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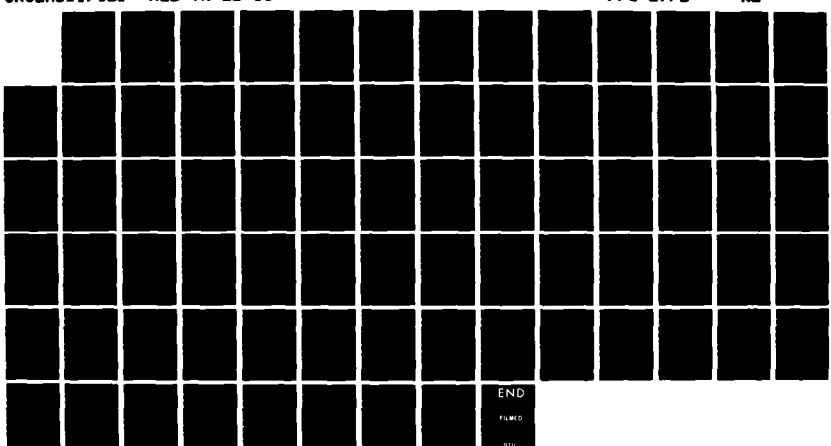

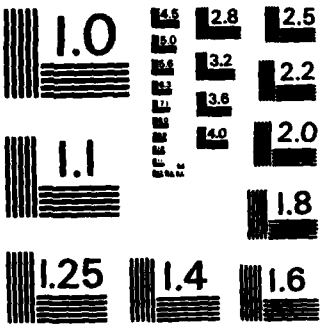

Technical Memorandum 12-85

COMMAND AND CONTROL (C^2) SURVEY OF SHORT-RANGE AIR DEFENSE (SHORAD) ELEMENTS

Jon J. Fallesen

July 1985
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Three versions of a short-range air defense command and control (SHORAD) C^2) questionnaire were developed based on issues identified in the system specification (MIS 34585) (ADCCS, 1985), the human factors engineering statement (HFES) (Kurtz, 1985), and internal working papers on the proposed research. A survey was conducted with SHORAD platoons from the 1st Cavalry Division and the 2nd Armored Division taking part. The participants were surveyed about their experience and preferences for information requirements and for display design formats for the developmental SHORAD C^2

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system and voice-tell message formats for the manual system. Vulcan, Redeye, and Chaparral platoons from each division completed a fire unit version of the questionnaire. Two forward area alerting radar (FAAR) platoons, one from each division, completed a FAAR version and personnel from the air defense artillery (ADA) battalion (Bn) tactical operations center (TOC) completed a Bn version.

The results of the survey are summarized in this report. The survey provided valuable information on the human factors of information requirements, device design, and voice-tell message formats, and provided general comments on air defense. The difficulties of eliciting comments on technological advances from the user population are discussed. The report cautions that the findings are best suited for narrowing the number of human factors issues that need to be examined by objective testing of simulated or actual equipment. Those issues likely to have a high payoff for further examination are: display orientation, alerting range and format, reduction of display clutter, correlation of the displayed scene to the visual one, event-based information requirements, and the ability to operate the device effectively. In addition to helping focus the needs of the research on the system development, the survey results also provide a baseline for testing the soldier-machine interface of the proposed equipment.

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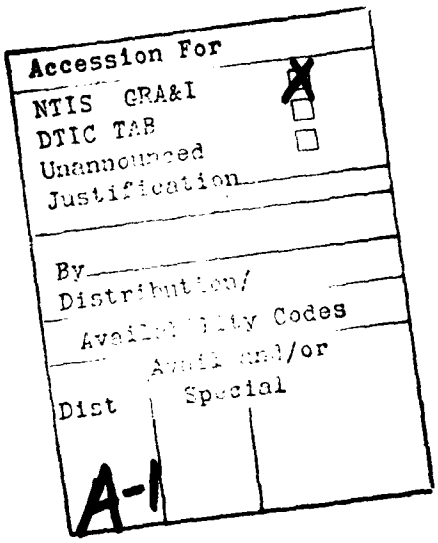

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July 1985

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COMMAND AND CONTROL (C^2) SURVEY OF SHORT-RANGE AIR DEFENSE (SHORAD) ELEMENTS

INTRODUCTION

Background

The Human Engineering Laboratory Division Air Defense Systems (HELDADS) program supports the major materiel acquisition of an automated short-range air defense command and control (SHORAD C^2) system. The HELDADS program, which is in Phase II, has two approaches. One approach is to design, develop, and demonstrate integrated displays and controls for the various echelons of the system. This work is being done through the U.S. Army Human Engineering Laboratory (USAHEL) Human Factors Research Simulation facilities for the fire unit and Air Battle Management Operations Center (i.e., Battalion Tactical Operations Center subsystems). The second approach is to identify and study pertinent human factors issues from the SHORAD C^2 requirements. Some thirty issues (which vary in specificity) have been identified to date.

Objective

To focus the HELDADS program, the present study surveyed SHORAD elements of the U.S. Army Forces Command (FORSCOM) divisions to obtain experiential and preferential data about the human factors of materiel design. The intent of the survey was to obtain data for three generic subsystems of the SHORAD C^2 system: the fire unit, the sensor, and the battalion command element. Because each of these elements has different responsibilities for the SHORAD mission, the purpose of the survey and the results presented here is not to identify differences among the elements. The results will be used for further planning and execution of the HELDADS program.

QUESTIONNAIRE DEVELOPMENT

A survey of SHORAD users' opinions was needed because of the number of research issues identified (see Appendix A). Additional issues from the SHORAD C^2 system specification (MIS 34585) were identified and, in part, described in the Human Factors Engineering Statement (HFES).

Questions were developed from the identified issues. General guidelines on questionnaire construction were used throughout (Dyer, Matthews, Stulac, Wright, & Yudowitch, 1976; Dyer, Matthews, Wright, & Yudowitch, 1976). Questionnaires were reviewed for content and readability by two college students (neither was familiar with the technical area), one E-7, two O-4's, and members of the laboratory's experimental design

review panel. Changes which improved the readability were incorporated.

The reading level of the questionnaire material (see Appendixes B through E) was addressed. Readability scores were not found to be entirely applicable to either a questionnaire format or to the SHORAD military occupational speciality (MOS) area. A New Fog count (Kincaid, Fishburne, Rogers, & Chissom, 1975) was made on the fire unit questionnaire to get a general idea of the reading level of the material. Incomplete questions or response categories were not included in the Fog count (e.g., questions 1-6, responses for 7, 9, etc.). The calculated New Fog count was 4.6, which corresponds to a fourth- to fifth-grade reading level. A Flesch-Kinkaid reading grade level formula (Katznelson, 1980), used for assessing difficulty of military technical writing, was also applied to the questionnaire. The calculated reading grade level by the Flesch-Kincaid method was 7.6. A difference of three between reading grade formulas is not uncommon (Kincaid, Fishburne, Rogers, & Chissom, 1975). The primary difference in the formulas is that the Fog count uses complete thoughts as a unit in its formulas while the Flesch-Kincaid uses complete sentences. Since there are more thoughts than there are sentences in this material, the results of the different formulas produce different reading grade levels. (All instructions were presented verbally to the respondents in addition to being read.)

The questionnaires were arranged in the following format: instructions, participants' characteristics, SHORAD C^2 information needs, automated SHORAD C^2 display preferences, manual SHORAD C^2 message formats, and general responses. Instructions for all three versions of the questionnaire are included in Appendix B. The fire unit (FU) version is included as Appendix C, the forward area alerting radar (FAAR) as Appendix D, and the battalion (Bn) version as Appendix E. In the Results section, the rationale for each question precedes the question (as presented in the questionnaire) with results following.

METHODOLOGY

Participants

Participants were obtained through the provisions of Ft. Hood Umbrella Week, a week set aside by the Fort to support the requirements of non-FORSCOM agencies. Four platoons and one Bn TOC element were requested from each of two divisions. The sample technique was chosen for convenience of administration and to minimize the burden on the responding battalions. The intent was not to survey only expert SHORAD practitioners but to obtain a sample across most levels of training and experience.

General personnel authorizations for the elements were expected as follows: 25 Chaparral, 32 Redeye, 19 Vulcan, 25 FAAR, and 15 Bn. A total of 130 respondents completed the questionnaires; one respondent from a Bn element did not.

Table 1 presents a breakdown of the numbers of respondents by questionnaire version, platoon, division, and skill/grade level, with average age, length of service, and time in their primary MOS.

Table 2 indicates the current operating strength by MOS and skill level and the percentage of the sample. There were 127 enlisted personnel participating in the survey, 1.2 percent of the 10,372 operating personnel in the U.S. Army with the surveyed SHORAD MOSs (Ballalius, personal communication, August 3, 1984). Assuming that the sample was representative and allowing the variance of the responses to be a maximum (viz., .002), the bounds on the responses are within +4.5 percentage points or a frequency count of about 6 (Scheaffer, Mendenhall, & Ott, 1979).

Procedures

The questionnaire was administered to each platoon type with soldiers from the 1st Cavalry Division and the 2nd Armor Division participating at the same time. An introduction was given by a major from USAHEL who stressed the importance of the questionnaire and the respondents' participation. Step-by-step instructions were given by the principal investigator. The instructions were presented orally for demographic data questions 1 through 8. Specific instructions were given for questions 9 and 10 for the FU, 9 through 11 for the FAAR, and 9 through 12 for the Bn versions. The format of the multiple choice questions was explained. The principal investigator encouraged the participants to ask questions if they had difficulty reading or understanding the questions.

Data Analysis

Data analysis was primarily descriptive. Quantitative summaries and qualitative results were evaluated in cases of extreme or significant minority viewpoints. The questionnaire items are presented by sections: information analysis, display formats, voice messages, and free response. Data summaries are presented for each of the versions of the questionnaires: FU, FAAR, and Bn. For the FU, additional summaries are presented by weapon system and by skill level. Comments on the questionnaire are discussed as the last portion of the Results section.

TABLE 1

Respondents' Characteristics

Questionnaire Version	Platoon	MOS	Number of Respondents	Number from Division 1st	Number from Division 2nd	Number in Skill/Grade Level O1-O2	Number in Skill/Grade Level E1-E4	Number in Skill/Grade Level E5	Number in Skill/Grade Level E6	Number in Skill/Grade Level E7	Average Age (yr)	Average Length of Service (yr)	Average Length of Service (mo)	Average Time in Primary MOS (yr)	Average Time in Primary MOS (mo)
Fire unit			90	48	42	4	53	14	16	3	24.1	4	7	3	8
	Chaparral	16P	37	22	15	2	21	7	6	1	24.2	4	3	3	3
	Redeye	16S	32	11	21	0	22	4	4	2	23.2	3	10	3	5
	Vulcan	16R	21	15	6	2	10	3	6	0	25.4	5	5	4	8
FAAR		16J	26	-	-	0	16	4	5	1	25.5	5	8	3	3
Battalion		16H	12	5	7	0	2	1	5	4	30.5	9	8	8	8

TABLE 2

Sampling Percentages

MOS	Skill Level	Operating	Sample	Percentage
16P	1	2290	21	.9
	2	386	7	1.8
	3	480	6	1.2
16S	1	1862	22	1.2
	2	568	4	.7
	3	623	4	.6
	4	55	2	3.6
16R	1	1416	10	.7
	2	446	3	.7
	3	500	6	1.2
	4	400	3	.8
16J	1	253	16	6.3
	2	112	4	3.6
	3	142	5	3.5
16H*	1	339	4	1.2
	2	146	1	.7
	3	134	5	3.7
	4	220	4	1.8
Total		10,327	127	1.2

* Note: Some 16H personnel are HIMAD- and not SHORAD-related.

RESULTS OF INFORMATION QUESTIONS

Question Background and Rationale

Question 9: FU, FAAR, Bn.

The first objective of the HELDADS Phase II program was to identify the information requirements in the SHORAD C^2 echelons. Two questions were developed directly from the information requirements. Question 9 used a checklist format. It asked the soldiers to mark any of the listed items of information which must be known for them to complete the combat mission. A question mark was placed by any item which was not understood. The FAAR version listed 38 items of which 3 were different from the FU version. The Bn version listed 39 items of which 2 were different from the FU version.

The checklist was used rather than rankings or an individual scaling of items because of the number of items. A simple, two-part question was considered to be the easiest for the respondents to complete. The two parts were understanding the item, then deciding if the item was necessary.

Question 10: FU, FAAR, Bn.

Whereas question 9 was an exhaustive approach for determining the information requirements, question 10 used a reductionist approach. Question 10 asked the respondents to select and rank the five most important items from the list in question 9 and to indicate how often the information would be used.

Fire Unit Responses on Information Questions

Thirty-six of the thirty-seven items were considered to be important by at least half of the 90 FU respondents. The least importance was associated with firing doctrine. Twelve percent of the respondents indicated that they did not understand what that item meant.

The fire unit rankings of items in question 9 appear in Table 3 as do the fire unit rankings of items in question 10. For question 10, a weighted sum of the first through fifth rankings of each information item was computed (with a weighting of 5 given to the most important item, 4 to the second, etc.). These weighted sums were ranked for the 37 information items and are similar to the ranks of frequency response for question 9. The top four items did not differ in rank between the two questions. No difference greater than nine places occurred for any item between lists. A Spearman's Rho correlation between the ranks of the frequency of response for question 9 and the weighted sum of rank frequencies for question 10 was .8429, significant at the .0001 level (i.e., the null hypothesis of no correlation was rejected).

TABLE 3

Ranked Importance of Information For Fire Unit Respondents
(Questions 9 & 10)

Question 9				Question 10		
Rank	Information Item	Importance	Not Understood	Rank	Information Item	Weighted Frequency Sum
1.5	Weapons control status (WCS)	89	0	1	WCS	154
1.5	Target position	89	0	2	Target position	152
3.5	Target identification	88	0	3	Target identification	123
3.5	Air defense warning	88	0	4	Air defense warning	121
5	Sector of fire	87	0	5	MOPP status	73
6.5	Target heading	85	2	6	Target heading	55
6.5	Hostile criteria	85	0	7	IFF/SIF	50
8.5	Target type	84	0	8.5	PTL	45
8.5	Number of rounds	84	1	8.5	State of alert	45
10	Identification friend or foe (IFF)/selective identification feature (SIF)	83	0	10.5	Number of rounds	42
				10.5	Movement order	42
				12	Ammunition supply point	37
				13	NBC report 1-5	33
				14	Hostile criteria	32
11	Raid size	82	3	16	Sector of fire	31
12.5	Primary target line (PTL)	81	1	16	Target type	31
				16	CEOI	31
12.5	State of alert	81	0	18.5	Raid size	30
14	Ammunition supply point	80	0	18.5	Enemy activity	30
				20	Target speed	24
15	Map data	78	0	21.5	Map data	13
16.5	Movement order	77	2	21.5	POL resupply	13
16.5	Engagement priority	77	1	24	Engagement priority	12
				24	ROE	12
				24	Weapons map location	12
18	Mission-oriented protection posture (MOPP)	76	1	26	Track designator	11
				27	Warning report	10
19	Nuclear, biological, and chemical (NBC) report	75	6	28	Defended assets	9
				29.5	Kill assessment	7
				29.5	Highest priority target	7
21	Rules of engagement (ROE)	72	3	31	Priority of assets	5
21	Defended asset	72	6	32.3	Area of operation	4
21	Weapons engagement zone	72	6	32.5	Air corridors	4
				34.5	Battle lines	2
				34.5	ECM	2
23	Enemy activity	71	3	36	Weapons engagement zone	1
24	Target speed	71	1	37	Firing doctrine	0
25	Warning report	69	5			
26.5	Communications-electronics operation instructions (CEOI)	68	4			
26.5	Petroleum, oils, and lubricants (POL) resupply	68	3			
28	Area of operation	66	5			
29	Priority of assets	64	8			
30	Highest priority target	63	4			
31	Battle lines	61	5			
32	Weapons map location	60	6			
33	Track designator	54	8			
34.5	Kill assessment	48	15			
34.5	Electronic countermeasures (ECM)	48	13			
36	Air corridors	46	16			
37	Firing doctrine	42	11			

Before the collection of data, importance rankings were estimated for the target data items. The rationale for the predicted rankings was presented by Fallesen (1985). The resulting data on these information items fell in nearly the same rank ordering (as determined by the percentage of respondents checking) as the hypothesized ordering (Table 4). Two exceptions were the sixth and eigth rankings for the items of engagement priority and track designator. These items were not ranked in the hypothesized ordering. Another difference was that target speed was combined with target heading into one item of target velocity for the subjective analysis.

The frequency of the desired timeliness of the information is indicated in Table 5.

FAAR Responses on Information Questions

The ordering of data from question 9 appears in Table 6. Twenty-nine of the thirty-eight information items were considered to be important by at least half of the 26 FAAR respondents. Three items which appeared much higher in the rankings for the FAAR respondents than for the FU respondents were electronic countermeasures (ECM) (rank 2 vs. 34.5), communications-electronics operation instructions (CEOI) (rank 2 vs. 26.5), and map location (6 vs. 32).

Question 11: FAAR, Bn.

The system specification (MIS 34585) requests that 29 types of battlefield geometry be used in the system, with one use being the display of this information on computer-generated maps. The question was intended to reduce the list to those items important to the most people. By shortening the list, software requirements could be decreased. Also, the data could indicate how often each might be displayed or used based on the frequency of the importance.

The battlefield geometry types were ranked according to the frequency of perceived usefulness by the FAAR respondents (Table 7). Twenty-three of the twenty-nine types were considered useful by at least half of the respondents. Those that were not understood by about 20 percent or more of the respondents were air head, fire support coordination line, and data link reference point.

Bn Responses on Information Questions

The rank orderings for question 9 data appear in Table 8. Thirty-seven of the thirty-nine information items were considered to be important by at least half of the 12 Bn respondents.

Twenty of the twenty-nine battlefield geometry types were considered useful by at least half of the Bn respondents (Table 9). Both the FAAR and Bn respondents considered the forward line of own troops (FLOT) and forward edge of the battle area (FEBA) to be the most useful types.

TABLE 4

Predicted and Observed Rankings of Target Data
For Fire Unit Respondents
(Question 9)

Relative Rank	Predicted Information	Observed Rankings of Target Data	Overall Frequency	Rank
1	Position	Target position	89	1.5
2	Identification	Target identification	88	3.5
3	Speed vector	Target heading	85	6
4	Classification	Target type (class)	84	8
5	Raid size	Raid size	82	11
6	Jamming	Engagement priority	77	16
7	Special track	Target speed	71	23
8	Identification conflict	Track designator	54	33
9	----------	Jamming/ECM	48	35

TABLE 5

Desired Timeliness of the Highest Priority Information
(Question 10)

Rank from Table 3 (Question 10)	Information Item	Frequency*	Timeliness Seconds	Minutes	Hours	Days/Weeks
1	Weapons control status	43	10	11	18	0
2	Target position	40	23	12	2	1
3	Target identification	35	18	11	1	1
4	Air defense warning	35	9	8	13	0
5	MOPP status	24	5	5	12	1
6	Target heading	18	14	4	0	0
7	IFF/SIF	18	11	3	0	2
8.5	Primary target line	12	6	2	4	0
8.5	State of alert	15	4	5	4	1
10.5	Number of rounds	15	2	7	4	1
10.5	Movement order	14	3	0	5	3
12	Ammunition supply point	18	2	1	7	5
13	NBC report 1-5	12	1	3	6	0
14	Hostile criteria	14	4	4	3	1
16	Sector of fire	10	4	0	4	0
16	Raid size	13	8	2	1	0
16	CEOI	12	1	3	3	2
18.5	Target type	11	6	5	1	0
18.5	Enemy activity	13	2	6	5	0
20	Target speed	12	7	3	2	0
21.5	Map data	5	0	2	2	1
21.5	POL resupply	7	0	0	3	2
24	Engagement priority	5	2	2	0	0
24	Rules of engagement	4	1	1	0	0
24	Weapons map location	4	0	2	1	0
26	Track designator	4	3	0	0	0
27	Warning report	4	2	1	1	0
28	Defended assets	4	1	0	2	0
29.5	Kill assessment	2	1	0	1	0
29.5	Highest priority target	3	2	1	0	0
31	Priority of assets	1	1	0	0	0
32.5	Area of operation	3	0	1	1	0
32.5	Air corridors	1	0	1	0	0
34.5	Battle lines	1	0	0	1	0
34.5	ECM	1	0	0	0	1
36	Weapons engagement zone	1	0	0	0	0
37	Firing doctrine	0	0	0	0	0

* The number of times the item was chosen as any one of the top 5 items of priority; the maximum possible frequency was 90.

TABLE 6

Ranked Importance of Information for FAAR Respondents
(Question 9)

Rank	Information Item	Importance	Not Understood
6	Target heading	24	0
6	FAAR map location	24	1
6	IFF/SIF	24	0
11.5	Target identification	23	0
11.5	Raid size	23	0
11.5	Air defense warning	23	1
11.5	Enemy activity	23	0
11.5	Map data	23	0
11.5	MOPP status	23	0
16	Area of operations	22	0
16	Movement order	22	0
16	POL resupply	22	1
19	Target type	21	0
19	NBC report	21	2
19	Ammunition supply point	21	1
20	State of alert	20	1
21	Track designator	19	1
23	Target speed	18	0
23	Hostile criteria	18	1
23	Warning report	18	1
25.5	Weapons control status	16	1
25.5	Highest priority target	16	2
27.5	Primary target line	15	1
27.5	Air corridors	15	7
29	Engagement priority	14	4
31	Sector of fire	12	4
31	Sector of radiate	12	7
31	Battle lines	12	4
32.5	Sensor blink	11	6
32.5	Weapons engagement zone	11	2
34.5	Defended asset	10	8
34.5	ROE	10	7
36	Priority of assets	9	8
37	Firing doctrine	9	3
38	Kill assessment	5	7

TABLE 7

Ranked Usefulness of Battlefield Geometry for FAAR Respondents
(Question 11)

Rank	Battlefield Geometry Item	Usefulness	Not Understood
2.5	Forward line of own troops	21	1
2.5	Forward edge of the battle area	21	1
2.5	Restricted area	21	0
2.5	NBC report 1	21	0
5	NBC report 2	20	0
7.5	Airfield	19	0
7.5	SHORAD engagement zone (SHORADEZ)	19	2
7.5	NBC report 3	19	1
7.5	NBC report 4	19	0
11.5	Unit boundary	18	0
11.5	Air defense identification zone	18	2
11.5	Missile engagement zone	18	1
11.5	Mine field	18	0
14.5	Drop zone	17	2
14.5	NBC report 5	17	3
16	High density airspace control zone (HIDACZ)	16	1
17	Weapons free zone	15	0
20	Coordinating artillery point	14	3
20	Fire support coordination line	14	5
20	Restricted fire line	14	2
20	Fighter engagement zone	14	2
20	Landing zone	14	0
23	Safe corridor	13	3
24	Data link reference point	12	5
25	Weapons control volume	10	3
27	Low-level transit route	9	4
27	Coordination line	9	4
27	Asset point	9	4
29	Air head	7	8

TABLE 8

Ranked Importance of Information for Bn Respondents
(Question 9)

Rank	Information Item	Importance	Not Understood
2.5	Air defense warning	12	0
2.5	CEOI	12	0
2.5	NBC report	12	2
2.5	State of alert	12	0
7	Bn map location	11	0
7	Area of operation	11	0
7	Weapons control status	11	1
7	Map data	11	1
7	MOPP status	11	1
11.5	Target position	10	0
11.5	Target heading	10	0
11.5	Air corridors	10	0
11.5	Weapons engagement zone	10	0
15	Raid size	9	1
15	Rules of engagement	9	0
15	Battle lines	9	0
21.5	Target speed	8	0
21.5	Target identification	8	1
21.5	Primary target line	8	1
21.5	Sector of fire	8	1
21.5	Defended asset	8	1
21.5	Priority of assets	8	1
21.5	Enemy activity	8	1
21.5	Movement order	8	1
21.5	Highest priority target	8	0
21.5	POL resupply	8	1
31	Target type	7	1
31	Kill assessment	7	1
31	Track designator	7	1
31	ECM	7	1
31	Rounds remaining	7	1
31	IFF/SIF	7	0
31	Hostile criteria	7	2
31	Warning report	7	1
31	Ammunition supply point	7	1
36.5	Engagement priority	6	0
36.5	Firing doctrine	6	0
38	Sector of radiate	3	3
39	Sector of blink	2	4

TABLE 9

Ranked Usefulness of Battlefield Geometry Items
(Question 11)

Rank	Battlefield Geometry Item	Usefulness	Not Understood
1	Forward line of own troops	12	0
2.5	Forward edge of the battle area	11	0
2.5	SHORADEZ	11	0
5	Unit boundary	10	0
5	HIDACZ	10	1
5	Safe corridor	10	0
11	Low-level transit route	9	0
11	Air defense identification zone	9	0
11	Missile engagement zone	9	0
11	Weapons free zone	9	0
11	NBC report 1	9	1
11	NBC report 2	9	1
11	NBC report 3	9	1
11	NBC report 4	9	1
11	NBC report 5	9	1
16	Fighter engagement zone	8	0
18	Fire support coordination line	7	0
18	Airfield	7	0
18	Weapons control volume	7	0
21	Restricted fire line	6	0
21	Restricted area	6	0
21	Data link reference point	6	1
24	Weapons control volume	5	0
24	Landing zone	5	0
24	Mine field	5	0
26	Coordination line	4	0
28	Coordinated artillery point	2	0
28	Air head	2	2
28	Asset point	2	1

Question 12: Bn.

The MIS 34585 (Table IV, 3.1.7.2) indicated 10 functions of the air battle management operations center (ABMOC). To get an idea about the relative importance of each, the functions were to be ranked from 1 to 10. Space was provided for additional Bn functions. If the importance of the functions can be determined, then prioritizing the software and human factors development can be made accordingly, as well as allotting for computer processing and memory space.

Question 12 for the Bn respondents instructed them to rank the importance of the Bn functions. The categories were taken from descriptive material in MIS 34585. One category was omitted unintentionally, "manage communications." The resulting ranking for the functions is given in Table 10.

RESULTS OF DISPLAY FORMAT QUESTIONS

First, the rationale and background for the question appear. Second, the question itself appears as it was presented to the respondents. The frequency of responses by answer and respondent category are shown below the question. Only those respondent categories which apply for a question are given. If a question applies to more than one version, only the FU number is given. The fire unit results are stratified by skill level (level 1 and levels 2 through 4) and type of weapon platoon. (Skill level data do not include the platoon lieutenants' responses, so the skill data do not sum to the fire unit total.) Abbreviations used for the response frequencies are C (Chaparral), R (Redeye), V (Vulcan), FAAR (forward area alerting radar), and Bn (battalion). For "other" responses, the answers and frequencies appear for FU, FAAR, and Bn, as applicable. Responses indicated by an asterisk indicate a specification from MIS 34585 (ADDCS, 1985).

Questions 11-14: FU; 12-15: FAAR; 13-16: Bn.

These questions were intended to determine preferences for the categories or classifications of data for several information items. With the responses, preferences for how to represent target position, altitude, identification, and wing type classification can be determined. Questions and response choices were the same for the three questionnaire versions.

11. How would you like to have target position represented?
    a. Target range and azimuth (compass heading)
    b. Target's geographic coordinates
    c. Other (please specify)_____
    d. Undecided

TABLE 10

Ranked Importance of Bn Functions
(Question 12)

Rank	Function	Sum of Weighted Frequencies
1	Conduct training	68
2	Coordinate with supported unit	53
3	Deploy and assign missions	51
4	Provide air defense warnings	50
5	Manage firepower	43
6	Perform logistic support	41
7	Monitor status of subordinates	40
8	Perform administration	36
9	Manage sensors	23

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	28	17	22	15	11	48	8	6
b.	16	7	9	7	8	24	10	5
c.	6	9	6	7	2	15	3	0
d.	3	0	0	3	0	3	4	0

c. Other--Fire unit

Clock position/reading azimuth	6
Radar display	3
Friend or foe	2
Map	1
a and b combined	1

c. Other--FAAR

Manual SHORAD Control System	1

12. How would you like to have target altitude represented?
    a. An elevation in degrees
* b. An altitude category such as high, medium, or low
    c. An altitude reading (meters or feet)
    d. Other (please specify)_____
    e. Undecided

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	11	5	6	7	3	16	4	0
b.	28	22	24	18	12	54	8	5
c	8	5	3	5	5	13	10	6
d.	4	1	4	0	1	5	10	0
e.	2	0	0	2	0	2	3	1

d. Other--FU

In range/out of range	1
High or low	1
b and c combined	1
Radar	1
Degrees	1

d. Other--FAAR

High or low	1

13. Which category of identification do you prefer?
* a. Hostile, friend, unknown
    b. Positive hostile, all others
    c. Positive friend, all others
    d. None of the above

	FIRE UNIT SKILL LEVEL 1	2-4	PLATOON C	R	V	Total	FAAR	Bn
a.	39	24	30	19	18	67	17	12
b.	5	4	4	3	2	9	2	0
c.	6	5	2	9	0	6	5	0
d.	3	0	1	1	1	3	2	0

14. How do you want targets to be classified?
    a. Jet, propeller, helicopter, missile, unknown
    * b. Fixed wing, rotary wing, missile, unknown "Display req't"
    * c. Specific targets, such as F-15, A-10, Hind-D, etc. "Data req,t"
    d. None of the above

	FIRE UNIT SKILL LEVEL 1	2-4	PLATOON C	R	V	Total	FAAR	Bn
a.	12	7	9	9	3	21	6	3
b.	5	7	4	6	3	13	5	4
c.	32	17	21	15	14	32	8	3
d.	3	2	3	1	1	5	7	2

Question 15: FU, 16: FAAR, 17: Bn.

This question was intended to determine the quantity of targets that subjects would prefer to have displayed. The response choices were developed for use in algorithms for reducing the number of targets.

15. How would you like the air battle picture shown?
    a. The single most threatening target
    b. The 2 most threatening targets
    c. The 3 to 5 most threatening targets
    d. All hostile targets
    e. All hostile and unknown targets
    f. All targets (hostile, unknown, and friendly)
    g. Other (please specify) _____
    h. Undecided

*Spec: Capable of 15 air track symbols, with indication of highest priority threat.

	FIRE UNIT SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FARR	Bn
a.	3	0	2	1	1	4	0	1
b.	2	2	2	1	1	4	0	0
c.	8	4	5	2	5	12	2	0
d.	7	4	5	4	3	12	2	1
e.	14	6	7	11	2	20	13	2
f.	12	15	13	9	7	29	8	6
g.	2	2	2	1	1	4	0	0
h.	4	0	1	2	1	4	1	0

g. Other--FU

All targets, color-coded by ID	1
All hostile, threatening targets	1
The 3-5 most threatening targets	1
c and e combined with c being brighter	1

Question 16: FU, 17: FAAR.

This question concerns how often target priority should be determined. If the priority is determined very often, the operator may be confused if the display indicates different targets of highest priority. If the priority is not determined often, then noncritical targets might be indicated for engagement.

16. If the map display device indicates the highest priority target, how often would you like the priority determined?
    a. After engagement was completed or called off
    b. Sometime before engagement is completed
    c. Every _____ seconds (fill in the blank)
    d. Undecided

	FIRE UNIT SKILL LEVEL		PLATOON				
	1	2-4	C	R	V	Total	FAAR
a.	8	5	3	5	5	13	5
b.	14	4	9	9	1	19	2
c.	22	21	20	12	13	45	14
d.	9	3	5	6	3	13	4

c. Every ____ seconds. -- All fire units
Mean=18.91, SD=21.94, n=44

Question 17: FU, 18: FAAR, Bn.

This question concerns whether a displayed target should appear to move continuously (with predicted position in between intermittent track updates) or discretely.

17. What method of display target movement do you prefer?
    a. The target to move when the radar has updated the new position.
    b. The target to move continuously as predicted from the last known position, heading, and speed.
    c. Other (please specify) _____
    d. Undecided

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	5	8	4	5	4	13	7	1
b.	43	25	30	27	15	72	18	10
c.	3	0	1	0	2	3	0	0
d.	1	0	1	0	0	1	0	0

c. Other--FU
Movement shown when target is within firing range of asset 1
Move continuously based on classification, altitude, ID, and priority 1

Question 18: FU, 19: FAAR, Bn.

This question concerns the range of coverage that is preferred for target information.

18. Out to what range would you like to have target information supplied?
a. 10 km
b. 15 km
c. 20 km
d. 30 km
e. 40 km
f. Other (please specify)_____
g. Undecided

	FIRE UNIT						
	SKILL LEVEL		PLATOON				
	1	2-4	C	R	V	Total	FAAR
a.	2	6	2	5	1	8	0
b.	6	2	4	3	3	10	0
c.	9	9	9	6	4	19	4
d.	15	2	10	5	2	17	3
e.	9	9	5	7	7	19	14
f.	9	3	6	3	3	12	4
g.	3	1	1	2	1	4	1

f. Other--FU
Max range 5
5-10 km 1
15-20 km 1
25-35 km 1
20 km 1
40 km 1
50 km 1
80 km 1

Mean for fire unit = 26.56 km, SD=12.36, n=80

19. For what area would you like to have target information supplied?
    a. 100 x 100 km
    b. 200 x 200 km
    c. 400 x 400 km
    d. 600 x 600 km
    e. Other (please specify) _____
    f. Undecided

	Bn
a.	2
b.	0
c.	2
d.	6
e.	1
f.	1

e. Other--Bn
   10-15 km 1
   300 x 300 1

Question 19: FU, 20: FAAR, Bn.

Four questions were used to ask what ranges are requested for the general presence of hostile and unknown or friendly aircraft, or when exact positions are wanted.

19. Answer the following 4 statements by filling in the blanks.
    1. I want to know that a hostile or unknown target is present when it is ____ km away
    2. I want to know that a friendly aircraft is present when it is ____ km away
    3. I want to know the exact position of a hostile or unknown target when it is ____ km away
    4. I want to know the exact position of a friendly aircraft when it is ____ km away

		FIRE UNIT							
		SKILL LEVEL		PLATOON					
		1	2-4	C	R	V	Total	FAAR	Bn
1.	$\bar{x}$	30.8	22.1	26.4	24.5	30.3	26.7	79.6	370.0
	SD	18.5	13.6	15.1	16.0	21.2	17.0	8.0	231.2
	n	49	33	37	28	21	86	26	10
2.	$\bar{x}$	25.0	20.8	24.0	21.2	22.9	22.8	71.5	347.8
	SD	18.7	15.9	17.4	15.0	21.0	17.3	36.5	261.6
	n	48	33	36	28	21	85	26	9
3.	$\bar{x}$	28.9	20.1	25.8	22.1	26.5	24.7	79.6	325.5
	SD	21.3	13.9	19.8	15.4	22.0	18.9	22.3	239.4
	n	50	33	37	29	21	87	25	11
4.	$\bar{x}$	24.2	16.8	20.4	19.4	22.7	24.2	66.8	352.2
	SD	19.0	11.8	14.6	14.1	22.5	16.6	74.0	256.5
	n	48	33	37	27	21	85	24	9

Note: $\bar{x}$ = mean n = sample size
SD = standard deviation
The units are in kilometers.

Question 20: FU, 21: FAAR, Bn.

This question asked what target position accuracy is preferred. The response choices range from 0.1 km to 5 km (the latter is the accuracy of the target alert data display system [TADDS] device).

20. What target position accuracy do you want?
    a. To within 100 m (1/10 km)
    b. To within 500 m (1/2 km)
    c. To within 1 km
    d. To within 2 km
    e. To within 5 km
    f. Other (please specify) _____
    g. Undecided

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	14	7	10	6	9	25	9	5
b.	3	4	2	4	1	7	2	2
c.	8	4	7	4	1	12	0	2
d.	8	3	4	4	3	11	0	0
e.	9	9	9	6	3	18	9	2
f.	5	4	2	5	2	9	3	0
g.	5	2	3	2	2	7	3	1

*Spec: Quality based on levels of sensor accuracy

f. Other--FU

as accurate as possible	3
100-500 m	1
5 km	1
10 km	2
15 km	1
as far as possible	1

FAAR

10 km	1
30 km	1
40 km	1
as far as possible	1

Question 21: FU, 22: FAAR.

This question was intended to decide whether the area of cueing should be 360° around the unit or whether it could be reduced based on the primary target line (PTL), or the area of responsibility. The question was modified for the FAAR. Sector of search replaced sector of fire, and radar coverage area replaced weapons engagement zone.

21. Which statement do you agree with the most?
    a. I want to know the positions of targets only within my primary sector of fire
    b. I want to know the positions of targets within my primary or secondary sector of fire
    c. I want to know the position of targets within or near my weapons engagement zone
    d. I want to know the position of all targets
    e. Undecided

*Spec: Two areas for alerting (FW, RW), operator adjustable filter

	FIRE UNIT					
	SKILL LEVEL		PLATOON			
	1	2-4	C	R	V	Total
a.	2	1	0	2	1	3
b.	7	3	3	4	3	10
c.	17	11	12	11	7	30
d.	23	17	21	12	9	42
e.	2	0	1	0	1	2

FAAR 22. Which statement do you agree with the most?

a. I want to know the positions of targets only within my primary sector of search
b. I want to know the positions of targets within my primary or secondary sector of search
c. I want to know the position of all targets within my radar coverage area
d. I want to know the position of targets within my radar coverage area and from other sensors as well
e. Undecided

	FAAR
a.	0
b.	0
c.	13
d.	13
e.	0

Question 22: FU.

SHORAD C^2 documents suggest that a hand-held display be used for presenting information in alphanumerics and graphs. This approach for target direction may detract from actual detection. Viewing the display with one's head down or glancing repeatedly from the display to the visual scene may diminish the detection of targets. This question inquired about the preference for other modes of presentation: voice commands, audible signals, and integrated display weapon sights.

22. How would you prefer to receive target position information from beyond visual range?

* a. From a display map
b. From voice commands directing or pointing to the direction of the target
c. From a display map shown within the weapon sight
d. From tones, beeps or other sounds directing or pointing to the direction of the target
e. Undecided

	FIRE UNIT					
	SKILL LEVEL			PLATOON		
	1	2-4	C	R	V	Total
a.	8	8	7	8	4	19
b.	13	12	9	9	7	25
c.	16	8	13	6	6	25
d.	9	4	4	7	2	13
e.	5	0	2	1	2	5

Question 23: FU.

This question asked what types of alerting information are preferred. The MIS 34585 specifies information based only on the general direction of approach.

23. When a target is outside of your visual range, which would you prefer for alerting?
    a. Know only the estimated time of arrival
    b. Know only the general direction of approach
    c. Know both the estimated time of arrival and the general direction of approach
    d. Other (please specify) _____
    e. Do not want to know anything about this type of target
    f. Undecided

*Spec: 30-degree arc, 10-30 km away

	FIRE UNIT					
	SKILL LEVEL			PLATOON		
	1	2-4	C	R	V	Total
a.	4	3	3	3	1	7
b.	3	1	3	1	0	4
c.	43	26	20	25	18	43
d.	2	2	1	1	2	4
e.	0	0	0	0	0	0
f.	0	0	0	0	0	0

d. Other

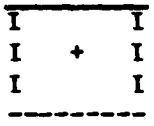
exact time of arrival and direction of approach	1
speed and direct heading	1
ETA, general direction and speed	1
ETA, general direction and identification	1

Question 24: FU, 23: FAAR, 22: Bn.

This question asks for preferences on the location of units. The center of the display, response a, is the orientation most familiar to the respondents (e.g., TADDS or FAAR). Responses b or d near the bottom or sides of the display would focus on the sector of interest, and give the most precision for targets within this area (i.e., more screen size per unit of represented distance).

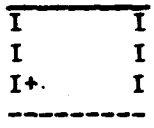
24. Where would you like to have your position located on the display? Refer to the diagrams found below.

a. At center of display map

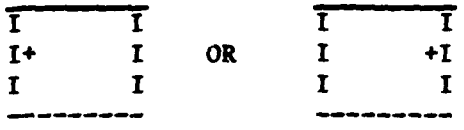


b. At top or bottom of display map

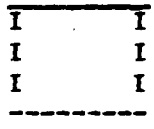
c. In corner of display map



d. At either side of display map



e. Other (please mark with an X)



f. Undecided

*Spec: Center of display, with offset capability

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	42	29	32	29	14	75	19	9
b.	1	2	0	0	3	1	1	0
c.	3	2	3	1	1	5	1	0
d.	2	0	1	0	1	2	1	1
e.	3	0	0	1	2	3	4	1
f.	0	0	0	0	0	0	0	0

Question 25: FU, 24: FAAR, 23: Bn.

Orientation is an important aspect of the display. Usual designs put north at the top. There may be a better way to orient the display, especially for a tactical display that will be continuously correlated or registered to the actual visual scene. The responses b-d provided some of these other orientations. Response d refers to a dynamic device which could reorient the display image to the actual direction to which the device is oriented.

25. How would you like the display map to be oriented?
    a. The top of the display map should always represent north
    b. The top of the display map should always represent the PTL
  * c. The top of the display map should be changeable to one of the four compass directions (east, west, north, south)
    d. The top of the display map should change direction as the display "box" is pointed to different directions
    e. Other (please specify)_____
    f. Undecided

	FIRE UNIT						
	SKILL LEVEL		PLATOON				
	1	2-4	C	R	V	Total	Bn
a.	25	21	20	19	9	48	7
b.	6	3	5	1	5	11	0
c.	3	2	2	3	0	5	1
d.	12	4	6	4	6	16	2
e.	4	1	3	2	0	5	1
f.	1	2	1	1	1	3	0

e. Other--FU
top to represent 12 o'clock 1
--Bn
use track ball to place location where wanted 1

FAAR 24. How would you like the radar display to be map oriented?
    a. The top of the display map to always represent north
    b. The top of the display map to always represent your PTL degrees
    c. The top of the display map to be changeable to one of the four compass directions (east, west, north, south)
    d. The top of the display map to change direction as the display "box" is pointed to different directions
    e. Other (please specify) _____
    f. Undecided

	FAAR
a.	17
b.	1
c.	5
d.	1
e.	0
f.	1

Question 26: FU, 25: FAAR, 24: Bn.

This question refers to the size of the display screen. Response categories differed for each questionnaire version. For the FU, the sizes

started as small as 4" x 4" and increased in 2-inch increments. For the FAAR, the responses used the current FAAR size as the baseline and asked whether it should be larger or smaller. For the Bn, the question used 8" x 8" as the smallest, which would be similar to an 11" diagnonal cathode-ray tube (CRT). The responses increased in 3-inch increments. Space was provided to explain the reason for selection of size to show on what basis the choice was being made.

26. About how large would you like the display area of the map device to be?

a. 4" x 4"
b. 6" x 6"
c. 8" x 8"
d. 10" x 10"
e. Other (please specify)_____
f. Undecided

	FIRE UNIT					
	SKILL LEVEL		PLATOON			
	1	2-4	C	R	V	Total
a.	7	3	6	4	0	10
b.	9	7	8	7	3	18
c.	6	3	3	2	4	9
d.	15	11	13	10	5	15
e.	7	4	3	4	5	12
f.	7	4	4	3	0	7

e. Other

6" x 6"	1
7" x 7"	1
12" x 12"	1
14" x 14"	1
15" x 15"	1
18" x 18"	1
19" x 19"	1
20" x 20"	1
24" x 24"	1

Explain why you chose the size you did.

small enough to move quickly and efficiently	19
large enough for sufficient information and increased accuracy	12
larger size minimizes eyestrain	8
"the bigger the better"	4
more area displayed	3
small screen would distort distances	2
small screen would be cluttered	1

FAAR 25. About how large would you like the radar display area to be?

a. Smaller than FAAR (please specify)_____
b. Same as FAAR (about 9" diameter)
c. Larger than FAAR (please specify)_____
d. Undecided

	FAAR
a.	1
b.	9
c.	15
d.	1

a. smaller than FAAR		not specified
b. larger than FAAR	10.5"	1
	12"	7
	13"	1
	15"	1
	16"	1
	24"	1

Explain why you chose the size you did.

easier to see	7
minimize eyestrain	3
smaller, easier to mount	1
more plotting space	1

Bn 24. About how large would you like the radar display area to be?

a. 8" x 8"
b. 11" x 11"
c. 14" x 14"
d. 20" x 20"
e. 20" x 20"
f. Other (please specify) _____
g. Undecided

	Bn
a.	0
b.	2
c.	3
d.	2
e.	3
f.	0
g.	2

Explain why you chose the size you did._____

not too big, not too small	2
extend range of TADDS and as small as possible	1

Questions 27 and 28: FU.

These questions asked the participants to indicate the smallest device they would be willing to use and carry. Spaces for three dimensions of length were given. Question 28 requested the maximum weight of such a

device. People have difficulty accurately estimating size and weight, so these questions were included only to get a rough indication of dimensions.

27. What is the largest size of the map display device (including battery power source) that you would be willing to use and carry?

A. _____ inches

B. _____ inches

C. _____ inches

		FIRE UNIT					
		SKILL LEVEL		PLATOON			
		1	2-4	C	R	V	Total
A.	$\bar{x}$	14.6	16.5	13.0	13.0	21.5	15.2
	SD	14.0	23.7	8.9	18.8	27.5	18.5
	n	44	23	28	26	17	71
B.	$\bar{x}$	13.5	16.8	11.2	13.8	21.5	14.7
	SD	14.9	24.2	4.8	18.3	28.3	18.2
	n	41	22	25	26	16	67
C.	$\bar{x}$	11.6	11.7	11.4	10.7	12.5	11.2
	SD	24.9	14.8	26.8	19.4	15.9	21.4
	n	40	19	23	24	16	63

28. What is the maximum weight that the map display device should be?

_____ pounds

	FIRE UNIT					
	SKILL LEVEL		PLATOON			
	1	2-4	C	R	V	Total
$\bar{x}$	17.2	11.7	20.8	10.4	11.0	14.8
SD	34.1	15.3	40.1	13.0	12.4	27.7
n	50	32	35	30	21	86

Note:

$\bar{x}$ = mean

SD = standard deviation

n = sample size

Question 25: Bn.

This question requested the respondents to judge the utility of a large screen display. Response categories were taken from Dyer, Matthews, Stulac, Wright, & Yudowitch (1976) to provide a balanced response framework.

25. How useful would a large screen display (1 meter x 1 meter) be for depicting the battle situation?
    a. Extremely useful
    b. Of considerable use
    c. Of use
    d. Not very useful
    e. Of no use

	Bn
a.	5
b.	4
c.	1
d.	0
e.	0

Question 26: Bn.

This question asked about the size of Bn track files. There has been some question about the basis for the specified track file size in MIS 34585. It is questionable whether the surveyed users have enough technical expertise to choose a track file size. Their responses, though, may provide some insight into the suitability of the specification.

26. What size or capacity would you like the track file to be?
    a. 50
    *b. 100 (minimum requirement)
    c. 200
    *d. 300 (desired requirement)
    e. 500
    f. Other (please specify) _____
    g. Undecided

	Bn
a.	1
b.	2
c.	1
d.	1
e.	3
f.	1
g.	1

f. Other
25 1

Summary of Preferred FU Display Formats

For the fire unit subsystem of SHORAD C^2, in a few cases (see Table 11), most of the responses agreed with the MIS 34585 (ADCCS, 1985). There was agreement for questions concerning target altitude, identification, and

location of fire unit position. The items which did not agree with MIS 34585 were the maximum range of display (however, the average response was close to the 30-km specification for alerting quality information), alerting range, cueing range, saturation alleviation, display modality, information content for alerting, and display orientation. Questions for which there was partial agreement concerned the items of wing type (see Note 1 in Table 11), accuracy/precision, device dimensions, and weight. Questions which did not specifically relate to specifications were items relating to target position, target priority update, target movement, and screen size.

Summary of FAAR and Bn Display Format Responses

The FAAR and Bn responses were similar to the FU on questions which were the same. For the questions which the FAAR participants received, there was a tie between which targets should be displayed on a radar operator's console: know the position of all targets within radar coverage and know the position of all targets within coverage and targets from other sensors as well. Most FAAR respondents preferred the radar display to be oriented with the top representing north. However, almost 20 percent (5/26) wanted the display to be changeable to either north, east, south, or west. Fifteen of the twenty-six wanted to see the radar display larger, with most of the 15 requesting a 12-inch diameter scope.

The most frequent response by the Bn for their coverage area agreed with the MIS 34585 desired area of 600 km x 600 km. There was no strong trend of response for the display screen size for use at the Bn. Four categories received about an equal number of responses. Most respondents considered a large screen display (of 1 meter by 1 meter in size) to be considerably useful.

RESULTS OF MESSAGE FORMAT QUESTIONS

These questions asked about the voice message formats used for transmitting target information in the current, manual system (Fallesen, 1984). Example A formats are in current use under Manual SHORAD Control System doctrine. Example B formats are USAHEL suggestions for simplifying and shortening the messages. The question asked the respondents to judge the formats on preference for use, quickness of transmission, understandability, and content.

Message Format Responses

29. Which example would you prefer to use?
    a. Message format A
    b. Message format B
    c. Undecided

TABLE 11

Summary of the Most Frequent Responses for Fire Units for Display Design

Question	Item	Response	Frequency	Agreement with MIS 34585 Specification
11.	target position	range & azimuth	53%	not addressed
12.	target altitude	high, medium, low	60%	agreement
13.	identification	hostile, friend, unknown	74%	agreement
14.	wing type	specifics (e.g., F-15, A-10)	56%	see Note 1
15.	air battle picture	all targets	33%	up to 15
16.	high priority update	every ___ seconds	50%	not addressed
	($\bar{x}$ = 18.91, SD = 21.94, n = 44)			
17.	target movement	continuous (predicted)	81%	not addressed
18.	maximum range of display	20 km	21%	tie (vs. 30 km)
		40 km	21%	tie
	(mean of categories of responses equals 26.5 km)			
19.	alerting/cueing ranges			
	1.	alerting--hostile/unknown		
	($\bar{x}$ = 26.72, SD = 17.00, n = 86)			vs. 10-30 km
	2.	alerting--friend		
	($\bar{x}$ = 22.78, SD = 17.34, n = 85)			vs. 0-10 km
	3.	cueing--hostile/unknown		
	($\bar{x}$ = 24.72, SD = 18.92, n = 87)			vs. 0-10 km
	4.	cueing--friend		
	($\bar{x}$ = 20.66, SD = 16.55, n = 85)			vs. 0-10 km
20.	accuracy/precision	within 100 meters	28%	see Note 2
21.	saturation alleviation	positions of all targets	48%	see Note 3
22.	display mode	voice commands	29%	tie see Note 4
		display within sight	29%	tie
23.	alerting contents	ETA & general approach	83%	see Note 5
24.	location of position	center	85%	agreement
25.	orientation	top always north	55%	see Note 6
26.	screen size	10" x 10"	33%	not addressed
	(mean of discrete categories of responses equals 8.63")			
27.	device dimensions	15/25" x 14.69" x 11.18"	(means)	see Note 7
28.	device weight	14.79 pounds	(mean)	see Note 7

Notes:
1 "specifics" agree with a spec requirement for information content, but not the requirement for display symbology
2 spec discusses levels of sensor accuracy
3 spec requires operator-adjustable filters, maximum of 15 displayed
4 spec implies a map-like display
5 spec requires a 30-degree arc with a range from 10 to 30 km
6 spec requires operator-controlled change among N, E, S, and W
7 spec only requires no more than two men to remove and install components

$\bar{x}$ = mean n = sample size
SD = standard deviation

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	25	16	16	15	12	43	15	8
b.	25	15	18	15	9	42	10	2
c.	2	2	2	2	0	4	1	2

30. Which example would be quicker to broadcast over radio?
    a. Message format A
    b. Message format B
    c. No difference in quickness
    d. Undecided

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	6	9	6	7	3	16	4	1
b.	41	22	27	22	16	65	19	8
c.	3	0	3	1	2	6	1	1
d.	1	0	0	1	0	1	2	1

31. Which example would be easier to understand?
    a. Message format A
    b. Message format B
    c. No difference in ease of understanding
    d. Undecided

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	22	16	16	11	13	40	10	7
b.	24	13	16	16	7	24	13	2
c.	4	4	4	3	1	8	2	1
d.	2	0	0	2	0	2	1	1

32. Which example gives the information which you would rather have?
    a. Message format A
    b. Message format B
    c. No difference in information
    d. Undecided

	FIRE UNIT							
	SKILL LEVEL		PLATOON					
	1	2-4	C	R	V	Total	FAAR	Bn
a.	28	21	20	18	15	53	14	9
b.	20	11	15	11	5	31	10	1
c.	1	0	1	0	0	1	1	0
d.	3	1	0	3	1	4	1	1

Summary of Message Formats

The preference of message formats was split between the two choices. Forty-three fire unit personnel preferred the current SHORAD message format and 42 preferred the USAHEL-proposed alternative. Only 16 thought the SHORAD message format would be quicker to broadcast and 65 thought the USAHEL alternative would be quicker. Forty thought the current format would be easier to understand and 39 thought the alternative format would be. Fifty-three preferred to have the information in the SHORAD format and 31 preferred the information in the USAHEL format. If each of these criteria, represented by the four questions, is weighted equally, the USAHEL format would come out slightly ahead (177 for the USAHEL format, 152 for the current format, 11 undecided, and 15 no difference). Using the same additive weighting technique, the FAAR respondents preferred the current format by a margin of 58 to 52 and the Bn respondents preferred the current format by a margin of 25 to 13. Tabulations of the results for the message format preferences follow.

RESPONSES FOR GENERAL QUESTIONS

Fire Unit Responses

33. What do you think is the biggest problem related to SHORAD command and control? Explain.

	Responses
Equipment - C^3 systems are inaccurate, unreliable, have inadequate coverage, and require excessive maintenance	30
Maneuver units - improper utilization and support of AD assets	3
Training - need more training time on equipment, more live-fire exercises	3
Leadership - small unit leaders need more experience	2
Tactics - tactics need to be refined	2
Fielding - need quicker fielding of new AD systems	1
No comment	47

34. What do you think is the biggest problem related to air defense artillery (ADA)? Explain.

Equipment - weapons and C^3 are inaccurate, unreliable, too slow, have inadequate range, and require excessive maintenance	47
Maneuver units - improper utilization and support of AD assets	19
Training - need more training time on equipment, more live-fire exercises, manuals are too hard to understand	13
Personnel - need more trained personnel performing their assigned jobs	9
Organization - excessive equipment for size of squads, too few weapon systems, Redeye/Stinger should be a separate unit	4

Camouflage - nets are inadequate for concealment	2
Fielding - Stinger should be issued to all Redeye units by now	1
Leadership - small unit leaders need more experience	1
Tactics - improvement needed	1
No comment/no problems	19

35. If you have any comments about this questionnaire, please explain.

	Responses
Very good	4
Hope it will help	2
Hope SHORAD is fielded soon	1
Some words were difficult to understand	2
Should have been questions on size and shape of weapon compartment	1
No comment	81

Summary of Fire Unit Responses

The most frequent concern cited by the fire unit respondents about the SHORAD C^2 was the poor performance of current equipment. Regarding the ADA, again poor equipment was cited most frequently. Most of the fire unit respondents did not comment about the questionnaire. Seven had positive comments, two thought some words were difficult, and one thought there was an omission concerning crew-compartment design.

FAAR Responses

30. What do you think is the biggest problem related to SHORAD command and control? Explain.

Equipment - outdated, too slow, excessive maintenance, unreliable, not ruggedized	6
Firing units - fails to provide C^2 or logistical support, do not use TADDS properly	4
Communications - poor equipment, maximum power required for effective operational range	2
No comment	15

31. What do you think is the biggest problem related to air defense artillery (ADA)? Explain.

C^3 - little sharing of information between elements, poor integration between fire units and command elements, excessive time required for voice communications	7
Equipment - outdated, difficult to move, inadequate range, not ruggedized	6
Maneuver units - improper utilization of AD assets	3
Leadership - too much harassment by leaders	1
Organization - too complex	1
Target identification - too difficult without visual detection	1
Training - too much time and money spent on AD unit training	1

32. If you have any comments about this questionnaire, please explain.

Need more writing space for questions 30 & 31	1
No comment	25

Bn Responses

31. What do you think is the biggest problem related to SHORAD command and control? Explain.

	Responses
Communication - voice communication too slow	2
Early warning - too slow, should be computerized	2
IFF - Air Force changes codes faster than SHORAD	1
No comment	9

32. What do you think is the biggest problem related to air defense artillery (ADA)? Explain.

Early warning - systems can't handle large numbers of tracks, too little information--too late	2
Weapon systems - outdated, too complex, inadequate all-weather capabilities	2
Ammunition - too few/little missiles or ammunition to perform mission	1
Communications - need more and improved (lighter, more compact, more reliable) AM radios	1
Maneuver units - difficult to coordinate with other units	1
Personnel - shortage of 16H MOS	1
Standardization - no cross-service standardization for performing the same task	1
No comment	5

33. If you have any comments about this questionnaire, please explain.

There should be more questionnaires like this one	1
No comment	13

Summary of FAAR and Bn Responses

Most FAAR and Bn respondents did not comment on problems related to SHORAD C^2. Eight FAAR respondents did mention problems of outdated equipment and communications, and five Bn respondents commented on communications, early warning, and IFF. Comments concerning ADA in general were complaints about equipment, C^3, or improper usage of AD assets by maneuver units. Most FAAR and Bn respondents did not comment on the questionnaire.

CONCLUSIONS

This survey met its objectives by providing initial data on SHORAD users' preferences and experiences for SHORAD C^2 information requirements, display characteristics, and voice-tell message formats. Over one percent of all SHORAD personnel were sampled which ensures results within plus or minus 4.5 percentage points (or a frequency of about plus or minus six responses). The results from the information requirements are presented and discussed in detail in a separate report (Fallesen, 1985). The display characteristics results are presented and summarized by display item in Table 11. Message formats and general responses have been presented and discussed.

The tendency of responses on the checklist of information items was that at least half of the respondents thought most of the items were important for completing their mission. The ranking of the items was verified by comparing two separate but similar questions (the first, a checklist, the second, a ranking of the top five items). There was a high degree of agreement. Considering the information items specifically related to target information, the ranking was very similar to that hypothesized: track position, identification, heading, wing type, raid size, engagement priority, speed, track designator, and jamming. The desired update rate or timeliness of the information items usually was on the order of seconds or minutes.

The FAAR and Bn respondents were asked which of the 29 battlefield geometry types would be useful. Most of the types had a usefulness response greater than 50 percent. The top ranking items were the forward line of own troops and the forward edge of the battle area.

The most notable result from the display format questions was that the responses indicated a desire for more information. The majority preferred the classification of wing type by specific air track type (such as F-15, A-10, Hind-D), all targets depicted in the battle picture, and position accuracy to within 100 m. Other key findings included a preference update rate for the highest priority targets of 18.9 seconds. A clear preference was shown for a continuous movement of target symbology on the display (80 percent). A tendency appears for all position information to be presented at a cueing level of precision with a radius of about 25 km. Over 80 percent (73/90) preferred to have an estimated time of arrival presented in addition to the general direction of approach specified for alerting by MIS 34585 (viz., a 30-degree arc at a range of 10 km to 30 km).

There was no difference in frequency of response among the four choices for the mode in which the SHORAD C^2 information is presented. Nineteen of ninety preferred the specification's approach of a display map type device, 25 of 90 preferred voice commands for directing to the target, 25 of 90 preferred a display map integrated with the weapon sight, and 13 of 90 preferred directional tones for pointing to the target. Although there was no clear preference among the presentation modes, the integrated weapon display received a plurality of preferences. The proposed advantages of this presentation mode are twofold. The information is

is available directly to the gunner and there is one fewer step in transmitting the data (e.g., when the squad leader provides the information verbally to the gunner). However, there are critical design issues with such a display which need to be addressed, so that the display will be uncluttered and easy to understand.

Another interesting result was that a majority of respondents (48/90) preferred the display map to be oriented to the north. This is the usual orientation of tactical displays and maps and, therefore, is the most common. The specification's requirement of a device changeable to one of the four cardinal directions was chosen by less than 6 percent (5/90) of the respondents. Either the choice of orientation to the PTL or to the direction which the device is pointed should have the most merit from a human factors standpoint. With either of these orientation methods, the visual registration of that which is represented on the display to that which is seen should be easiest. However, these two choices received only 11 (12 percent) and 16 (18 percent) preferences, respectively.

The results of the two alternate message formats were split, which suggests the need for a follow-on objective test and measurement, as do several of the display design items. Tests have been planned for issues of the content and display of alerting information, cueing accuracy, device orientation, and landmark symbology. Additional issues which should be examined further, and are likely to have high payoff for the soldier-machine interface, include information requirements during specific events for specific missions, "expert" recommendations for information requirements, display mode (e.g., hand-held device vs. integrated weapon display), display clutter and number of targets, device dimensions and display resolution, correlation of the display to the visual scene, and the ability to interact with the input device. Additional soldier-machine interface issues are suggested in the Human Factors Engineering Statement (Kurtz, 1985) and by the list of performance issues in Appendix A.

This survey has provided valuable information on the human factors of SHORAD C^2 information requirements and device design. The survey made it possible to obtain data quickly on many display concepts which, had they been developed for comparison testing, would have required extensive resources. A difficulty of this type of survey is that it relies on the participants' ability to imagine a technological advancement as well as a dynamic and pictorial display. The survey has provided only subjective preferences by a wide range of SHORAD users. The data do not provide definitive answers for display design choices. The survey results do provide a baseline for the selection of issues which need further examination through objective testing of prototype devices.

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APPENDIX A

PARTIAL LIST OF SOLDIER PERFORMANCE ISSUES FOR SHORAD C^2

PARTIAL LIST OF SOLDIER PERFORMANCE ISSUES FOR SHORAD C^2

A list of SHORAD human factors research questions follows. There are eight topics coded A through H: A displays, general; B target display; C dialogue; D procedures; E mode of input; F operations; G user characteristics; and H methodology development. The term node refers to subsystems.

A Displays - General

A.1 What is the optimum area size to represent on each node's display? What is the greatest distance ever needed for each node? What is the usual distance needed? Should any of the nodes have fixed areas? Where should the node be represented within the area: centered or located to maximize sector of responsibility? How should size be controlled: by function keys, typed commands, or other means?

A.2 Which display orientation of a FU device will maximize effective use as a detection cueing or pointing device? [Also use of landmarks and sector of fire symbology.]

A.3 For matrix-addressable displays, what are acceptable characteristics of (1) "cell loss" (number and distribution), (2) small area nonuniformity (luminance of neighboring elements), (3) chrominance and luminance tradeoff (especially for high ambient), (4) upper and lower case font, (5) tactical symbology? [Evaluated for task specific cases: map-graphical search and textual legibility and readability.]

A.4 [color - multiple issues]

A.5 What is the tradeoff among cost, risk, and utility for large screen display applications? [Are there any candidates commercially available? What is the practicality of registering paper maps to the LSD? What resolution requirements are there? What are the constraints on workspace, viewability, and location?]

A.6 What are the problems encountered when using other than a hand-held visual display for general information displays? [modality - see B.2]

A.7 [alerting of critical events - general recommendations]

A.8 [integrated design recommendations]

A.9 Selection of output devices other than real-time displays (printers)?

B Target Display

B.1 What is the least precise cueing or pointing resolution possible for a gunner to translate device-grid cueing to aircraft detection to minimize detection time and maximize detection range?

B.2 What is the best mode of presentation for target cueing or alerting of a gunner? (What is the optimal format: graphical or alphanumeric?)

B.3 What alerting procedure (range or ETA) and resolution combination is most effective for readying the gunner for an engagement?

B.4 How much information should be displayed when there are many targets? Is the gunner able to selectively identify and correlate cued-target indications to specific aircraft (i.e., effectiveness of saturation-alleviation algorithms).

B.5 Is a predictive, continuous movement of the target on the display more effective for cueing than a discrete movement, occurring with each update?

B.6 What is the best rate of updating the target priority? [Too fast of an update might interrupt the acquistion and engagement procedures. Too slow might cue to unengageable or low priority targets.]

B.7 What degree of specification of target information is needed at command levels? Can multiple targets be clustered?

B.8 Should there be a difference in symbology depending on the accuracy of the data (e.g., using symbols of different sizes for alerting and cueing, as specified)?

C Dialogue

C.1 What dialogue types are most effective for user-message interaction? Which dialogue layout is better: common or separate dialogue and information display areas? For menu dialogues what should the depth of the menu be, how many choices are appropriate for a single menu, what should the format and coding of the menu be? How should help-systems be accessed and what should be their content?

C.2 ("user friendly" operating procedures)

D Procedures

D.1 Is the classification of SHORAD data into the RFP information sets appropriate, considering the priorities and information distribution procedures?

D.2 (decision aiding - multiple issues)

D.3 (information management - see D.2 as related area)

E Mode of Input

E.1 What are the most effective input devices?

E.2 What techniques are most effective for specifying and selecting targets or graphical information (i.e., hooking)?

F Operations

F.1 What is the degradation in viewing and controlling from MOPP 0 to MOPP 1-4, with the cold weather uniform?

F.2 (workspace - general and specific recommendations)

F.3 (manual back-up)

F.4 What effects do battle stressors, like fatigue, have on the user operation of the device?

F.5 (Bn task allocation)

F.6 (operation on move)

F.7 (operation in blackout conditions)

G User Characteristics

G.1 What are the preferred user characteristics (level of computer skills), user acceptance, and user satisfaction?

H Methodology Development

H.1 What are appropriate methodologies for assessing cognitive workload to predict human performance in emergencies characterized by an overload of information, the need for the operator to make critical choices, and the stress of battle.

H.2 What methodologies are appropriate for studying transmission and reception, perception and understanding, and effective use of SHORAD C^2 information?

APPENDIX B

USAHEL SHORAD QUESTIONNAIRE BACKGROUND AND INSTRUCTIONS

USAHEL SHORAD Fire Unit Questionnaire

The United States Army Human Engineering Laboratory (USAHEL) is the Army's lead laboratory in the assessment of the soldier-equipment interface. Our purpose is to increase the efficiency and ease of use of Army materiel.

The purpose of this questionnaire is to improve a new short-range air defense command and control (SHORAD C^2) system. The laboratory is working currently on the design of this system. It is very important to find out how you think the system should work. Your honest opinion is essential.

At the fire unit, the SHORAD C^2 system will provide a device, similiar to the TADDS, but with greatly improved reliability, capability, and quickness of operation. In addition to target location and identification, the system will be able to display other important information in written or map form. Also, the device will allow two-way communication by data or digital link and will replace much of the voice radio transmission currently required.

At the radar, one of the purposes of the SHORAD C^2 system will be to enter target data into the system.

At battalion, the associated devices will have many command purposes and capabilities.

Each question should be answered according to the instructions. All answers and personal data provided will be treated with regards to your privacy in accordance with the Privacy Act of 1974. If you have any questions, please ask one of the questionnaire administrators for assistance. When you have completed the questionnaire, leave it with one of the administrators.

1. Length of military service: _____ year(s) _____ month(s)

2. Rank: _____ 3. Primary MOS: _____

4. Number of years and months in primary MOS: _____ yr(s) _____ month(s)

5. Additional MOSs (if any): _____ 6. Age: _____

7. Check the highest level of education completed.

_____ 11th grade or below
_____ High school diploma
_____ Graduate equivalency degree (GED)
_____ Some college
_____ College degree

8. Check all of the following which apply to you:

_____ Have played video games
_____ Frequently play video games
_____ Have taken computer course(s)
_____ Have had some experience with a home computer
_____ Have had a lot of experience with a home computer
_____ Have used a computer some of the time in my work
_____ Have used a computer much of the time in my work

APPENDIX C

USAHEL SHORAD FIRE UNIT QUESTIONNAIRE

USAHEL SHORAD FIRE UNIT QUESTIONNAIRE

1. Place a check mark by those items of information which you must know to complete your combat mission. Place a question mark "?" by any item which you do not understand.

_____ Target position
_____ Target speed
_____ Target heading
_____ Target identification
_____ Target type
_____ Kill assessment
_____ Raid size or number of aircraft
_____ Track designator
_____ Engagement priority
_____ Jamming or electronic countermeasures (ECM)
_____ Map location of weapon
_____ Number of rounds or missiles remaining
_____ Primary target line
_____ Sector of fire
_____ Area of operations
_____ Weapons control status
_____ Air defense warning
_____ Defended asset
_____ Priority of assets
_____ Air corridors
_____ Weapons engagement zone
_____ Identification friend or foe (IFF)/selective identification feature (SIF) codes
_____ Communications-electronics operation instructions (CEOI)
_____ NBC report 1-5
_____ Firing doctrine
_____ Rules of engagement
_____ Hostile criteria
_____ Enemy activity report
_____ Movement order and mission
_____ Map data, including manmade objects (roads, buildings, bridges)
_____ Battle lines and other battlefield geometry
_____ State of alert
_____ Highest priority target
_____ Warning report
_____ MOPP status
_____ Ammunition resupply point
_____ POL resupply point

2. Of those items which you checked in the question above, list the 5 most important items in the first column below. List them in order of importance with 1 being the most important, 2 being less important, and so forth.

Then for each item indicate how often you would use the information.

Items	Continuously-every few seconds	Immediately-every few minutes	Occasionally-every few hours	Infrequently-every few days or weeks
1.				
2.				
3.				
4.				
5.				

**In the following section, circle the letter of the best answer or fill in the blank.

3. How would you like to have target position represented?
   a. Target range and azimuth (compass heading)
   b. Target's geographic coordinates
   c. Other (please specify) _____
   d. Undecided

4. How would you like to have target altitude represented?
   a. An elevation in degrees
   b. An altitude category such as high, medium, or low
   c. An altitude reading (meters or feet)
   d. Other (please specify) _____
   e. Undecided

5. Which category of identification do you prefer?
   a. Hostile, friend, unknown
   b. Positive, hostile, all others
   c. Positive, friend, all others
   d. None of the above

6. How do you want targets to be classified?
   a. Jet, propeller, helicopter, missile, unknown
   b. Fixed wing, rotary wing, missile, unknown
   c. Specific targets, such as F-15, A-10, Hind-D, etc.
   d. None of the above

**Answer the following questions assuming that you have an automatic display capable of showing target position beyond visual range.

7. How would you like the air battle picture shown?
   a. The single most threatening target
   b. The 2 most threatening targets
   c. The 3 to 5 most threatening targets
   d. All hostile targets
   e. All hostile and unknown targets
   f. All targets (hostile, unknown, and friendly)
   g. Other (please specify) _____

8. If the map display device indicates the highest priority target, how often would you like the priority determined?
   a. After engagement was completed or called off
   b. Sometime before engagement is completed
   c. Every _____ seconds (fill in the blank)
   d. Undecided

9. What method of display target movement do you prefer?
   a. The target to move when the radar has updated the new position
   b. The target to move continuously as predicted from the last known position, heading, and speed
   c. Other (please specify) _____
   d. Undecided

10. Out to what range would you like to have target information supplied?
    a. 10 km
    b. 15 km
    c. 20 km
    d. 30 km
    e. 40 km
    f. Other (please specify) _____
    g. Undecided

11. Answer the following 4 statements by filling in the blanks.
    a. I want to know that a hostile or unknown target is present when it is ____ km away
    b. I want to know that a friendly aircraft is present when it is ____ km away
    c. I want to know the exact position of a hostile or unknown target when it is ____ km away
    d. I want to know the exact position of a friendly aircraft when it is ____ km away

12. What target position accuracy do you want?
    a. To within 100 m (1/10 km)
    b. To within 500 m (1/2 km)
    c. To within 1 km
    d. To within 2 km
    e. To within 5 km
    f. Other (please specify) _____
    g. Undecided

13. Which statement do you agree with the most?
    a. I want to know the positions of targets only within my primary sector of fire
    b. I want to know the positions of targets within my primary or secondary sector of fire
    c. I want to know the position of targets within or near my weapons engagement zone
    d. I want to know the position of all targets
    e. Undecided

14. How would you prefer to receive target position information from beyond visual range?
    a. From a display map
    b. From voice commands directing or pointing to the direction of the target
    c. From a display map shown within the weapon sight
    d. From tones, beeps, or other sounds directing or pointing to the direction of the target
    e. Undecided

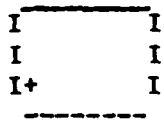
15. When a target is outside of your visual range, which would you prefer for alerting?
    a. Know only the estimated time of arrival
    b. Know only the general direction of approach
    c. Know both the estimated time of arrival and the general direction of approach
    d. Other (please specify) _____
    e. Do not want to know anything about this type of target
    f. Undecided

16. Where would you like to have your position located on the display? Refer to the diagrams found below.

a. At center of display map

b. At top or bottom of display map

c. In corner of display map



d. At either side of display map

e. Other (please mark with an X)

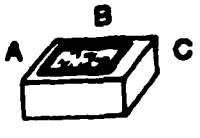
f. Undecided

17. How would you like the display map to be oriented?
   a. The top of the display map should always represent north
   b. The top of the display map should always represent the PTL
   c. The top of the display map should be changeable to one of the four compass directions (east, west, north, south)
   d. The top of the display map should change direction as the display "box" is pointed to different directions
   e. Other (please specify) _____
   f. Undecided

18. About how large would you like the display area of the map device to be?
   a. 4" x 4"
   b. 6" x 6"
   c. 8" x 8"
   d. 10" x 10"
   e. Other (please specify _____
   f. Undecided

   Explain why you chose the size you did. _____
   _____
   _____

19. What is the largest size of the map display device (including battery power source) that you would be willing to use and carry?



A. _____ inches

B. _____ inches

C. _____ inches

20. What is the maximum weight that the map display device should be?
_____ pounds

**There are different ways of broadcasting voice messages. Two examples of reporting initial, update, and scrub messages follow. Read the example and answer the following questions.

EXAMPLE A

Initial Track, Initial Track
Unknown
At Legion Three, Four
Heading Southwest
One (optional)
Jet (optional)
Track Designator: Alpha Zero One

Track Update
Alpha Zero One
Now at Kentucky Seven, Eight
Heading Southwest

Scrub Track
Alpha Zero, One

EXAMPLE B

New Track
(identification only reported for positive hostile or friendly tracks)
At Legion Three, Four
Track: Alpha Zero, One

Update
Apha Zero, One
At Kentucky Seven, Eight

Scrub
Alpha Zero, One

21. Which example would you prefer to use?
    a. Message format A
    b. Message format B
    c. Undecided

22. Which example would be quicker to broadcast over radio?
    a. Message format A
    b. Message format B
    c. No difference in quickness
    d. Undecided

23. Which example would be easier to understand?
    a. Message format A
    b. Message format B
    c. No difference in ease of understanding
    d. Undecided

24. Which example gives the information which you would rather have?
    a. Message format A
    b. Message format B
    c. No difference in information
    d. Undecided

25. What do you think is the biggest problem related to SHORAD command and control? Explain.

26. What do you think is the biggest problem related to air defense artillery (ADA)? Explain.

27. If you have any comments about this questionnaire, please explain.

APPENDIX D

USAHEL SHORAD FAAR QUESTIONNAIRE

USAHEL SHORAD FAAR QUESTIONNAIRE

1. Place a check mark by those items of information which you must know to complete your combat mission. Place a question mark "?" by any item which do you not understand.

_____ Target position
_____ Target speed
_____ Target heading
_____ Target identification
_____ Target type
_____ Kill assessment
_____ Raid size or number of aircraft
_____ Track designator
_____ Engagement priority
_____ Jamming or electronic countermeasures (ECM)
_____ Map location of FAAR
_____ Primary target line
_____ Sector of fire
_____ Sector of sensor radiate
_____ Sector of sensor blink
_____ Area of operations
_____ Weapons control status
_____ Air defense warning
_____ Defended asset
_____ Priority of assets
_____ Air corridors
_____ Weapons engagement zone
_____ Identification friend or foe (IFF)/selective identification feature (SIF) codes
_____ Communications-electronics operation instructions (CEOI)
_____ NBC report 1-5
_____ Firing doctrine
_____ Rules of engagement
_____ Hostile criteria
_____ Enemy activity report
_____ Movement order and mission
_____ Map data, including manmade objects (roads, buildings, bridges)
_____ Battle lines and other battlefield geometry
_____ State of alert
_____ Highest priority target
_____ Warning report
_____ MOPP status
_____ Ammunition resupply point
_____ POL resupply point

2. Of those items which you checked in the question above, list the 5 most important items in the first column below. List them in order of importance with 1 being the most important, 2 being less important, and so forth.

Then for each item indicate how often you would use the information.

Items	Continuously-every few seconds	Immediately-every few minutes	Occasionally-every few hours	Infrequently-every few days or weeks
1.				
2.				
3.				
4.				
5.				

3. Place a check mark by the battlefield geometry information types, if any, which would be useful if displayed on a computer-generated map. Place a question mark "?" by any items which you do not understand.

_____ Coordinated artillery point (CAP)
_____ Forward line of own troops (FLOT)
_____ Forward edge of the battle area (FEBA)
_____ Fire support coordination line (FSCL)
_____ Unit boundary
_____ Restricted fire line
_____ Air defense identification zone (ADIZ)
_____ High density airspace control zone (HIDACZ)
_____ Low-level transit route (LLTR)
_____ Safe corridor
_____ Missile engagement zone (MEZ)
_____ Fighter engagement zone (FEZ)
_____ Airfield
_____ Restricted area
_____ Short-range air defense engagement zone (SHORADEZ)
_____ Coordination line (CL)
_____ Weapons free zone (WFZ)
_____ Weapons control volume
_____ Landing zone
_____ Drop zone
_____ Air head
_____ Asset point
_____ Mine field
_____ NBC report 1
_____ NBC report 2
_____ NBC report 3
_____ NBC report 4
_____ NBC report 5
_____ Data link reference point

** In the following section, circle the letter of the best answer.

4. How would you like to have target position represented?
   a. Target range and azimuth (compass heading)
   b. Target's geographic coordinates
   c. Other (please specify) _____
   d. Undecided

5. How would you like to have target altitude represented?
   a. An elevation in degrees
   b. An altitude category such as high, medium, or low
   c. An altitude reading (meters or feet)
   d. Other (please specify) _____
   e. Undecided

6. Which category of identification do you prefer?
   a. Hostile, friend, unknown
   b. Positive hostile, all others
   c. Positive friend, all others
   d. None of the above

7. How do you want targets to be classified?
   a. Jet, propell[illegible] helicopter, missile, unknown
   b. Fixed wing, [illegible]tary wing, missile, unknown
   c. Specific type, such as F-15, A-10, Hind-D, etc.
   d. None of the above

** Answer the following questions assuming that you have an automatic display capable of showing target position beyond visual range.

8. How would you like the air battle picture shown?
   a. The single most threatening target
   b. The 2 most threatening targets
   c. The 3 to 5 most threatening targets
   d. All hostile targets
   e. All hostile and unknown targets
   f. All potential targets (hostile, unknown, and friendly)
   g. Other (please specify) _____
   h. Undecided

9. If the map display device indicates the highest priority target, how often would you like the priority determined?
   a. After engagement was completed or called off
   b. Sometime before engagement is completed
   c. At a fixed interval of _____ seconds (fill in the blank)
   d. Undecided

10. What method of display target movement do you prefer?
   a. The target to move when the radar has updated the new position
   b. The target to move continuously as predicted from the last known position, heading, and speed
   c. Other (please specify) _____
   d. Undecided

11. Out to what range would you like to have target information supplied?
   a. 10 km
   b. 15 km
   c. 20 km
   d. 30 km
   e. 40 km
   f. Other (please specify) _____
   g. Undecided

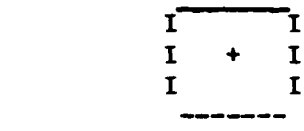
12. Answer the following 4 statements by filling in the blanks.
   1. I want to know that a hostile or unknown target is present when it is ____ km away
   2. I want to know that a friendly aircraft is present when it is ____ km away
   3. I want to know the exact position of a hostile or unknown target when it is ____ km away
   4. I want to know the exact position of a friendly aircraft when it is ____ km away

13. What target position accuracy do you want?
    a. To within 100 m (1/10 km)
    b. To within 500 m (1/2 km)
    c. To within 1 km
    d. To within 2 km
    e. To within 5 km
    f. Other (please specify) _____
    g. Undecided

14. Which statement do you agree with the most?
    a. I want to know the positions of targets only within my primary sector of search
    b. I want to know the positions of targets within my primary or secondary sector of search
    c. I want to know the position of all targets within my radar coverage area
    d. I want to know the position of targets within my radar coverage area and from other sensors as well
    e. Undecided

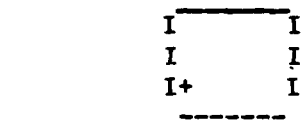
15. Where would you like to have your position located on the display? Refer to the diagram(s) found below.

    a. At center of display map

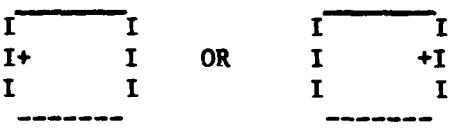


    b. At top or bottom of display map

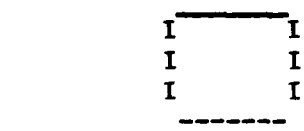
    c. In corner of display map



    d. At either side of display map



    e. Other (please mark with an X)



    f. Undecided

16. How would you like the radar display to be map oriented?
    a. The top of the display map to always represent north
    b. The top of the display map to always represent your PTL degrees
    c. The top of the display map to be changeable to one of the four compass directions (east, west, north, south)
    d. The top of the display map to change direction as the display "box" is pointed to different directions
    e. Other (please specify) _____
    f. Undecided

17. About how large would you like the radar display area to be?
    a. Smaller than FAAR (please specify) _____
    b. Same as FAAR (About 9" diameter)
    c. Larger than FAAR (Please specify) _____
    d. Undecided

    Explain why you chose the size you did._____
    _____
    _____

** There are different ways of broadcasting voice messages. Two examples of reporting initial, update, and scrub messages follow. Read the examples and answer the following questions.

EXAMPLE A

Initial Track, Initial Track
Unknown
At Legion Three, Four
Heading Southwest
One (optional)
Jet (optional)
Track Designator: Alpha Zero One

Track Update
Alpha Zero One
Now at Kentucky Seven, Eight
Heading Southwest

Scrub Track
Alpha Zero, One

EXAMPLE B

New Track
(identification only reported for positive hostile or friendly tracks)
At Legion Three, Four
Track: Alpha Zero, One

Update
Alpha Zero One
At Kentucky Seven, Eight

Scrub
Alpha Zero, One

18. Which example would you prefer to use?
    a. Message format A
    b. Message format B
    c. Undecided

19. Which example would be quicker to broadcast over radio?
    a. Message format A
    b. Message format B
    c. No difference in quickness
    d. Undecided

20. Which example would be easier to understand?
    a. Message format A
    b. Message format B
    c. No difference in ease of understanding
    d. Undecided

21. Which example gives the information which you would rather have?
    a. Message format A
    b. Message format B
    c. No difference in information
    d. Undecided

22. What do you feel is the biggest problem related to SHORAD command and control? Explain.

    _____
    _____
    _____
    _____

23. What do you feel is the biggest problem related to air defense artillery (ADA)? Explain.

    _____
    _____
    _____
    _____

24. If you have any comments about this questionnaire, please explain.

    _____
    _____
    _____
    _____

APPENDIX E

USAHEL SHORAD BN QUESTIONNAIRE

USAHEL SHORAD BN QUESTIONNAIRE

1. Place a check mark by those items of information which you must know to complete your combat mission. Place a question mark "?" by any item which do you not understand.

_____ Target position
_____ Target speed
_____ Target heading
_____ Target identification
_____ Target type
_____ Kill assessment
_____ Raid size or number of aircraft
_____ Track designator
_____ Engagement priority
_____ Jamming or electronic countermeasures (ECM)
_____ Map location of battalion
_____ Number of rounds or missiles remaining
_____ Primary target line
_____ Sector or fire
_____ Sector of sensor radiate
_____ Sector of sensor blink
_____ Area of operations
_____ Weapons control status
_____ Air defense warning
_____ Defended asset
_____ Priority of assets
_____ Air corridors
_____ Weapons engagement zone
_____ Identification friend or foe (IFF)/selective identification feature (SIF) codes
_____ Communications-electronics operation instructions (CEOI)
_____ NBC report 1-5
_____ Eiring doctrine
_____ Rules of engagement
_____ Hostile criteria
_____ Enemy activity report
_____ Movement order and mission
_____ Map data, including manmade objects (roads, buildings, bridges)
_____ Battle lines and other battlefield geometry
_____ State of alert
_____ Highest priority target
_____ Warning report
_____ MOPP status
_____ Ammunition resupply point
_____ POL resupply point

2. Of those items which you checked in the question above, list the 5 most important items in the first column below. List them in order of importance with 1 being the most important, 2 being less important, and so forth.

Then for each item indicate how often you would use the information.

Items	Continuously-every few seconds	Immediately-every few minutes	Occasionally-every few hours	Infrequently-every few days or weeks
1.				
2.				
3.				
4.				
5.				

3. Place a check mark by the battlefield geometry information types, if any, which would be useful if displayed on a computer-generated map. Place a question mark "?" by any item which you do not understand.

_____ Coordinated artillery point (CAP)
_____ Forward line of own troops (FLOT)
_____ Forward edge of the battle area (FEBA)
_____ Fire support coordination line (FSCL)
_____ Unit boundary
_____ Restricted fire line
_____ Air defense identification zone (ADIZ)
_____ High density airspace control zone (HIDACZ)
_____ Low-level transit route (LLTR)
_____ Safe corridor
_____ Missile engagement zone (MEZ)
_____ Fighter engagement zone (FEZ)
_____ Airfield
_____ Restricted area
_____ Short-range air defense engagement zone (SHORADEZ)
_____ Coordination line (CL)
_____ Weapons free zone (WFZ)
_____ Weapons control volume
_____ Landing zone
_____ Drop zone
_____ Air head
_____ Asset point
_____ Mine field
_____ NBC report 1
_____ NBC report 2
_____ NBC report 3
_____ NBC report 4
_____ NBC report 5
_____ Data link reference point

4. For the following SHORAD Bn command and control functions, rank the importance to the combat mission of each (1 being the most important, 10 being the least important).

_____ Conduct training
_____ Coordinate with supported unit
_____ Deploy and assessing missions
_____ Manage firepower (weapons and jammers)
_____ Manage sensors
_____ Monitor status of subordinates
_____ Perform administration
_____ Perform logistics support
_____ Provide air defense warnings

List any SHORAD Bn functions which you do not feel are included or implied by these function titles.

_____ _____
_____ _____

** In the following section, circle the letter of the best answer or fill in the blank.

5. How would you like to have target position represented?
   a. Target range and azimuth (compass heading)
   b. Target's geographic coordinates
   c. Other (please specify) _____
   d. Undecided

6. How would you like to have target altitude represented?
   a. An elevation in degrees
   b. An altitude category such as high, medium, or low
   c. An altitude reading (meters or feet)
   d. Other (please specify) _____
   e. Undecided

7. Which category of identification do you prefer?
   a. Hostile, friend, unknown
   b. Positive hostile, all others
   c. Positive friend, all others
   d. None of the above

8. How do you want targets to be classified?
   a. Jet, propeller, helicopter, missile, unknown
   b. Fixed wing, rotary wing, missile, unknown
   c. Specific type, such as F-15, A-10, Hind-D, etc.
   d. None of the above

** Answer the following questions assuming that you have an automatic display capable of showing target position beyond visual range.

9. How would you like the air battle picture shown?
   a. The single most threatening target
   b. The 2 most threatening targets.
   c. The 3 to 5 most threatening targets
   d. All hostile targets
   e. All hostile and unknown targets
   f. All potential targets (hostile, unknown, and friendly)
   g. Other (please specify) _____
   h. Undecided

10. What method of display target movement do you prefer?
   a. The target to move when the radar has updated the new position
   b. The target to move continuously as predicted from the last known position, heading, and speed
   c. Other (please specify) _____
   d. Undecided

11. For what area would you like to have target information supplied?
   a. 100 x 100 km
   b. 200 x 200 km
   c. 400 x 400 km
   d. 600 x 600 km
   e. Other (please specify) _____
   f. Undecided

12. Answer the following 4 statements by filling in the blanks.
    1. I want to know that a hostile or unknown target is present when it is _____ km away.
    2. I want to know that a friendly aircraft is present when it is _____ km away.
    3. I want to know the exact position of a hostile or unknown target when it is _____ km away.
    4. I want to know the exact position of a friendly aircraft when it is _____ km away.

13. What target position accuracy do you want?
    a. To within 100 m (1/10 km)
    b. To within 500 m (1/2 km)
    c. To within 1 km
    d. To within 2 km
    e. To within 5 km
    f. Other (please specify) _____
    g. Undecided

14. Where would you like to have your position located on the display? Refer to the diagrams found below.
    a. At center of display map
    b. At top or bottom of display map

    c. In corner of display map
    d. At either side of display map

    e. Other (please mark with an X)
    f. Undecided

15. How would you like the map display to be oriented?
    a. The top of the display map to always represent north
    b. The top of the display map to always represent your PTL degrees
    c. The top of the display map to be changeable to one of the four compass directions (east, west, north, south)
    d. The top of the display map to change direction as the display "box" is pointed to different directions
    e. Other (please specify) _____
    f. Undecided

16. About how large would you like the radar display area to be?
    a. 8" x 8"
    b. 11" x 11"
    c. 14" x 14"
    d. 17" x 17"
    e. 20" x 20"
    f. Other (please specify) _____
    g. Undecided
    Explain why you chose the size you did._____
    _____
    _____

17. How useful would a large screen display (1 meter x 1 meter) be for depicting the battle situation?
    a. Extremely useful
    b. Of considerable use
    c. Of use
    d. Not very useful
    e. Of no use

18. What size or capacity would you like the track file to be?
    a. 50
    b. 100
    c. 200
    d. 300
    e. 500
    f. Other (please specify) _____
    g. Undecided

** There are different ways of broadcasting voice messages. Two examples of reporting initial, update, and scrub messages follow. Read the examples and answer the following questions.

EXAMPLE A

Initial Track, Initial Track
Unknown
At Legion Three, Four
Heading Southwest
One (optional)
Jet (optional)
Track Designator: Alpha Zero One

Track Update
Alpha Zero One
Now at Kentucky Seven, Eight
Heading Southwest

Scrub Track
Alpha Zero, One

EXAMPLE B

New Track
(identification type only reported for positive hostile or friendly tracks)
At Legion Three, Four
Track: Alpha Zero, One

Update
Alpha Zero One
At Kentucky Seven, Eight

Scrub
Alpha Zero, One

19. Which example would you prefer to use?
    a. Message format A
    b. Message format B
    c. Undecided

20. Which example would be quicker to broadcast over radio?
    a. Message format A
    b. Message format B
    c. No difference in quickness
    d. Undecided

21. Which example would be easier to understand?
    a. Message format A
    b. Message format B
    c. No difference in ease of understanding
    d. Undecided

22. Which example gives the information which you would rather have?
    a. Message format A
    b. Message format B
    c. No difference in information
    d. Undecided

23. What do you feel is the biggest problem related to SHORAD command and control? Explain.

_____
_____
_____
_____

24. What do you feel is the biggest problem related to air defense artillery (ADA)? Explain.

_____
_____
_____
_____

25. If you have any comments about this questionnaire, please explain.

END

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