timing of releasing PAVER came at a time when the nation's attention was directed towards its infrastructure problem which includes roads. Also

the product had established credibility as a good system due to tests of it and the support of professional organizations. The third reason for success was the organizational support the system received by the lab, headquarters level, and outside organizations.

Expected or Encountered Problems

The rules and regulations of the military posed problems in getting the technology accepted. The politics of working within the military system and gaining support of key high level people for the technology had to be considered and addressed in technology transfer efforts.

Lack of upper management support at the installation level for the cost of purchasing computers and computer time was cited as one reason why people are hesitant to implement PAVER. A second complaint on the system is it needs to be more user-friendly.

USA-CERL devotes a session at PAVER classes to help attendees give short presentations to their bosses to convince them of the value of implementing PAVER. A version of PAVER on a microcomputer is currently being developed in an attempt to cut down the costs of using PAVER. Additional research is also being conducted to make PAVER more user-friendly.

Improving the Transfer Process

Additional help to conduct research could have freed up the interviewer's time to conduct more efforts on technology transfer. Providing support to users was also perceived to be a key ingredient to successful transfer.

Using Outside Experts

Marketing expertise would have been valuable in technology transfer even though the interviewee perceived himself to be a good marketing person. However, any marketing person brought in would have to have a working knowledge of the technical aspects of the product and the workings of the Army. Over 100 consultants have attended the PAVER courses. These consultants in essence become spokespersons for PAVER in their contacts with their clients.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix H
Case Study Review: Environmental Technical Information System

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: Environmental Technical Information System
Date: 27 October 1985

Description of Technology

The Environmental Technical Information System (ETIS) was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to assist Army personnel in putting together Environmental Impact Statements. ETIS is a computer-based information retrieval system which consists of three subprograms. The Environmental Impact Computer System (EICS) identifies possible environmental impacts of a variety of military activities. The Computer Evaluation of Legislative Data System (CELDS) contains abstracts of Federal and State environmental legislation throughout the country. The third and most often used subprogram is the Economic Impact Forecast System (EIFS) which enables the user to perform an economic analysis of the impact of military activities.

ETIS is currently made available to users through the ETIS Support Center at the University of Illinois at Urbana-Champaign (UIUC). The support center updates the ETIS data

files, assists users over the phone with the system, and offers training courses twice a year on the system. In addition to the three EIS-related programs, ETIS also contains about another 30 programs developed by USA-CERL for military-related needs. These programs are also accessible to users of ETIS.

The early users of ETIS consisted primarily of those individuals responsible for dealing with economic impact analysis. As additional programs were added, users became more varied in both their work backgrounds and their needs. This case study centers primarily upon the transfer of the EIFS subprogram which paved the way for the transfer of ETIS as an umbrella system for many environmentally related computer programs.

Timetable of Activities

Research on EIFS was begun in 1973. A small pilot model for 360 counties was completed in 1974. Modifications to the program were completed for 3600 counties in 1975. The military began using EIFS in 1976. The EICS and CELDS programs were completed shortly afterwards. In addition to these programs, an electronic mail system was developed on EITS which enabled users to easily communicate with both USA-CERL staff and each other on the use of ETIS.

Technology Transfer Approach

Informing the Field

The approach used consisted primarily of looking for opportunities to apply the system in the field and then to inform the field using personal contacts and peer exchanges of information. Lee Aiken, the environmental chief at headquarters at the TRADOC major command found out about the system between word of mouth or possibly the publication of a technical report. USA-CERL staff showed him how to use the system. Aiken immediately recognized the value of the system and encouraged its use throughout TRADOC.

As information on EIFS got around the Army, individuals usually called USA-CERL to obtain additional information. Many of these phone calls were prompted by the distribution of technical reports. Callers often stated they did not follow the information in the report, but thought the system could help them with a problem they faced.

A variety of other methods were also used to inform the field about EIFS and ETIS:

- * The support center publishes a newsletter which contains information on new programs and applications within ETIS.

- * The electronic mail system within ETIS is used by personnel at USA-CERL and the support center to receive and respond to questions from the field.

* Personnel from USA-CERL and the support center have presented papers on ETIS at conferences of the American Planning Association in an effort to inform non-Federal users about the system.

* Articles on ETIS have been published in Army Research, Development, and Acquisition magazine and in Engineer Update-- a newspaper put out by Corps of Engineers headquarters.

Implementation Strategies

User groups were developed in 1978 primarily to solicit input from the users on how to improve the usefulness of the system. The technical design and implementation of the EIFS and ETIS was initially the responsibility of USA-CERL. Once developed, prototype programs were modified to incorporate recommendations of the users.

As people found out about the system, they would call up USA-CERL for more specifics on the system. USA-CERL staff would discuss the system with the caller and often give them a free courtesy password to use the system for a short period of time.

A DA Pamphlet on EIFS was published by the environmental office of the Army around 1977. The pamphlet was a copy of the user manual previously published by USA-CERL.

The ETIS Support Center was set up at UIUC in 1981 to avoid tying up research personnel in answering basic questions on the system.

Effectiveness of Transfer Activities

Informing the Field

The personal contact effort was perceived to be the most important way to both inform people and get them to use the ETIS. The interviewee did not perceive the more formal methods of articles and presentations employed by the support center personnel to be as effective in drawing new users out of the non-Federal audience.

Implementation Strategies

During the development of EIFS there were a lot of realignment activities going on within the military. The proposed closure of military offices and the shifting of military responsibilities from one geographic area to another was a big concern among local politicians and businessmen. Many military organizations were involved in lawsuits concerning the realignment effort. The military was in a position where they had to come up with a realistic assessment of what the impact of these realignment activities would have on the local economy.

Under these conditions, the EIFS system essentially sold itself and ETIS. Both the Air Force and the Army began using EIFS as it provided a way to provide an answer to the realignment questions with some degree of credibility. Having obtained numbers on the economic impact from a computer program was viewed much more credibly by critics of realignment activities than the seat-of-the-pants approach previously used. Because EIFS provided a solution to a very real problem at the time, that program and ETIS in general received extensive use in the field. Use of ETIS was never made mandatory; the interviewee stated people used it because they wanted to.

The results generated by EIFS stood up in one application over another. Court decisions were made using data supplied by military users of EIFS. Consultants brought in to examine realignment problems reconfirmed the accuracy of data generated by EIFS. USA-CERL participated in some seminars attended by other companies involved in economic modeling. Individuals at these seminars supported the ability of EIFS to do what it was designed to do. The trials and tests of the system created credibility for the system which was passed throughout the user community through peer contacts.

The use of free passwords worked well in allowing potential users to experiment with the system and learn its capabilities at their own pace. Giving a potential user a

free trial of the system precluded him or her having to go through the paperwork drill of submitting purchase orders to pay for the trial use. The bureaucracy involved in submitting purchase orders when only a minor amount of money is involved could have discouraged a potential user from getting involved with the system.

The DA Pamphlet came after EIFS was already well in use by the Army. However, the document did provide an added level of legitimacy for use of the system. DA Pamphlets are guidance documents for Army staff.

The interaction with the field and their use of the system led to a sizeable inflow of dollars into USA-CERL to develop specific applications. The interviewee commented that a sign that technology transfer is working is that users come back to you to modify the technology to meet additional specific needs they have.

Expected or Encountered Problems

The ETIS program was initially set up on a minicomputer with a relatively new programming language called C-language. At that time minicomputers and C-language were not the standard for the Army. Consequently, the Facilities Engineering Support Agency (FESA) would not take over the completed system to maintain and provide support to users. Normally, FESA would provide such support to personnel at Army installations.

This eventually led USA-CERL to set up the ETIS Support Center at UIUC about 1981. USA-CERL provided such support until the development of the center. The development of the center also solved another problem in transferring the technology outside the military. USA-CERL could not take money from non-Federal organizations to assist them in using ETIS. Transferring the support operation to UIUC would allow this exchange of funds and assistance to occur.

The biggest expected problem was to get people comfortable with using the computer. C-language was very flexible and allowed ETIS to be developed in a very user-friendly format.

Criticism of EIFS tend to be the data is old or the system does not address their problems (i.e., civil works or nonmilitary users). The criticism of old data is largely one of the lack of awareness by critics that the data is the best available short of gathering brand new, site specific data.

Nonmilitary use of ETIS was not as extensive as the interviewee had expected. Although many individuals expressed an interest in using the system, many of them did not follow up on their expressed intention to use it. The interviewee stated some of these individuals may be turned off by the military perspective for the system.

The interviewee stated that he had heard about distribution problems with technical reports. Some people in

the field claim to never have seen a copy of a technical report even though they were an addressee on the distribution list.

The interviewee pointed out two other things which contributed to the successful transfer of ETIS. One was the lack of technology available to the field. Anything they developed would be welcomed and looked at by the field. Secondly, The technology they developed was not overlapping with any other military organization's area of responsibility. Consequently, they did not have to contend with any political turf battles.

Improving the Transfer Process

The interviewee stated he would be interested in going over to the support center for a short while to see if his personal, soft-sell approach would work for non-Federal users. He indicated we are too formal sometimes in our approach to convince users to use technologies.

The usability of the product is the key to a successful transfer effort. It is important to obtain the input from the real users of the system as opposed to the headquarters people who may or may not be well versed in the problems facing the field.

Using Outside Experts

Outside experts were valuable in the development and refinement of the system. The support center is currently thinking about hiring a marketing consultant for ETIS through UIUC.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix I
Case Study Review: Construction Management Microcomputers

University of Illinois at Chicago
Department of Communications and Theater

Applied Research Project
Technology Transfer Activities of the U.S. Army Construction
Engineering Research Laboratory
Jeffrey J. Walaszek

Case Study Review: Construction Management Microcomputers
Date: 6 October 1985

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 became 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 guide 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 incorporated 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 hoarding 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.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix J
Listing of Interview Questions for Army Personnel

Interview Questions for Technology Transfer

I appreciate you taking the time to speak with me today.

The Directorate of Research and Development is taking a close look at the process involved in getting its technology into the hands of Corps and Army personnel that could benefit from it. We're trying to find ways to improve upon the technology transfer process, if necessary. I've been sent up here from the Construction Engineering Research Laboratory to spend the next two months looking into this issue for DRD. Dr. Choromokos suggested I speak with you to obtain your perceptions on the technology transfer process as the programs and people you oversee are potential recipients of much of this technology. I'd like to ask you few questions.

For the purpose of this project I've put together a working definition of what technology transfer means to the Corps. I'd appreciate your comments on the appropriateness of this definition. Technology transfer consists of two general activities: 1. Informing potential users of the existence of an available technology and its applications, and 2. getting the technology into the hands of the users in a usable form with appropriate technical support.

What is your impression of the response by the field in using new technologies developed by the Corps labs? Are the new technologies being effectively transferred to the field?

What are some of the obstacles or problems that you've observed in the transfer of Corps R&D technologies to those Corps/Army personnel that fall under your area of responsibility?

What could be done to overcome some of these obstacles/problems?

What do you feel is the best way to inform potential users about new Corps R&D technologies?

What mechanisms are available within your organization that could be used to convey information on new technologies directly to those individuals working on programs under your area of responsibility?

We've spoken about individuals working on programs under your area of responsibility, who are those people and how receptive are they to new technologies?

I'm handing you a list of some of the programs and activities that make up our technology transfer activities. Which of these do you feel are effective in transferring technology to users? Why do some of these

approaches work? Why don't the others?

What can be done to improve the technology transfer process? As a potential user, what would convince you and your people to take advantage of research products from the Corps labs?

What role might your office have in the technology transfer process?

I appreciate your comments and thank you very much for your time.

Technology Transfer Activities of Corps of Engineers Research Laboratories

1. Facilities Technology Applications Test (FTAT) Program--A five year, 29 million dollar program designed to demonstrate technologies in base support. R&D funds are used to implement technologies at installations to demonstrate their effectiveness and cost savings. Similar demonstration/research programs have also been established in support of civil works activities (Repair, Evaluation, Maintenance, and Rehabilitation--REMR) and in the area of combat support (Air-Land Battlefield Environment--ALBE).
2. Technology Transfer Test Bed (TTTB) Program--A program designed to demonstrate the use of technologies at District and Division offices and to get those offices actively involved in transferring demonstrated technologies to other Corps offices by identifying them as centers of expertise for a technology area.
3. Publication of research findings in technical reports.
4. Publication of articles on research products in newsletters.
5. Publication of articles on research products in technical magazines.
6. Use of authorization documents such as Technical Manuals and Engineering Regulations to encourage use of new technologies.
7. Conducting workshops, training classes, and presentations on the application of new technologies.
8. Use of audiovisual presentations such as videotapes, films, or slide presentations to inform potential users of a new technology.
9. Personal contacts between research staff and potential users.

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix K
Copy of Survey for Public Relations Professionals

**QUESTIONNAIRE FOR PUBLIC RELATIONS/AFFAIRS (PA) ACTIVITIES
AT ORGANIZATIONS CONDUCTING RESEARCH**

Please answer the questions by placing a checkmark or the requested information in the box or space provided.

The following questions are designed to identify how PA Offices are organized and staffed for conducting PA efforts on research activities.

1. Who is primarily responsible for PA efforts for research activities?

- a) in-house PA staff at research center
- b) PA staff at parent organization
- c) consultant
- d) no PA efforts are conducted on research activities
- e) other. _____

- a) under \$100,000
 - b) \$100,001 to \$250,000
 - c) \$250,001 to \$500,000
 - d) \$500,001 to \$750,000
 - e) \$750,001 to \$1 million
 - f) \$1 million to \$2 million
 - g) \$2 million to \$3 million
 - h) over \$3 million
- if over \$3 million, please state figure _____

If answer d is checked off, please move on to question 16.

Comments: _____

2. How many people are assigned to conduct PA efforts on the research activities of the organization?

- a) under 4
 - b) 4 to 8
 - c) 9 to 15
 - d) 16 to 25
 - e) 26 to 50
 - f) 51 to 75
 - g) over 75
- if over 75, please identify number _____

Comments: _____

3. What is your PA Office called?

- a) Public Relations
- b) Public Affairs
- c) Public Information (or Office of Information)
- d) Communications
- e) Public Relations, Public Affairs
- f) Public Relations and Advertising
- g) Community Relations
- h) Other. _____

- staffing*
- a) media relations _____
 - b) community relations _____
 - c) employee relations _____
 - d) publications _____
 - e) special projects _____
 - f) audio-visual communications _____
 - g) marketing _____
 - h) advertising _____
 - i) technology transfer _____
 - j) other. _____

4. What is your total PA Budget including salaries and expenses (do not include operating overhead or other accounting indices used in overall budgeting for the organization)?

Comments: _____

7. List the number of people on your in-house staff which have the following duties as their primary responsibility. Place these numbers in the in-house column.

	<u>In-house</u>	<u>Contract</u>
a) PA office supervisor	_____	_____
b) department managers	_____	_____
c) media liaison	_____	_____
d) writers	_____	_____
e) editors	_____	_____
f) writer editors	_____	_____
g) editorial assistants	_____	_____
h) illustrators	_____	_____
i) photographers	_____	_____
j) videotape specialists	_____	_____
k) secretaries/clerks	_____	_____
l) typists	_____	_____
m) technology transfer specialist	_____	_____
n) others. _____	_____	_____

Comments _____

8. Please check off those duties listed in question 7 which you contract out regularly. Place your checkmarks in the contract column.

Comments: _____

9. As the head of the PA Office, whom do you report to?

- a) chief executive officer
- b) number two executive
- c) administrative staff officer
- d) department head
- please identify department title. _____
- e) other _____
- please identify. _____

Please attach a line and staff chart for both the overall research organization and your PA Office if they are readily available.

The following questions are designed to obtain information on the research organization.

10. What field(s) do you conduct research in?

- a) engineering
- b) medicine
- c) computers
- d) natural sciences
- e) social sciences
- f) electronics
- g) life sciences
- h) chemicals
- i) other. _____

Comments _____

Comments _____

12. Identify the type of research organization?

- a) government
- b) corporate
- c) nonprofit
- d) other. _____

13. How many people does your organization employ to conduct or support research?

11. How large is your organization in terms of its current annual research budget?

- a) under \$10 million
- b) \$10 to \$35 million
- c) \$35 to \$75 million
- d) \$75 to \$125 million
- e) \$125 to \$250 million
- f) \$250 to \$500 million
- g) over \$500 million

- a) under 75
- b) 75 to 150
- c) 151 to 300
- d) 301 to 500
- e) 501 to 750
- f) 751 to 1,000
- g) 1,001 to 2,000
- h) 2,001 to 3,500
- i) over 3,500

The following questions are designed to identify PA efforts for research activities and their relative importance.

14. Indicate the importance of the following PA tasks to your organization by assigning a number from 1 to 5 on the space next to the task. Using the scale shown below, a task assigned a 1 would be very important to your organization and a 5 would be not at all important. Please add any major tasks which do not appear in the list.

<i>very</i>		<i>moderately</i>	<i>somewhat</i>	<i>not at all</i>
<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>
1	2	3	4	5

- a) media relations: business and technical publications _____
- b) media relations: general media _____
- c) community relations _____
 - tours _____
 - open houses _____
 - speakers bureaus _____
 - others. _____
- d) employee relations _____
 - publications _____
- e) counseling chief executive _____
- f) assistance to others in the organization _____
 - speech writing _____
 - answering information requests _____
 - article writing editing _____
 - designing visual displays and graphic materials _____
 - other. _____
- g) participation in trade shows _____
- h) advertising product publicity _____
- i) public issues identification _____
- j) tracking new technological developments of competition _____

<i>very</i>		<i>moderately</i>	<i>somewhat</i>	<i>not at all</i>
<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>
1	2	3	4	5

- k) recruiting personnel _____
- l) fund raising _____
- m) other major activities, please list _____
- _____
- _____
- _____

Comments: _____

15. Estimate what percentage of time is spent by your office on the following general categories of PA activities.

- a) media relations: business and technical publications _____
- b) media relations: general media _____
- c) community relations _____
- d) employee relations _____
- e) assistance to personnel in organization _____
- f) technology transfer _____
- g) other categories, please list _____
- _____
- _____
- _____

Comments: _____

The following questions are designed to identify the organizational mechanisms and tools used to transfer technologies developed by the organization to potential users. Technology transfer efforts typically involve first informing potential users that a new technology exists and then delivering the technology into the hands of the user.

Most likely, the primary responsibility for technology transfer will belong to some department other than the PA Office such as technology transfer office or marketing department. It may be necessary for you to consult individuals in such offices to obtain the requested information.

16 What office individual is responsible for ensuring the successful transfer of technology developed at your organization?

- a) technology transfer officer(s)
- b) marketing department
- c) PA Office
- d) an assistant to the chief executive
- e) research team that develops the technology
- f) other. _____
- g) no one office or individual

Comments: _____

17 Of those individuals involved in technology transfer in your organization, what percentage of them have the following professional and/or educational backgrounds?

- a) technical _____
- b) communications _____
- c) marketing business _____
- d) law _____
- e) other. _____

Comments _____

18 Identify the importance of the following communications tools to your organization in introducing its technologies to potential users. Place a number from 1 to 5 on the line next to each tool using the scale shown below:

- | | | | | |
|------------------|------------------|-------------------|------------------|-------------------|
| <i>very</i> | | <i>moderately</i> | <i>somewhat</i> | <i>not at all</i> |
| <i>important</i> | <i>important</i> | <i>important</i> | <i>important</i> | <i>important</i> |
| 1 | 2 | 3 | 4 | 5 |
- a) advertisements _____
 - b) articles in technical, trade, and business publications _____
 - c) stories placed in general audience publications and newspapers _____
 - d) videotapes _____
 - e) displays at trade shows _____
 - f) videoconferencing _____

<i>very</i>		<i>moderately</i>	<i>somewhat</i>	<i>not at all</i>
<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>
1	2	3	4	5

- g) sales people _____
- h) individual contacts by research staff _____
- i) demonstrations briefings _____
- j) newsletters _____
- k) technology open houses _____
- l) cable television _____
- m) others. _____

Comments: _____

19. The following techniques can be used to assist users in properly implementing a new technology. Identify the importance of each technique to your organization by placing a number from 1 to 5 in the appropriate space. Use the scale shown below in assigning numbers.

<i>very</i>		<i>moderately</i>	<i>somewhat</i>	<i>not at all</i>
<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>	<i>important</i>
1	2	3	4	5

- a) users groups-meetings of users of technology to discuss its use _____
- b) support center staffed with people trained to answer questions _____
- c) training classes _____
- d) videotape on using technology _____
- e) videoconferences _____
- f) researchers answer questions by phone _____
- g) users manuals _____
- h) service staff to assist users onsite _____
- i) technology support provided by manufacturer distributor of technology _____
- j) other. _____

Comments: _____

20. What role could your organization's Public Relations/Affairs Office have in the technology transfer process?

Name of organization (optional): _____

If you would like to receive a summary of the results of this survey, please write your mailing address in the lines below

Thank you for taking the time to complete this survey. Please use the self-addressed stamped envelope to return the survey to

Mr. Jeff Walaszek
U.S. Army Construction Engineering Research Laboratory
P.O. Box 4005
Champaign, Illinois 61820-1305

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix L
Cover Letters for Public Relations Survey



DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORY, CORPS OF ENGINEERS
P.O. BOX 4006
CHAMPAIGN, ILLINOIS 61820-1306

333

REPLY TO
ATTENTION OF:

CERL-ZP

13 DEC 1985

SUBJECT: Request for Assistance with Survey

Commander
U.S. Army Training and Doctrine Command
ATTN: ATEN-FE
Fort Monroe, VA 23651

1. The U.S. Army Construction Engineering Research Laboratory (USA-CERL) is continually looking for ways to provide better service to the installation DEH. Providing information on new products, research findings, and services available from USA-CERL and other Corps labs is critical to our ability to support the DEH. We ask your assistance in trying to find out how we can most effectively provide such information to the DEH.
2. We request your approval to send five copies of the enclosed survey to the DEH at five installations of your choice. The nine-question survey is designed to determine how the DEH staff currently obtains information and makes decisions on using new technologies. We will ask that the survey be filled out by the DEH, and personnel within the following branches and offices -- utilities, buildings and grounds, management, and the environmental office. The survey will be sent out in early January. The survey should take no longer than a maximum of ten minutes to fill out.
3. We would appreciate a response and a listing of the five installations you'd like to receive the survey by 30 Dec 85. Any questions on the survey should be directed to Jeff Walaszek at 217-373-7216.

Encl

Paul
PAUL J. THEUER, P.E.
Colonel, Corps of Engineers
Commander and Director

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix M
Survey on Communications of New Research
and Development Technologies

SURVEY ON COMMUNICATIONS OF NEW RESEARCH AND DEVELOPMENT TECHNOLOGIES

The U.S. Army Construction Engineering Research Laboratory in Champaign, Illinois, is trying to improve upon its efforts to inform potential users about new technologies it develops. Please help us in our efforts by responding to this short, nine question survey. The survey shouldn't take any more than 10 minutes of your time. We welcome and value your opinions.

1. Check off the description that best reflects your current position.

- Director or Assistant Director of Engineering and Housing at Army installation _____
- employed in Directorate of Engineering and Housing at Army installation _____
- employed in Corps of Engineers District/Division _____
- other, please specify _____

2. Please check off the following ways you typically learn about new technologies related to construction, maintenance, or engineering activities?

- technical reports describing technology _____
- Army guidance documents (i.e., Engineer Technical Notes) _____
- articles in Army magazines or newspapers _____
- articles in newspapers _____
- articles in trade publications _____
- exhibits at conferences _____
- demonstrations/briefings _____
- workshops/seminars _____
- personal contacts with staff from research organization _____
- audiovisual materials (videotapes, slide presentations, audio cassettes, etc.) _____
- newsletters (i.e., CERL Reports) _____
- videoconferencing or teleconferencing _____
- textbooks _____
- others, _____

3. How would you prefer to receive information on new construction and maintenance technologies? Check off the three approaches which would benefit you most.

- technical reports _____
- Army guidance documents _____
- articles in Army magazines or newspapers _____
- articles in newspapers _____
- articles in trade publications _____
- exhibits at conferences _____
- demonstrations/briefings _____
- workshops/seminars _____
- personal contacts with staff from research organization _____
- audiovisual materials (videotapes, slide presentations, audio cassettes, etc.) _____
- newsletters (i.e., CERL Reports) _____
- videoconferencing or teleconferencing _____
- textbooks _____
- others, _____

4. Several non-print approaches to the communication of technologies are now being used. However, they require the availability of equipment or facilities. Do you have easy access to the following items?

- | | | |
|--|---------|---------|
| 3 1/4-inch videotape playback unit | Y _____ | N _____ |
| slide projector cued by audio signal in audio cassette | Y _____ | N _____ |

- teleconferencing facility* Y _____ N _____
- videoconferencing facility* Y _____ N _____
- microcomputer or computer terminal with the capability to send or receive electronic mail messages Y _____ N _____
(please identify computer system(s) you use for electronic mail _____)

(*many hotel chains such as Holiday Inns are now offering these services.)

5. Check off the frequency with which you read the following publications. Feel free to add any additional publications you receive. Please comment on how often you read them also.

	Read Every Issue	Read Sometimes	Never Read	Do Not Receive
a. CERL Technical Reports	_____	_____	_____	_____
b. CERL Reports (CERL)	_____	_____	_____	_____
c. FE Items of Interest (USACE)	_____	_____	_____	_____
d. FESA Briefs (FESA)	_____	_____	_____	_____
e. Engineer Update (USACE)	_____	_____	_____	_____
f. Military Engineer (SAME)	_____	_____	_____	_____
g. Army R.D. & A (AMC)	_____	_____	_____	_____
h. Benchnotes (CRREL)	_____	_____	_____	_____
i. REMR Bulletin (WES)	_____	_____	_____	_____
j. Engineering News-Record	_____	_____	_____	_____
k. ASCE Civil Engineering	_____	_____	_____	_____
l. Other publications, please write in name _____	_____	_____	_____	_____
_____	_____	_____	_____	_____

6. Which of the following claims would most likely encourage you to try a new construction and maintenance technology?

- a. improved efficiency of operations through timesavings _____
- b. improved product quality _____
- c. reduced labor reduced costs of operation _____
- d. other, please explain below _____

7. If a new construction and maintenance technology appeared to be appropriate for use in your organization, when would you try it?

- a. after initially reading about it _____
- b. after evaluating additional information on the technology _____
- c. after technology was in use for some time and results on its use were available _____
- d. after use of technology became mandated by higher authority in organization _____
- e. other, please explain below _____

8. What primary source of information would you depend upon for obtaining reliable information on a technology to assist you in making a decision on using that technology? Select one item.

- a. information published or provided by research staff that developed the technology _____
- b. articles on technology published in publications not produced by research organization _____
- c. peers which have used the technology _____
- d. higher level authority within your organization familiar with technology _____
- e. architect engineering firm using technology _____
- f. GSA stock list _____
- g. other, please identify _____

9. Below are some construction and maintenance technologies developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) in Champaign, IL. As best as you can remember, please check off how you found out about those technologies.

Product	Read about it	Heard about it through briefings or workshops	Heard about it through word-of-mouth	Not familiar with
a. Environmental Technical Information System (ETIS)	_____	_____	_____	_____
b. Pavement Maintenance Management System (PAVER)	_____	_____	_____	_____
c. Construction Management Software	_____	_____	_____	_____
d. Ceramic Anode	_____	_____	_____	_____
e. 1391 Processor	_____	_____	_____	_____
f. Concrete Quality Monitor	_____	_____	_____	_____
g. Portawasher	_____	_____	_____	_____
h. Building Loads and System Thermodynamics (BLAST) Program	_____	_____	_____	_____
i. Computer Aided Architectural Design System (CAEADS)	_____	_____	_____	_____
j. Voice-Activated Inspection System	_____	_____	_____	_____

10. (Optional) Please sign your name and add your title.

Name: _____

Title: _____

Thank you for taking the time to fill out this survey. Please use the self-addressed, stamped envelope to return the surveys to

U.S. Army Construction Engineering Research Laboratory
P.O. Box 4005
Champaign, Illinois 61820-1305
ATTN: Jeff Walaszek

The Role of Communications Within
Technology Transfer Activities of the U.S. Army
Construction Engineering Research Laboratory

Appendix N
List of Survey Recipients and Survey Correspondence

Coding of Survey Recipients for Information Exchange Study

No.	Agency
AMC Installations--5 each	
1-5	Aberdeen Proving Ground
6-10	Radford Army Ammunition Plant
11-15	Anniston Army Depot
16-20	Watervliet Arsenal
21-25	Fort Monmouth
TRADOC Installations--5 each	
26-30	Fort Benning
31-35	Fort Eustis
36-40	Fort Jackson
41-45	Fort Leavenworth
46-50	Fort Lee
FORSCOM Installations--5 each	
51-55	Fort Lewis
56-60	Fort Stewart
61-65	Fort Campbell
66-70	Fort Drum
71-75	Praesidio of San Francisco
Corps of Engineers--9 each	
76-84	Memphis District
85-93	Missouri River Division
94-102	Philadelphia District
103-111	Detroit District
112-120	Alaska District
121-129	Ohio River Division
130-138	Pittsburgh District
139-147	South Atlantic Division
148-156	Savannah District
157-165	Sacramento District
166-174	Fort Worth District
175-179	Japan District
175-179	HQ AMC--5 each
180-184	HQ TRADOC--5 each
185-189	HQ FORSCOM--5 each
USAREUR Installations--5 each	
V190-V194	Vincenza
K195-K199	Karlsruhe
200-204	Heidelberg
205-209	Baumholder
210-214	Ansbach
215-219	HQ USAREUR--5 each

END

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DTIC