Research Note 86-52

AD-A168 661

THROUGH-THE-SIGHT VIDEO: EQUIPMENT AND CONCEPTS FOR GUNNERY TRAINING

John C. Morey

Army Research Institute

Robert L. Rollier, Jon G. Graber and James A. Salter

Mellonics Systems Development Division
Litton Systems Inc.

and

Margaret S. Salter

Army Research Institute

for

ARI FIELD UNIT AT FORT BENNING, GEORGIA
Joel D. Schendel, Acting Chief

TRAINING RESEARCH LABORATORY
Seward Smith, Acting Director

U. S. Army

Research Institute for the Behavioral and Social Sciences

January 1986

86 6 ? 114

U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the

Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

WM. DARRYL HENDERSON
COL, IN
Commanding

Research accomplished under contract
for the Department of the Army

Mellonics Systems Development Division
Litton Systems, Inc.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER ARI Research Note 86-52	2. GOVT ACCESSION NO. ADA 168 66	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Through-the-Sight Video: Equipment and Concepts for Gunnery Training		5. TYPE OF REPORT & PERIOD COVERED Final Report January 1985-December 1985
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John C. Morey, ARI; Robert L. Rollier, Jon G. Graber and James A. Salter, MSSD, Litton Systems, Inc; Margaret S. Salter, ARI		8. CONTRACT OR GRANT NUMBER(s) MDA 903-83-C-0545
9. PERFORMING ORGANIZATION NAME AND ADDRESS Mellonics Systems Development Division Litton Systems, Inc. PO Box 3407, Sunnyvale, CA 94088-3407		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263744A795
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences, Fort Benning Field Unit, PO Box 2086, Fort Benning, GA 31905		12. REPORT DATE January 1986
		13. NUMBER OF PAGES 16
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue Alexandria, VA 22333 -5600		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

—

18. SUPPLEMENTARY NOTES

Seward Smith, Contracting Officer's Representative

This research was technically monitored by Dr. John C. Morey.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Bradley Fighting Vehicle System
Bradley Integrated Sight Unit
Gunnery
Infantry Fighting Vehicle
Through-the-sight video
Training

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The phrase "through the sight video" (TSV) denotes a relatively recent application of existing video and optical technology. When the device is integrated with the Bradley Infantry Fighting Vehicle (BIFV) Integrated Sight Unit (ISU), the optical display that is seen simultaneously by the gunner and commander is transmitted also to a video camera/recorder. This provides a means for duplicating the exact sight picture to a remote video monitor and/or to video tape for permanent storage. The capabilities of the device in field settings was explored and the conclusion is that TSV shows promise in a number of training

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ARI Research Note 86-52

20. Abstract (Continued)

and research areas related to BIFV gunnery, tactics and techniques. Future work should be planned and implemented to further develop the TSV device for BIFV-specific training. The prototype TSV should be explored further in future research to develop procedures, lesson plans and audio visual materials for gunnery training applications and applications related to tactics and techniques for BIFV small unit leaders.

FOREWORD

Since 1975 the Army Research Institute has contributed to the U. S. Army program to develop Bradley Infantry (M2) and Cavalry (M3) Fighting Vehicles, including human factors evaluation of prototype vehicles and task analyses of crew tasks to identify special aptitude requirememts. Further task analysis resulted in preparation of a set of Procedures Guides for Bradley Commanders, Gunners, and Drivers, identification of leader tactical training device requirements, and recommendations for a Bradley Leader Tactical Trainer.

As Bradley vehicles began to be introduced to combat units, the need to evaluate tactical doctrine, operational effectiveness, and training issues in a systems context became apparent. At the request of the Deputy Chief of Staff for Training, U.S. Army Training and Doctrine Command (TRADOC) a research program was formalized among the Training Technology Agency, TRADOC, the U. S. Army Infantry School, and the Army Research Institute, to define emerging operational and training problems and to undertake research to address the most critical issues affecting combat effectiveness. Because Bradley vehicles incorporate advanced weapons systems and sights to be used under darkness and reduced visibility, special emphasis was placed on research which focused on operations under these conditions.

The first year of the project resulted in definition of critical research issues and identified gunnery, tactical operations, equipment, and training as topical areas for subsequent research and development. The problem identification and supporting analyses are presented in a separate report.

The results of the second year of research are documented in a series of publications, of which the present report is one. The emphasis of the second year effort was on making products available to Bradley users as they were developed. These analyses, training materials, job performance aids, improved procedures, and equipment prototypes have thereby served immediately to increase combat effectiveness. Further interactions between the project scientists and the user community have resulted in additional improvements and refinements. As a result of this approach the project has been unusually responsive to both the U. S. Army Infantry School and Bradley units worldwide.

THROUGH-THE-SIGHT VIDEO:
EQUIPMENT AND CONCEPTS FOR GUNNERY TRAINING

CONTENTS

LIST OF FIGURES

BACKGROUND

The phrase "through-the-sight video" denotes a relatively recent application of existing video and optical technology. When the device is integrated with the BIFV ISU, the optical display is seen simultaneously by the commander and gunner at their stations and is also transmitted to a video camera/recorder. The image is not degraded at any of the three terminal points. In other words, the optical component of the system (the "beam splitter") provides a means of duplicating the exact sight picture to a remote video monitor and/or to video tape for permanent storage. The through-the-sight video (TSV) device shows promise in a number of training and research areas relating to BIFV gunnery, tactics and techniques.

The TSV was demonstrated at Fort Benning during the course of a gunnery training device Concept Evaluation Program test entitled "Gowen South." This exercise was conducted by the Infantry Board for the Directorate of Training and Doctrine, USAIS and a number of devices were investigated at that time. The TSV device was used as a research tool at that time, but it serendipitously demonstrated training potential. The BIFV research team determined that substantive work to develop this concept should be done and that purchase of a system would be necessary to facilitate ARI/Litton work in this area. In prototype form, the cost for the complete system is approximately $46,000, with the most expensive component being the beam splitter at $11,000 (a complete description of the system is presented below). The order was placed in January, 1985, but problems encountered by the manufacturer delayed delivery of a working prototype until August, 1985. This severely limited the opportunity to implement any systematic investigation within the remaining period of the current contract. However, the research team has accumulated experience with the operation and capabilities of the device and these preliminary results are reported here.

DESCRIPTION OF THE TSV SYSTEM

The system consists of five components which accomplish the duplication of the ISU sight picture without any degradation of the ability of the commander and gunner to use the ISU in a normal manner.

Beam Splitter

The manufacturer (DBA Systems, Inc.) designates this component as the M2/M3 Light Beamsplitter. The beamsplitter is an optical mechanical device that is inserted into the ISU system in front of the Bradley Commanders Relay Assembly. It duplicates the optical transmission for presentation to the camera (see Figure 1). In order to duplicate the gunner's sight resolution at the edge of the field of view, the optics are designed to correct the field curvature for the flat image plane of the camera to provide high resolution over the full field of view. An adjustable iris is incorporated into the beamsplitter to manipulate the aperture for optimum camera exposure over varying scene illumination conditions. The system can deliver image plane resolution of 80 line pairs/mm.

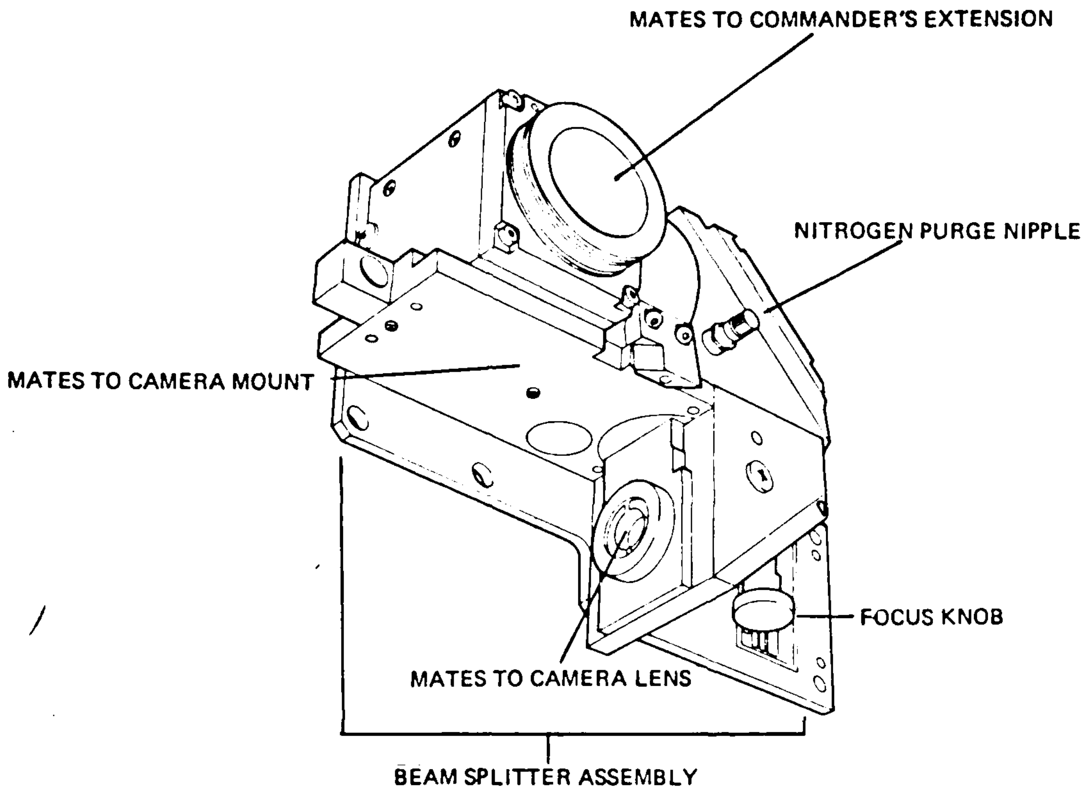

Figure 1. The TSV beam splitter.

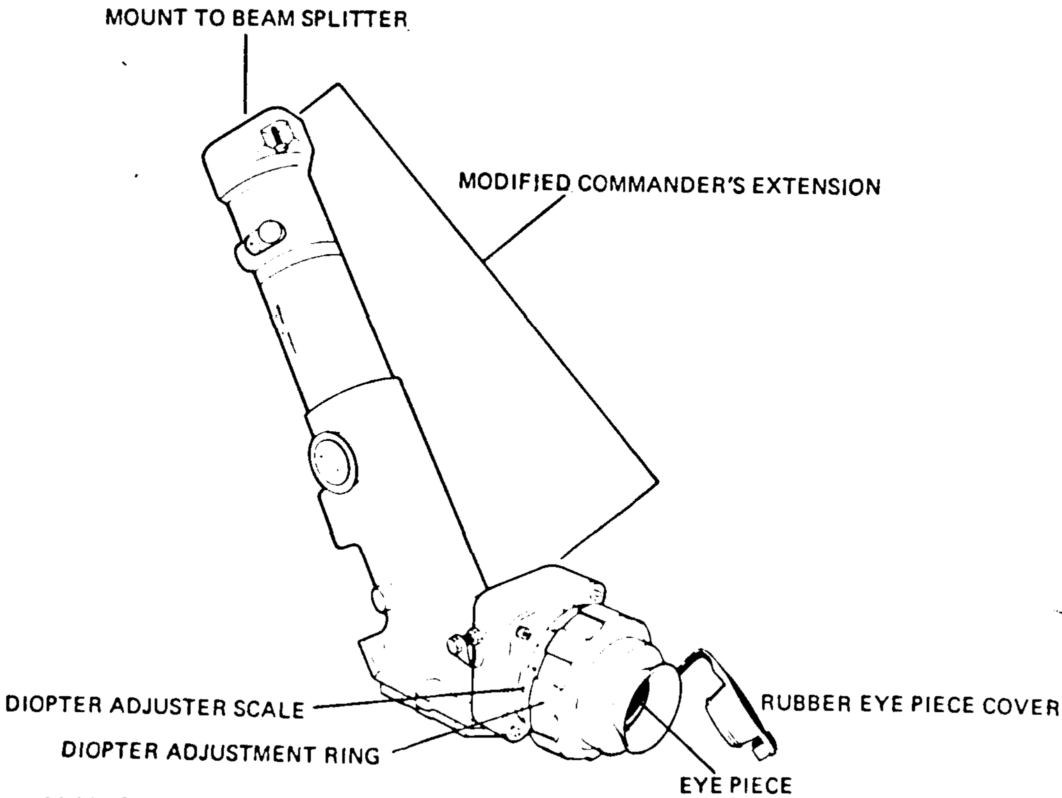

Figure 2. The modified commanders sight extension.

Modified Commanders Extension

The modified commanders sight extension is also supplied by DBA Systems, Inc. (see Figure 2). To install the system, the present commander's extension is disconnected from the ISU, the beam splitter is connected to the ISU, and the modified extension is connected to the beamsplitter. The modification is designed to accomodate the presence of the inserted beam splitter so that the position of the commanders extension eyepiece in the horizontal and vertical planes is not changed.

Camera

The video camera used in this prototype is supplied by GBC, Inc. (see Figure 3). The current model is a black and white camera. The camera is connected to the beamsplitter by insertion in a mount that is a part of the beamsplitter. Cables connected at the rear of the camera carry the output to the monitor and the control module separately.

Monitor

The monitor is manufactured by GBC, Inc., and supplied by DBA, Inc. It is black and white capable without audio capability and requires 28 volt DC power for operation.

Control Module

This multifunction component centralizes the video recording controls. (See Figure 4.) A time code generator (TCG) overlays date and running time on the monitor and the video tape. A VHS Format VCR providing 120/360 minute tape run time is incorporated in the module. The module receives 28 volt DC vehicle power, shunts it to the video monitor and steps down the 28 volt DC to 12 volt DC via two power regulators mounted in series. The 12 volt DC powers the camera, VCR, and TCG.

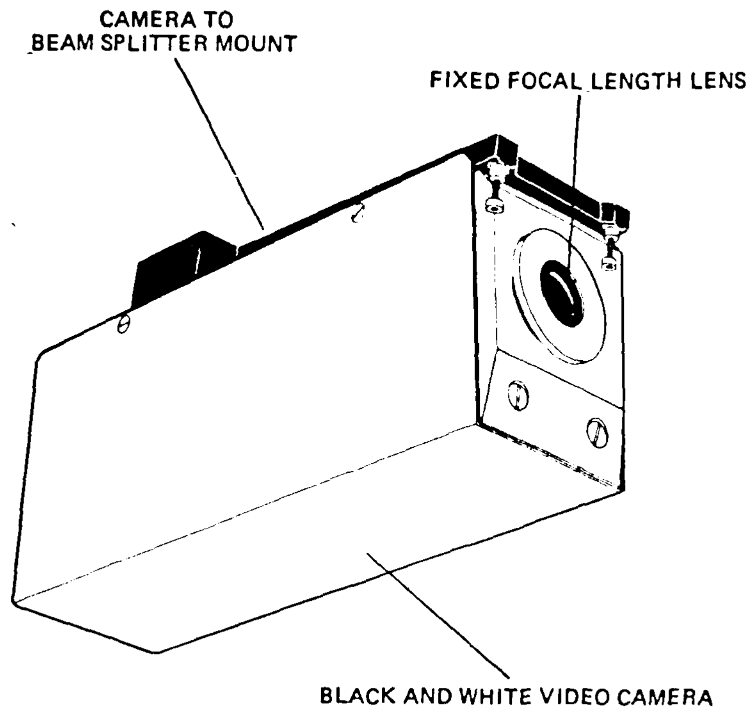

Figure 3. Video camera used in the TSV prototype.

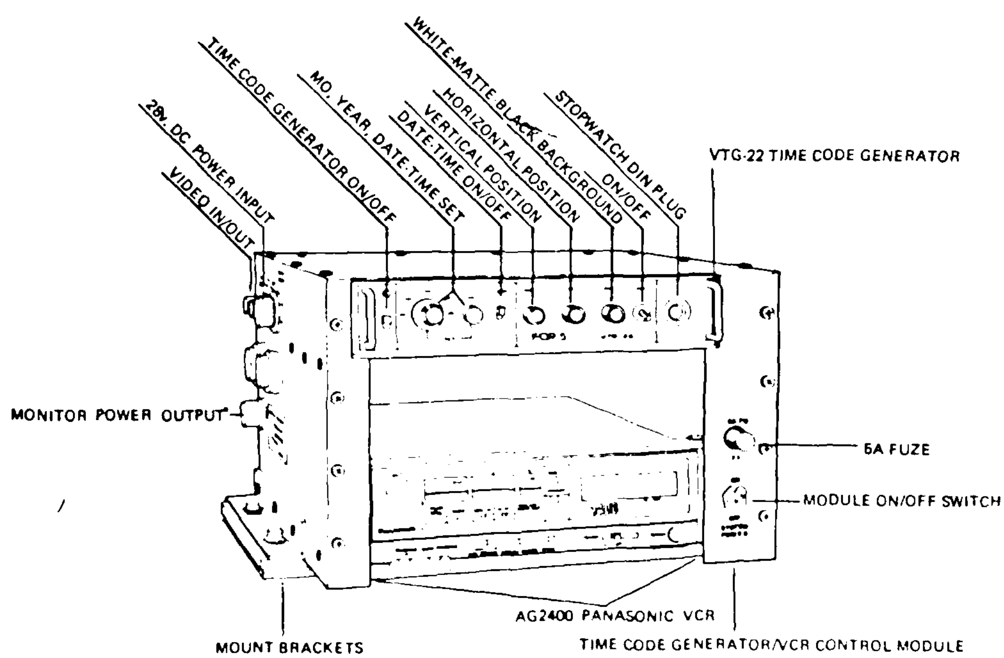

Figure 4. The TSV control module.

APPLICATIONS

The research team developed a list of the major applications of the TSV device for immediate investigation and also noted potential "spin-off" uses for institutions, field units or basic research. The most important applications, of course, are those which show potential for solving some of the BIFV issues which were identified during the problem analysis phase. These identified needs related positively to gunnery training and research to enhance the BIFV data base, as explained below.

Gunnery Training Applications

A great deal of the training must occur in and around the turret of the vehicle, which has limited space for both a group of students and an instructor. Many of the training tasks are sensitive to both the instructor/student ratio and to the need for the instructor to see the sight picture simultaneously with the student as he performs. Also, the transitory nature of the sight picture information hampers effective instructor critique. A device enabling training cadre (and nonperforming students) to view the sight picture from a remote station during training would relieve the turret bottleneck. The capability to selectively store pre-screened sight pictures and sequences of events in real-time motion (with the associated audio record) would enhance the training flexibility available to cadre in several ways. It would permit the presentation of classroom type preperformance instruction to groups of students using a sequence of previuosly obtained sight images ranging across a variety of visibility conditions and target arrays. Secondly, storage of actual training events would increase instructor ability to present meaningful critiques. The sequence of enhanced group instruction, enabling the student to derive increased benefits from the current techniques of hands-on training, reinforced by a specifically tailored post-performance critique, would be a powerful modification of current institutional and unit training.

In particular, unit gunnery sustainment training could be expected to benefit in the following task areas:

- Aiming
- Zeroing
- Thermal control manipulation
- Thermal sight image interpretation
- Tracking
- Fire commands
- Range estimation/indexing

- o Target selection/classification

- o Move-out gunnery engagements

Properly implemented, the TSV concept will have almost unlimited potential for realistic institutional and unit training in gunnery, tactics and techniques.

Research Applications

Development of the TSV concept would have immediate favorable impact on current training. In addition, the device is potentially useful as a tool for research of presently unresolved issues. Increasing the data base for modifying/improving current gunnery procedures will have future application to training and combat performance. For example, baseline data is needed on the way variables such as battlefield obscurants, target type and range to the target affect the thermal image of the ISU. At present, the need to use actual sight images at a prepared range severely limits the scope and objectivity of research studies. A systematically produced and edited video tape obtained with the TSV could serve as the basis for a rigorously controlled study with large numbers of subjects.

LIMITED FEASIBILITY TESTING

As noted, late delivery of the prototype prevented implementation of a large-scale test plan within the scope of this project. It was possible, however, to capitalize on two field studies previously scheduled for Fall, 1985. These were a tactical exercise and an exploration of improved training for thermal sight manipulation (see Bibliography). Research personnel acquired experience in mounting the TSV in an operational BIFV and perfected techniques for operating the device in a real-world situation. The video tape products obtained, support a number of conclusions.

Video tape obtained with the target scenarios used for evaluating the modified thermal training program, demonstrate the versatility of the TSV device. The experimental tape has been viewed critically by the research team and SMEs at Fort Benning. Evaluations are unanimous that the images have high fidelity in both motion and still modes, across all variations of polarity, magnification, and brightness/contrast. Editing would support training in scanning techniques, appearance of thermal signatures, manipulation of thermal image controls to obtain the best picture, and other applications.

During the tactical exercise that was designed by the research team to investigate the leader span of control issue, the opportunity to further explore TSV in additional real-world situations was exploited. The TSV was mounted in a vehicle assigned to the friendly force. It was noted that the friendly force commander and gunner were not hampered in their combat performance by the presence of the TSV device in their BIFV. Video tape was obtained of a fluid battlefield situation as it appeared through the ISU, in contrast to the static range situation filmed earlier. Portions of the taping captured thermal images of enemy vehicles on the move before and during obscuration of the battlefield by smoke. Clear sequences of an attack helicopter during a simulated enemy air strike also were obtained. When the vehicle itself was moving, engagement of the gun stabilization system was sufficient to produce video tape of a quality comparable to the static situation.

The exploratory video tape products suggest a number of possible applications in addition to use in gunnery training. For example, the terrain is depicted as seen by the Bradley gunner and commander through the daylight and thermal sight at high and low magnification. Through effective editing, such representations would provide a low-cost type of surrogate travel experience for use in classroom settings. Terrain driving, route selection and land navigation are potential areas for training with this aid.

Finally, shortcomings of the device were logged during the activities described above. The prototype TSV was adequate to demonstrate the viability of the concept, but improvements could be made in selected system components. The beam splitter is sturdy and reliable, but addition of a mechanism to permit on-site adjustment of the fit, to accomodate differences in individual ISUs when mounting the device, could be developed at little additional cost. The cost and feasibility of exchanging the video camera used in the prototype should be investigated. There is a need for a model which offers: (a) color capability; (b) audio pick-up; (c) reduced size; (d) greater reliablility; (e) capability for radio-frequency signal transmission to a remoted monitor or recorder. The method of transmitting the video signal by cable used in the prototype TSV should be retained as an alternative system. However, techniques of arranging the cable array so that it does not become entangled during free turret operation must be developed. Finally, modifications permitting weather-proofing and space-saving design of the assembled system should be pursued.

CONCLUSIONS AND RECOMMENDATIONS

Despite the delay in delivery of a TSV prototype, the research team was able to accumulate valuable experience with the concept by planning non-interfering satellite activities during the conduct of previously scheduled research in other areas. It was found that installation and operation of the device are compatible with the practical requirements of both training and research applications.

The monitor display and storage on tape obtained under realistic conditions, show dramatic promise for multiple applications. The discovered shortcomings of the present prototype device were analyzed and it was found that reasonable recommendations for viable modifications could be made in each case. Therefore, future work should be planned and implemented to further develop the concept for BIFV specific training.

Specifically, it is recommended that:

- The prototype TSV be used in future work to develop procedures, lesson plans and audio-visual materials for gunnery training applications;

- The prototype TSV be used in future work to develop applications in tactics and techniques for BIFV small unit leaders;

- The prototype TSV be used in future research to expand the data base relating to BIFV ISU thermal imagery;

- The prototype TSV be used in future research to develop and validate improved gunnery procedures and techniques;

- Work be undertaken to upgrade the prototype TSV to produce an operational version applicable for use in a wide variety of institutional and unit settings; modifications should be designed to provide for weatherproofing, ruggedness, compactness, and simplified installation.

BIBLIOGRAPHY

ARI Bradley Research Project Reports

The accomplishments of the project to date are documented in a series of publications, of which the present report is one. Other publications in the series are listed below for reference.

Rollier, R. L., Salter, M. S., Perkins, M. S., Bayer, G. C., Strasel, H. C., Lockhart, D. C., Kramer, A. J., and Hilligoss, R. E. (1984) Review and analysis of BIFV operations under all visibility conditions. (ARI Working Paper FB 85-01; to be reissued as an ARI Research Note).

Strasel, H. C., Lockhart, D. C., Hilligoss, R. E., and Fusha, J. A. (1984). Anaysis of gunnery training for Bradley Infantry Fighting Vehicle. (ARI Working Paper FB 85-02; to be reissued as an ARI Research Note).

Rollier, R. L., Salter, J. A., Graber, J. G., Roberson, P. R., Harbin, K. W., Wilkinson, C. S., Morey, J. C., and Salter, M. S. (1985). Bradley Fighting Vehicle System combat effectiveness: Evaluations of developments in tactics, training and equipment. (ARI Research Note).

Perkins, M. S. (1985). Analysis of BIFV gunnery with emphasis on factors affecting first-round hit capability of the 25-mm gun. (ARI Research Report).

Rollier, R. L., Roberson, P. R., Salter, J. A., Graber, J. G., and Harbin, K. W. (1985). BIFV squad and platoon leader span of control. (ARI Research Note).

Graber, J. G., Rollier, R. L., and Salter, J. A. (1985). Continuous Operations SOP for BIFV units. (ARI Research Note).

Rollier, R. L., Salter, M. S., Morey J. C., and Roberson, P. R. (1985). Effects of revised 25mm ammunition reloading procedures on ammunition reloading time. (ARI Technical Report).

Rollier, R. L., Wilkinson, C. S., and Salter, J. A. (1985). Improved BIFV troop compartment visibility: Development of a transparent, bullet-proof dome. (ARI Research Note).

Rollier, R. L., Salter, M. S., Morey, J. C., Salter, J. A., and Graber, J. G. (1985). Exploration of techniques for Bradley Infantry Fighting Vehicle thermal sight training. (ARI Technical Report).

Perkins, M. S., and Rollier, R. L. (1985). Analysis of content and organization of the Bradley Infantry Fighting Vehicle Commanders Course. (ARI Research Report).

Graber, J. G., Rollier, R. L., and Salter, J. A. (1985). Training for night and limited visibility operations. (ARI Research Note).

Morey, J. C., Rollier, R. L., Graber, J. G., Salter, J. A., and Salter, M. S. (1985). <u>Through-the-sight video: Equipment and concepts for gunnery training</u>. (ARI Research Note).

Morey, J. C., Rollier, R. L., Salter, J. A., and Salter, M. S. (1985). <u>Scaled vehicles and ranges: Development of a scaled, reactive, mobile target and range</u>. (ARI Research Note).