Research Note 82-7

GUIDELINES: ASSESSING USE OF INFORMATION SOURCES AND QUALITY OF PERFORMANCE AT THE WORK SITE

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The report contains a sample training schedule and training materials for observers to use unobtrusive observation techniques in U.S. Army organizational-level and direct support-level automotive shops. Training materials include conceptual models and practical instructions for performing front-end analyses of tasks common to these shops. Instructions for using methodology to predict information seeking and errors are also given.

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GUIDELINES: ASSESSING USE OF INFORMATION SOURCES AND QUALITY OF PERFORMANCE AT THE WORK SITE

INTRODUCTION

The purpose of these guidelines is threefold:

- To demonstrate how to write task descriptions of vehicle maintenance tasks.
- To demonstrate a method for estimating likelihood of information need for vehicle maintenance.
- To demonstrate a method for systematic observation and data-gathering on personnel performing vehicle maintenance tasks.

Methods for predicting and assessing technical information need and usage are presented here and were developed by ASA in the course of fulfilling the requirements of Contract No. DAHC19-77-C-0025 "Predicting Effectiveness of Manuals Designed for Use by Job Incumbents At Their Work Sites."

These guidelines are organized in the following manner:

- Front-end analysis of vehicle maintenance tasks.
- Unobtrusive observation techniques
- Training procedures

Front-end analysis requires both a step-by-step description of the tasks of interest and a method for estimating information needs to successfully accomplish the task. The step-by-step task descriptions not only establish a structure for recording an observed task, but also provide the task analyst with the specifics of the task on which he can assess information need.

The method for estimating information needs is the Information Demand Rating (IDR) instrument. This instrument was developed as a system of rating task difficulty based on the interaction of specific task characteristics and equipment design. The IDR instrument rates tasks on six different scales which results in an overall measure of task difficulty.

These front-end analysis methods were validated by ASA on a sample of vehicle maintenance tasks. The results of the validation studies were:

1. Reliability of task description:

   a. Total number of steps in task description for 10 tasks by 4 analysts - Chi square=15.47, df=27, $p > .95$, no difference.

b. Number of steps assigned from TM description for 10 tasks by 4 analysts - Chi square=7.19, df=27, p>.99, no difference.

c. Number of steps added by the analyst (TM description felt incomplete) for 10 tasks by 4 analysts - Chi square=39.55, df=2, p>.05.

2. Reliability of application of IDR for 15 tasks independently rated by 3 raters:

a. Lawless & Chatfield (1974)[1] Index of Agreement for agreement within one point between raters, p>.95 no difference (Number of agreements within 1 point = 103,
Number of disagreements within 1 point = 60
P of chance agreement 3 raters within 1 point on 5-point scale = 0.232)

b. Lawless & Chatfield (1974)[1] Index of Agreement for agreement within one point, test/retest within raters, p>.95 no difference (Number of agreements within 1 point = 121,
Number of disagreements within 1 point = 42,
P of chance agreement for test-retest within 1 point on 5-point scale = 0.52)

Application of the IDR system is reliable across raters and within raters. The raters were all familiar with automotive repair techniques and had all received the training outlined on pp. 31-34 of this guide.

The unobtrusive observation technique requires that the maintenance technician be observed at the usual job site, performing routine duty assignments, with minimum intervention. That is, observers try to minimize distraction of the task performer and disruption of the shop routine. This differs from other techniques that require the task performer to think out loud. Any questions the observer may have concerning the task performance are deferred until the post-task interview.

This is a get-down-in-the-dirt technique. This technique requires observers to go into the motor pools in work clothes and stand ready to grab the end of a torsion bar, or hold a nut from turning as needed. This approach, unlike a study conducted in the artificial confines of a laboratory environment, makes it posible to collect data which reflects the real world state of affairs rather than some theoretical abstraction of the real world. Complete instructions for observing vehicle maintenance tasks and recording the observations are detailed later in these guidelines.

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[1]Lawless, G. F., & Chatfield, D. Multivariate approaches for the Behavioral Sciences: A brief text. Lubbock, TX: Texas Tech Press, 1974.

Reliability scores for this unobtrusive observation technique were obtained as follows. Two observers watched the same task performance and wrote independent narrative observations. The observers independently transcribed the observation. Then the transcripts were compared for comparability of breakdown into number of steps and significant steps regarding behavior coding. Agreement levels were greater than 95% for all pairs of observers.

The primary goal of this training is to reduce variation in the performance of the data collection from observer to observer. It has been demonstrated that the problem of observer uniformity and training is usually handled best by having the observer participate in the development of the system of observation (Heyns & Lippitt, 1954).[2] Therefore, this training procedure requires that a new observer first become completely familiar with the methodology for front-end analysis (including practice writing step-by-step task descriptions and rating tasks for information demand) and with the existing body of task write-ups, demand ratings and observations previously collected.

The methods presented in these guidelines are not theoretical. They have been validated and used to observe more than 300 U.S. Army mechanics over a two year period. Using these methods ASA has been able to develop a picture of technical information need and use for U.S. Army mechanics performing their usual duties at their normal work sites. These methods thus provide an opportunity to provide feedback to training and technical literature developers on the way their training and TMs are actually employed under routine job conditions.

CONCEPTUAL FRAMEWORK

In order to make a front-end analysis for any type of task, it is necessary to have a conceptual picture of the basic nature of that task. Vehicle maintenance tasks can be conceptualized with two basic models. The first is a linear model of the task, in which the task follows (stage by stage) from initiation to end. This model is schematized in Figure 1.

The Linear Process Model begins with the detection of a problem with the vehicle. This is the initiating cue which sets the task process into motion. Stage 1 of the task is the "identification of the goal action required." This is the 'identify the most likely solution' stage. Based on the data from the Phase I research, Stage 1 is usually accomplished by

[2]Heyns, R., & Lippitt, R. Systematic observational techniques. In G. Lindzey (Ed.), Handbook of Social Psychology, Vol. 1 Cambridge: Addison-Wesley, 1954.

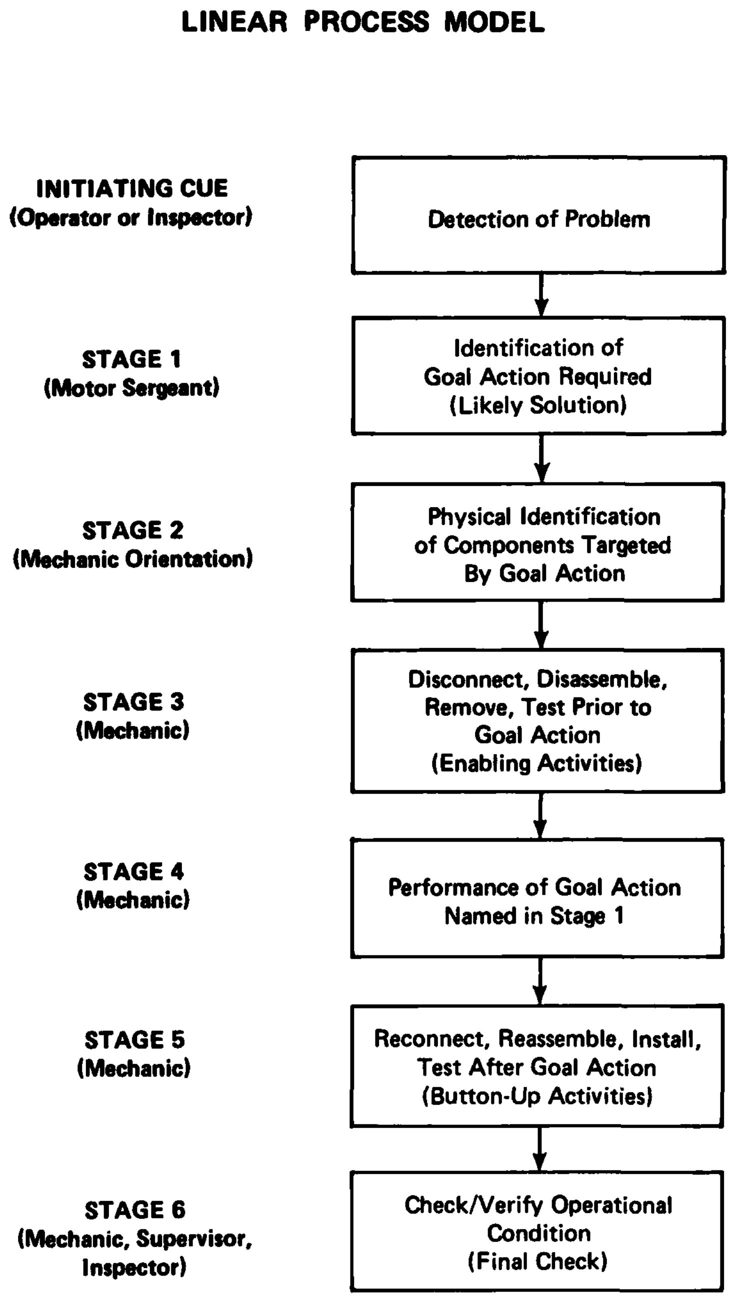


Figure 1. Illustration of the Process Model Used as the Conceptual Framework for Development of Front-end Analysis

the motor sergant or a technical inspector. This person's proposed solution becomes the mechanic's assignment.

Stage 2 of the task model is the physical identification of the target component or components upon which the goal action is to be performed. Our observations indicate that the mechanic usually enters the task process here, rather than at Stage 1. The mechanic normally receives his assignment as "replace such and such," or "adjust such and such." This stage is the orienting stage--where is it, what is it, how do I get to it, what tools or equipment do I need?

Stage 3 is the enabling process which precedes the "goal action." This stage involves the disconnecting, disassembling, etc. required prior to performance of the goal action.

Stage 4 is performance of the goal action named in Stage 1. This stage is narrowly defined, focusing on the activities directly performed on the component identified in the task statement. It also includes any actions with test equipment, special connections or disconnections, etc. which occur during the goal action process.

All activities then, which occur after the goal action has been initiated and before it has been completed, are considered to have occurred in Stage 4. In this model, simple Remove/Install tasks may not have a Stage 4. For instance, in the task "Remove/Install Radiator," the actual physical lifting out of the radiator is simply the last part of Stage 3, and the physical setting-in-place of the radiator is the first step of Stage 5. Thus, there is no Stage 4 in this simple task.

Stage 5 is the "button up" stage. Reconnect, reassemble, adjust, test, and any other activity that would normally be performed in putting the equipment back together after completing the goal action occur in this stage.

Stage 6 is the Check/Verify operational condition stage. This is the final check, after all activities have been completed, to certify that the equipment should be returned to service.

The other model is an an operational task model. It is a closer approximation to the way maintenance tasks are performed in the real world. The Linear Process Model neglects the necessarily recursive or repetitive nature of tasks as they actually occur. Orienting activities may occur -- then enabling activities -- then more orienting activities, etc. Also, Stage 1 is seldom observed in the motor pool environment. Instead, the result of Stage 1, the task assignment, is the starting place for our observations and for the descriptions of tasks as they are presented in the TMs. Furthermore, Stage 6 of the theoretical process model is seldom observed in organizational motor pools if it occurs at all.

The operational task model, shown in Figure 2, resolves these problems by simply classifying the activities involved in performing an assigned task into four categories. The first category is initial or orienting activities. Orienting activities are the activities required to begin a task, but these activities do not involve operations on the equipment itself. Such activities are: locating/identifying the specific area, component, or parts on the vehicle to be manipulated; identifying and obtaining special tools, test equipment, parts, fluids, etc.

The second category is that of accessory activities. This category includes all activities which involve operations on, or manipulations of, the equipment, but are not the assigned task. Thus, any enabling or buttoning-up activities, installing or removing test equipment, warming the engine, jacking up the vehicle, etc. are activities in the accessory category.

Central task activities are the third category and simply comprise the activities identified in the task title. This category includes all manipulations, adjustments, and alignments necessary for proper completion of the assigned task, but only those activities directly related to the task title component.

Checkout/verification activities are the fourth category. These activities are all activities which certify proper completion of operations or conditions. Final operational checks which certify that the vehicle is again serviceable are also included in this category.

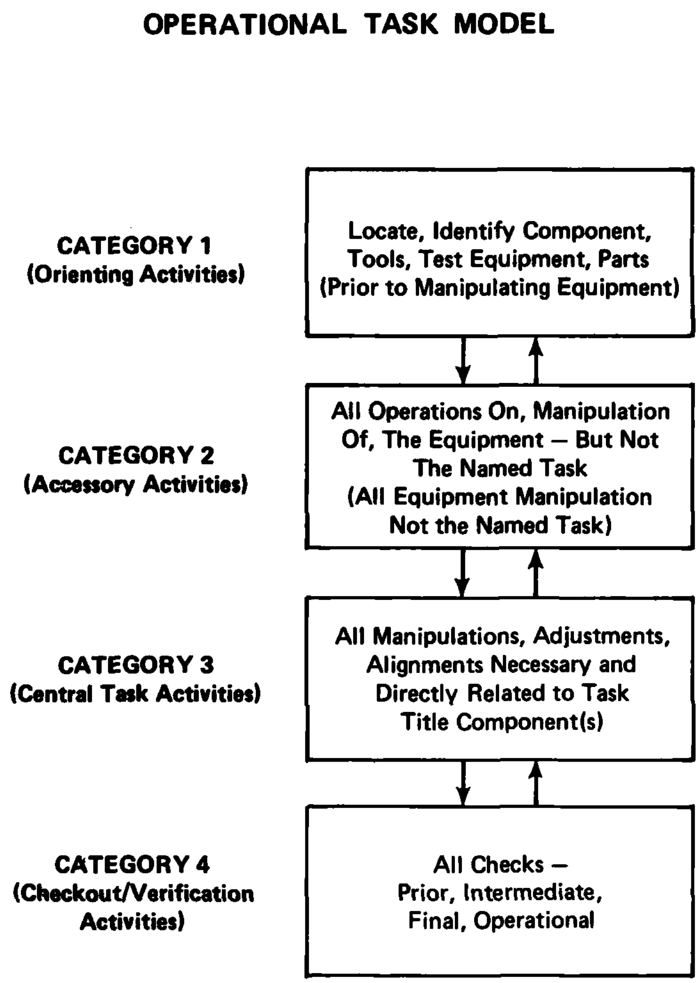
After developing a model of maintenance tasks to aid in writing task descriptions and assessing information needs, it became clear that a model of the mechanic, who performs the task, was missing.

Description of a Model of the Mechanic

The last conceptual requirement, before the task description can be written, is a model of the task performer. This model of a performer is necessary in order to decide the level of detail at which the task descriptions should be written.

Our model mechanic is a naive mechanic who possesses the basic knowledge to use the tools in the mechanic's issue and possesses basic skills, such as bolt tightening, spark plug removal, etc. The model mechanic is completely naive regarding Army equipment, however.

Thus, our task descriptions do not instruct basic mechanics' operations common to all types and classes of vehicles, but do instruct, locate, and identify steps for components or areas of the vehicle to be worked on.



igure 7 .llustration of the Operational Task Model

FRONT-END ANALYSIS

The front-end analysis organizes and structures the information about a particular task. Thus, front-end analysis has intrinsic value in providing a standard of comparison for observed task behavior and in highlighting those places in a task where the task performer could be expected to have problems. The front-end analysis also is a useful training tool for observers, familiarizing them with the tasks to be observed and providing them with a structure for the narrative record of observations.

This system of front-end analysis is designed to be used by people who are very familiar with automotive maintenance tasks. The person making the front-end analysis should be familiar with the equipment being analyzed and should make the analysis while in the presence of the equipment.

The operational task model and the model of the mechanic are used as guides to construct step-by-step task descriptions. The descriptions are all written with the final goals of the description - assessing probabilities of information seeking behaviors (ISB) and identifying probable trouble spots occurring during the task - kept in mind.

In order to estimate the likelihood of ISB or making an error for any given task, the Information Demand Rating (IDR) instrument is used. It is based on the assumption that information need is greatly influenced by the task/equipment stimulus characteristics. That is, the need for outside information is partly determined by the nature of the task (e.g., is it a matter of screwing on a cover with 4 screws, or is it a matter of making 6 electrical and 10 hydraulic corrections, and carefully aligning the cover to mount with 17 bolts?).

Information need is also influenced by the design of the equipment for any given task (e.g., is there no possible way to do it wrong, or are careful alignments necessary, and is it necessary not to mix up the 4 bolts in the cover because they are slightly different lengths?).

On the basis of the considerations, the first version of the IDR instrument was constructed. Several revisions reduced the instrument to six items that are best able to discriminate likelihood of ISB for individual tasks.

Step-by-Step Task Description

The description of tasks as found in the TM are used as a starting point. However, those descriptions are more "memory joggers" than fully proceduralized job performance aids (JPAs). For example, TM task descriptions often do not include orienting activities. The TM also leaves out many steps of "good mechanics' practice" since these practices are simply assumed.

Therefore, the task description found in the TMs must be modified as follows:

- Each step of the task description will involve only <u>one</u> task action.

- The addition of steps involving good mechanical practice based on a logical understanding of the task and equipment configurations (e.g., draining the oil from engine before removing oil filter, placing vehicle on jack stands before climbing under it to remove the muffler).

- The addition of orienting steps ("locate" steps) for each part or component to be worked on if they have not been named in a previous step. Parts or components which are in the <u>same visual area</u> or which serve similar functions can be named in one step (e.g., locate generator, air ducts, flexible boots, and flexible connector).

The task analyst needs to keep in mind his primary goal - task descriptions which are detailed, and which are similar in structure for all tasks and all equipment - when applying the above rules. An example of a task description is presented in Figure 3.

Information Demand Rating

In order to classify tasks as to likelihood of ISB during task performance, an instrument to measure the information requirements, or information demands, of the task is required. This instrument, the Information Demand Rating (IDR), is shown in Figure 4.

The first two scales of this rating instrument rate the task on a perceptual dimension. They concern the accessibility of the part or component to be worked on. One, can the mechanic easily see the part he is working on, (visual accessibility) or is it hidden from view? Two, can the part or component to be worked on be gotten to easily, (manual accessbility) or is access restricted?

The next two scales rate the task on a cognitive dimension. That is, how well does the design of the equipment insure that the mechanic can determine what the necessary task steps are (Clarity of Necessary Task Steps) - "What do I want to do?", and what are the techniques to accomplish this task, (Clarity of Techniques to Perform Tasks Steps) - "How do I do it?".

These first four items are rated on five-point scales (easy/hard on the perceptual dimension, clear/unclear on the cognitive dimension) for the task as a whole. For examples of anchor points for these measures see Figure 4.

TM9-2350-215-20 Fig. 2-143
ADJUST STEERING CONTROL LINKAGE
M60/A1 (ORG)

1. Park and chock vehicle

2. Center steering control

3. Remove transmission shroud (Q.V.)

4. Locate transmission control valve body

5. Locate steering linkage rods, jam nuts, and pivot points

6. Check steering position indicator for centering on stamped dot

7. If it is off center, proceed by disconnecting rod end from clevis by unscrewing bolt. If it aligns, no adjustment is necessary

8. Physically move indicator to center mark

9. Locate first pivot point from steering control

10. Insert locating pin through alignment holes in bracket and clevis

11. If pin can be inserted, go to Step 17. If pin cannot be inserted with steering control in center position, loosen jam nut on rod end and go to Step 12.

12. Remove screw securing rod end to clevis

13. Screw or unscrew rod end on rod until locating pin can be inserted through clevis and bracket and steering bar remains centered

14. Insure that screw part of rod extends past gauge hole in rod end

15. Install screw securing rod end in clevis

16. Tighten jam nut

17. Remove locating pin

18. Locate fourth pivot point (in engine compartment)

19. Insert locating pin through alignment holes in bracket and clevis

20. If pin can be inserted, go to Step 22. If pin cannot be inserted, go to pivot point two in crew compartment and go to Step 21

21. Repeat Steps 10-16 for this pivot point

22. Locate pivot point three (in engine compartment)

Figure 3. Example of Task Analysis

TM9-2350-215-20 Fig. 2-143
ADJUST STEERING CONTROL LINKAGE
M60/A1 (ORG)
(continued)

23. Pivot point three can be reached through shield on A1 models; on M60 models--remove power pack (Q.V.)

24. Remove cover from control box

25. Insert locating pin

26. If pin cannot be inserted at point three, repeat steps 10-16 for this pivot point. If pin can be inserted, go to Step 27

27. Locate pivot point four (in engine compartment)

28. Insert locating pin

29. If pin cannot be inserted at point four, repeat Steps 10-16 for this pivot point. If pin can be inserted, go to Step 30

30. Connect rod end to clevis by installing and tightening bolt at transmission control valve body

31. If steering position indicator does not point to center mark, repeat Steps 12-16 for the rod end at transmission control valve. If it does point to the center mark, go to Step 32

32. Remove all locating pins from all pivot points

33. Install transmission shrouds (Q.V.)

34. Road test

Figure 3 (continued)

INFORMATION DEMAND RATING

Perceptual Dimension

1. Visual Accessibility — 1 ☐ (easy) 2 ☐ 3 ☐ 4 ☐ 5 ☐ (hard)

(Can the part or component to be worked on be seen easily - such as the upper radiator hose? Or is it hard to see - such as the parking brake drum?)

2. Manual Accessibility — 1 ☐ (easy) 2 ☐ 3 ☐ 4 ☐ 5 ☐ (hard)

(Can the part or component to be worked on be gotten to easily - such as the radiator cap? Or is it hard to get to - such as the double spray linkage?)

Cognitive Dimension

1. Clarity of Necessary Task Steps — 1 ☐ (clear) 2 ☐ 3 ☐ 4 ☐ 5 ☐ (unclear)

(Is it clear that something has to be done first - such as removing the spark plug wire before removing spark plug? Or is it unclear whether something has to be done before starting on the central task - such as disconnecting the battery ground before removing an electric fuel pump?)

2. Clarity of Techniques to Perform Task Steps — 1 ☐ (clear) 2 ☐ 3 ☐ 4 ☐ 5 ☐ (unclear)

(Is it clear as to just what needs to be done first - such as removing the distributor cap and rotor before cleaning the breaker points? Or is it unclear, such as which tubes and hoses must be removed before removing the cylinder head?)

Performance Requirements

1. Special Tools Required — 0 ☐ (no) 1 ☐ (yes)

(Are any tools required that are not found in the mechanic's common tool box - such as torque wrenches, timing light, feeler guages?)

2. Formal Specification Required — 0 ☐ (no) 1 ☐ (yes)

(Does the task require any close tolerances or fine adjustments - such as torque cylinder head bolts, or adjusting valve tappet clearance?)

Figure 4. Illustration of the Information Demand Rating

The last two items of the IDR concern the precision of actions required by the mechanic, (Formal Specification Required) and any special equipment required to accomplish these actions (Special Tools Required). Special tools refers to any tools not found in the mechanic's common tool box (e.g., torque wrenches, timing light, fuel gauges, etc.) Formal Specification refers to any close tolerances or fine adjustments required by the task (e.g., torque cylinder head bolts to 65 lbs. ft., adjusting valve tappet clearances, etc.). These two items are simply rated yes or no.

The IDR rating for a task is the simple sum obtained from the six items. However, an assigned task will often consist of several idealized tasks nested within it (e.g., after installing a distributor the mechanic adjusts the contact breaker points and times ignition). This problem is solved by summing the IDR ratings obtained for the three tasks and using this simple sum as the measure of information need for the observed task.

UNOBTRUSIVE OBSERVATION TECHNIQUES

The unobtrusive observation (minimum interaction) technique presented here involves a full narrative form of data collection. A major advantage of the narrative data collection form of the unobtrusive observation technique is that it provides the possibility of a "line audit" from the actual observed task performance to the step-by-step task description produced during the front-end analysis.

The typical problems with this kind of approach (unsystematic collection of data, lack of formal data structure) are overcome by comparison of observed tasks with front-end analysis of the tasks and by special training of the data collection personnel. The step-by-step task descriptions from the front-end analysis provides the necessary structure for development of the narrative. The system for the observation methodology is described in the "Instructions for Observers" (pp. 14-30) and the system for training observers is detailed in the "Observer Training Procedures" (pp. 31-34) which follows.

INSTRUCTIONS FOR OBSERVERS

These instructions serve as a guide for systematic observation and data-gathering on personnel performing maintenance tasks. The instructions attempt to establish decision rules enabling the gathering of usable data.

Procedure for Briefing Task Assigners

1. Introduce yourself. Tell the task assigner who you represent.

2. Tell the task assigner the name(s) of the higher level authorizations and the division-level contact.

3. Explain the following points of the study:

   a. The study is based on unobtrusive observation of regular, ongoing work in the shop.

   b. The purpose is to provide information about what the situation in the shops really is, as opposed to what the situation in the shop is supposed to be. We want to find out what the problems are and what causes them.

   c. The goal is to supply information to the Army so the Army can improve the way it supplies tools, equipment, and information required to perform the job effectively and efficiently.

   d. Explain that the goal is not to evaluate the performance of the shop, unit, or any individual member of the unit.

   e. Explain that we are not looking for specific or detailed changes, but are observing tasks as they are performed in the usual manner.

4. Brief the task assigner on the kinds of tasks needed for the observation.

5. Explain to the task assigner the importance of his/her cooperation in the following areas:

   a. Assigning the tasks in the normal manner so as to minimize the disruption caused by having observers present.

   b. Help in keeping casual observers away from the task under observation in order to minimize disturbing the routine.

c. Whenever possible, assign a single individual to a task.

d. Explain how more than one person assigned to a task or the presence of a casual observer can interfere with the data collection process.

6. Explain the complete data collection structure to the task assigner.

7. Review scheduled maintenance for the week with the task assigner and establish a workable schedule for the data collection.

8. Emphasize again the aim of the study to remain as unobtrusive as possible and our need for the help of the task assigner in achieving this aim.

Procedure for Briefing Task Assignees

1. Be sure that you are present, if possible, when the maintenance technician is being assigned to the task to be observed. The task will be considered initiated once the maintenance technician is informed of his assignment to the task.

2. Determine if any information-seeking behavior occurs between the task assignee and task assigner at this time.

3. Record the information-seeking behaviors, if any occurs, on the Observation Data Sheet (ODS) according to the guidelines set forth in the observation procedure section.

4. Upon arrival at the task site, find out the maintenance technician's MOS/duty position and record in the appropriate space on the ODS.

5. Record the date, task name, time and your initials in the appropriate spaces in the ODS.

6. Assign the observation number to the maintenance technician at this time. The observation number and the observer's initials serve to identify each task observation.

7. Record the assigned observation number on the consent form and the ODS.

8. Explain to the maintenance technician how the observation procedure is structured, i.e., pre-task interview, task observation.

9. Emphasize to the maintenance technician that he is not being evaluated in any way. Answer any questions the maintenance technician may have concerning the observation procedure.

10. Ask the maintenance technician to read and sign the consent form.

11. If the subject requests a copy of the consent form, comply. Be sure to retain the original signed consent form.

12. Prior to the beginning of the actual task performance, find out how many times the maintenance technician performed this task prior to the present time, and how long it has been since he last performed the task.

13. Record this information in the appropriate spaces on the ODS.

14. Ask the maintenance technician the exact name of the task.

15. Ask the maintenance technician to inform you when he has completed the task.

Observation Procedure

1. Record all task-relevant activities (as defined) in narrative style on the observation data sheet (i.e., describe what is happening). Be sure to include enough of the context that actions can be understood when the narrative is read next year.

2. When information seeking behavior, errors, and other behaviors occur, they should be recorded in detail in the narrative text. The appropriate code for that behavior should be placed in the "code" column (see Definitions and Criteria section).

3. The narrative text should include as much detail about information seeking behavior and errors made as is necessary to actually describe the event.

4. For information seeking behavior, it should include exactly what information was sought. It should also include why the information was sought and from where or whom it was sought. Whether or not the desired information was obtained should also be recorded.

5. Situations in which information is sought but not obtained should be coded as information-seeking events. Make a note that the information was not obtained by putting an (x) in the code column. Be sure to find out and note in the narrative what kind of information was being sought. Distinguish information that was not obtained from information that was found but was not understandable or useful. If information is obtained that is not useful find out why, i.e., wrong question, wrong model, etc.

6. When the mechanic is looking in a manual, it will usually be necessary to ask (casually), "What were you looking for?" and "Did you find what you were looking for?"

7. When recording an information-seeking behavior (ISB) involving a technical manual (TM), be sure to note the TM number, page number, figure number, and TM date.

8. There may be occasions when the mechanic seeks information for a short time, works briefly, and goes back for more information. If he is working for less than a minute between information-seeking behaviors, the information seeking will be scored as a single event.

9. Information codes are to be used in the following manner. Record information-seeking events in four categories: Volunteered or Requested / Internal or External / Source / Type. Every information-seeking event will include all four categories. Record the abbreviations for each section in the order stated (i.e., R/E/[illegible]/H). See Codes for Narrative Data section and the example ODS.

10. When the observer realizes that an error has been made he should record its occurrence in detail in the narrative text.

11. The exact nature of the error, the step on which it occurred (if possible), and whether the mechanic knew an error has been made, should be recorded. Whether or not the error was corrected should also be indicated. Also, try to determine and note the source of the error--the reason the error was made. (Enough information should be included to allow the correct coding of errors during the Data Transcription Procedure.) Indicate error events on the ODS in some unobtrusive way in case mechanics wants to read the narrative text.

12. Some steps will require non-information seeking behavior codes (see Definitions and Criteria section, Codes for Narrative Data section, and the example ODS).

13. The non-information seeking behavior codes will be placed in parentheses, i.e., (J1) (X) (3) in the code column.

14. Any behaviors that seem unclear should be flagged (?) in the code column. This will enable you to remember certain points that can be discussed with the mechanic during the post-task interview. Even though we want to be as unobtrusive as possible, do not hesitate to interact with the technician to have questions resolved. Chances are any scoring problems will be cleared up.

15. It is necessary to the observation technique to observe no more than two persons per task unless a particular part of the task requires more than two persons. Do not disrupt the usual operation and task assignment procedure of the motor pool, but make the needs of the research clear to the task assigner.

16. If the task assigner assigns more than two persons to the task, consider employing instruction for observing teams (see Instructions for

Observing Teams, pp. 29-30). If team procedures are not possible then abort the observation.

17. When two mechanics are observed per task, one is assigned as the Subject and referred to as such in the narrative text. The other mechanic is referred to as the Assistant (AS). The assignment should be made on the basis of who seems to be the major actor at the beginning of the task.

18. If one or two people are helping the mechanics at some point in the task, continue the observation. These mechanics should be referred to as assistants in the narrative text. (AS2, AS3, etc.)

19. If three or more people are helping the mechanic, stop the observation until the number of helpers is down to one or two, then continue the observation. Note in the narrative that there were too many people working on the task to keep track of the flow of information during that time period.

20. If the information flow of the mechanic and his assistant(s) becomes unobservable because of too many people working on the task, and there is no indication that the number of people will lrop to acceptable levels (2 helpers), abort the observation.

21. In any situation where people are helping the mechanic, the observer must use his judgment as to whether he can keep track of all the activity.

22. The task is considered completed when the mechanic being observed states that it is.

Definitions of Task-Relevant Activities

Those activities which are recorded in narrative style during the observation. Task-relevant activities include:

1. Task-Relevant Information. Refers to information that enables the mechanic to complete part or all of the maintenance task he is presently performing. It also refers to information that permits the mechanic to verify his past work was correctly performed.

2. Task-Relevant Behavior. Refers to behavior of the mechanic that is directed toward completion of part or all of the maintenance task he is presently performing. These are actions directed toward any tools, parts, equipment, or similar equipment, or information whether they appear productive or not.

3. Task-Relevant Observations. Refers to all task-related observations made by the mechanic as he performs a maintenance task.

4. Task-Relevant Conversation. All conversation addressed to the mechanic performing the task or addressed by that mechanic to any other person if some part of the subject matter of conversation pertains to task-relevant information, whether phrased as a question or not, excludes obvious non-relevant information or questions.

Directions and Criteria of Directions of Information Flow

1. Volunteered Information. Task-relevant information volunteered by the mechanic's assistant(s), or by some other person.

2. Requested Information. Task-relevant information actively sought or requested by the mechanics.

General Information Sources

1. External to Task. ISB is considered external to the task when the mechanic receives information from an external source.

2. Internal to Task. ISB is considered internal to the task when the mechanic receives information from the task process, i.e., from observation or manipulation of the equipment itself.

3. Discussion. Refers to discussions in which the mechanic and one or more persons talk over the task but it is not clear who is requesting or giving information (i.e., information flow directions are confused).

Specific Information Sources

1. Books (external). Refers to any consulting with technical manuals where there is written, photographic or graphic material presented.

2. Person (external). Refers to any interaction with other personnel during which task-relevant information is obtained. The information includes that volunteered by a supervisor as well as information sought by the mechanic so long as it is relevant to the task the mechanic is performing.

3. Equipment Data (external). Refers to events in which an equipment data plate is consulted.

4. Equipment Model (external). Refers to events in which a part/area of another or the same vehicle, identical or similar to the part/area the mechanic is presently working on, is consulted (e.g.

looking at the left wheel of a truck to see how the rubber boot on the right wheel should be installed).

5. Job Aids (external). Refers to any consulting with portable charts, diagrams not in manual, or data cards that are task-specific (e.g., data cards that list torque values).

6. Process Provided (internal). Refers to events in which the mechanic "checks" or "inspects" parts/area of the equipment being worked on. These events are made visible by overt behavior of the mechanic as he performs the required tasks on the equipment (e.g., rotates a cover plate to identify the correct alignment of bolt holes).

Criteria for Overt Non-Verbal Behavior to be Scored as Internal ISB

1. Manual Manipulation of Part. Characterized by rotating, turning, inverting, shaking, spinning or squeezing the parts and then attempting to align or fit them into position on the equipment (e.g., aligning, or fitting throttle linkage until it falls into the proper holes).

2. Mechanical Manipulation of Equipment. Characterized by engaging a mechanical device on the equipment, which in turn activates another mechanism (e.g., engaging the starter to turn over the engine), so the action of the mechanism can be observed.

3. Test Equipment Readings. Characterized by using a mechanical or electrical device to measure or record task-related information from the equipment.

4. Directed Observation. Characterized by the mechanic holding a part steadily and concentrating his attention on some point on the part (e.g., holding a lever steadily so he sees the critical markings on it); or by the mechanic stopping his movement around the equipment and concentrating his attention on some area of the equipment (e.g., stopping to listen for a clanking sound coming from the rear end).

5. Non-directed Observation. Characterized by moving around the equipment searching for task-relevant information (e.g., walking around a jeep sniffing for burning electrical wires).

Definitions and Examples for Types of Information Sought or Volunteered

1. Technique for a Task Step. Questions concerning how to complete the task step presently being performed. Examples include information about how to remove a brake shoe clip, how to detach a universal joint, or special precautions to be followed.

2. Task Steps Required for Completion. Questions about what the next step in the task is. Step-by-step information seeking is distinguished from how-to seeking by whether the question addresses "what to do next?" That is, if the mechanic seeks information about how to successfully complete the action presently engaged in, it is a Technique event. If the mechanic completes a step, then seeks information about what to do next, it is a Task Steps Required for Completion event.

3. Location/Identification of Components. Questions about the nomenclature of task-related hardware items and where they are located on the equipment being worked on.

4. Formal Specification Data. Questions about the range of conditions and indications for a device operating within acceptable limits. Examples of specification information include torque values, electrical values, and pictures of acceptable and unacceptable spark plug conditions.

5. Data Flow. Questions about the functional relationship between components and equipment items, and how a given operational device acts upon a given input to produce a desired output. Examples would include wiring diagrams, schematic diagrams, information showing the components involved in a given functional unit, and information explaining the theory of operation of equipment (e.g., how it works).

6. Internal/From Task. Information seeking when the exact type of information being sought cannot be discerned. This information type is most often sought from a Task Process Source.

7. Help on Serviceability Judgment. Questions about whether or not an equipment part or assembly is serviceable in its present condition. Examples include such questions as, "Are these bearings OK?", or "Can I use this gasket again?"

8. Help on Alignment Judgment. Questions about whether or not an adjustment has been completed correctly or whether equipment parts or assemblies are correctly positioned (aligned). Examples include such questions as, "Is this the right brake pressure?", or "Is this road wheel on all the way?"

Outside Support Information Sought or Volunteered. When Technique, Task Steps Required or Specifications information is sought, questions concerning any special implements, instruments, provisions, or other necessities required to complete a given task - or needed to facilitate performance of a given task should be indicated with the outside support code, in addition to the appropriate information type code. Examples include information about using a torque wrench or meter, how many helpers are necessary, and which lubricants or solvents are needed. This definitely includes how to use or read test equipment.

Definitions and Examples for Sources of Errors

OUTSIDE - Refers to errors that arise from a previous error by another person or when another person gives incorrect information which is used by the mechanic. An example is stripping a bolt that has been cross-threaded during prior installation, or following incorrect torque instructions.

EXPEDIENT - Refers to an error that arises from tool, part, or information unavailability. Examples include not torquing bolts to specifications because no one has a torque wrench, or applying oil to threads of access plugs before reinstalling because antiseize compound is not available.

MECHANIC - Refers to those errors which arise from the individual mechanic's own lack of knowledge or carelessness. Examples include pulling hoses without draining fluid reservoir first, thus spilling antifreeze all over floor; removing parts without disconnecting electrical connections, thus often breaking wires; and not bothering to find out if bolts should be tightened to a specific torque value.

Definitions and Examples for Process-Error Types

1. Violate Good Mechanical Practice. Errors made when the mechanic violates good general mechanical practice. These are errors which often lead to damaged parts or sloppy workmanship. Examples include improperly greasing wheel bearings, and failing to drain oil reservoir before attempting to change primary oil filter.

2. Wrong Technique Used. Errors when the mechanic uses the wrong tools or procedure during the task process. Errors of this type often lead to damaged equipment parts. Examples include: not using a sling to support heavy equipment parts being removed or installed, and prying with a screwdriver to remove an oil filter element--damaging the element.

3. Specification Error. Process errors made when the mechanic does not follow exact specification requirements stated in the Task Manual. Examples include adjusting contact breaker points to an incorrect gap width, or tightening cylinder head bolts to an incorrect or unknown torque value.

4. Wrong Part or Component. Errors made when an incorrect equipment part is installed, or an attempt is made to install it. Occasions

when an equipment part is left out of an assembly are also Parts Errors. Examples include installing a secondary oil filter in the primary filter case, or leaving out part of the U-joint assembly.

5. Wrong Position or Orientation of Part/Component. This error usually occurs when equipment parts are installed in such a place or rotated so that they cannot be properly seated and attached. An example is seating an oil cooler in such a position that the inflow/outflow links cannot be attached.

6. Wrong Order-of-Steps. Errors made when the mechanic does task steps out of their prescribed order. (Occasions when task steps are completely omitted are also Order-of-Steps errors.) These errors often resemble Recursive Errors until the mechanic realizes, or is told, of the missed step. Examples include repeated efforts to pull off a brake drum before contracting brake shoes, or repeated attempts to pull out generator before removing all attached wires.

7. Wrong Adjustment Technique. Errors made when the mechanic uses a wrong tool or procedure to complete adjustment of an equipment part. Examples include turning an adjustment the wrong way to tighten/ loosen it, and not jacking up a jeep before adjusting the wheel bearings.

Definitions of Modifiers of Process Error Types

Any action coded as one of the above error types might also be recursive and/or destructive.

1. Recursive Error. A recursive error is defined by a mechanic making one of the above error types two or more times while working on the same component part, such as when working on the bearings of one wheel assembly. This should be distinguished from occasions when the same mistake is made once on each of two or more "mirror image" component parts on the same vehicle, such as the same mistake on each of the four wheel assemblies. In this second situation the errors made during work on each mirror image part should be coded as individual errors.

2. Destructive Error. An error is destructive when either a mechanic does something that immediately results in damage to an equipment part, or does something which will, over time, decrease the servicable life of the equipment part and vehicle. Examples of the first include tearing a gasket or rounding off a bolt head or nut. Not packing dry bearings or using the wrong filter element are examples of the second.

Definitions of Completion-Error Types

1. Serious Uncorrected Errors. Any error which was left uncorrected when the mechanic stated that the job was finished and which, in the opinion of expert mechanics, would: (a) shorten the serviceable vehicle life, (b) immediately endanger the vehicle, (c) endanger drivers or passengers in the vehicle, or (d) endanger by-standers near the vehicle.

2. Checkout Possible - Not Made. This is when the mechanic does not attempt to complete a checking of the equipment part that has been installed or adjusted. What tasks should have a checkout depends on the task itself, the operational status of the vehicle apart from the task at hand, and pertinent regulations. Examples include not testing the brakes, and not starting the vehicle and checking for leaks in the coolant system.

Data Transcription Procedure

1. The purpose of the data transcription is to transform the raw narrative data into an easy-to-read, concise, step-by-step format. You will use a pen, so that the transcripts can be copied later.

2. Record observation number, MOS/duty position, time, date, task name, number of times task performed, time since task last performed, and time in MOS in the spaces provided at the top of the data transcription sheet.

3. Be sure to record the observation number and page number at the top of all subsequent pages.

4. Detail each step sufficiently so that the actual series of events can be easily understood. This is the most important function of the transcriptions.

5. Number each step.

6. When an information-seeking event occurs, code the step with the appropriate code. When the information which was sought was not obtained, the narrative should make clear whether the information was not available, or whether obtained information was not useful.

7. When a step includes the use of a TM, record the TM number, page number, paragraph number, figure number, and date in the data transcription.

8. When a step requires a non-information seeking behavior code, code the step in the same manner as for the observation narrative data.

EXAMPLE
OBSERVATION DATA SHEET

INITIALS _____

O #: ________ DATE: ________________

MOS/DUTY POS.: ____________________ TIME: ________________

NO. TIMES TASK PERFORMED: ____________ TIME IN MOS ___________

TIME SINCE LAST TASK: ______________

TASK: ____

Steps Code

Task Decision Information: (Symptom? Selection Criteria? Other possible actions?)

____ ____

____ ____

____ ____

____ ____

Task Performance:

____ ____

____ ____

____ ____

____ ____

____ ____

____ ____

____ ____

____ ____

____ ____

____ ____

9. When coding an error, determine the step in the task where the error was made and place the code at that step.

10. If the process error is also Destructive and/or Recursive error, the appropriate code should also be marked. Special attention should be given to Recursive Errors as noted previously in Definitions of Modifiers of Process Errors.

11. If the error is also a Serious Uncorrected Error, the appropriate code should be placed in the code column.

DATA TRANSCRIPTION CODES

Information Codes: (Place in code blank with slashes between symbols and in the following order, e.g., R/E/PB/H:

V/R

V = Volunteered Information
R = Requested Information

I/E/D

I = Internal to Task
E = External to Task
D = Discussion about Task

SOURCE

PB = Person, Supervisory (Boss)
PF = Person, Fellow Enlisted Man
D = Data Plate
E = Equipment Model (same or different piece of equipment)
J = Job Aid
F = From Task Process (not otherwise identifiable)
TM = Tech. Manual (Get TM #, page #, paragraph or figure #)

TYPE

T = Technique for a Task Step
P = Procedural/Step-by-Step
G = Geography of Equipment/Parts I.D.
S = Specification Data

D = Data Flow
I = Internal from Task (not otherwise identifiable)
SJ= Make the judgment for me on serviceability
AJ= Make the judgment for me on adjustment/alignment

OUTSIDE SUPPORT INFORMATION

O = Outside Support Information

Error Codes: (Place code in blank with slashes between symbols and in the following order, e.g., MC/A/DE/AC.)

Source of Errors

OT = Previous Errors by Others or Incorrect Information
EX = Expedient Error
MC = Mechanic's Error

Process Errors

G = Violate Good Mechanical Practice
T = Wrong Technique Used
S = Specification Error
P = Wrong Part/Component
R = Position/Rotation Error
O = Wrong Position or Orientation of Part/Component
A = Wrong Adjustment Technique

Modifiers of Process Error Types

RE = Recursive Error
DE = Destructive Error

Completion Errors

SUE = Serious Uncorrected Error
CN = Checkout Possible/Not Made

Non-Information Seeking Behavior Codes

J1 = Serviceability Judgments
J2 = Adjust/Align Judgments
AS n = Assigned by n persons during this step
X = Information sought is not what was obtained

EXAMPLE

DATA TRANSCRIPTION SHEET Initials _____

O #: ____________ MOS/DUTY ____________ TIME ________

DATE: ____________ TASK ______________________________

CLOZE: ____________ NO. TIMES TASK _____ TIME SINCE LAST ________

CIV. EXP: ____________ TIME IN MOS ________ MM ________ GT ______

Step #	Task Steps	Code

INSTRUCTIONS FOR OBSERVING TEAMS

A team is defined as three or more mechanics assigned to work on the same automotive task. This situation is different from one in which there is one principal mechanic with one or more assistants helping at various times.

The procedures outlined in Instructions for Observers are applicable to a team situation, with the following exceptions.

Observation Procedure for Teams

1. Two observers are necessary to keep track of the work flow, due to the number of mechanics at work and because the mechanics may be engaged at different locations around the vehicle or work area.

2. Observers should agree on labels for the mechanics, e.g., Mechanic A, Mechanic B, etc.

General Information Sources for Teams

Internal to Task (I). ISB is considered internal to the task when the mechanic receives information from the task process.

External to Task/Within a Team (TE). ISB is considered external to the task and from within a team when the mechanic receives information from another member of the team.

External to Task (E). ISB is considered external to the task when the mechanic receives information from some source outside the team.

Discussion Within a Team (TD). Refers to discussions in which two or more team members talk over the task, but it is not clear who is requesting or giving information (i.e., information flow directions are confused).

Discussion (D). Refers to discussions involving one or more team members and one or more persons who are not members of the team, but it is not clear who is requesting or giving information (i.e., information flow directions are confused).

Transcription Procedure for Teams

1. Observation records should be combined into a single narrative.

2. In order to facilitiate understanding, the narrative should be structured around related portions of tasks, rather than actions of mechanics in real time.

OBSERVER TRAINING PROCEDURE

Purpose

The purpose of this procedure is to train new observers in this unobtrusive data collection technique.

Technique Description. This is a low-reactivity (unobtrusive) data collection technique. It is designed for the collection of complete narrative descriptions of task performances at the usual job site under essentially normal work conditions. That is, every effort has been made to avoid the appearance of a test or an evaluation of either the worker or his organization. The primary data of interest are: the use of technical information, where the information is sought and obtained, what kind of information is sought and obtained, and what kinds of errors occur. The secondary data of interest are the context in which technical information is used and sought. The "context" refers to both where, in the particular task, the information is used or sought and to what the environmental and work circumstances are.

Training Goals. The primary goal of this training, as of most training, is to reduce variation in the performance of the data collection from observer to observer. There must be commonality in the selection of which behavior to record or not record during an observation. There should be a minimum information base which every observer brings to the observation with him. The minimum base must include basic mechanical practice, familiarity with vehicles to be observed, familiarity with the tasks to be observed, familiarity with the Army Motor Pool structure and systems, familiarity with the definitions and codes for data collection, and an understanding of the task process model being used.

Training Procedure. The training of a new observer starts with an overview of the purpose and goals of data collection. Next the new observer gets an explanation of the methodology, from development to analysis. After familiarizing the observer with the methodology of the front-end analysis, the observer is given hands-on experience with the write-up of typical tasks from the technical documentation (as step-by-step task descriptions). He then rates the tasks for information demand. Finally, the observer familiarizes himself with the existing body of task write-ups, demand ratings, and observations previously collected. The last step is practice observations for discussion and critique.

Example of ASA's
Training Schedule

A. First Day

1. Overview of purpose and goals of the project and the data collection. 1 hour - Project Director (PD) and staff.

    a. Purpose: Provide advice and guidance to writers of technical manuals.

    b. Goal 1: Gather baseline data on use of and need for technical information under job performance conditions.

    c. Goal 2: Find out why and by whom tasks are usually assigned, as well as completion cues and checkout process for task completion.

    d. Goal 3: Collect data on information-seeking behavior (ISB) by type and source, errors, and other personnel variables of interest.

    e. Goal 4: Determine the factors which allow prediction of ISB by type and source.

2. Explanation of methodology. 1 hour - PD and staff

    a. Task process model - the conceptual framework for the methodology.

    b. Evolution of narrative recording of unobtrusive observation.

    c. Stages of front-end analysis which precede observation.

    d. Methods and goals of analysis of collected data (what do we do with the data).

3. Description of the Army and Army Motor Pools as they affect our data collection. 2 hours - PD and staff

    a. Officer and E-M rank and meaning.

    b. Structure of Army Infantry Divisions

    c. Structure of motor pool

    d. Military terminology and slang

B. Second Day

1. Discussion of task analysis procedure. 1 hour - staff

   a. Q&A clarification time.

2. Introduction of technical manuals (TM). 2 hours - staff

   a. Comparison of a task description write-up and the same task as described in the TM.

   b. Discussion of how to use TM for basis of task description.

3. Practice task description write-up. 2 hours - staff

   a. Independent applications of prior learning to write up practice task.

   b. Comparison of previous write-ups and critique (feedback).

4. Practice task description write-up for five tasks on jeep-TM9-2320-218-20. 4 hours.

C. Third Day

1. Comparison and critique session on jeep tasks. 1 hour - PD and staff

2. Practice task description write-up for M113 Armored Personnel Carrier and M60A1 Tank - five tasks each - remainder of day.

D. Fourth Day

1. Complete practice write-ups. 2-4 hours.

2. Feedback session, reliability rating with previous analyses. 1 hour - PD and staff

3. Feedback session. 1/2 hour - staff

4. Reliability rating with previous analyses. staff

E. Fifth Day

1. Practice making information demand ratings (IDR) on first task write-ups. 1/2 hour

2. Feedback and discussion of IDR. 1/2 hour - staff

3. Practice IDR on other 14 tasks. 6 hours maximum

4. General Q&A and discussion of front-end analysis procedure. 1 hour - PD and staff.

5. Study "Instructions for Observers" booklet - ad lib

F. Sixth Day

1. Discussion of observation technique and procedures. 2 hours PD and staff

2. Study existing body of observations and transcriptions. 6 hours assisted by staff

G. Seventh Day - Ninth Day

1. Study existing body of task descriptions and observations - study relations between the two - all day ad lib.

2. Discussion of lore of actual data collection. As needed - staff

H. Tenth Day

1. Discussion. 3 hours - PD and staff

I. First Day of Field Data Collection

1. Practice observation and reliability tests with fellow team members. 8 hours

2. Discussion and consensus correction of narrative and transcription. 2 hours.