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ABSTRACT (Maximum 200 words)
This report summarizes project achievements over the period 1-July-98 through 30-November-01. Two maj successes are reported. First, the project's scientific objectives were achieved. Empirical testing identified a significant weakness in soldiers' capabilities to detection landmines with low metallic content when using standard US Army techniques with the currently fielded detector (AN19/PSS-12). Expert operators were identified who exhibited superior detection performance. A cognitive theory of expert mine detection performance with the AN19/PSS-12 was developed and validated via tests of a training program based on expert skill. Second, findings have been applied in several ways. Foremost, project results led the US Army Engineer School to replace established mine detection training procedures and adopt the training program engineered using the theory and data generated by this project, and subsequently tested, refined, and transfer to Army personnel. US Army Observer/Controllers at the Joint Readiness Training Center, Ft. Polk have successfully given this program's training to troops participating in MREs The program also has been successfully generalized to train users of the HSTAMIDS system currently in development. This project has also supported development, testing, and distribution of training aids currently being applied in training Arm and Marine Corps personnel in landmine detection.

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Enclosure 1

1. Foreward

The speed with which the basic scientific findings of this project have resulted in application has been unusual. This has occurred for several reasons. One is the importance of the problem. Another is the resources that have been brought to bear on solving it. Beyond the core funding from the US Army Research Office (ARO), supplementary support from several sources contributed significantly to this project's surpassing its basic research goals and achieving a practical, and hopefully beneficial impact on US Army capabilities and personnel.

First, all PSS-12 training studies were performed in full collaboration with Dr. Alan Davison, (LTC-R), Chief, Army Research Laboratory Human Research Engineering Directorate (ARL-HRED) Field Element, United States Army Maneuver Support Center, Ft. Leonard Wood, MO. His contribution to this project has been immeasurable. Mr. Glen Boxley of the Directorate of Combat Developments, United States Army Maneuver Support Center, Ft. Leonard Wood, MO., worked tirelessly to support the data collections carried out at Ft. Leonard Wood in the Fall of 1999, above and beyond his regular duties. Soldiers will never find better friends than these men.

Funding from ARL-HRED, the Office of the Program Manager - Mines, Countermines, and Demolition (Countermine Division), and the Army Material Command - Field Assistance for Science and Technology Program supported different important facets of this project.

The support and advice of Dr. James F. Harvey, who managed ARO's MURI and Landmine Detection Programs, clearly contributed to the success of this effort. Mr. Dick Weaver of the Joint Unexploded Ordnance Coordinating Office provided critical support in launching the initial studies of PSS-12 expertise.

The PI and all who benefit from this work are indebted to the efforts of the late Floyd R. Rockwell, whose landmine detection expertise *is* the foundation of this work.

Finally, the pioneering research on human expertise conducted by the late Herbert A. Simon and William G. Chase provided the scientific tools to build the foundation.

2. Table of Contents

Section	Content	Page
1.	Foreward	1
2.	Table of Contents	2
3.	List of Appendices, Illustrations, and Tables	3
4.	Statement of Problem	4
4.1.	Research Objectives	4
5.	Summary of Most Important Results	5
5.1	Basic Research Issues	5
5.1.1.	Identification, Analysis, and Modeling of Expertise	5
5.1.2.	Model Validation via Training Studies	5
5.1.3.	Further Training Studies	7
5.2.	Practical Impact: Applications	8
5.2.1.	Impact on U.S Army Countermine Training and Doctrine	8
5.2.2	Impact on HSTAMIDS Development	8
5.2.3	Development of New Training Aids	9
5.2.4.	Impact on Robotic Detection and Training Technology Development	10
6.	List of Publications and Technical Reports	10
7.	Scientific Personnel	11
8.	Report of Inventions	12
9.	Bibliography	12
10.	Appendices	13

3. List of Appendices, Illustrations, and Tables

Appendices **Page**

Appendix 1: Personal communication to PI and collaborator Davison received on 25 September 2001 evaluating program of training based on expert skill administered by JRTC Observer/Controllers' in September 2001…….. 13

Appendix 2: Briefings requested by and for military personnel………………………….... 14

Figures

Figure 1: Detection performance for experimental and control groups as a function of target type following administration of training treatment........................... 15

Figure 2: NCO detection performance following 3-4 hours of training based on expert skill administered at JRTC, Ft. Polk, in August 2001………………………… 16

Figure 3: Distribution of NCO responses to shown questionaire item upon conclusion of the 'train-the-trainer' exercise at JRTC, Ft. Polk in August 2001................. 17

Figure 4: Distribution of NCO responses to shown questionaire item upon conclusion of the 'train-the-trainer' exercise at JRTC, Ft. Polk in August 2001................. 18

Figure 5: Distribution of NCO responses to shown questionaire item upon conclusion of the 'train-the-trainer' exercise at JRTC, Ft. Polk in August 2001................. 19

Figure 6: Detection performance of soldiers from 27th En Task Force, 10th Mountain Division following less than 1 hour of training on expert techniques administered by JRTC Engineer Observer/Controllers in September 2001…………………… 20

Tables

Table 1: Action items recommended by DTLOMS Integration Board regarding experimental PSS-12 training and approved by Commandant and Assistant Commandant of the US Army Engineer School, February 9, 2002……………… 9

4. Statement of Problem

Casualties due to landmine strikes have produced an increasing proportion of total US casualties in every major conflict since World War II. Currently, landmines represent a major threat to military ground operations and the personnel and light armor involved. In some theaters, they are *the* major threat. These inexpensive weapons represent a force multiplier that enables asymmetric threats to negate US advantages in firepower and mobility by limiting maneuver capability (Schneck, Visser, & Leigh, 1993).

The longevity of these weapons, whose lifetimes typically extend years beyond the conflicts motivating their deployment, also threatens local civilian populations (US Department of State, 1998). Unless these weapons are found and neutralized, their presence creates a problem with serious medical, social, psychological, economic, and political dimensions.

The problem of detecting landmines has been exacerbated in the past quarter-century by advances in landmine technology that have outstripped corresponding developments in countermine technology. Antipersonnel mines, in particular, have becomes smaller, but more importantly, their firing chains contain minute metal metallic components. Because countermine equipment since World War II has relied on Electromagnetic Induction (EMI) technology to detect landmines, the development and escalating deployment of mines (both anti-tank (AT) and anti-personnel (AP)) with low metallic content (LM) represent an rapidly growing threat to US ground forces. For example, 1991 tests of the AN19/PSS-12, the handheld countermine technology currently fielded by both the US Army and US Marine Corps, conducted just prior to its introduction showed that in soldiers' hands it performed extremely well against landmines with high metallic content, achieving near perfect detection rates. However, it could only detect 3% of M14 simulants, small, plastic-bodied anti-personnel mines (AP-LM) with minimal metallic content (US Army TECO, 1991). After Action Reports from Operations Desert Shield and Desert Storm and Operation Restore Hope focusing on countermine in these operations produced findings consistent with these results and documented the major threats to armor and personnel created by the deployment of low metal mines (Schneck, 1993, 1994).

Because no autonomous technologies could match the detection capabilities of handheld EMI systems used by human operators either at the time this program was initiated (Harvey, 1998) (or can currently), programmatic investigation of the detection capabilities and skills of PSS-12 operators was initiated. The needs to deploy maximally capable operators and to develop technologies with improved capabilities, and perhaps remove human operators from the threat, motivated this program's efforts.

4.1 Research Objectives

The general aim of this effort was to produce a body of scientific data that could support and advance engineering efforts in the following three areas:

1) Training experienced and novice detection personnel in ways expected to improve detection performance and increase training efficiency;

2) Designing autonomous detection systems to enhance their performance by identifying critical information that proficient human operators use to achieve superior performance;

3) Designing man-machine interfaces of human-operated systems to make detection efforts more effective and efficient and reduce their mental demands.

Specific objectives for accumulating this knowledge involved

1) Empirical assessment of operator performance capabilities to identify individuals most qualified to serve as "expert" subjects in subsequent studies;

2) Analysis of the cognitive foundation of expert landmine detection skill to generate a detailed description of its key functional components that will take the form of an idiographic, domain-specific information-processing theory;

3) Execution of experiments using expert subjects to validate key elements of this theory;

4) Conducting an experimental training study to test the validity of this theory as well as its utility for designing instruction in this domain;

5) investigation of the relative contribution of acquired knowledge and psychometrically-defined abilities to the development of expertise.

5. Summary of Most Important Results

5.1 Basic Research Issues

5.1.1. Identification, Analysis, and Modeling of Expertise Two operators of PSS-12s with extensive demining experience were identified and tested on their detection capabilities in the initial phase of this project. The wide variety of mine types found in the handheld test lanes at Range 71A, Fort A. P. Hill served as targets. They included multiple samples of mines from the four major mine classes, anti-tank, metallic (AT-M), anti-personnel-metallic (AP-M), anti-tank, low-metal (AT-LM), and anti-personnel, low metal (AP-LM). Both quantitative performance data and qualitative process data were collected.

The operators' high levels of performance across the spectrum of mines with high as well as low metallic content confirmed their expertise**.** Analysis of the techniques and thought processes showed that the experts achieved Probabilities of Detection (PDs) far above those observed for low-metal mines in Army test data (US Army TECO, 1991) using techniques and procedures that were qualitatively different from those taught by the Army. These results were reported in technical report (Staszewski, 1999), presented at SPIE in April 1999 and subsequently published in the SPIE Proceedings.

A second round of testing at Ft. A. P. Hill addressed questions about performance and collected a large corpus of audio-visual observations for detailed, second-by-second analysis of expert detection procedures. The test performance further validated the proficiency of the expert participating in this testing. Analysis of the audio-video records provided a wealth of qualitative data for confirming previous theoretical conclusions and refining the model of expert skill (Staszewski, Hibner, Delahanty, & Rockwell, 2000).

5.1.2. Model Validation via Training Studies The theoretical model of PSS-12 expertise was tested and validated in the Fall of 1999 in three training studies carried out in collaboration with Dr. Alan Davison (LTC-R) at Ft. Leonard Wood and Aberdeen Proving Ground (APG). (These studies are summarized in Staszewski & Davison, 2000). If, as hypothesized, the performance of the experts was due to skills acquired though experience, and not a set of unique innate abilities or talents, then giving new operators instruction on the expert strategies and techniques and the opportunity to practice them should produce rapid improvement in detection capabilities.

The training design process merits description due to its novelty; the instructional program was developed using ‘cognitive engineering.’ To elaborate, the training was engineered in the sense that the theoretical model of expert skills produced by the initial studies served as a template for training, providing a blueprint for both training content and organization. Theory, principles, and methods of Cognitive Science relevant to human learning, memory, and complex skill acquisition also guided the delivery of the training as well as formative and summative assessment of trainees. This approach differs sharply from traditional approaches to instructional design, which rely heavily on personal introspections and intuitions of the training designers, instead of deriving instruction from a body of scientific data in a principled way.

The program of instruction (POI) also incorporated a number of innovative training aids, whose functions were to support provision of practice on all training tasks, which would be immediately followed by feedback on performance. These tools included: a novel training and testing environment, simulated mine targets; low-cost tools for scoring detection rates and false alarm rates; and a computer-based system for evaluating operators’ coverage of ground surface in drill and blind testing. This Sweep Monitoring System (SMS), designed and developed under ARO MURI subcontract to Carnegie Mellon University's Robotics Institute, was also used to record operators' actions to evaluate the degree to which the techniques they employed corresponded with those taught.

This experiment used a pretest-posttest design. Mine simulants served as targets in testing and training. Targets simulated 5 different mines and represented high- and low-metal AT and AP mine types. Results of pretesting 20 US Army Combat Engineers, who had just completed Advanced Individual Training, *which included standard Army training on PSS-12 operating procedures*, failed to distinguish the treatment and control groups. Overall PD’s for the combined groups was .57. Both groups achieved very low PDs on low metal mines. Most alarming was the observation that, overall, soldiers found less that 1 in 5 targets with the lowest metal content, M14 simulants (PD = .16). Generally, the group PD for all low-metallic targets (ATs and both types of APs) was 0.40. As expected PDs for AT and AP targets with considerable metallic content were much higher, 0.91 and 0.74 respectively.

Treatment-group soldiers then received approximately 12-15 hours of experimental, hands on training, drill, and task practice apiece. Posttest results showed that the treatment group achieved an overall PD of 0.94. This PD exceeded the control group’s by a factor of 3. The treatment group’s PD on minimal metal targets (M14 simulants) was more than 6 times that of the control group. The results of the initial study, shown in Figure 1, confirmed the model of expert detection skill, showing that training and practice on expert techniques could quickly raise the detection capabilities of PSS-12 operators whose baseline performance, particularly against low metallic targets would otherwise place in jeopardy both mission success and their safety.

A second study sought to confirm these results through replication and also examine their generality. To do so, this study tested a subset of the treated soldiers in the same setting, now wearing body armor. Results replicated those of Study 1.

Study 3 tested treatment group soldiers against real mine targets, a critical test of the generality of the previous two studies’ results. This test was made possible by substantial supplementary funding provided by the Office of the Program Manager, Mines, Countermines, and Demolitions (Countermine Division). Targets were real mines from each of the four major classes, AT-M, AP-M, AT-LM, and AP-LM, whose firing chains were interrupted, removing the threat of detonation. Several mine types from within each class were employed and multiple exemplars from each mine type were used. The surface of the mine lanes at the test site, Range

16 at APG, presented a road surface of crushed and rolled gravel. This surface was expected to increase detection difficulty by denying operators immediate visual feedback on area coverage during their search.

Soldiers who had received the experimental training nonetheless achieved an aggregate PD of 0.97 and showed significant improvement in detecting low-metal mines. The group PD against M14s in this setting was 1.00. Also, notable in the results was the impact of training on individual differences; all of the 8 soldiers who had received the experimental training and were available for testing at APG achieved PDs of 0.90 or better.

The success of this cognitively-engineered PSS-12 training program also demonstrated the potential practical utility of the various training aids it employed. Although no effort was made to assess the relative contribution of any single training aid, the entire package clearly supported substantial improvements in participating soldiers detection capabilities. The relatively low cost of the entire set of training aids (<$7K) showed that considerable improvement in detection performance could be achieved with a very modest investment in time and money.

5.1.3. Further Training Studies Dissemination of the above results led to an invitation from personnel at the Joint Readiness Training Center, Ft. Polk, LA, to

A. set up a permanent mine detection training site for use during (1) JRTC's normal rotations and Mission Rehearsal Exercises, which train units being deployed to Bosnia, Kosovo, and other third world nations, and (2) the training of FORSCOM units permanently assigned to Ft. Polk, such as the 2nd Armored Cavalry Regiment, the Warrior Brigade, and the 519th MP Battalion,
B. present a two-day mine detection seminar to personnel in the JRTC Operations Group, the 2nd ACR, the Warrior Brigade, and the 519th MP Bn., and
C. train a group of NCO trainers on the experimental training program. These NCOs from the 209th MP of the 519th were to subsequently use the training to prepare troops for their October deployment to Kosovo. NCOs from the 41st En. Bn. Of the 10th Mountain Division also participated. Once familiarized with the training program, the NCOs trained would then provide training on the new, expert PSS-12 techniques to troops unfamiliar with them.

ARL-HRED, PM-MCD, and AMC-FAST provided supplementary funding to support these efforts. Although the motivations of the recipients and the above organizations were oriented toward practical application, the training component of this effort provided an opportunity to further examine the generality of the findings produced by the initial training studies. Specifically, higher rank enlisted soldiers were involved as participants and the duration of the training delivered at JRTC was much shorter than in the initial training studies. While the confounding of these variables would not yield sound scientific conclusions about the effects of these variables that could only be obtained through controlled experimentation, the observations could nonetheless inform future experimental investigations focusing on these variables.

Figure 2 shows that the 11 NCOs who participated in approximately 3-4 hours of hands-on drill and practice in the training program showed a pattern of improvement similar to those observed in Staszewski & Davison's (2000) Study 1. The magnitude of treatment gains, however, was reduced and particularly against the targets with the lowest metallic content. It is suspected the 3-to-4-fold reduction in drill and practice time was largely responsible for observed drop in detection performance. There was evidence that the adverse weather conditions encountered also contributed as heavy rains occurred frequently throughout the training period. Moisture is known to compromise the capability of the PSS-12 (Das, 1998).

Self-report measures were also used to evaluate the train-the-trainers activity. Summaries of several post-training questionnaire items, shown in Figures 3, 4, and 5, show that the NCOs involved as both operator-trainees and Assistant Instructors perceived themselves as confident and well-prepared to train the new techniques.

Further indications of effectiveness of the experimental training came from its application two weeks after the train-the-trainers activity. JRTC Engineer Observer/Controllers administered the training program to Sappers in the Task Force 27th Engineer engaged in KFOR Mission Rehearsal Exercises at Ft. Polk in September 2001. The duration of the training was further reduced to approximately an hour of instruction and practice per soldier. Approximately 25-30 soldiers were trained per day for six days. Pre-test and post-training performance data provided by JRTC personnel in charge are plotted in Figure 6. Interpretation and evaluation of these results provided by the officer assigned the training mission are shown in Appendix 1. In summary, JRTC personnel were very satisfied with the training program's results.

Overall, results of the JRTC activities suggest that the PSS-12 training based on expert skill is robust to variability in instructors, trainee MOS and rank, soils and surface conditions, weather conditions, targets, and large reductions in the time available for operators to practice the new techniques and acquire proficiency.

It should be noted, however, that these variables were not examined in a systematic parametric way. Rather, the variation along these dimensions was that imposed by the testing opportunities afforded. Further research that examines the effects of these variables is needed to produce a scientifically sound and comprehensive account of their effects.

In particular, a comprehensive examination of the effects of training duration would be of enormous practical importance. Clearly, reductions in training and drill time observed in the above studies have yielded lower detection rates for the greatest threat - low metal mines. A sound and detailed understanding of this apparent inverse relation between training/drill and detection performance is needed in order to perform a cost/benefit analysis of training duration. The results of such a cost/benefit analysis could be of enormous practical importance to supporting decision making of U. S. Army command personnel.

5.2. Practical Impact: Applications

The most significant result of the project is the application that it has generated. The most significant practical applications are listed below.

5.2.1. Impact on U.S Army Countermine Training and Doctrine The most significant feature of this project is the practical impact it has had on mine detection training, techniques, and procedures. On January 9, 2002 a Doctrine, Training, Leadership, Organization, Materiel, and Soldier Integration Board composed of high-ranking Engineer School Officers convened to review current PSS-12 training performance and practices, review the results produced by this project, and make recommendations to the Engineer School Commandant regarding mine detection training.

Table 1 lists the actions items produced by the Board that the Deputy Assistant Commandant to the Engineer School directed occur. The items were presented to MG Aadland and BG Castro, Commandant and Assistant Commandant of the Engineer School, and approved on 98 February 2002. To summarize these actions, the Engineer School, and therefore the U. S. Army, will adapt the training and the detection techniques and procedures developed and tested by this project, thus replacing those previously in place.

5.2.2. Impact on HSTAMIDS Development The technology for training development and the training design developed in this project was adapted to development of training for the prototype Handheld Stand-Off Mine Detection System (HSTAMIDS). This system is a technologically-advanced dual sensor (electromagnetic induction and ground penetrating radar sensors) system intended as the next-generation handheld landmine detection equipment. The resulting training program was used to train novice HSTAMIDS operators in two separate training exercises conducted at Aberdeen Proving Ground in April and June 2000. The performance of trainees in subsequent tests conducted by HSTAMIDS test personnel resulted in successful transition of this technology development program from an extended Product Definition and Risk Reduction phase to an Engineering and Manufacturing Development Phase. The training development and training application

Table 1: Action items recommended by DTLOMS Integration Board regarding experimental PSS-12 training and approved 9 February 2002 by MG Aadland and BG Castro , Commandant and Assistant Commandant of the US Army Engineer School.

Operational Safety of Use Message (DOTD) (re old techniques)
Change TM (DOTD)
Change POI (DOTD)
Change of Individual Tasks (DOTD)
Doctrinal changes (DOT)
Exportable TSP to send to field (DOTD)
Engineer Qualification Test (DOTD)
Modify and build a training site (PTBDE)
Letter to Schiebel recommending change in user manual

were performed by the PI and sponsored by the Office of the Program Manager – Mines, Countermine, and Demolition and administered by the U.S. Army Communications and Electronic Command.

5.2.3. Development of New Training Aids

Sweep Monitoring System (SMS) Data, and recorded audio and video observations from development and testing of the model of PSS-12 expertise were provided to Dr. Herman Herman, subcontractor on ARO's Mine Detection MURI, and affiliated with the Robotics Institute of Carnegie Mellon University. These materials were selected and provided to support his development of two training technologies (1) his Sweep Monitoring System (SMS) and (2) the Virtual Mine Lane.

The studies of Staszewski & Davison (2000) and the later HSTAMIDS training exercises (referenced above) provided the first practical tests of the Sweep Monitoring System as a training aid. A SMS acquired through supplementary ARO funding was purchased and used in the JRTC training activities described above. This system will transition to the possession of TASC at JRTC and will be used in training activities carried out there by Army personnel. The utility of the SMS is best confirmed by the redesign, hardening, and manufacturing of this system by STRICOM for military training.

Ownership of the SMS purchased with ARO funds and used for the JRTC training studies will be permanently be transferred to TASC at JRTC, Ft. Polk. The system will be used for training sessions conducted at that site for MREs and normal unit rotations.

Mine Simulants A major impediment to effective military training in landmine detection has been limited availability of LM targets. Staszewski and Davison's (2000) solution to the problem involved embedding metallic components developed by PM-MCD (Riggs, Lowe, Mooney. Barnett, Ess, & Paca, 1999) in hockey pucks for use as targets in their mine detection training. The metal components designed by Riggs, et al., 1999 to simulate the metallic signatures of low-metal mines. The demonstration that training against these simulant targets produces skills that generalize to the detection of actual mines (Study 3, Staszewski and Davison, 2000) is important in two ways. First, it indicates that detection training facilities can be constructed and maintained at far less than the cost involved if actual mines are used for training. It also makes it easier for units to set up such facilities at numerous sites to provide initial and refresher training to troops.

The simulants are currently being used to train troops at the JRTC training site. Two hundred were requested by USAES in the fall of 2001. Samples were requested and provided to units of the 5th Special Operations Group at Ft. Campbell, KY. LTC J. P. Lopez, USMC, requested and received samples of targets as well as materials regarding their use in the experimental PSS-12 training program. While on overseas duty with a Marine Expeditionary Unit in the spring of 2001, he and his troops have trained against these targets and rendered a very positive evaluation of their utility. One thousand have been ordered for use by the USMC.

Training Environments and Tools The training site design created for and used in the studies of Davison and Staszewski (2000) has been built replicated (and enhanced) at the permanent training site established at JRTC in the summer 2001. This design was used to build sites for HSTAMIDS training at Aberdeen Proving Ground and Yuma Proving Ground. These sites included calibration area, training grids, and test lanes for both on-road and off-road (vegetated) surfaces. Following successful use in HSTAMIDS operator training, the training site design has been designated as an integral component of the forthcoming HSTAMIDS Training Support Package.

Finally, the materials for scoring blind search and supporting basic drills have been adopted for current PSS-12 and HSTAMIDS training.

5.2.4. Impact on Robotic Detection and Training Technology Development

The findings of this project have advanced technology development in two areas: autonomous detection systems and Virtual-Reality-based mine detection training.

In the area of autonomous detection system development, Dr. Herman Herman of Carnegie Mellon University National Robotics Engineering Consortium, has developed and begun field testing of an autonomous robotic platform that uses the expert detection techniques identified by this project.

Dr. Herman has also developed a Virtual Reality environment for implementing the PSS-12 operator training program developed and tested in this project.

6. List of Publications and Technical Reports

(a) Papers published in peer-reviewed journals

Staszewski, J. (2001). Expert analysis and training: Using cognitive engineering to develop mine detection skill. *Demining Technology Information Forum Journal, 1,* http://www.maic.jmu.edu/dtif */toc_dtif.html*.

Davison, A., Staszewski, J., & Boxley, G. (2001). Improving soldier performance with the AN/PSS-12. *Engineer: The Professional Bulletin of Army Engineers*, *31*, PB-01-3, 17-21.

(b) Papers published in non-peer-reviewed journals or in conference proceedings

Staszewski, J. and Davison, A. (2000). Mine detection training based on expert skill. In A. C. Dubey, J. F. Harvey, J. T. Broach, and R. E. Dugan, (Eds.), Detection and Remediation Technologies for Mines and Mine-like Targets V, Proceedings of Society of Photo-Optical Instrumentation Engineers 14th Annual Meeting, SPIE Vol. 4038, 90-101.

Staszewski, J. and Davison, A. (2000). Mine Detection Training Based on Expert Skill, Proceedings of 4th International Symposium on Technology and the Mine Problem. Charlottesville, VA: Mine Warfare Association.

Staszewski, J. (1999). Information processing analysis of human land mine detection skill. In T. Broach, A. C. Dubey, R. E. Dugan, and J. Harvey, (Eds.), Detection and Remediation Technologies for Mines and Minelike Targets IV, Proceedings of the Society for Photo-Optical Instrumentation Engineers 13th Annual Meeting, SPIE Vol. 3710, 766-777.

(c) Papers presented at meetings, but not published in conference proceedings

Staszewski, J. J. & Davison, A. Landmine detection based on expert skill. Presentation at AUSA Symposium, Heidelberg, GR, 26-27 September, 2001.

Staszewski, J. J. Training for operators of handheld detection equipment: A cognitive engineering approach. 2001 UXO/Countermine Forum, 9-12 April 2001.

Staszewski, J.J., Hibner, J., Delahanty, P. & Rockwell, F. R.(2000). A Theory of Skilled Landmine Detection: Validation and Refinement. In Conference Detection and Remediation Technologies for Mines and Mine-Like Targets V, International Society for Photo-Optical Instrumentation Engineers 14th Annual Meeting, 24 April 2000, Orlando, FL.

Staszewski, J. J. & Davison A. (2000). Mine Detection Training Based on PSS-12 Expertise. In UXO/Countermine Forum sponsored by the U.S. Department of Defense, 2-4 May 2000, Anaheim, CA.

(d) Manuscripts submitted, but not published

None.

(e) Technical Reports submitted to ARO:

Information Processing Analysis of Human Landmine Detection Skill

Mine Detection Training Based on Expert Skill

Improving Soldier Performance with the PSS-12 Handheld Detector by Employing Techniques of Experts

7. Scientific Personnel

Supported on this project were the following personnel:

Staszewski, James J., Ph.D., PI
Hibner, Jeffrey, Research Associate and Project Engineer
Delahanty, Polly, Research Associate
Bierman, Damien, Research Associate

8. Report of Inventions

(a) Low-cost low-metallic mine simulants

(b) Materials for scoring blind search

(c) Training environment for handheld mine detection

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Y. Das, and J.D. Toews, "Issues in the performance of metal detectors," *Conference Proceedings of UXO FORUM '98*, Anaheim, CA, 5-7 May, 1998.

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J. J. Staszewski & A. Davison, "Mine detection training based on expert skill," In A. C. Dubey, J. F. Harvey, J. T. Broach, and R. E. Dugan, (Eds.), Detection and Remediation Technologies for Mines and Mine-like Targets V, Proceedings of Society of Photo-Optical Instrumentation Engineers 14th Annual Meeting, SPIE Vol. 4038, 90-101, 2000.

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10. Appendices

Appendix 1: Personal communication to PI and collaborator Davison received on 25 September 2001 evaluating program of training based on expert skill administered by JRTC Observer/Controllers' in September 2001.

Sirs,

Wanted to get off a quick e-mail to you and thank you for the briefings you gave us and for getting two of our NCOs into the AN/PSS-12 train the trainer course here at Ft Polk. This allowed us to provide the training to all the sappers in TF 27th Engineer during their KFOR MRE. Got to tell you the training was a huge success! The NCOs and officers that participated in the training are sold on the new techniques. LTC Harvey (BN CDR) and his CSM had nothing but praise for the technique and the training range you set up here.

We kept stats on all the soldiers trained and our results were comparable with the statistics you presented to us during the briefings here at Ft. Polk. For your info the results were:

Old Technique			New Technique		
M14	17%	65/375	M14	75%	235/310
PMA3	35%	106/300	PMA3	87%	215/248
VS 2.2	29%	66/225	VS 2.2	85%	159/186
M16	72%	54/75	M16	94%	58/62
M15	75%	56/75	M15	94%	58/62

It's important to note that we were limited in the amount of time we had to train these soldiers. We trained about a PLT a day. After the run through using the old technique, we simply provided a quick, 20 - 30 minute class on the new technique, gave them a few minutes each to practice the new technique, and then ran them through the lanes again using the new technique. Given the limited actual training, I'd say the results clearly demonstrate the superiority of this new technique. I was sold before and am even more so now. Unfortunately, time did not allow us to go into great detail on pattern recognition. Also, we had a tremendous amount of problems with the camera system and never did get it to work properly. We abandoned it after the second day because of the technical problems we were having. This was the only disappointing portion of the training. I understand that work is on-going for a new improved camera system - one that is more durable and works better in inclement weather (such as overcast days). This will greatly enhance the training.

Again, I'd like to thank you all for the time and effort you have put into developing this new technique and training program. It definitely improves the ability of our Sappers to perform one of their critical wartime tasks.

V/r
MAJ Mize
Senior Engineer Observer Controller, JRTC

Appendix 2: Requested Briefings for Military Personnel

Requests for briefings and demonstrations of expert detection techniques have come from multiple military sources. The sources, dates the briefings and demos were provided, and locations are listed below.

At the request of COL Van Horn, Commandant, US Army Engineer School, the PI and collaborator Alan Davison (Chief, Army Research Laboratory Human Research Engineering Directorate Field Element, United States Army Maneuver Support Center, Ft. Leonard Wood, MO) briefed COL Van Horn and his staff on the results of the initial tests of the PSS-12 operator training program based on expert skills, 07 December 1999.

At the invitation of CENTCOM personnel, the PI and collaborator Alan Davison (Army Research Laboratory Human Research Engineering Directorate Field Element, United States Army Maneuver Support Center, Ft. Leonard Wood, MO) briefed CENTCOM personnel and soldiers of the 5th Battalion, SFG (ABN), ODA 513 16-17 May 2000 on the findings of Staszewski and Davison (2000) and demonstrated the PSS-12 detection techniques and training exercises incorporated in their training program. The objective was to support their efforts to train indigenous deminers in Jordan.

At the invitation of USMC liaison to the Joint Unexploded Ordnance Coordinating Committee and the USMC Engineer School, Camp Lejeune, NC, Stazewski and Davison provided a similar briefing and demo to USMC Engineer School personnel on 12 May 2000.

At the invitation of MAJ. Darrell Strother, Chief, Humanitarian Demining, ARCENT/Engineers, Staszewski briefed personnel of the 5th Battalion, SFG (ABN), ODA 581 on 29 January 2001at Ft. Campbell, KY, on the findings of Staszewski and Davison (2000). The PSS-12 detection techniques and training exercises incorporated in that training program were demonstrated using samples of the targets and training aids used in that program. Samples of the targets and training aids were provided to the unit for their use. The objective of this effort was to support this unit's upcoming mission to train indigenous deminers in Omam.

At the invitation of James S. Ainsworth, PH.D. , Command Science Advisor to the CG , Joint Readiness Training Center and Fort Polk, Staszewski and Davison organized and presented at a present a two-day mine detection seminar to personnel I the JRTC Operations Group, the 2nd ACR, the Warrior Brigade, and the 519th MP Bn. 24-25 July 2001.

At the invitation of Army Material Command - Field Assistance for Science and Technology, the PI presented on the PSS-112 and related HSTAMIDS training programs at AUSA (EUR) Symposium, 24 September 2001, Heidelberg, GR.

At the invitation of the USMC Engineer Advocacy Center, USMC Headquarters, on 7 January 2002, the PI briefed personnel from the USMC Advocacy Center and Mine Countermeasures on the findings and practical impact of this work at USMC Headquarters.

At the invitation of the Office of the Program Manager - Mines, Countermine, and Demolition (Countermine Division) and upon request of the Australian and Canadian Liaison Officers to the US Army Maneuver Support Center, the PI briefed Australian Army Liaison Officer (Manoeuvre Support) LTC Kavanaugh and Canadian Liaison Officer MAJ Sheahan at Ft.. Belvoir, VA, 20 March 2002.

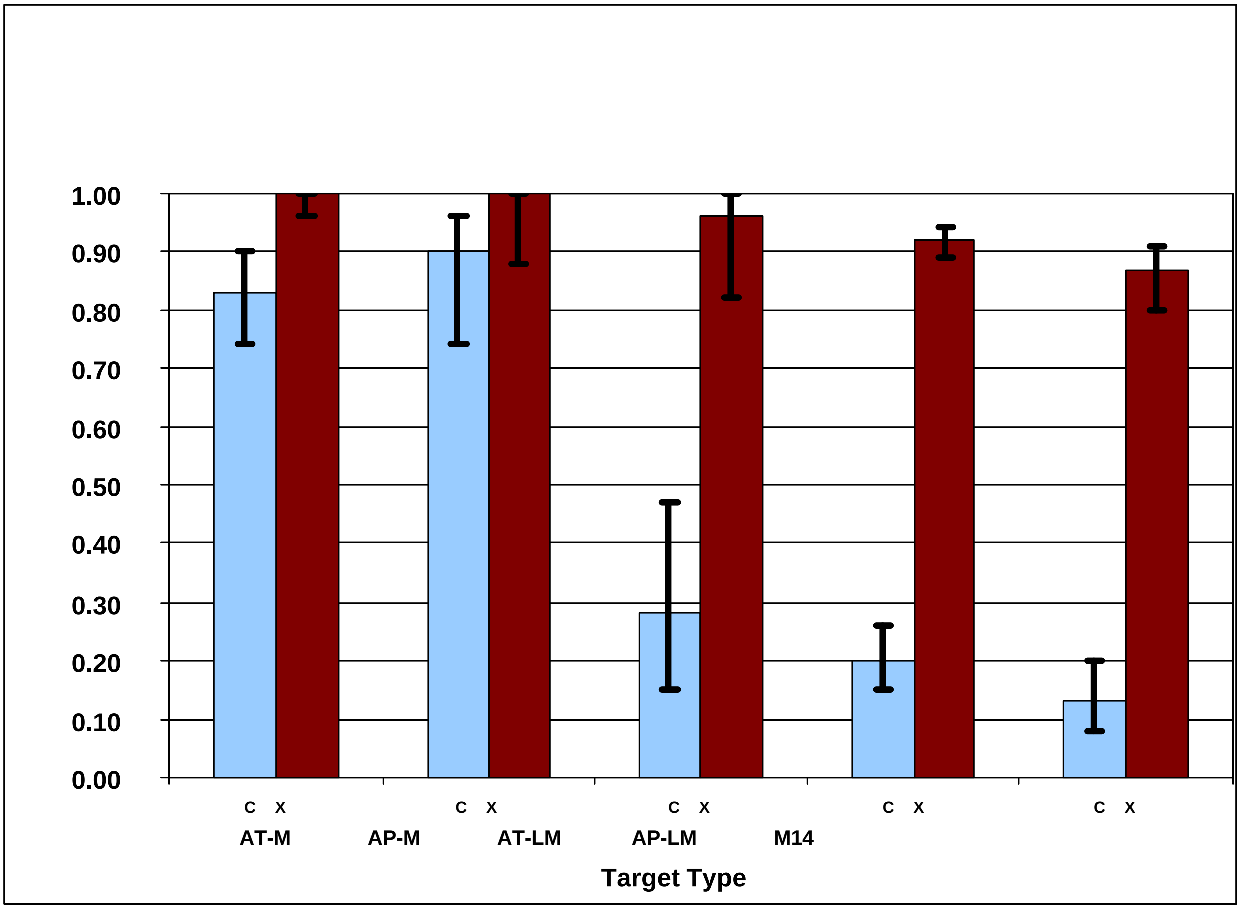

Figure 1: Detection performance for experimental and control groups as a function of target type following administration of training treatment. Error bars show 95% Confidence Intervals. C labels on the abscissa identify contol group data; Xs identify the performance of the experimental group soldiers who had received the training based on expert PSS-12 skill.

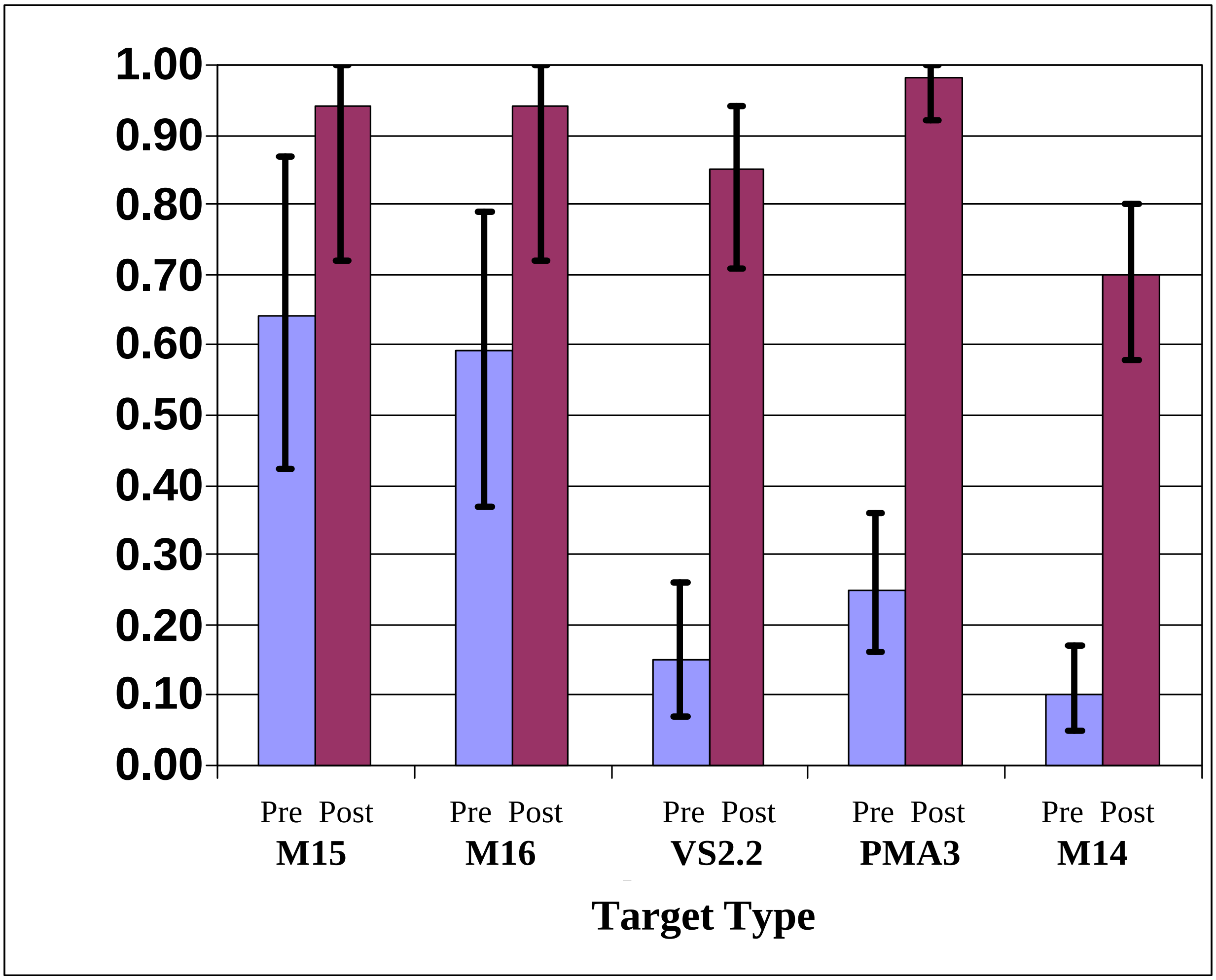

Figure 2: NCO detection performance following 3-4 hours of training based on expert skill administered at JRTC, Ft. Polk, in August 2001. Error bars represent 95% Confidence Intervals.

Figure 3: Distribution of NCO responses to shown questionaire item upon conclusion of the ‘train-the-trainer’ exercise at JRTC, Ft. Polk in August 2001.

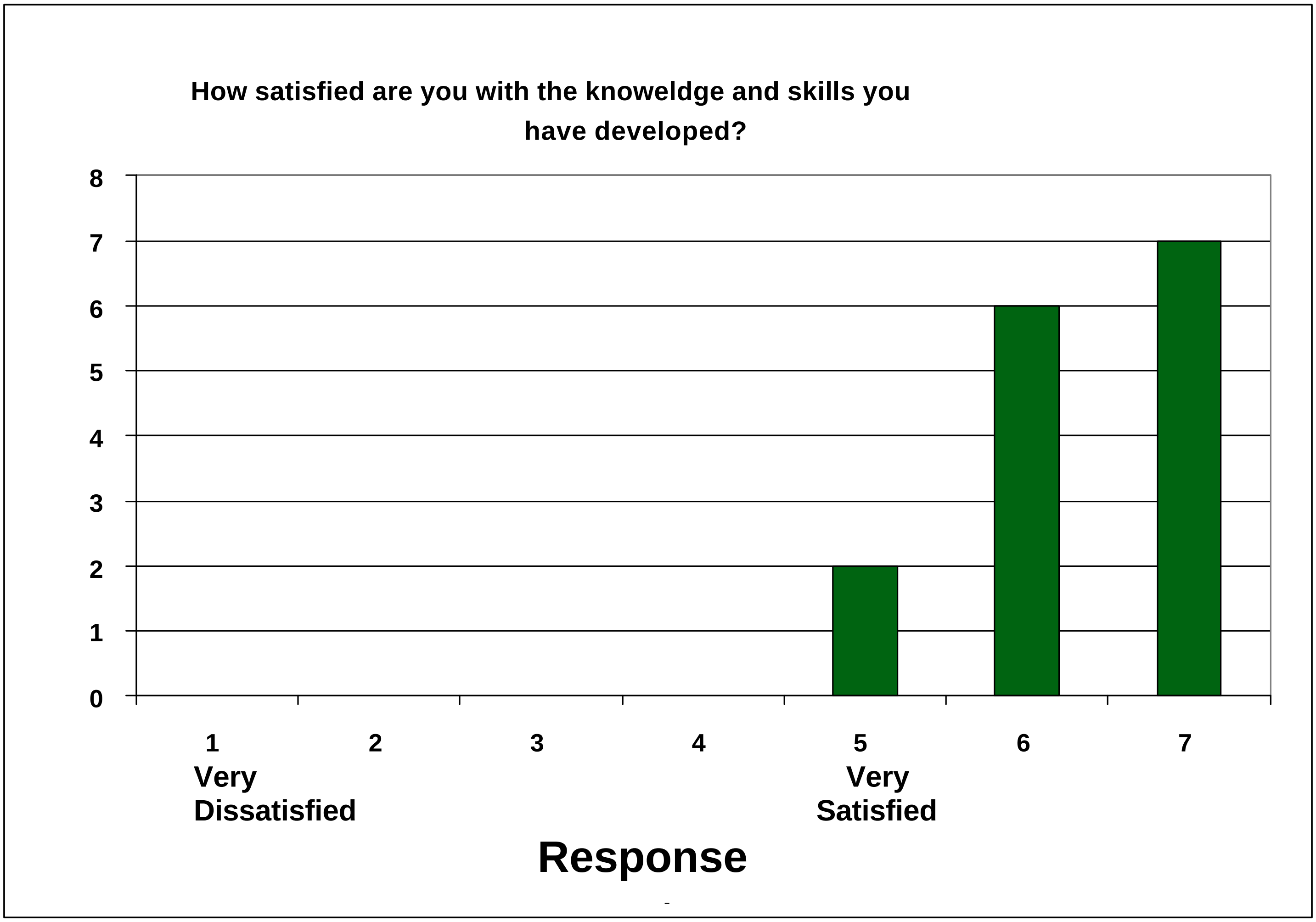

Figure 4: Distribution of NCO responses to shown questionaire item upon conclusion of the 'train-the-trainer' exercise at JRTC, Ft. Polk in August 2001.

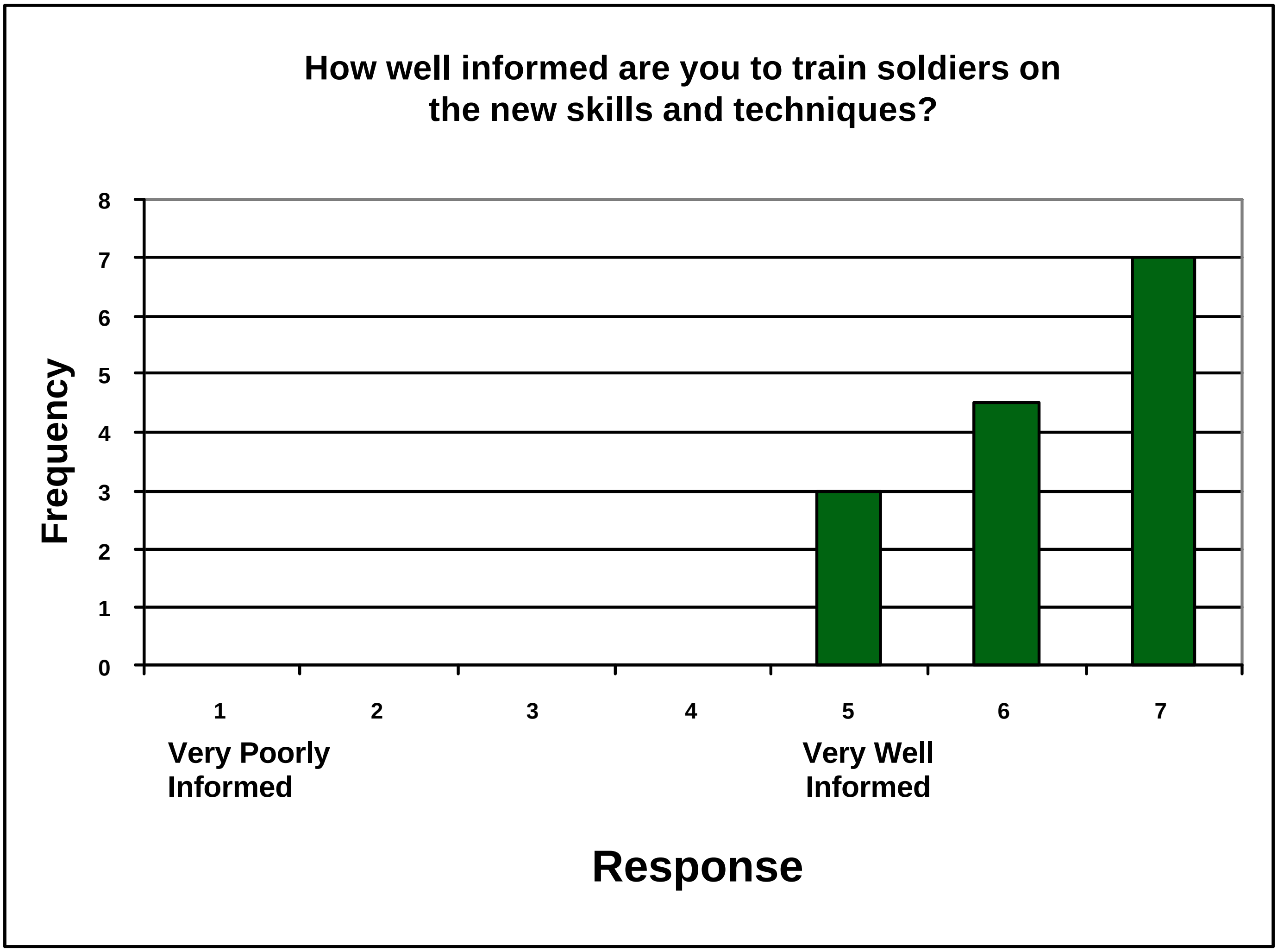

Figure 5: Distribution of NCO responses to shown questionaire item upon conclusion of the 'train-the-trainer' exercise at JRTC, Ft. Polk in August 2001.

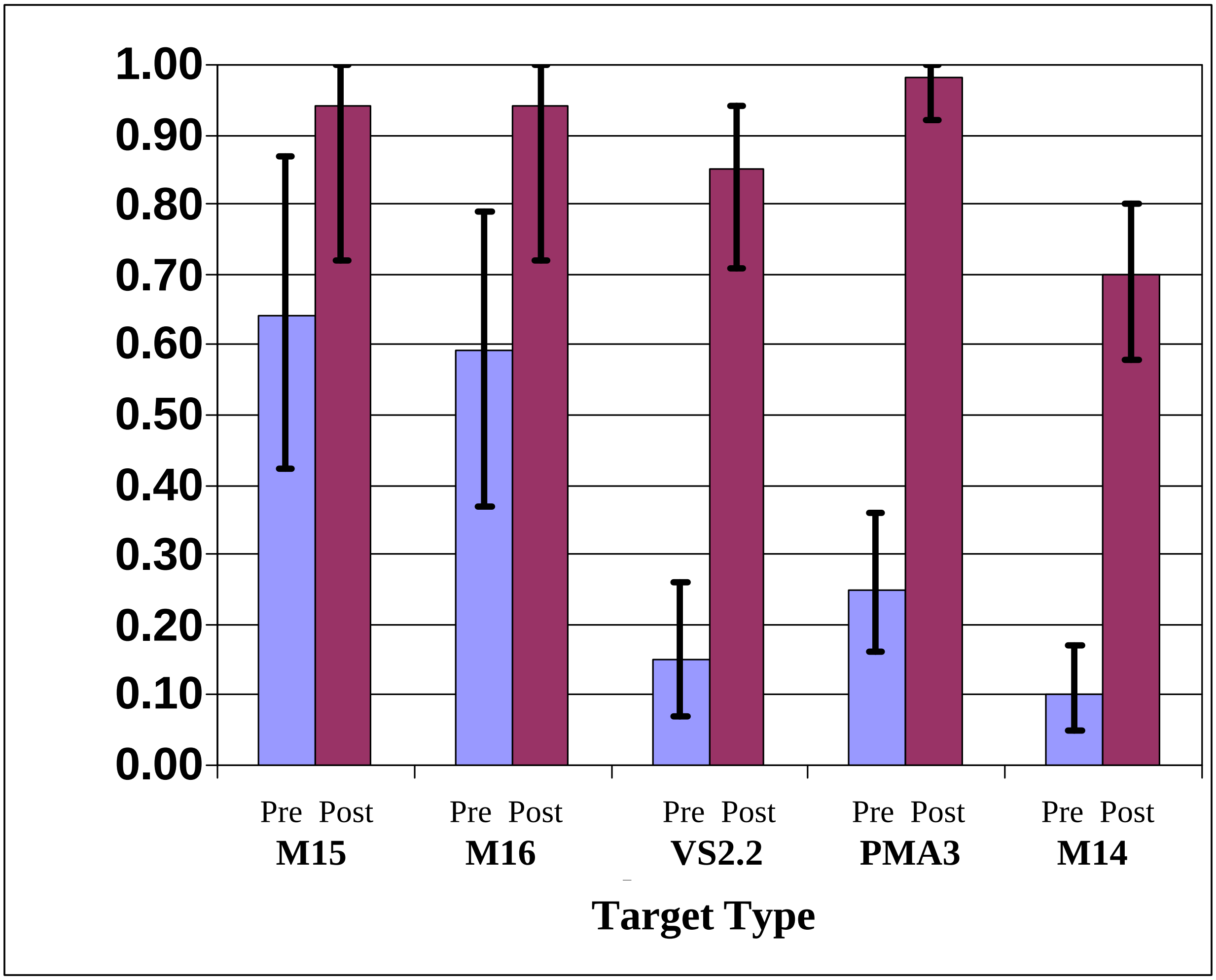

Figure 6: Detection performance of soldiers from 27th En Task Force, 10th Mountain Division following less than 1 hour of training on expert techniques administered by JRTC Engineer Observer/Controllers in September 2001. Error bars represent 95% Confidence Intervals.

MEMORANDUM OF TRANSMITTAL

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CONTRACT/GRANT NUMBER: DAAG55-98-1-0417

REPORT TITLE: Final Report: "Mine detection expertise and training based on expert skill"
is forwarded for your information.

Sincerely,

James J. Staszewski
Research Scientist
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213-3890