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Application of ARI Skill Retention Model to Wheel Vehicle Maintenance Tasks

Douglas Macpherson, Chavis Patterson, and Angelo Mirabella
U.S. Army Research Institute

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The Skill Retention Model is a model that describes how people forget technical tasks in terms of such task characteristics as the number of steps in the task and the quantity of the job aids. We administered the Skill Retention Model to seven expert wheeled vehicle mechanical/instructors (SMEs) at the Ordnance Center School, Aberdeen, MD. A total of nine tasks were covered, five tasks in five hours on each of two days, with one task being evaluated on both days and one evaluator serving on both days. We identified three out of nine tasks that are rapidly forgotten. Out of ten task characteristics, five differentiated the three tasks easily forgotten from those that are not easily forgotten. We recommended ways to improve training and calculated how much retention would increase with improved training.

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Training and Simulation

FOREWORD

The US Army Research Institute (ARI), in cooperation with TRADOC and its schools, performs research and development on ways to achieve more cost-effective training. In 1987, ARI joined with TRADOC and the US Army Ordnance Center and School (USAOC&S) in a partnership at Aberdeen Proving Ground (APG), Maryland, to identify and solve maintenance training problems. The partnership was defined by a memorandum of understanding (MOU) entitled "Establishment of a Training Technology Field Activity (TTFA) at the USAOC&S," and dated 10 May 1987.

The present report is one result of that partnership. The work was carried out as part of Task 344 by members of the Logistics Training Technologies Technical Area of the Training Research Laboratory in order to provide practical guidelines for designing maintenance training which will result in a high degree of skill retention and transfer.

This and other products of the TTFA were briefed to the Deputy Assistant Commandant, USAOC&S, in October, 1988. It will be used to help develop model training instruction and plan additional TTFA projects at USAOC&S. Its value was recognized by MG Ball, Commandant, USAOC&S, in a letter of appreciation to the author. In October 1989 this project was briefed in detail to a representative of the Israeli Army, who showed great interest in it.

EDGAR M. JOHNSON
Technical Director

APPLICATION OF ARI SKILL RETENTION MODEL TO WHEEL VEHICLE MAINTENANCE TASKS

EXECUTIVE SUMMARY

Requirement:

Support a Training and Doctrine Command (TRADOC) effort to identify performance deficiencies among 63W mechanics in FORSCOM units. Recommend corrective training procedures.

Procedure:

In order to identify potential performance deficiencies, we administered the Skill Retention Model to seven subject matter experts (SMEs) at the U.S. Army Ordnance Center & School (USAOC&S), Aberdeen Proving Ground (APG). The SMEs rated nine critical tasks on ten characteristics. From these ratings and a table in the Model, we generated skill decay curves for each task. We also identified reasons for the decay. Then we inferred and recommended corrective training procedures from the 10 subscales of the Model.

Findings:

(1) It is feasible and practicable to administer the Skill Retention Model to SMEs at APG. A SME can easily evaluate two tasks per hour.

(2) Three of the tasks rated are subject to severe skill decay: replace and time the fuel injector pump; diagnose engine that starts but stalls; diagnose engine that cranks but doesn't start. The SMEs disagreed among themselves on the task characteristics and, therefore, on the retention for remove/replace the steering gear. The SMEs agreed that the remaining five tasks were resistant to skill decay.

(3) Out of ten task characteristics, five account for the results above, i.e., quality of technical manuals, number of facts to memorize, difficulty of facts to recall, mental requirements, and motor control requirements. The SMEs agreed that the tasks differed on these task characteristics and did not agree that the tasks differed on the other five characteristics.

(4) From the 10 characteristics, we inferred and recommended ways to reduce skill decay through improved training and job aiding. We also estimated the increase in retention time for each training solution.

(5) We concluded that the model could be used routinely to help prioritize tasks for training and to evaluate cost-effectiveness tradeoffs.

Utilization of Findings:

(1) Help USAOC&S and TRADOC decide whether to use the Retention Model routinely for training development and cost-effectiveness analysis.

(2) Help the Training Technology Field Activity produce and test training development guidelines for programs of instruction at USAOC&S.

APPLICATION OF ARI SKILL RETENTION MODEL TO WHEEL VEHICLE MAINTENANCE TASKS

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APPLICATION OF ARI SKILL RETENTION MODEL TO WHEEL VEHICLE MAINTENANCE TASKS

1.0 INTRODUCTION

1.1 Overview

This report is one of a series in the Training Technology Field Activity (TTFA) program to improve automotive maintenance training at the U.S. Army Ordnance Center & School (USAOCS) (Ramsay, Kessler, & Mirabella, in preparation; Mirabella, Macpherson, & Patterson, 1988; & Kessler, in preparation). It shows how we used the ARI skill retention model to identify critical 63W10 tasks which are subject to severe forgetting (Rose, Manning, Radtke, & Ford, 1984; Rose et al., 1985a; Rose, Radtke, Shettel, & Hagman, 1985b). The report supports a larger TTFA effort to identify maintenance skill deficiencies (Applied Sciences Associates, 1988). It also demonstrates how the model can be used by school SMEs and quantifies the effort required.

1.2 Background

a. The Army Research Institute has joined USAOCS and the Training Development & Analysis Directorate of TRADOC in a TTFA at Aberdeen, Maryland. The goal of the TTFA is to identify shortfalls in maintenance performance and then build one or more model course segments to demonstrate how those shortfalls can be reduced through improved training methodology. To identify the shortfalls, the TTFA representatives will observe 63W10s at work in FORSCOM active and reserve component maintenance units such as those at Forts Riley and Stewart.

b. The results of the present study will supplement the field evaluations and could help us interpret the data from those evaluations. For example if we are unable to observe some critical tasks in the field we could substitute data obtained via the retention model. Or, if we find that Task X is done well at Riley but poorly at Stewart, we could turn to the skill retention data to find that this task is not well remembered unless it is practiced often. The "discrepancy" in field data would then make some sense, if we also found that Task X is performed more frequently at Fort Riley.

c. To do the analysis, we selected the 1985 revision of the "User's Manual for Predicting Military Task Retention" (Rose et al., 1985b). The skill retention model is based upon extensive research into the task characteristics that are associated with skill retention. This version of the skill retention model was developed using 78 Army tasks and military personnel (Hagman et al., 1986). Furthermore, it has extremely high validity and reliability (Rose et al., 1984, 1985a; Hagman, 1986). It,

therefore, can be used with reasonable confidence for TTFA purposes.

d. The model is based upon ten task characteristics that were found to influence skill retention such as the quality of the available job aids, the number of steps in the task, and several mental characteristics of task performance. The "User's Manual" presents these characteristics as ten scales. Each scale is divided into a small number of categories. The subject matter expert (SME) examines the task and determines, for each scale, the category that best describes the task. Next the SME sums these retention values to determine the total retention score for the task. Finally the user refers to a table which translates the retention score into the percent of soldiers who will be able to perform the task without training for any period from a week up to a year. With the "User's Manual" the user can evaluate tasks which are so easy that they can be remembered without practice for a year as well as tasks so difficult that only a few performers can do them properly after a week off.

1.3 Objectives of the Study

a. The principal objective was to provide explanatory information on task performance deficiencies in FORSCOM units by generating theoretical curves of pure forgetting without intervening practice for the unit tasks and based on task characteristics known to be associated with forgetting. This report is complete in the sense that it provides all the information that the reader needs to apply the methodology.

b. A secondary goal was to support a related TTFA project "State of the Art Analysis of Research on Skill Acquisition, Retention, and Transfer." We want to use the results of that analysis to design improved training for a testbed maintenance task that is subject to severe skill decay. Results of the current study will help us select an appropriate task.

c. A third goal was to find out if the retention model could be used easily at Aberdeen. The skill decay model is an inexpensive, quick, and valid way to prioritize tasks for training emphasis. We need to ensure, however, that the method does not impose an excessive personnel burden.

2.0 METHOD

2.1 Subjects

The raters were seven instructors from the Ordnance School's Wheel Vehicle Department at Edgewood MD. Each instructor had served in an Army maintenance unit. During the interview each demonstrated that he knew each of the tasks that he rated by such behaviors as discussing the strengths and weaknesses of the appropriate technical manuals from memory. No rater could be considered senior to the others, although the raters in the second group regarded one of their number as more knowledgeable concerning removal and replacement of the steering gear. One rater participated in both rating sessions.

2.2 Research Instruments. Three sets of instruments were used:

a. Procedure lists for nine tasks. The task lists (Appendices C1 -C9) were prepared by Applied Science Associates (1988) from Army technical manuals, in order to evaluate 63W maintenance performance in FORSCOM active and reserve components. The first five tasks in the list below were selected as important by school SMEs and school training development personnel. Tasks 5 - 9 were found to be frequently performed in the field by Applied Science Associates. Thus task 5 was considered important and was performed frequently in the field. Each list included the task steps, an indication of which steps had to be performed sequentially, the end products of the sub-tasks, the safety requirements, as well as the tools and materials needed. The tasks were:

(1) Diagnose hard starting

(2) Diagnose loss of engine power

(3) Diagnose stalling engine

(4) Diagnose engine which cranks but doesn't start

(5) Replace fuel injector pump

(6) Remove and replace the steering gear on an M35A2

(7) Remove and replace the axle on an M813A1

(8) Remove and replace the clutch on an M35A2

(9) Remove and replace the transmission on a M35A2.

b. The Questionnaire for Predicting Military Task Retention (Rose et al., 1985b). The Questionnaire requires that the user rate the task on 10 scales that have been demonstrated to predict how quickly soldiers will forget tasks. The scales are: 1) presence of job/memory aid, 2) job/memory aid quality, 3)number of steps in the task, 4) sequence of steps, 5) feedback, 6) time pressure, 7) mental requirements, 8) number of facts to remember, 9) difficulty of remembering the facts, 10) motor control requirements. (See Appendix B for definitions).

c. Tables for estimating skill retention. Rose et al., (1985b) and Hagman (1986) provide tables which allow the user to estimate the percentage of soldiers who will be able to perform a task after periods of no practice ranging from one week to 1 year. These tables are provided in Appendix B.

2.3 Procedure

a. We administered the questionnaire to two groups of four SMEs. As stated, one SME was in both groups. The first rating session concentrated on the tasks that had been recommended by the Ordnance School. The second session was devoted to tasks which Applied Science Associates had observed were being performed in the field. Task 5, "remove and replace the fuel injector pump", was rated by both groups of SMEs.

b. We interviewed each rater independently. We gave the rater a questionnaire and the "User's Manual" and then "talked" him through the ratings. The task analyses and the questionnaire for predicting military task retention were amplified beyond the manual, according to the protocol in Appendix C. In addition we also "highlighted" the most relevant sections of the User's Manual so that the raters could find the information defining the scale values more quickly. At the request of our SMEs, we made two additions to the protocol. In response to our experts' uneasiness at rating recent graduates we defined our mechanic as one with two years experience. We standardized the location of the operations by specifying that all maintenance took place in the shop rather than in the field on maneuvers.

c. After the SMEs finished their ratings, we assembled them into a group. The group then discussed each rating of each task until it reached a consensus or seemed unable to do so. If it failed to agree, we used the modal value, as required by the manual. Three situations occurred where we decided to present the disagreement among the observers. We present the two sets of data that were produced for these three tasks. We describe the situations producing the two sets of data below:

(1) In the "engine cranks, doesn't start diagnosis" the four raters split into two equal groups and were unwilling to shift. The manual states that both sets of results should be

used.

(2) In the "remove/replace steering gear" task the rater considered most expert by the others scored the task on the basis that the job aids (manuals) would not be available on the shop floor, then was unable to attend the group session. We include his data because he was considered most knowledgeable, his responses demonstrate the predicted effect of lack of technical manuals, and they correspond with the informal observations of an Ordnance School field observer. Furthermore, they agreed with those of Schruman, Joyce and Porsche (1980) who, in their study of Army wheeled vehicle maintenance, reported that TMs were unavailable, obsolete, and that "mechanics who did try to use the manuals seemed unfamiliar with the layout and indexing" of them.

(3) The "remove/replace fuel injector pump" was rated in both sessions because it was selected as important by school personnel and performed frequently in the field. Thus it was rated by the group of raters who rated the important tasks and the group who rated the frequently performed tasks.

3.0 RESULTS

3.1 Application of the Skill Retention Model.

a. Total labor for application of the model to 8 SMEs was 26 hours or 2.8 hours per task. Total clock time was 10 hours or 1.0 hour per task. Each rater, working individually with an interviewer, took an hour to rate the 5 tasks, i.e. 12 minutes per task, per rater. The group discussion, led by the interviewer, took another hour for each group, i.e. 12 minutes per task. Interviewer labor was 12 min per task, per rater for independent sessions, and 12 minutes per task for the group sessions.

b. The equations below were used to calculate the total effort required:

(1) SME labor (individual) = 12 min x number of tasks x number of raters

(2) SME labor (group session) = 12 min x number of tasks x number of raters

(3) Interviewer (individual) = 12 min x number of tasks x number of raters

(4) Interviewer (group session) = 12 min x number of tasks

3.2 Data on Skill Retention

a. The retention data appear in Table 1, which is a task scoring sheet. The data's implications for task performance are presented graphically in Figures 1 and 2. The table gives the group ratings for each task and questionnaire item. The tasks are presented in the left column in two groups -- "Diagnostic" and "Remove & Replace." Total task ratings are shown under "Total Score." The numbered columns identify the scales. The labels for the columns present the scale values and instructions for skipping certain scales. The scale value assigned by the group to the task is on the row for that task. The cell for a column is filled with a dash when the instructions require that the scale be skipped. The right-most column translates the total scores into the time lapse since last proficient performance that is required for 50% of the troops to forget the task. Thus for the task "engine starts, but stalls" half the mechanics would be unable to perform the task to standards if they had not performed the task for about 6.5 weeks.

b. Note that group ratings varied by one scale step or less for scales 1, 3, 4, and 5. Technical manuals exist for all the tasks.[1] All tasks have more than 10 steps. All tasks are sequential or mostly sequential. All tasks were rated easy to perform within the time allotted. Scores for the remaining scales, however, varied considerably, e.g., the range of values for amount of feedback is 0 to 22. Scales that differentiated among tasks are listed below in order of decreasing effect on retention.

(1) technical manual quality,
(2) mental requirements,
(3) feedback provided by the task,
(4) number of facts to memorize,
(5) ease of recalling the memorized facts, and
(6) and physical skill required.

We identified and rank ordered the preceding scales by examining the columns of Table 1. We observed that the tasks differed by large numerical values on the scales listed above, and that these values represented adjacent scale categories. Examination of the Performance Predication Tables in Rose et al. (1985b) indicated that differences of these magnitudes would increase retention times by at least 50%, therefore we considered these scales to identify possible areas for training intervention.

c. The task retention tables in the User's Manual were used to create two graphs presenting 12 retention curves for our nine tasks.[2] The results are presented in Figures 1 and 2. Figure 1 shows that skills for low to moderate scoring tasks decay very rapidly compared to those for tasks with higher scores. For example, at one month the passing rate ranges from 90% for "engine hard to start" down to 33% for "engine cranks, not start 2" even though the soldiers were able to get a "GO" on all tasks a month earlier.

d. Another way to see this difference in decay rates is to follow a horizontal line from, for instance, the 50% point on the Y-axis, mark where that line crosses each of the retention curves. Figure 2 shows that, without practice in replacing the fuel injector pump, 50% of repairmen would lose that replacement skill in only 2 months, according to the first group of raters. In contrast it would be 8 months before 50% of repairmen forget how to remove and replace an axle.

e. Tasks achieving scores above 180 are not forgotten in a year, the maximum time spanned by the tables in Rose et al. (1985b). Since removing and replacing both the clutch and the transmission scored 180 or higher, the curves for these two tasks are plotted as a single line across the top of Figure 2.

Table 1
Task Characteristics Rating

MOS: 63W

Task	Scale Questions 1: Job/Memory Aid: Yes = 1, No = 0 (GO TO 3)	2: Job/Memory Aid Quality: Excellent = 56 (GO TO 6), Very Good = 25, Marginally Good = 2, Poor = 1	3: Number of Steps: 1 Step = 25 (GO TO 6), 2 to 5 Steps = 14, 6 to 10 Steps = 12, More than 10 = 0	4: Sequence: None Are = 10, All Are = 5, Some Are and Some Are Not = 0	5: Feedback: For All Steps = 22, For Most Steps = 19, Only A Few = 11, None = 0	6: Time: None = 40, Early = 35, Difficult = 0	7: Mental Requirements: Almost None = 37, Simple = 28, Complex = 3, Very Complex = 0	8: Number of Facts: None = 20, A Few (1-3) = 18, Some (4-8) = 13, (More Than 8) = 0	9: How Hard to Remember: Not Applicable = 20, Not Hard At All = 18, Somewhat Hard = 12, Very Hard = 0	10: Motor Control Requirements: None = 34, Simple = 31, Considerable = 12, Very Great = 0	Total Score	50 % Retention Weeks
Diagnostic												
Engine cranks, doesn't start	1	2	0	0	19	40	28	0	12	0	102	3.5
Engine cranks, doesn't start	1	2	0	0	19	40	3	0	12	0	77	0.6
Engine starts, but stalls	1	25	0	5	22	35	3	0	31	0	122	6.5
Engine hard to start	1	25	0	5	22	35	28	0	31	16	163	31.0
Engine has loss of power	1	25	0	5	22	35	3	20	34	16	161	28.0
Remove & Replace												
Fuel injector pump (group 1)	1	2	0	5	0	35	3	18	12	16	92	2.5
Fuel injector pump (group 2)	1	2	0	5	22	35	3	13	31	16	128	8.0
Steering gear (w/o manual)	0	—	0	0	22	35	37	18	31	2	145	13.0
Steering gear (with manual)	1	56	—	—	—	35	28	18	31	2	171	52.0 +
Axle	1	56	—	—	—	35	28	13	31	0	164	34.0
Transmission	1	56	—	—	—	35	28	20	31	16	180	52.0+
Clutch	1	56	—	—	—	35	28	20	34	16	183	52.0+

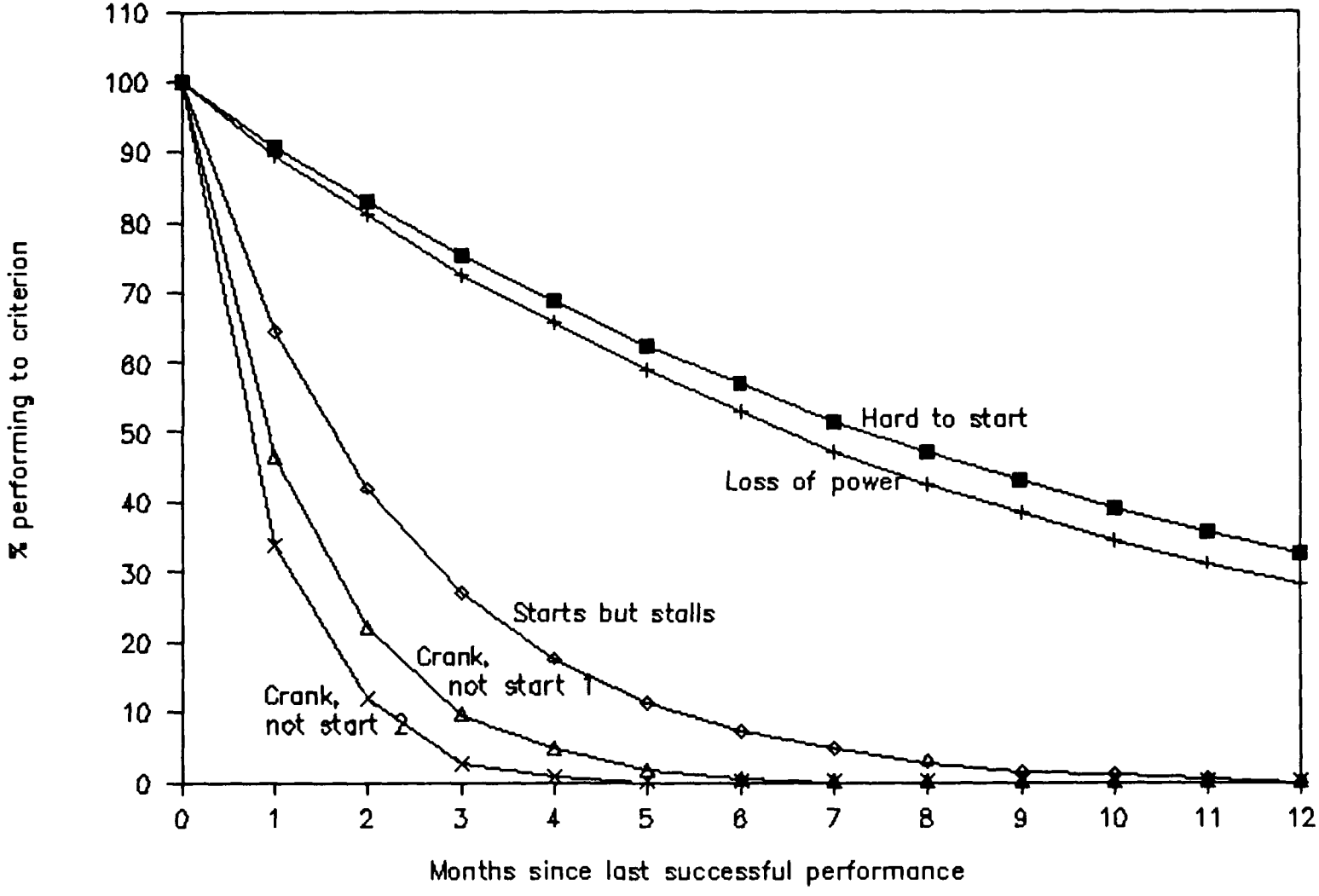

Fig 1. Predicted engine diagnostic performance

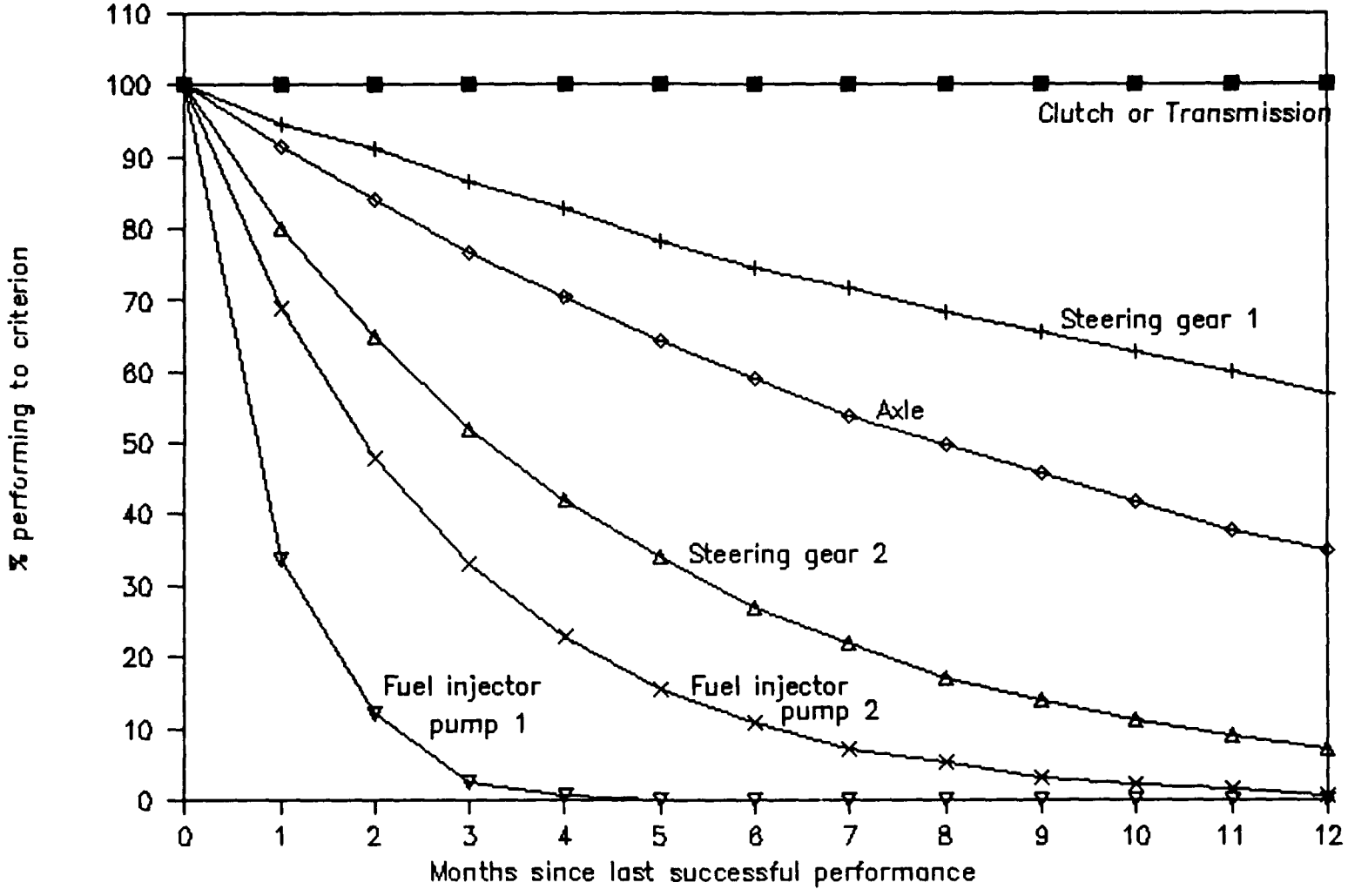

Fig 2. Predicted remove/replace performance

f. As described in the procedure section multiple scores are presented for three tasks:

(1) The task "engine cranks, doesn't start" two SMEs believed that the mental requirements (scale 7) best matched the "simple" examples in the manual, whereas the other two believed that the average 63W mechanic found the mental requirement more like the "complex" examples. Although these responses were adjacent on the rating scale, tasks with complex mental requirements are retained only half as long as those with simple mental requirements.

(2) "Remove and replace fuel injector pump" received ratings from the two rating groups. The two ratings differ primarily because the first group believed that the task provided feedback only at the end, when the mechanic tested the pump. The second group considered that each step provided feedback, that the mechanic could tell if he had miss-threaded a nut, for instance. Thus the difference between these ratings is a result of differing definitions of the scope of feedback to be considered in the evaluation.

(3) In "remove and replace steering gear" the most expert SME on that task stated that manuals were not used on the shop floor. The remaining SMEs scored the manuals "excellent" and stated that they were available to the mechanics on the shop floor. Thus we present the "without manual" results with the caveat that they represent the judgment of one individual rather than a consensus. As stated in the procedure section other observers have commented on the lack of manuals on the shop floor in the field.

4.0 DISCUSSION

4.1 Overview

a. The results show that it is feasible to use the Skill Retention Model as a tool for differentiating and prioritizing critical tasks at the USAOCS. The model can be used to identify those tasks most susceptible to skill decay and therefore most in need of special training resources. Given its high reliability and validity the model provides a very cost-effective supplement to field studies since the current procedure can process 1 task per clock hour. A similar number of tasks, studied in the field is currently taking about 8 months, at a cost of about $200,000 in contract funds, in addition to extensive labor by TRADOC and ARI personnel. The model, however, is not a substitute for good field evaluation, which reflects many factors other than pure forgetting and which provides details not available from the model.[3] However, it is a critical supplement, since it permits the user to quickly evaluate large numbers of tasks.

b. This application of the model demonstrated that SMEs could agree on appropriate scale values a large proportion of the time, since they agreed to disagree on only one task of the nine studied, "engine cranks, doesn't start." The results of the two administrations of "Remove and replace fuel injector pump" suggest that intra-group agreement on a task does not rule out *different ratings by different groups.* Thus, when multiple groups are being used to rate tasks some of the same tasks should be rated by all the groups, so that any biases can be corrected. The correction might consist of immediate retraining of the discrepant groups or post-hoc adjustment of their scores, thereby making all group ratings more comparable.

c. The results also point to clues as to how to overcome the performance deficiencies predicted by this study. They do so by identifying potential task and training variables which account for low task ratings, and especially variables which differentiate among the tasks studied. We discuss these clues further in the next section.

4.2 Training Development/Job Aiding Implications of the Results

a. Job Aids.

(1) Problem

(a) A major difference among the tasks was the varying quality of available technical manuals (TMs). TMs don't help much if they are hard to search through. If they were judged

"excellent" then the task would be performed correctly for twice as long as the same task with less than excellent manuals. The curves for the "remove and replace steering" demonstrate how important available excellent manuals can be.

(b) The major difference among the TMs' effectiveness for the different tasks was in the number of manuals required to perform the task. The low rated tasks tended to require searching multiple manuals to do the job whereas the other tasks did not.

(2) Training Solutions.

(a) Increase the amount and quality of training in how to use TMs, especially where multiple TMs are required.

(b) Place even more emphesis on requiring 63W students in Phases 1 and 2 to use manuals in all aspects of training. Give much more experience in the tasks requiring multiple manuals.

(c) Develop special aiding techniques for tasks requiring multiple manuals or very difficult searches through the TMs. e.g. special checklists which pull procedures together in one place. (See Swezey (1987) and Elliot & Joyce (1971) for detailed guidance). Use the results from applications of the skill retention model to identify the tasks most in need of special job aiding.

(3) Example of Pay-off. For the "engine cranks - doesn't start" problem, the 50% failure rate point could move from 4 days to 3.5 weeks with improved job aiding. Excellent job aiding places the memory in the aid so, essentially, the job is not forgotten as long as the job aid is used.

b. Mental Requirements

(1) Problem.

(a) We could double retention by doing a better job of teaching students to analyze maintenance problems more effectively. This is, in fact, the goal of the Basic Skills and Knowledge (BKS) training, Phase I of the 63W10 Program at Aberdeen. But, nothing the ARI researchers have observed would suggest that Phase I training has a marked effect on task performance or retention (Ramsay et al., 1988).

(b) The "Users Manual" provides clues for solving the "mental requirements" problem. It describes simple mental processing as "making gross comparisons ... or performing simple computations" (op. cit. p. 29). "Complex mental processes require the soldier to make a choice ... based on subtle but

discrete clues (e. g., ... identifying different types of aircraft or vehicles)" (op. cit. p. 29). Thus the manual implies that the students must be taught how to discriminate, generalize, and reason about situations so well that the behaviors required become as natural as gross comparisons or simple computations.

(2) Solutions:

(a) Front-end Analysis (FEA). Apply the basic principles of FEA described in the Harless method (Harless, 1982). In particular identify where soldiers must discriminate or generalize to perform effectively. The Army routinely ignores this prescription and describes tasks as lists of chained procedures, an inaccurate and misleading approach. We can't begin to solve the skill decay problem imposed by "mental requirements" unless we define those requirements accurately and operationally.

(b) Apply special techniques and pay special attention to training discriminations and generalizations, as explained in Harless (1982). These techniques included isolating these parts of a task, using verbal mediators or shaping techniques for difficult discriminations, and providing added practice. For instance it might be possible to train soldiers to use learn auditory diagnostic cues to the level that these cues would be as natural as gross comparisons. Among the target cues might be universal joint, differential, and brake noises. We suspect that auditory cue training might be useful in adjusting the fuel injector assembly.

(3) Example of Pay-off. For the "replace fuel injector pump" task improved methods for coping with "mental requirements" could move the 50% failure rate point from 2.5-8.0 to 5.0-16.0 weeks.

c. Number of Facts to Memorize/Difficulty to Remember

(1) Problem:

(a) Number of facts contributes substantially to skill decay for the three tasks involving engine starting problems. Difficulty of remembering facts is an added problem for a cranking engine that won't start. Number of facts is not a major problem for the remaining tasks, although the few facts connected with replacing the fuel injector pump were considered a bit difficult to recall by one group of SMEs.

(2) Solutions:

(a) Good job aids can do much to off-set this problem. The key however is to make the facts easy to get at. The SMEs stressed that facts buried in multiple TMs are not easy to find.

A small well indexed card catalog with the most frequently used tolerances, settings, and diagnostic readings may be one answer. The Skill Retention Model can help identify what set of facts should go in the catalog.

(b) Training solutions.

(i) If a task has 8 or more facts, pull them out in a condensed list and give the trainee practice in reviewing the list. Teach three or four facts at a time. Do this before the soldiers practice the whole task, and then again after they finish the task. If the same facts are used in other tasks, prepare a list of those tasks so that the trainees can see how the facts generalize. Show clearly how the same fact (e.g tolerance, spec, formula) applies to other tasks.

(ii) Use memory aids (i.e. mnemonics). This requires cleverness on the part of the instructor to generate mnemonics which make sense and are easy to remember for these particular students and topics. e.g. the instructor may need different mnemonics for different types of students.

(3) Example of Pay-off. Successful efforts to reduce the skill decay effects of large numbers of facts would move the 50% failure rate point for diagnosing a stalling engine from 6.5 to 9.5 weeks.

d. Motor Control Requirements

(1) Problem. The "User's Manual" and its first author state that tasks requiring a considerable amount of motor control, such as that required for touch typing or driving a manual transmission car, are retained better than other tasks of greater or lesser difficulty. Some of the tasks, "hard-starts", injector replacement", and "power loss" require considerable amounts of motor control, the optimal level for task retention. Other tasks, such as "remove and replace clutch", "engine cranks/no start", and "engine stalls", do not.

(2) Solution. Consider increasing the complexity of the physical performance demands of the task during training. For example, require use of torque wrenches and other precision tools even though they may not be required or used on the job.

(3) Example of Pay-off. For the "engine stalls" problem, the 50% failure point would move from 6.5 to 10 weeks.

4.3 Implications of the Model and the study for cost-training effectiveness analysis (CTEA).

a. The examples of pay-off suggest that the Skill Retention model can be a very useful tool in doing CTEAs, i.e. in answering the question "how much is a pound of training worth". For example, we can, with relative ease (e.g. see Adams, 1986), estimate costs for any proposed training solution or solutions derived from the model and then estimate from the model, the number of weeks of retention provided by the solution.

b. For example, the model suggests that a 50% pass rate for replacing the fuel injector pump can be extended from 2.5 to 5 weeks (worst rating) if we provide job aids that help the mechanic move through multiple TMs. We can estimate how much it will cost to develop and implement the job aid or even alternative job aids. Putting a value on the extra 2.5 weeks is not quite as straight forward, but with some imagination it can be done. Look at the cost of retraining, especially for reserve units that meet once a month. You can then make statements of the form "a dollar for improved training will save two dollars in retraining".

5.0 CONCLUSIONS

5.1 We conclude that the Skill Retention Model can:

a. be administered easily and at modest cost to APG SMEs,

b. predict skill decay for wheel vehicle maintenance tasks,

c. identify tasks that will be forgotten most quickly,

d. identify task features that promote skill retention,

e. help define training to reduce maintenance skill decay, and

f. support cost training effectiveness analysis.

5.2 The Skill Retention Model is sensitive to differences in how fast 63W skills decay and can be used with 63W SMEs. Furthermore, prior research has proven that the model is reliable and valid. Therefore, we recommend that

a. it be used to rate the remaining 63W tasks, and

b. that its use in CTEA be examined.

6.0 SUMMARY

6.1 The questionnaire provided in the "User's Manual for Predicting Military Task Retention" was completed by seven wheeled vehicle SMEs at Edgewood Arsenal, working in two groups. One group of SMEs rated five tasks that had been selected by school personnel as important. The other group rated five tasks that occur frequently in the field. One of the tasks was rated by both groups since it had been selected as important by the school and occurred frequently in the field. The raters were able to use the instrument to rate ten task characteristics. The instrument discriminated between the tasks and predicted large differences in the retention of different tasks. The results of the ratings suggested that 63Ws may need much more frequent refresher training on some tasks than might be expected. The descriptions of the rating scales provided in the "User's Manual for Predicting Military Task Retention" suggested approaches to revising the training that could increase retention.

6.2 We concluded that the Skill Retention Model is sensitive to differences among 63W tasks, that it can be used by 63W SMEs, and that it can help identify job aiding and training procedures to reduce skill decay. We also concluded that it could be a useful tool for cost-training effective analysis.

7.0 END NOTES

1. The steering gear replacement is not an exception. One rater stated that they exist but are not available on the shop floor. The reason for including this rater is explained in the text.

2. The reasons for two sets of results for some tasks were explained in the procedure section.

3. For instance, the initial analysis suggested that the diagnostic tasks should be critical. The field research failed to observe them and determined that the remove and replace tasks were critical in terms of frequency of actual performance.

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APPENDIX A: Task Descriptions

Diagnose hard starting

Diagnose loss of engine power

Diagnose stalling engine

Diagnose engine which cranks but doesn't start

Replace fuel injector pump

Remove and replace the steering gear on an M35A2

Remove and replace the axle on an M813A1

Remove and replace the clutch on an M35A2

Remove and replace the transmission on a M35A2.

Engine hard to start

TASK EVALUATION FORM

Performer _____ Task Title Troubleshoot Fuel System Evaluator _____

AFSC _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TASK SPEED		SEQUENCE FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Scientific Measuring	3 Standard	4 Sequence	5 End Product Criteria	6 Procedures and Regulations	7 Item, Size or Type, Use
1 Review safety precautions	N/A		1			
2 Refer to Operator's Manual						Operator's Manual
3 Check area ventilation						
4 Park truck		MAC	5		Well ventilated area/ away from flames, sparks smoking/ fire extinguisher within 50'	
5 Check brake and gear setting			5 before 6 5 before 13	Truck parked and secure		
6 Locate electrical fuel shut-off valve obtain multimeter		MAC	6			Standard tools Operator's Manual
7 Set multimeter to measure resistance				Multimeter set		Multimeter
8 Put multimeter (-) minus lead on EFSV valve contact				(-) Lead on EFSV contact		
9 Put multimeter (+) plus lead on other EFSV valve contact				(+) lead on other EFSV contact		
10 Multimeter does not read 28-32 ohms			10	Multimeter read correctl		

Engine hard to start

TASK EVALUATION FORM

Task Title Troubleshoot Fuel System

STEP	TIME SPEED		SEQUENCE FOLLOWING	END PRODUCTS	SAFETY	T.O.S. EQUIPMENT AND MATERIALS USE
1 Description	2 Slow/Slow Measuring	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item, Spec or Type, Use
11 End task: Recommend replace EFSV				Recommend replace EFSV		
12 Multimeter reads 28-32 ohms; go to 13				Read correctly		
13 Locate fuel pump; obtain pressure gage					1. See that pressure gage glass and needle are not broken/	Pressure gage
14 Unscrew, remove pipe plug in EFSV			14	Pipe plug removed	2. Check pressure hose for cracks, holes, kinks,	Operator's Manual
15 Put elbow adapter fitting in EFSV				Elbow adapter fitting in EFSV	3. See that fittings are tight/ 4. Check to see that input end is dirt free	
16 Hand tighten: Wrench tighten						Standard tools
17 Screw pressure line fittings into elbow adapter and gage				Pressure line fittings in elbow adapter and gage		
18 Hand tighten: Wrench tighten						Standard tools
19 Have helper start engine						
20 Check for leaks at all fittings						

Engine hard to start

TASK EVALUATION FORM

Personnel _____ Task Title Troubleshoot Fuel System Evaluator _____

AFSC _____ Date of Development _____ Date _____

STEP	TEST SPEED		SEQUENCE FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Start/Stop Measuring	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item Size or Type Use
21 If leaks found, retighten fittings						
22 No leaks, allow engine to achieve normal temp				Fittings tight		
23 Have engine run to 1000 rpm						
24 Check pressure to see if between 17 and 23 psi				Reads correctly		
25 Have helper rev engine at full throttle						
26 Is pressure between 170-180 psi			26	Reads correctly		
27 Incorrect pressure? Recommend replace fuel pump				Recommend replace fuel pump		
28 Correct pressure? Recommend engine assembly overhaul				Recommend engine assembly overhaul if problem not solved		

ENGINE HAS LOSS OF POWER

TASK EVALUATION FORM

Performer _____

MOS _____

Task Title TROUBLESHOOT COMPREESION IGNITION ENGINE (MULTIFUEL)

Evaluator _____

Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
☐				Vehicle engine off Hand brake set Chock wheels		
☐				Remove jewelry Raise and secure hood Lower side panels		
☐				on engine compartment		TM 9-2815-210-34-2-2 9-4910-571-10&8
☐						General Mechanics Tool box STE/ICE
☐						DA Forms 2404 2407 2407-1
1 ☐ Check all fan-belts for tension/ serviceability						
2 ☐ Check ignition cables for condition						
3 ☐ Check engine oil level						
4 ☐ Check radiator coolant level						
5 ☐ Check batteries and cable connections for serviceability			Pre-test inspection completed			

ENGINE HAS LOSS OF POWER

TASK EVALUATION FORM

Performer _____

MOS _____

Task Title TROUBLESHOOT COMPRESSSION IGNITION ENGINE (MULTIFUEL)

Evaluator _____

Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
6 Remove VTM and WS power cable from case				Make sure push on/ push off switch is off		
7 Connect red (+) power cable lead to positive battery terminal		& P1				
8 Connect black (-) power cable lead to negative battery terminal		to J1	VTM connected to vehicle power			
9 Push the push on/ pull off switch to on position						
10 VTM displays 8888 (2 sec) then ----			VTM power up connected			
11 Dial 66 press and release test						
12 VTM displays 0.0.6.6						
13 Dial 99, press and release test						
14 VTM displays .0.0.9.9 to blank to .8.8.8.8 to blank						
15 VTM displays ans holds pass			Confidence test complete			

ENGINE HAS LOSS OF POWER

TASK EVALUATION FORM

TROUBLESHOOT COMPRESSION

Performer _____ Task Title IGNITION ENGINE (MULTIFUEL) Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
16 Dial 67, press and release test						
17 VTM displays 22 VDC or above						
18 Dial 60, press and release test						
19 VTM displays prompt VEH						
20 Locate vehicle ID. number from the testcard/VTM flip cards/TM	table,	vehicle				
21 Dial 02 press and release test						
22 VTM displays VID number 2			Vehicle ID. number (VID) entered			
23 Disconnect vehicle tachometer cable				Vehicle engine off clean all mounting surfaces		
24 Install pulse tachometer TK item 34						
25 Connect P1 of transducer cable W4 to J2 on VTM						

ENGINE HAS LOSS OF POWER

TASK EVALUATION FORM

Performer _____

MOS _____

Task Title TROUBLSHOOT COMPRESSION IGNITION ENGINE (MULTIFUEL)

Evaluator _____

Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
26 Connect P2 of transducer cable to connector on pulse tachometer			Pulse tachometer installed	Be sure W4 cable is clear of belts and fan blades		
27 Connect P1 to W4 to J3 on the VTM						
28 Connect P2 of W4 to current probe TK item II						
29 Clamp current probe around a positive battery cable connected to starter			Current probe is closed and arrow is pointed toward the	starter		
30 Crank engine several cycles with fuel shut off						
31 Turn off all electrical power						
32 Dial 7Z, press and hold test						
33 VTM displays CAL message prompt						
34 Release test						
35 VTM displays offset value -225 to 225			Transducer offset test completed			

ENGINE HAS LOSS OF POWER

TASK EVALUATION FORM

Performer _____ SSN _____

Task Title TROUBLSHOOT COMPRESSION IGNITION ENGINE (MULTIFUEL)

Evaluator _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
36 Press and release test						
37 VTM displays GO						
38 Crank engine for 2 seconds						
39 VTM displays OFF or error message						
40 VTM displays first peak current reading			SPEC for first peak current reading 700-1400 amps			
41 Start vehicle engine				Check oil level do not check coolant level if engine is hot		
42 Check oil pressure gauge			Minimum oil pressure reading present 15 psi	Make sure all hydraulic power switches are off Disengage manual hydraulic levers if vehicle is so equipped		
43 Check generator gauge			Normal range reading present			
44 Check all other gauges			Normal range readings present GO3 completed			
45 Adjust engine speed turn on headlights and accessories			Engine speed 1000-1200 rpm headlights accessories on			

ENGINE HAS LOSS OF POWER

TASK EVALUATION FORM

TROUBLESHOOT COMPRESSION

Performer _____ Task Title IGNITION ENGINE (MULTIFUEL) Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
46 Dial 01, press and release test						
47 VTM displays PASS						
48 Dial 67, press and release test						
49 VTM displays battery voltage and engine rpm alternately						
50 Verify battery voltage is within SPEC			Battery voltage is within 26.5 to 29.5 VDC range			
51 Turn off head-lights, accessories and engine			Go 4 completed			
52 Check vehicle for oil, fuel, and coolant leaks						
53 Start vehicle engine and set rpm			Engine rpm 1000-1200 rpm			
54 VTM diaplays rpm						
55 Allow engine to reach normal operating temperature			Engine temperature 140° to 200° F			

ENGINE HAS LOSS OF POWER

TASK EVALUATION FORM

TROUBLESHOOT COMPRESSION

Performer _____ Task Title IGNITION ENGINE (MULTIFUEL) Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
56 Dial 10, press and release test						
57 Increase engine rpm speed			VTM displays 2850 rpm			
58 Observe oil pressure gauge			Oil pressure gauge indicates 50-75 psi GO7 completed			
59 Observe VTM and increase engine speed to maximum govenor speed			Maximum engine govenor speed 2600-2950 rpm	Check govenor operation prior to performing the power test		
60 Press accelerator to fill throttle			RAM stays within SPEC limits			
61 Release excelerator						
62 Dial 13, press and release test				Do not run power test if engine temperature is above normal engine below 1000 rpm		
63 VTM displays CIP prompt						
64 Press accelerator to the floor and hold						
65 VTM displays OFF						

ENGINE HAS POSS OF POWER

TASK EVALUATION FORM

Performer _____ MOS _____

Task Title TROUBLESHOOT COMPRESSION IGNITION ENGINE (MULTIFUEL)

Evaluator _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
66 Release accelerator when OFF prompt appears						
67 Observe VTM for % of power display						
68 Compare VTM display with % of power table number				Use TM power test procedures for turbo or fuel limiter equipped vehicles		
69 Dial 10, press and release test				GO6 completed adjust idle speed rpm using TM to rpm SPECs shown in table		
70 Observe VTM display for 10 sec. to verify idle speed remains in SPEC			Engine idle speed SPECs 650-850 rpm			
71 Perform compression test						

Engine will not start; engine stalls

TASK EVALUATION FORM

Purpose _____ Task Title Troubleshoot Fuel System Evaluator _____

AFSC _____ Date of Development _____ Base _____

Page ____ of ____

STEP	TASK SPEED		SEQUENCE/FOLLOWING	END PRODUCTS	SAFETY	T.O.S. EQUIPMENT AND MATERIALS USE
1 Enumeration	2 Slow/Fast Measuring	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item, Size or Type, Use
1 Review safety precautions	N/A		1 through 5			
2 Refer to operator manual						
3 Check area ventilation						
4 Park truck						Operator's Manual
5 Check brake and gear setting			5 before 6 5 before 13	Truck parked and secure	Area well ventilated/away from sparks, flames, smoking/ fire extinguisher within 50'	
6 Locate electrical fuel shut-off valve Obtain multimeter			6			Multimeter
7 Set multimeter to measure resistance				Multimeter set		
8 Put multimeter (-) lead on one EFSV valve contact				(-) lead on one EFSV contact		
9 Put multimeter (+) lead on other EFSV valve contact				(+) lead on other EFSV contact		
10 Multimeter does not read 28-32 ohms				Multimeter read correctly		

Engine will not start; engine stalls

TASK EVALUATION FORM

Performer _____ Task Title Troubleshoot Fuel System Evaluator _____

MOS _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TASK SPEED		SEQUENCE-FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Enumeration	2 Slow/Slow Discovering	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item, Size or Type Use
11 End task - recommend replace EFSV				Electrical fuel shut-off valve not working - recommend		
12 Multimeter reads 28-32 ohms - go			12 before 27			
13 Locate fuel pump			13			
14 Refer to operator's manual						Operator's Manual
15 Go to proper page and chart						
16 Unscrew fuel line fitting						
17 Unscrew clamp bolt on fuel supply line						
18 Remove clamp bolt				Clamp and bolt removed		
19 Pull fuel supply line from fitting, cylinder head	female			Fuel supply line free		
20 Slide fitting back on fuel supply line						

Engine will not start; engine stalls

TASK EVALUATION FORM

Performer _____ Task Title Troubleshoot Fuel System Evaluator _____

MOS _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TIME/SPEED		SEQUENCE-FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Start/Base Measure	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item, Spec or Type, Use
21 Put rubber hose over end of fuel supply lines						
22 Put other end of hose in can of fuel						Filled fuel can
23 Crank engine for about 10 secs. then stop			23			
24 Check fuel can						
25 Fuel remaining - stop - recommend new fuel pump				No fuel in fuel can		
26 No fuel remaining - stop				Is the problem fixed?		
27 Recommend engine assembly overhaul				Recommend engine assembl overhaul		

Engine cranks; doesn't start

TASK EVALUATION FORM

Performer _____ Task Title Troubleshoot Electrical System Evaluator _____

AFSC _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TIME/SPEED		SEQUENCE-FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Start/Stop Measuring	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item, Size or Type, Use
1						
2						
3 Check area safety					Fire extinguishers within 50'/well ventilated area	
4 Park Truck				Identify proper procedure		Operator's Manual
5 Check brakes and gear setting				Truck secure		
6 Locate emergency engine stop control handle			6			Operator's Manual
7 If not all the way in, push it in				Emergency engine stop control handle in		
8 Is emergency fuel shut-off lever all way to front						
9 If not, push all way to front				Emergency fuel shut-off lever to front		
10 Test engine if levers were not in proper position			10			

Engine cranks; doesn't start

TASK EVALUATION FORM

Performer _____ Task Title Troubleshoot Electrical System Evaluator _____

MOS _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TIME/SPEED		SEQUENCE-FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Time/Speed Measure	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item, Size or Type, Use
11 Does engine run? Yes				Engine runs, task complete		
12 Does engine run? No. Locate ignition switch						Operator's Manual
13 Remove ignition switch from panel			13	Ignition Switch removed		
14 Allow to hang from leads						
15 Remove lead 54 from ignition switch				Lead 54 removed from ignition switch		
16 Set battery switch to on				Battery switch set to on		
17 Set ignition switch to run				Ignition switch set to run		
18 Set multimeter to measure +24 volts DC				Multimeter set to measure +24 volts DC	Check multimeter glass, pointer, batteries	Multimeter
19 Put multimeter (-) minus lead on good ground				(-) Lead on adequate ground		
20 Put multimeter (+) plus lead on lead 54				(+) Lead on lead 54		

Engine cranks; doesn't start

TASK EVALUATION FORM

Task Title Troubleshoot Electrical System

Date of Development

Page ____ of ____

STEP	TASK SPEED		SEQUENCE-FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
4 Description	5 Slow/Fast Measuring	6 Standard	7 Sequence	8 End Product Created	9 Procedures and Regulations	10 Item, Spec or Type Use
21 Read multimeter			↓ 21			
22 Multimeter reads +23 to +2(volts DC? No				End task: recommend next step (replace ignition switch)		
23 Reads +23 to +26 volts DC? Yes						
24 Check lead 54 from ignition sw tch to battery switcl			24			
25 Set battery switch to off				Battery switch set to off		
26 Set ignition switch to off				Ignition switch set to off		
27 Put lead 54 back in ignitio switch				Lead 54 in ignition switch		
28 Put ignition switch back in anel				Ignition switch replaced		Operator's Manual
29 Take battery switch from instrument panel				Battery switch removed		
30 Take lead 54 from ignition switch off of battery switch			↓	Lead 54 off of battery switch		

Engine cranks; doesn't start

TASK EVALUATION FORM

Task Title: Troubleshoot Electrical System

Date of Development:

Page ____ of ____

STEP	TIME/SPEED		SEQUENCE/FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Rate/Speed Measure	3 Standard	4 Sequence	5 End Product Created	6 Precautions and Regulations	7 Item, Size or Type, Use
31 Set battery switch to on				Battery switch on		
32 Set ignition switch to on				Ignition switch on		
33 Put multimeter (-) lead on ground				(-)Lead on ground		
34 Put (+) lead on lead 54 contact			34	(+) lead on lead 54		
35 Multimeter does not read +2 to +26				End task/recommend repair or replace front harness		
36 Check battery switch						
37 Set battery switch to off			37	Battery switch off		
38 Set ignition switch to off				Ignition switch off		
39 Put lead 54 back on battery switch				Lead 54 on battery switch		
40 Take other lead 54 off battery switch				Other lead 54 off battery switch		

Engine cranks; doesn't start

TASK EVALUATION FORM

Performer _____ Task Title Troubleshoot Electrical System Evaluator _____

ASVAB _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TIME/SPEED		SEQUENCE-FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Start/Rest Measures	3 Standard	4 Sequences	5 End Product Events	6 Procedures and Regulations	7 Item, Spec or Type, Use
41 Set battery switch to on				Battery switch on		
42 Set ignition switch to on				Ignition switch on		
43 Put multimeter (-) lead on good ground				(-) Lead on good ground		
44 Put (+) lead on lead 54 contact of battery switch			44	(+) Lead on lead 54 contact of battery switch		
45 Multimeter does not read +2 to +26 volts						
46 End task: Recommend replace battery switch				Recommend replace battery switch		
47 Check lead 54 from battery switch to electrical fuel shut-off valve						
48 Put lead 54 back on battery switch			48	Lead 54 on battery switch		
49 Put battery switch back on instrument panel				Battery switch back in instrument panel		Operator's Manual
50 Take lead 54 off EFSV assembly contact				Lead 54 off electrical fuel shut-off assembly		

Engine cranks; doesn't start

TASK EVALUATION FORM

Person _____ Task Title Troubleshoot Electrical System Evaluator _____

MOS _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TASK SPEED		SEQUENCE-FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1. Description	2. Speed/Time Measure	3. Standard	4. Sequence	5. End Product Created	6. Procedures and Regulations	7. Item, Source or Type, Use
51 Set battery switch to on				Battery switch on		
52 Set ignition switch to run				Ignition switch on		
53 Put multimeter (-) lead on good ground				Multimeter (-) lead on ground		
54 Put multimeter (+) lead on lead 54 contact			54	Multimeter (+) lead on lead 54 contact		
55 Multimeter does not read +23 to +26 volts DC						
56 End task: Make recommendation				Recommend: Replace front harness		
57 Multimeter does read +23 to +26 volts DC						
58 Clean lead 54 contact & EFSV assembly contact						
59 Set battery switch to off			59	Battery switch off		
60 Set ignition switch to off						

Engine cranks; doesn't start

TASK EVALUATION FORM

Performer _____ Task Title Troubleshoot Electrical System Evaluator _____

AFSC _____ Date of Development _____ Date _____

Page _____ of _____

STEP	TIME/SPEED		SEQUENCE/FOLLOWING	END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, AND MATERIALS USE
1 Description	2 Time/Step Measured	3 Standard	4 Sequence	5 End Product Created	6 Procedures and Regulations	7 Item, Spec or Type, Use
61 Clean lead 54 contact						
62 Clean EFSV assembly contact				Both contacts clean		
63 Put lead 54 back on EFSV assembly				Lead 54 back on EFSV assembly		
64 Start engine			64			Operator's Manual
65 Engine starts task complete				Engine starts		
66 Engine does not start- recommend				Recommend- Check resistance EFSV assembly coil		

TASK EVALUATION FORM

Performer _____ Task Title REPLACE FUEL INJECTION PUMP Evaluator _____

MOS _____ Date _____

Page 1 of 5

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
				Engine off Hand brake set Chock wheels		
				Remove jewelry Disconnect battery Neg. ground cable		
				Raise and secure hood Open engine compart-		
				ment side panels Engine cool		
						TM 9-2320-209-203-1 9-2815-210-34-2-1 9-2815-210-34-2-2
						DA Forms 2404 2407 2407-1
						General Mechinics Tool box Tongue wrench
						(0-150 lb/ft) Holding wrench Drip pan
1 Drain vehicle cooling system			Radiator drained		6 gal. container	
2 Remove radiator brush guard						

TASK EVALUATION FORM

Performer _____ Task Title REPLACE FUEL Evaluator _____

MOS _____ INJECTION PUMP Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
3 Disconnect and and remove radiator						
4 Check engine data plate for engine mod						
5 Disconnect fuel injector pump fuel lines &oil hoses						
6 Remove fuel tube clamps						
7 Remove six fuel injector tubes						
8 Remove fuel injector pump drive gear access cover						
9 Remove fuel injector pump drive gear retaining plate						
10 Remove fuel pump drive gear						
11 Remove fuel pump rear bracket						
12 Remove ruel injector pump assembly from engine						

TASK EVALUATION FORM

Performer _____ Task Title REPLACE FUEL INJECTOR PUMP Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
13 Complete DA form 2407-1 to obtain new fuel injection pump						
14 Change drive gear hub on new injection pump					Holding wrench	
15 Remove crankcase breather adapter						
16 Remove front cyclinder head cover						
17 Bar engime over to timing mark			Timing mark on crankshaft damper aligned with pointer			
18 Check clearance of #1 rocker arms			on timing gear Clearances between roller and pads and			
19 Replace drive gear hub (if it was removed)			valve stems			
20 Remove louse from automatic timing device						
21 Remove timing window cover						
22 Turn drive gear hub to align timing mark with pointer			Timing mark and pointer aligned			

TASK EVALUATION FORM

Performer _____ Task Title REPLACE FUEL INJECTION PUMP Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
Install fuel pump to flame heater tube						
Install fuel pump mounting bracket						
25 Install fuel pump drive gear						
26 Check timing marks for correct position			Injection pump timed			Tongue drive gear to 23-27 lb/ft
27 Install drive gear access cover						Can be performed any time after step 26
28 Install automatic timing device cover on timing window						
29 Install front cylinder head cover						
30 Install crankcase breather adapter						
31 Install six fuel injector tubes						

TASK EVALUATION FORM

Performer _____ Task Title REPLACE FUEL INJECTOR PUMP Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
33 Install fuel tube clamps						
34 Reconnect fuel lines, hoses and fittings						
35 Install radiator and refill						
36 Connect battery negative ground cable						
37 Start engine and run to governed no load speed			2800 RPM			
38 Stop engine						
39 Check for leaks			No leaks present			
40 Install radiator brush guard						
41 Complete DA form 2404						

TASK EVALUATION FORM

Performer _____ Task Title REMOVE & REPLACE STEERING GEAR - M35A2 Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
☐ Correct Tools					Gen. toolbox Bushing remover/replacer Sleeve bearing hand bornisher	
☐ Correct TM's					TM 9-2320-209-10 TM 9-2320-209-20 TM 9-2815-210-34	
☐ Vehicle prepared IAW TM 9-2320-209-10						
1 ☐ Remove Pitman arm					TM 9-2320-209-20	
2 ☐ Remove Steering wheel					TM 9-2320-209-20	
3 ☐ Remove Air cleaner indicator					TM 9-2320-209-20	
4 ☐ Open Hood						
5 ☐ Disconnect battery ground					TM 9-2320-209-20	
6 ☐ Remove radiator and fan					TM 9-2320-209-20	
7 ☐ Remove turn signal control					TM 9-2320-209-20	

TASK EVALUATION FORM

Performer _____ Task Title REMOVE & REPLACE STEERING GEAR - M35A2 Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
8 Remove engine rear lifting bracket					TM 9-2815-210-34	
9 Remove throttle control and linkage					TM 9-2815-209-20	
10 Remove band from steering column						
11 Remove electric horn plug						
12 Put hoist on front engine lifting eye						
13 Remove nuts, cap-screws from front engine mounting bracket						
14 Remove primary fuel filter						
15 Remove rear engine mount						
16 Remove steering column pad (interior cab)						
17 Remove exhaust pipe from engine, remove intake hose at air cleaner; move engine to right						

TASK EVALUATION FORM

Performer _____ MOS _____

Task Title REMOVE & REPLACE STEERING GEAR - M35A2

Evaluator _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
18 Remove steering column & gear box			End of Task: Remove Steering Gear			
19 Put steering column thru hole in frame; put gear box into frame			Start Task: Replace Steering Gear			
20 Install steering column pad						
21 Install primary fuel filter						
22 Install exhaust pipe at engine; install intake hose at air cleaner						
23 Move and aline engine; tighten bolts						
24 Attach engine mounting bracket						
25 Take engine off hoist						
26 Connect electric horn plug						
27 Refer to step 10 of Remove Steering Gear & work backwards						

TASK EVALUATION FORM

Performer _____ Task Title REMOVE & REPLACE AXLE - M813A1 Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
☐ Correct Tools					*Gen. Mech. Tool Kit *2 floor jacks *Prybar	
☐					*Knockout adapter *Torque wrench *2 jack stands	
☐ Correct TM's					TM 9-2320-260-34-2-2 TM 9-2320-260-10	
☐ Prepare vehicle IAW -10						
1 ☐ Jack up truck & support chasis						
2 ☐ Remove wheels						
3 ☐ Remove drag link						
4 ☐ Remove power steering cyl. assy.						
5 ☐ Remove brake lines & hoses						
6 ☐ Remove shock absorbers						

TASK EVALUATION FORM

Performer _____ Task Title REMOVE & REPLACE AXLE - M813A1 Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
7 Remove prop. shaft f. axle to xfer case						
8 Place floor jacks under axle housing						
9 Disconnect axle U-bolts						
10 Remove lower seats (U-bolts)						
11 Lower jacks						
12 Slide axle from vehicle			Axle Removed			
13 Remove U-bolts & top brackets						
14 Prepare new axle						
15 Position axle under vehicle						
16 Attach U-bolt & top axle seat						

TASK EVALUATION FORM

Performer _____ Task Title REMOVE & REPLACE AXLE - M813A1 Evaluator _____

MOS _____ Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
17 Raise axle into spring seats						
18 Attach lower seat						
19 Torque bolts						Torque to 325-400 ft.lbs.
20 Attach prop. shaft f. axle to xfer						
21 Install shock absorbers						
22 Install brake lines & hoses						
23 Install power steering cyl. assy.						
24 Install drag link						
25 Install wheels						

TASK EVALUATION FORM

Performer _____ Task Title REMOVE AND REPLACE CLUTCH Evaluator _____

MOS _____ M35A2 Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
☐ Correct Tools						
☐ Correct TM's					TM 9-2320-209-34-2-1 TM 9-2320-209-10	
☐ Vehicle Prep. IAW -10						
1 ☐ Remove XMSN						
2 ☐ Push clutch in and install spacer blocks						
3 ☐ Remove 8 screws & lock washers, two turns at a time						
4 ☐ Remove pressure plate and clutch disk						
5 ☐ Install clutch against flywheel with long hub away from flywheel						
6 ☐ Place clutch alignment tool in clutch hub						
7 ☐ Install pressure plate on flywheel						

09

TASK EVALUATION FORM

Performer _____ Task Title REMOVE AND REPLACE CLUTCH Evaluator _____

MOS _____ M35A2 Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
8 Install 8 cap screws with washers						
9 Torque 8 cap screws 23-27 ft.lbs.						
10 Push in clutch release levers & remove spacer blocks						
11 Remove clutch alignment tool						
12 Replace XMSN						

TASK EVALUATION FORM

Performer _____ Task Title REMOVE & REPLACE XMSN Evaluator _____

MOS _____ M35A2 Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
☐ Correct Tools					General mechanic tool kit torque wrench	
☐ Correct TM's					TM 9-2320-209-34-2-1	
☐ Prep vehicle IAW -10						
☐ Remove XMSN						
1 ☐ With shifter in neutral, remove shift lever						
2 ☐ Remove inter & front tunnels on cab floor						
3 ☐ Disconnect reverser linkage						
4 ☐ Remove clutch control rod						
5 ☐ Remove XMSN to xfer prop. shaft						
6 ☐ Place jack under XMSN						

TASK EVALUATION FORM

Performer _____ Task Title REMOVE & REPLACE XMSN Evaluator _____

MOS _____ M35A2 Date _____

STEP	STANDARD/SEQUENCE		END PRODUCTS	SAFETY	TOOLS, EQUIPMENT, and MATERIALS USE	COMMENTS
Description	Std.	Seq.	End Product Criteria	Procedures/Regulations	Item, Size, Type, Use	
7 Remove XMSN to engine bell housing bolts						
8 Lower XMSN						
9 Place XMSN on jack & align to bell housing						
10 Bolt XMSN to housing, torque bolts			Bolts torqued 23-26 ft.lbs.			
11 Remove jack						
12 Replace XMSN to xfer prop. shaft						
13 Replace reverse shift lever rod						
14 Replace clutch linkage						
15 Replace front & inter cab tunnels						
16 Replace XMSN gear shift lever						

APPENDIX B: Definitions of Scales in Retention Model

II. Instructions for the Paper-and-Pencil Version

The task rating method has been developed in both a paper-and-pencil version (described in this manual) and a computer-based version. This manual is intended to serve as a basic guide for those who are asked to rate tasks to determine their level of retention. While it contains the essential information needed to use the rating method properly, situations may arise for which adequate guidance is not provided. Further assistance may be obtained from the U.S. Army Training Board at Comm (804) 878-4658 or AV 927-4658.

The Rating Procedure

The task rating procedure contains ten questions with each having from two to four choices of answers. In addition, there is a Definitions section designed to clarify the meaning of each question and help with the selection of the most appropriate answer. It is important to read all of the Definitions information before selecting an answer.

The paper-and-pencil version contains a Task Retention Rating Form on which the answers to each question for each task are to be recorded. A copy of the Rating Form is included on Page 40 of this manual.

Here is the step-by-step procedure to follow:

1. List the number designation and title of each of the tasks you are going to rate in the first two columns of the Rating Form. Use one line on the form for each task. You may shorten or abbreviate the task title. Enter the Military Occupational Specialty (MOS) or Specialty Code (SC) designation at the top of the form. If you are rating tasks in more than one MOS/SC, use separate Ratings Forms for each.

2. Refer to the current task summary to obtain a description of each task you intend to rate. You may also use information found in referenced documents for each task.

3. Read the first question and the associated Definitions section. Review the supporting documentation for each task as needed to arrive at an answer. Note the Scale Value for the answer you selected. Write that Scale Value in the box in the Rating Form corresponding to that task and question.

4. Continue in this manner until you have answered all 10 of the questions for Task 1 and have entered the appropriate Scale Values on the Rating Form. Depending on your answers you may be asked to skip certain questions. Follow the instructions given for each question.

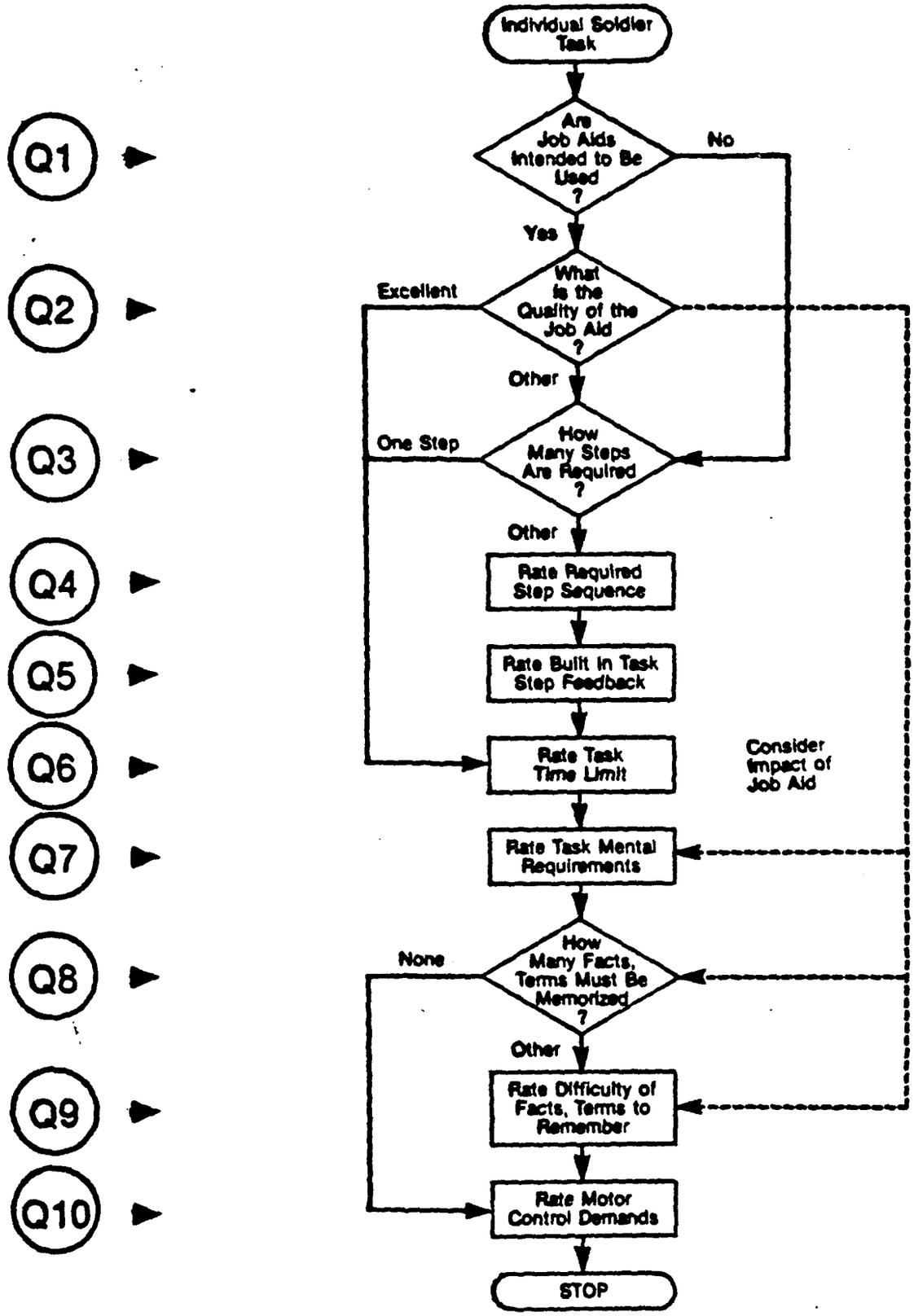
5. Add the individual Scale Values for Task 1 and enter the total in the "Total Score" column of the Rating Form.

6. Follow the same procedure for the remaining tasks you wish to rate.

7. Review the ratings given to each task by other raters. Resolve differences and document any changes in or assumptions made about a task. When the scale values for each question and the final score have been agreed upon by the raters, record them on a separate Rating Form noting that it is the "Approved Task Rating Form." Supplementary documentation should be attached to this Rating Form to support the ratings given.

In order to convert the final ratings to retention performance predictions, follow the instructions starting on Page 38.

The flow chart on the next page shows the decision algorithm that is built into the series of 10 questions. As you go through the questions, you will note that the instructions contain specific guidance with respect to the decision points shown in the chart. It is important that these instructions be followed carefully.


Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Individual Soldier Task
Are Job Aids Intended to Be Used ?
No
Yes
What is the Quality of the Job Aid ?
Excellent
Other
How Many Steps Are Required ?
One Step
Other
Rate Required Step Sequence
Rate Built In Task Step Feedback
Rate Task Time Limit
Consider Impact of Job Aid
Rate Task Mental Requirements
How Many Facts, Terms Must Be Memorized ?
None
Other
Rate Difficulty of Facts, Terms to Remember
Rate Motor Control Demands
STOP

Question 1. Are job or memory aids used by the soldier in performing (and in the performance evaluation of) this task?

Answer Choice	Scale Value
• Yes	1
• No	0

Definitions

Job and memory aids are designed to guide or facilitate the soldier in on-the-job performance and to minimize the need for recall. Examples include:

- Memory joggers learned in school, such as S - A - L - U - T - E
- Technical manuals or pamphlets when used on the job to help do the task properly.
- Labels or instructions that are printed on or attached to equipment or containers.
- Checklists, flowcharts, worksheets, decision tables, and system-fault tables.
- Manuals published by manufacturers to be used while performing maintenance tasks on equipment.
- Instructions on forms that tell how to complete them. The form itself is not a job aid, even though it has headings that indicate what should be entered in the form. It is considered to be an integral part of the task itself.

The key to accurately answering this question lies in the way the task is intended to be evaluated and performed.

For example, it is intended that a Technical Manual be used while performing most maintenance tasks. That is the way these tasks are taught and the way they are evaluated. If a job or memory aid is not used while performing a task, and none is used in evaluating that task, then the answer to this question would be No.

All reference-dependent tasks; that is, tasks for which required references are noted in the conditions section of the task summary; should be considered job aided.

Tools or equipment needed to perform a task are not job aids. However, if a supervisor is permitted to aid a soldier during the task performance evaluation, the supervisor should be considered as a job aid.

Write the Scale Value ("1" or "0") for the answer you select in the first column, labeled "Job/Memory Aid," of the Rating Form.

If you selected a No answer ("0") to this question, skip the next question and go to Question 3.

If you selected a Yes answer ("1") to this question, answer Question 2 on the next page. You will also be reminded of the fact that a job or memory aid is used to perform this task on several of the other questions. Their rating will depend on how much support is provided by the aid, which is covered by the next question.

NOTE: IF THERE IS NO JOB OR MEMORY AID,

DO NOT ANSWER THIS QUESTION.

GO TO QUESTION 3

Question 2. How would you rate the quality of the job or memory aid?

Answer Choice	Scale Value
• Excellent. Using the job/memory aid, a typical soldier can do the entire task correctly with no additional information or help.	56
• Very Good. With the job/memory aid, a typical soldier would need only a little additional information to complete the task.	25
• Marginally Good. Even with the job/memory aid, a typical soldier would need important additional information to complete the task.	2
• Poor. Even with the job/memory aid, a typical soldier would need a great deal of additional information in order to complete the task.	1

Definitions

This question requires you to think about the ability of the job or memory aid to actually lead the soldier through the entire task without error.

There are several dimensions that help to define the quality of a job or memory aid.

- Clarity - an excellent job aid presents the information a soldier needs to perform the task in

a way that the soldier can understand; that is, the language and terminology matches the soldiers' level of understanding and reading ability. If necessary, pictures, diagrams, tables and charts are used to present critical information.

- Completeness - an excellent job aid provides all of the information the soldier needs to do the task. A complete job aid tells the soldier what, when, and how to perform at a necessary level of detail. However, an aid that covers only a portion of a task very well is still less than excellent if other portions are left uncovered or are covered poorly.

- Useability - an excellent job aid is useable while the job is actually being performed. For example, a detailed, well-written technical manual is still less than an excellent job aid if the soldiers cannot take the time to read it or if it is physically impossible to use the aid while performing the task. In the same way, a job aid may be excellent under some conditions but poor under others (e.g., darkness).

In some cases a task may have more than one job aid. The rater should consider the overall excellence of the job aids in relation to the entire task. Only if the job aids, taken together, provide clear, complete and useful coverage of the whole task can the rating on this question be excellent.

The following examples for the task "Turn On Electrical Test Panel" may help in making your choice:

Excellent job aid - Easy-to-read instructions printed clearly on the electrical test panel itself, telling you when to do the task, what to do, how to do it, and in what order to do it. Pictures are used to help locate things.

Very Good job aid - A booklet that tells you basically the same information but it does not show where the knobs and switches are located. Operator errors are more likely.

Marginally Good job aid - Printed technical instructions that contain other information about the test system mixed in with the needed information. No pictures or diagrams.

Poor job aid - Technical reference manuals in which general principles of operation are given using complex language - you must try to determine the actual procedure for yourself.

Choose your answer using the above guidance and enter the Scale Value for that answer on the Rating Form under the column labeled 2, "Job/Memory Aid Quality."

If you select excellent as the answer to this question you will skip the next 3 questions. Look at these 3 questions now to see if your assessment of the job aid is accurate. In effect, if a job aid is excellent it is the same as saying the task has only 1 step (read job aid), no particular sequence to remember (job aid tells you) and has lots of built in feedback (job aid tells you if you are doing each step correctly). If you have any doubts about whether the job aid that you have rated excellent meets these standards, you should down-grade your rating to very good and answer the next 3 questions.

NOTE: IF YOU RATED THE JOB AID AS "EXCELLENT" DO NOT ANSWER THIS QUESTION OR THE NEXT TWO QUESTIONS. GO TO QUESTION 6

Question 3. Into how many steps has the task been divided?

Answer Choice	Scale Value
• One step	25
• Two to five steps	14
• Six to ten steps	12
• More than ten steps	0

Definitions

For purposes of this rating you should use the number of evaluated performance measures listed in the task summary under the Evaluation Guide as the number of steps. Where there are non-evaluated sub-steps, these should also be counted. However, do not include performance measures relating to whether the soldier performed the task steps in sequence or within a certain time period. These are viewed only as "scoring steps" and not as "task steps" for this question.

If the reference material does not provide sufficient information, or if you feel that a task has not been

accurately divided into performance steps, the following guidance may be helpful:

- A step is a separate physical or mental activity within a task, which has a well-defined, observable beginning and ending point. It must be performed to complete a task correctly. Thus, "Identifying a Tank" is one step, even though a number of mental operations are needed to arrive at the correct answer (e.g., note location of turret, count number of road wheels, etc.). These operations, however, are not observable and are not scored as separate steps.

- Steps should include all safety-related activities, even though they are not directly part of the task. The step "Check Backblast Area" is an observable step and is graded when measuring proficiency on preparing the LAW for firing.

- Tasks involving assembling or disassembling a piece of equipment tend to be multi-step tasks. "Assembling the M16 Rifle" would be an example of a multi-step task and it is scored as such.

- A step in a higher Skill Level task (E-5 or above) may be a separate task at a lower skill level. This is as it should be, since one must assume that the procedure was learned earlier and is no longer a separate task. For example, "Identify Terrain Features" is assumed at higher skill levels and is simply one step in a task such as "Navigate with a Map." At Skill Level One it is a separate task with many steps of its own.

Note that this question is skipped if the job aid for this task was judged to be excellent. This is consistant with the definition of an excellent job aid as one that provides the soldier with complete information about each of the steps of the task. Obviously, the number of steps in a task would be irrelevant to the soldier who had forgotten them if the job aid presented them clearly and completely.

If steps are repeated in a task, the instruction to repeat them should be counted as a step, but the repeated steps themselves should not be recounted. For example, when shifting indirect fire the soldier would repeat the steps of estimating range, and communicating information to the gun crew several times until the target was destroyed. Each repetition would not constitute a separate step.

If it is agreed that there are clearly more than 10 steps to a task, there is no point in trying to resolve differences of opinion about the actual number. Anything over 10 is given a 0 Scale Value regardless of the actual number.

Determine your answer. Enter the Scale Value for this answer on the Rating Form in the third column labeled "Number of Steps."

If you select the first answer (One step), skip to Question 6.

NOTE: IF THE TASK HAS ONLY ONE STEP,

GO TO QUESTION 6

Question 4. Are the steps in the task required to be performed in a definite sequence?

Answer Choice	Scale Value
• None are	10
• All are	5
• Some are and some are not	0

Definitions

Some tasks are composed of steps that can be performed in any sequence. For example, "Identify Terrain Features on a Map" is a task that is not scored for sequence in the evaluation guide of the task summary. Such tasks should be given a Scale Value of "10".

Other tasks, such as "Splint a Fracture," are made up of steps that have only one correct sequence. Failure to follow the particular sequence results in a "NO GO" on that task. These tasks should be given a Scale Value of "5".

A task that is a mixture of sequenced and non-sequenced steps should be given a Scale Value of "0". "Perform Operator Maintenance on an M16A1 Rifle" is such a task. Only steps 1-5 are scored for sequence.

The reasoning behind this question is that it is easier to remember to do a task when sequence does not matter. However, if sequence is scored, it is easier to remember a specific sequence for all steps than for only some of the steps.

If a task, or parts of it, are supposed to be performed in sequence, there must be a statement to that effect in the task summary; e.g., "Do, in order, all steps to clear the object from the casualty's throat." In the absence of any statement about sequence, it should be assumed that sequence for that task is not scored, even though there may be a natural or preferred order to doing the steps.

Choose your answer. Enter the Scale Value for your answer in the fourth column (labeled "Sequence") of the Rating Form.

NOTE: IF THE TASK HAS ONLY 1 STEP

SKIP THIS QUESTION AND GO TO

QUESTION 6

Question 5. Does the task provide built-in feedback so that you can tell if you are doing each step correctly?

Answer Choice	Scale Value
• Has built-in feedback for all steps	22
• Has built-in feedback for most steps (50% and above)	19
• Has built-in feedback for only a few steps (up to 50%)	11
• Has no built-in feedback	0

Definitions

Examples of tasks that provide built-in feedback are:

- Disassembling a piece of equipment in which removing one section automatically uncovers the next section (e.g., opening up a container to remove contents).
- Equipment operation in which the steps form a logical or natural progression. For example, radio operators are expected to adjust or turn on several dozen switches in a certain order when "powering up" their radio sets. However, the equipment is arranged so that the operator can follow a natural right-to-left or left-to-right progression.

- Assembling a subpart that does not fit the larger assembly, thus indicating that some earlier step was incorrect.
- Any task where there is some observable effect due to the soldiers' actions, e.g., warning light, buzzer, meter reading, and the like.

For some tasks, the completion of the task provides an automatic check on the correctness of it. For example, "Changing a Tire" would have some of those characteristics (e.g., parts left over, wheel does not turn). The impact of an artillery round would have a similar effect. However, such end-of-task feedback may not assist the soldier in performing the steps of the task correctly in the first place, and should not be considered in answering this question.

The important point to consider in selecting an answer to this question is whether the feedback to the soldier indicates the correctness of his performance at each step. Feedback that simply indicates that the step was completed is not the kind of feedback that this question is addressing.

Steps that have the least built-in feedback tend to have many branching routines ("If A, then B"), or have safety checks that break the flow of a task's steps (e.g., "Place the selector on SAFE before cleaning the rifle").

Do not confuse the feedback that a performance test administrator may give to a soldier to allow him to continue

the test after an error is made, with the feedback that is being addressed by this question. We are concerned only with feedback that is an inherent part of the task, not an artifact introduced by test conditions.

Before answering this question you may wish to look back to question 3 to see how many steps you identified for the task. You need to consider each of them in arriving at the correct answer to this question.

Enter the Scale Value for your answer on the Rating Form in the column headed "Feedback."

Question 6. Does the task or part of the task have a time limit for its completion?

Answer Choice	Scale Value
• There is no time limit	40
• There is a time limit, but it is fairly easy to meet under test conditions	35
• There is a time limit and it is difficult to meet under test conditions	0

Definitions

The first choice means that no time limit has been established for the task or any part of the task, so that a "GO" may be achieved even though one soldier may take much longer to do the task than another soldier. This choice is also appropriate when a time limit is so liberal that no one ever fails to meet it.

The second choice above applies to those tasks, such as "Assemble the M60 Machinegun," that have a time limit that some soldiers may find difficult to meet. In this case, the task summary has set a time limit that "pressures" the average soldier a bit, but only a few would get a "NO GO" because of it.

The third choice is for tasks that have a time limit that is difficult to meet. Safety and combat-related tasks, such as "Sight a Target Through the Gunner's Telescope" within 10 seconds would fall into this category. Soldiers being tested on this kind of task often get a "NO GO" on the basis of time alone.

Time limits, if any, are indicated in the task summary in the standards section or as the last item in the list of performance steps to which they apply. Some examples are: "Put On, Clear and Check Mask" within 9 seconds, or "Complete Steps 1 Through 5 in 9 Seconds or Less." (Remember, however, that the time limit statement itself is not counted as a step.) If no time limit statement is found in the task summary it may be assumed that there is none.

Question 7. How difficult are the mental processing requirements of this task?

Answer Choice	Scale Value
• Almost no mental processing requirements	37
• Simple mental processing requirements	28
• Complex mental processing requirements	3
• Very complex mental processing requirements	0

Definitions

This question usually cannot be answered entirely on the basis of the task summary (as could the time and sequence questions) but often must be deduced from a careful reading of the summary and first-hand knowledge of the task itself. This question gets at the difficulty of the thought processes that a soldier must carry out during task performance. Such processes as often described by terms such as "thinking," "reasoning," "analyzing," "judging," "inferring", and "problem solving".

Be careful not to confuse this question with the next 2 questions which deal with the number of facts, terms, etc., that must be memorized and the difficulty of those facts, terms, etc., to memorize. Here we are concerned only with

what you have to do with the recalled information in order to perform the task correctly.

A task requires almost no mental processing if it is essentially physical, or highly repetitive (e.g., "Marching in Line," "Saluting").

A task requires simple mental processing if it involves making gross comparisons; estimating relative size, weight, or distance; or performing simple computations.

Complex mental processes require the soldier to make a choice or decision based on subtle but discrete clues (e.g., prioritizing fixed targets, identifying different types of aircraft or vehicles).

A task requires very complex mental processes if it requires rapid decisions based on detailed, technical information, often under stress (e.g., planning an attack, troubleshooting complex equipment).

In answering this question, consider the impact of a job or memory aid on the thinking requirements of this task. However, note that job aids are generally less helpful in the area of higher thought processes than they are in the areas of rote memory or proceduralized (step-following) tasks. Nevertheless, an excellent aid may reduce a very complex mental processing task to a complex mental processing task.

Question 8. How many facts, terms, names, rules or ideas must a soldier memorize in order to do the task?

Answer Choice	Scale Value
• None (or the job/memory aid provides all necessary information)	20
• A few (1 - 3)	18
• Some (4 - 8)	13
• Very many (more than 8)	0

Definitions

This question gets at the number of isolated pieces of information a soldier must remember in order to do the task (not how hard it is to remember them, which is asked in the next question).

Examples of the types of information that may have to be remembered are:

- Military nomenclature (terms)
- Conversion formulas
- Codes or call numbers
- Technical names, specifications or tolerances
- Doctrinal principles or rules of thumb

Remember to consider the impact of the job or memory aid (if any) in answering this question. If there are facts, terms, etc., that are needed in order to do the task, but some or all are covered in the job aid, your answer should reflect this.

The steps required to perform the task should not be considered in answering this question. It is the facts, terms, etc., that must be remembered to do these steps that are being addressed by this question, not the steps themselves.

This question (and the next one) do require some judgment about the level of experience of the typical soldier doing the task being rated. One could safely assume that the typical soldier who has completed AIT knows basic military terminology and concepts, and that these should not be included in deciding on the answer to this question. Those facts, terms, etc., unique to the task being rated, however, should be included.

Here again, if the number of facts, etc., is obviously greater than 8, there is no need to seek consensus on this question - it will get a Scale Value of "0" regardless of the outcome.

Select your answer and then enter the Scale Value for that answer in the column labeled "Number of Facts."

Question 9. How hard are the facts, terms, that must be remembered?

Answer Choice	Scale Value
• Not applicable - there are none to remember or the job or memory aid provides all of the needed information	34
• Not hard at all - the information is simple	31
• Somewhat hard - some of the information is complex	12
• Very hard - the facts, rules, terms, etc., are technical or specific to the task and must be remembered in exact detail	0

Definitions

This question rates the difficulty of the facts, terms, etc., needed to do the task (even if there are only a few).

Facts and terms that have a close connection to the task itself are more likely to be remembered. For example, the terms "firing pin," and "whip antenna" have a logical relationship to their function and are easy to recall. Specific, detailed, or technical information that is unrelated to the task is more difficult to recall. Call signs and radio frequencies are examples of difficult-to-recall information since they are purposely assigned at random but must be used with precision. Also, unorganized facts and terms (e.g., much military

nomenclature) are more likely to be forgotten than facts and terms that are part of a system (e.g., the phonetic alphabet).

The amount of help provided by job and memory aids applies very directly to this question. They are often designed specifically to help the soldier recall information that is quickly forgotten (e.g., S-A-L-U-T-E).

Choose your answer and then enter the Scale Value for your answer in the column labeled "How Hard to Remember."

Question 10. What are the motor control demands of the task?

Answer Choice	Scale Value
• None	2
• Small but noticeable degree of motor control required	0
• Considerable degree of motor control needed	16
• Very large degree of motor control needed	3

Definitions

This question has to do with the level of precision and/or accuracy of finger, hand and arm movements, not with large body movements. Thus a task would be given a mor~ if it involves only sheer physical strength or simple, reflexive actions (e.g., pushing, lifting, carrying).

A small but noticeable degree of accuracy/precision is required by tasks such as driving a nail or adjusting a carburetor screw.

A considerable degree of motor control is needed for tasks such as typing, driving a manual transmission car or tracking a moving target.

A task requiring a very large degree of demands would be the repair of a very delicate piece of equipment, such as a microcircuit chip, or sending Morse code using a key.

Some tasks may combine both a strength component and a motor control component. For example, a fairly heavy piece of equipment may have to be positioned in a precise location. In such cases, a value of considerable or even very large would be appropriate, depending on the degree of motor control required.

Almost all tasks require some speaking skills and many of them require written skills as well. While these are indeed complex motor demands, they are considered to be already in the repertory of the typical soldier, and therefore should not be included in making this rating. However, typing or sending Morse code may be an integral and unique part of a task. Therefore, they should be considered in selecting a Scale Value for this question.

While the Scale Values associated with this question may appear to be incorrect, since they are not in decending order as are all the others, they are, in fact, the correct values. A task with a small degree of motor control proves to be more difficult to remember than a task with a considerable degree of motor control. This finding is reflected in the low value for the former ("0") and the high value for the latter ("15").

Select your answer and enter the Scale Value in the column labeled "Motor Control Requirements."

III. Calculating a Total Score

This completes the instructions on the rating procedure itself. Check back to make sure you answered all the questions that apply to the task being rated. The questions you skipped (if any) should be blank on the Rating Form. All others should have a 0 or a number written in. If you rated the first question a "1" there should be a rating for the second question; if you rated the first question a "0", the second question should be blank. If question two has a rating of "56" the next 3 questions should be blank.

Remember, if you change a rating for one question then you must also change all the other questions that would be effected by that change and adjust your Total Score accordingly. (See the flow diagram on page 12 for a graphic representation of how the questions interact.)

The Total Score should be the one that reflects the input of all team members. When this process has been completed, a new Rating Form should be prepared and dated that is labeled "Approved Task Rating Form." That form will be the one kept for future reference. Subsequent changes in the way a task is performed as reflected in the task summary, will probably require that its rating be revised. At that point a new form should be prepared and dated reflecting those changes.

IV. Using the Performance Prediction Tables

The two Performance Prediction Tables (pp. 41 and 42) provide the performance predictions for tasks that have been rated. The numbers within the body of the table represent the expected proportion of soldiers in a unit able to perform a task correctly after up to 1 year of no practice since a task was last performed correctly.

The first Table gives these predictions at monthly intervals, up to 12 months. The second Table gives these estimates at weekly intervals, up to 26 weeks.

To find a specific task retention prediction, first locate the score in the left column that corresponds closest to the obtained Total Score. Then read across either Table until you reach the time interval you are concerned about (shown at the top of the Table). The Table entry at that point will be the proportion of soldiers that could be expected to perform the task correctly at that time interval.

For example, the Total Score from the Rating Form on Task X is "140." You want to know what percentage of soldiers can still perform the task 4 months after they last practiced it. The entry in the first table under "4" (months) is 36 percent. The entry in the weekly table is also 36 percent.

A second way of using the tables is as follows: If a task has a score of "140," how often should sustainment training be provided in order to have at least 50 percent of the soldiers proficient on that task at all times? Looking at the line on the table next to the value "140," we see that 46 percent is in the column headed "3" (months). This, then, is the training frequency required to sustain a level of proficiency on that task of approximately 50 percent.

A third way to use the tables is to determine what level of proficiency you would expect in your unit if you could only provide sustainment training every "X" months or weeks. By looking at the Total Score for each of your tasks you can see what the percentage is for each one under the appropriate months or weeks column. For those tasks with a rating of "130" for example, the percentage of proficiency at a 4-month frequency of training schedule is 25 percent; for tasks with a rating of "170" it is 81 percent, and so on.

Task Retention Rating Form

MOS: _____

Task No.	Title	Judgement Aid	Scale Questions 1	2	3	4	5	6	7	8	9	10	Total Score
		Yes / No	Judgement Aid Quality: Excellent / Very Good / Satisfactory / Poor	Number of Steps: 1 Step / 2 to 5 Steps / 6 to 10 Steps / More than 10	Sequence: Steps Are / Steps Are and / Steps Are Not	Feedback: All Steps / Most Steps / Only a Few / None	Time: Easy / Difficult	Mental Requirements: Almost None / Simple / Complex / Very Complex	Number of Fields: None / A Few (1-3) / Some (4-6) / Many (More Than 6)	How Hard to Remember: Not Applicable / Not Hard At All / Somewhat Hard / Very Hard	Motor Control Requirements: None / Simple / Considerable / Very Great		

Performance Prediction Table — Months

Total Score from Answer Sheet	Months Since Last Performance *											
	1	2	3	4	5	6	7	8	9	10	11	12
180+	100	100	100	100	100	100	100	100	100	100	100	100
175	97	95	92	90	87	85	83	81	79	77	75	73
170	94	90	85	81	76	72	69	65	62	59	56	53
165	92	85	78	72	66	61	56	52	48	44	40	37
160	89	80	71	64	57	51	45	40	36	32	29	26
155	86	75	64	56	48	42	36	31	27	23	20	17
150	83	70	58	49	40	34	28	24	20	16	14	11
145	80	65	52	42	34	27	22	17	14	11	9	7
140	77	60	46	36	27	21	16	12	10	7	6	4
135	74	55	40	30	22	16	12	9	6	5	3	2
130	70	50	35	25	17	12	8	6	4	3	2	1
125	67	45	30	20	13	9	6	4	2	1	1	0
120	63	40	25	16	10	6	4	2	1	1	0	0
115	59	35	20	12	7	4	2	1	0	0	0	0
110	54	29	16	8	4	2	1	0	0	0	0	0
105	50	25	12	6	3	1	0	0	0	0	0	0
100	44	20	8	4	1	0	0	0	0	0	0	0
95	38	15	2	0	0	0	0	0	0	0	0	0
90	31	10	3	1	0	0	0	0	0	0	0	0
85	22	5	1	0	0	0	0	0	0	0	0	0
80 or less	3	0	0	0	0	0	0	0	0	0	0	0

*Performance at "GO" level of Proficiency

Performance Prediction Table — Weeks

Total Score from Answer Sheet	Weeks Since Last Performance *																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
180+	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
175	99	98	98	97	96	96	95	95	94	93	93	92	92	91	90	90	89	89	88	87	87	86	86	85	85	84
170	98	97	96	94	93	92	91	90	88	87	86	85	84	83	82	81	79	78	77	76	75	74	73	72	71	71
165	97	96	94	92	90	88	86	85	83	81	79	78	76	75	73	72	70	69	67	66	65	63	62	61	60	58
160	97	94	91	89	86	84	82	80	77	75	73	71	69	67	65	64	62	60	58	57	55	54	52	51	49	48
155	96	93	89	86	83	80	77	75	72	69	67	64	62	60	58	56	54	52	50	48	46	45	43	42	40	39
150	95	91	87	83	80	76	73	70	66	64	61	58	56	53	51	49	46	44	42	40	39	37	35	34	32	31
145	94	89	85	80	76	72	68	65	61	58	55	52	49	47	44	42	40	37	35	34	32	30	28	27	26	24
140	93	88	82	77	72	68	63	60	56	52	49	46	43	40	38	36	33	31	29	27	26	24	23	21	20	19
135	92	86	79	74	68	63	59	55	51	47	43	40	37	35	32	30	28	26	24	22	20	19	17	16	15	14
130	91	84	77	70	64	59	54	50	45	42	38	35	32	29	27	25	22	21	19	17	16	14	13	12	11	10
125	90	81	74	67	60	54	49	45	40	36	33	30	27	24	22	20	18	16	15	13	12	11	10	9	8	7
120	89	79	70	63	56	50	44	40	35	31	28	25	22	20	17	16	14	12	11	10	9	8	7	6	5	5
115	87	76	67	59	51	45	39	35	30	26	23	20	18	15	13	12	10	9	8	7	6	5	4	4	3	3
110	86	74	63	54	47	40	34	29	25	22	19	16	14	12	10	8	7	6	5	4	4	3	3	2	2	1
105	84	70	59	50	42	35	29	25	21	17	14	12	10	8	7	6	5	4	3	3	2	2	1	1	1	1
100	81	66	54	44	36	29	24	20	16	13	10	8	7	5	4	4	3	2	2	1	1	1	0	0	0	0
95	78	62	49	38	30	24	19	15	11	9	7	5	4	3	2	2	1	1	1	0	0	0	0	0	0	0
90	74	56	42	31	23	17	13	10	7	5	4	3	2	1	1	1	0	0	0	0	0	0	0	0	0	0
85	68	47	32	22	15	10	7	5	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	42	17	7	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70 or less	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*Performance at "GO" level of Proficiency

APPENDIX C: Questionnaire Administration Protocol

1. I'm Chavis Patterson

2. I'm here from ARI, the Army Research Institute.

3. TRADOC has asked us to help them improve 63W training. They have some concern about how well 63W are doing their job.

4. The approach we're taking today is to find out if the 63W are forgetting some important material before they get a chance to practice it in the field.

We know the time it takes to forget different kinds of Army tasks but we need SMEs to tell what kinds of tasks these are.

5. That's where you come in Mr.

---

10. ARI developed this 10-item questionnaire for field commanders so that they can find out how often they should train their people on each of their unit's tasks.

11. Lets look at the questionnaire rating form and see what it involves.

12. The answer sheet has the 10 items right on it.

13. Here's the explanation for each of the columns.

14. Now let's look at the tasks we're going to rate. These task lists are taken directly from the organizational manuals that the 63Ws have available.

15. The task name is in the center, and more specific info. is in the upper right corner. The steps for the task are listed down the left side. There is an arrow in the 4th column to show the steps that are done in sequence. The 5th column shows what the result should be, and the last two columns show the safety and tools required.

16. Let's look at the first task. Are you familiar with this task or should we look at another one? Is this the way the task is done or should be done? Any comments?_____

_____

_____

17. Now let's go to the questionnaire.

END OF ADMINISTRATION:

1.We have gotten your unbiased opinion. Next we have to get you together with the other SMEs to get a consensus opinion from all of you. Can we meet again at ____?