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Studies Made by Human Research Unit Nr I, CONARC During Project STALK

Part I—Results of Interviews with the STALK Crew Members (U)

by

Andrew J. Eckles III, Melvin A. Schmitz and Norman Willard, Jr.

U.S. Army Armor Human Research Unit
Fort Knox, Kentucky

Under the Technical Supervision of

The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
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CONFIDENTIAL

Task STALK

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During Project STALK

Part I—Results of Interviews with the STALK Crew Members (U)

SUMMARY AND CONCLUSIONS

THE PROBLEM

The primary objective of Project STALK, conducted jointly by the Ballistics Research Laboratories and the Office of the Chief of Army Field Forces, was to determine the time required to achieve a hit on a suddenly appearing target with the main armament of several contemporary United States tanks. Five tanks—the M4, T41, M47, M47E1, and M48—were tested, using various combinations of fire control equipment.

As part of this over-all project, the Human Research Unit Nr 1 was asked to measure crew preferences and attitudes toward the different tanks and equipment used in the project.[1] It was felt that some such measure was necessary, since strong preferences on the part of the crewmen for or against any tank or equipment might seriously bias the results of the tests. In addition, the project provided an excellent opportunity to obtain information which might be of value in the human engineering field.

THE METHOD

The STALK tests were conducted at Camp Irwin, Calif., during September-December 1953. Tank crews were supplied by the 2d Battalion of the 11th Armored Cavalry Regiment, a representative user unit, which was authorized to execute the test. The 140 crew members (25 five-man crews and 15 alternates) had been selected as tank crewmen and assigned to their positions prior to the assignment of the 2d Battalion to the project.[2]

The project was divided into five phases, each phase covering the training and testing on one tank. Each platoon (five tanks) was trained on the tanks in different order. The crew members were interviewed after each phase of the project; tank commanders and gunners were also interviewed separately, as range finder operators, after they were tested on the tanks equipped with this instrument—the M47, M47E1, and M48. Crew members were assured that their responses would be confidential, to be used only for research purposes.

The interviews were conducted by six enlisted men from the 2d Battalion, each man interviewing all the crew members holding one position. None of the six had had previous experience with interviewing; they were trained in appropriate techniques before the first round of interviews, and were provided with interview schedules to follow. These schedules were revised as necessary after each phase, in an effort to maximize the amount of relevant information obtained.

[1]The Unit was also asked to help formulate the research design, in order to control for various human factors which might bias or distort results, and to measure the proficiency of individual crew members at different stages of the project, with special attention being given to the training and proficiency of range finder operators. The results with respect to the operators will be incorporated in reports stemming from Task RANGEFINDER.

[2]Shortly before the beginning of the project, the participating crewmen were tested on potential proficiency as range finder operators; so far as possible, the tank commanders and gunners, who would operate the range finders, were chosen from those who showed high potential proficiency as operators.

SUMMARY AND CONCLUSIONS

FINDINGS

Operation

(1) Tank commanders reported that the over-ride controls on the M47 and M48 models were too low for the commander to reach them easily from the observation position in which he has his head and shoulders outside the turret.

(2) Gunners said that (a) on the M48, the manual firing switch was difficult to use because of its position, and that the ammunition selection handle, at the gunner's right rear, was hard to reach and operate; (b) on the M47E1, the ballistic unit was difficult to work with; (c) on the M48, M47, and M47E1, the turret traversed too slowly when operated manually.

(3) Drivers thought that the position of the brake pedals on the M47 and M48 made them difficult to operate; on the M47, the brake and accelerator were too close together, and on the M48 the brake pedal was too high on the front of the hull. They suggested that the accelerator on the M48 be moved to the left so that the left foot could operate it and the right foot the brake. Most drivers preferred wobble stick steering to the wheel.

(4) Loaders reported that ammunition storage on the M47 models caused trouble, because the turret had to be traversed to get at new rounds. They thought that reset switches and used-round disposal equipment were needed on the M48. About half the loaders reported that they had difficulty in loading the M47E1 stabilized gun during movement over rough terrain.

Vision

(1) Tank commanders reported that visibility was generally poor because of obscuration by dust, causing difficulty in sensing rounds. They said they preferred to use binoculars rather than the periscope or range finder for sensing.

(2) Gunners preferred the M12 range finder and the T156 telescope to the M20 periscope as sighting devices, because of their greater magnification. A large percentage of the gunners could not use the burst-on-target method satisfactorily because of obscuration by dust and because of the low magnitude of the M20 periscope.

(3) Drivers reported that visibility on the M47 was poor, and that on the M48 the periscopes tended to fall out of their mounts during movement over rough terrain.

Comfort and Safety

(1) Tank commanders suggested that on the M47 models a guard be placed around the commander's platform to prevent his catching a foot between the turret and the hull.

(2) Drivers asked that the exhaust outlets be moved to the side of the tank so that the engine cover plates would not become too hot to handle.

Range Finder Operation

(1) Commanders preferred the T46E1 range finder to the M12.

(2) Most operators thought that the range finder should be operated by the gunner rather than the commander.

(3) About half of the operators thought they could achieve a hit more quickly using the range finder to determine range.

SUMMARY AND CONCLUSIONS

Job Load

(1) About half of the commanders thought that their work load on the M48 was too heavy and recommended that the range finder be returned to the gunner.

(2) Other crew members were generally satisfied with the distribution of the work load on each of the tanks.

Crew Preferences

(1) Crew members ranked the tanks in the following order, according to their estimates of how well their crew had performed on them: M47E1, M47, T41, M48, M4. They thought that they had been well trained on the M47 models, whereas many men expressed a need for more training on the M48.

(2) For combat use the men ranked the tanks in this order: M47E1, M47, M48, T41, and M4. The features cited most often as the reason for favoring a tank were the stabilized gun of the M47E1 and the heavy armor of the M48.

CONCLUSIONS

The information obtained from the STALK crewmen points up several problem areas in the tank program as it has been developed at the time of the project. The findings lend themselves to three interpretations:

(1) The many suggestions and comments made by the crew members concerning specific changes may indicate that U.S. tanks have not been given adequate human engineering in the past. Maximum efficiency can not be expected of tank crews unless they are given adequate consideration by the men who design their equipment.

(2) It may be that users do not readily accept new and complex equipment, perhaps because they do not know enough about it. The advantages inherent in the M48, for instance, may not have been "sold" to the users.

(3) The men's reactions may also reflect the varying quality of the training they received on the different tanks. Lack of complete understanding and familiarity with a tank could lead to poor performance, and poor performance might well bias their opinion of the tank's capabilities. In view of the need reported by many crewmen for more training on the complex M48, this factor may have influenced the men's rankings of this tank.

Whatever the interpretation placed upon the findings, some of the suggestions made by the crew members may be of value to those responsible for human engineering U.S. tanks.

RECOMMENDATIONS

(1) The Chief of Ordnance should be advised of the findings reported herein, for such use as might be appropriate in materiel design.

(2) In tests made for purposes of equipment comparison, in order not to bias the results care should be taken to ensure that the various groups of men are trained to equivalent levels of performance on the various items to be compared. The training on each item should also be carried to the point where the men's performance would be judged acceptable for combat.

SUMMARY AND CONCLUSIONS

(3) User confidence in and acceptance of new armor equipment should be actively sought through a thorough training and "selling" job, by making sure that the user is given adequate instruction and information concerning the new equipment and by making clear to him its improvements and advantages over existing equipment. Insofar as possible, training problems should be isolated and dealt with before equipment is issued, and adequate training doctrine and techniques developed as new considerations arise.

Chapter 1

OBJECTIVES AND METHOD

THE RESEARCH PROBLEM

The primary objective of Project STALK, conducted jointly by the Ballistics Research Laboratories and the Office of the Chief of Army Field Forces in 1953, was to determine the time required to achieve a hit on a suddenly appearing target with the main armament of several contemporary United States tanks. The test was intended to compare the tanks and their fire control systems using crews selected in the same manner as combat crews, under test conditions involving some stress and making desirable a rapid rate of fire. Secondarily, the project was conceived as an experimental model for analyzing the performance of equipment involving the coordination of machines and men.

The Human Research Unit Nr 1 was given three assignments in this over-all project:

(1) To examine the test design with special reference to controlling the human variables which might bias or distort results;

(2) To measure crew preferences and attitudes toward the different tanks and special equipment used in the project;

(3) To measure the proficiency of individual crew members at different stages in the project, with special attention being given to measuring range finder proficiency.

The present report describes the Unit's work in connection with its second objective, determining the attitudes and opinions of the participating crew members.[1]

GENERAL DESCRIPTION OF THE STALK TESTS[2]

The STALK tests were conducted at Camp Irwin, Calif., from 1 September to 10 December 1953. The 25 tank crews trained and tested as crews during the project came from the 2d Battalion of the 11th Armored Cavalry Regiment, a representative user unit which was authorized to execute the test.

[1]Results of the other Unit studies made during the project, concerning the relationship between human variables and tank crew effectiveness and an evaluation of the training and performance of the range finder operators, are being reported separately.

[2]For a complete description of the STALK project, see *An Assembly of Project STALK Data* (in three volumes), Memorandum Report 745, Ballistics Research Laboratories, Aberdeen Proving Ground, January 1954 (CONFIDENTIAL).

The five tanks tested were the T41, the standard light tank, and four medium tanks, the M4, M47, M47E1, and M48. The M4—the Sherman with a 76mm gun—was used as a sort of reference vehicle since many contemporary concepts of tank design and use are based on World War II experience with the M4. The M47 was the tank in greatest supply at the time of the tests, and the M48 was the most recent medium tank designed. The M47E1 was included to permit study of the effectiveness of a gyro-stabilized gun in obtaining a hit under the conditions of the test. To determine the effect of different fire control systems on hit time, several combinations of fire control equipment were used in the Army experiment.

The 140 enlisted men who participated in the tests had been selected as tank crewmen prior to the assignment of the 2d Battalion to Project STALK. A crew consisted of five men, a platoon of 28 men—five crews plus three men who served as alternates. Of the 125 regular crew members, all but four were 16-week basic trainees.

Within each of the five platoons, the 28 men had been assigned to permanent tank crew positions on the basis of the composite judgments of the platoon officers. Before the STALK training began, all crewmen were tested by representatives of Human Research Unit Nr 1 and assigned an index of potential as a range finder operator. Since only the tank commander and the gunner would be using the range finder during the project, some adjustments were made in the assignment of men to crew positions so that, insofar as possible, men who showed potential as range finder operators would be assigned as tank commanders or gunners.

According to the STALK plan of test,[1] the 25 crews were divided into five platoons of five crews each, and the crews of each platoon were trained and tested on each of the five tanks. The project was thus divided into five phases, with each tank under test by one platoon during each phase (see Figure 1). To prevent bias due to accumulated training which might favor one tank over another, no two platoons were trained and tested on the tanks in the same order. During Phase I, for example, the

TRAINING AND TESTING SCHEDULE FOR PROJECT STALK

Phase	*Platoon*				
	1st	*2d*	*3d*	*4th*	*5th*
I	M47	M4	M47E1	T41E2	M48
II	M4	M47E1	T41E2	M48	M47
III	T41E2	M48	M47	M4	M47E1
IV	M48	M47	M4	M47E1	T41E2
V	M47E1	T41E2	M48	M47	M4

Figure 1

[1] *Op. cit.*, pp. 1-28.

five crews in the 1st platoon were given complete training on the M47 tank, each crew in the platoon being tested separately on the M47 at the end of the phase; the 2d platoon was trained and tested on the M4, the 3d platoon on the M47E1, and so on.

The test at the end of each phase was given to determine the time required by the crew to recognize a suddenly appearing target, load ammunition, and fire until a hit was achieved. The test course consisted of five targets, distributed along a trail; there were 11 such trails. Each tank type was tested on one of the trails by the five crews of one platoon. No tank crew negotiated the same test course twice.

ASSESSMENT OF CREW MEMBERS' OPINIONS

In the STALK attempt to assay the efficiency of the various tanks and fire control systems, some measure of the attitudes and preferences of the crew members was essential, since these attitudes might seriously bias test results. In addition, the project provided an excellent opportunity to obtain information of potential value in the human engineering area. For these reasons, the Human Research Unit Nr 1 was requested to measure the reactions of crewmen participating in Project STALK.

Collection of Data

It was decided to accomplish this objective by means of personal interviews with the crew members at the end of each phase. The interviews were intended not only to gather personal attitudes and opinions, but to obtain constructive criticism on such vital human engineering factors as ease of vehicle operation and deficiencies in equipment, and on effectiveness of training. Consequently, the method of interviewing and the questions asked were designed to elicit the crew members' considered judgments on the equipment under test.

Each crew member was interviewed five times; the tank commanders and gunners were also interviewed separately, as range finder operators, after they were tested on the tanks equipped with this instrument—the M47, M47E1, and M48. The interviews usually took place within 24 hours after the test run, and sometimes immediately afterward. Crew members were assured that their answers would be confidential, that is, that they were to be used for research purposes only and would not affect crew member status.

Interview schedules for each of the crew positions and for the range finder operators were drawn up, composed of questions submitted by staff members of the Unit and other interested agencies.[1] The schedule was intended not to limit the information obtained to the specific questions listed but rather as a guide for the interviewer, to provide some structure to the interviews. The type and quantity of the

[1]The interview schedules are available upon request from the U.S. Army Armor Human Research Unit, Fort Knox, Ky. (formerly Human Research Unit Nr 1, CONARC).

information which would be obtainable during such interviews could only be estimated at the beginning of the project; after each phase the researchers re-examined the interview schedule and made whatever changes seemed appropriate.[1]

The interviews were conducted by six enlisted men temporarily assigned to the Unit from the 11th Armored Cavalry Regiment. The men—none of whom had had any previous experience or training in interviewing techniques—were trained as interviewers by the research staff. Each man was assigned one crew position to interview; it was thought that this procedure would facilitate the gathering of information, as the interviewers became familiar with the problems of their assigned positions. The interviewers were instructed to (1) rephrase any question which the crew member did not understand in its original form, (2) ask him to clarify any vague or incomplete response, and (3) make an immediate record of what he said.

Tabulation of Data

Wherever possible, in the tabulation of the interview data, similar responses were grouped into general response categories, in order to simplify presentation. The following procedures were adopted for reporting the results of the study:

(1) The interview data are presented by crew position; since the crew members do not have identical duties, many questions were specific to one position.

(2) The responses for each crew position are dealt with under five major topics: operation, sighting devices, training, preferences, and suggestions for improvement.

(3) Only those human engineering problems which were mentioned by a relatively large number of crewmen are elaborated; it is assumed that these are the problems most in need of attention.

(4) Tabular data for each crew position are presented in appendices.

(5) In a separate chapter, the more important data have been re-presented, grouped this time according to tank tested instead of by crew position.

Repetition of response categories is inevitable in this method of reporting. However, what appears to be repetition of information for a given crew position actually reflects responses to the different types of questions. For example, when a gunner says that the way of storing ammunition on the M47 causes trouble, he is answering a specific question about an operational difficulty. When he says that ammunition on the M47 ought to be stored where it can be used without moving the turret, he is making a specific suggestion in response to a general "open-end" question. The similar responses are thus given in answer to questions differing in nature; the recurrence of the point might be

[1]Both the quality and quantity of the data collected improved as the project progressed. This was probably due to several factors: the increased skill of the interviewers, the greater knowledge and experience of the crew members concerning the equipment under test, and the revisions in the interview schedule.

interpreted as a kind of validation or emphasis of a human engineering difficulty.

Many of the questions pertaining to suggestions for change were of this open-end variety. Generally such questions are answered by the better educated, more articulate men; hence a large proportion of the suggestions may have come from a small number of men. For this reason, the frequencies specified are not necessarily representative of the entire sample of crewmen tested.

Chapter 2

RESULTS OF INTERVIEWS WITH CREW MEMBERS

In this chapter the information obtained from the STALK crewmen will be presented according to crew position—first the responses of the tank commanders, then of the gunners, and so forth. The data are based on a total of 125 interviews for each position, 25 for each tank. The section on responses of range finder operators is based on 75 interviews, 25 each for the M47, M47E1, and M48 tanks. In the following chapter the suggestions and criticisms pertaining to each tank will be brought together in summary form. Tabulations of the interview responses are presented in the appendices.[1]

RESPONSES OF TANK COMMANDERS[2]

Control of the tank is the responsibility of one crew member, the tank commander, who directs its operation and maintenance. In addition to performing his own duties, he must see that the other crew members are trained and prepared to perform efficiently. He must also act as eyes and ears for the tank while he is directing its operation during combat. On the M48, he operates the T46 range finder.

During Project STALK every tank commander was extensively interviewed on his own job and on the performance of the other crewmen, because Army selection and promotion processes generally ensure that he is the most skillful and experienced man in the crew, and because his position of leadership enables him to observe both his crew's performance and the operation of tank equipment.

Operation

Communications. The STALK tests required constant communication between the crew members over the intercom, and the movement of tanks in the vast training areas required extensive communication between tanks (though the tests themselves did not). Since the tank commander is an integral part of the tank intercom net, as well as being the man responsible for handling communications between tanks, he was asked if the intercom system functioned satisfactorily. About two thirds

[1] The N's for various interview items vary somewhat, because of the revision of the interview schedule during later phases on the basis of experience during the earlier phases.

[2] See Appendix A for interview data.

of the commanders said that it did; most of those who mentioned an objection said that the head set irritated the ears.

The Over-Ride Control. The tank commander is provided with an over-ride control for laying the main gun, enabling him to relieve the gunner of this task. Commanders often use the over-ride, usually releasing control to the gunner after making the first approximate lay on the target. The commanders' responses, when they were asked if they could easily reach the control, suggest that several changes are needed:

(1) They wanted the control moved closer to them.

(2) They wanted an elevation control on the M4 and the M47E1.

(3) They felt that the T41 control, which operates backward, created a training problem.

(4) They thought that the position of the M47 control was awkward.

(5) They disliked the vertical positioning required in operating the M48 control, where the pistol grip must be returned to the vertical position before the gun can be moved in the opposite direction.

Loading Before Making the Firing Run. At the end of STALK the crews were given a test during which they made firing runs with a round already loaded, a procedure which is frequently used in combat. When questioned about its effectiveness, 60 per cent of the commanders said that it did not reduce hit time, for the loader can finish loading before the gunner has completed his lay. (This response did not apply to the M47E1; its stabilized gun increased the difficulty of loading when the tank was in motion, since the gun elevation changed constantly to stay in line with the target.) However, 75 per cent of the commanders thought that this procedure did reduce lay time; since lay time is a part of hit time, this opinion contradicts the judgment that the procedure did not reduce hit time. The commanders gave no explanation of the contradiction.

Work Load. As tank design and operation become more complex, the work load of one or more of the crew members may become excessive. On the M48, half of the commanders felt that they had too many duties; the chief solution they suggested was to return range finder operation to the gunner.

Summary of Other Comments. Other aspects of operation of the various tanks drew the following comments from the tank commanders:

The M4. About a third of the commanders asked for mechanical changes in the track and suspension systems. Two thirds made comments on the operation of the turret, half of which reflected the fact that the loader's compartment does not traverse. Half of the commanders mentioned poor ammunition storage.

The T41. One third of the commanders made scattered comments on the operation of the turret. Four asked for a power elevation control on the over-ride. Almost every commander commented on the T41 fire control equipment, seven mentioning the need for a vane sight, and seven the need for a range finder. More than a third commented on discomfort, several stating that the commander's seat is not sufficiently adjustable to permit him to get his head and shoulders out of the tank.

The M47. One fourth asked for a vane sight on the M47. More than half said the commander's platform needs a guard, because it is

too small and because a foot may be caught between the platform and the revolving turret. Half of the commanders mentioned poor ammo storage.

The M47E1. One fourth said the gunner's controls should be simplified and made more easily accessible. One third recommended changes in the ammo storage.

The M48. Several commanders suggested that the M48 cut-off switch be moved nearer to the commander so that he may see and reach it more easily. Many of them suggested changes in the M48 fire control system, 10 recommending that the range finder be returned to the gunner.

Sighting Devices

Visibility and Sensing. Since the commander is responsible not only for recognizing the target but also for adjusting fire, visibility is one of his chief problems. If the gunner cannot sense the rounds, the commander is responsible for issuing orders to adjust fire on the basis of his own sensings. Less than half of the commanders said they sensed the rounds satisfactorily; two thirds of them said that rounds were lost because of obscuration by dust.

Use of the Optical Systems. The tests did not require that the commander use a particular device for sensing rounds; test conditions made it advisable for him to use whatever technique would reduce hit time. Seventy per cent of the commanders said they relied heavily on the binocular, rather than on the periscope or the range finder (although, in the M48, the range finder has greater magnification).

Training

Since the tank commander is both a student to be trained and an overseer of the training of his crew, he may look at training more critically than either a student or an instructor.

Training Effectiveness and Crew Improvement. In answer to questions about the effectiveness of the STALK training program, 23 commanders reported improvement as a result of the training and experience. Specifically, they mentioned improvement in teamwork or crew coordination, and the acquisition of skill in sensing and range estimation.

Comparison of Training on the Five Tank Types. The commanders reported that the quality of the training they had received varied for the five tanks. The great majority felt that they were best trained on the M47 and the M47E1, and most poorly trained on the M48; they thought that the M48 instructors were poorly prepared, the instruction mediocre. Such a discrepancy in training effectiveness might well affect the results of the tests.

Use of Training Time. About two thirds of the commanders felt that some training time was wasted and that additional training in certain areas would have benefited them. They most often mentioned .30 caliber manipulation and servicing of the main armament as being overemphasized; they suggested increased training on (1) firing, especially at moving targets, (2) combat tactical training, (3) range estimation and sensing, and (4) M48 fire control.

Freferences

Choice of Crew Position. Because a man's satisfaction with his job may influence his performance, the tank commanders were asked to rank the crew positions, listing first the position they liked best, and so on. The rankings, given below, show that as a group the commanders were satisfied with their own position in the crew:

Crew Position Preferred	*Rank*
Tank commander	1
Gunner	2
Driver	3
Bow gunner	4
Loader	5

Opinion of Crew Performance. At the end of Phase V the commanders were asked their opinions on the performance of their crews on the five tanks. They ranked the M47E1 first, chiefly because of its stabilized gun. The composite rankings were as follows:

Tank	*Rank*
M47E1	1
M48	2
M47	3
T41	4
M4	5

Choice of Tank for Use in Combat. The commanders were also asked to rank the five tanks in the order in which they preferred them for combat use. The composite rankings were:

Tank	*Rank*
M48	1
M47E1	2
M47	3
T41	4
M4	5

The reason most often given for preferring the M48 was the thickness and shape of its armor. The reason most often given for preferring the M47E1 was the stabilized gun system.

Relationship Between Performance and Combat Rankings. A test of the relationship between the commanders' rankings of the tanks according to their opinion of crew performance and their choice for use in combat yields a rank order correlation of .91. This high relationship suggests that the two rank orders are nearly identical. Apparently opinion of crew performance on the tanks influenced choice of tank for combat, or vice versa; or perhaps some such outside variables such as instructor bias influenced both. As the following discussions show, this high relationship, and possibly the explanations suggested here, apply also for the other crew positions.

Suggestions for Improvement

After each phase of the test, the tank commanders were encouraged to give their opinions on tank features they particularly liked or disliked. The most frequently mentioned "likes" were these:

(1) The fire control systems of the M48 and the M47E1.
(2) The general operation and ammunition storage of the T41.

The most frequently mentioned "dislikes" were these:

(1) The poor ammunition storage facilities on the M47 and M47E1.
(2) The discomfort of the commander's position (inadequate platform and seat) on the M4, M47, M47E1, and M48.

RESPONSES OF GUNNERS[1]

The gunner is primarily responsible for laying the gun on the target, firing the gun, and adjusting fire until the tank commander orders him to cease fire. In addition, he is responsible for the maintenance of the tank gun. On the M47 and the M47E1, his job also includes ranging on the target with the M12 range finder.

Operation

Controls. For the gunner to perform efficiently, the gun controls must be designed so that they are easy to reach and manipulate. The gunners most often specified the manual firing switch and the manual traverse control as causing difficulty of operation on every tank, especially the M48. They also mentioned difficulty in operating the computer box on the M48, particularly the ammunition selection handle, and the inaccessibility of the ballistic unit on the M47E1.

The ease with which the controls can be manipulated determines how quickly and accurately the gunner can lay the gun, and therefore how quickly he can get a first round hit. On four of the tanks, about two thirds of the gunners felt that they could handle the controls satisfactorily. On the M47E1, however, 60 per cent said that the controls were unsatisfactory, half of these men saying that the manual controls operated too slowly. This was also the reason given by those who said they could not handle the controls properly on the M47 and the M48.

Other Problems. The speed with which a gunner can lay on the target and fire a round also depends on the space he has to move in, and the accessibility of ammunition to the loader. Most of the gunners felt that ammunition storage on the M47 models caused trouble, because the turret had to be traversed to get at the ammunition stored under the turret floor. The gunners showed a general concern about lack of space in the M47E1; this may have been due to the added stabilizer equipment. On the M4, the men said that the ready racks were too small.

Firing Procedure. In combat a round is usually kept in the chamber for quick firing at a sighted target, but it is not known whether this procedure facilitates a hit. The gunners said that it reduced lay time, but

[1]See Appendix B.

not hit time. Their answers agreed with those of the tank commanders, and involved the same unexplained contradiction (lay time being a part of hit time).

Sighting Devices

In laying the gun and adjusting fire, the gunner depends on the sighting equipment installed in the tank. During Project STALK the M4 was equipped with the M71 telescope, the T41 with the M97 telescope, the M47 and the M47E1 with the M20 periscope and the M12 range finder, and the M48 with the M20 periscope, the T156 telescope, and the T46 range finder. The M12 range finder is operated by the gunner, the T46 by the tank commander.

Comparison of Reticles. In answer to the question, "Which of the sight reticles gave you the clearest view of the target?" nine gunners named the M12 range finder, seven the T156 telescope, five the M20 periscope, and four the M71 telescope. Several gunners said that they would like greater magnification in the M20 periscope.

Effectiveness of Burst-on-Target. The primary way of adjusting fire is the burst-on-target method, which requires a clear view through the sighting device in order to make an accurate adjustment. To find out whether this method was used during the project, the gunners were asked if they could use it at all. Only about one fifth of them said they could use it all the time. The only reason given for not being able to use it was the reduced visibility due to the obscuring effect of dust and blast. The difficulty which they reported in using the burst-on-target method on the M47, M47E1, and M48 may have been due to the increased blast from the 90mm gun.

Determining Range. The gunners were also asked their opinion of the range finder. Two thirds of them said they preferred it for determining range and for sensing rounds, because of its greater magnification. The others said they preferred to estimate distance with the eye.

Training

Half of the gunners thought they had received sufficient training during the project. Those who did not think so, without giving any reasons, said they "just thought" their training was insufficient. A third of them said that the complex equipment made training on the M48 especially difficult; they specifically mentioned trouble with the T30 computer.

Asked if their training and experience with one tank led to improved performance on the tanks tested later, 21 gunners said "Yes"; 10 men thought they improved in adjusting fire, another 10 mentioned improvement in laying the gun, and one man said he learned to zero the gun better. Ninety per cent said that testing one tank did not lead to confusion or difficulty later in testing other tanks.

Preferences

Choice of Tank for Design and Operation. In addition to the questions about specific pieces of equipment in the tanks, the gunners were

asked which tank they liked best for over-all design and operation. One third of them preferred the T41, giving most frequently as their reasons simplicity of controls and adequate space. The rest of the votes were about equally divided among the M47, M47E1, and M48. Only one gunner chose the M4.

Choice of Crew Position. Job satisfaction is generally thought to affect performance. The STALK gunners ranked their own position first, with the other positions as follows:

Crew Position Preferred	*Rank*
Gunner	1
Driver	2
Bow gunner	3
Tank commander	4
Loader	5

Opinion of Crew Performance. The gunners were also asked to rank the tanks according to how well they thought their crews performed on them; the composite rankings are these:

Tank	*Rank*
M47	1
M47E1	2
T41	3
M4	4.5
M48	4.5

Few of the gunners offered any explanation of why the crews performed best on this tank and poorest on that; most of them said only that they "felt" they "did best on this tank" or "poorest on that tank." Those who gave reasons specified the gyro-stabilizer and gun accuracy as the factors responsible for satisfactory crew performance on the M47E1.

Choice of Tank for Use in Combat. The gunners also ranked the five tanks in the order in which they preferred them for combat use:

Tank	*Rank*
M47	1
M47E1	2
M48	3
T41	4
M4	5

The reasons most often specified for preferring certain tanks for combat use were the thickness and shape of the armor on the M48 and the stabilized gun system on the M47E1.

Relationship Between Performance and Combat Rankings. The rank order correlation between the rankings by the gunners according to their opinion of crew performance on the tanks and their choice for use in combat was .83. It should be noted that the M48 was ranked fifth on crew performance but third as a choice for use in combat; the reason for this discrepancy appears to be the heavy armor, which was specified 25 times as a reason for the combat usefulness of the M48.

Suggestions for Improvement

An effort was made to find out, by using open-end questions, what changes the gunners would consider important. Concerning the sighting

devices used on the M48, the changes most often suggested were to move the T156 telescope to the right closer to the gunner, and to increase the power of the M20 periscope.

The following miscellaneous suggestions and comments were made:

(1) The seat on the M48 should be made to adjust easily.

(2) The ammunition in the M47 should not be stored under the floor in such a way that the turret has to be traversed to get at it.

(3) The T41 traverse mechanism leaked oil.

(4) The T41 should have another reticle design.

(5) The T41 should possibly be equipped with a range finder.

RESPONSES OF RANGE FINDER OPERATORS[1]

On the M47, M47E1, and M48 tanks which were equipped with a stereoscopic range finder, either the tank commander or the gunner had to use the instrument for determining target distance. Stereoscopic ranging may proceed independently of other tank activity, and begins when the target is brought into the field of view of the instrument. When the range has been determined, the gunner is ready to fire as soon as he places the gun laying reticle on the target. (In tanks which do not have the range finder, target distance may be derived by estimation or by using the mil formula.)

Operation

The range finder operators in Project STALK represented the largest single body of Armor men ever to use the stereoscopic range finder during controlled training and testing; they were therefore questioned closely about problems encountered in using the instrument.

Time Required for the Firing Cycle. Although the range finder is an effective aid in determining range, a disadvantage to using it is the time required to operate it. The men's acceptance of the instrument as operational equipment depends in part on their opinion of how much time is consumed in operating it. Throughout the project, the gunners and tank commanders were asked about the delay involved in using the range finder. A third of them said they could get a round off faster when they were using it, and about the same number felt that its use tended to slow operations.

Rounds Required to Get a Hit. The range finder helps no more than other optical sights in laying the gun in azimuth, but its primary contribution in determining target distance should increase the probability of a first round hit. Furthermore, if the first round misses, the adjustment of the second round should be facilitated, so that fewer rounds should be required to destroy the target. About half of the operators felt that they required fewer rounds to get a hit with the range finder, because it made more accurate ranging possible.

[1]See Appendix C.

Time Required to Get a Hit. Of course, neither determining target range nor the time required to do so should be considered singly; rather the question is, does the range finder combine these two attributes to produce target hits more quickly? Slightly more than half the operators said they could get target hits more quickly with the fire control systems which included the range finder.

Appraisal of Performance. In many perceptual-motor tasks some men are able to appraise their performance at once, without receiving further knowledge of results. This phenomenon appears among range finder operators; if their appraisal is reliable, it might be an aid in reducing ranging errors. But less than a fifth of the STALK operators said they could tell if they had made an incorrect ranging.

The Gyro-Stabilizer. The gunners who performed on the M47E1 during Phases IV and V were asked if this tank's gyro-stabilizer affected the speed or accuracy of ranging. Five said that it hindered the ranging operation, one said that it helped, and four could see no difference. In explaining their answers, most of those who said it was a hindrance felt that unless the course was level and the speed constant, the vibration of the range finder was very pronounced.

Difficulties Encountered in Operation. The gunners mentioned several specific difficulties:

(1) The quarters on the M47 and M47E1 were cramped.

(2) On the M47, the ranging reticle did not remain in constant relationship with the target while the ranging knob of the M12 range finder was being turned and superelevation was fed into the gun system.

(3) On the M48, the ranging reticle of the T46 range finder tended to lose depth when rangings were made against targets which had trees or hills for a background. However, the number of comments on this difficulty decreased from Phases I to V.

(4) At the end of Phases IV and V, six of the tank commanders said they had trouble locating the target in the T46 range finder while they were laying the gun on target. The only solution, they said, was for the gunner to announce "Identified" as soon as he has sighted the target in his periscope. (Four tank commanders reported no difficulty.)

Training

Range finder training was given throughout the project. Each operator made a total of at least 4,200 range settings, nearly 3 1/2 times the number prescribed in the ATP. This extensive training was carried on to determine whether a longer training program would result in significantly improved performance. The responses of the operators, by phase, showed that about a third of them considered the continued training beneficial.

Preferences

Choice of Range Finder. The tank commanders were experienced in operating both the M12 range finder (used on the M47 and M47E1) and the T46 (used on the M48). Asked which instrument they preferred, 22

chose the T46, one the M12, and two stated no preference. On Phases IV and V, the gunners were also asked to state their preferences, though their lack of experience with the T46 made their comparison of the instruments less valid than that of the tank commanders. Five gunners chose the M12, five the T46; one stated no preference, and nine gave no answer. Ease of operation was the reason most often given for preferring the T46 range finder.

Choice of Sighting Device. Since the gunners used the range finder for laying the gun as well as for ranging, they were able to compare it with other optical instruments. Thirty-five of the gunners and tank commanders said they preferred the range finder as a sighting and laying device, seven preferred other devices, two saw no difference, and six gave no response. The two reasons they gave most often for preferring the range finder were that the sight reticle is easier to lay and read and that the brightness of the reticle is adjustable.

Operation by Tank Commander or Gunner. Whether the range finder is operated by gunners, as is the M12, or by tank commanders, as is the T46, makes a major difference in the work load of these two positions. To check opinions as to which crew member should operate the range finder, the operators were asked whether it should be mounted for the gunner, as in the M47, or for the tank commander, as in the M48. Three fourths preferred the gunner location, saying that the tank commander already has a heavy work load. The others preferred the commander location, feeling that this position made it possible to time the firing cycle better.

Choice of Fire Control System. Each tank used in the project had a fire control system not duplicated in any other. After the operators had gained experience with these systems they were asked, in Phases IV and V, "Which of the tanks you've been in so far do you think has the best fire control system?" The average rankings which they gave the systems are these:

Fire Control System	*Rank*
M48	1
M47E1	2
M47	3
T41	4.5
M4	4.5

They gave the M48 first choice chiefly for its optical system, and rated the M47E1 next for its stabilized gun and efficient turret control.

Choice of Tank for Best Performance. After Phases IV and V the commanders and gunners were also asked to choose the tank in which they performed best. They probably knew how many rounds they needed to destroy the test targets, and, although they did not have accurate time scores on the test runs, they might have made crude estimates of how much time it took to make the runs. These factors, as well as those which might influence the operators' choice of tank, probably governed their opinion of performance. In general, no tank seemed to impress a majority of the operators as the one in which they performed best. The M47 received eight votes, the M47E1, M48, and T41 six each, and the M4 three; one man made no choice.

Choice of Tank for Use in Combat. It is acknowledged that training doctrine and combat procedure differ. Test conditions of Project STALK made it possible to use equipment which might not be used in combat. The crucial question about new operational equipment is, "Would you use it in combat?" Three fourths of the operators said that they would use the range finder in combat. Those who said they would not use it gave no reasons. In conjunction with this question, the operators were also asked to rank the tanks in the order in which they preferred them for combat use. The results are almost identical with their rankings of the tanks on fire control systems:

Tank	*Rank*
M48	1
M47E1	2
M47	3
T41	4
M4	5

Suggestions for Improvement

After Phase IV the range finder operators were asked, "What improvements would you make on the range finder if you had the chance?" It was thought that, though the operators were not skilled in engineering, they might recognize problems for which there are practical solutions. They did not give many responses to the question; their chief suggestion was to move the controls of the M12 range finder closer to the gunner.

RESPONSES OF DRIVERS[1]

The driver's duties consist in using the driving controls to move the tank, performing preventive maintenance, and servicing the tank.

Operation

Ease of Operation. The STALK drivers reported that on the M47E1 the brake pedal was too close to the driver, and that on the M48 it was placed too high and behind the steering wheel. They also said that on the M47 the accelerator was too close to the brake pedal.

Most of the drivers felt that the steering mechanism of the later tank types was easy to operate compared with the lateral lock lever system of the M4. Among the later types, the drivers seemed to have a marked preference for a "wobble stick" type of control. They also felt that the automatic transmission on the later models was easier to operate than the standard transmission on the M4.

Pulling Power. Most of the drivers were satisfied with the pulling power of each tank, but said that tanks equipped with automatic transmission did not have the pulling power of the M4.

Work Load. Most of the drivers said they did not have too many jobs to do; those who did say they had too many jobs objected to the amount of maintenance which they were responsible for.

[1]See Appendix D.

Comfort. The drivers complained that, in all tank types, fumes from the engine compartment and the gun leaked into the driver's compartment.

Sighting Devices

When the tank is "buttoned up," the driver's primary source of vision is his periscope. To find out whether their equipment gave them a good view of the terrain, the drivers were questioned about the problem of visibility. Seventy per cent of them said that visibility was too narrow, except in the M48, which is equipped with two extra periscopes. However, the drivers said that when they were driving over rough terrain, the M48 periscopes dropped out of their mounts.

Poor visibility due to obscuration by dust seemed to be a problem chiefly on the M4.

Training

Eighty per cent of the drivers said they had had enough training during the project, 20 per cent thought they had not.

Twenty-two of the 25 drivers said they improved from the first test to the last, but gave no reasons. Only five drivers said they were confused by changing from one tank to another during the project.

The tasks they found hardest to learn were these:

(1) The gear shift system on the M4, which required double clutching.

(2) Steering on the T41 and the M48.

About a third of the drivers said that training time was wasted in overemphasizing maintenance; the other two thirds said that the time was properly allocated and that none was wasted.

Preferences

Choice of Crew Position. Like the tank commanders and the gunners, the drivers interviewed in Project STALK were satisfied with their own job; 20 of them chose driving as the job they most preferred. These were their rankings of the crew positions:

Crew Position Preferred	*Rank*
Driver	1
Bow gunner	2
Gunner	3
Loader	4
Tank commander	5

Opinion of Crew Performance. The drivers ranked the tanks according to their opinions of crew performance as follows:

Tank	*Rank*
M47E1	1.5
T41	1.5
M47	3
M48	4
M4	5

They gave few reasons for thinking the crew did best or poorest on a specific tank, and of these few, no one reason seemed to predominate.

Choice of Tank for Combat Use. The drivers ranked the tanks for combat use as follows:

Tank	Rank
M47E1	1
M47	2
M48	3
T41	4
M4	5

The outstanding reasons they gave for preferring a specific tank for combat use were the gyro-stabilizer on the M47E1 and the armor on the M48. They were most impressed by the fact that the M47E1 could be fired while the tank was in motion.

Relationship Between Performance and Combat Rankings. The rank order correlation between the drivers' rankings of the tanks according to their opinion of crew performance and according to their preference for combat use was .68.

Suggestions for Improvement

The M4. Most of the comments were in two areas:

(1) Most suggestions pertaining to changes in operation concerned wobble stick steering and automatic transmission.

(2) All of the drivers' comments on vision concerned the need for a wide-view periscope and for a reduction of obscuration by dust.

The T41. Some specific suggestions were made:

(1) The chief change recommended was wobble stick steering.

(2) Four drivers suggested a change in the driver's seat to make it more comfortable.

The M47 and the M47E1. The only suggestion consistently made concerned maintenance difficulties. Ten drivers asked that the tracks be changed in such a way that tightening them would be easier, and required less often.

The M48. Driver suggestions included the following:

(1) A wobble stick should be installed for steering.

(2) The shift controls should be nearer to the driver.

(3) The accelerator should be moved so that one foot would operate the brake and the other the accelerator.

(4) The exhaust outlet should be moved to the side of the tank, so that the engine hatch plates would not become too hot to handle.

(5) The hatch should be changed in such a way that the driver could enter and leave the tank without having to traverse the turret.

RESPONSES OF BOW GUNNERS[1]

The bow gunner's general responsibilities include firing the .30-caliber bow machine gun on the tank commander's order, driving the

[1]See Appendix E.

tank if the driver is injured, and sharing the driver's maintenance duties. The bow gunner is a regular crew member on the M4, M47, and M47E1 tanks, but has been dropped from the crews of the T41 and M48. Though they did not participate in the tests for these two tanks, they were trained as drivers.

Operation[1]

About 60 per cent of the bow gunners said they had difficulty in reaching and operating the controls. They said, for example, that the placement of the brake and accelerator was confusing (the brake on the right and the accelerator on the left). They also thought that on the M47 the brake was too high on the front of the hull, causing difficulty in braking.

Most of the bow gunners considered the automotive properties of all the tanks satisfactory.

Since the bow gunners share maintenance with the drivers, they were asked to give an opinion on maintenance and to mention parts which are hardest to maintain on each tank. The comment made most frequently was that on all tank types the track and connectors had to be tightened too often.

They were asked to specify if they had too many jobs to do and to offer solutions for an excessive work load. One third of them said their work load on the M48 was too heavy because of the maintenance required.

Sighting Devices. The only question asked of the bow gunners on sighting devices was, "What difficulty did you have with visibility from this tank?" The hindrances they mentioned most often were (1) dust thrown up by the tracks, (2) dust settling on the periscopes, and (3) the tendency (also noted by the drivers) for the periscopes on the M48 to fall out when the tank was moving over rough terrain.

Training

In answer to the question on adequacy of training during the project, 23 of the bow gunners said they had been adequately trained on each tank.

The bow gunners thought that training was most effective on the M47 and least effective on the M48, saying that the M48 instruction was inferior and the equipment over-complex.

The procedures which they said they found most difficult to learn were shifting gears on the M4 and steering on the M47 and M47E1.

Seven of the bow gunners felt that training time was wasted because of an overemphasis on maintenance.

Preferences

Opinion of Crew Performance. In ranking the tanks according to how they thought the crews had performed on them, the bow gunners gave

[1]Because the bow gunners functioned primarily as assistant drivers, most of the questions were asked only after certain phases of the project; hence the number of responses varies.

no specific reasons for their estimates, merely saying they "just felt" they "did well." These were the average rankings:

Tank	Rank
M47E1	1
M47	2
T41	3
M48	4
M4	5

Choice of Tank for Use in Combat. The bow gunners agreed with the other crew members in naming most often the stabilizer on the M47E1 and the armor on the M48 as reasons for preferring a tank for combat use. They ranked the tanks as follows:

Tank	Rank
M47E1	1
M47	2
M48	3
T41	4
M4	5

Suggestions for Improvement

Likes and Dislikes. The bow gunners mentioned the following items most often in specifying what they especially liked about the tanks:

(1) The standard transmission on the M4.
(2) The driver's controls on the M47 and M47E1.
(3) The speed of the T41.

The items which they mentioned unfavorably most often were these:

(1) Maintenance requirements for the M4, M47, and M47E1.
(2) Ammunition storage on the M47 and M47E1.
(3) The driver's controls on the M48.

Changes Recommended. Asked to list changes which would make the bow gunner's job easier, they made the following suggestions:

(1) The gear shift on the M47 should be changed.
(2) The track and connectors on the M47 should be changed to prevent loosening.
(3) The accelerator and the brake pedal on the M48 should be moved farther apart.
(4) The exhaust outlets on the M48 should be moved to the sides of the tank.
(5) The gear shift handle on the M48 should be changed so that it would not slip into reverse from high.

RESPONSES OF LOADERS[1]

The loader's chief duty is to keep the gun loaded with the proper kind of ammunition. On order of the tank commander, he selects ammunition from the ready racks and places a round in the chamber. After loading

[1]See Appendix F.

the first round, he should be ready to reload (with the same kind of ammunition) as soon as the first round is fired, and to continue doing so until the tank commander orders him to change ammunition or to cease fire.

Operation

Among the factors which may affect the speed and ease with which the loader functions are the location and accessibility of the ready racks, responsibility for too many jobs, and, on the M47E1, the problem of loading a stabilized gun (which moves to stay in line with the target at all times).

Selecting and Reaching Ammunition. The loaders were asked whether they had difficulty in choosing and locating the right kind of ammunition and whether the location of the ready racks caused any trouble. None reported difficulty in choosing ammunition, but some said that the location of the racks caused trouble, especially on the T41, the M47, and the M47E1.

Work Load. Only three of the loaders said that they had too many jobs to do; all of them said their job load on the M48 was satisfactory.

Loading a Stabilized Gun (M47E1). Asked if they had trouble loading the M47E1, which was equipped with a gyro-stabilizer, half of the loaders said "No," a fifth reported having some difficulty, and the rest said they had trouble every time.

Training

The loaders were asked the same questions on training which were given to the other crew members. Twenty answered that they were adequately trained and that no training time was wasted.

Preferences

Opinion of Crew Performance. The loaders were asked to rank the tanks from one to five, ranking first the tank on which they thought the crew performed best. They gave no reasons for listing any tank high or low, in their rankings according to crew performance:

Tank	*Rank*
M47	1
T41	2
M47E1	3
M4	4
M48	5

Choice of Tank for Use in Combat. Again, the two factors mentioned most often as reasons for making a tank first choice were the gyro-stabilizer on the M47E1 and the heavy armor on the M48. Overall, the loaders ranked the M48 comparatively low, but gave few reasons for doing so:

Tank	*Rank*
M47	1
M47E1	2
M48	3.5
T41	3.5
M4	5

Relationship Between Performance and Combat Rankings. The rank order correlation between the two sets of rankings was .73.

Suggestions for Improvement

The loaders gave only scattered suggestions for changing the tanks tested during the project:

(1) Install reset switches on the M48.
(2) Incorporate used-round disposal equipment on the M48.
(3) Put the reset switch closer to the gunner on the M47.
(4) Change the ammunition storage on the M47.

Chapter 3

COMMENTS WITH REGARD TO TANK MODELS

The suggestions and criticisms of the STALK crewmen concerning factors of tank operation and equipment may have important implications along human engineering lines. In this chapter, the information collected has been summarized by tank; this presentation, while repeating information reported earlier by crew position, may give the reader a clearer picture of the men's over-all evaluations of the tanks under test.

COMPARISONS OF TANKS

The crew members thought that, on the whole, they had performed best on the M47 models, and they generally preferred these two tanks for use in combat. The specific factors cited most frequently as reasons for preferring a tank for combat were the stabilized gun on the M47E1 and the heavy armor of the M48. The M4 and the T41 were generally named as fourth or fifth choices. The rankings by the five crew positions, and the average rank of each tank, are shown in Tables 1 and 2.

In comparing fire control systems used on the various tanks, about half of the operators thought that fewer rounds were required to get a hit using fire control systems which included the range finder. As a sighting device, the range finder was preferred to other optical instruments because the sight reticle was easier to lay and read and because the brightness of the reticle could be adjusted. Most of the tank commanders preferred the T40 range finder, which was used in the M48, to

Table 1

RANKINGS ACCORDING TO CREW PERFORMANCE

Tank	Tank Commanders	Gunners	Drivers	Bow Gunners	Loaders	Average Rank
M47E1	1	2	1.5	1	3	1.7
M47	3	1	3	2	1	2
T41	4	3	1.5	3	2	2.7
M48	2	4.5	4	4	5	3.9
M4	5	4.5	5	5	4	4.7

Table 2

RANKINGS ACCORDING TO CHOICE FOR COMBAT

Tank	Tank Commanders	Gunners	Drivers	Bow Gunners	Loaders	Average Rank
M47E1	2	2	1	1	2	1.6
M47	3	1	2	2	1	1.8
M48	1	3	3	3	3.5	2.7
T41	4	4	4	4	3.5	3.9
M4	5	5	5	5	5	5

the M12 range finder, used in the M47 models; however, most of the operators thought that the range finder should be mounted for the gunner, as in the M47 models, rather than for the commander, as in the M48, saying that the commander already had a heavy work load.

Asked which of the tanks had the best fire control system, the operators ranked them in this order: M48, M47E1, M47, T41, and M4. However, they did not feel that they had performed markedly better in one tank than in another.

COMMENTS ON TANK OPERATION AND DESIGN

The M4

Gunners ranked this tank last on over-all design and operation. Tank commanders mentioned poor ammunition storage, and suggested an elevation control on the over-ride and mechanical changes in the track and suspension systems. Commenting on the operation of the turret, they mentioned the fact that the loader's compartment does not traverse.

Drivers reported a need for a wide-view periscope. They thought that the gear shift system was difficult to learn, and said they would prefer wobble stick steering and automatic transmission; however, they thought that the M4 had greater pulling power than tanks with automatic transmission. Bow gunners liked the standard transmission, but disliked the maintenance requirements of the tank.

The T41

Tank commanders considered the backward operation of the over-ride control to be a training problem, and asked for a power elevation control. Almost all of them commented on the fire control equipment, especially on the need for a vane sight and a range finder. Gunners suggested a different reticle design, and said that the traverse mechanism leaked oil. Commanders and drivers reported that their seats were not sufficiently adjustable. However, the men liked the general operation and design of the T41, because of its simplicity of controls and adequate space.

Drivers found steering hard to learn, and recommended wobble stick steering. Bow gunners liked the speed of the T41; loaders said that the location of the ready racks caused some trouble.

The M47

Tank commanders asked for a vane sight, and said that the over-ride controls were awkwardly placed, that the commander's platform needed a guard, and that the seats caused some discomfort. Some gunners thought that the manual controls operated too slowly. They found it hard to use the burst-on-target method, a difficulty also reported for the M47E1 and the M48; this may have been due to the increased blast from the 90mm gun. Most men disliked the ammunition storage, since the turret had to be traversed to get at ammunition stored under the turret floor. In addition, loaders reported that the location of the ready racks caused some trouble, and suggested that the reset switch be placed closer to the gunner.

Drivers reported that the accelerator was too close to the brake pedal. Many commented on the maintenance requirements, which they considered heavy, and suggested that the tracks be changed so that tightening them would be easier and required less often.

The M47E1

Tank commanders asked for an elevation control on the over-ride, and said that the commander's platform and seat caused some discomfort. They liked the fire control system, but said that the gunner's controls should be simplified and made more easily accessible. Many crewmen suggested a change in the ammunition storage, for the same reason as cited for the M47. Gunners thought that the ballistic unit was relatively inaccessible; many thought that the manual controls operated too slowly.

With respect to the stabilized gun, half of the gunners thought that it hindered the ranging operation, saying that unless the course was level and the speed constant, the vibration of the range finder was very bad. They reported that their operating quarters were very cramped. Tank commanders thought the stabilized gun increased the difficulty of loading the gun when the tank was in motion; about a third of the loaders said they had some difficulty every time they loaded the stabilized gun.

Drivers said that the brake pedal was too close to the driver, and also suggested changes in the tracks so that tightening would be easier. Bow gunners found steering hard to learn, although they liked the driver's controls; they disliked the maintenance requirements. Loaders reported having some trouble with the ready racks.

The M48

The tank commanders disliked the vertical positioning required in the operation of the over-ride control in order to change direction and several recommended that the cut-off switch be moved nearer to them. They liked the fire control system, although they suggested many

changes; three fourths of the operators thought that the range finder should be returned to the gunner's control, a suggestion which reflected the commanders' feeling that they had too many duties on the M48.

The gunners reported that the computer box, especially the ammunition selection handle, and the manual firing switch and traverse controls caused some difficulty in operation; some also felt that the manual controls operated too slowly. They suggested moving the T156 telescope to the right, closer to the gunner, and asked for an increase in the power of the M20 periscope. They also wanted a seat which could be adjusted more easily.

According to the drivers, the two extra periscopes in the M48 provided better visibility than in the other tanks; however, they reported that on rough terrain the periscopes tended to fall out of their mounts.

The drivers complained that the brake pedal was too high behind the steering wheel, and recommended that the accelerator be moved so that it could be operated with one foot and the brake with the other. They thought that the shift controls might be moved closer to the driver, and recommended wobble stick steering. Other suggestions were to move the exhaust outlet to the side of the tank, so that the engine plates would not become too hot to handle, and to change the hatch in such a way that the driver could enter and leave the tank without having to traverse the turret.

Bow gunners disliked the driver's controls and the maintenance required on the M48, and suggested changing the gear shift so that it would not slip from reverse to high. Loaders suggested installing reset switches and incorporating used-round disposal equipment.

COMPARISONS OF TRAINING ON VARIOUS TANKS

The men's attitudes, especially with regard to their general opinions as to crew performance and combat advantages on the various tanks, may in part reflect the quality of the training they received on the different tanks. Their rankings of the tanks (see Tables 1 and 2) indicate not only their judgment as to tank capabilities but also how competent they felt to handle the various models.

The men generally felt that they had received the best training on the M47 tanks, the worst on the M48. Tank commanders considered the instruction on the M48 mediocre, the instructors poorly prepared; many men reported that the complex equipment of the M48 made training difficult, and indicated that they felt a need for more training. The man who does not thoroughly understand his job and the equipment he is to operate will find it hard to perform efficiently—and poor performance may easily influence his opinion of the equipment itself. That this factor may have been operating is suggested by the relatively low ranking the STALK crewmen gave the M48 as a choice for use in combat, despite its heavy armor (which almost all the men mentioned as an advantage). Similarly, the M47 models, on which the men felt that they had been well trained and that they had performed well, were generally rated first for combat use.

APPENDICES

Appendix A

INTERVIEW RESPONSES OF TANK COMMANDERS

Table A-1

THE INTERCOM SYSTEM

How did the intercom work?	M4	T41	M47	M47E1	M48	Total
Responses						
All right	15	21	16	20	21	93
Troublesome	6	1	4	4	1	16
Complete failure	4	3	5	1	3	16
Total	25	25	25	25	25	125
Desirable characteristics						
Whole system			2	5		7
Lip mike	2	3		1	1	7
"On" switch lock	3		2		1	6
Hand mike		3				3
Total	5	6	4	6	2	23
Undesirable characteristics						
Head set	7	4	6	5	4	26
Controls	2			1		3
Vibration	2					2
Phone box				1	1	2
Position	2					2
Range		2				2
Lip mike	1					1
Speaker	1					1
Whole system	1					1
Static	1					1
Auxiliary engine			1			1
Total	17	6	7	7	5	42

Table A-2

THE OVER-RIDE CONTROL

How did you like this over-ride?	M4	T41	M47	M47E1	M48	Total
Responses						
Good, as is	9	6	12	7	6	40
Needs elevation control	13			17		30
Controls bad			8	1	19	28
Too slow	2	5	5			12
Operates backwards	1	11				12
Can't take away from gunner		5				5
Give firing mechanism to tank commander				1		1
Total	25	27	25	26	25	128
Other comments						
Present position OK	20	20	2	23	12	77
Raise controls	1	1	16	2	10	30
Move controls closer	4	4	3			11
Set handles at angle			4		4	8
Use wobble stick			7			7
Use grip handle			2			2
Total	25	25	34	25	26	135

Table A-3

EFFECTIVENESS OF KEEPING ROUND IN CHAMBER[a]

Can lay be completed faster with round in chamber?	M4	T41	M47	M47E1	M48	Total
Faster	3	1	4	5	5	18
Slower	2	2				4
No difference		2	1			3
Total	5	5	5	5	5	25

[a]At the end of STALK, the crews made a test run with a round already loaded, a procedure frequently used in combat.

Table A-4

WORK LOAD

Did you have too many jobs?	M4	T41	M47	M47E1	M48	Total
No	15	15	15	15	6	66
Yes					8	8
Don't know					1	1
Total	15	15	15	15	15	75

Table A-5

VISIBILITY

Responses	M4	T41	M47	M47E1	M48	Total
How was your visibility from this unit after firing?						
No obscuration	11	13	7	5	5	41
Some obscuration (dust)	10	10	15	16	12	63
Considerable obscuration	4	2	3	4	8	21
Total	25	25	25	25	25	125
Could you sense your rounds?						
Yes, most of them	12	16	7	10	4	49
Some trouble (dust)	12	7	11	7	12	49
Considerable trouble (dust)	1	2	7	8	8	26
Total	25	25	25	25	24	124
Did dust cause any lost rounds?						
None	5	5	1	4	1	16
1-3 rounds	3	4	4	2	2	15
4-6 rounds	2	1	2		1	6
More than 6			3	4	6	13
Total	10	10	10	10	10	50

Table A-6

INSTRUMENTS USED FOR SENSING

With what did you sense?	M4	T41	M47	M47E1	M48	Total
Binoculars	8	6	5	7	9	35
Binoculars or naked eye	2	2	3	1		8
Naked eye		1	1	2		4
Periscope		1	1			2
Range finder	(*)	(*)			1	1
Total	10	10	10	10	10	50

*Not equipped with a range finder.

Table A-7

USE OF TRAINING TIME

Training Areas	Number of Commanders
Commanders thought training was wasted in:	
30-caliber manipulation	7
Service on main armament	4
Crew coordination course	2
Range finder	2
Dry runs	1
Fire commands	1

(Continued)

Table A-7 *(Continued)*

USE OF TRAINING TIME

Training Areas	Number of Commanders
Commanders thought training was wasted in: *(Continued)*	
Sensing practice on models	1
Turret manipulation	1
Total	19
Commanders would have liked more training in:	
Firing (including moving targets)	11
Combat tactical training	5
Range estimation and sensing	3
M48 fire control	2
Total	21

Table A-8

FACTORS UNDERLYING RANKINGS OF CREW POSITIONS

Reason For Ranking of Crew Position	Tank Commander	Gunner	Driver	Loader	Bow Gunner	Total
As First Choice						
Interest	3	4	3		1	11
Knowledge or experience	7					7
Curiosity	3					3
Easier					2	2
Top man	2					2
Total	15	4	3		3	25
As Last Choice						
Too much work			2	11		13
Nothing to do					6	6
Low man in crew				5		5
Dangerous				4		4
Total			2	20	6	28

Table A-9

REASONS FOR RANKING TANK FIRST ON CREW PERFORMANCE

Response	M4	T41	M47	M47E1	M48	Total
Fire control equipment	1	3	1	7	6	18
Ease of operation	4	9	1		3	17
Crew attitude	2	5	4	2		13
Training	2	2	4	4	1	13
Gun	1	3		1		5
Total	10	22	10	14	10	66

Table A-10

REASONS FOR NAMING TANKS FIRST OR LAST CHOICE FOR COMBAT

Response	M4		T41		M47		M47E1		M48		Total	
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Fire control		5			2		21	3	12		35	8
Armor		9		4	2	1	4		16		22	14
Gun	2	6	7	1	2	1	3		6		20	8
Ease of operation		2	4		1		1		5		11	2
Speed	1	2	4				2		1		8	2
Comfort			2				1		2		5	
Maintenance					1	1	3				4	1
Obsolete		9										9
Total	3	33	17	5	8	3	35	3	42		105	44

Table A-11

LIKES AND DISLIKES

Area of Response	M4		T41		M47		M47E1		M48		Total	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Fire control	7	5		2	14	2	26	2	25	15	72	26
Operation	5	1	15	8	6	1	2	4	1	12	29	26
Comfort	4	13	1	6	3	19	7	18	11	11	26	67
Ammo storage	1	6	17		1	18		13	6	1	25	38
Gun	10	7	7		2	1	2		4	11	25	19
Power	5		13	1		1	1		1		20	2
Maintenance	4	1	9	1			1			5	14	7
Whole tank	1		5		4		1				11	
Armor		1		6				1	8		8	8
Safety	4			8		2		1		2	4	13
Total	41	34	67	32	30	44	40	39	56	57	234	206

Table A-12

SUGGESTED IMPROVEMENTS

Area of Response	M4	T41	M47	M47E1	M48	Total
Fire control	8	24	11	6	20	69
Gun turret controls	18	9	3	8	10	48
Comfort	6	10	6	9	11	42
Storage	12	1	5	8	5	31
Safety	2	2	20	1	1	26
Power train	3	6	2	1	1	13
Track and suspension	9	1			3	13
Armor	1	2	2	2		7
Driving	1				5	6
Crew	1	2		1		4
Maintenance	1			3		4
Speed	1		1	2		4
Radio	1					1
Total	64	57	50	41	56	268

Appendix B

INTERVIEW RESPONSES OF GUNNERS

Table B-1

OPERATION OF CONTROLS

Were the controls easily accessible and simple to operate?	M4	T41	M47	M47E1	M48	Total
Response						
Yes	20	18	16	5	15	74
No	5	7	9	20	10	51
Total	25	25	25	25	25	125
Reasons given for "No" responses						
Manual firing switch difficult to use	3	3	1	3	9	19
Ballistic unit hard to reach			3	8	1	12
Manual traverse difficult to operate		4	1	3	3	11
Ammo index knob hard to reach			5	3		8
Computer box hard to operate					6	6
Power traverse handle too low	2	1				3
Range finder hard to reach			1	2		3
Traversing mechanism too close	2			1		3
Telescope hard to use					2	2
Total	7	8	11	20	21	67

Table B-2

MANIPULATION OF CONTROLS

Were you able to manipulate the controls satisfactorily?	M4	T41	M47	M47E1	M48	Total
Response						
Yes	17	16	16	10	15	74
No	8	9	9	15	9	50
Total	25	25	25	25	24	124
Reasons given for "No" responses						
Manual traverse slow	1		3	4	6	14
Manual elevation slow				4		4
Power traverse slow	4					4
Controls too close to gunner		3				3
No manual control with power on	1	1			1	3
Power elevation slow		3				3
Play in controls		2				2
Total	6	9	3	8	7	33

Table B-3

TURRET CONSTRUCTION AND AMMO STORAGE

Does turret construction and ammo storage make the job difficult?	M4	T41	M47	M47E1	M48	Total
Response						
Yes	17	3	23	25	10	78
No	8	22	2		15	47
Total	25	25	25	25	25	125
Reasons given for "Yes" responses						
Must traverse to get ammo	3	2	22	23	1	51
Not enough space	9		8	24	7	48
Ready racks too small	17			2		19
Unsatisfactory ammo storage	2				6	8
Adjustable seat needed	1				3	4
Total	32	2	30	49	17	130

Table B-4

VENTILATION, RADIO, AND HYDRAULIC SYSTEMS

Were you satisfied with the performance of this system?	M4	T41	M47	M47E1	M48	Total
Blower						
Yes		15	18	21	19	73
No		9	1	2	2	14
Intercom						
Yes	11	21	17	11	20	80
No	12	6	6	13	8	45
Hydraulic						
Yes		5	7		6	18
No	4		8		3	15

Table B-5

USE OF BURST-ON-TARGET METHOD

Were you able to employ the burst-on-target method of fire adjustment?	M4	T41	M47	M47E1	M48	Total
Yes	7	9	7	4	4	31
No	10	10	17	19	17	73
Sometimes	7	6	1	2	4	20
Total	24	25	25	25	25	124

Table B-6

OPERATIONS MOST DIFFICULT TO LEARN

Operation	M4	T41	M47	M47E1	M48	Total
Laying the gun	16	12	2	7	7	44
Accessory equipment			7		3	10
Range finder			7	3		10
Bore sighting and zeroing	3	1	1	3		8
Computer					7	7
Gyro equipment				6		6
Maintenance		1				1
Sensing		1				1
Nothing	4	7	4	1	4	20
Total	23	22	21	20	21	107

Table B-7

REASONS FOR TANK PREFERENCES

Reason	M4	T41	M47	M47E1	M48	Total
Simple controls	2	10	10	4	4	30
Traverse and elevation mechanism		7	13	1	1	22
Space	4	9	2	1	5	21
Range finder			4	3	4	11
Gyro-stabilizer				10		10
Sighting devices	1	5	1	2	1	10
Smooth riding		3	2			5
Accurate gun		2	2			4
Computer box					2	2
Total	7	36	34	21	17	115

Table B-8

REASONS FOR CONSIDERING CREW PERFORMANCE GOOD OR POOR

Reason	M4		T41		M47		M47E1		M48		Total	
	Good	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Simplicity of operation	3		1		1					4	5	4
Gyro-stabilizer							4	1			4	1
Accuracy of gun				1			3		1		4	1
Accessibility of controls		1	2		1						3	1
Range finder					2				1		3	
Computer									2	1	2	1
Sighting devices	1		1	3		1				3	2	7
Seat										2		2
Total	4	1	4	4	4	1	7	1	4	10	23	17

Table B-9

REASONS FOR NAMING TANKS FIRST OR LAST CHOICE FOR COMBAT

Reason	M4		T41		M47		M47E1		M48		Total	
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Armor		4		7	3		4		25		32	11
Gun		3	1		3		1		7		12	3
Speed	2		4		2				2		10	
Sighting devices		2			[illegible]		3		2	1	7	3
Power traverse and elevation					3		2		2		7	
Gyro-stabilizer							7				7	
Maintenance		1	3			1	1			2	4	4
Simple operation			1		2						3	
Ammunition storage			2							3	2	3
Total	2	10	11	7	15	1	18		38	6	84	24

Table B-10

SUGGESTED IMPROVEMENTS

Area of Response	M4	T41	M47	M47E1	M48	Total
Sighting devices	6	11	6	6	17	46
Turret movement	5	9	9	9	3	35
Used round disposal		4	5	3	4	27
Ammo storage	3		3	11		17
More space	4		5	5	2	16
Seat		1	3		12	16
Range finder		3	3		2	8
Computer					5	5
Stabilizer				5		5
Breech					4	4
Firing switch		3				3
Total	18	31	34	50	49	182

Appendix C

INTERVIEW RESPONSES OF RANGE FINDER OPERATORS

Table C-1

COMPARISON OF RANGE FINDER WITH OTHER FIRE CONTROL SYSTEMS

Range Finder Versus Other Systems	M47	M47E1	M48	Total
Time required to get a round off				
Range finder is				
Faster	7	9	10	26
Slower	9	8	11	28
Same	9	8	4	21
Total	25	25	25	75
Rounds required to get a hit				
Range finder requires				
Fewer	13	14	14	41
More	6	5	1	12
Same	6	6	10	22
Total	25	25	25	75
Total time required to get a hit				
Range finder is				
Faster	13	15	15	43
Slower	7	3	6	16
Same total time	5	7	4	16
Total	25	25	25	75

Table C-2

OPERATION OF RANGE FINDER

Are any of the range finder controls difficult to operate?	M47	M47E1	M48	Total
Responses				
None	1	4	8	13
Ammo knob	7	3		10
Range knob	2	4	2	8
Others	5	1		6
Total	15	12	10	37

(Continued)

Table C-2 *(Continued)*

OPERATION OF RANGE FINDER

Are any of the range finder controls difficult to operate?	M47	M47E1	M48	Total
Chief problems in operation				
Stereo pattern	16	6	15	37
Operational sequence	11	21	2	34
Location of controls	12	6	4	22
Manipulation of controls	5	5	10	20
Sighting	2	2	6	10
Total	46	40	37	123

Table C-3

APPRAISAL OF PERFORMANCE

Can you tell when you have made a bad ranging?	M47	M47E1	M48	Total
Yes	4	8	4	16
No	12	9	16	37
Sometimes	9	8	5	22
Total	25	25	25	75

Table C-4

COMPARISON OF RANGE FINDERS

Why do you prefer either the M12 or the T46?	M12	T46
Ease of operation	1	33
Engineering factors (ease and accuracy)	2	11
Accuracy	1	8
Controls	1	4
Location	3	1

Table C-5

COMPARISON OF RANGE FINDER WITH OTHER RETICLES

Reason for Gunner's Choice	Range Finder	Other
Brightness (adjustable)	22	2
Easier to lay and read	19	2
Reticle design	4	4
Most information	4	

Table C-6

REASONS FOR PREFERRING A CONTROL SYSTEM

Reason	M4	M47	M47E1	M48	Total
System as whole		4	1	5	10
Turret control		3	6	1	10
Stabilizer or computer			7	2	9
Optical system	1		3	4	8
Work distribution		4		2	6
Total	1	11	17	14	43

Table C-7

USE OF RANGE FINDER IN COMBAT

How would you feel about using the range finder in combat?	M47	M47E1	M48	Total
Like	10	12	12	34
Dislike	4	2	3	9
Indifferent	1	1		2
Total	15	15	15	45

Table C-8

REASONS FOR PREFERRING A TANK FOR COMBAT

Reason	M4	T41	M47	M47E1	M48	Total
Fire control			2	11	7	20
Armor			1	4	10	15
Fire power	2	1		2	6	11
Speed	1	2	2	3	1	9
Ease of operation and comfort	3		3			6
Room			2	1	3	6
Total	6	3	10	21	27	67

Appendix D

INTERVIEW RESPONSES OF DRIVERS

Table D-1

OPERATION OF CONTROLS

Are driving controls easy to reach?	M4	T41	M47	M47E1	M48	Total
Responses						
Yes	11	11	12	14	20	68
No	12	13	13	10	5	53
Total	23	24	25	24	25	121
Controls which caused difficulty in maneuvering						
Steering system	14	7	6	4	11	42
Gear shift	9	6	1	1		17
Brake			4		2	6
Acceleration		1		1		2
Clutch	1					1
Magneto switch	1					1
Reverse control		1				1
Total	25	15	11	6	13	70
Other controls and equipment which caused difficulty						
Brake pedal		1	6	10	17	34
Accelerator pedal		1	1	1	13	16
Gear shift	10			1	5	16
"Little Joe" controls	1	6	2	3		12
Steering	2	1	1	2	1	7
Inadequate room		2	2		1	5
Poor seating					4	4
Clutch	3					3
Sighting devices	1			1	1	3
Starting engine			1			1
Total	17	11	13	18	42	101

Table D-2

PREFERENCES EXPRESSED CONCERNING STEERING AND TRANSMISSION SYSTEMS

Reason for Preference	M4	T41	M47	M47E1	M48	Total
Steering systems						
Ease of operation	8	19	18	16	19	80
Steering control			26	23		49
Ability to turn sharply	1	2	2	2	1	8
Total	9	21	46	41	20	137
Transmission systems						
Ease of operation		28	17	20	12	77
Pulling power	12		2	4	5	23
Ease of maintenance		6	3	1		10
Speed of tank	9					9
Total	21	34	22	25	17	119

Table D-3

WORK LOAD, COMFORT, AND VISIBILITY

Questions	M4	T41	M47	M47E1	M48	Total
Did you have too much work to do?						
Yes	3	1	6	6	9	25
No	19	20	19	16	14	88
Were there fumes in driver's compartment?						
Yes	9	3	4	2	8	26
No	1	7	6	7		21
Was visibility a problem?						
Yes	24	11	18	19	15	87
No	1	14	7	6	10	38
Source of visibility problem						
Sighting device (periscope)	24		13	10	16	63
Obscuration	20	1	2	6	3	32
Poor vision going up hills	2	9	1		4	16
Seat					4	4
Total	46	10	16	16	27	115

Table D-4

OPERATIONS MOST DIFFICULT TO LEARN

Operation	M4	T41	M47	M47E1	M48	Total
Shifting gears	17			1	1	19
Steering	1	4	1	3	5	14
Reversing		3	2	2	3	10
Maintenance			2	1	1	4
Acceleration				1	2	3
Neutral steer		3				3
Starting				1	2	3
Reading oil gauge		1		1		2
Engine			1			1
None	7	11	19	13	9	59
Total	25	22	25	23	23	118

Table D-5

REASONS FOR CONSIDERING CREW PERFORMANCE GOOD OR POOR

Reason	M4		T41		M47		M47E1		M48		Total	
	Good	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Ease of handling			3	1	1						4	1
Sighting devices	1	1	3								4	1
Familiar with tank					3						3	
Gyro-stabilizer							3				3	
Engine power		1	2	1						1	2	3
Maintenance		1	1						1	3	2	4
Range finder							1		1	1	2	1
Gun accuracy		2	1							1	1	3
Obscuration		1		1		1				1		4
Total	1	6	10	3	4	1	4		2	7	21	17

Table D-6

REASONS FOR NAMING TANKS FIRST OR LAST CHOICE FOR COMBAT

Reason	M4		T41		M47		M47E1		M48		Total	
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Armor	1			5	6		2		16		24	6
Gyro-stabilizer							18	1			18	1
Fire power	1				4		1		3		8	1
Maintenance					3		1		3	1	7	1
Maneuverability	1	2			2				2	1	6	2
Tank speed		3	4						2	1	5	5
Control of tank	4				2				3		5	4
Comfort					2				1		3	
Visibility	2								2	1	2	3
Smooth ride	3		1			2		1				7
Ventilation	3											3
Total	15	5	10		19	2	22	2	32	4	78	33

Table D-7

SUGGESTED IMPROVEMENTS

Area of Response	M4	T41	M47	M47E1	M48	Total
Operation	27	10	7	11	24	79
Vision	25		4	2	3	34
Comfort	1	4	8	1	17	31
Maintenance	2	4	10	4	2	22
Safety	2					2
Total	57	18	29	18	46	168

Appendix E

INTERVIEW RESPONSES OF BOW GUNNERS

Table E-1

OPERATION OF TANK

Did you have difficulty with controls?	M4	T41	M47	M47E1	M48	Total
Responses						
Yes	14	6	6	9	12	47
No	5	7	11	10	1	34
No answer	6	12	8	6	12	44
Total	25	25	25	25	25	125
Controls that cause difficulty						
Brake			2	9	10	21
Gear shift	9	1			1	11
Accelerator		2			6	8
Steering controls	1	2	1	1	1	6
"Little Joe" controls		1	3			4
Clutch	3					3
Total	13	6	6	10	18	53
Problem areas in maneuvering						
Gear shift	3	1	1		3	8
Steering	2	1	3			6
Brake system					2	2
Power					1	1
Starting			1			1
Total	5	2	5		6	18

Table E-2

OPINIONS OF TANK CAPABILITIES

What is your opinion of the automotive abilities of this tank?	M4	T41	M47	M47E1	M48	Total
Opinions						
Good	8	8	6	6	3	31
Poor			1		1	2
Total	8	8	7	6	4	33
Weakest part of the power train						
Transmission	1	3	1	3		8
Tracks	1				3	4

(Continued)

Table E-2 *(Continued)*

OPINIONS OF TANK CAPABILITIES

What is your opinion of the automotive abilities of this tank?	M4	T41	M47	M47E1	M48	Total
Weakest part of the power train *(Continued)*						
Clutch	3					3
Gear shift	1			1		2
Generators	1					1
Magnetos		1				1
Power pack				1		1
Suspension			1			1
Total	7	4	2	5	3	21

Table E-3

MAINTENANCE

Opinions of Maintenance	M4	T41	M47	M47E1	M48	Total
Responses						
No problem	3	6	2	1	6	18
Too much	1	2	5	8	3	19
Parts most difficult to maintain						
Tracks	10	5	15	19	16	65
Air cleaners	8	3	6	2	1	20
Oil filters	1	8				9
Checking oil		1	1			2
Gun				2		2
"Little Joe"				2		2
Keeping instruments clean	1					1
Total	20	17	22	25	17	101

Table E-4

WORK LOAD

Did you have too many jobs?	M4	T41	M47	M47E1	M48	Total
Responses						
Yes	6	1	8	3	7	25
No	5	6	1	9	7	28
No answer	4	8	6	3	1	22
Total	15	15	15	15	15	75
Suggested solutions for heavy work load						
More men for maintenance	5	1			7	13
No trip tickets				2		2
Turret crew to clean gun				1		1
Total	5	1		3	7	16
Did you help the loader?						
Yes	10		9	8		27
No		4	1	1	5	11

Table E-5

VISIBILITY DIFFICULTIES

Problem	M4	T41	M47	M47E1	M48	Total
Dust	12	9	6	6	5	38
Periscope	14	1	6	3	8	32
Blind spots	7	6	2			15
Poor going up hills		2			4	6
Total	33	18	14	9	17	91

Table E-6

ESTIMATES OF TRAINING

Estimate	M4	T41	M47	M47E1	M48	Total
Best	2	1	12	3	2	20
Poorest	2	3		1	9	15
Total	4	4	12	4	11	35

Table E-7

OPERATIONS MOST DIFFICULT TO LEARN

Operation	M4	T41	M47	M47E1	M48	Total
Steering		2	5	4	2	13
Transmission	9				2	11
Reversing		1		1	1	3
Brake and accelerator positions					3	3
Driving with hatch closed	1					1

Table E-8

REASONS FOR RANKING TANK FIRST ON CREW PERFORMANCE

Reason	M4	T41	M47	M47E1	M48	Total
Good gunner	1	2	1	3	1	8
Stabilizer				5		5
Accurate gun				1	1	2
Tank handled well	1					1

Table E-9

REASONS FOR NAMING TANKS FIRST OR LAST CHOICE FOR COMBAT

Reason	M4		T41		M47		M47E1		M48		Total	
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Armor	5		4		6		2		19		27	9
Gun	5				2		2		10		14	5
Stabilizer							12	2			12	2
Ease of handling					6		1			2	7	2
Ammo storage									6		6	
Total	10		4		14		17	2	35	2	66	18

Table E-10

LIKES AND DISLIKES

Item	M4		T41		M47		M47E1		M48		Total	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Driver controls	5	1	5	3	14	1	10	1	6	5	40	11
Transmission	13	4	1	2			2		4		20	6
Ammo storage	2	5	1			2		5	4	1	7	13
Maintenance	2	6	5		3	7	3	4	2		15	17
Space	2			1	3		6		2		13	1
Armor	1			3					3		4	3
Power			1					1	4		5	1
Maneuverability	3		2	1	4		6				15	1
Speed	1		9				1				11	
Sighting devices		1	3		1		1				5	1
Gyro-stabilizer							3				3	
Gun		4										4
Total	29	21	27	10	25	10	32	11	25	6	138	58

Table E-11

SUGGESTED IMPROVEMENTS

Area of Response	M4	T41	M47	M47E1	M48	Total
Driving controls	8	4	3		14	29
Sighting devices	10		3	1	2	16
Ammo storage	9	1	2	3		15
Transmission	3	4	3		5	15
Tracks	2		5	2	4	13
Seat	4	1	3	2		10
Dual controls	1		5	3		9
Exhaust system					7	7
Maintenance	2		1	2		5
Total	39	10	25	13	32	119

Appendix F

INTERVIEW RESPONSES OF LOADERS

Table F-1

DIFFICULTIES WITH READY RACKS

Did location of ready racks cause trouble?	M4	T41	M47	M47E1	M48	Total
Responses						
Yes	10		11	5	4	30
No	15	25	14	20	21	95
Total	25	25	25	25	25	125
Reasons given for difficulties						
Not enough room	1		8	6	4	19
Hit hands	2		8		1	11
Rounds stick in rack	8	1				9
Not enough racks	5					5
Total	16	1	16	6	5	44

Table F-2

REASONS FOR NAMING TANKS FIRST OR LAST CHOICE FOR COMBAT

Reason	M4		T41		M47		M47E1		M48		Total	
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Armor				3			2		13		15	3
Ammunition storage		3	2				1		9		12	3
Space			2		4				6		12	
Stabilizer							12				12	
Maneuverability	2	9	5		2		1		1		11	9
Ease of handling rounds	5		2					1	3	1	10	2
Accuracy of gun		1		2	1				1		2	3
Maintenance		1			2					2	2	3
Ventilation		2							1		1	2
Total	7	16	11	5	9		16	1	34	3	77	25

Table F-3

SUGGESTED IMPROVEMENTS

Area of Response	M4	T41	M47	M47E1	M48	Total
Ammo storage	1	1	7	1		10
Ready racks	3	2		1	2	8
Used round disposal			1		6	7
Reset switch		1		3	1	5
Ventilation	4				1	5
Space					3	3
Radio position			2			2
Total	8	4	10	5	13	40