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Job Requirements System: Procedure for the Analysis of Occupational Requirements Within Job Sets

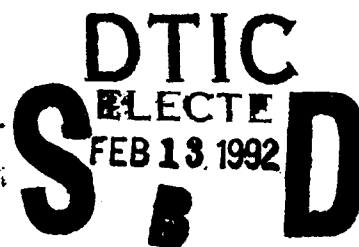
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**JOB REQUIREMENTS SYSTEM: PROCEDURE FOR THE ANALYSIS OF
OCCUPATIONAL REQUIREMENTS WITHIN JOB SETS**

EXECUTIVE SUMMARY

Requirement:

The Job Sets for Efficiency in Selection Recruiting and Training (JSERT) program is an effort by the U.S. Army Research Institute for the Behavioral and Social Sciences aimed at improving the selection and classification of recruits into MOS. The core of this effort is the definition of sets or clusters of MOS that all have similar human ability requirements and, therefore, should be filled by personnel with similar abilities. These job sets can then serve as the basis for MOS consolidation and restructuring, as well as the choice of selection/classification tests. This effort was aimed at the development of a procedure, called the Job Requirements System (JRS), that was designed to support the JSERT process by

- Defining job sets based on human ability requirements
- Identifying the selection and classification tests that could be used to distinguish among different job sets and different MOS within a job set

Procedure:

The JRS process was developed by combining elements from existing or similar procedures with the data and findings recently produced by the Army's Project A. The total system consists of two modules. The Job Requirements Inventory (JRI) is used to describe the activities that make up an MOS or job and group MOS based on these activities. The Test Selection Process (TSP) takes data produced by the JRI and then serves as a guide for identifying psychometric tests that can be used to select or classify personnel into the MOS or MOS groups.

The JRS was tested by using it to collect job requirements data for a number of Army MOS.

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Findings:

The JRS procedure has shown that it may be useful within the JSERT concept and applications. The procedure has acceptable reliability with relatively small sample sizes. It can define the requirements for individual MOS and provide a basis for grouping MOS into sets. Its TSP module can be used to recommend psychometric tests to select and classify personnel into those MOS. Further, our post-briefs with the subject matter experts who provided data throughout the procedure indicate that it is easy to use and understand.

**JOB REQUIREMENTS SYSTEM: PROCEDURE FOR THE ANALYSIS OF
OCCUPATIONAL REQUIREMENTS WITHIN JOB SETS**

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JOB REQUIREMENTS SYSTEM:
PROCEDURE FOR THE ANALYSIS OF OCCUPATIONAL REQUIREMENTS
WITHIN JOB SETS

The Job Sets for Efficiency in Selection Recruiting and Training (JSERT) program is an Army Research Institute effort aimed at improving the selection and classification of recruits into MOS (Arabian and Schwartz, 1990). The core of this effort is the definition of sets or clusters of MOS which all have similar human ability requirements and, therefore, should be filled by personnel with similar abilities. These job sets can then also serve as the basis for MOS consolidation, restructuring, and the choice of selection/classification tests.

Efficient implementation of the JSERT concept required the use of a psychometric procedure or technique capable of performing two functions:

- Defining job sets based upon human ability requirements,
- Identifying the selection and classification tests that could be used to distinguish among different job sets and different MOS within a job set.

This paper reports on the development and initial testing of an analytical procedure specifically designed to accomplish these functions. We call this procedure the Job Requirements System (JRS). We will first discuss the development of the JRS procedure and then report on its trial application.

Procedure Development

Overview

Based upon the requirements of the product's use and implementation, we visualized the application of the JRS as comprising three steps, which are illustrated in Figure 1 on the next page. Our goal then became to develop components of the process that could be used to address each of these steps.

In developing the JRS we started from two basic foundations. First, our previous work (i.e., Smith and Rossmeissl, 1987) had shown that it was difficult for people, such as Army subject matter experts (SMEs), to make judgments about what abilities may

be required of a person before he or she could do a specific job. While SMEs could voice opinions about what may be required, those opinions were not founded on a thorough understanding of human abilities, and did not prove to be reliable. However, these same job experts could reliably tell you about the actions or activities that made up the job. We thus decided to ask SMEs questions that were focused on activities rather than abilities.

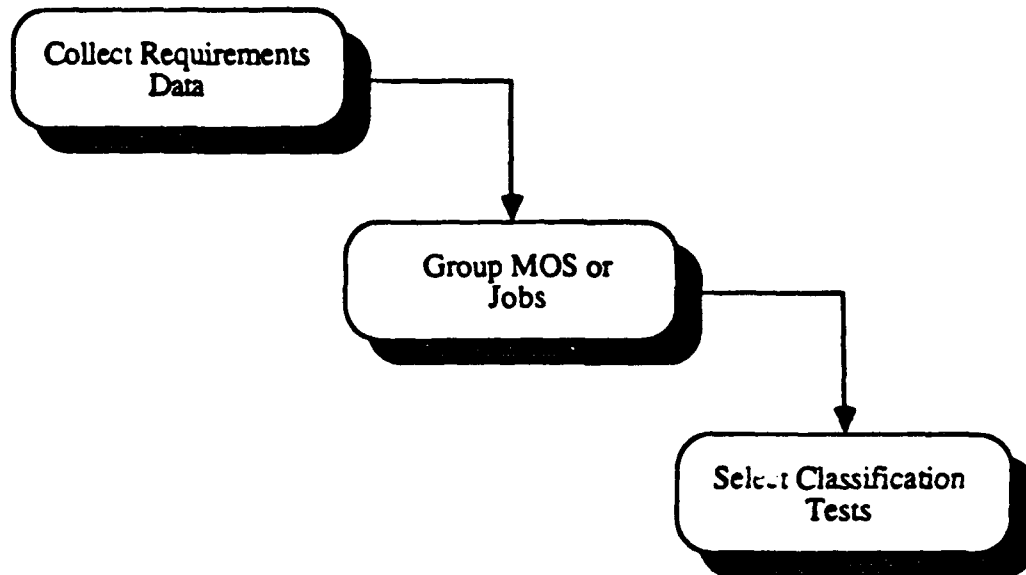


Figure 1. Basic steps in applying the JRS

Given that we would ask questions about activities or what is accomplished as part of a job, we needed a method for mapping the activities onto human abilities and tests to measure those abilities. Our second starting assumption was that we could accomplish this mapping through analyses of existing data collected under the Army's Project A (Campbell, 1988).

With these assumptions as a roadmap we set out to develop the JRS. We starting by developing a module that could be used to determine the ability requirements for a MOS. This module was called the Job Requirement Index (JRI) and its development is described in the next section.

Job Requirement Index (JRI)

Rossmeissl, Wise, and Alderson (1987) developed a taxonomy of human activities encompassing the range of behaviors that soldiers might evidence during the operation and maintenance of an Army system. This taxonomy was developed, in large measure, by merging

and modifying two existing systems (i.e., Berliner, Angell, & Shearer, 1964; McCormick, 1985), and was used to facilitate the sorting of over 2,000 hands-on performance measures (corresponding to steps involved in performing Army tasks) that were administered as part of a Project A validation effort (Campbell, Campbell, Rumsey, & Edwards, 1985). The final sorting yielded the 14 activity categories presented in Table 1. These categories were used in the present research to support the development of the Job Requirements Index.

Table 1

Job Analysis Activity Categories or Blocks

Activity Block Code	Activity Block Name
S1	Searching for / receiving information
S2	Identifying objects actions or events
A1	Use of job-related knowledge
A2	Input from representational sources
A3	Use of miscellaneous equipment / devices
B1	Information processing
B2	Problem solving and decision making
C1	Communication
D1	Connecting
D2	Moving
D3	Setting
E1	Adjusting
E2	Aligning / Synchronizing
E3	General body activity

The development of the Job Requirements Index involved three basic steps: (a) defining activity categories; (b) organizing activity categories hierarchically; and (c) systematizing the Job Rating Index and rating process for data collection purposes.

Defining activity categories. The first step entailed determining the specific human behaviors encompassed by each activity category. Most of the behaviors that were used to describe each activity category were drawn from the work of Berliner *et al.* (1964). Other behaviors were selected based on a review of the performance measure sorting data referenced earlier (Rossmeissl *et al.* 1987). The purpose of this review was to assure that the most frequently referenced behaviors were not overlooked as possible category descriptors. For example, Berliner *et al.* (1964) included seven "Specific behaviors" under the activity category, "Searching for and receiving information." We too used seven behaviors to describe this category. Five of the behaviors were taken directly from the Berliner *et al.* (1964) taxonomy. The other two behaviors were included following an assessment of the numbers and types of performance measure, or task step, behaviors that had been assigned to particular categories.

After determining the behaviors to be used as category descriptors, a glossary of terms was developed. The glossary lists each behavior (e.g., check, detect, observe) and provides its definition. The glossary was developed because many of the behaviors used as category descriptors have more than one potential definition, but only one intended definition (e.g., survey, check).

A list of examples of performance measures, or steps, that depend on specific behaviors was also developed. The overall intent of the glossary and the list of examples was to provide raters a clear, concise understanding of the behaviors associated with particular activity categories.

There were some instances where activity categories were developed which were not part of the original Berliner *et al.* (1964) taxonomy. In these instances, an effort was made to define the category in the intended manner, but also in a manner consistent with other related works. Thus, for example, the activity category, "Input from representational sources," is not part of the Berliner *et al.* (1964) taxonomy. However, on review of the sorting data, it was determined that McCormick and Jeanneret's (1988) definition for the term "representational sources" provided a good fit.

Organizing activity categories. The next step was to organize the activity categories hierarchically. This step was performed in recognition of research demonstrating the value of

organization in facilitating the speed and accuracy of information processing (e.g., Naylor, Briggs, & Reed, 1968).

In accomplishing this step, we depended first and foremost on the hierarchy previously established by Berliner *et al.* (1964). For example, Berliner *et al.* (1964) organized the activities, "Searching for and receiving information" and "Identifying objects, actions, events," under "Perceptual processes," and the activities "Information processing" and "Problem solving and decision making" under "Mediational processes." They treated "Connects," "Moves," and "Sets" as "Simple-discrete" "Motor processes," and "Adjusts," "Aligns," and "Synchronizes" as "Complex-continuous" "Motor processes."

Other activity categories, not based on the Berliner *et al.* (1964) taxonomy, were grouped as appropriate, given the results of the Rossmeissl *et al.* (1987) research. For example, "Input from representational sources," "Use of job-related knowledge" and "Use of technical equipment" were subsumed under a common organizer. In total, six higher order categories emerged from the organization process.

Systematizing the Job Rating Index and process. The final step was to systematize the Job Rating Index and process for data collection purposes. Completing this step entailed performing the following operations.

First, higher-order organizers and activity categories, including behavioral descriptors, were phrased in the form of questions (e.g., Does the job depend on the effective use of specialized information or technical equipment?) Second, higher-order organizers and activity categories were organized into a flow chart, or decision tree, with discrete "yes" - "no" response alternatives and arrows to help raters route themselves through the flow chart. Third, two seven-choice rating scales were built into the flow chart. One scale was designed to assess the relative amount of time job incumbents spent engaged in work behaviors encompassed by specific activity categories. The second scale was designed to assess the relative importance of the work in relation to all other work performed. Both ratings typically are recommended by authors of sources on job analysis (e.g., Gael, 1988; McCormick, 1979). An example of the flow-chart showing these questions and scales is presented in Figure 2 on the following page.

All of these materials (e.g., glossary, definitions, and flow-charts) were combined to form the complete Job Rating Index (JRI) (A copy of the JRI can be found in Appendix A).

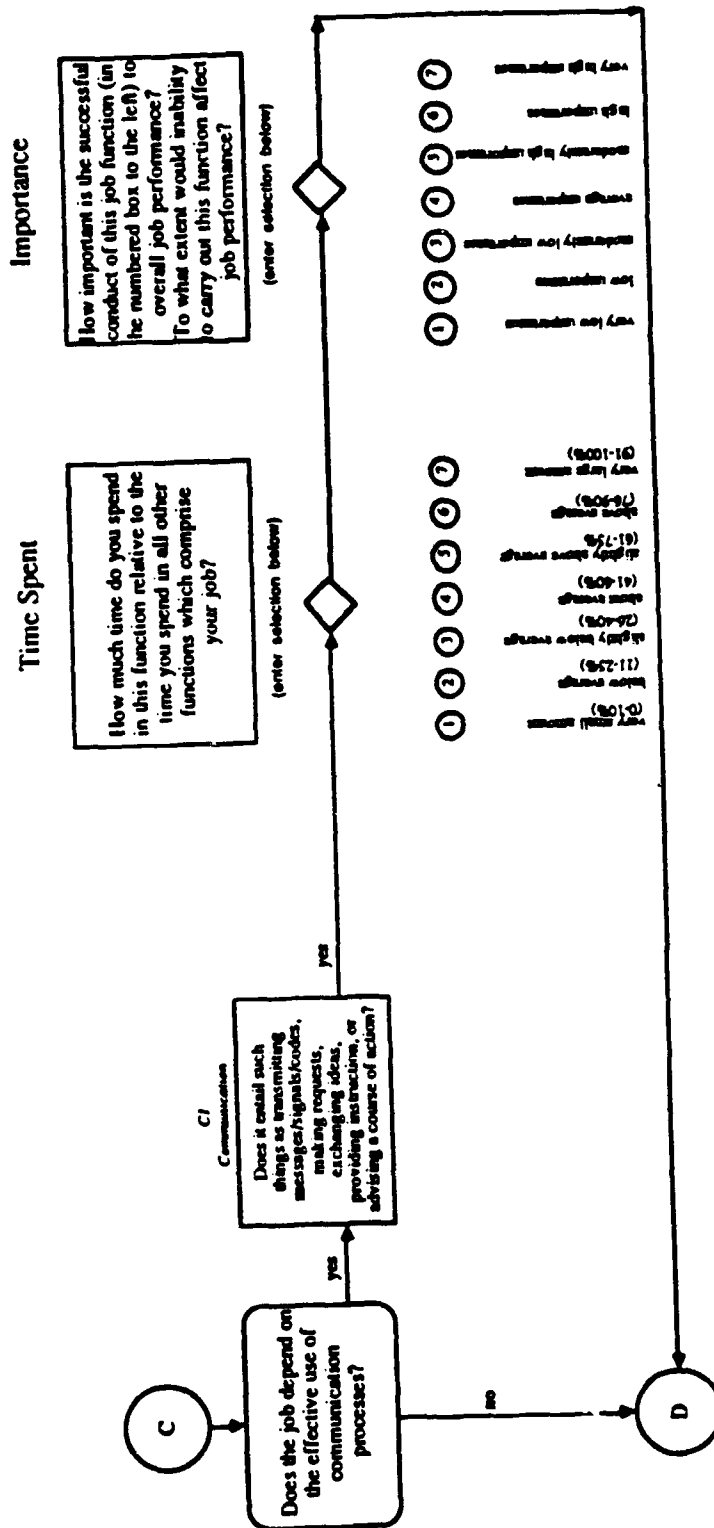


Figure 2. Sample JRI flow-chart

Test Selection Process (TSP)

Having established a procedure for measuring what must be done in a job or MOS, we then turned to which development of a JRS module could be used to determine the selection and classification tests that should be used to select and classify personnel into MOS based upon those requirements. We call this module the Test Selection Process (TSP).

Development of the TSP called for two separate but related analyses:

- 1) It was necessary to determine what human abilities or ability constructs are required for effective performance within each of the activity categories or blocks of the JRI; and
- 2) For each of the ability constructs found to be important within step one, we needed to identify a set of selection/classification tests that could measure the specific ability.

We found the data or information needed to accomplish both of these analyses in work conducted previously in related research and development efforts.

The first of these related efforts was conducted under the Army's Project A (e.g., Campbell, 1988) which identified a set of basic human ability constructs or factors that predict successful performance in Army MOS. Project A also associated with each of these factors a set of selection/classification tests that could be used to measure those abilities. Table 2 (on the following page) presents these constructs and tests. This work from Project A provided the starting point for determining what human abilities are required for each of the job blocks of the JRI.

These categories had already been used by Rossmeissl et al. (1987) to determine the abilities needed to perform each of the JRI activity constructs. They based their analysis upon the hands-on performance and human ability measures from the Project A concurrent validation effort. First, they computed simple correlations between all possible combinations of performance activities and ability variables. They then reviewed the matrix of correlations to select a set of variables to include multiple regression runs that would output the relative contributions of each ability in predicting performance within an activity category. The results of this analysis are shown in Table 3 on a following page. Table 3 presents the relative weight of each ability construct for predicting performance within a JRI activity block or category. The larger the weight of an ability construct, the more important that ability is in performing the activity. It also shows the overall (uncorrected) correlation (r) for the prediction of that performance.

Table 2

Project A Selection/Classification Tests and Constructs

Construct	Test	Source
Verbal	Verbal	ASVAB
	General Science	ASVAB
Numeric	Math Knowledge	ASVAB
	Arithmetic Reasoning	ASVAB
Technical	Mechanical Comprehension	ASVAB
	Auto Shop	ASVAB
	Electronics Information	ASVAB
Speed	Coding Speeding	ASVAB
	Number Operations	ASVAB
Spatial	Object Rotation Test	Project A
	Maze Test	Project A
	Assembling Objects Test	Project A
	Orientation Test	Project A
	Figural Reasoning Test	Project A
	Map Test	Project A
Psychomotor	Target Tracking Test 1 *	Project A
	Target Tracking Test 2 *	Project A
	Target Shoot Test (MTF) *	Project A
	Target Shoot Test *	Project A
	Cannon Shoot Test *	Project A
* Designates a computerized test		

Table 3

Mapping (Correlations) of JRI Activities onto Test Constructs

Block Code	Block Name	Verbal	Numeric	Technical	Speed	Spatial	Psycho- motor	I
S1	Searching for / receiving information					1	1	0.33
S2	Identifying objects actions or events		1	1		2		0.40
A1	Use of job-related knowledge		2		2	1		0.37
A2	Input from representational sources		1		1	2		0.40
A3	Use of miscellaneous equipment / devices		2	4	3	1		0.32
B1	Information processing		1		2	1		0.30
B2	Problem solving and decision making		2			1		0.30
C1	Communication	2			1			0.26
D1	Connecting			1				0.24
D2	Moving			2			1	0.33
D3	Setting			3	2	1	1	0.30
E1	Adjusting	2				1		0.32
E2	Aligning / Synchronizing					1		0.37
E3	General body activity		2		2	1		0.39

The basis for determining the abilities required of each JRI activity block is provided in Table 3. The next step in the development of the TSP was to identify which tests should be used to predict those abilities. Table 2 provided part of the answer to this question in the listing of the tests that apply to each construct. For decisions requiring ASVAB construct scores, the specific sub-test (test) scores can be obtained from the Military Personnel Records Systems (MEPRS) and summed for the appropriate construct score. However, for the tests developed under Project A, special test administrations would be needed, since these tests are not currently in operational use by the Army. Furthermore, the user would need to decide which spatial and/or psychomotor tests to administer.

As a basis for selecting among the Project A tests, we used the data on the test characteristics obtained by Peterson, Hough, Dunnette, Rosse, Houston, Toquam, and Wing (1990). Three of the test characteristics reported by Peterson et al (1990) were of particular importance to the TSP:

Uniqueness	How well the test measures human traits that are not already measured by ASVAB. In other words, how much new information about abilities is provided by the test. In general, the higher the uniqueness of a test the greater its potential utility in this situation.
Reliability	How stable or replicable are the results of the test. Tests with high reliability are more useful than those with low reliability.
Time limit	How long does it take to complete the test. Testing time is valuable, so short tests have some advantages.

Table 4, on the next page, presents these characteristics for the tests that are of relevance to the TSP and JRS.

The data presented in Tables 2-4 provided all of the information needed to develop and apply the TSP. An overview of the TSP is provided in Figure 3. The TSP uses JRI data as its input and can be applied to define a selection/classification test battery for an MOS or set of MOS. The application of the TSP can be accomplished through the following steps:

- 1) The ability constructs that predict performance for the critical JRI activities should be read off of Table 3. These abilities become the targets for selection/classification testing.

- 2) After an ability construct has been selected for testing, the tests that measure that ability should be examined through application of these criteria to the data in Table 4:
 - a) Tests should be selected that are of high uniqueness (vis a vis ASVAB),
 - b) If two tests are equal or nearly equal in terms of uniqueness, preference should be given to the test with highest reliability.
- 3) After a test has been selected through Step 2, its testing time (from Table 4) should be compared to the time that is available. If the time limit is within the constraints the test should be included in the selection/classification battery. If the selected test takes too long to administer, or if there is additional testing time remaining, Step 2 should be repeated.

Table 4

Psychometric Characteristics of Project A Tests

Construct	Project A Test	Uniqueness (vis a vis ASVAB)	Reliability	Time Limit (Minutes)
Spatial	Object Rotation Test	0.81	0.72	8
	Maze Test	0.71	0.70	6
	Assembling Objects Test	0.65	0.70	16
	Orientation Test	0.60	0.70	10
	Figural Reasoning Test	0.53	0.65	12
	Map Test	0.46	0.78	12
Psychomotor	Target Tracking Test 1 *	0.82	0.74	8
	Target Tracking Test 2 *	0.78	0.85	5
	Target Shoot Test (MTF) *	0.78	0.58	5
	Target Shoot Test *	0.70	0.37	5
	Cannon Shoot Test *	0.56	0.52	7
* Designates a computerized test				

These steps and the overall TSP process are illustrated and summarized in Figure 3 on the next page.

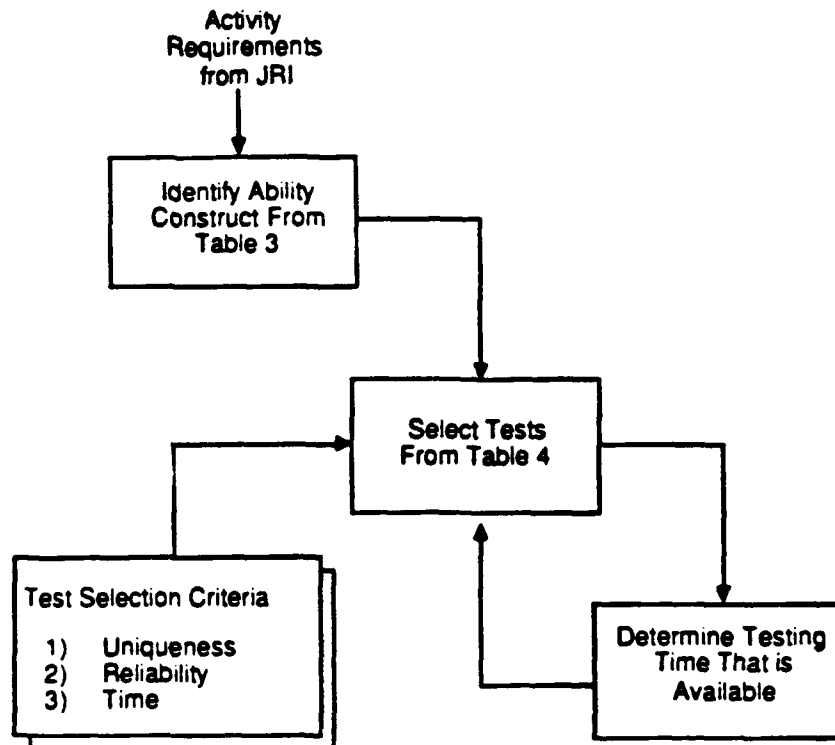


Figure 3. Test Selection Process (TSP) overview

Integration and Summary

The JRS was developed by pulling together existing data and findings from a number of research efforts. The total JRS is made up of two principle components: the Job Requirement Index or JRI and the Test Selection Process or TSP. How these components combine to reach the objectives of the complete JRS procedure is illustrated in Figure 4, on the next page.

The JRI is used to collect the basic data from SMEs in order to define the activity requirements and group MOS or jobs. The TSP is then used to identify the abilities and tests that can be used to select and classify personnel into those MOS.

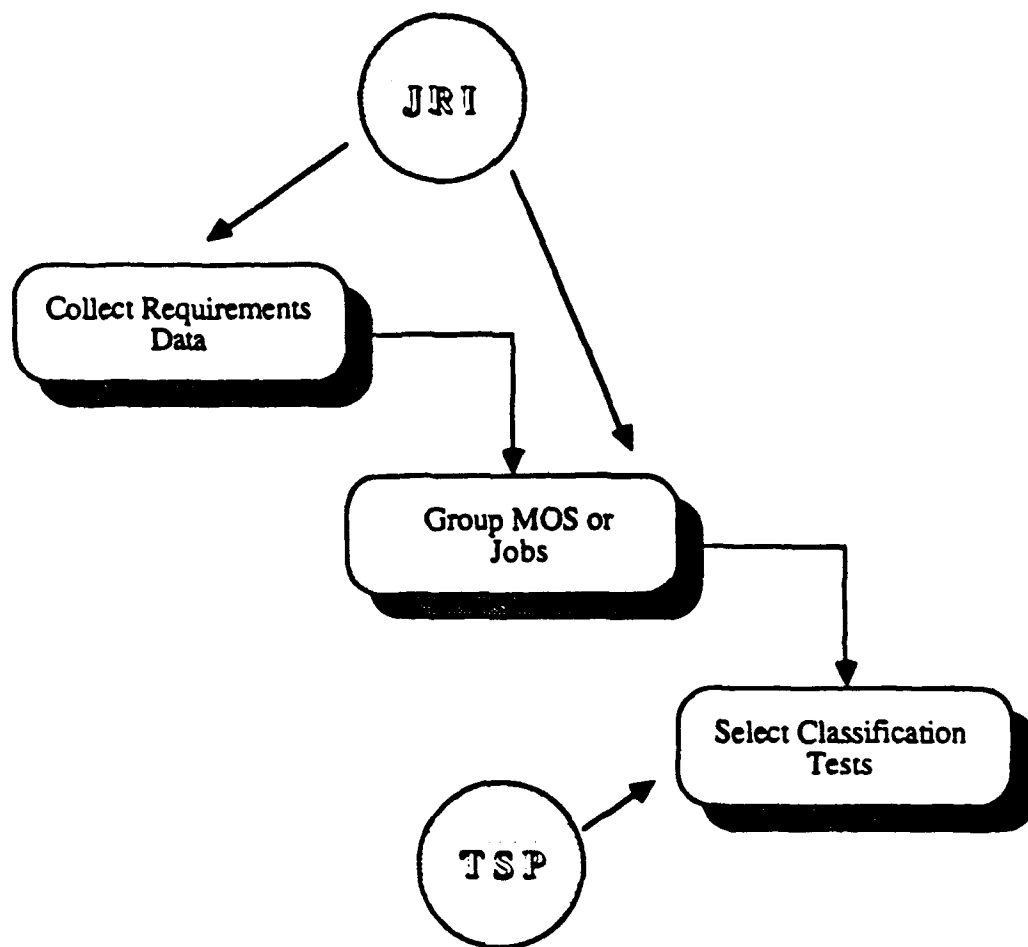


Figure 4: Components and functions of the Job Requirement System

Application/Test One

Sample

We completed our first test of the JRS procedure by using it to evaluate the requirements of several MOS which are currently the responsibility of the U.S. Army Quartermaster School at Ft. Lee, Virginia. Table 5 lists these MOS and gives the number of raters who analyzed each one for this application.

Five of these MOS (76C, 76P, 76V, 76X, and 76Y) were existing MOS and were analyzed by Subject Matter Experts (SMEs) who were instructors at the school and had at least two years experience working with the MOS. The remaining MOS, 92A, does not currently

exist. It is a hypothetical MOS that is being considered as a consolidation of the four MOS above. It was evaluated by SMEs who were part of the MOS consolidation team and were thoroughly familiar with what the MOS would be expected to do.

Table 5

Application Test One: MOS and Sample Sizes

MOS	Name	Number of Raters
76C	Equipment Records and Parts Specialist	7
76P	Material Control and Accounting Specialist	11
76V	Material Storage and Handling Specialist	9
76X	Petroleum Supply Specialist	10
76Y	Unit Supply Specialist	14
92A	TBD	12

Data Collection Procedure

The data for this application were collected in two ways. For MOS 76C, 76P, 76V, 76X, and 76Y, the data were collected in a workshop setting. The SMEs were given a brief introduction to the JSERT effort and then were given verbal instructions on completing the JRI. These instructions explained how they were to follow the decision flow-charts and make ratings on the time spent and relative importance scales. The SMEs were also reminded that not all activities can make up "75-100%" of soldiers' time within the MOS and that all activities cannot be of "very high importance" to overall MOS performance. These last two reminders were administered in order to reduce potential problems of rating inflation. The JRI was then completed by the SMEs and turned over to HAY Systems, Inc. (HSI) for analysis.

The activity requirements for MOS 92A were collected using a mail-out/ return procedure. Detailed instructions on how to complete the JRI (a copy of these instructions are contained in Appendix B) were first prepared. These instructions captured all of the information that was presented verbally for the other MOS. The instructions and copies of the JRI were sent to a point of contact (POC) at Ft. Lee, who then distributed the materials to the SMEs. The SMEs completed the JRI according to the instructions and returned the completed forms to the POC. The POC then forwarded the completed JRIs to HSI for analysis.

For both types of data collections the final dependent variable that was used in subsequent analyses was a combination of

the time spent and importance ratings. The two ratings were multiplied to obtain a strength rating for each activity (e.g., strength for activity i = [time spent]_i X [importance]_i). This equation provided a combination of the two ratings which gives more weight to high ratings. This was desired to ensure that key activities within the MOS received a high strength index.

All data collections were conducted using the JRI, the instrument for obtaining the basic requirements information. Analyses of what tests should be potentially considered to select and classify personnel into these MOS were accomplished using the TSP. The TSP uses the data produced by the JRI and thus did not need a separate data collection. In this manner, the SMEs were only asked questions about what must be accomplished by the MOS and not questions about human abilities that might be beyond their area of expertise.

Results and Discussion

Reliability analysis. Our first step in analyzing the data from application one was to determine the reliability of the SMEs' data. If these data were not found to be psychometrically reliable, the procedure would not have been producing sound data, and there would be no reason to proceed further.

In order to measure the reliability of the SME's ratings, we calculated the intraclass correlation coefficient (ICC) of the ratings for each MOS in the test sample. This particular form of the ICC we used was α_k which measures the reliability of the mean rating for a group of k raters (James, Demaree, & Wolf, 1984). Since subsequent analyses would use the mean ratings, we judged α_k to be the proper measure of reliability.

The α_k ICC is calculated from the results of analysis of variance (AN.VA). In this case, we first conducted Rater X Activity Block ANOVAs using the strength index defined above as the dependent variable. The outputs from these ANOVAs were used to determine ICC reliability measures according to the following formula:

$$ICC = \frac{(\text{Mean Square Activity Block}) - (\text{Mean Square Error})}{(\text{Mean Square Error})}$$

Table 6 on the next page gives the results of this reliability calculation for all of the MOS in application test one.

Table 6

Application Test 1: JRI Reliability Analysis

	76C	76P	76V	76X	76Y	92A
No. of Raters	7	11	9	10	14	12
Mean Square - Block	614	1016	644	662	1194	540
Mean Square- Error	104	145	138	179	116	115
ICC (Reliability)	0.83	0.86	0.79	0.73	0.90	0.79

In general, the reliabilities shown in Table 6 are consistently high. The average reliability is .82. In this respect, the JRI compares quite favorably to other requirements procedures such as the Fleishman ability taxonomy (e.g., Olson & Hanser (1983); Mallamad, Levine, & Fleishman, 1980), which found reliabilities ranging from .48 to .78¹. These high reliabilities suggest that the JRI produces stable data and its output can be used to make meaningful personnel decisions when about ten (seven to twelve) raters are used to provide the requirements data.

Analysis of MOS activity requirements. Most users of the JRI would skip the analysis of reliabilities and proceed directly to the analysis of MOS or job requirements, as that is the primary function of the model. The first step in the analysis of MOS activity requirements is to obtain the mean strength value for each activity block for each job being investigated. These mean values are the basis for all subsequent job requirements analyses.

The analysis of job requirements has two major objectives. First, it is necessary to find how similar or dissimilar are the various jobs, in order to decide which may be combined. Second, the requirements for a single job or a set of jobs should be studied to find the "high driver" or most critical activities since these activities should be the basis for further selection or classification testing. We think that the data from the JRI should be used in two different ways when addressing these issues.

The first of these ways is the plotting of an abilities requirements profile for the jobs or MOS under analysis. An example of such a profile, developed from the Quartermaster School data, is shown in Figure 5.

The requirements profile is produced by plotting the mean strength values for each activity block. When the data from several MOS jobs are combined onto a single plot, a profile emerges that shows where the jobs are similar and where they are different. For example, in Figure 5 the requirements for block A2 (input from representational sources) is very similar for all of the MOS, but the MOS differ considerably with regard to how much block D3 (setting) is a part of their job. The requirements profile can also be used to identify the higher driver activities for an MOS by observing which of the blocks has the highest mean score. For example, in the case of the hypothetical MOS 92A, the profile indicates that its most critical activities would be S1 (searching for/receiving information) and C1 (communication).

¹ We should note that the Mallamad, Levine, & Fleishman, (1980) research only used five raters in obtaining their ratings.

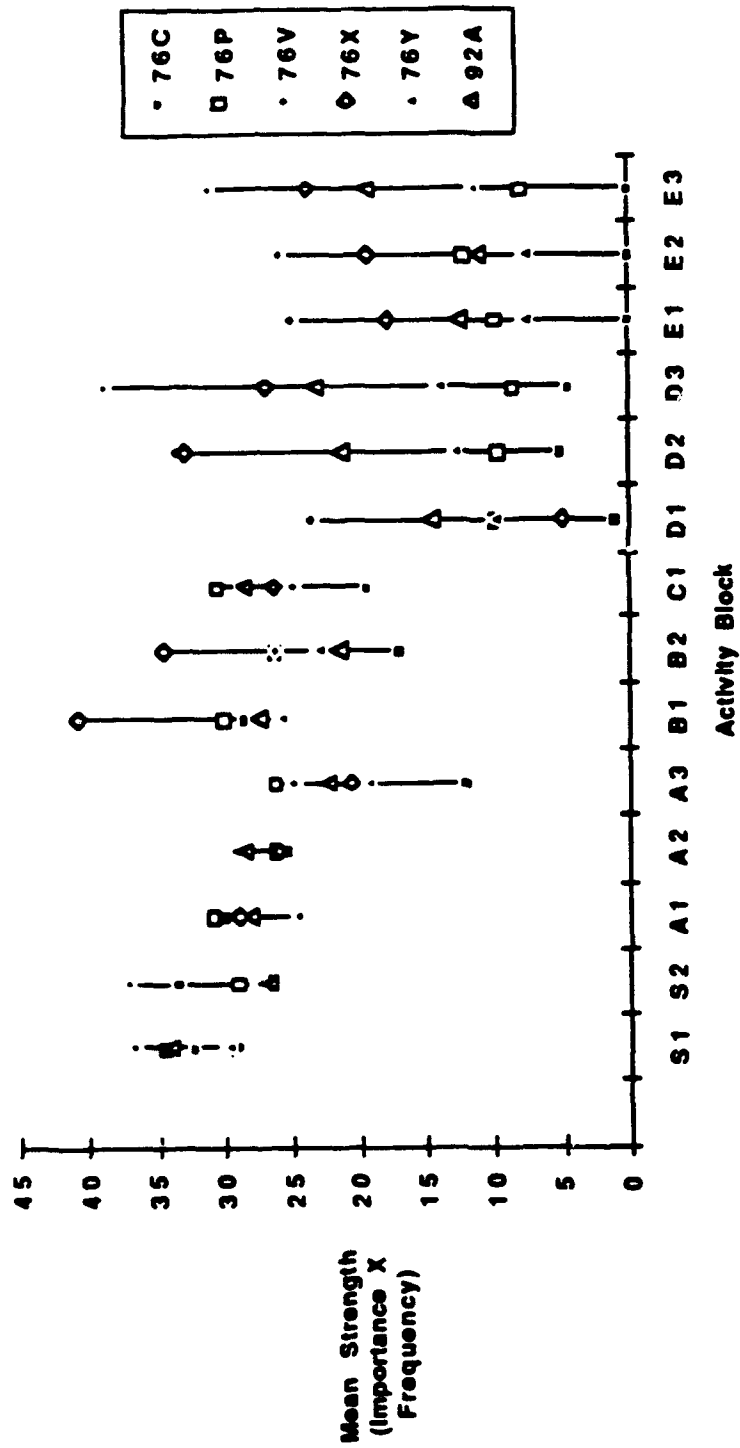


Figure 5. Application 1 JRI Requirements Profile

The second way to use the data produced by the JRI is to compute a MOS difference matrix. A difference matrix shows how close each MOS is to all the other MOS in terms of its requirements. Table 7 shows an example of a difference matrix, based upon the Quartermaster School data.

Table 7

Application Test 1: JRI Difference Matrix

	76C	76P	76V	76X	76Y	92A
76C	-					
76P	6	-				
76V	15	11	-			
76X	12	8	7	-		
76Y	6	11	11	8	-	
92A	9	5	7	6	4	-

As its name implies, the difference matrix looks at the differences between MOS in terms of their JRI requirements. Each cell in the matrix is computed according to the following formula:

$$\text{Diff}(\text{job}[x] - \text{job}[y]) = \text{Average over all blocks}_i (\text{absolute value} [\text{block}_{ix} - \text{block}_{iy}])$$

For example, the difference cell comparing MOS 76C to 76P in Table 7 was computed by first calculating the absolute value of the difference in strength scores between the two MOS for each JRI activity block. These values are then averaged together to get the overall difference score. The smaller the value the value of the difference score the more similar the MOS are to each other in terms of their basic activities. MOS pairs with small difference scores are good candidates for membership in a JSERT job set.

In fact, we feel that the difference matrix is particularly useful tool in defining job sets. For example consider the data in Table 7. The average difference score across all of the entries for the five existing MOS in this table is 9.50. Assume that one wishes to organize these five MOS into two JSERT job sets. An analyst could compare different combinations of MOS pairing until a solution is reached that has the smallest average difference score. For example, a job set consisting of 76C, 76P, and 76Y would have an average difference score of 7.76, while the set made up of the remaining two MOS (76V and 76X) would have an average difference score of 7.00. Each of these job set averages is less than the overall average of 9.50. This finding indicates that the MOS within the two job sets are more similar to each other than to the MOS in the other set. Thus, the two job sets

make sense from the perspective of similarities among the requirements in performing the job.

TSP analysis. As noted earlier, TSP applications are based upon JRI data and do not require a separate reliability analysis, so its workings can best be discussed as an example. In this case, we will assume that one wished to use the TSP to identify tests to select and classify persons into MOS 76V and 76X which are assumed to comprise a JSERT job set.

Referring to Figure 3, the starting points for the TSP application are the key activity requirements for that MOS from the JRI analysis. Examination of Figure 5 shows that for MOS 76V the seemed the critical component appears to be D3 (setting), while for MOS 76X the primary component is B1 (information processing). We shall, therefore, use these requirements as the foundations for the TSP analytic example.

Figure 3 indicates that the next step in applying the TSP is to identify ability constructs. Table 3 indicates that the ability constructs that best predict D3 (setting) are technical, speed, spatial, and psychomotor ability, so these are the abilities that are key to performance in MOS 76V. On the other hand, the construct of B1 (information processing) is best predicted by numeric ability, speed and spatial ability and these abilities are critical for MOS 76X performance. Since MOS 76V requires technical and psychomotor ability and MOS 76X does not, these abilities should be the basis for classifying soldiers into this MOS. Likewise, since MOS 76X requires numeric ability while 76V does not, this ability should be the basis for entry into that MOS.

The next step (see Figure 3) is to find ways of measuring these abilities. Reference to Table 2 shows that the factors of technical and numeric ability can both be measured from ASVAB so there would be no need to conduct special testing to obtain measures of these abilities. The factor of psychomotor ability, however, is not part of the ASVAB and would require the Project A tests, if it is to be measured.

The first TSP criterion for selecting a test from the Project A battery is uniqueness (vis a vis ASVAB). Inspection of Table 4 shows that under this criterion the Target Tracking 1 test would be selected to measure psychomotor ability. If additional testing time were available, further tests could be added to this battery to increase it's overall reliability and effectiveness.

To summarize the TSP analysis for the JSERT job set comprising MOS 76V and 76X, we would suggest that soldiers be classified into MOS 76V based upon their scores on the ASVAB technical subtests and the Project A developed test Target

Tracking 1. The ASVAB numeric subtests could be used to classify personnel into MOS 76X.

Application test one summary.

Our first test of the JRS process was quite successful. The procedure was found to be highly reliable and was useful in making meaningful decisions regarding MOS groupings and requirements. However, in order to gain additional information on the utility of the procedure, we decided to proceed with a second application or test.

Application/Test Two

Sample

The second test of the JRS was based upon data collected at the U.S. Army Ordinance School at Aberdeen Proving Ground MD. Table 8 lists these MOS and gives the number of raters who analyzed each one for this application.

Table 8

Application Test One: MOS and Sample Sizes

MOS	Name	Number of Raters
41C	Fire Control Instrument Repairer	9
45B	Small Arms Repairer	2
45G	Fire Control Systems Repairer	11
45K	Tank Turret Repairer	12
45L	Artillery Repairer	8

These jobs were existing MOS and were analyzed by Subject Matter Experts, SMEs, who were instructors at the school and had at least two years experience working with the MOS.

Data Collection Procedure

The data for this application were all collected in a workshop setting. The SMEs were given a brief introduction to the JSERT effort and then were given verbal instructions on completing the JRI. These instructions explained how to follow the decision flow-charts and make ratings on the time spent and relative

importance scales. The SMEs were also reminded that not all activities can make up "75-100%" of soldiers' time within the MOS and that all activities cannot be of "very high importance" to overall MOS performance. Again, these last two reminders were administered in order to reduce potential problems of rating inflation. The JRI was then completed by the SMEs and turned over to HAY Systems, Inc. (HSI) for analysis.

As was the case in the first application/test, for each activity block the two ratings (time spent and importance) were multiplied to obtain a strength rating for each activity (e.g., strength for activity i = [time spent]_i X [importance]_i).

Results and Discussion

Reliability analysis. ICC reliabilities were calculated for the Ordinance School JRI using the same procedure and formula that were utilized in application one. The resulting reliabilities for these data are shown in Table 9.

Table 9

Application/Test 2: JRI Reliability Analysis

	41C	45B	45G	45K	45L
No. of Raters	9	2	11	12	8
Mean Square - Block	436	180	310	351	700
Mean Square- Error	131	148	116	109	175
ICC (Reliability)	0.70	0.18	0.63	0.69	0.75

These reliabilities are not as high as those obtained in the first application. (One reason for this finding may be that the data collection was conducted towards the end of the day and the SMEs were very anxious to leave.) Still, if one ignores the data from MOS 45B, which had only two raters, the average reliability was .69, which is still respectable.

Analysis of MOS activity requirements. The analyses of the Ordinance School MOS requirements were conducted using the same procedures described in the discussion of application one. The abilities requirements profile for these data are shown in

Figure 6 (on the following page), while Table 10 presents the difference matrix².

Table 10

Application Test 2: JRI Difference Matrix

	41C	45B	45G	45K	45L
41C	-				
45B	5	-			
45G	6	6	-		
45K	4	7	5	-	
45L	8	7	6	6	-

As was the case with the data from the previous application, one way of deciding upon possible job set groupings of MOS based upon the JRI data is to compare the mean difference score for a group to the overall mean of all difference scores. In this case, the mean of all the scores in Table 10 (excluding the unreliable data from MOS 45B) is 5.83. Alternative groupings of MOS can be compared to this mean value. If a group is composed of MOS who are similar, its mean group difference score should be less than the overall value.

For example consider an MOS set consisting of 41C, 45G, and 45K. Taking the difference scores for all comparisons among these MOS (41C & 45K, 41C & 45G...) from Table 10 we see that the mean difference score for this job set is:

$$\text{Mean Diff} = \frac{6.0 + 4.0 + 5.0}{3} = 5.0$$

Since the job set mean of 5.0 is less than the overall mean 5.83, this job set must be grouping MOS with similar requirements as defined by the JRI.

² We should note that while the data from MOS 45B is included here for the sake of completeness, the low sample size and resulting poor reliability for this MOS make any conclusions based upon its data tenuous at best.

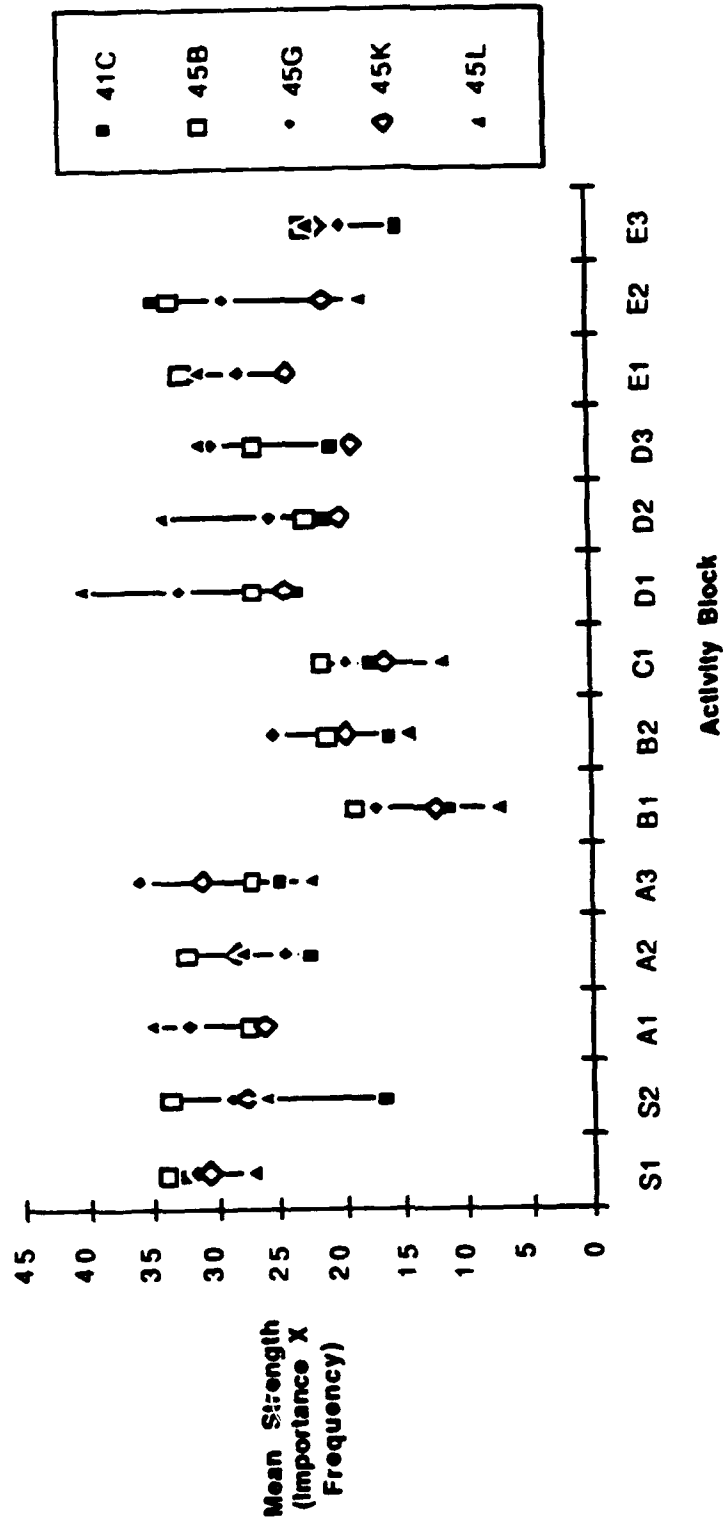


Figure 6. Application 2 JRI Requirements Profile

Other groupings of MOS into job sets do not meet this criteria. For example, a small job set, being considered by the Ordinance School, partially consists of MOS 45K and 45L³ would have a mean difference score of 6.00, which is larger than the 5.83 value for the overall mean. According to our analyses, therefore this job set is grouping together relatively dissimilar MOS.

TSP analysis. One of the primary design functions of the TSP was to identify tests that could be used to select and classify personnel into individual MOS from within a job set. The data collected at the Ordinance School permits a test of that function.

Assume that the job set consisting of MOS 41C, 45G, and 45K, discussed above, has been defined, and one wishes to choose tests to select and classify personnel into these MOS. Using the TSP procedure (see Figure 4) the first step in the process would be to identify the high driver requirements for these MOS. Looking at their abilities requirements profile (Figure 6), we see that for MOS 41C the high driver activity is E2 (aligning/ synchronizing) and the high driver activity for MOS 45G is A3 (use of miscellaneous equipment/devices). MOS 45K does not have a clear high driver activity, so special tests to select or classify personnel into it would be less useful.

Table 3 tells us that the activity of aligning/synchronizing requires primarily spatial ability, so the selection/classification for MOS 41C should measure that ability. Table 4 indicates that the Object Rotation Test from Project A is a good measure of this ability. This test has high uniqueness (vis a vis ASVAB), is quite reliable, and can be completed in a reasonable amount of time.

Turning to MOS 45G, Table 3 indicates that a number of abilities are required for its key activity, use of miscellaneous equipment/devices. These abilities include numeric, technical, speed, spatial, and psychometric constructs. However, the heaviest weighted construct is that of technical ability. Since ASVAB scores on the technical composite are already available, further testing would not be needed.

³ The set being considered by the Ordinance School also includes MOS 45B. However, as mentioned above, sample size restrictions rendered our data from that MOS not reliable and could not be included in any of our analyses,

Summary and Conclusions

The JRS procedure has shown that it has potential utility within the JSERT concept and applications. The procedure has acceptable reliability with relatively small sample sizes. It can define the requirements for individual MOS and provide a basis for grouping MOS into sets. Its TSP module can be used to recommend psychometric tests to select and classify personnel into those MOS. Furthermore, our post-briefs with the SMEs who provided data through the procedure indicate that it is easy to use and understand.

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Appendix A
The Job Requirements Index (JRI)

Job Analysis Flowcharts

MOS 41C-Fire Control Instrument Repairer

The fire control instrument repairer performs and supervises intermediate maintenance on fire control instruments and related equipment. Duties for MOS 41C at skill level 10 are: Performs maintenance in intermediate maintenance units on fire control instruments and related equipment. (From AR 611-201)

MOS 45G-Fire Control Systems Repairer

The fire control system repairer performs and supervises intermediate maintenance on combat vehicle fire control systems and related test equipment. Duties for MOS 45G at skill level 10 are: Performs intermediate maintenance on fire control systems and related equipment mounted in combat vehicles. (From AR 611-201)

MOS 45K-Tank Turret Repairer

The tank turret repairer performs and supervises intermediate maintenance on turret mechanisms and weapons of tanks, cupolas, and similar materiel, and supervises intermediate maintenance of towed artillery, self-propelled artillery, and small arms. Duties for MOS 45K at skill level 10 are: Performs intermediate maintenance on turret-mounted weapons and mechanisms such as loading, firing, and recoil mechanisms, turret-cupola hydraulic systems, and wiring systems. (From AR 611-201)

MOS 45B-Small Arms Repairer

The small arms repairer performs intermediate maintenance repair and limited overhaul of small arms and other infantry weapons. Duties for MOS 45B at skill level 10 are: Performs intermediate maintenance on small arms. (From AR 611-201)

MOS 45L-Artillery Repairer

The artillery repairer performs and supervises intermediate maintenance on artillery turrets and similar materiel. Duties for MOS 45L at skill level 10 are: Performs intermediate maintenance on light, medium, and heavy self-propelled artillery and component turret mechanisms, towed artillery, air defense artillery, and similar materiel. (From AR 611-201)

MOS with which you are most familiar _____

How long (years) have you worked with this MOS? _____

MOS with which you are next most familiar _____

How long (years) have you worked with this MOS? _____

Does the Job Depend on Speed and Accuracy of Perceptual Processing?

Definitions for Block:

S1. Searching for/Receiving Information

- **Checking** —→ **Testing, examining, or making sure of for correctness or good condition**
- **Detecting** —→ **Discovering the presence of**
- **Inspecting** —→ **Examining carefully and critically**
- **Looking** —→ **Focusing one's gaze or attention**
- **Observing** —→ **Watching attentively**
- **Scanning** —→ **Looking over or through quickly**
- **Surveying** —→ **Examining or looking over comprehensively**

S2. Identifying Objects, Actions, and Events

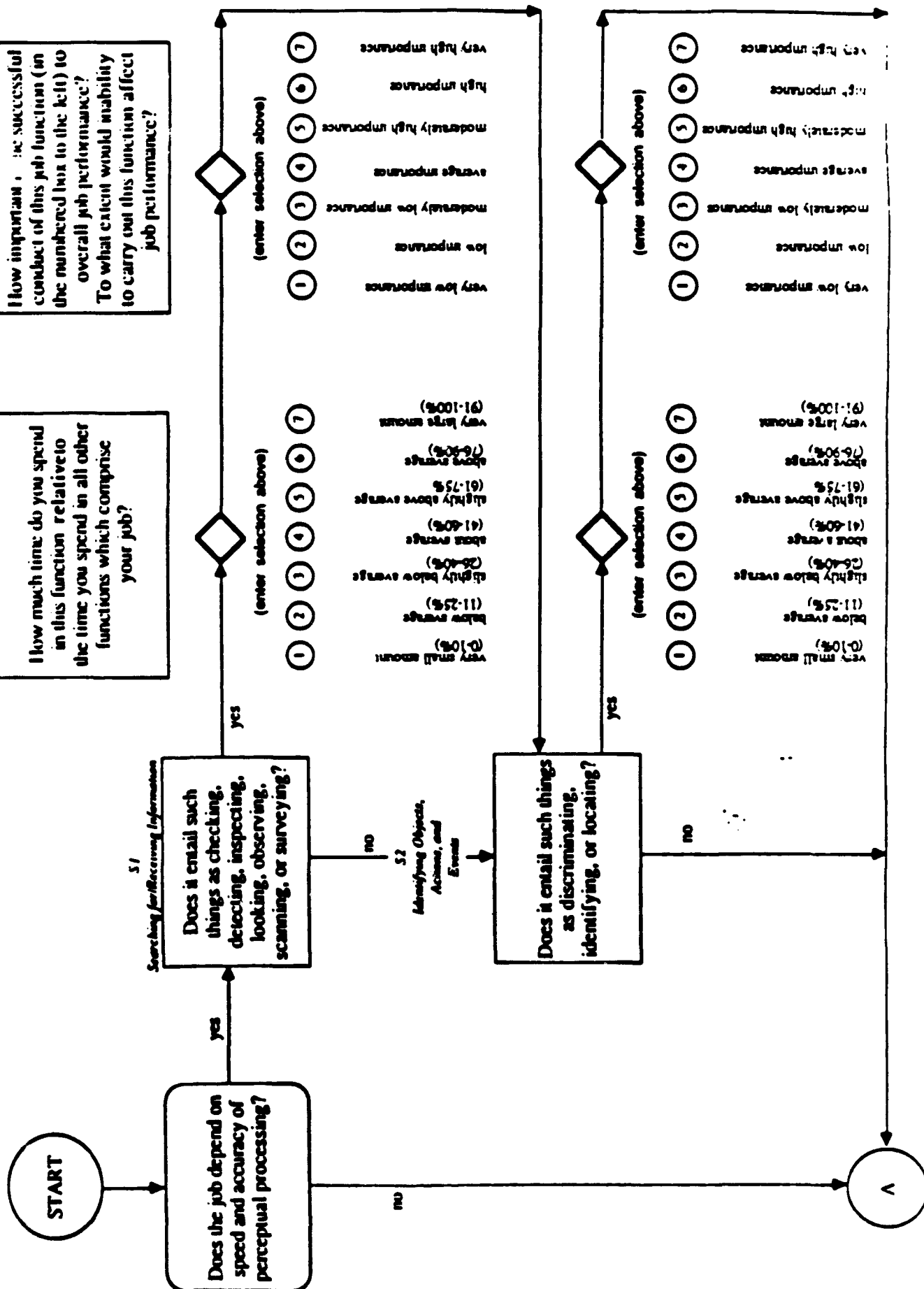
- **Discriminating** —→ **Distinguishing; differentiating**
- **Identifying** —→ **Establishing the identity of**
- **Locating** —→ **Determining or specifying the position of**

Time Spent

Relative Importance

How much time do you spend in this function relative to the time you spend in all other functions which comprise your job?

How important is the successful conduct of this job function (in the numbered box to the left) to overall job performance? To what extent would inability to carry out this function affect job performance?



Does the Job Depend on Effective use of Specialized Information or Technical Equipment?

Definitions for Block:

A1. Use of Job-Related Knowledge

- **Job-related Knowledge** —————→ Information, ideas, or understanding about a job gained through experience, observation, or study

A2. Input From Representational Sources

- **Written Materials** —————→ Books, reports, articles, manuals, instructions, signs, etc.
- **Quantitative Materials** —————→ Graphs, specifications, tables, etc.
- **Pictures** —————→ Drawings, photographs, blueprints, maps, television pictures, etc.

A3. Use of Miscellaneous Equipment/Devices

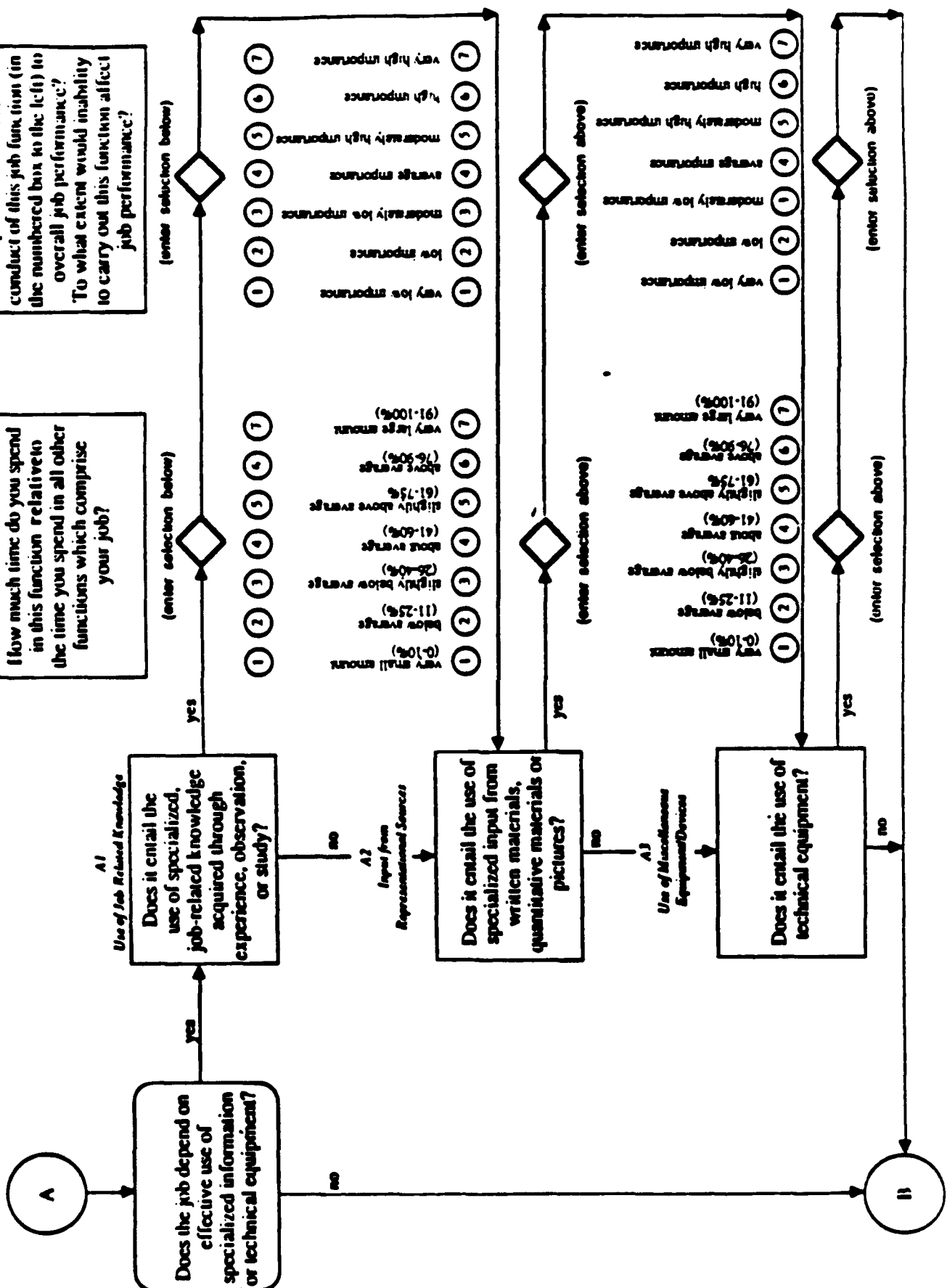
- **Use of Technical Equipment** —————→ Any specialized equipment used in performing a job, e.g., hand tools (hammer, wrench, screw driver), surgical gloves, measurement devices, (compass, protractor)

Time Spent

Relative Importance

How important is the successful conduct of this job function (in the numbered box to the left) to overall job performance? To what extent would inability to carry out this function affect job performance?

How much time do you spend in this function relative to the time you spend in all other functions which comprise your job?



Does the Job Depend on Speed and Accuracy in Manipulating Information?

Definitions for Block:

B1. Information Processing

- **Calculating** → Finding or determining by using mathematics; computing
- **Categorizing** → Putting into categories; classifying
- **Interpolating/Extrapolating** → Determining the value of (a function) between known values (interpolate); estimating the value of (a function) greater or smaller than known values (extrapolate)
- **Itemizing** → Setting down item by item; listing
- **Memorizing** → Committing to memory or holding in memory through active rehearsal
- **Translating** → Changing or carrying forward from one form to another; converting

B2. Problem Solving and Decision Making

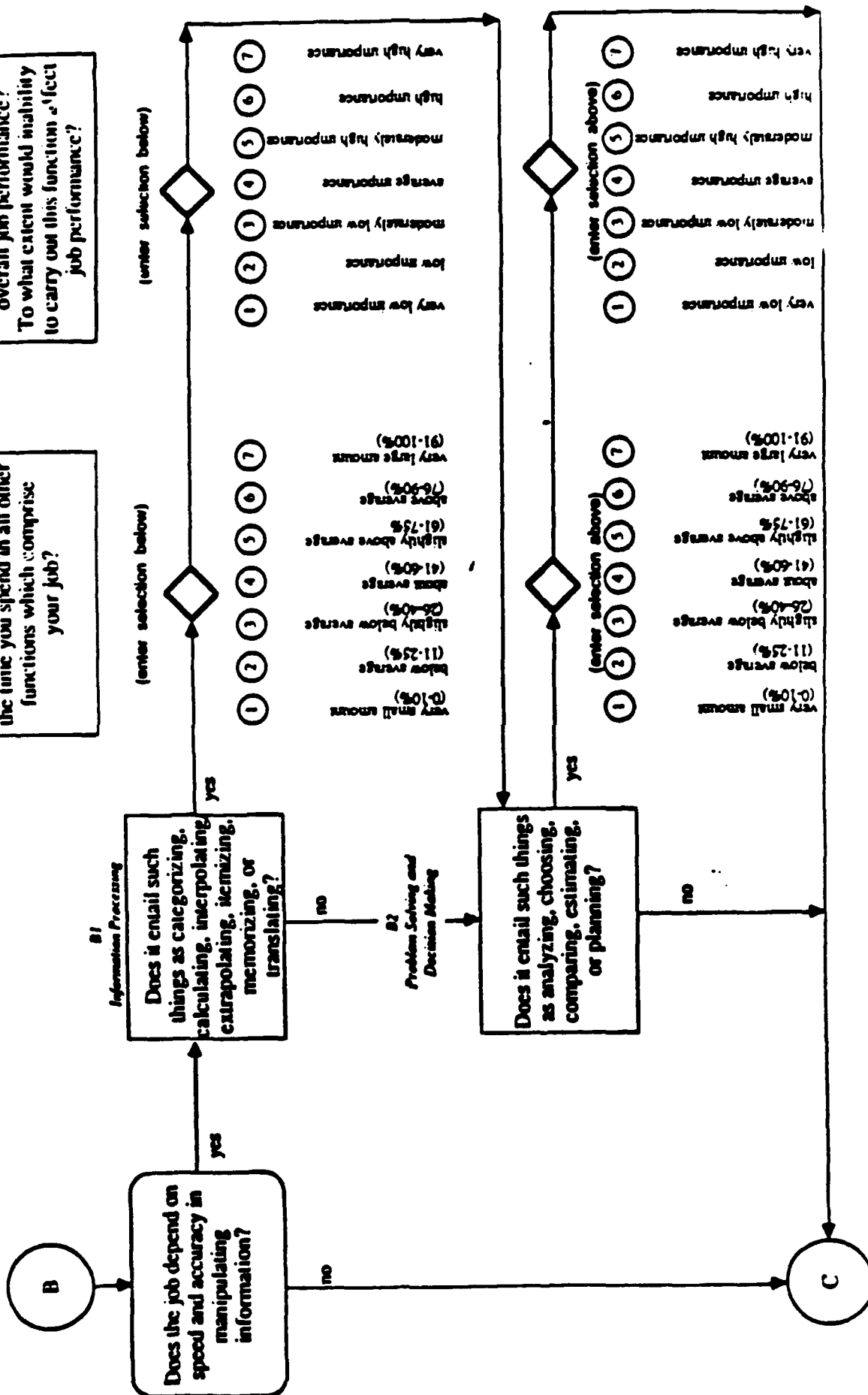
- **Analyzing** → Breaking up any whole, such as an idea, condition, event, etc., into its parts in order to study them individually so as to determine their nature, significance, or function
- **Choosing** → Selecting from a number of possible alternatives; deciding upon and picking out
- **Comparing** → Examining in order to note the similarities or differences of
- **Estimating** → Making judgement as to the likely or approximate cost, quantity, or extent of
- **Planning** → Thinking out ahead of time

Relative Importance

How important is the successful conduct of this job function (in the numbered box to the left) to overall job performance? To what extent would inability to carry out this function affect job performance?

Time Spent

How much time do you spend in this function relative to the time you spend in all other functions which comprise your job?



Does the Job Depend on Effective use of Communication Processes?

Definitions for Block:

C1. Communication

- **Advising** —————→ **Recommending; suggesting**
- **Instructing** —————→ **Furnishing with knowledge; teaching, educating**
- **Requesting** —————→ **Asking for; expressing a desire for**
- **Transmitting** —————→ **Sending from one person, place, or thing to another; conveying**

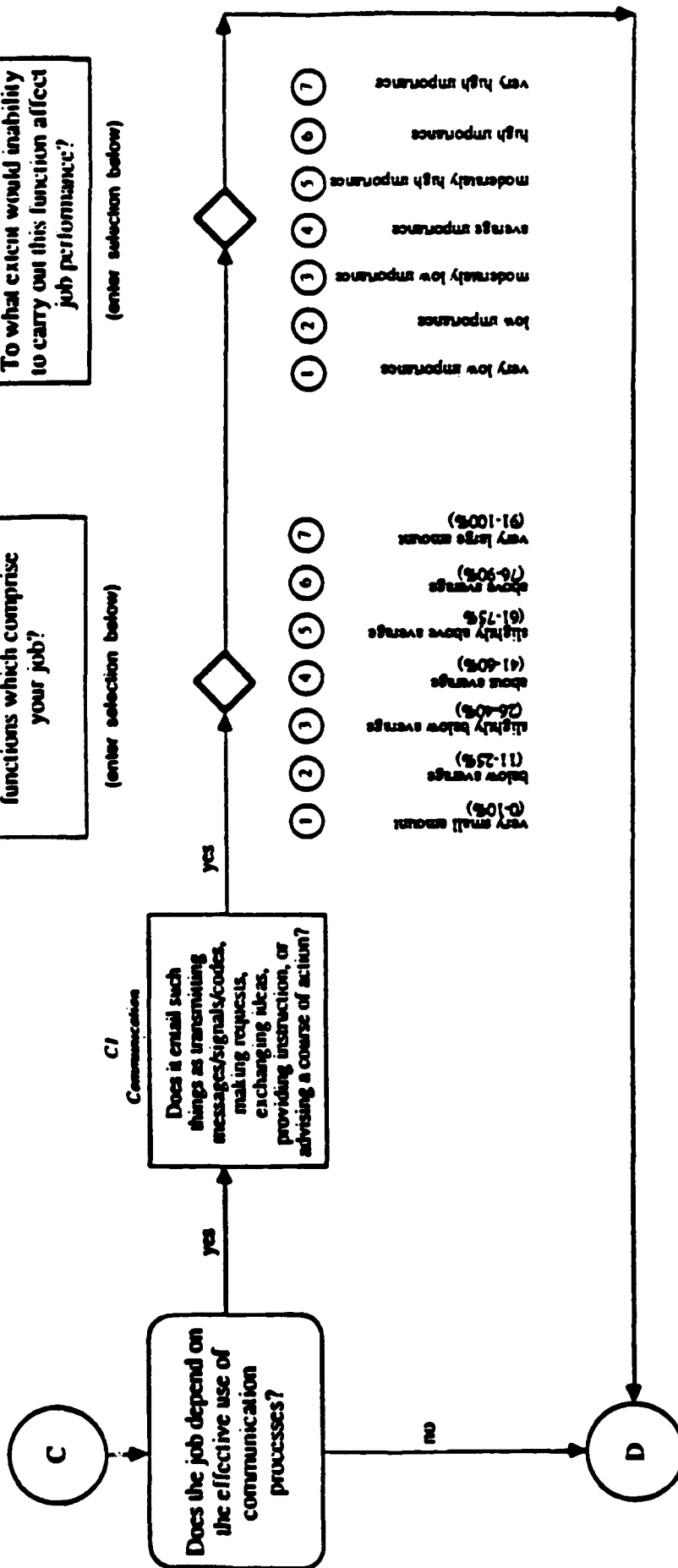
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Time Spent

How much time do you spend in this function relative to the time you spend in all other functions which comprise your job?

Relative Importance

How important is the successful conduct of this job function (in the numbered box to the left) to overall job performance? To what extent would inability to carry out this function affect job performance?



Does the Job Depend on Speed and Accuracy of Motor (Movement) Processes?

Does it entail making discrete movements (i.e., movements with a distinct beginning and end) or series of discrete movements (e.g., procedural motor tasks)?

Definitions for Block:

D1. Connecting

- **Assembling** —→ Fitting or joining together the parts of
- **Inserting** —→ Putting or setting into, between, or among another or other things
- **Installing** —→ Putting in position and connecting for use
- **Fastening** —→ Attaching firmly to; joining; connecting
- **Tying** —→ Fastening or securing with a cord, rope, strap, etc.

D2. Moving

- **Closing** —→ Shutting
- **Lifting** —→ Carrying from a lower to a higher position; raising; elevating
- **Pulling** —→ Applying force to so as to cause or tend to cause motion toward the source of the force
- **Removing** —→ Moving from a position occupied

D3. Setting

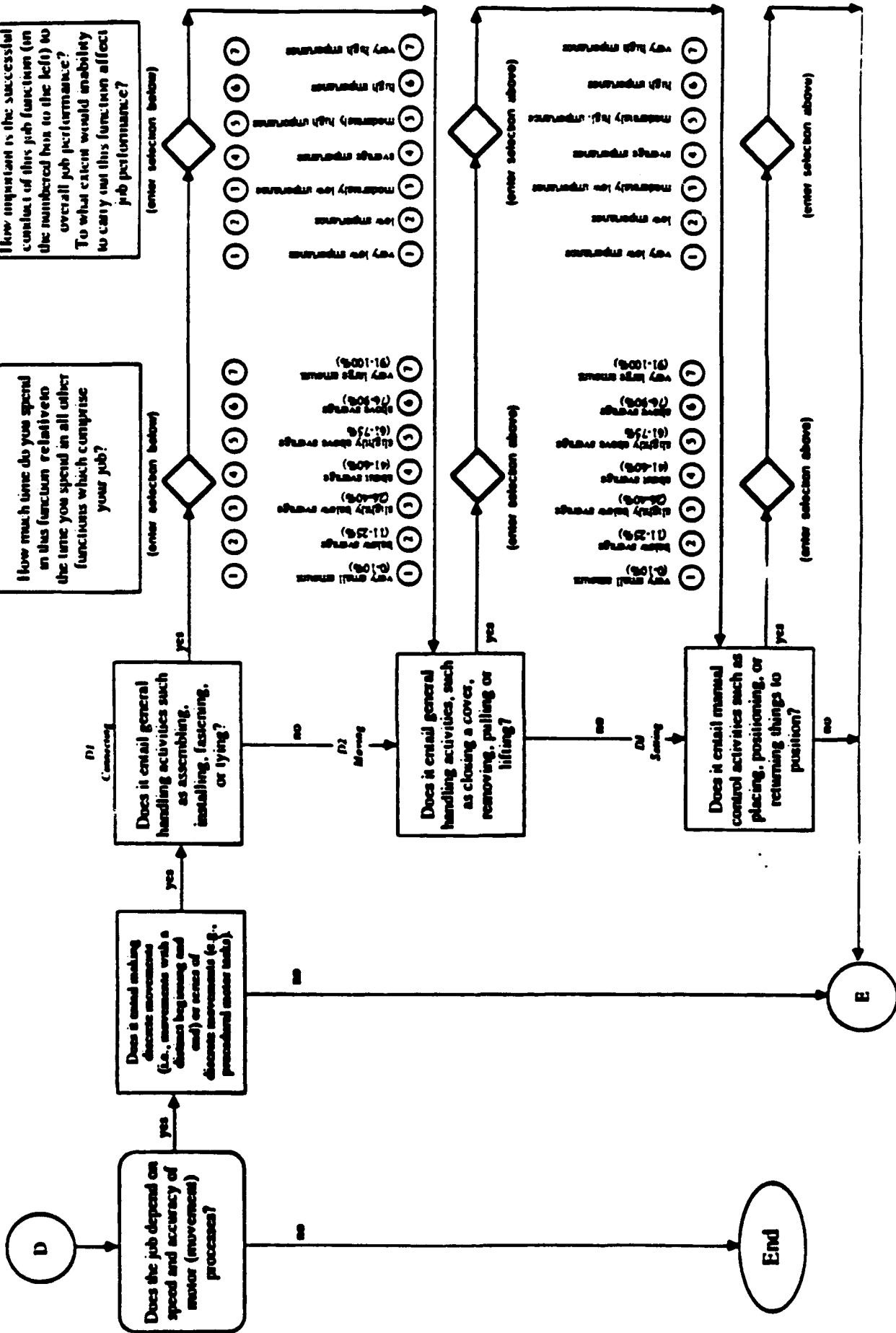
- **Placing** —→ Putting in some particular place
- **Positioning** —→ Placing in proper position

Time Spent

Relative Importance

How much time do you spend in this function relative to the time you spend in all other functions which comprise your job?

How important is the successful conduct of this job function (in the numbered box to the left) to overall job performance? To what extent would inability to carry out this function affect job performance?



Does the Job Depend on Speed and Accuracy of Motor (Movement) Processes?

Does it entail adjusting machines or equipment to prepare them to perform their functions, change their performance, or restore their proper functioning if they break down?

Definitions for Block:

E1. Adjusting

- **Adjusting** —————→ **Bringing into proper relationship; correcting**

E2. Aligning/Synchronizing

- **Aligning/
Synchronizing** —————→ **Bringing into or arranging in a straight line (aligning);
operating in unison (synchronizing)**

E3. General Body Activity Versus Sedentary Activities

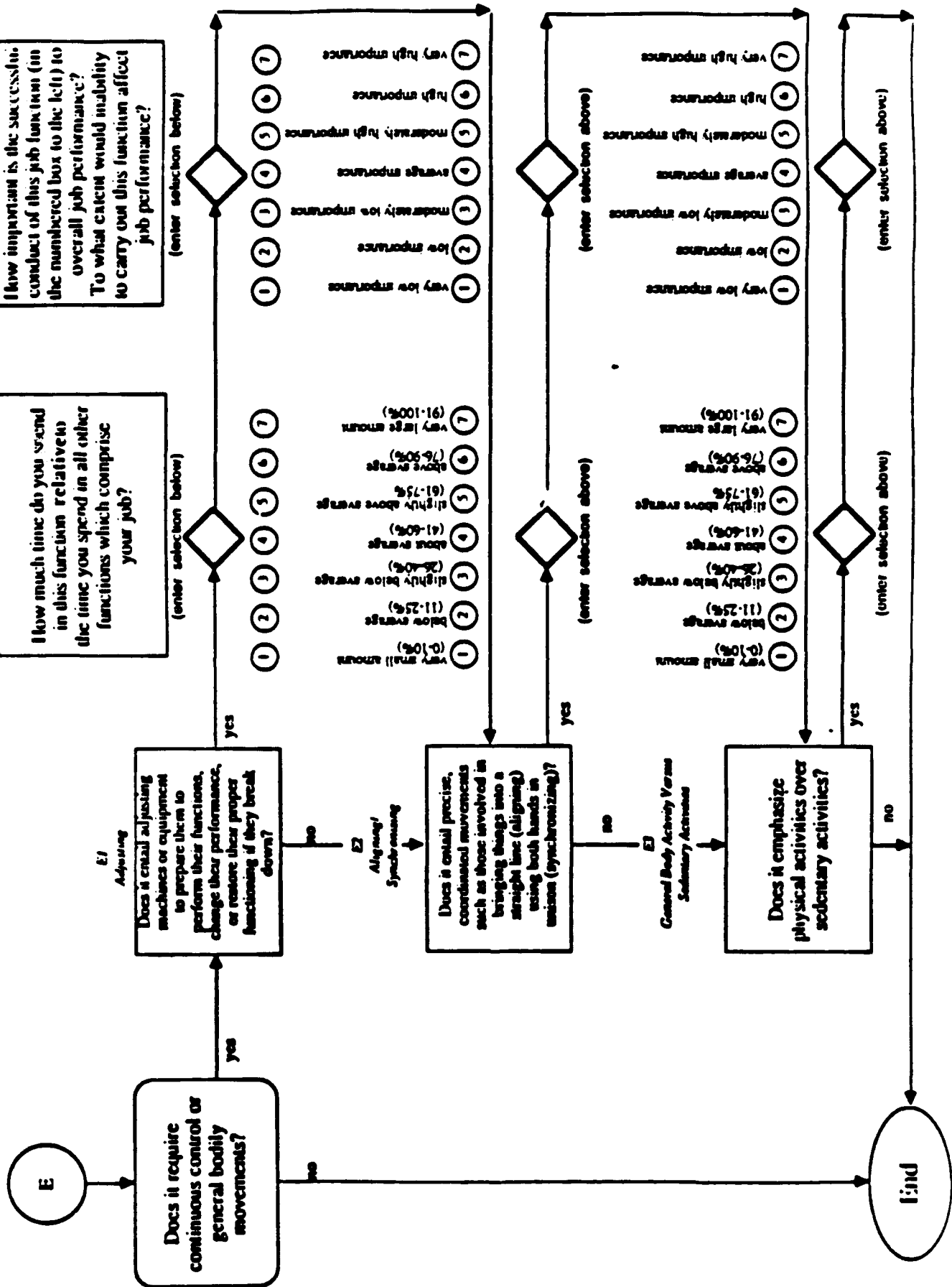
- **Physical Activity** —————→ **Putting in some particular place**
- **Sedentary Activity** —————→ **Placing in proper position**

Time Spent

How much time do you spend in this function relative to the time you spend in all other functions which comprise your job?

Relative Importance

How important is the successful conduct of this job function (in the numbered box to the left) to overall job performance? To what extent would inability to carry out this function affect job performance?



Appendix B
JRI Instructions

INSTRUCTIONS FOR THE JOB ANALYSIS FLOW CHART

Introduction

The Job Analysis Flow Chart is designed to assist you in completing the required job analysis. The flow chart presents a series of questions about fourteen specific job functions described in the rectangles. It is up to you to:

- Say whether or not soldiers perform that function as part of their job,
- Rate, using the first scale provided on each flow chart, the relative amount of time they spend in the function, and
- Rate, using the second scale provided on each flow chart, the relative importance of the function.

Definitions are provided to assist you in completing the job analysis flow chart. The terms are defined as they are used in the flow chart. The definitions are located on the opposite page from the flow chart in which the terms are presented. This should assist you as you follow the flow charts.

Step-by-step Instructions

Fill out the job analysis flow chart data sheet by following these steps:

1. Enter background information.
 - a. On one of the blank job analysis flow chart data sheets write down your name and rank in the upper right hand corner of the first page.
 - b. On the bottom of the page indicate which of the MOS listed on the page you know the best. Then indicate how many years of experience you have had with that MOS. Next indicate which MOS you know the next best and how long you have worked with it.
 - c. Open the data sheet and begin the job analysis at the circle labeled:



2. Decide whether each function will be part of the soldier's job for the MOS that you are analyzing.
- Follow the arrows and answer the questions in the blocks as you encounter them.
 - For all the blocks with a label above them, such as that shown below, examples of the activity described within the block are presented on the page facing the flowchart. These examples may help you in deciding whether or not a soldier in the MOS will need to perform that function.

SI
Searching for/Receiving Information

Does it entail such things as checking, detecting, inspecting, looking, observing, scanning, or surveying?

- If you think a soldier in the MOS will perform the function described in the block, circle the "yes" next to the block. If a soldier in the MOS will not perform the function, circle the "no".
 - If you circle "no," go on to the next function on the flow chart.
 - If you circle "yes," rate "Time Spent" and "Importance" as described in sections 3 and 4 of these instructions. Then follow the arrows to the next function on the flow chart.
 - Repeat this process until you have completed all of the analysis.
3. If a soldier in the MOS will perform a function, rate the relative amount of time spent.
- On the scale like that shown on the next page, rate the time the soldier spends in each job function relative to the time he/she spends in all other functions which will comprise the MOS.
 - Be sure to consider the entire job when assigning a time spent rating. For each function, choose the number on the scale that corresponds to your best estimate of how much time is spent in the function.

Time Spent

How much time do you spend
in this function relative to the
time you spend in all other
functions which comprise
your job?



(enter selection above)

1
2
3
4
5
6
7

very small amount (0-10%)	below average (11-25%)	slightly below average (26-40%)	about average (41-60%)	slightly above average (61-75%)	above average (76-90%)	very large amount (91-100%)
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- c. Write in the appropriate number in the diamond above the line that says "enter selection above."
-
3. If a soldier will perform a function, rate how important that function will be to overall MOS performance.
 - a. Rate the importance of the function relative to all other functions. Ask yourself these questions: "How important will the successful conduct of this job function be to overall MOS job performance?" And, in turn, "To what extent would inability to carry out this function affect the soldier's job performance?"
 - b. Remember that there may be functions that will not be performed very often but are still very important for overall success in the MOS.
 - c. Consider the categories in the rating scale (an example is given below) and then write in the appropriate number in the diamond above the line that says "enter selection above."

Importance

How important is the successful conduct of this job function (in the numbered box to the left) to overall job performance?
To what extent would inability to carry out this function affect job performance?



(enter selection above)

① ② ③ ④ ⑤ ⑥ ⑦

very low importance

low importance

moderately low importance

average importance

moderately high importance

high importance

very high importance

Final instructions on the next page

Key Things To Remember When Making Ratings

- **All of the activities will not be relevant for a particular MOS**
- **Soldiers spend more time on some activities than others (e.g., A soldier cannot spend 100% of their time doing each activity)**
- **While many activities may be important for performance in an MOS only a few activities can be most important**