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THE VALUE OF SPECIAL TRAINING FOR THE INTERPRETATION OF UGS EMPLOYED IN A GRID

Sterling Pilette and Bill Biggs
HRB-Singer, Inc.

and

Harold Martinek
U.S. Army Research Institute

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Based on an error analysis of unattended ground sensor operator target detection data, a self-paced training program was developed to reduce the frequency and magnitude of operator errors and increase target detection rate. The first training unit dealt with solitary targets--only one vehicle or vehicle convoy traveling through the grid. The second dealt with target clusters--several vehicles or vehicle convoys traveling through the grid at one time.

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To assess the value of training a pre-posttest design was used. Operators monitored for 2 hours activation data from seismic sensors employed in a grid, received the special training, and again monitored for 2 hours. The two monitoring periods were counterbalanced to control for differences in the target activation data. Four workload levels (numbers of targets activating the sensors) were used to ascertain training effects across a range of workloads typical of operational conditions.

The self-paced training program resulted in improved operator performance in target detection and target speed and direction estimation accuracy of both practical and statistical significance. Target detection improved from 58% to 79%, averaged over all conditions. Target detection after training averaged 61%, 66%, 94%, and 97% for the four workload conditions (27, 15, 8, and 5 targets/hour). Speed and direction estimation improved by 23% and 20% respectively as a result of training. The false alarm rate was negligible under all conditions. Conclusions and recommendations for the implementation of this training program and for utilization of grid deployment are provided.

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HUMAN FACTORS TECHNICAL AREA

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FOREWORD

The Battlefield Information Systems Technical Area of the Army Research Institute (ARI) is concerned with the human resource demands of the increasingly complex battlefield systems required to acquire, transmit, process, disseminate, and use information. Research focuses on interface problems and interactions within command and control centers in such areas as topographic products and procedures, tactical symbology, information management, user oriented systems, staff operations and procedures, and sensor systems integration and use.

An area of special interest is that of human factors problems in the efficient and effective presentation and interpretation of surveillance and target acquisition information. One relatively new source of intelligence information is remote monitoring of the battlefield using seismic, acoustic, and magnetic unattended ground sensors (UGS). When these remote sensors are activated by enemy personnel or vehicle movement, a monitor display located behind friendly lines indicates the activity. From this display, the operator can deduce not only the presence of the enemy but also such information as the direction and speed of convoys and personnel, the number of vehicles in a convoy, and the composition of the convoy, e.g., armored versus wheeled vehicles.

Previous ARI research has demonstrated a need for special operator training in the interpretation of activation patterns for effective employment of sensors in a grid for surveillance of large area, enemy intrusion. The research effort reported here developed and demonstrated the effectiveness of a special training module and provides estimates of operator-sensor capability using the grid concept.

Research in the area of sensor systems integration and utilization is conducted as an in-house effort augmented through contracts with organizations selected for their unique capabilities and facilities for research on sensor systems. The present research was conducted in collaboration with personnel from HRB-Singer, Inc., under the program direction of Robert S. Andrews. The effort is responsive to requirements of Army Project 2Q762717A721 and to special requirements of the U.S. Army Intelligence Center and School, Fort Huachuca, Ariz., the Assistant Chief of Staff for Intelligence, and the Remotely Monitored Battlefield Sensor System Project (REMBASS). Special requirements are contained in Human Resource Need 74-21, Analysis of Unattended Ground Sensor Derived Data, and 75-5, Development of Basic UGS Data for Displays, Training, and Operational Use.

JOSEPH ZEIDNER
Technical Director

THE VALUE OF SPECIAL TRAINING FOR THE INTERPRETATION OF UGS EMPLOYED IN A GRID

BRIEF

Requirements:

1. To determine the value of specialized training for improving operator target detection and direction and speed estimation performance when using unattended ground sensors (UGS) employed in a grid.

2. To provide estimates of operator performance in an operational situation for target detection completeness and direction and speed estimation accuracy for UGS employed in a grid.

Procedure:

Based on an error analysis of operator target detection data from previous research, a self-paced training program was developed to reduce the frequency of operator errors. To assess the value of the training program, a pre-posttest design was used. Two 2-hour scenarios consisting of various numbers and compositions of convoys traveling cross country were constructed from activation data collected at a field exercise. Four target workload conditions (2.5, 4.0, 7.5, and 13.5 targets per 30-minute period) were systematically varied within each 2-hour scenario. Each operator monitored all four workloads during both the pretest and posttest scenarios.

Two groups of eight trained operators of the Remote Sensor Platoon of the 2nd Armored Division at Fort Hood participated in 3 days of training and performance testing. Prior to the pretest, each group was given an orientation briefing, an introduction to the grid employment of UGS, row patching technique training, and test procedure training. Each operator then interpreted one of the two scenarios to determine his baseline performance in target detection and direction and speed estimation accuracy. He next completed the specialized two-unit training program. The first unit dealt with solitary targets (vehicle or vehicle convoy traveling alone through the grid), and the second dealt with target clusters (several targets in the grid area at the same time). The training program was individualized (self-paced), and expert assistance was rendered when needed. Student mastery was ascertained by the monitors checking practical and criterion exercise answers.

Operators used three aids in the training and in the posttest; they used the UGS ruler and the speed table to make time measurements and to facilitate arithmetic calculations, and used the protractor to make more precise target direction estimates.

Findings:

The specialized training program with operator aids significantly improved operator performance in target-detection completeness and target speed and direction estimation accuracy. Target-detection completeness improved by 38%, while speed-estimation accuracy improved by 23%. The accuracy of target-direction estimation improved by 20%. The initially low false-alarm rate showed no significant change. After training, operators detected about 95% of the targets during low workload conditions (5-8 targets per hour), 66% when the workload was doubled (15 targets per hour), and 61% when the workload reached 27 targets per hour.

Utilization of Findings:

The training materials and operator aids have been integrated into UGS training at U.S. Army Intelligence Center and School (USAICS), Fort Huachuca, Ariz.

The lesson materials should be given to personnel of all remote sensor platoons periodically (every 6-12 months) to provide practice and review.

Intelligence personnel should be trained to properly assess operator's reports based on the operator capability data in this report, so that they can effectively employ UGS and use the resulting intelligence information.

The grid employment of UGS can be used as an early warning and target acquisition system. The grid can also provide approximate speed estimates for use in a target acquisition system.

The atypical target paths used in this experiment prevent a good estimation of the operator's ability to provide target direction data. However, results from the few available "normal" target paths indicate that the operator can give useful direction information (average deviation from true direction was $\pm 26°$). The usefulness of direction estimates should be ascertained using additional activation data in a second experiment.

THE VALUE OF SPECIAL TRAINING FOR THE INTERPRETATION OF UGS EMPLOYED IN A GRID

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THE VALUE OF SPECIAL TRAINING FOR THE INTERPRETATION OF UGS EMPLOYED IN A GRID

INTRODUCTION

Unattended ground sensors (UGS) represent a significant part of the Army's capability for detection, location, and acquisition of enemy activity at a remote location. They can be used alone or combined with ground surveillance radars, night vision devices, aerial surveillance--side-looking radar (SLAR), infrared (IR), photography, and visual--signal intelligence, patrols, and observation and listening posts to produce timely and reliable intelligence information. The Army uses several types of UGS, which can be categorized according to the method of remote sensing: seismic, acoustic, magnetic, electromagnetic, and infrared. UGS are tactically employed for offensive and defensive operations by units from small independent patrols to full division-size operations. Among the offensive operations are the following:

Target acquisition--Sensor's real-time detection capability leads to immediate reaction.

Landing (drop) zone--Sensors monitor enemy activity for future airmobile assault.

Combat sweep--Sensors monitor enemy withdrawal or attack activity.

Ambush--Sensors establish enemy habits; are employed with a remote firing device and command-detonated mines.

Among the defensive operations are the following:

Base camp defense--Sensors provide warning of enemy presence; extend listening post/observation post detection range.

Convoy security--Sensors provide ambush detection and warning.

Border surveillance--Sensors provide warning of enemy presence and fire control information for real-time reaction.

Beach defense--Sensors provide warning of counterattack in beachhead situations.

Whether for offensive or defensive tactical purposes, UGS can be employed in any of three ways: string, grid, or alerting. In string employment, UGS are employed along a potential transportation route (land or water). Whether UGS are hand-emplaced or air-delivered, the sensors should be emplanted accurately so that their location with

respect to the route and their separation distances are known. This enhances manual readout by permitting the derivation of relatively accurate direction, speed, and length of column information from the sensor activation patterns. If hand-emplaced, the sensor locations can be accurately located on a map and "seated" properly in the ground.

In grid employment (sometimes called field, belt, gate, or gate array), UGS are deployed in a regularly spaced, two-dimensional pattern to "cover" a given geographical area or field (see Figure 1). A grid would normally be used in defensive operations such as for base camp security or early warning near the forward edge of the battlefield. Again, the objective is to emplant the sensors accurately although this is more difficult than in string employment. The grid is designed to maximize the probability of detecting and acquiring enemy forces intruding into any portion and from any direction within a large area (several square kilometers). Because the path of the target is estimated, the operator can only grossly estimate speed. Even with special operator training, procedures, and job aids, the accuracy of estimates of speed, direction, and number of targets probably will be below that usually obtained with the string employment of UGS.

In the alerting employment, UGS are employed to "cover" a given route or ground area where, for various reasons, the exact locations and the ground distances between sensors are not accurately known. This situation can occur from an inaccurate string or grid employment, as may be the case when sensors are delivered by mortar or artillery in areas heavily dominated by enemy forces and in areas inaccessible to friendly units. Also, the situation can occur when sensors have been air-delivered under poor visibility conditions. Whatever the cause, the operator knows only the approximate location of the sensors. Reliable detections of the presence of activity can be made, but additional information such as speed, number of targets, and direction cannot be computed accurately.

The U.S. Army Intelligence Center and School (USAICS) teaches the string employment concept and the alerting employment concept. Other than a brief overview, however, the school does not train students on monitoring and interpretation procedures for grid-type employment. Although it has received little attention by military or civilian researchers, grid employment can be used in almost all the offensive and defensive operations discussed previously. In the past, UGS operators were not likely to encounter grid monitoring situations. However, because of the shift in emphasis from the Southeast Asia (SEA) type of conflict to worldwide usage, the potential applications of grid employment in area intrusion situations have increased.

The effects of this lack of formal training in grid interpretation have been apparent in previous experiments (Edwards, Rochford, & Shvern, 1977; Pilette et al., 1978; and Edwards et al., 1978). Operator performance in such areas as target detection, direction determination, and speed estimation has been lower than performance using the string employment of sensors.

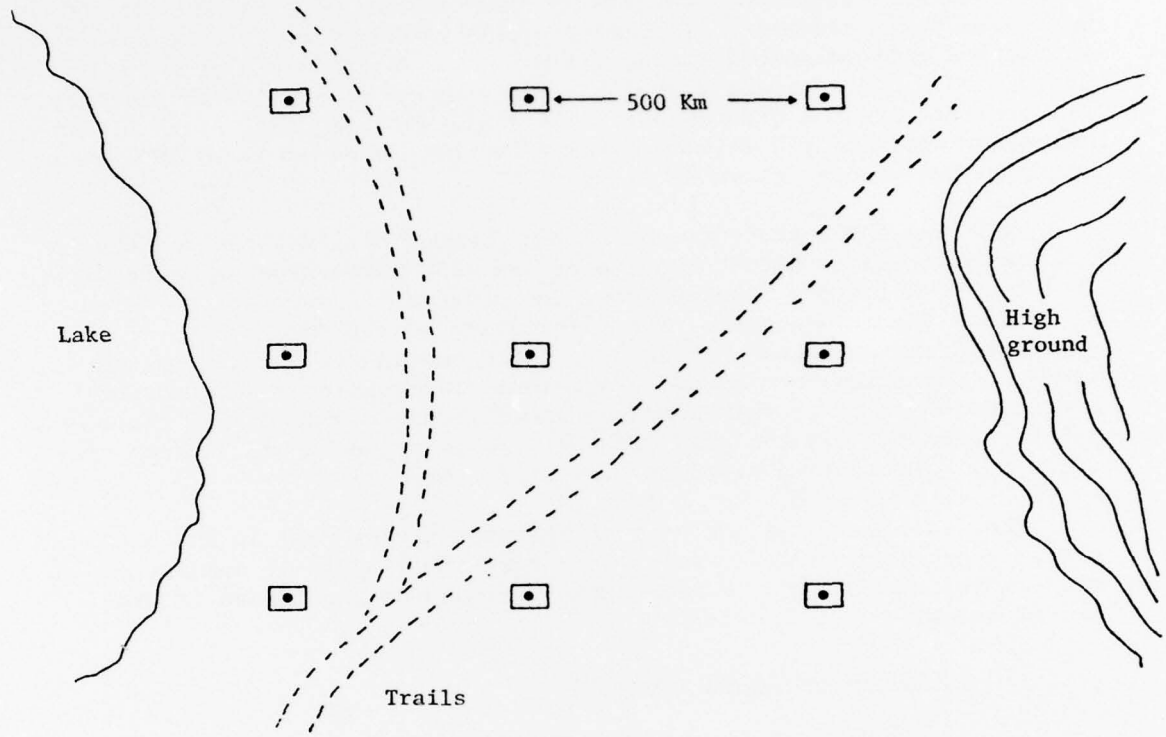

Figure 1. Example of a 9-sensor grid used at a natural chokepoint.

An error analysis was performed on data collected in the above experiments to determine specifically where errors were being made and what were their causes. All three projects involved seismic sensor activation data collected during field exercises conducted at Fort Bragg, N.C. During these exercises, different combinations of military vehicles traversed a grid sensor field 1 kilometer square. Within this kilometer square, nine seismic sensors had been hand-emplaced 500 meters apart in the pattern shown in Figure 1.

In these three projects, as in the present one, the task of the UGS operator was to detect and analyze as many targets as he could within the time allotted. The operator was given a "Target Log" in which to report his target analyses. The information he was required to report was consistent with that needed by a field commander, i.e., target detection, direction, and speed. Additional information collected for scoring and error analysis purposes included the distance that the target traveled through the grid and the time that the target took to traverse the grid (called midpoint time difference).

The details of the analyses of operator errors made in the above research are in Edwards, Pilette, and Martinek (1977). A summary of the errors, causes, and circumstances surrounding the errors is presented below.

1. Errors of omission increased:

   a. During conditions of high target activity or high target loads;

   b. For targets occurring near the end of the activation records during high-target-load conditions;

   c. For targets traveling direct (straight) trails during low target activity;

   d. For targets with noncontinuous sensor patterns;

   e. For targets having other targets in close proximity (adjacent activations on the activation records);

   f. For targets with small sensor patterns;

   g. For targets whose sensor patterns overlapped with the sensor patterns of other targets during high activity; and

   h. When operators mismanaged target logs.

2. False alarms increased (but were infrequent) during low target activity.

3. Direction deviation error increased:

   a. For vehicle convoys during high activity (as compared to single-vehicle targets);

   b. For targets traveling indirect routes during high activity;

   c. For targets traveling direct routes during low activity; and

   d. Because of operator procedural errors in reporting.

4. Speed deviation error increased:

   a. For single-vehicle targets in high-target-activity conditions;

   b. Due to underestimates of the distance that the target traveled through the grid; and

   c. Because of procedural errors in reporting.

OBJECTIVES

1. To develop a training package for grid employment, based upon an error analysis of operator performance using sensors employed in a grid.

2. To determine the improvement in operator performance resulting from use of the training package.

3. To provide estimates of the completeness of target detection and accuracy of direction and speed estimates of operators when using the grid employment of UGS.

METHOD

Development of the Training Content and Instructional Approach

The operator monitoring errors and their apparent causes and circumstances formed the basis for developing the subject matter content and presentation. The content was organized into two major topic areas or units, one dealing with solitary targets and the other with target clusters. Solitary targets are those that pass through the grid area alone--i.e., their sensor patterns are easily distinguishable because they are far removed from the sensor patterns of other targets. A solitary target can be either a single vehicle (e.g., one tank) or a convoy

of vehicles (e.g., five tanks), but with no other targets in the grid. Developing a unit of instruction dealing with only solitary targets permitted a sound development of those problem areas that deal with the basic principles of monitoring.

A target cluster occurs on the activation records (hereafter called the X-T plot) when more than one vehicle or convoy passes through the grid at the same time, or about the same time, causing their sensor patterns on the X-T plot to overlap or to be very close. In this experiment, target clusters occurred only during the high-target-activity condition (seven targets appearing within a 30-minute period). As with solitary targets, the vehicles within a target cluster can be composed of single vehicles and/or convoys of vehicles.

These two major content areas were divided into the following lesson units:

Unit I - Solitary Target Analysis
- Lesson 1. The Grid Employment Pattern
- Lesson 2. Target Pattern and Path Analysis for the Grid Employment
- Lesson 3. Speed and Direction Determination
- Lesson 4. Small Sensor and Target Patterns

Unit II - Target Cluster and Multi-readout Analysis
- Lesson 1. Target Cluster Analysis
- Lesson 2. Multidisplay Readout

With the training content determined, a training system was designed to allow each individual to proceed at his own pace, test his own knowledge after short segments (lessons) of instruction, obtain immediate feedback on his mastery of the content, and require only minimal instructor control and assistance. Each lesson contained the following six steps[1]:

Step 1. The Lesson Sheet was divided into three sections: Objective, Purpose, and Concept. The Objective section stated what the operator (student) should be able to do at the end of the lesson, the Purpose section stated the importance of the lesson, and the Concept section contained the instructional materials with examples.

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[1] Training text is available from the U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, Va. 22333.

Step 2. The Practical Exercise Questions contained questions on the material discussed in the lessons. These questions were intended to allow the operator to test his mastery of the concepts in the lesson.

Step 3. The Practical Exercise Answer Key provided the operator with the correct answers to the questions and allowed him to check his own knowledge. The operator could restudy the lesson if necessary.

Step 4. The Criterion Exercise Questions contained questions relating to information in the lesson. These questions tested the same thing as the practical exercise questions and were the final check for mastery before going on to the next lesson.

Step 5. The Criterion Exercise Answer Key enabled the instructor to evaluate the operator's performance on the Criterion Exercise. If the operator performed within pre-established criterion levels, he was given the next lesson. If he did not, he was sent back for additional review or to an instructor for individualized help.

All the lessons except Lesson 1 of Unit II are self-administerable with instructor checking the operators' criterion exercise answers. Lesson 2 of Unit II presents target cluster analysis, which is a more complex topic. It is anticipated that the instructor will have to assist the operator with this lesson, especially the inexperienced, in understanding the concepts presented.

Population and Sample

The population of concern is the Army enlisted UGS operator (MOS 17M20), school-trained at the U.S. Army Intelligence Center and School at Fort Huachuca, Arizona. Sixteen enlisted personnel of the UGS platoon, 502nd MI Battalion, 2nd Armored Division stationed at Fort Hood, Tex., participated in the research as UGS operators.

Apparatus

Ten RO376 Tactical Data Recorder simulators were used to display the sensor activation records (X-T plots). The simulators were mechanically adjusted to drive the records at 12 inches/hour, a speed equal to that of the operational RO376 (30-pen) Tactical Data Recorder and a BASS III (60-pen) Tactical Data Recorder. Display housings were placed on each simulator to reduce its viewing area size to that of the RO376 or BASS III. The X-T plots were therefore presented at the same speed and format as in the field situation.

Research Design

The following independent variables and combinations of variables were studied:

Pretest/Posttest (Training Effect). The comparison of posttest results in relation to pretest results provides the measure of the overall effectiveness of the training.

Workload. Four different workloads were analyzed:

Workload	Target Activity	Display	Total Targets in a 30-Minute Period
I	Low	30 pen	2-3
II	Low	60 pen	4
III	High	30 pen	7-8
IV	High	60 pen	13-14

These workloads are similar to those used in the research which provided the data for the error analysis (ref. 3). They span an operationally relevant range from a low-target-load condition (only 5 targets per hour) to a high-target-load condition (27 targets per hour).

Period (Practice Effect). An analysis was performed comparing performance during each of the 30-minute periods of both the pretest and the posttest to determine whether the operators' performance varied over time (period) during the test. If they improved as time progressed, practice effects would be assumed which would confound the pretest/posttest analysis.

Pretest/Posttest Workload Interaction. This interaction shows whether the training affected performance differently in each of the four workload conditions.

Pretest/Posttest Period. This interaction shows whether period effects could have occurred differentially in the posttest and the pretest conditions. If an improvement over time was found (practice effects), an appropriate adjustment could be made to the pretest/posttest comparisons.

Groups (and Order Effects). The 16 operators were divided randomly into four groups of 4 each for control purposes. Each group received the workload conditions in a different order to control on order effects. Within each group, two operators received one set of 30-minute segments of the scenario for the pretest and the second set for the posttest. The other two operators received the sets in reverse order, thereby preventing scenario effects from confounding the pretest/posttest comparison.

The following dependent variables were used:

Detection Completeness. If an operator reported a target when the scenario indicated that a target could have been causing activation on the designated pens, the response was classified as a correct detection. Detection results are reported as detection completeness, i.e., the number of correct detections divided by the number of targets presented times 100.

False Alarms. If an operator reported a target when the scenario indicated that no target could cause activations on the designated pens, the response was classified as a false alarm. In addition, if an operator reported two or more targets on the same pens when in actuality there was only one, the additional response(s) was classified as a false alarm(s).

Target Direction Deviation. If the direction and speed of a target as it leaves the grid area are known, its location at a later time can be estimated. To compute direction deviation, the actual direction (in degrees) that the target traveled after leaving the grid was subtracted from direction the operator reported. The operators were trained to use a 360° protractor for this purpose.

Results on target direction should be generalized with caution. Due to space restraints in the area assigned for the collection of sensor activation data at Fort Bragg, most targets after passing through the grid were required to turn and travel parallel to the last row and approximately 100 meters from it. Thus most of the targets activated the entire last row of sensors; this situation made direction estimates more difficult than if the target had kept going straight as would normally be expected.

Target Speed Deviation. As with target direction, deviation scores were computed for target speed by comparing the operator's responses with school solutions based on time and distance data obtained during the exercise. If a correct speed (in meters/minute) was given, a score of zero deviation would result. For an incorrect score, the deviation in meters/minute from the school solution would be determined.

Experimental Design

The experimental design used for the target detection completeness analysis is a three-factor Latin Square with repeated measures on the pretest/posttest factor (Winer, 1962). The Latin Square factors are workload, period, and groups (see Table 1). Certain interactions were not analyzed but were summed into a "residual" interaction term because they were not of value to the objectives of the research except for control purposes. Scenario effects were counterbalanced between the pretest and posttest periods but were confounded with workload.

Table 1

Experimental Design Showing Workload Order by Groups and Periods

Subjects	Pretest periods 1	2	3	4	Posttest periods 1	2	3	4
Group A (n=4)	IV	II	I	III	IV	II	I	III
Group B (n=4)	II	IV	III	I	II	IV	III	I
Group C (n=4)	III	I	IV	II	III	I	IV	II
Group D (n=4)	I	III	II	IV	I	III	II	IV

Development of the Test Scenarios

To objectively assess the performance of the operators, RO376, X-T (event versus time) plots containing operationally collected target activation patterns were developed for presentation to the operators. The target activation patterns (target patterns) were transcribed from magnetic tapes recorded at Fort Bragg during a field exercise specifically designed to test sensors and collect activation patterns. Included in these exercises were armored and wheeled vehicles traveling singly or in convoys of up to 10 vehicles. The presence of artillery fire added operational "noise" to the scenarios. Since these were controlled exercises, target location and time were known and could be related to target patterns in developing school solutions.

The X-T plots were developed into 30-minute segments and then were combined into 2-hour scenarios to include the correct levels and presentation order of target activity to satisfy the specific experimental design requirements discussed earlier. No changes were made to the original target patterns, although the relative positions of some target patterns were changed. Each segment portrayed three 9-sensor grids, using 27 of the 30 columns available on the RO376 plot. Two 30-minute, 3-grid segments could be combined in a side-by-side presentation to represent 30 minutes of viewing on a 60-pen recorder (or 6 grids--workload conditions II and IV).

In accordance with the experimental design, twelve 30-minute segments (3 grids each) were selected from previous research material (Edwards et al., 1978) and numbered 1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, and 14. A 2-hour scenario was constructed for each subject by combining six 30-minute segments for the pretest and six 30-minute segments for the posttest (see Table 2). Two of the six 3-grid segments were combined to produce a low-target-activity, 6-grid (or 60-pen recorder) workload

Table 2

Order of Administration of 30-Minute Segments

Operators	Pretest Period 1	Pretest Period 2	Pretest Period 3	Pretest Period 4	Posttest Period 1	Posttest Period 2	Posttest Period 3	Posttest Period 4
				Subject Group A				
1	1-3	8-12	9	2	6-7	13-14	10	5
2	6-7	13-14	9	5	1-3	8-12	10	2
3	1-3	8-12	10	2	6-7	13-14	9	5
4	6-7	13-14	10	5	1-3	8-12	9	2
				Subject Group B				
5	8-12	6-7	2	10	13-14	1-3	5	9
6	13-14	1-3	5	10	8-12	6-7	2	9
7	13-14	1-3	2	9	8-12	6-7	5	10
8	8-12	6-7	5	9	13-14	1-3	2	10
				Subject Group C				
9	2	10	1-3	13-14	5	9	6-7	8-12
10	5	10	6-7	8-12	2	9	1-3	13-14
11	2	9	6-7	13-14	5	10	1-3	8-12
12	5	9	1-3	8-12	2	10	6-7	13-14
				Subject Group D				
13	9	2	8-12	1-3	10	5	13-14	6-7
14	9	5	13-14	6-7	10	2	8-12	1-3
15	10	2	8-12	1-3	9	5	13-14	6-7
16	10	5	13-14	6-7	9	2	8-12	1-3

condition (eight targets/hour). Two other 3-grid segments were used for the high-target-activity, 6-grid workload conditions (27 targets/hour). The remaining two 3-grid segments (low and high target activity) were used for the other two workload segments (each 3-grid). The 30-minute segments were counterbalanced across the four groups of subjects periods, and pretest/posttest conditions in the order shown in Table 2, to prevent confounding of these variables by scenario differences. The workload variable and scenario effects are confounded.

Test Procedure

Prior to taking the pretest, the operators participated in a four-part grid orientation and test procedure training. These involved the following: Orientation Briefing (Appendix A), Introduction to the Grid Employment Pattern (Appendix B), Test Procedure Training (Appendix C), and Row Patching Technique Training (Appendix D).

Three job aids were provided to the operators for their use in this training--a speed table, an UGS ruler, and a protractor. The speed table circumvents the need to perform arithmetic division, which is a frequent error source for some operators. The UGS ruler assists the operator in measuring ground distance on the grid and time on the X-T plots. Both job aids were used in previous studies. They are discussed in Appendix D.

The protractor is a new job aid introduced in this study. The operators were taught how to use the protractor to determine the direction (in degrees) in which the target was heading when it left the grid area. The protractor helps the operator provide a more precise target direction to the Army commander--which of course is not needed when strings are employed along a roadway. Use of the protractor is discussed in Appendix D.

The training and testing schedule by day is presented in Table 3. Because only 11 Tactical Data Recorder simulators were available, two groups of eight operators each participated in the 3-day program in succession. The first group of operators participated for 3 work days for the first week and the second group of operators for 3 work days the second week.

RESULTS AND DISCUSSION

The results are discussed in terms of the four dependent variables: detection completeness, false alarms, target direction deviation, and target speed deviation. The independent variables are discussed separately under each of these as appropriate; not all independent variables were analyzed for all dependent variables, because of restrictions in the data obtained. Thus, the complete analysis of variance was computed on only the detection completeness variable.

Table 3

Schedule of Administration at Fort Hood

Day 1	8:00 a.m.	-	Orientation Briefing
	8:15	-	Introduction to the Grid Employment Pattern
	8:30	-	Test Procedure Training (average 1 hour)
			Patching Technique Training (average 2 hours)
	11:30	-	Lunch
	1:00 p.m.	-	Finish Pretraining - Question Period
	2:00	-	Pretest Scenario Administration
	4:00	-	Finish
Day 2	8:00 a.m.	-	Unit I - Lesson 1 (average 45 minutes)
	9:00	-	Unit I - Lesson 2 (average 1 hour)
	10:00	-	Unit I - Lesson 3 (average 1 hour 15 minutes)
	11:00	-	Unit I - Lesson 4 (average 1 hour)
	11:30	-	Lunch
	1:00 p.m.	-	Finish Unit I materials
			Start Unit II - Lesson 1
	5:00	-	Finish
Day 3	8:00 a.m.	-	Finish Unit I - Lesson 1
	10:30	-	Unit II - Lesson 1, Practical Exercise Vu-graph
	11:00	-	Unit II - Lesson 1, Final Lesson Exercise Vu-graph
	11:45	-	Lunch
	1:00 p.m.	-	Unit II - Lesson 2
	2:00	-	Posttest Scenario Administration
	4:00	-	Finish

Detection Completeness

Table 4 presents the analysis of variance results for target detection completeness expressed as the percentage of targets detected.

The significant difference between pretest and posttest performance indicates that the training package was effective in increasing operator performance. The operator average detection completeness increased from 57.5% on the pretest to 79.4% on the posttest. This increase represents a 38% improvement over pretest performance.

Table 4

Analysis of Variance for Detection Completeness

Source	df	SS	MS	F	Significance
Between subjects	15	21,900			
Groups	3	4,554	1,518	1.05	NS
Subjects w. groups	12	17,346	1,446		
Within subjects	112	115,034			
Workload (A)	3	58,693	19,564	65.83	.01
Periods (B)	3	6,581	2,194	7.38	.01
Pretest/posttest (C)	1	15,312	15,312	51.52	.01
A x C	3	4,664	1,555	5.23	.01
B x C	3	1,063	354	1.19	NS
Residual interactions	15	3,756	250	<1	NS
Pooled error	84	24,964	297		
Total	127	136,934			

Significant differences were found (as shown in Table 4) for both workload and its interaction with pretest/posttest. The workload differences in detection completeness are generally similar to those of previous research but are lower and do not indicate the same linear relationship between number of targets (workload) and detection completeness (Edwards et al., 1978). A possible explanation of these dissimilarities may be in the difficulty levels of the target patterns used in the specific 30-minute segments: i.e., the scenario effects were confounded with workload.

The significant workload x pretest/posttest interaction indicates that the training had a differential effect on the operators' performance under the various workloads. Table 5 shows that significant improvements occurred in the case of Workloads I, III, and IV but not for Workload II. Although Workload II presented more targets than Workload I, detection completeness was 88% for Workload II and only 81% for Workload I in the pretest condition.

Table 5

Means and Analysis of Workload
Pretest/Posttest Interaction for Detection Completeness

Workload	Pretest	Posttest	SS	df	F	Significance
I (5 targets/hr, 30-pen)	81%	97%	1,953.125	1	6.57	.05
II (8 targets/hr, 60-pen)	88%	94%	312.500	1	1.05	NS
III (15 targets/hr, 30-pen)	28%	66%	11,742.78	1	39.51	.01
IV (27 targets/hr, 60-pen)	34%	61%	5,967.78	1	20.08	.01
Error (within)			24,964.375	84		

Note: Analysis of simple effects, from Winer, 1962, pp. 571-574.

A similar result in the pretest condition for Workloads III and IV is shown in Table 5, where detection was 28% for Workload III (15 targets/hr) and higher (34%) for Workload IV (27 targets) in spite of the greater number of targets presented. A possible hypothesis to explain these results is that a 60-pen display (6 grids) was used for Workloads II and IV. However, this effect was not found in a previous study by Edwards et al. (1978), which used some of the same workload conditions (30- and 60-pen) and similar scenarios.

The detection rates for the heavier workloads (III and IV) were about 100% higher in the posttest as compared to the pretest. The corresponding increase for Workload I (which also showed a significant increase) was much lower (20%). The increase of Workload III (28% to 66%) was significantly higher ($t = 2.17$, $df = 15$) than the increase of Workload I (81% to 97%); other comparisons of increases were not significantly different. A greater increase at high workloads was expected, as the greatest emphasis in the training was placed on eliminating errors of omission occurring during high-workload conditions and because of the limited increase possible for Workload I--at most 19%.

The differences found between workloads might be attributed to differences in the individual target difficulties, although it is assumed that target difficulty was randomly distributed over workload conditions. However, the increases in performance between pretest and posttest could not have occurred because of target difficulty differences, because the same targets appeared equally often in the pretest and posttest.

The nonsignificant period x pretest/posttest interaction indicates that the relationship between the four periods (30-minute scenario segments) was similar for both the pretest and posttest. For both the pretest and posttest, performance decreased as the periods progressed from 1 to 4 (see Table 6). This significant (see Table 4) decrease in performance over periods (or time) is probably due to fatigue, loss of motivation, etc. It is important to note that an increase in performance (practice effect) did not occur. Thus, the difference from pretest to posttest is attributable to the training given and not to practice effects.

Table 6

Pretest/Posttest x Period Interaction for Detection Completeness

	Period 1	Period 2	Period 3	Period 4
Pretest	66%	62%	60%	42%
Posttest	88%	84%	74%	73%

The group's effect, which is confounded with workload order, is nonsignificant (Table 4). This indicates that the four subgroups of operators (each having a different workload order) did not perform significantly differently from one another.

False Alarms

The number of false alarms reported by operators was small, only six in the pretest and 12 in the posttest (see Table 7). The increase between the pretest and posttest was not significant ($t = 1.19$, $df = 15$). The number of false alarms was at a minimal level and was not affected by training.

Target Direction Deviation

Target directions were scored as deviations (in degrees) above and below school solutions based upon ground truth. One method of analyzing this score is to calculate the arithmetic sum of the direction deviation for each operator and divide it by the total number of targets for which the operator reported a direction to obtain an average. The average for the pretest was -6°, while that for the posttest was -9°. Using this method, these figures appear to indicate that the operators were very accurate, whereas in fact the opposite is true because of two conditions.

The first was the atypical target paths used: The targets turned 70° after passing through the grid and traveled parallel to the last row of sensors. The second was that half the target activation patterns were generated by taking mirror images of the other half (e.g., if a target traveled down one side of the grid and then turned 70° to the right, its mirror image would travel down the other side and turn 70° to the left). In general, the operators missed the turning of the targets. Thus, for one-half of the target activation patterns, the average deviation for both pretest and posttest was -46°. For the mirror image of these patterns, the average deviation was +35°. In summing these, an average of -8.5° results, which does not reflect the actual accuracy of estimates of direction.

Table 7

Pretest/Posttest False Alarms

Operator	Pretest	Posttest
a	2	2
b	1	0
c	1	0
d	1	0
e	1	3
f	0	3
g	0	3
h	0	1
Total	6	12

Based on the above considerations, a different method of scoring was used. The analysis was conducted using the absolute value of the direction deviation, that is, ignoring the sign of the deviation. This method cancels the effect of the second condition above (mirror image target paths).

Because data were missing in 12 cells in the design matrix, the planned analysis of variance (see research design section) was not conducted. The missing data occurred when a particular operator did not report any target detections within a 30-minute segment or did not give a direction for a reported target. By combining Workloads I and II into a low-target-activity condition and III and IV into a high-target-activity condition, an analysis could be performed using a 2 (groups) x 2 (activity) x 2 (pre- posttest) design.

Although training improved target detection, there was a loss of intelligence information associated with training and these variables. Direction information was omitted on 19% of the targets in the posttest and on only 3% in the pretest. This caused too many missing cells and prevented the planned analysis. However, training still resulted in more targets being reported, both with and without complete information on direction estimation.

Table 8 presents the analysis of variance for the absolute value of the operators' direction deviations using the modified workload variable of low and high target activity (6-7 targets/hr and 20-22 targets/hr, respectively). The only significant difference found was between pretest and posttest. The training improved direction estimation by 20%, or from 56° to 45°. Thus the training used not only increased the detection of targets as indicated in the previous section, but also improved the estimates of the direction of target movement.

Table 8

Analysis of Variance for Direction Deviations (Absolute)

Source	df	SS	MS	F	Significance
Between subjects	15	5,279			
Groups (A)	1	150	150	<1	NS
Subjects w. groups [error (a)]	14	5,129	366		
Within subjects	48	14,473			
Pretest/posttest (B)	1	2,025	2,025	5.76	.05
A x B	1	105	105	<1	NS
B x subjects w. groups [error (b)]	14	4,923	352		
Activity, low/high (C)	1	689	689	2.86	NS
A x C	1	100	100	<1	NS
C x subjects w. groups [error (c)]	14	3,374	241		
BC	1	333	333	1.62	NS
ABC	1	42	42	<1	NS
BC x subjects w. groups [error (bc)]	14	2,882	206		

The usefulness for intelligence purposes of the operator's report on target direction as estimated in this experiment is difficult to determine because of the atypical target path used. The relatively useless value of 45° reported above is based largely on targets which turned 70° after passing through the grid. However, six straight target paths were available on which 21 targets were reported. Using these sparse data, the operator's average direction deviation was ±26°. This accuracy corresponds roughly with the accuracy of a report using such terms as north, northeast, east, southeast, etc.

No practice effect was indicated by the average direction deviations by period. Analysis of Table 9 does not suggest any systematic decrease in average deviation over time (over periods) for either the pretest or posttest.

Table 9

Means of Absolute Direction Deviations by Periods

	Pretest periods				Posttest periods			
	1	2	3	4	1	2	3	4
Average deviation	61°	52°	52°	62°	45°	46°	46°	45°
n	16	14	16	12	16	15	15	13

Target Speed Deviation

Target speed was scored as deviations (in meters/minute or mpm) above and below ground truth speeds. As with direction deviation, 12 cells with missing data precluded the planned analysis of variance. The data were tabulated to conduct a matched group t test. An average deviation was computed for each operator on the pretest and posttest. The average deviation was computed by dividing the arithmetic sum of the deviations by the total number of target speeds reported by the operator.

The average arithmetic pretest deviation is -82 meters per minute (mpm) (3.1 mph), and the average posttest deviation is -67 mpm (2.4 mph). The difference of .7 mph represents an 18% improvement over the pretest deviation error and is statistically significant at the .05 level ($t = 1.80$, $df = 15$). Based on these results, it is concluded that the training reduced the size of the average deviation.

Practice effects (learning) were minimal or nonexistent during the administration of the pretest and posttest. The pretest average deviations for the four periods (in mpm) are 59, 70, 121, and 98. The posttest average deviations for the four periods (in mpm) are 70, 64, 85, and 67.

As these results show, operators tend to underestimate the ground truth speeds. This was noted in previous research and was attributed to the problem of underestimating the actual distance that a target traveled through the grid (Edwards et al., 1977; Pilette et al., 1978; and Edwards et al., 1978). When drawing a target's path through the grid, it is normal to draw a smoother and straighter path than the one that it actually traveled. Sensor patterns do not usually indicate if vehicles turn to avoid hills, trees, etc. The operators' estimates of speed may be more useful than the true target speed, since they are estimates of how fast that target will get from one point to another using cross-country (not straight) traveling procedures. Generally, this is the information the commander needs to know. However, if true speeds are required (e.g., to be used to differentiate between vehicles and personnel), then a correction factor would need to be added to the operators' estimates.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Overall, the operator's detection completeness significantly increased from a pretest average of 57.5% of the targets detected to a posttest average of 79.4% of the targets detected. This represents a 38% improvement over pretest performance. The self-paced training material with minimal instructor participation is considered successful.

Workloads I, III, and IV posttest results indicate significant improvements in detection completeness. Workload I (5 targets/hr, 30-pen) improved by 20%, Workload III (15 targets/hr, 30-pen) improved by 136%, and Workload IV (27 targets/hr, 60-pen) improved by 79%. The substantial improvements for Workloads III and IV represent success in training target cluster analysis for high-target-activity situations.

Workload II (8 targets/hr, 60-pen display) did not result in a significant pretest-posttest improvement in detection completeness. Performance was relatively high for both the pretest and posttest (88% and 94%).

The false alarm rate was negligible with or without the training. While this is contrary to the reports on the uses of the sensors in Vietnam, newer sensors, better training, and different environments and employment could easily account for this improvement.

The accuracy in target direction determination improved significantly as a result of the training. Due to the atypical target paths used, a good estimate of the operators' ability to determine target direction cannot be given. The best estimate of the operators' mean performance, based on the results of only 21 reported targets, is ±26 from the true direction.

The average accuracy in target speed estimations improved significantly as a result of the training, from a 3.1 mph underestimation to a 2.4 mph underestimation. The underestimation is of the actual speed of the target and not necessarily of the cross-country speed which takes into account minor changes in direction to avoid obstacles. The operators' estimates could be more useful to the commander than the actual speed.

Performance estimates of what the commander can expect of operators in the field interpreting activations of sensors employed in a grid are shown in Table 10.

Table 10

Field Detection Performance Expectations

Workload	Existing[a] operator	Operator with 13 additional hours of training
5 tgts/hr	81% (4.0 tgts)	97% (4.8 tgts)
8 tgts/hr	88% (7.0 tgts)	94% (7.5 tgts)
15 tgts/hr	28% (4.2 tgts)	66% (10.0 tgts)
27 tgts/hr	34% (9.2 tgts)	61% (16.5 tgts)

[a]School-trained and with some basic introduction to the grid employment.

Recommendations

The training materials should be integrated into the UGS school curriculum as part of training required for award of the MOS 17M.20.

Unattended ground sensor personnel already trained and in the field should be given special grid training. Training should be administered periodically as a refresher course to maintain proficiency for operators in the field.

During low-target-activity conditions, the grid employment pattern of the type tested is recommended as a highly effective early warning and target acquisition system (95% detection rate). During high-activity conditions, the early warning and target acquisition capability of the grid is still recommended, but intelligence personnel should base their estimates of threat on its effectiveness of 67% detection rate. The problems of false alarms are negligible for this type of employment.

In terms of target acquisition information, the commander can expect more accurate target speed determinations as a result of the training, but the estimates will still be below the actual target speed. However, speed is used by the commanders' staff to estimate when a target will reach a certain location. The operators' estimate is of cross-country speed and may provide a more useful estimate in the sense of how far the target will travel in a certain amount of time, assuming that the terrain does not change. Actual speed can be estimated from the cross-country speed estimate, for such purposes as target identification (e.g., personnel versus vehicles).

Although training significantly improved direction estimation accuracy, and the results on the few "normal" target paths indicated that the reports are sufficiently accurate, the data are insufficient for any recommendation as to the usefulness of direction estimation using grid employment. It is recommended that operator estimates of direction using additional target activation data from a grid be obtained to determine the system's accuracy for direction estimation.

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APPENDIX A

ORIENTATION BRIEFING

Monitor: Paraphrase the following:

I want to welcome everyone here today and thank your for coming. We are glad that you could make it and can participate in the exercises we have planned. We think you will find it worthwhile. You will be participating in a five-day program and we will be spending the next several hours briefing you and giving you an orientation as to what it is all about. Before going any further I want to introduce myself and my associates and find out who you are.

- Introductions -

Our purpose in coming here is to evaluate, with your assistance, several different display and target activity conditions using seismic sensors employed in a grid. We have been asked by the Army Research Institute for the Behavioral and Social Sciences and the Department of the Army to administer this exercise to you. The Army is interested in the development of improved displays of unattended ground sensors to maximize information output and make the job easier for you. Your task in this study will be to act as a sensor operator and interpret various X-T plot presentations. Many of the skills you have acquired in school and on the job will apply to these tasks, however, the patching technique will be new to you and details such as measurement and reporting procedures will differ. In these cases, training and instructions will be provided. If at any time during your work with us you do not understand something or you are not sure of what you are to do----ASK. You will not be penalized and asking might prevent your having to repeat some of your work. We will be using simulated RO-376 drive mechanisms. If any of the equipment appears to be malfunctioning, inform one of us immediately.

Previous studies of this kind have dealt primarily with sensor strings emplaced along roads, trails, or other infiltration routes. Here, we are applying seismic sensors to an area intrusion problem. In such a situation, we would have sensor fields emplaced over a wide geographical area that an enemy force would utilize should he elect to maneuver his forces cross-country and not along the existing road network. This type of sensor field would be used to help detect and identify different tactical maneuvers such as reconnaissance probes, feints, or major attacks and is referred to as a gated array, grid and grid employment.

For our experiment, we have taped actual sensor activations from a grid employment during field exercises using various types of targets. The target activations were collected under simulated battlefield conditions complete with noise activations produced by artillery fire, helicopters, and wind. These tapes will not be played back to you in real time, but in the form of pre-prepared X-T plots. You will interpret these X-T plots and extract information using our procedures and forms. Since we know where and when target activations actually occurred, we can score your reports for accuracy.

Each of you will participate three days this week. Your NCOIC will post the schedule each day. During that time, you will be given training on the row patching technique and multi-display training. During the program you will be given appropriate breaks, lunch, etc. You must be here for all scheduled times or we cannot use your results.

I would like to emphasize that we are not giving a test to see how good an operator you are. The purpose of this study is to determine what are the effects of different display and target activity conditions. We are not interested in how good you are as an operator. However, you and your superiors are interested in how good you are. I am sure they will not base the next promotion on how well you do on these practical exercises. Still, these activations are actual activations recorded in the field and your accuracy in interpreting is one indication or example of what you can do. You will be able to compare what you can do to what others did as a group. You will be able to get your score and the group average from your commanding officer. He will be able to objectively assess you against the others on this one sample of one of your duties. However, there are no standards of performance -- even if you do worse than everyone you still could be a competent operator.

All we ask is that you interpret the X-T plots to the best of your ability and try to make sense out of what sometimes might appear to you to be rather difficult. Let me stress that we have tried to make these records as realistic as we could.

You are important because you as a group represent the hundreds of specialists that have graduated and will graduate from the UGS school for a long time to come. Army employment plans for UGS equipment and personnel will be partly influenced based upon what you can do.

Monitor: Begin the briefing on grid employment pattern.

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APPENDIX B

INTRODUCTION TO THE GRID DEPLOYMENT PATTERN (LECTURE/DISCUSSION)

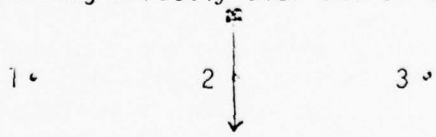
The Grid array consists of unattended ground sensors (UGS) deployed in a matrix within a designated field area as opposed to the string pattern in which UGS are deployed in sequential alignment along a roadway. The grid array can be used for area intrusion surveillance problems encompassing entire border areas or smaller gate (gap) areas where coverage by radar or other means is limited or not feasible. It is designed to maximize the probability of detecting and acquiring enemy forces intruding in any portion or in any direction within a covered geographical area. The UGS in the grid array are deployed in a systematic way with pre-planned distances between the sensors so that information extraction is enhanced.

For this exercise we are utilizing a sensor grid, consisting of 9 sensors, each sensor is 500 meters apart. X-T plot readouts of various target runs through this sensor grid will be presented to you. Your task will be to detect these targets, track their path through the sensor grid, and provide further information about them. You have already received some information concerning this task. At this time we would like to provide you with further information which should aid you in monitoring sensors in the sensor grid.

After you have detected what you believe is a target, your next objective is to chart or trace its path across the sensor grid. In the past, when you have worked with sensor strings, targets coming down a road will generally activate all the sensors in order. However, in a grid formation, the targets may come from any direction and take any course across the grid. They will also come closer to some sensors than they will to other sensors. This presents more of an interpretation problem to the monitor.

We have prepared some examples of targets entering the sensor grid from different angles and taking different paths through the grid. We also have copies of the sensor activations caused by these targets.

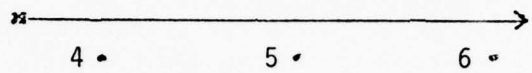
Example 1 - Here is a target entering a grid, and crossing the first line of sensors, passing directly over one of them.



Activations would first appear on the middle sensor. As the target proceeds the sensors to the right and left would activate for a shorter

period of time. The sensors to the right and left would cease activating before the middle sensor thus the activations would appear as below:

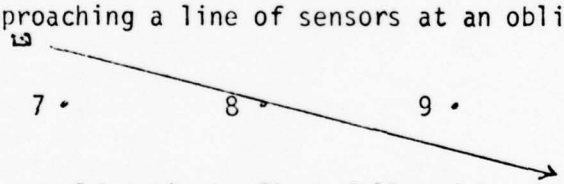
Example 2 - A target traveling in parallel with a line of sensors would



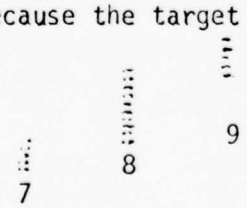
appear like this on the X-T plot.

This would be very similar to the activation of a sensor string with a stair-step pattern. All sensors would activate for approximately the same length of time.

Example 3 - Shows a target approaching a line of sensors at an oblique angle.



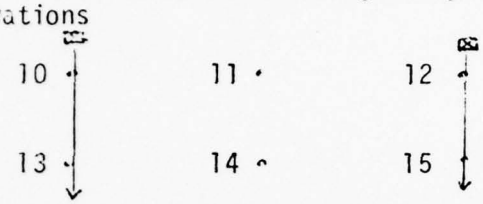
Here the left hand sensor would activate first followed by the middle sensor and the right-hand sensor, however, the middle sensor would be activated for a longer time because the target would come closest to it.



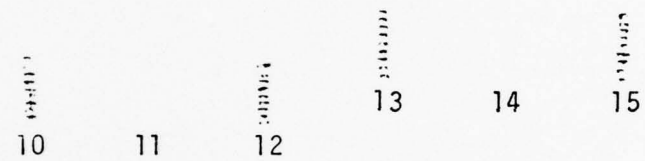
In all three of the above examples, other groups of sensors in the grid would, in the same way, indicate the path of the target as it traveled the grid. A good general rule to remember when monitoring a sensor grid is to look at the overall pattern of the sensors being activated, and then make a determination from this overall pattern, where the target is traveling.

At times, there may be more than one target present in the sensor field. Monitors should be able to detect this again by studying the overall pattern of activations

Example:



In this example, with sensors activating on the left and right but not in the middle, it must be assumed that two targets are present. In these situations it is important to take note of sensors that are not activating as well as sensors that are activating.



APPENDIX C

TEST PROCEDURE TRAINING

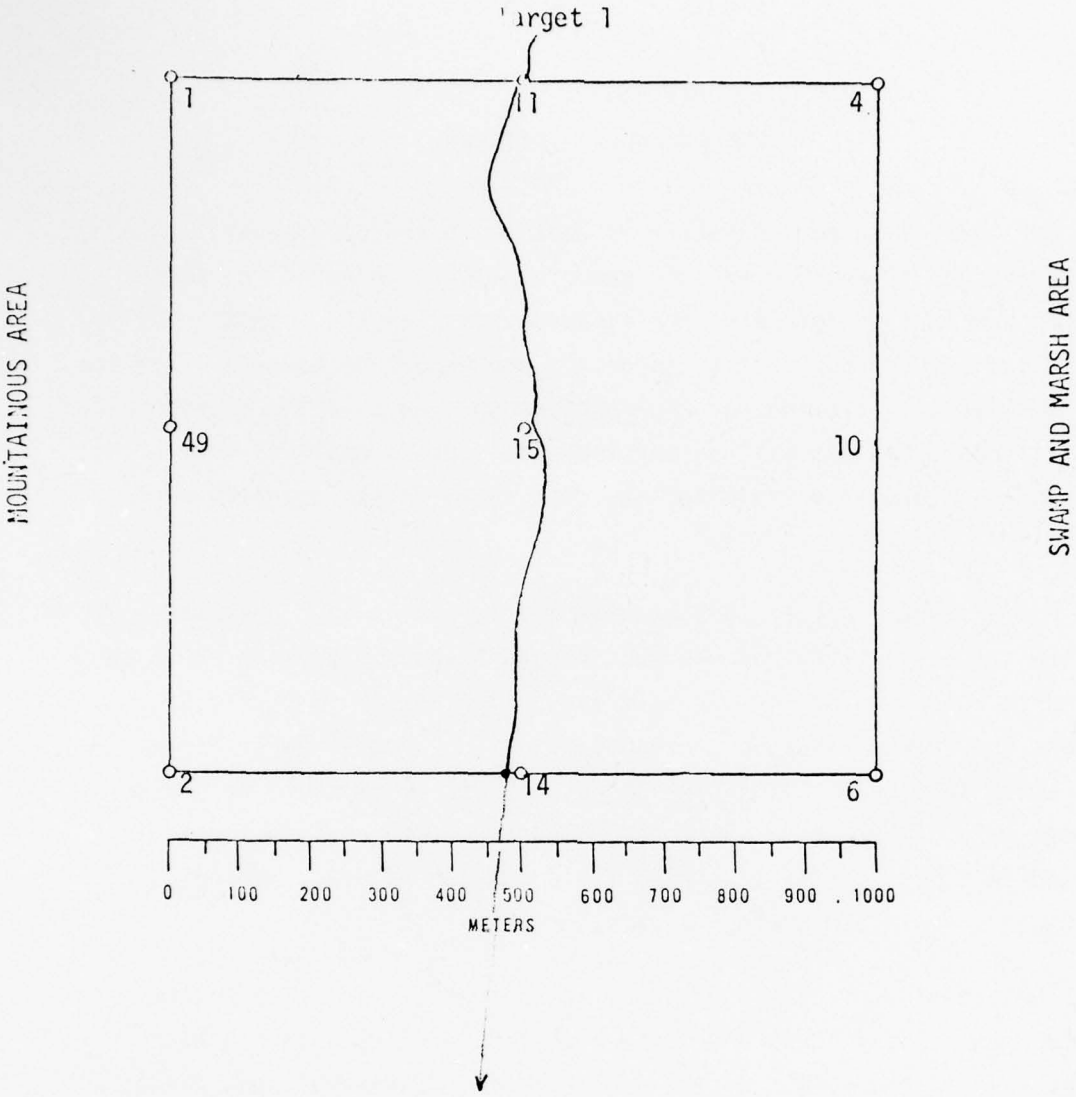
Our purpose in coming here this week is to evaluate several display and target conditions for seismic sensors patched to an R0376 readout device. We want to determine how different display and target activity conditions affect your ability to detect and report on targets. You are all familiar with the idea of employing sensors in a string configuration along a road. Now you will be working with sensors employed in a grid configuration and in a field such as that shown in the top half of Figure 1.

Pull Figure 1 out of this booklet and lay it on your desk where you can see it clearly. As you can see, Figure 1 shows 9 sensors employed in a grid which is 1000 meters on a side. The sensor identification numbers are shown. In an operational situation, a grid this size could be a small section out of a long sensor network or it could be placed between natural barriers. For our purposes, assume that each grid is located in a flat partially wooded field between natural barriers such as rugged terrain and marshy terrain.

The expected direction of enemy approach is from top to bottom. As you can see, target 1 has come from the expected direction and has passed through the center of the sensor field. The target has passed over sensors 11, 15, and 14.

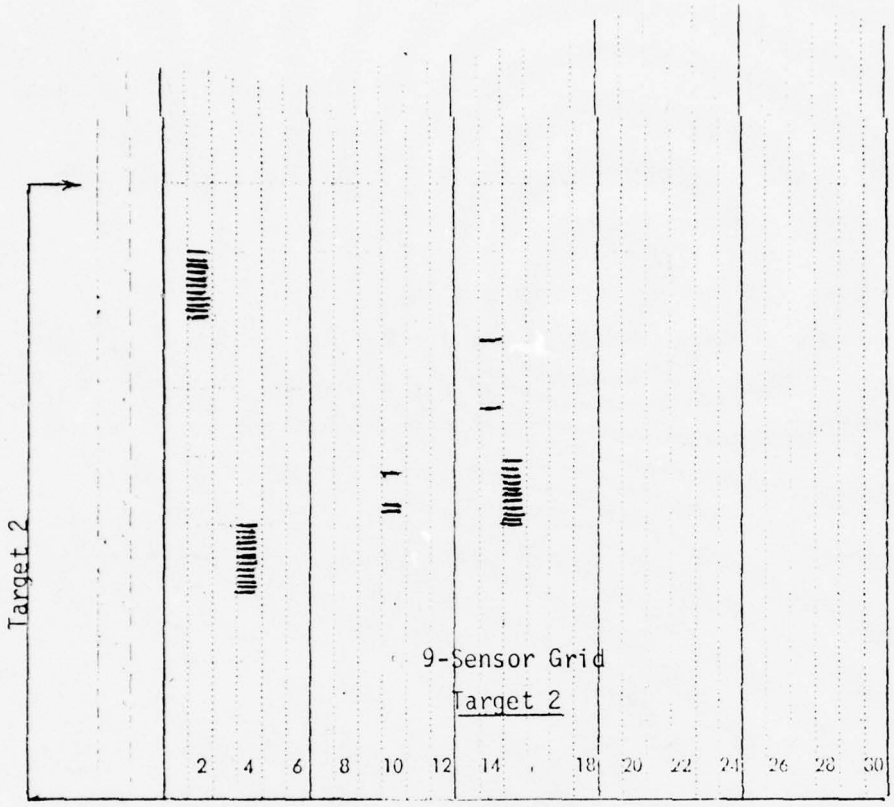
The bottom half of Figure 1 shows blank spaces and a six step procedure which you will use to report on targets.

YOUR JOB DURING THIS EXERCISE WILL BE TO FIND TARGETS ON X-T PAPER AND FOR EACH ONE THAT YOU FIND, FILL IN THE BLANKS FOR THE SIX STEPS.



STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
TARGET NUMBER	DISTANCE (METERS)	CONFIDENCE 25%,50% 75%,100%	DIRECTION (DEGREES)	MID-POINT TIME (min) DIFFERENCE	SPEED (m/min)
1	1050	50%	185°	8	$\frac{1050}{8}=131$

Figure 1. Nine-sensor target log.



Sensor	
Pen	ID
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23

FIGURE 3

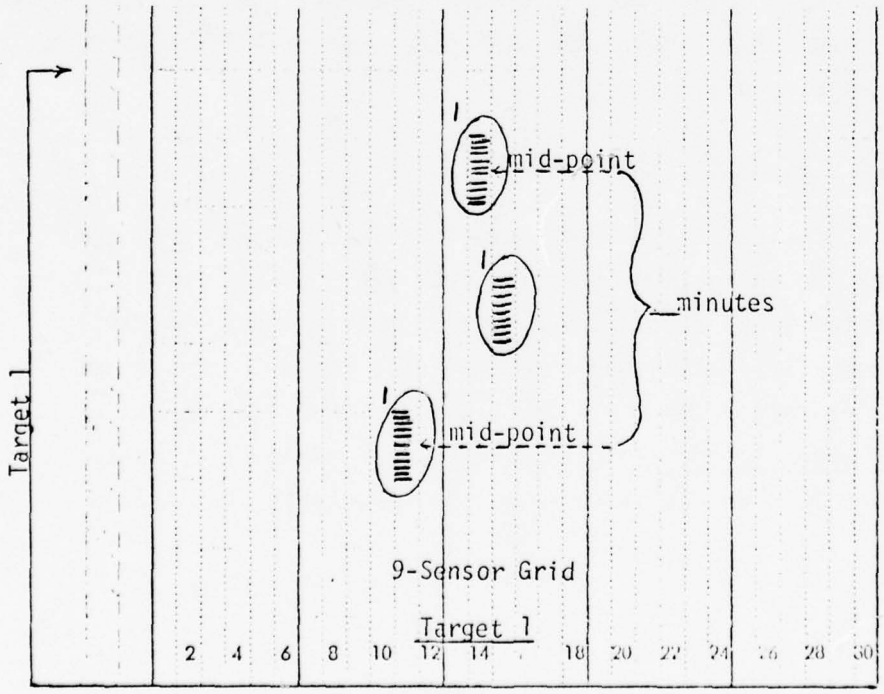


FIGURE 2

You will be working with X-T chart paper and targets similar to that shown in Figure 2. Study target 1 and target 2 of Figure 2. Notice the pen/ID chart at the side showing that the X-T pen numbers correspond to the same sensor grid numbers.

At this time we will define what we mean by the word "target". A target is any vehicle or personnel activity in the field which is distinguishable from other personnel or vehicle activity. For example, three tanks 50 meters apart traveling in a convoy formation would be one target as would a tank traveling alone. These two targets may enter different sections of the grid simultaneously or at different times. Because their activation patterns can be separated from one another, they are classified as separate targets.

Step 1 on the Target Log - TARGET NUMBER

In Figure 2 you will notice that the target activations are circled and numbered. This is exactly what we want you to do when you detect a target. Circle all the target's activations and number them with the number of that target. Since this is the first target, the activations caused by this target are labeled target 1 and a number 1 is recorded in Step 1 of the Target Log as shown.

Step 2 on the Target Log - DISTANCE (Meters)

Study the characteristics of the sensor activations and draw the probable path of the target through the sensor field on the Target Log grid. Estimate the total distance (in meters) that the target traveled through the sensor field using the distance scale shown. Estimate the distance to the nearest 50 meters - for example, 200 or 250 meters. In the case of Target 1, the path has already been drawn. The estimated distance is about 1050 meters and this has been recorded in the Step 2 blanks.

Step 3 on the Target Log - CONFIDENCE

This step seeks to answer the question, "How confident are you that what you think is a target really is a target?" Record your confidence using the following four-point scale:

100% - This means you are positive or certain.
75% - This means you are highly confident, but not positive.
50% - This means that you think it probably is a target, but you are uncertain - it may or may not be a target.
25% - This means that you have only a suspicion, but it should be recorded and checked out. You have low confidence that this is a target.

A 50% confidence has already been placed in this column on the Target Log.

Step 4 on the Target Log - DIRECTION (Degrees)

For this step, record the direction in which the target is heading after it leaves the grid area. The direction will be reported in degrees. A protractor is provided for this purpose. Assume that the grid is oriented exactly along east-west and north-south lines. The row lines connecting the sensors, therefore, are oriented in an east-west direction.

To determine target direction, lay the protractor on the target path, line up the east-west and north-south lines, and read the targets' direction in degrees from zero. As you can see, the direction has already been determined and recorded in the Step 4 blank. That direction is (fill in the blank) _____.

Step 5 on the Target Log - MID-POINT TIME (min) DIFFERENCE

On the X-T plot, find the mid-point of the activation patterns for the first and last sensors. As shown, the first sensor is 11 and the

last is 14, which is the same as pens 11 and 14 on the X-T plot. Check this yourself by looking at the pen/ID chart on the right-hand side of Figure 3. Now determine the time difference between the two mid-points. This is done directly off the X-T chart paper as shown in Figure 3. Remember, there are 2-minutes between lines (rows) on the X-T chart paper. Estimate this time to the nearest half minute, for example, 3 or 3.5 minutes. For target 1 the mid-point time difference is _____ minutes. Check your answer. If you missed it, reread this section and/or see the Training Monitor.

Step 6 on the Target Log - ESTIMATED SPEED

Having an estimate of the time that a target traveled through the sensor field and the distance that was traveled will permit you to get an estimate of the speed of the target. Only an estimate is possible, however, since you will not know for sure how close the target traveled to any of the sensors. It is possible to obtain a more accurate estimate of speed when the sensors are deployed along a road because the target is normally traveling on the road and the distance between the sensor and the road is known.

An estimate of speed can be obtained by using the speed table provided for this purpose. The speed table (Table 1) is enclosed in plastic and will remain at your desk. To use the speed table, find the time column (using the answer from Step 5) along the top. Line this up with the distance row (using the answer from Step 2) along the left-hand side. The place where the column and row converge gives you the speed. In the case of target 1 the speed is _____ meters per minute. Check your answer with the one already provided in the Target Log. If you missed it, reread the instructions and/or see the Training Monitor.

Now you will receive practice on what you have just learned concerning the SIX STEP target reporting procedure. Study target 2 presented on the X-T plot in Figure 3. The sensor ID and pen number combinations are the same as those for Figure 2.

When you are finished, take your booklet to the Training Monitor. If you feel you need to review the test procedure before working the practice targets, do so! If you have any questions, ask the Training Monitor.

SPEED TABLE

DISTANCE IN METERS	TIME IN MINUTES																					
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	11	12	13
500	500	333	250	200	167	143	125	111	100	91	83	77	71	67	62	59	56	53	50	45	42	38
550	550	367	275	220	183	157	138	122	110	100	92	85	79	73	69	65	61	58	55	50	46	42
600	600	400	300	240	200	171	150	133	120	109	100	93	86	80	75	71	67	63	60	55	50	46
650	650	433	325	260	217	186	163	144	130	118	108	100	93	87	81	76	72	68	65	59	54	50
700	700	467	350	280	233	200	175	156	140	127	117	108	100	93	87	82	78	74	70	64	58	54
750	750	500	375	300	250	214	188	167	150	136	125	115	107	100	94	88	83	79	75	68	63	58
800	800	533	400	320	267	229	200	178	160	145	133	123	114	107	100	94	89	84	80	73	67	62
850	850	567	425	340	283	243	213	189	170	155	142	131	121	113	106	100	94	89	85	77	71	65
900	900	600	450	360	300	257	225	200	180	164	150	138	129	120	112	106	100	95	90	82	75	69
950	950	633	475	380	317	271	228	211	190	173	158	146	138	127	119	112	106	100	95	86	79	73
1000	1000	667	500	400	333	286	250	222	200	182	167	154	143	133	125	118	111	105	100	91	83	77
1050	1050	700	525	420	350	300	263	233	210	191	175	162	150	140	131	124	117	111	105	95	88	81
1100	1100	733	550	440	367	314	275	244	220	200	183	169	157	147	137	129	122	116	110	100	92	85
1150	1150	767	575	460	383	329	288	256	230	209	192	177	164	153	144	135	128	121	115	105	96	88
1200	1200	800	600	480	400	343	300	267	240	218	200	185	171	160	150	141	133	126	120	109	100	92
1250	1250	833	625	500	417	357	313	278	250	227	208	192	179	167	156	147	139	132	125	114	104	96
1300	1300	867	650	520	433	371	325	289	260	236	217	200	186	173	162	153	144	137	130	118	108	100
1350	1350	900	675	540	450	386	328	300	270	245	225	208	193	180	169	159	150	142	135	123	113	104
1400	1400	933	700	560	467	400	350	311	280	255	233	215	200	187	175	165	156	147	140	127	117	108
1450	1450	967	725	580	483	414	363	322	290	264	242	223	207	193	181	171	161	153	145	132	121	112
1500	1500	1000	750	600	500	429	375	333	300	273	250	231	214	200	187	176	167	158	150	136	125	115
1550	1550	1033	775	620	517	443	388	344	310	282	258	238	221	207	194	182	172	163	155	141	129	119
1600	1600	1066	800	640	533	457	400	356	320	291	267	246	229	213	200	188	178	168	160	145	133	123
1650	1650	1100	825	660	550	471	413	367	330	300	275	254	236	220	206	194	183	174	165	150	138	127
1700	1700	1133	850	680	567	486	425	378	340	309	283	262	243	227	212	200	189	179	170	155	142	131
1750	1750	1166	875	700	583	500	428	389	350	318	292	269	250	233	219	206	194	184	175	159	146	135
1800	1800	1200	900	720	600	514	450	400	360	327	300	277	257	240	225	212	200	189	180	164	150	138
1850	1850	1233	925	740	617	529	463	411	370	336	308	285	264	247	231	218	206	195	185	168	154	142
1900	1900	1267	950	760	633	543	475	422	380	345	317	292	271	253	237	224	211	200	190	173	158	146
1950	1950	1300	975	780	650	557	488	433	390	355	325	300	279	260	244	229	217	205	195	177	163	150
2000	2000	1333	1000	800	667	581	500	444	400	364	333	308	286	267	250	235	222	211	200	182	167	154
2100	2100	1400	1050	840	700	600	525	467	420	382	350	323	300	280	262	247	233	221	210	191	175	162
2200	2200	1467	1100	880	733	629	550	489	440	400	367	338	314	293	275	259	244	232	220	200	183	169
2300	2300	1533	1150	920	767	657	575	511	460	418	383	354	329	307	287	271	256	242	230	209	192	177
2400	2400	1600	1200	960	800	685	600	533	480	436	400	369	343	320	300	282	267	253	240	218	200	185
2500	2500	1666	1250	1000	833	714	625	556	500	455	417	385	357	333	312	294	278	263	250	227	208	192

APPENDIX D

THE GRID DEPLOYMENT OF SEISMIC SENSORS USING ROW PATCHING

OBJECTIVE

To familiarize you with how the row patching technique is used with a grid deployment pattern and to train you on how to use it to detect and report on targets using the six-step procedure. Part I of this workbook deals with training and Part II deals with practice in target reporting.

PART I - TRAINING

WHAT IS THE ROW PATCHING TECHNIQUE?

The row patching technique is defined as patching the sensors which have been deployed in a symmetrical grid pattern into horizontal rows on the X-T plot. Look at the next page of this workbook. The top half of Figure A presents a symmetrical 9-sensor grid which shows the sensors grouped into three horizontal rows: Row I, Row II, and Row III. All the sensors are seismic and are set at the same medium gain setting. The bottom half of Figure A contains the six-step reporting procedure that you are already familiar with. Notice that the sensor numbers are shown. At this time pull Figure A out of this booklet, write your name in the upper right-hand corner and place it on your desk where it is clearly visible.

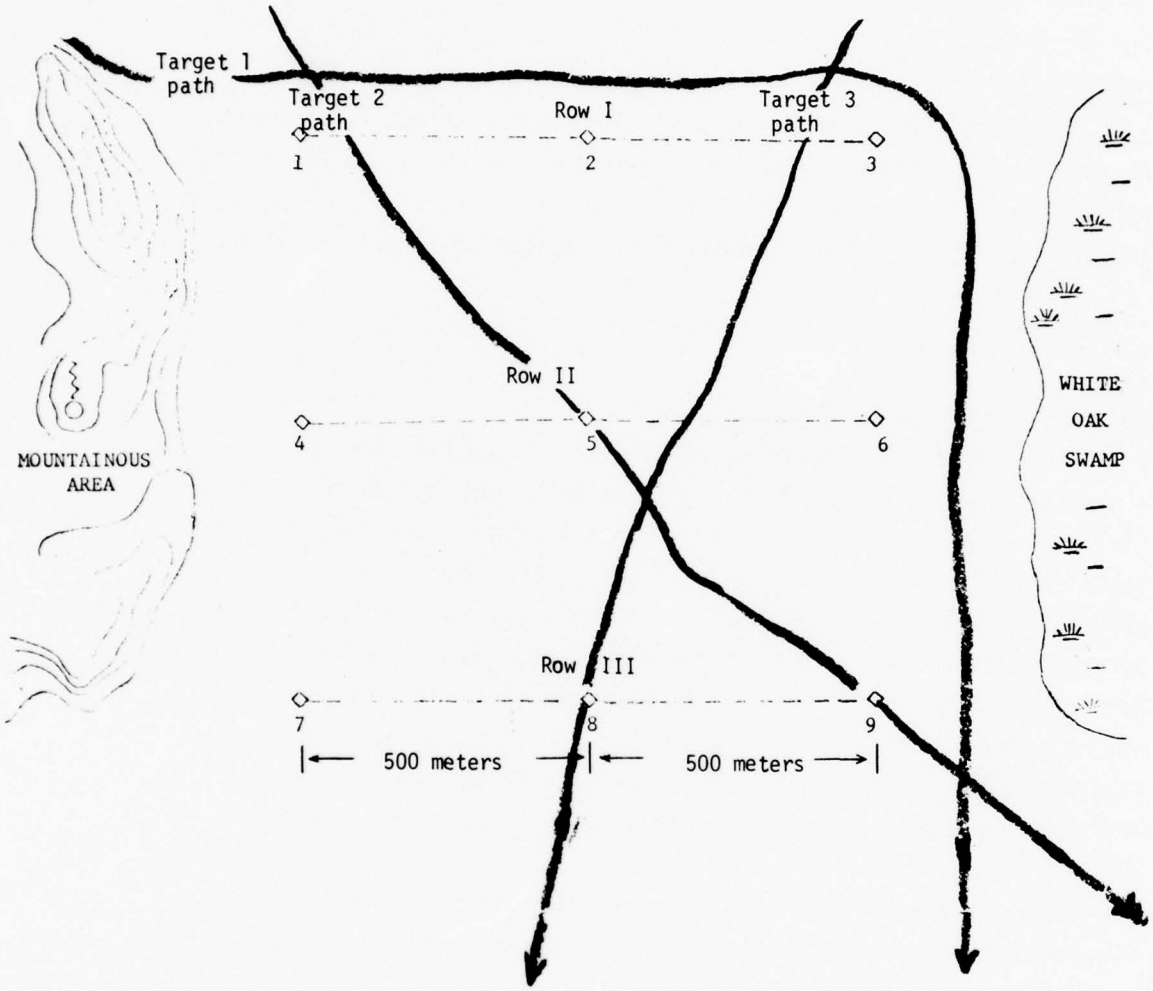
Examine the 9-sensor grid of Figure A more closely. Study again which sensors have been assigned to the various rows. Fill in the following blanks as you come to them.

Row I is composed of sensors 1, 2, and 3.
Row II is composed of sensors 4, ___, and 6.
Row III is composed of sensors ___, ___, and ___.

HOW DO YOU DETECT TARGETS?

Any target that enters this grid will have to pass <u>through</u> or <u>around</u> one or more of these rows. What this means to you is that you will be able to detect and report on targets by observing what activation activity

OPERATOR_____



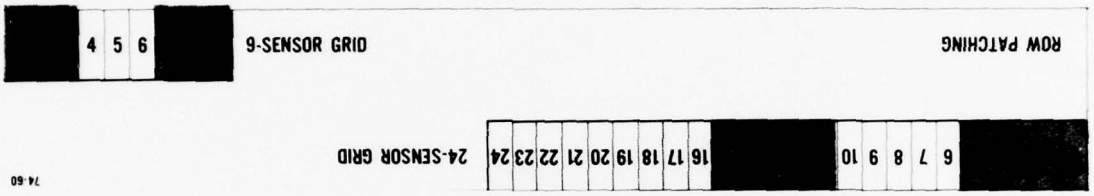
STEP 1 TARGET NUMBER	STEP 2 DISTANCE (METERS)	STEP 3 CONFIDENCE 25%,50% 75%,100%	STEP 4 DIRECTION (DEGREES)	STEP 5 MID-POINT TIME (min) DIFFERENCE	STEP 6 SPEED (m/min)
1	2100	50%	180°	10	$\frac{2100}{10}$ =210
2	1450	50%	130°	8	$\frac{1450}{8}$ =181
3	1050	50%	191°	7	$\frac{1050}{7}$ =150

Figure A. Target Log.

is taking place in each row. In other words, any target entering or leaving the grid area will have to activate one or more sensors in one or more rows.

Now look at the X-T plot in Figure B. The sensors that you have just studied in the grid are each patched to a pen of the same number on this X-T plot (one-for-one). Pen 1 on the X-T plot, therefore, refers to sensor 1 on the grid, etc. Throughout this lesson the terms "sensor" and "pen" will be used interchangeably.

Find your job aid (UGS Ruler). One side of the ruler has a 24-pen (sensor grid) scale and a 9-pen (sensor grid) scale as shown below.



For this exercise you will be concerned only with the 9-pen scale. You will notice that your 9-pen scale is broken down into three (3) colors. Each of these colors represents a row of sensors within a 9-sensor grid.

BY PLACING THIS SCALE ON THE X-T PLOT YOU WILL BE ABLE TO QUICKLY DETERMINE WHICH SENSORS IN EACH ROW HAVE ACTIVATED.

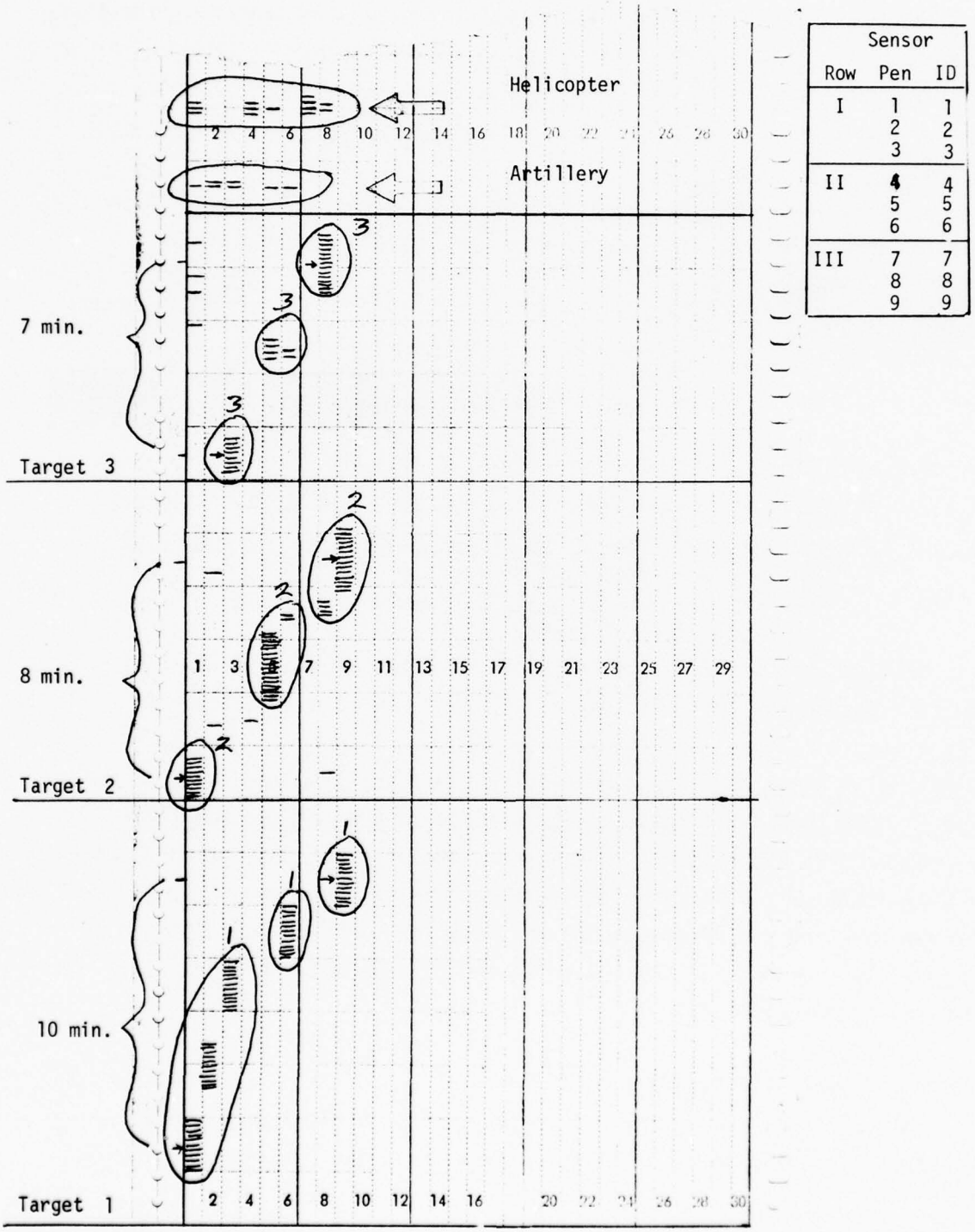
Now lay this scale on the X-T plot and line it up properly. Notice how quickly you can tell which sensor in each row is activating. In many situations, this job aid may help you to: 1) detect a target, 2) determine where the target entered and left the grid area and, 3) determine if more than one target is within the grid area at the same time.

Go back to Figure A. Figure A shows the paths of three targets which we will analyze. As you can see these targets passed through or around various rows and activated sensors in these rows. Place your job aid on the X-T plot for each of these targets and briefly note which pens of each row have activated.

a. Example 1 - Target 1

For target 1, the pattern of activations provides good examples of interpretation principles. All three sensors in Row I have activated in

FIGURE B: X-T Plot for Row Patching
Using 9-Sensor Grid
(Learning Targets)



Row	Sensor Pen	Sensor ID
I	1	1
	2	2
	3	3
II	4	4
	5	5
	6	6
III	7	7
	8	8
	9	9

a noticeable stairstep pattern. This indicates that the target traveled somewhere along Row I itself as though the sensors were deployed along a road as in a trail/road monitoring situation. In this case the target was traveling perpendicular to what we consider the primary watch direction of the grid. Because sensor 5 (the internal sensor) did not activate, you should be able to conclude that the target probably did not penetrate the grid, but merely traveled along the top as shown in the target 1 path of Figure A. The last two sensors to activate (sensors 6 and 9) are the last sensors on the right-hand side of Rows II and III respectively. Again, since only outer sensors activated, you would probably be right in concluding that the target did not penetrate the inside of the grid. Also, because of the regular stairstep pattern formed by sensors 1, 2, and 3, it can be concluded that the target passed these sensors one right after the other at a relatively constant speed.

It is important also to note that each sensor activated for about the same period of time (2 minutes). This indicates that the target had entered the detection range of each sensor for about the same period of time. Of more importance, this condition implies that the target traveled the same distance away from each sensor. If the activation lengths had differed, this would imply that the target traveled closest to the sensor with the longest activation pattern. We can say this because gain setting, which is important in determining detection range, is in the medium range for all the sensors. Keep in mind, however, that other factors can also influence detection range such as the seismic response characteristics of the ground, the environmental/weather factors, and the condition of the equipment.

Review Period - Take a few minutes now and study target 1 and the row patching technique. Start with the X-T plot and retrace the path of target 1 on the grid and try to visualize the relationships that we have just discussed.

b. Example 2 - Target 2

Turn your attention now to target 2. First look at the X-T plot, then the grid. The activations are in which row(s)? _____ Sensor 1 of

Row I shows the first activations. The sensor which shows the first activations will usually tell you the closest point in the grid where a target first made contact with the grid by entering or going around the grid. The word usually is used here because in the field another sensor may activate first even though it is further away from the target because of detection range differences. Next, sensor 5 of Row II activated and was followed by sensor 9 of Row III. This indicates that the target moved out of Row II and into Row III.

YOU MUST USE JUDGMENT IN TRACING A TARGETS' PATH AND BE ABLE TO USE CLUES FROM THE LENGTH OF ACTIVATIONS.

It is important to understand the concept of solitary targets versus a cluster of targets traveling through the grid. Try the following exercise while still looking at the X-T plot. Imagine that target 1 and target 2 are starting at the same time and progressing through the grid at the same time. In your mind, superimpose target 2 onto target 1 so that the PEN 1 ACTIVATIONS OVERLAP. Now, actually fill in the remaining activations of target 2 with your pencil or pen. Be careful as you fill in the activations to reproduce the same time relationships of target 2.

Now look at the combined activations of both targets carefully. If you had just now seen these activations for the first time would you be able to tell that two targets were involved? Would you have been able to separate the one long activation pattern on pen 9 into two targets? Remember, several targets can travel through the grid at the same time or close to the same time especially during a battle situation. If an intruder tried this tactic do you think that you would be able to distinguish and report on the separate targets?

Review Period - Take a few minutes and study the combined activation patterns in relation to the paths of these separate targets on the grid.

c. Example 3 - Target 3

Look at target 3 on the X-T plot. Line up your UGS ruler on the X-T plot directly under target 3. Using your UGS ruler to help you

with your answer, which pens have activated? _____. It is easy to see that sensors in all three rows have activated. Again it would be safe to assume that <u>the target probably passed through the entire grid</u>.

Notice the differences in the lengths of the various activation patterns on the X-T plot. Generally, you can use this as a guide in giving you an idea as to how close the target came to the various sensors. Compare the lengths of the activations on pens 3 and 8. The activation length on pen 8 is about one minute longer than the one on pen 3. Since the gain setting of all the sensors is the same,

YOU CAN SAFELY CONCLUDE THAT THE TARGET PASSED CLOSER TO THE SENSOR WITH THE LONGEST ACTIVATION PATTERN.

In the example discussed, the target probably passed closer to sensor _____ than it did to sensor 3. Look at the target path in Figure A and check where the target did pass.

Sensors 5 and 6 activated and it would be a reasonable assumption that they are valid activations associated with target 3. Do you think you can conclude the same about the four activations on pen 1? Probably not. Chances are the activations on pen 1 are unrelated to target 3 and probably do not even involve a target. Sensor 1 may be starting to mal-function and if it becomes a "talker" it will run down its power supply.

Look at the X-T plot and answer the following question for the pairs of sensors listed below. The target passed closer to which sensor?

Target 3: Sensor 5 or Sensor 6? _____

Target 3: Sensor 3 or sensor 5? _____

Now superimpose target 2 which you studied previously <u>onto</u> target 3 so that they start in the same time frame. With your pencil or pen, fill in the target 2 activations in the same manner that you did previously with target 1. This will take you several minutes to do as before. Now look at the combined activations carefully. If you had just now seen these activations for the first time, would you be able to tell that <u>two</u>

targets were involved? Lay your job aid on the X-T plot. Does the job aid help you in distinguishing these targets?

Review Period - Take a few minutes and study the combined activation patterns in relation to the paths of these separate targets as shown on the grid.

d. Example 5 - Artillery and Helicopter Activity

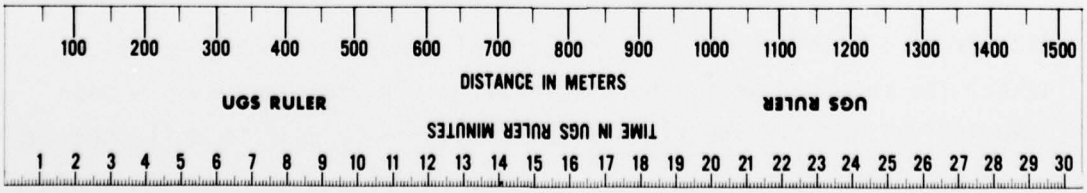
Look in the upper portion of the X-T plot and you will see a typical activation pattern for artillery and helicopter activity. Could you have recognized them if they had not been annotated? An artillery shellburst usually shows as a thin band of one or two activations per sensor with the activations occuring at the same time. Helicopter activity is different in that there are groupings of two or more activations per sensor occuring at the same time. There are more activations because the helicopter is in the area longer and therefore the disturbance created by the helicopter has an effect on the sensors for a longer period of time.

For this exercise circle and annotate on your X-T plot but do not report artillery or helicopter activity as targets. It is important for you to know what it looks like on an X-T plot so you do not report this activity as targets. Study the examples shown.

HOW DO YOU ESTIMATE DISTANCE?

Once you have detected a target on the X-T plot, numbered it, and drawn what you think is the path of the target on the grid, you must estimate the distance of that path. This, of course, is step ____ of the six-step procedure that you learned previously.

For this task you will find it helpful to use the other side of the UGS ruler. Take your UGS ruler and look for the scale which is labeled "Distance in Meters" as shown below.



To use this scale, place it along a target path that you have drawn on a grid and measure the length of the path to the nearest 50 meters. Remember that the path of an actual target traveling across country will never be a straight line because of turns in the horizontal direction to avoid obstacles and inclines (hills) in the vertical direction.

BECAUSE OF HILLS AND OBSTACLE AVOIDANCE, ALWAYS OVER-ESTIMATE THE DISTANCE IN METERS THAT YOU GET FROM THE UGS RULER.

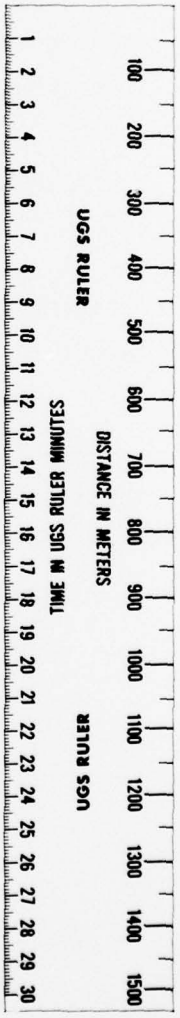
Using your UGS ruler, measure the target paths drawn in Figure A and check your estimate with the answers already provided. If your answers differ from the given answers by over 100 meters, consult the Training Monitor.

HOW DO YOU DETERMINE THE MID-POINT TIME DIFFERENCE?

As you learned previously, an estimate of target speed can be made only by knowing the: 1) distance that the target traveled through or around the grid and 2) the amount of time that the target spent in the grid. Step 3 asks for your _____ as to whether you feel you in fact have detected a real target. Step 4 requires you to record the direction in which the target is heading by reading the angle from your protractor. See if you can get the same directions as in Figure A.

Step 5 requires you to find and mark (on the X-T plot) the mid-points of the activation patterns of the first and last sensors which activated and record the time difference. All considered, the time difference between these two mid-points probably gives you the best estimate of how long the target was in the grid then any other method. Any easy way to estimate this midpoint time difference is to use a scale.

Check the scale on your UGS ruler which is labeled "Time in UGS Ruler Minutes". An example is shown on the right. The scale extends from 0 to 30 minutes and should be adequate for measuring most activation patterns that you will be working with. To use this scale simply measure



the distance between the two midpoints as though it were a ruler and you were measuring inches. Read the time to the nearest ½ minute. This answer would be recorded in the Step _____ blank.

Take a few minutes now and check the midpoints of the first and last sensors of targets 1, 2, and 3 on the X-T plot. Measure the midpoint time differences with your UGS ruler and see how close you come to the school solutions provided in Figure A. You may feel that using the UGS ruler for this measurement is not needed because the answers can be sight-read, but remember that these learning targets were intentionally simplified for training purposes and field-collected targets will be more difficult. Also, you will make fewer mistakes if you use the ruler. In the event that your answers differ by over ½ minute from the given answers, consult the Training Monitor. If your answers differ by over _____ minutes from the given answers consult the Training Monitor.

HOW DO YOU CALCULATE SPEED?

Step 6 requires an estimated average speed concerning the type of target whether vehicle or personnel. In order to save time and avoid arithmetic errors, you should use the Speed Table which you have already been taught to use.

MONITOR CHECK

Before you begin Part II below take your materials to the monitor and take a short break.

PART II - PRACTICE TARGETS

Figure C presents an X-T plot of operationally collected targets for you to practice on using the patching technique and principles that you have just learned. After you are finished reading this booklet, study this X-T plot for targets starting at the bottom and working upwards in the order you would see them on a field recorder. For each target that you detect report on it in Figure D.

Figure D presents a blank 9-sensor grid Target Log. Pull it out of your booklet, write your name in the upper right-hand corner and place it in a handy area. Take your other Target Log (Figure A), fold it in half and place it under your papers where it will not get in the way. As you report on each target, remember to circle all the activations associated with that target by row, number all your circles, and fill in the six -step procedure in the Figure D Target Log.

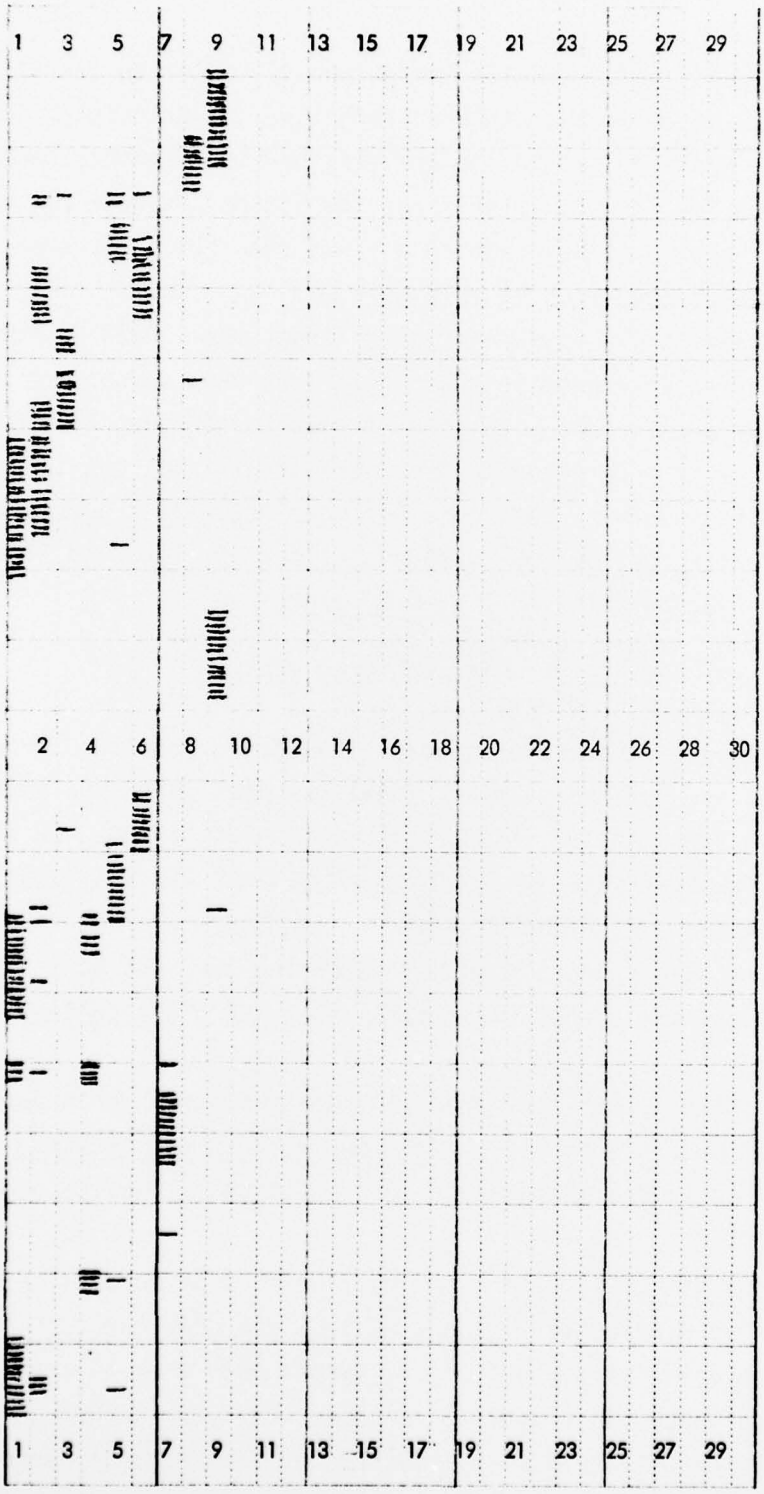
USE ALL THREE FUNCTIONS OF YOUR UGS RULER:
SENSOR ROW GROUPS, DISTANCE MEASUREMENT,
AND TIME MEASUREMENT.

As you work through these operationally-collected practice targets, remember that they are not the sterile, ideal examples which you have just worked with. THE PRACTICE TARGETS CONTAIN VARIOUS SOURCES OF BACKGROUND NOISE AND THE EFFECTS OF MALFUNCTIONING SENSORS AND VARIATIONS IN SENSOR DETECTION RANGE DUE TO GROUND/TERRAIN CONDITIONS AND WEATHER. To be able to do a good UGS reporting job, you must learn how to detect and extract target information from X-T plots collected in the field.

Consult the Training Monitor when you feel the need. When you are finished with your practice targets, take your work to the Training Monitor. He will determine whether you need additional practice and/or review.

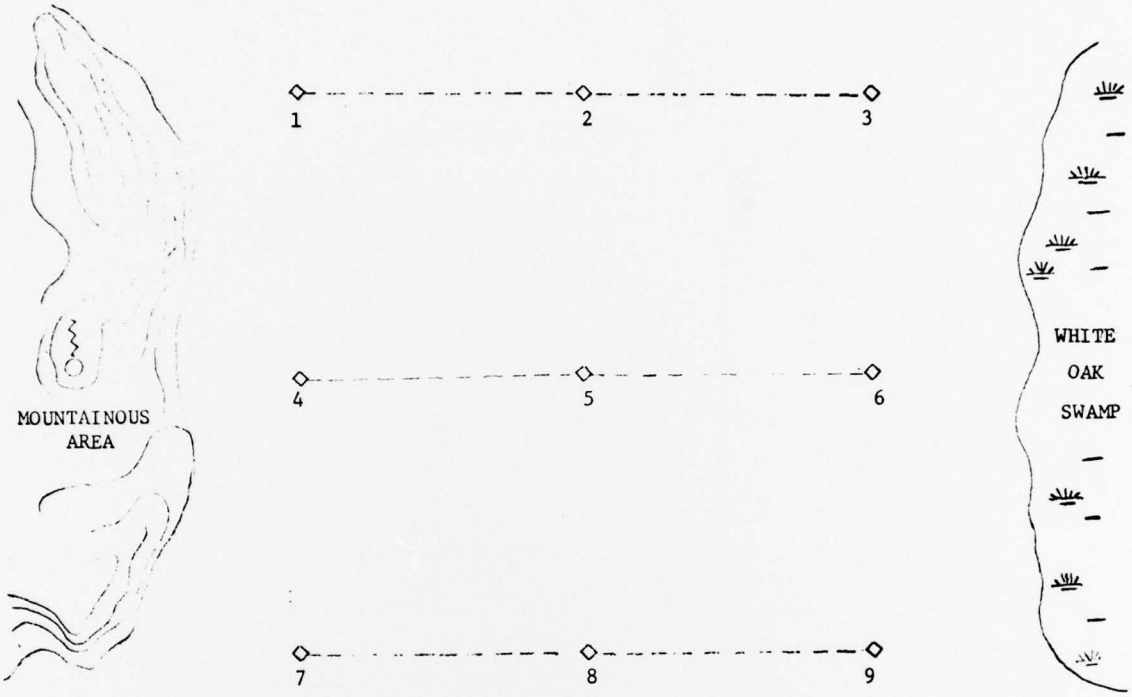
There is one additional point which must be made because it is an important part of your response. Each time that you draw the path of a target through the grid, at the end of the target path draw an arrow in the direction that the target is traveling. Assume that your target direction and speed information will be used by your CO for fire control purposes.

Figure C: X-T Plot for Row Patching
Using the 9-Sensor Grid (Practice Targets)



OPERATOR_____

FIGURE D
Target Log
(Practice Targets)



STEP 1 TARGET NUMBER	STEP 2 DISTANCE (METERS)	STEP 3 CONFIDENCE 25%,50% 75%,100%	STEP 4 DIRECTION (DEGREES)	STEP 5 MID-POINT TIME (min) DIFFERENCE	STEP 6 SPEED (m/min)

Figure E: X-T Plot for Row Patching
Using the 9-Sensor Grid (School Solution)

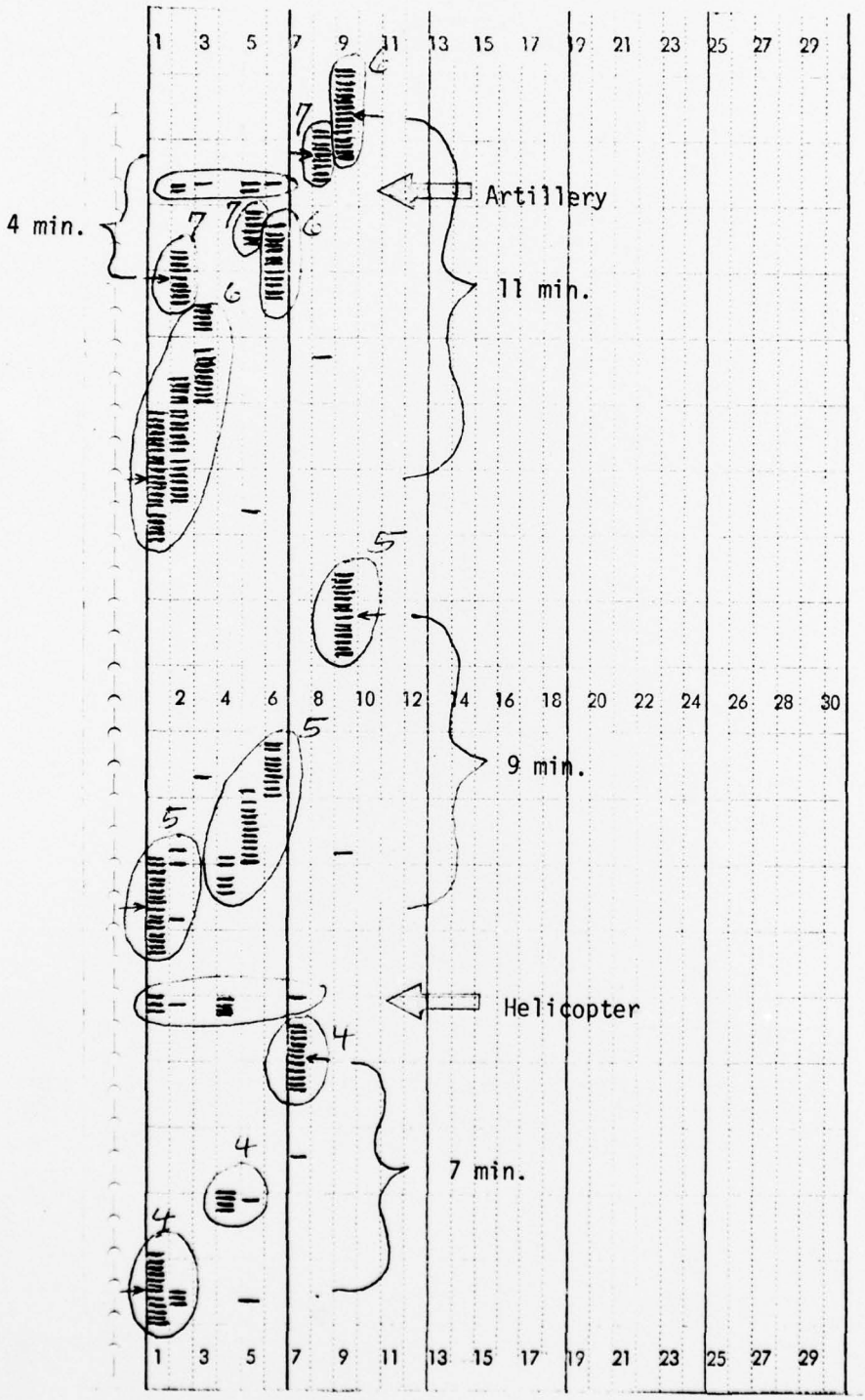
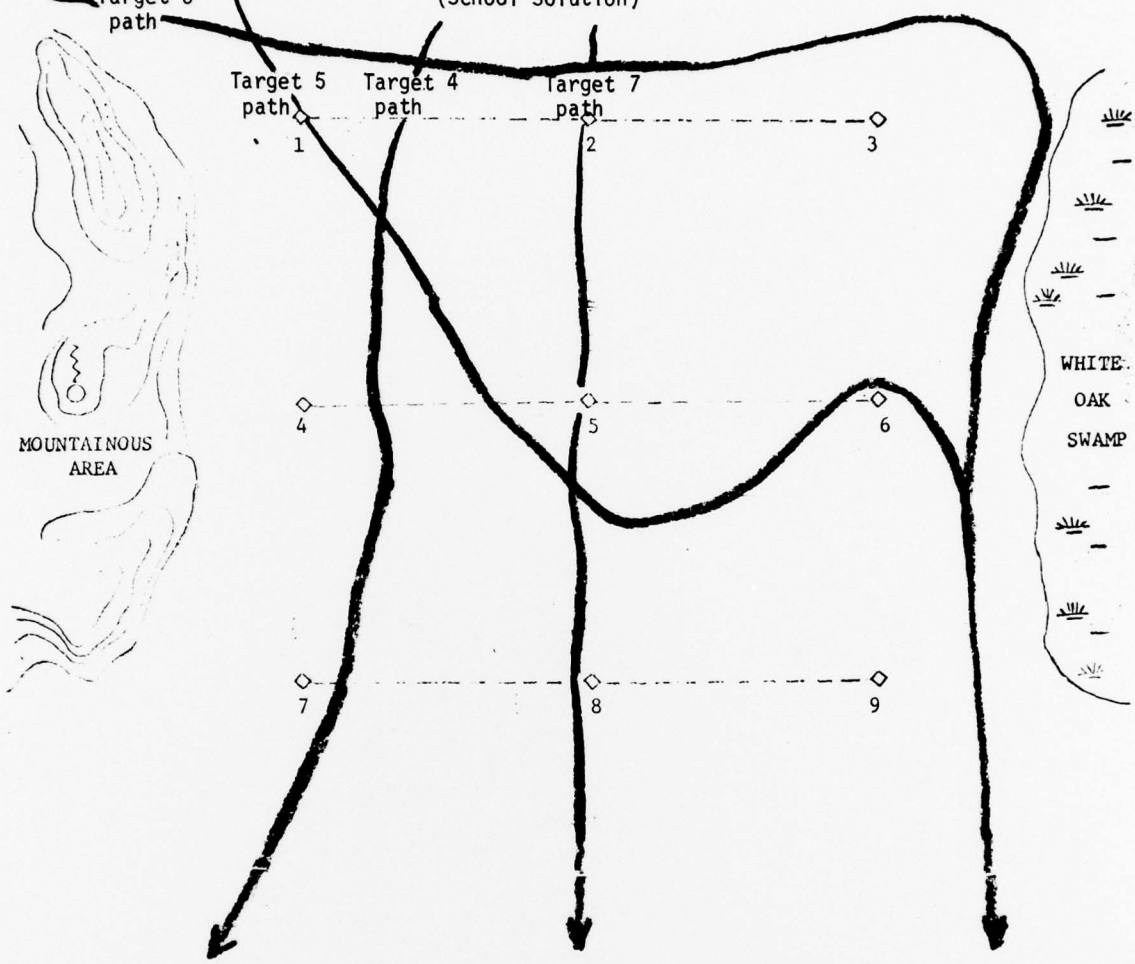


FIGURE F
Target Log
(School Solution)

OPERATOR _____



STEP 1 TARGET NUMBER	STEP 2 DISTANCE (METERS)	STEP 3 CONFIDENCE 25%,50% 75%,100%	STEP 4 DIRECTION (DEGREES)	STEP 5 MID-POINT TIME (min) DIFFERENCE	STEP 6 SPEED (m/min)
4	1150	50%	205°	7	164
5	1900	50%	177°	9	211
6	2200	50%	177°	11	200
7	1050	50%	180°	4	263

APPENDIX E

PART IV MULTI-DISPLAY PROCEDURE TRAINING (LECTURE/DISCUSSION)

Monitor: Paraphrase the following:

You will be monitoring one 30-pen and two 30-pen displays.

To familiarize you with the procedures needed to monitor one 30-pen and two 30-pen displays using the six-step reporting procedure. Each person will have an opportunity to interpret two targets at each display condition. Each 30-pen display contains three 9-sensor grids. The following diagram clarifies the grid arrangement.

Monitor: Draw this picture on the blackboard and paraphrase the following.

	Display A			Display B			Display C		
Grid	I	II	III	I	II	III	I	II	III
Pens	1-9	11-19	21-29	1-9	11-19	21-29	1-9	11-19	21-29

As you can see in the diagram there are three 9-sensor grids in each display. For each display:

Grid 1 is composed of sensors 1-9 and uses the green Target Log.

Grid 2 is composed of sensors 11-19 and uses the yellow Target Log.

Grid 3 is composed of sensors 21-29 and uses the blue Target Log.

Take the target logs located on your desk and study them in relation to the three grids. Notice how the grids are geographically related to each other.

When you detect a target you will report on it using the six-step procedure that you have already learned. However, there is one important exception.

For each target that you report, you must include a display letter (A, B, or C). At this time, check to see which display or displays you are working with. For each target that you report, always include the display letter in which the target is located.

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The place to report the display letter is with the target number in Step 1. Suppose the fifth target that you have detected is located in Display A, Grid 2. In Step 1 with the Target Number heading on the blue Target Log, you would write A-5. Suppose that the tenth target that you detect falls in Display B, Grid 1. For this example, in Step 1 under the Target Number heading of the (green/yellow/blue) Target Log you would write B-1.

Monitor: Go through several more examples to be sure everyone understands. Paraphrase the following:

Find your job aid (UGS ruler). Turn to the side that has the 9-pen scale. You will be able to use this ruler effectively if you desire. The ruler, as you have already learned, is divided into three sections. Each section is a different color and represents a different row of sensors. This ruler can be used for each of the three grids that you will be working with in each display as shown.

1	2	3	4	5	6	7	8	9	Grid I
11	12	13	14	15	16	17	18	19	Grid II
21	22	23	24	25	26	27	28	29	Grid III

Of course, when you are working with Grid I, you will be working with sensor 1-9. When you are working with Grid II, simply add 10 to each sensor number and use the ruler as you have learned. When you are working with Grid III simply add 20 to each sensor number and use the ruler as you have learned.

Monitor: Be sure that practice targets are in positon on all of the displays for a practice session. Paraphrase the following:

You will now be given practice scenarios to work with. Detect and report on two targets using the procedure that you have learned. After you have completed reporting on these practice targets, take your target log sheet or sheets to the training monitor. He will check you work and determine if you need more practice targets.

After you have completed the practice targets you will be rotated to a different display condition and you will report on two more targets. Since under some display conditions you will be monitoring more grids and sensors there is a good chance that you will be detecting and reporting on more targets. As you work through the practice targets, think about how you would successfully handle heavy target activity situations. In

these situations, your time would be at a premium and you must know your procedures well. For example, if you have detected three targets simultaneously you would want to share your time evenly with all three rather than with just one of them. Time/task sharing is therefore important.

Monitor: Begin the practice phase to complete the first cycle of display training and practice . Rotate the students and complete cycle 2 in the same manner.

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