R & D TASK ACCOMPLISHMENT

AT A

U.S. ARMY MATERIEL COMMAND

CORPORATE LABORATORY

by

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S.M., Massachusetts Institute of Technology
(1951)

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENT FOR THE

DEGREE OF MASTER OF SCIENCE

at the

MASSACHUSETTS INSTITUTE OF

TECHNOLOGY

JUNE, 1972

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Alfred P. Sloan School of Management, May 12, 1972

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Chairman, Departmental Committee on Graduate Students

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"Submitted to the Alfred P. Sloan School of Management on May 12, 1972 in partial fulfillment of the requirements for the degree of Master of Science in Management."

ABSTRACT

It is commonly acknowledged that a large percent of the R & D effort expended by the Corporate Laboratories of the Army Materiel Command involves projects and tasks that, although militarily important, are relatively small in scope and dollar value. These particular projects and tasks are said to be especially vulnerable during their life-cycle to the wide range of difficulties and problems normally associated with R & D activities.

The general purpose of this thesis was to study the accomplishments of a large sample of typical R & D tasks at an AMC Corporate Laboratory in an effort to identify and bring into focus project officer and task characteristics and to relate in a meaningful and useful way major problems encountered and task outcomes. Task outcome was measured in terms of schedule, funding, scope of work, and technical quality.

Information about project officers and their tasks was obtained through the use of a two part questionnaire. A total of thirty-four project officers responded from three different government R & D laboratories located at one installation, all engaged in the development of end-items. The number of individual tasks reported on was sixty-four.

Characteristics of project officers and tasks were developed and are presented for both individual laboratories and all laboratories taken as a group. In addition, a general problem typology was developed and is included. Frequencies of major problems encountered by project officers were determined and related to task outcomes in tabular form. Some of the specific major findings are:

(1) Nearly all (97%) of the project officers considered "meeting technical goals" to be the most important factor regarding task accomplishment whereas only 33 percent felt the same factor was most important to their laboratories.

(2) Multiple sources are infrequently used by project offices in their development and selection of technical approaches for task accomplishment.

(3) Most of the stimulation for undertaking new tasks is the result of technical opportunities perceived for a new or improved end-item rather than the direct response to specific user (customer) requirements.

(4) About 90 percent of all tasks experienced schedule overruns and 60 percent funding overruns of some degree.

(5) As a group, project officers experienced technical problems more frequently than any other category. Next are schedule problems and user (customer) problems are third.

(6) Technical problems have a greater adverse impact on task outcomes than any other problem category.

Recommendations are made based on the findings of this study to enhance the accomplishment of small R&D tasks in the AMC Corporate Laboratory studied.

Thesis Supervisor: Donald G. Marquis
Title: Professor of Management

ACKNOWLEDGEMENT

I wish to express my appreciation to Professor Donald G. Marquis, who, as my thesis advisor, provided the encouragement and guidance throughout the preparation of the thesis. I also wish to express my thanks to Professor George F. Farris for his patience and understanding help which was so essential in the early development of the questionnaire used in the study.

My appreciation to the U.S. Army Natick Laboratories for the excellent support I received. Special thanks to Mo Gionfriddo, Irv Weitzler, and Mal Henry who gave so freely of their time during the preparation and processing of the questionnaire at NLABS.

My sincerest thanks also to the many anonymous project officers who contributed the body of data for the study.

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CHAPTER I

INTRODUCTION

The Army Materiel Command (AMC) with Headquarters in the Washington D.C. area is the Command within the Department of Army responsible for: research and development, procurement and production, test and evaluation, storage and distribution, and maintenance support for all weapons, equipment and supplies peculiar to the Army. The AMC organizational structure is shown in FIGURE I-1. The subordinate elements of the Command involved in R & D activities can be classed into three major groups; namely, project managers, corporate laboratories/centers and subcommands. There are five corporate laboratories/centers that report directly to Headquarters, AMC and conduct both basic and applied research that concerns more than one subcommand. Natick Laboratories (NLABS), the laboratory selected for study, is one of these five laboratories/centers. NLABS is located approximately twenty miles west of Boston, Massachusetts.

The basic mission of NLABS is oriented toward support of the soldier in-the-field. Its overall organizational structure is shown in FIGURE I-2. The three product (end-item) laboratories from which data were obtained are: the Airdrop Engineering Laboratory; General Equipment & Packaging Laboratory; and the Clothing & Personal Life Support Equipment Laboratory. Their specific R & D responsibilities

encompass the commodity areas of airdelivery equipment, containers, food service equipment, field support equipment, tentage and equipage, textiles, clothing, body armor, footwear, and organic materials.

The general purpose of this thesis is to study the accomplishments of a large sample of typical R & D tasks in a effort to identify and bring into focus project officer and task characteristics and to relate in a meaningful and useful way major problems encountered and task outcomes. Specific objectives are presented in CHAPTER II.

FIGURE I-1

ARMY MATERIEL COMMAND STRUCTURE

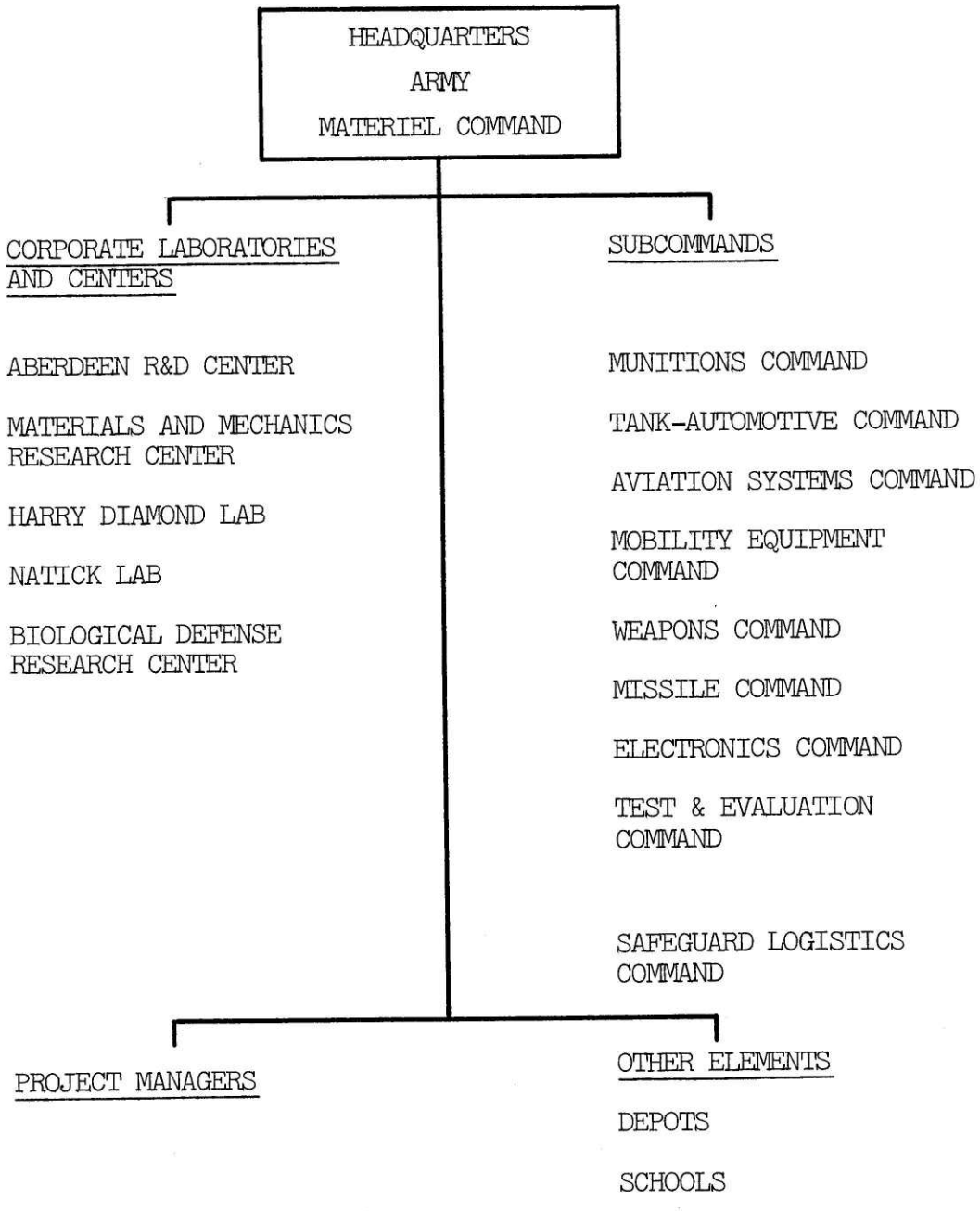
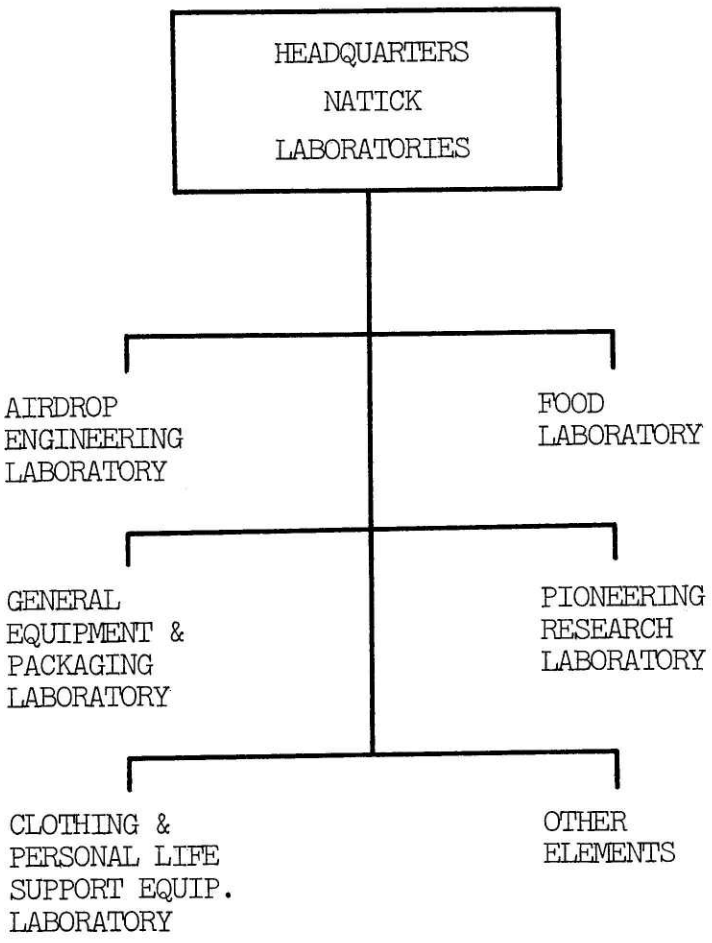


FIGURE I-2

NATICK LABORATORIES STRUCTURE



CHAPTER II

OBJECTIVES

A. Specific Objectives

The specific objectives of this thesis are as follows:

1. To develop characteristics of project officers assigned R & D tasks.
2. To develop characteristics of R & D tasks undertaken.
3. To determine if the selected three laboratories differ in regard to project officer and task characteristics.
4. To identify and categorize the major problems encountered by project officers in managing their tasks.
5. To determine relationships between major problems encountered and task outcomes (schedule, funding, scope of work, and technical quality).

B. Background

It is commonly acknowledged that a large percentage of the R & D effort expended by the corporate laboratories/centers of AMC involves projects and tasks that, although militarily important, are relatively small in scope and dollar value (a few million dollars and less). These particular projects and tasks are said to be especially vulnerable during their life cycle to the wide range of difficulties

and problems normally associated with R & D activities. For example:

1. Generally speaking, the information and control systems used to manage Army R & D activities were designed primarily for large projects and therefore tend to be less congruent with small project and task developments. As a result, there is a disproportionate administrative and cost burden frequently locked in the R & D process of small projects and tasks. Such a burden in turn serves to amplify funding and scheduling difficulties encountered and therefore can have an adverse impact on final outcome of small projects and tasks. In general discussions, project officers on small projects and tasks often indicate that they are required to spend an inordinate amount of their time on paperwork; thus, seriously limiting the time available "to get the technical job done."

2. Some small projects and tasks are liable to suffer excessively when competing for support provided by other government agencies, such as test agencies. The larger and more financially attractive projects usually are given preference when conflicts in demand for support arise. Also the overhead costs levied on small projects and tasks tend to be a larger fraction of the total cost of the support given.

3. Additional serious difficulties have been cited by project officers regarding the request for bids from industry because of the low dollar value of many of their tasks. It is not uncommon to hear that no bids had been received or that bids had been received from marginally qualified sources. To maintain the interest of a sufficiently large number of highly qualified sources is a continuing concern and

challenge for project officers working on small R & D projects and tasks.

4. Many small projects and tasks are very sensitive to reductions and delays in funding. Work usually can not be readily divided into meaningful and feasible parts to respond effectively to unexpected changes in funding. A total revision of the scope of work frequently is the only viable course of action possible. Often the manpower levels are at such a minimum level, that even modest changes in funding easily can force termination or postponement of the task.

5. The requirements for small projects and tasks, more often than not, are said to be subject to rather large and frequent variations during the development process. Reported causes for these variations are many and not infrequently have been linked to the fact that there are usually only a few people (at times, only one) at lower levels of management who, in effect, control the requirement documents and that the turnover rate for these positions is rather high. In addition, there tends to be much less attention given to the development of doctrine for small projects and tasks in support of requirements. The net result is that the originally approved requirement documents are apt to be unclear, overstated, and subject to subsequent vagaries.

In all fairness, one should not infer that because Natick Laboratories was selected for study that it is any worse off or better off then any other government laboratory that is engaged in small R & D project and task developments. It is fair to assert that all such laboratories are exposed to similar work environments under the Army Materiel

Command and are continually seeking ways to improve the management of their projects and tasks.

To the best of the knowledge of the author, no specific study has been made of R & D accomplishments involving small R & D projects and tasks and relating their outcomes to the major problems encountered. In doing so, it is hoped to shed some light on what might be done at the project officer and higher levels of management to enhance the outcome of small R & D projects and tasks.

CHAPTER III

RESEARCH METHODS

General

This study differs from most past efforts in that:

(1) Its focus is at the task level

(2) All the data are obtained directly from the project officer

(3) Tasks are relatively small in size

The three laboratories selected for study are product (end-item) oriented laboratories with similar R & D missions but differ in regard to commodities assigned. For the purpose of this study these three laboratories and Natick Laboratories will be referred to in the following manner:

ADEL	Airdrop Engineering Laboratory
GEPL	General Equipment and Packaging Laboratory
C&PLSE	Clothing and Personal Life Support Equipment Laboratory
NLABS	U.S. Army Natick Laboratories

Sample Selection

Special effort was made to obtain a representative sample of tasks and project officers in each of the laboratories studied. Key people in each laboratory as well as the NLABS Review and Analysis Division were consulted. In the selection of project officers (respondents) it

was necessary to consider simultaneously tasks assigned to each in order to satisfy the requirement for a representative sample of tasks. Only those tasks which were worked on within the past five years are included. All presently active tasks were excluded. Data on both completed and not completed (terminated) tasks were collected.

The information and data about the project officers and tasks were obtained through the use of a two part Questionnaire. The first part covered facts about the project officer, the second part about one of his typical tasks. Each project officer was asked to provide data on two or three of his tasks. He was also asked to include whenever possible at least one task that had been terminated.

The Questionnaire was pre-tested at two levels. It was first carefully reviewed at the laboratory directors' level for applicability and clarity. Extensive revisions were made as a result of this first review. The revised Questionnaire was then administered to a few project officers in each of the laboratories. Changes to the Questionnaire as a result of the second pre-test were made to encourage participation and to assure forthright responses. In structuring the Questionnaire more data were called for than was expected to be fully analyzed in the thesis to aid the researcher in enterpreting data and putting it in proper context.

Study Instrument

The Questionnaire (appendix) was developed after reading the material listed in the bibliography, consulting with Professor Donald G. Marquis and George F. Farris, M.I.T. and talking to key people at NLABS.

PART I of the Questionnaire consists of 15 questions, most of which relate to training and work experience. There are 18 questions in PART II. The first group of questions provide data on task characteristics. Questions 12 through 15 cover overall task outcome in terms of schedule, funds, scope of work, and technical quality. Question 16, which is semi-structured, requests the project officer to list those administrative and technical problems that arose during the life cycle of the task and which affected the outcome of his task in an adverse and significant way. Outcome is defined in terms of schedule, funds, scope of work, and technical quality.

The questions in PART I were used to develop characteristics of project officers. The first group of questions in PART II was used to develop characteristics of typical R & D tasks undertaken. Characteristics of project officers and tasks were developed for each laboratory as well as for all three laboratories taken as a group (ALL LABS). The data from questions 12 through 15 were used to characterize task outcomes for each laboratory and for ALL LABS. Question 16 was used to identify major problems that actually occurred during the life-cycle of tasks and to categorize these problems. Finally, the data in question 16 were used to explain, in general terms, the overall task outcome results expressed in questions 12 through 15.

D. Data Limitations

Of the 85 project officers receiving the questionnaire, the actual number of responses received was 34 or 40 percent. A summary of the response to the questionnaire is included as FIGURE III-1. As can be

seen, the total number of tasks reported on by the 34 respondents (project officers) is 65. Actually 71 task responses were received, however, 7 were found to be unusable. This averages out to be about two tasks per respondent. The request for data asked that each respondent report on two or three typical tasks.

Sufficient inconsistencies in the data reported in PART II of the questionnaire was observed to warrant mentioning. These inconsistencies are first listed and then discussed.

1. Schedule and funds in questions 12 and 13 were reported as "originally planned", yet under question 16 major problems were listed on eight occasions which showed an adverse impact on both schedule and funds.

2. Overruns in funds were reported in question 13, yet no major problems were listed which adversely affected funds as a task outcome (question 16). This occurred eleven times.

3. Overruns in schedules were reported in question 12, yet no major problems were listed which adversely affected schedule as a task outcome (question 16). This occurred six times.

4. Under question 15, the technical quality of the outcome was estimated as expected or higher than expected, yet major problems were cited on six occasions in question 16 which adversely and significantly affected the technical quality under task outcome.

5. There were six instances of the data in question 14, scope of work, being inconsistent with that reported under question 16, task outcome.

Where the reason for the inconsistencies was obvious or could be explained by reference to tasks reported on by the same respondent or laboratory, the data were adjusted to eliminate the inconsistencies. Otherwise the inconsistent data were deleted as not usable, with one exception.

Inconsistencies regarding scope of work was accepted as reasonable because no distinction was made in the questionnaire between changes in content of planned work and amount of planned work. Thus it was possible for a respondent to indicate in question 14 no change in amount of scope of work, "same as originally planned", and yet show a change in content of scope of work under question 16 as an adverse impact. To what extent this did occur can not be determined without additional data.

Tasks which were terminated before completion tended to fall into two groups. The first group were those tasks which having major problems were terminated well within the originally planned schedule and funds. The second group were those tasks which having major problems were terminated after schedule and fund overruns. There were three tasks in the first group and twenty tasks in the second group. Only those tasks falling within the second group were considered acceptable candidates for problem analysis. The data under questions 12 and 13 for the first group were so biased toward "less than originally planned" it was impossible to relate major problems encountered in question 16 to task outcomes in terms of schedules and funds. Also there were so few tasks in the first group, its deletion was not very significant to the study. The not completed (terminated) tasks of the second group

involved problems no different from those reported on for completed tasks. Thus there appeared to be no good reason to segregate those tasks in the second group from those tasks completed in the analysis of major problems and task outcomes.

There were a few respondents who listed major problems under question 16 but failed to check off the impact on task outcome. Where it was reasonably clear, appropriate task outcomes were checked off, otherwise the reported problem was ignored in the compilation and analysis of problems.

For many of the FIGURES, a number identified as "central tendency" is shown. This is a measure of the mean response of a group in terms of the scales used to indicate responses. The central tendency number does not include a consideration of the spread of data or the shape of the districation of the responses, caution must be used in attaching too much statistical importance to it.

FIGURE III-1

SUMMARY OF THE RESPONSES

TO QUESTIONNAIRE BY LAB.

	ADEL	GEPL	C&PLSE	TOTAL
Number of Project Officers in Labs	20	51	100	171
Number of Project Officers Solicited	16	44	25	85
Number of Responses From Project Officers	12	11	11	34
Percent Response From Project Officers	75	25	44	40
Percent of Project Officers in Lab(s) Responding	60	22	11	20
Number of Tasks	22	23	19	64

CHAPTER IV

DISCUSSION OF PROJECT OFFICER CHARACTERISTICS

This chapter considers the responses to PART I of the questionnaire that covered some facts about the project officers. The data reported are used to develop characteristics of the project officers at two levels of aggregation; for each laboratory studied (ADEL, GEPL, C&PLSE) and for all three laboratories taken as a unit (ALL LABS).

Age

FIGURES IV-1 and IV-2 show the age distribution of the project officers. It is apparent that there is a much larger number of project officers in C&PLSE above age 50, than there is in the other two laboratories. The distribution of ages in GEPL is somewhat more uniform than the other two laboratories with a concentration of ages in the range of 31-40 years. The age distribution of ADEL falls between that of C&PLSE and GEPL with a noticeable concentration in the 41 - 50 year range. For ALL LABS the number of project officers in the age range of 30 years or less is conspicuously low. This situation suggests a weakness in the recruitment programs in the LABS. It is plausible, however, that the lack of younger project officers is a direct result of severe cut-backs in the size of the civilian workforce in the Department of Defense and the practice of absorbing cut-backs through attrition and

reductions based on seniority. The combination of these factors would seriously limit opportunity for recruitment of recently trained younger personnel. From FIGURE IV-2, it can be seen that most of the project officers fall between the ages of 31 to 40 and 51 to 60. The average age of project officers in ADEL is 45.7 years, in GEPL 42.1, and in C&PLSE 54.0. The average age of all project officers is 47.2 years. These averages appear to the author to be unduly high for an R & D agency such as Natick Laboratories, where fresh ideas, innovations, latest technical skills and computer competence are essential ingredients for the maintenance of an effective and viable R & D program. In the author's view these ingredients are most easily acquired through the continual recruitment of young college graduates.

Level of Education

With one exception, all of the project officers have had some higher education. Out of the 34 respondents, 32 or 94 percent have either B.S. or advanced degrees. The distribution of responses is shown in FIGURES IV-3 and IV-4. Nine of the eleven respondents in GEPL have advanced degrees. Most of the respondents in ADEL have attained the B.S. level of education. Six of the eleven respondents in C&PLSE have advanced degrees, four B.S. degrees.

How Long Since Last College Course

Responses from each Laboratory were similar in that a large number of respondents had quite recent college training and another large number, although not quite as large as the first has not had exposure to a college course in many years. The distributions of these responses

are shown in FIGURES IV-5 and IV-6. On the average, the project officers in GEPL have had the most recent college training, ADEL next, and C&PLSE last. It is striking to note that of all the project officers, nearly fifty percent have taken a college course within the past two years. This is a reflection of a liberal and viable training program and the importance that management at NLABS attaches to the need to remain technically up-to-date.

Experience As a Project Officer

FIGURE IV-7 shows a distinct difference in the experiences of project officers among the three laboratories. For ADEL, over 60 percent of the project officers have total experience between 11-15 years. For C&PLSE there are no project officers with experience in the 11-15 year interval. However, there is nearly an equal division of project officers with experiences greater and less than this range. The nearly constant number of respondents over all time intervals for GEPL is in striking contrast to those of the other two laboratories. For both ADEL and GEPL there are no project officers with experience greater than twenty years, but for C&PLSE over 25 percent of the project officers have experience beyond twenty years. The unequal number of respondents over the different time intervals for ADEL and C&PLSE suggests that in the past, there were interruptions in the recruitment efforts, resulting in a temporary halt of entries of younger project officers. As shown in FIGURE IV-8, as a group, the number of respondents is about the same for all intervals between zero and twenty years with a noticeable concentration at the 11-15 year interval.

Ranking of the Task Accomplishment Factors

Data for task accomplishment rankings were obtained from questions 10 and 11. Project officers ranked the following factors according to their relative importance to themselves and to their laboratories regarding task accomplishment:

1. meeting technical goals
2. meeting schedules
3. staying within fund allocations

FIGURES IV-9 and IV-10 show a remarkable degree of agreement among the three laboratories and the outstanding importance project officers give to "meeting technical goals". It should be noted that only the results of first rankings are plotted. Of the total number of project officers, some ninety-seven percent ranked "meeting technical goals" as being relatively most important of the three factors to themselves. Although there is little difference between the other two factors, "meeting schedules" was reported as being more important than "staying within fund allocations". The ranking of factors in order of (1) technical (2) schedule and (3) funds agrees with the findings of Marquis and Straight (5). They studied criteria used by project managers in evaluating project outcomes and found that project managers ranked technical, schedule, and cost performance in that order in terms of importance.

When ranking of the three factors was made according to their relative importance to the laboratory,"meeting schedules" becomes the most important factor,"meeting technical goals" second, and "staying within

fund allocations" last. (See FIGURES IV-11 and IV-12). Over fifty percent of the project officers felt that the laboratories consider meeting schedules the most important. This is consistent with the emphasis given through the R & D hierarchy to slippages in phase completions. The conflict between what project officers and laboratories consider important in task accomplishment no doubt has an adverse impact on task accomplishment. It, therefore, is an area where management might profitably devote some attention in an attempt to better align the objectives of the project officer and the laboratory.

Task Assignment

Matching of assignment to area(s) of specialization was reported on by the project officers when they responded to the question:

"Do you feel that you are assigned to the area(s) of specialization where you have the most competence?"

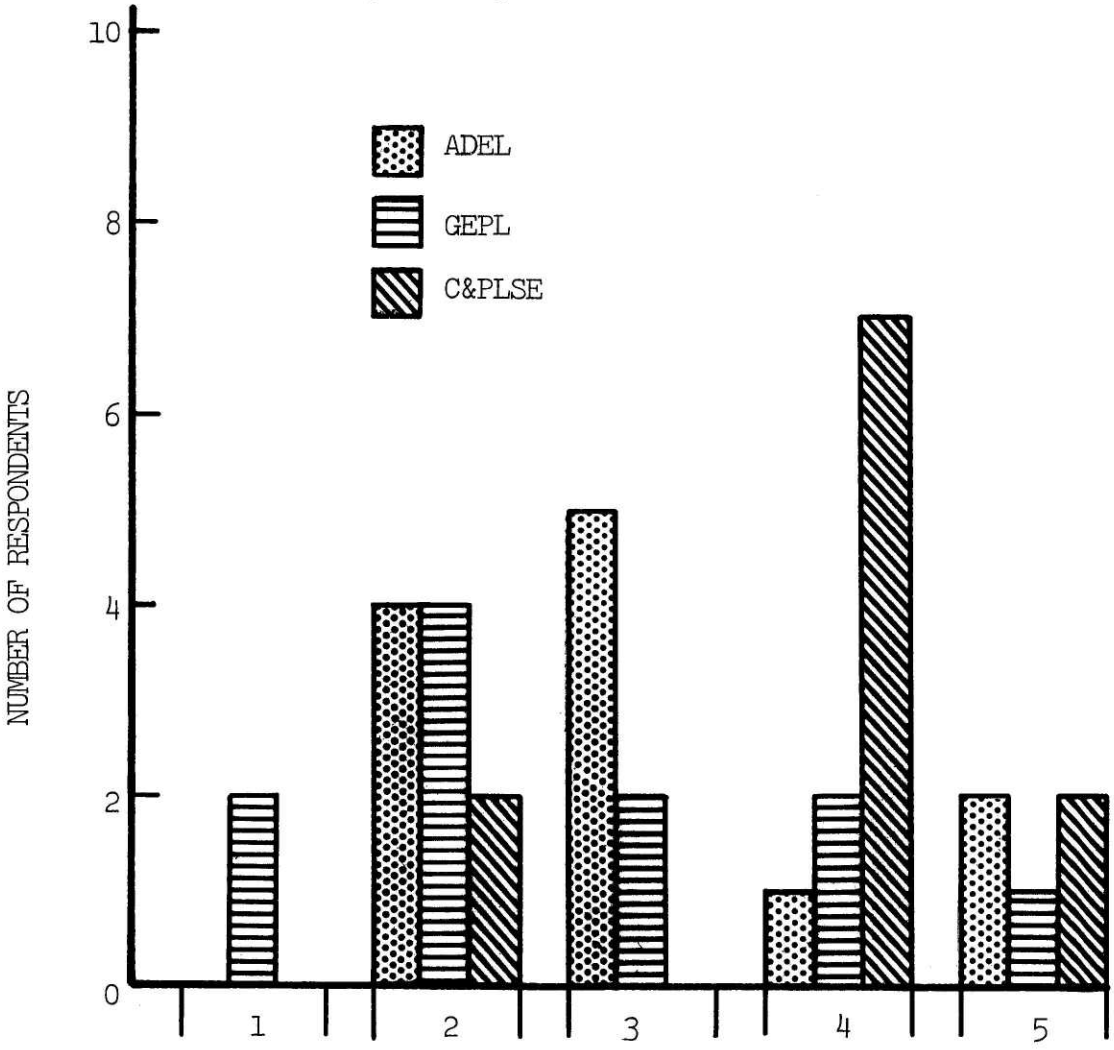
Of the thirty-four project officers responding, about 85 percent reported that they were assigned to the area(s) of their specialization. (FIGURE IV-13). Responses for individual laboratories were similar, with ADEL reporting the highest percent (92%) of project officers assigned to their areas of specialization. Although the results show a very favorable matching of project to his job, there is a sufficient number of project officers (15 percent) who felt that they were not properly assigned to warrant some attention to adjustment of task assignments.

FIGURE IV-1

COMPARISON OF LABS: AGE (YEARS)

Key

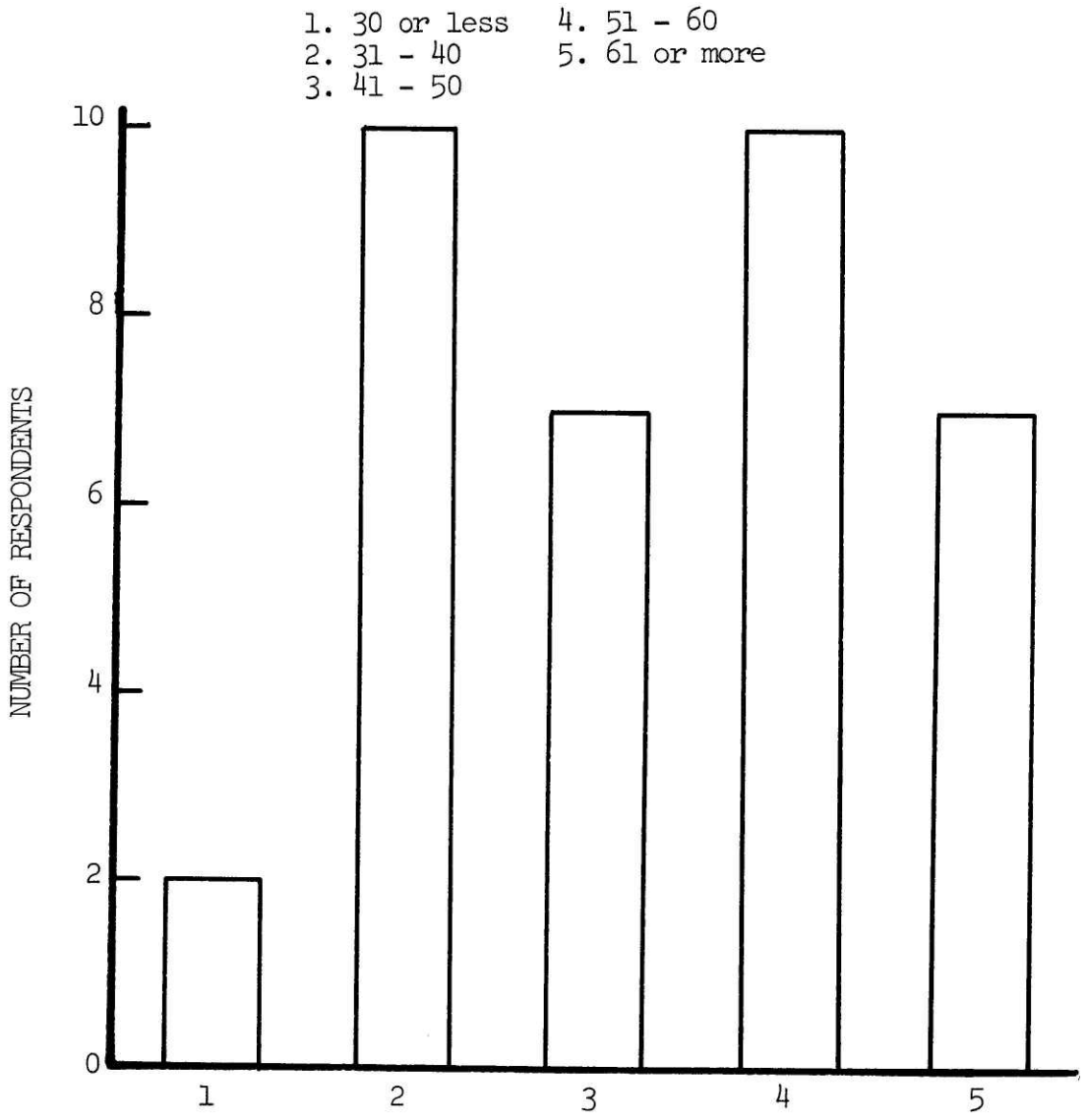
1. 30 or less
2. 31 - 40
3. 41 - 50
4. 51 - 60
5. 61 or more



ADEL	GEPL	C&PLSE
12	11	11

FIGURE IV-2

AGE OF PROJECT OFFICERS IN YEARS (ALL LABS)

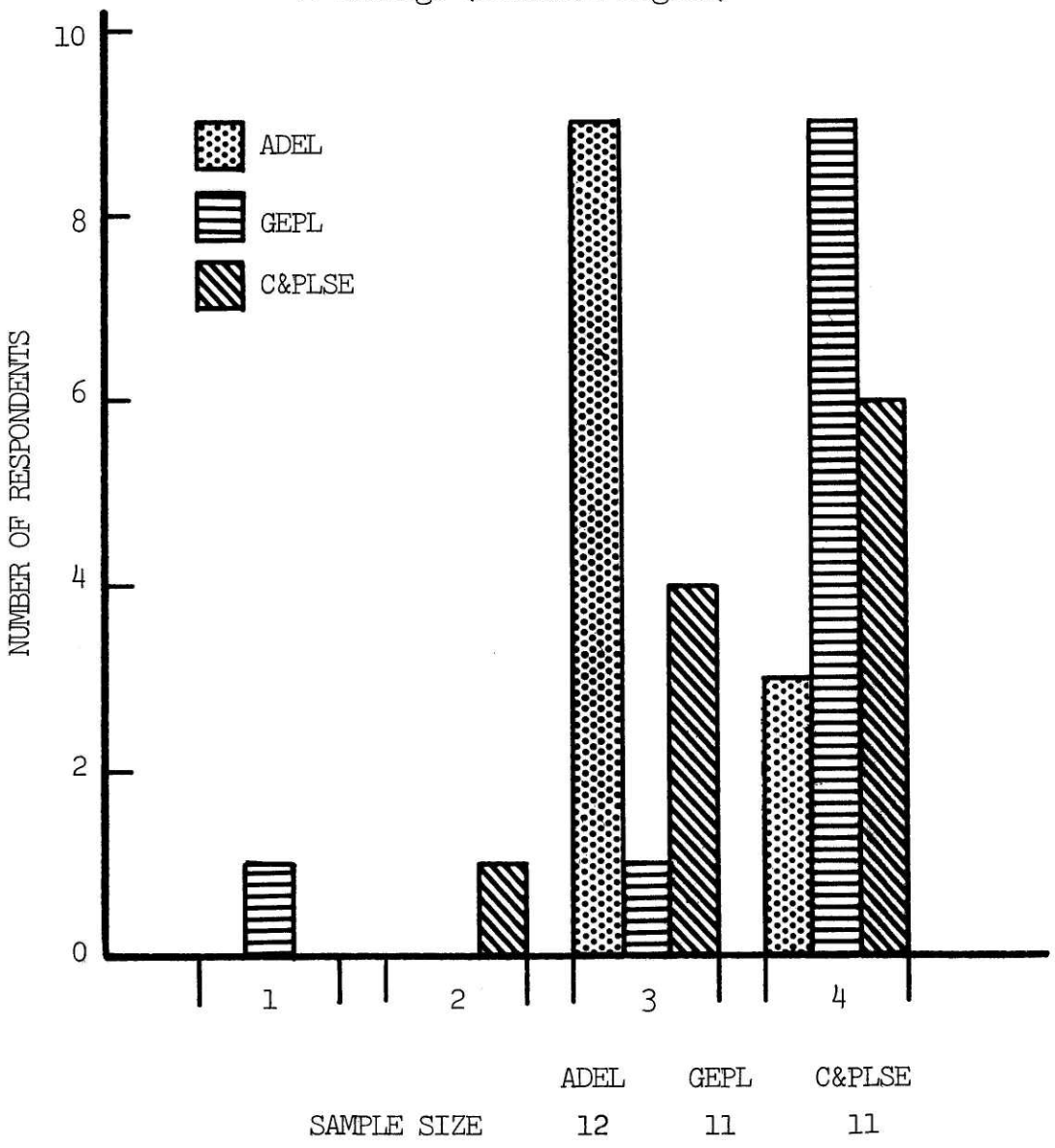


SAMPLE SIZE 34

FIGURE IV-3

COMPARISON OF LABS: LEVEL OF EDUCATION

Key
1. High School
2. College (less than B.S.)
3. College (B.S.)
4. College (Advanced Degree)

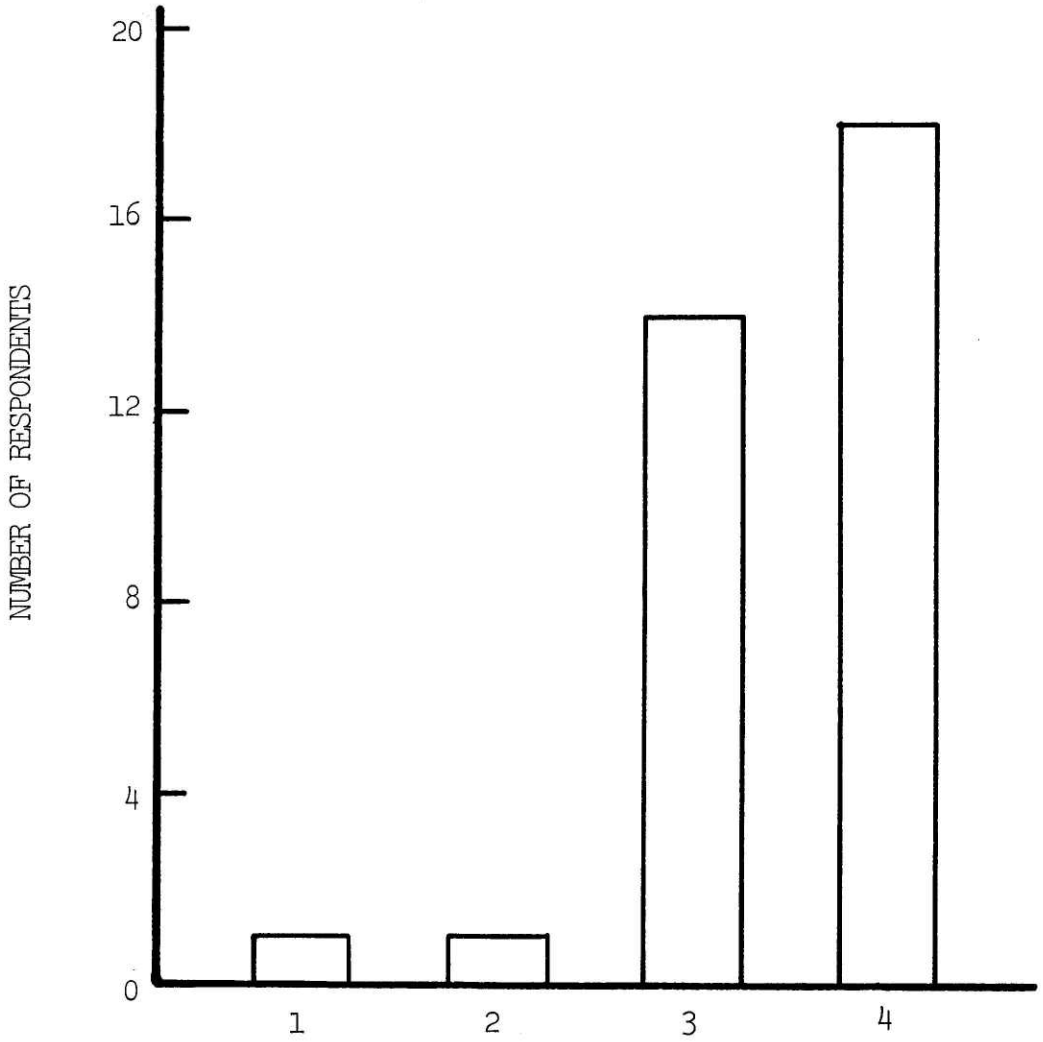


	ADEL	GEPL	C&PLSE
SAMPLE SIZE	12	11	11

FIGURE IV-4

LEVEL OF EDUCATION (ALL LABS)

Key
1. High School
2. College (less than B.S.)
3. College (B.S.)
4. College (Advanced Degree)



SAMPLE SIZE 34

FIGURE IV-5

COMPARISON OF LABS: HOW LONG SINCE LAST COLLEGE COURSE (YEARS)

Key
1. 2 or less
2. 3 - 5
3. 6 - 8
4. 9 - 11
5. 12 or more

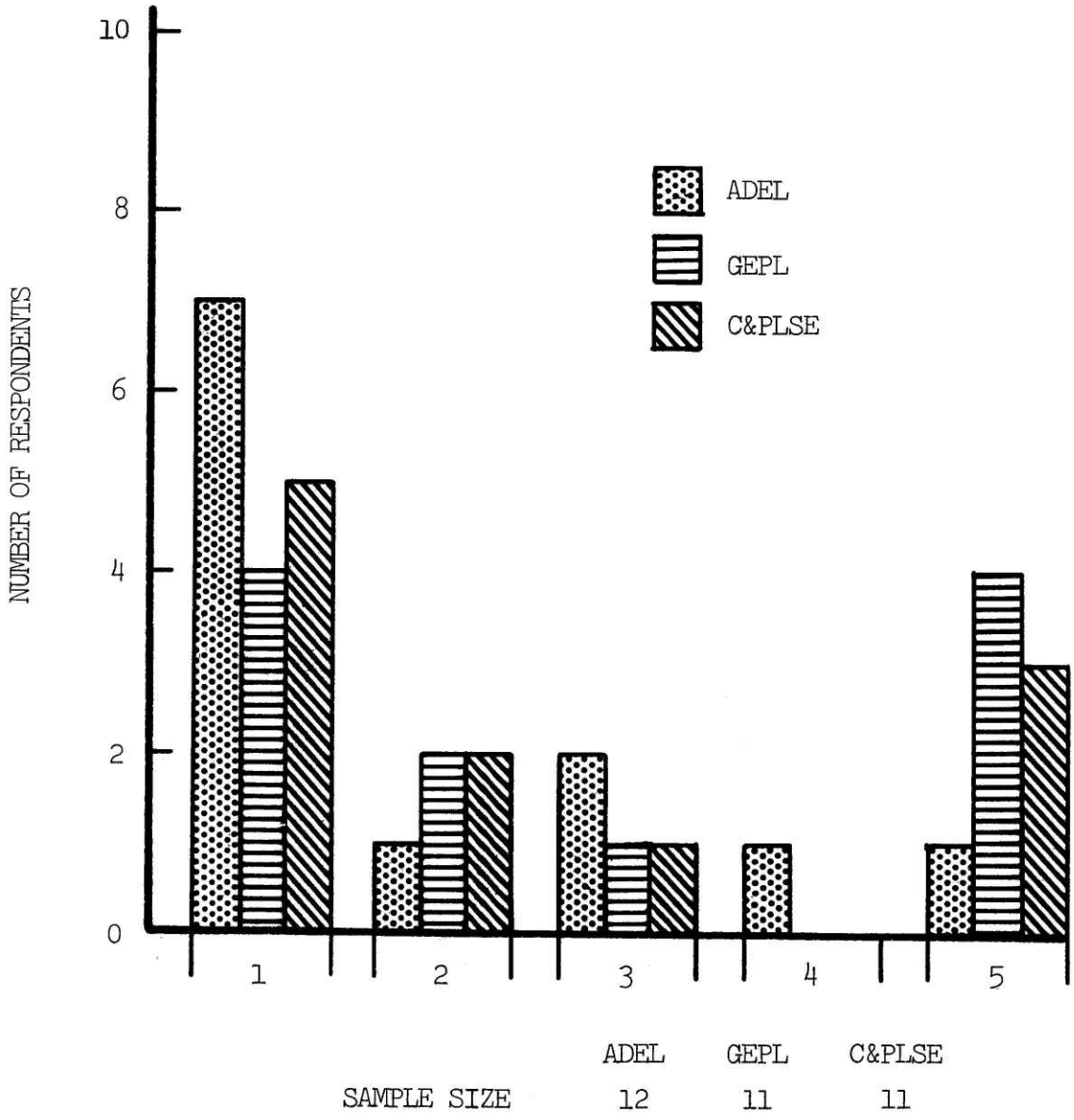
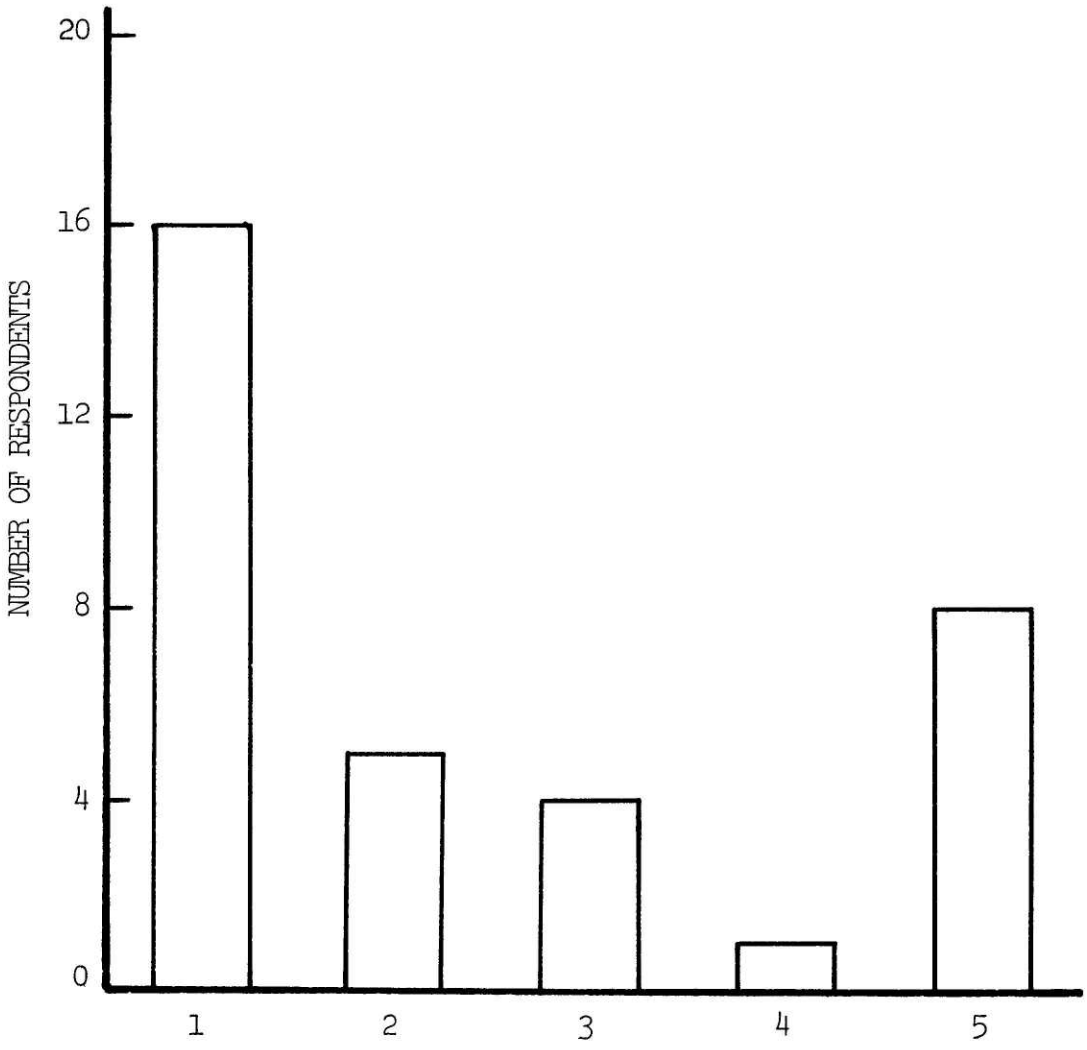


FIGURE IV-6

HOW LONG SINCE LAST COLLEGE COURSE IN YEARS (ALL LABS)

Key

1. 2 or less
2. 3 - 5
3. 6 - 8
4. 9 - 11
5. 12 or more



SAMPLE SIZE 34

FIGURE IV-7

COMPARISON OF LABS: TOTAL EXPERIENCE AS A PROJECT OFFICER (YEARS)

Key

1. 0 - 5
2. 6 - 10
3. 11 - 15
4. 16 - 20
5. 21 or more

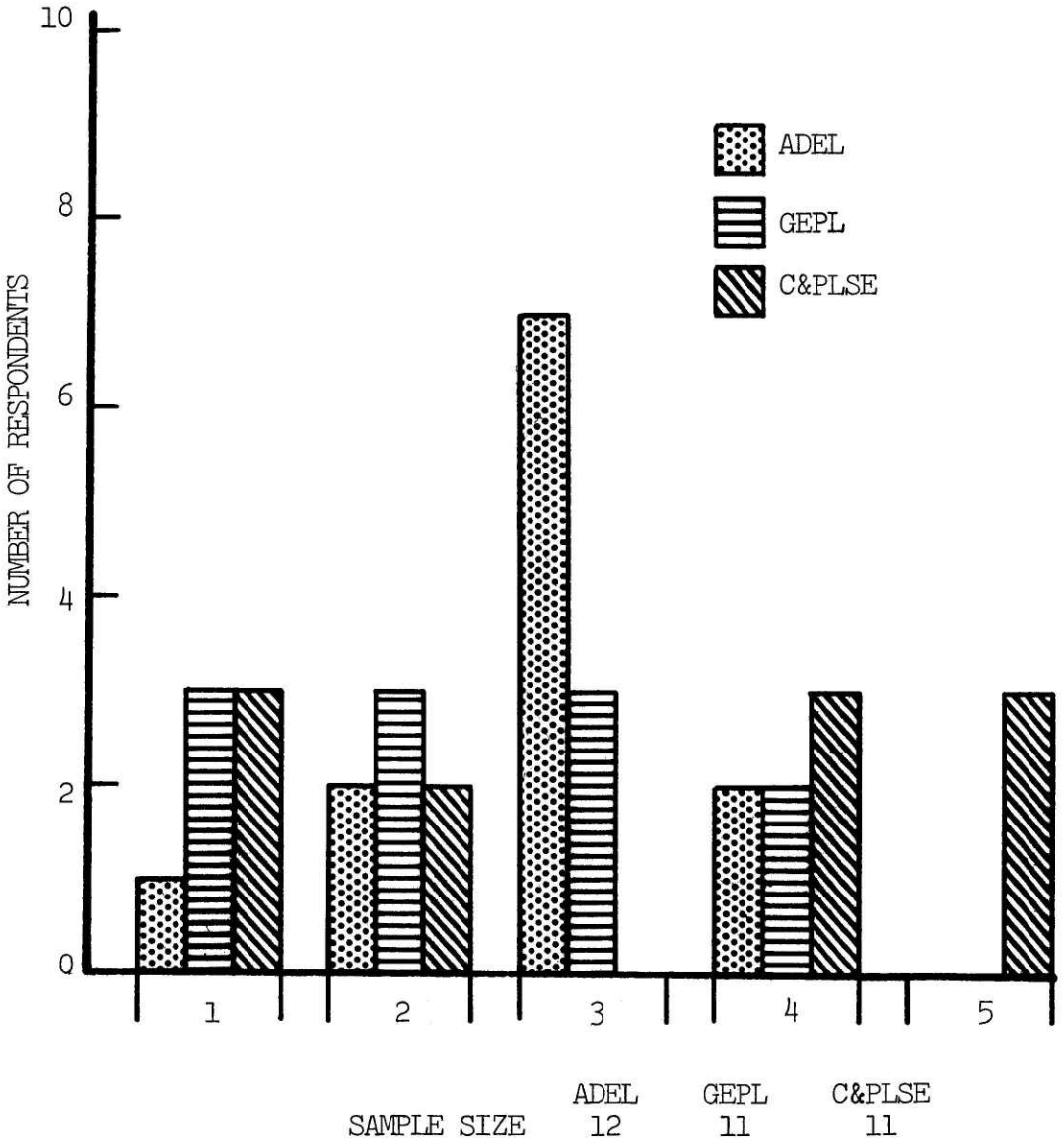
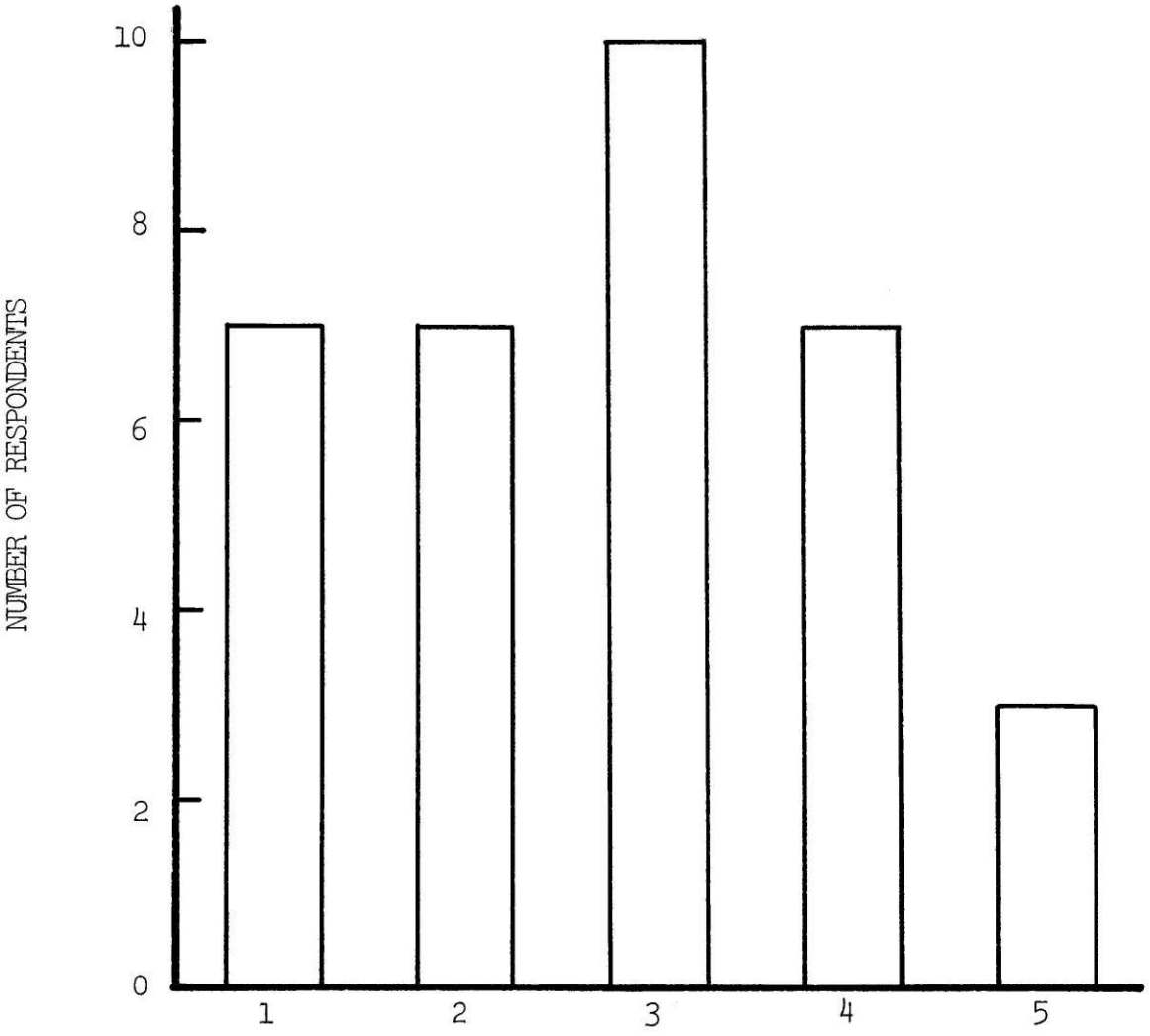


FIGURE IV-8

TOTAL EXPERIENCE AS PROJECT OFFICER IN YEARS (ALL LABS)

Key

1. 0 - 5
2. 6 - 10
3. 11 - 15
4. 16 - 20
5. 21 or more



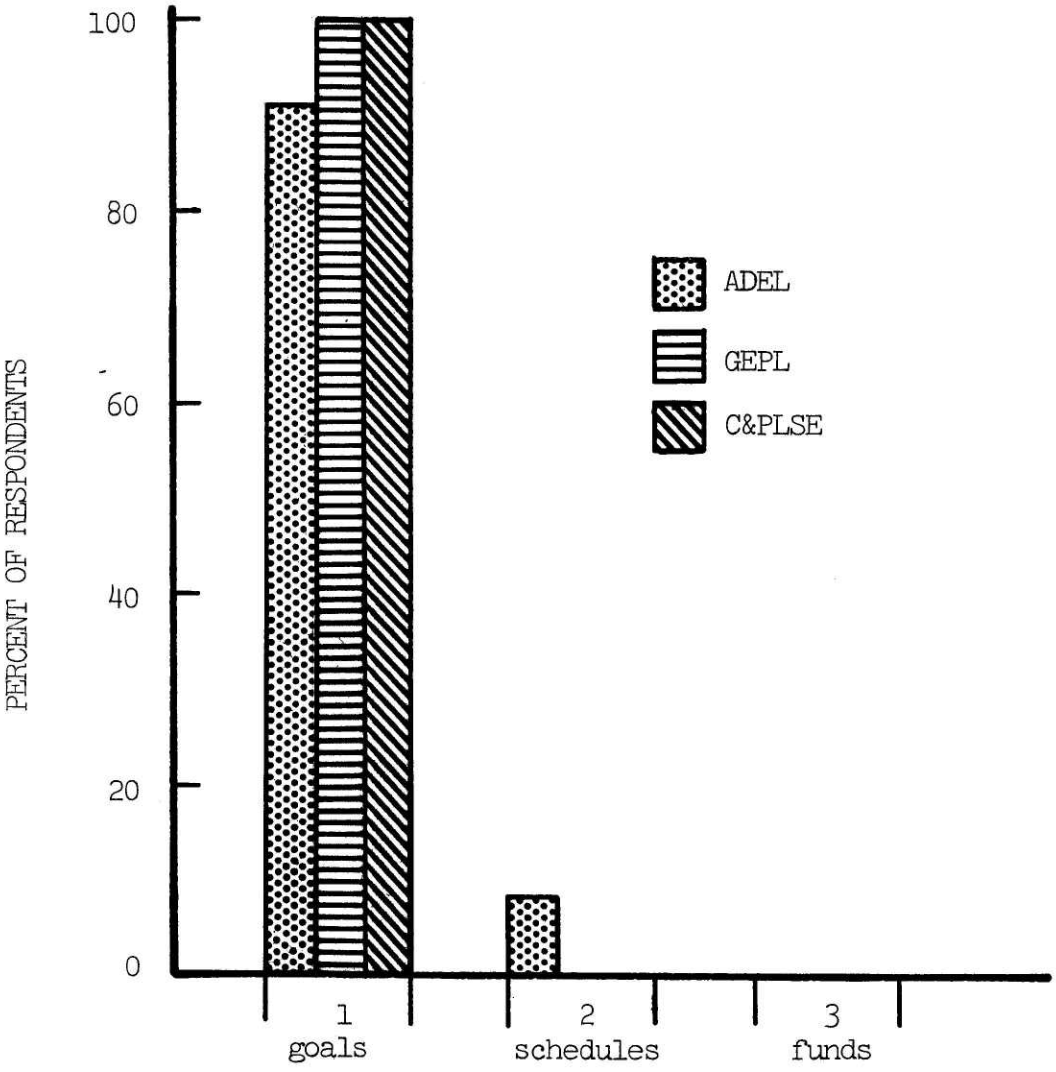
SAMPLE SIZE 34

FIGURE IV-9

COMPARISON OF LABS IN RESPONSE TO:

"Rank (1,2,3) the following factors according to their relative importance to you regarding task accomplishment:"

1. Meeting technical goals
2. Meeting schedules
3. Staying within fund allocations



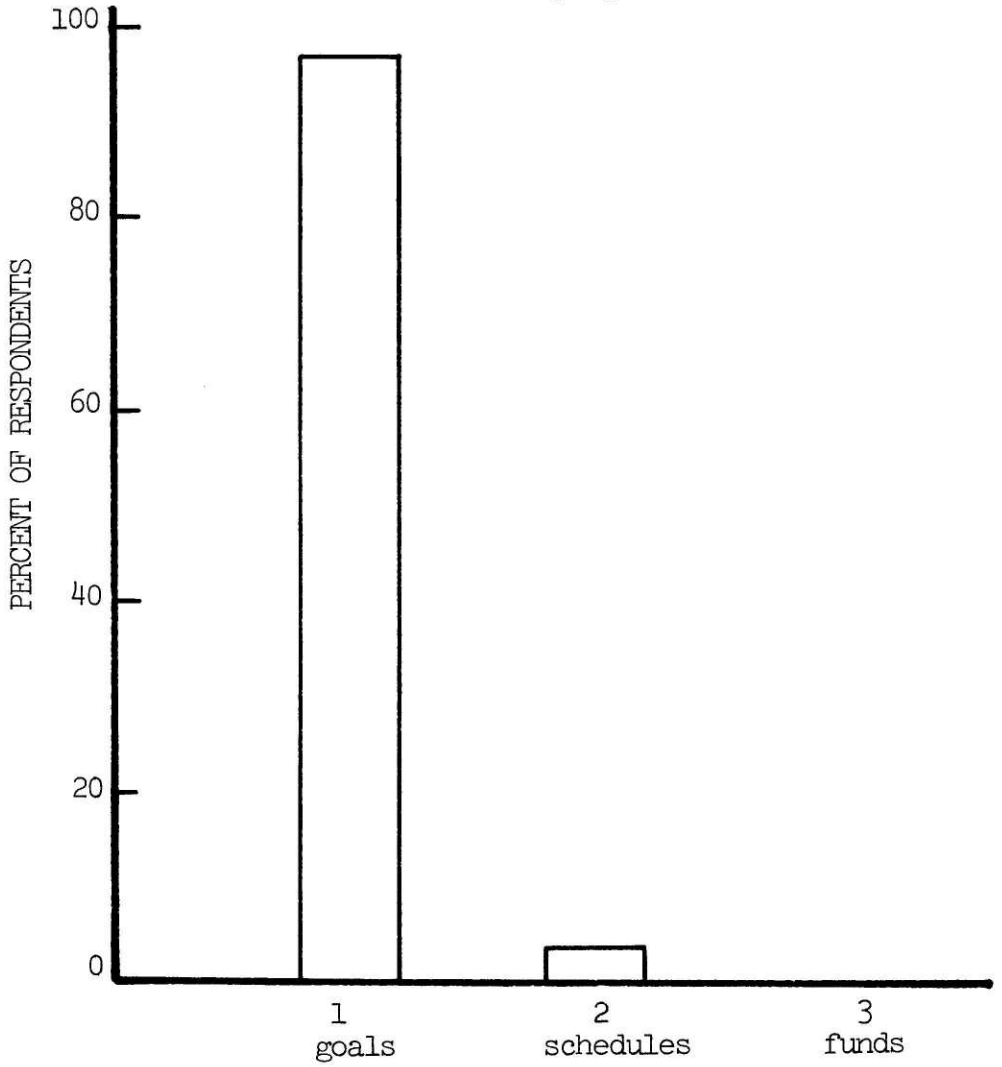
	ADEL	GEPL	C&PLSE
SAMPLE SIZE	12	11	11

FIGURE IV-10

ALL LABS IN RESPONSE TO:

"Rank (1,2,3) the following factors according to their relative importance to you regarding task accomplishment:"

1. Meeting technical goals
2. Meeting Schedules
3. Staying within fund allocations



SAMPLE SIZE 33

FIGURE IV-11

COMPARISON OF LABS IN RESPONSE TO:

"Rank (1,2,3) the following factors according to their relative importance to your lab regarding task accomplishment"

1. Meeting technical goals
2. Meeting schedules
3. Staying within fund allocations

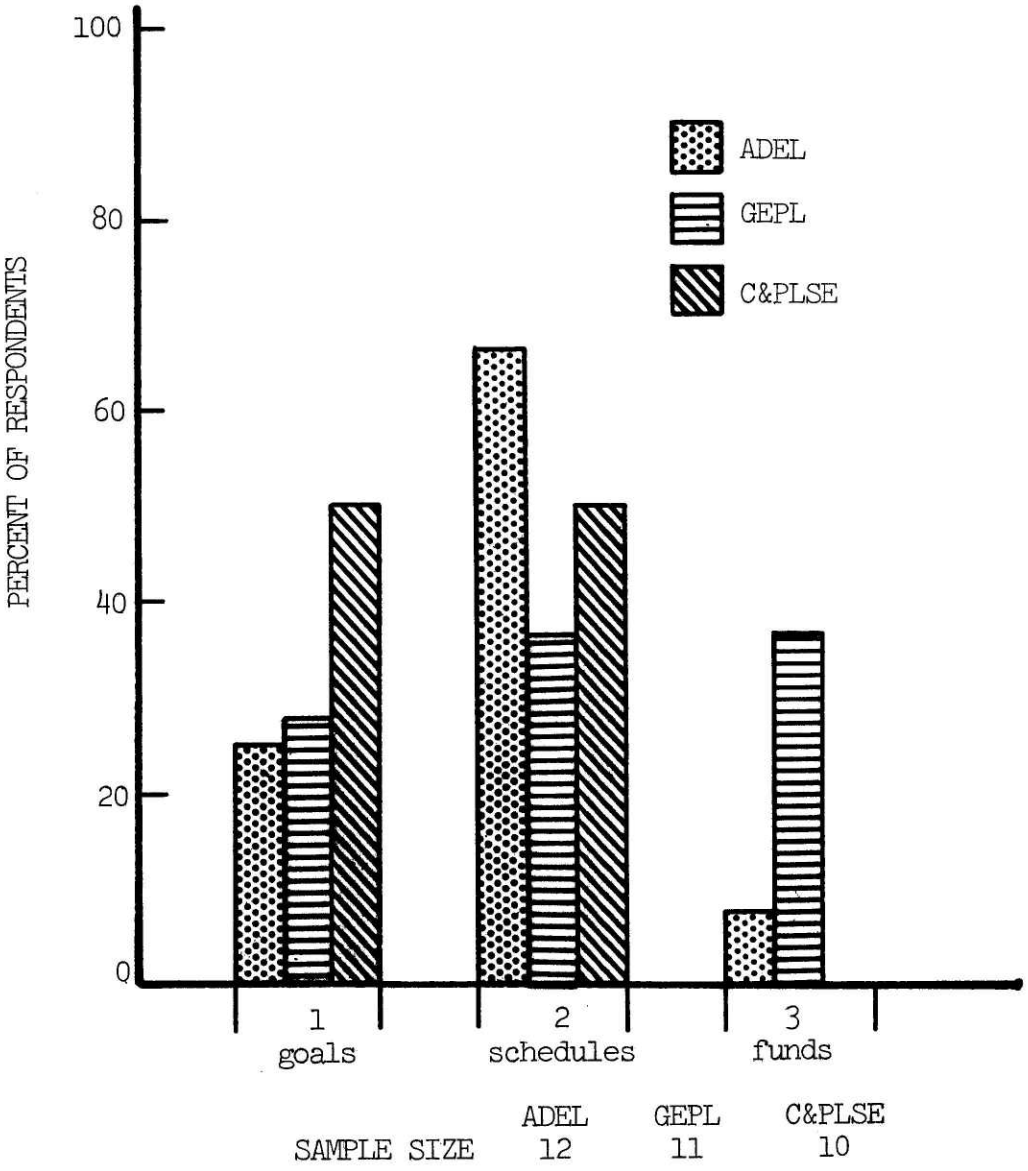
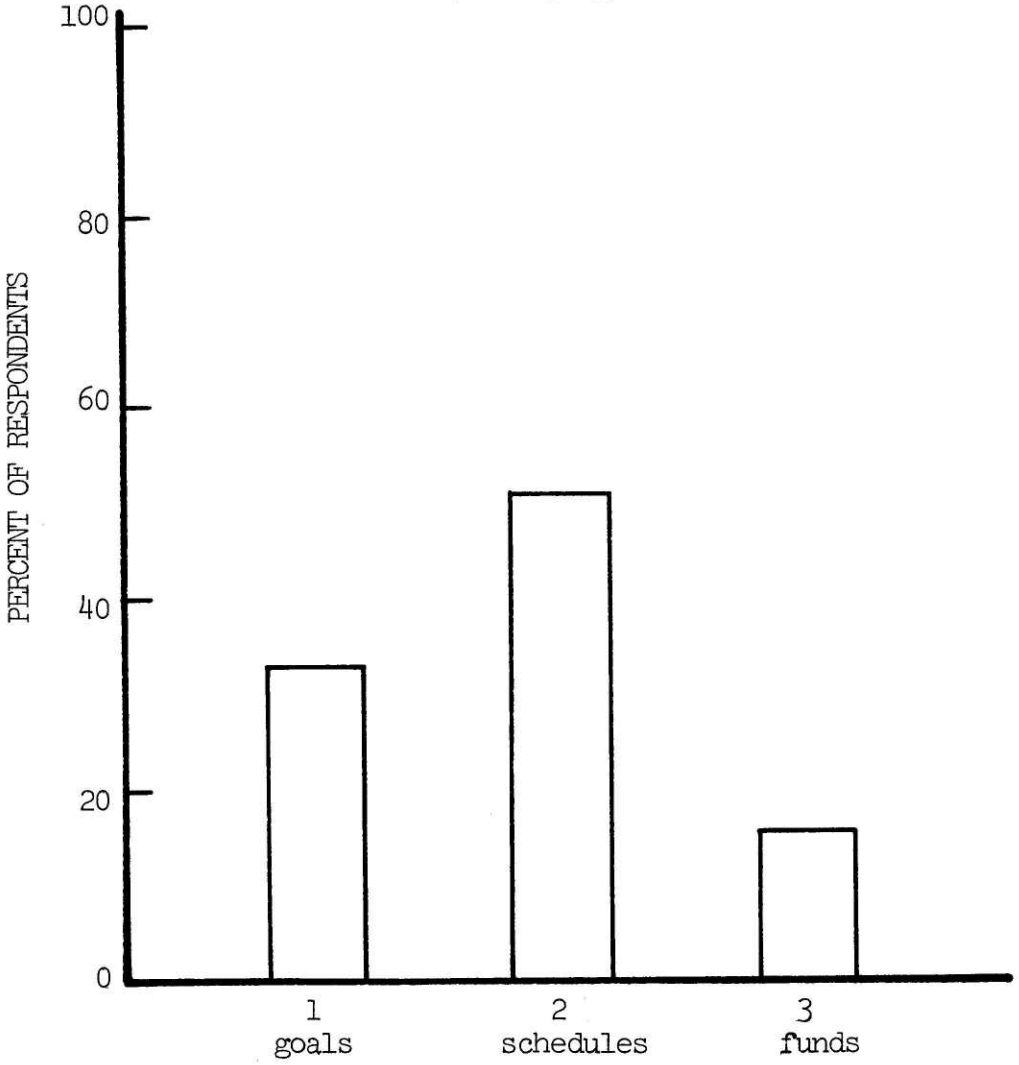


FIGURE IV-12

ALL LABS IN RESPONSE TO:

"Rank (1,2,3) the following factors according to their relative importance to your lab regarding task accomplishment:"

1. Meeting technical goals
2. Meeting schedules
3. Staying within fund allocations

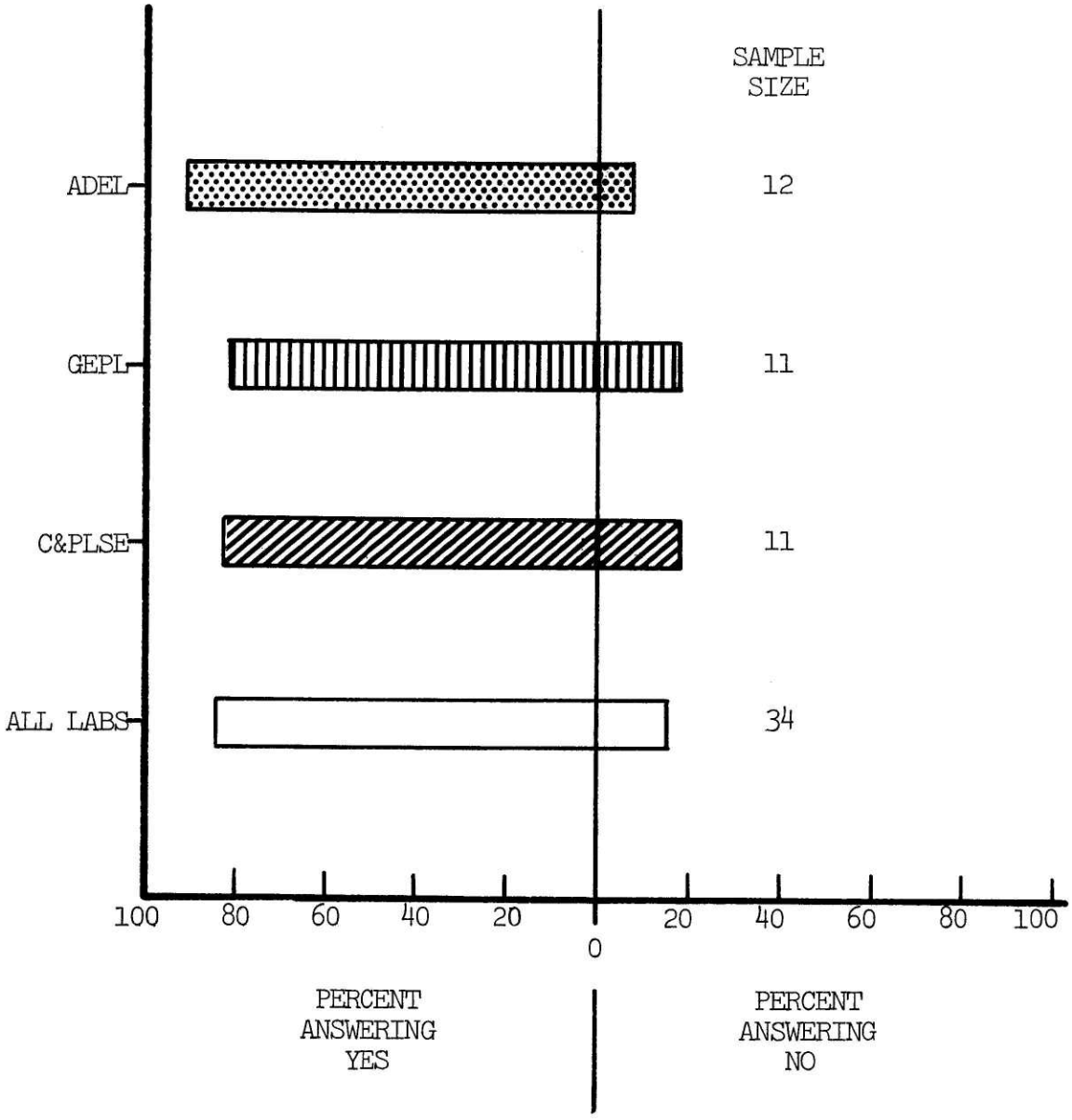


SAMPLE SIZE 33

FIGURE IV-13

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"Do you feel that you are assigned to the area(s) of specialization where you have the most competence?"



CHAPTER V

DISCUSSION OF TASK CHARACTERISTICS

Characteristics of tasks as determined by the responses to questions 1 through 11 of PART II of the Questionnaire are covered in this chapter. Chapter VI discusses task outcomes as reported under questions 12 through 15. Chapter VII analyses the major problems encountered and task outcomes (schedule, funds, scope of work, and technical quality).

Categories of Tasks

FIGURES V-1 and V-2 list the types and number of tasks studied and identifies the number of tasks in different categories of "completed" and "not-completed". Most of the tasks studied were either exploratory or engineering development tasks. Together, these tasks accounted for about 80 percent of those studied. Nearly 70 percent of the tasks were completed satisfactorily. Of those tasks "not-completed" (terminated before completion) three of the twenty were deleted from the study and for record purposes were assigned the group 1 designation, the remainder the group 2 designation. The distribution of tasks among the three laboratories is about equal.

Man-years of Technical Work

It is apparent from FIGURES V-3 and V-4 that most of the technical work is accomplished either within the laboratory originating the work or under contract. This characteristic exists for each of the laboratories. About 55 percent of the technical work is done within the laboratory, about 30 percent under contract, and the remaining 15 percent is accounted

for by other in-house laboratories and other government agencies. The total amount of technical work done in-house is about 65 percent compared to 35 percent out-of-house. The rather small amount of work done by other in-house laboratories and other government agencies suggests that it would be advisable for laboratories to more actively seek and utilize the expertise assumed available in other in-house laboratories and other government R&D agencies in the accomplishment of their tasks.

Complexity of Tasks

The complexity of tasks is shown in FIGURES V-5 and V-6. The distribution of responses from each laboratory appears to be nearly Normal with a mean of about 3 on the scale from "extremely complex"(1) to "not at all complex" (5). This indicates that on the average the project officer does not consider his task to be either "extremely complex" or "not at all complex". Complexity as used here is relative in that it is based on the perception of the project officer. In reference to the high level of education and substantial experience project officers have on the average (FIGURES IV-4 and IV-8) if follows that they should not perceive their assigned tasks of being anything but average in complexity. In other words, on the average, they "measure up" to the challenges of the task assigned and "take it in stride".

Technical Objectives and Approaches

FIGURES V-8 through V-10 are the responses to the questions, "How well defined were the major technical objectives at the start of the task?" and "How clearly were the major technical approaches set out at the start of the task?" The indications are from FIGURES V-8 and V-10, that, on the on the average, objectives were quite well defined and major

technical approaches clearly set out at the start of tasks. The responses of each laboratory however were varied regarding technical objectives. A striking variation is the large peak at scale 4 for ADEL (FIGURE V-7). For this laboratory, the problem of defining objectives appears to arise frequently enough to warrant special attention. For the other two laboratories, although a lesser problem exists, it is probably prudent that they look at this area of activity, as well. The number of responses for each of the laboratories which fell toward the "not clearly" end of the scale regarding technical approaches was frequent enough to indicate that a problem needing attention exists in this aspect of task accomplishment.

Contribution of Others to Technical Approaches

It is generally expected that the quality of technical approaches improves when a number of other sources contribute to the development and selection of the technical approaches finally used. FIGURES V-11 and V-12 present the response to question 8 of PART II of the Questionnaire which requested data about the contribution of others in regard to the technical approach used on a task. The aggregate (ALL LABS) response strongly indicates that other sources are not used as frequently as they should (40 percent of the responses fall toward "not at all"). The individual laboratory response distributions shown in FIGURE V-11, support this conclusion. Thus, it would be well if each laboratory promoted actively the exchange of technical data and ideas among their project officers and also between their laboratories and other labora-

tories, in-house and out-of-house.

Number of Assigned Tasks

The responses to the following question are presented in FIGURES V-13 and V-14:

> "At the time you were working on this task, how many other assigned tasks were you actively working on, currently?"

Over 60 percent of the project officers in ADEL are assigned three additional tasks, 40 percent in GEPL, and only 26 percent in C&PLSE. For both GEPL and C&PLSE a large number of project officers are assigned five or more additional tasks. As a group, the predominant number of other tasks assigned project officers is "three" and "five or more", the former representing about 45 percent of the total number of tasks reported on (64) and the latter 30 percent.

Time Devoted to Tasks

FIGURES V-15 and V-16 show the percent of time project officers devoted to the tasks reported on. It is clear that ADEL project officers spend a greater amount of time on each of their assigned tasks than those in GEPL and C&PLSE. About 45 percent of ADEL tasks fall into the 26-50% (time) range while less than 22 percent of the tasks in GEPL and C&PLSE fall into this range. For all the laboratories, 36 out of 64 or about 56 percent of the tasks fell within the 25% or less time range. It is apparent from FIGURES V-13 through V-16 that, in general, project officers in ADEL are assigned fewer tasks and devote more time

to each task than do their counterparts in GEPL and C&PLSE.

Primary Factors in Undertaking Tasks

Myers and Marquis (6) in their study of factors underlying innovation in 121 firms in five industries found that out of a total of 567 innovations, 120 (21 percent) were attributable to technical factors and 257 (45 percent) were attributable to market (customer) factors. This is a ratio of about two to one in favor of the customer factors. FIGURE V-17 shows similar data regarding the undertaking of tasks. There is a marked disagreement with the results of Myers and Marquis. The ratio of user (customer) to technical factors for all laboratories is about 1/2 as compared to 2 for Myers and Marquis. This indicates that most of the stimulation for undertaking a task is from technical recognition rather than from user (customer) recognition. In addition, the responses of the individual laboratories show in each case that the technical factors are much more important than customer (user) factors in stimulating initial task undertaking. This result, nonetheless, is consistent with experiences of most project officers at NLABS. That is, most new tasks are initiated by the developer rather than the user. Thus, one can fairly conclude that the development process in general is not supported by a strong user or customer demand (requirements) base. This is a weakness of the R & D process which was alluded to in the introductory remarks of CHAPTER I.

FIGURE V-1

COMPARISON OF LABS:

NUMBER OF TYPES OF TASKS

TYPE	ADEL	GEPL	C&PLSE	ALL LABS
Exploratory Development	10	14	6	30
Engineering Development	11	3	8	22
Production Engineering	1	3	2	6
Other	0	3	3	6
TOTALS	22	23	19	64

FIGURE V-2

COMPARISON OF LABS: NUMBER OF

TASKS COMPLETED AND NOT COMPLETED (TERMINATED)

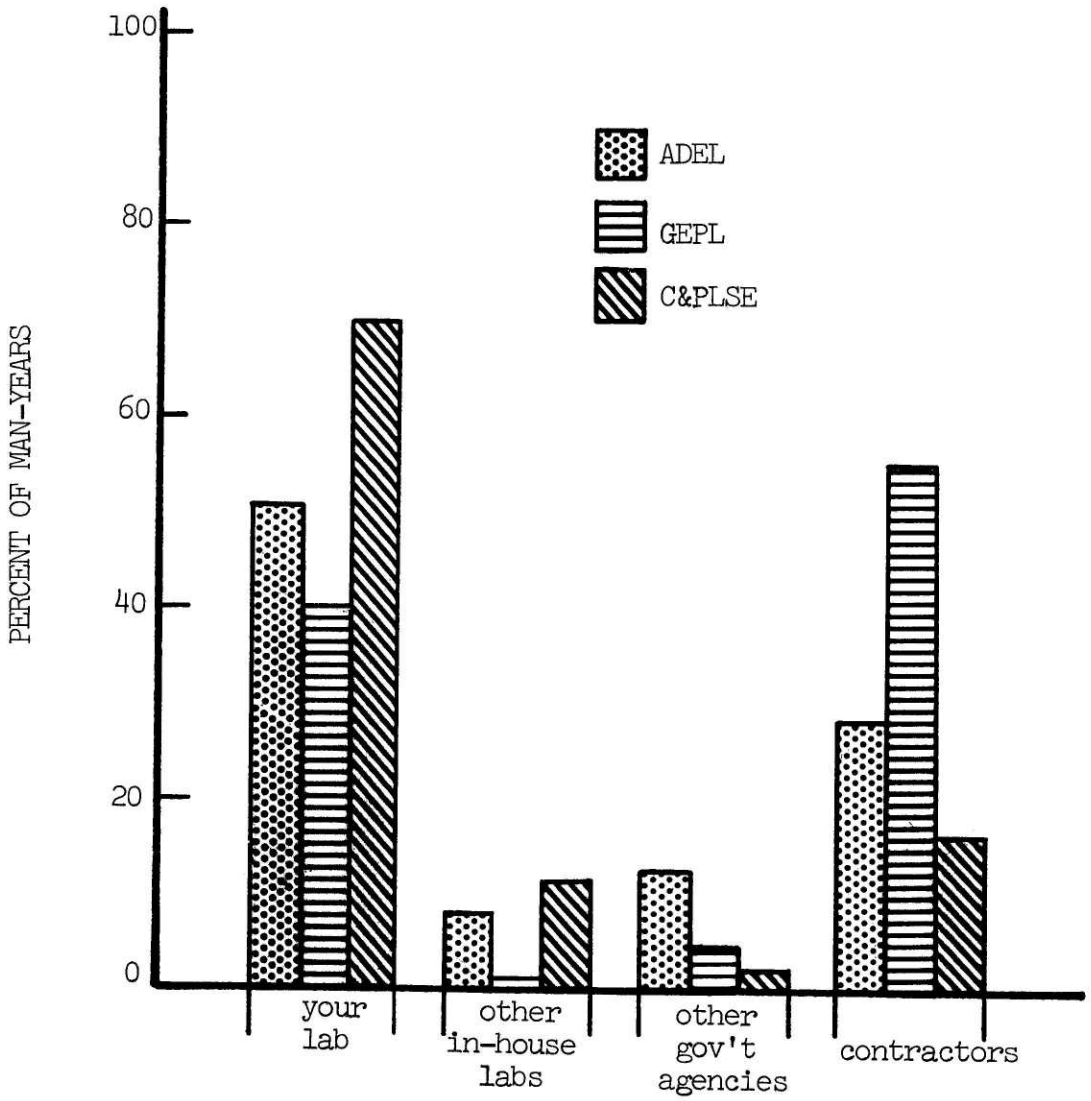
TASK	ADEL	GEPL	C&PLSE	ALL LABS
Completed	19	14	11	44
Not-Completed (Group 1)	1	1	1	3
Not Completed (Group 2)	2	8	7	17
TOTALS	22	23	19	64

FIGURE V-3

COMPARISON OF LABORATORIES:

PERCENT DISTRIBUTION OF MAN-YEARS

OF TECHNICAL WORK EXPENDED ON TASKS



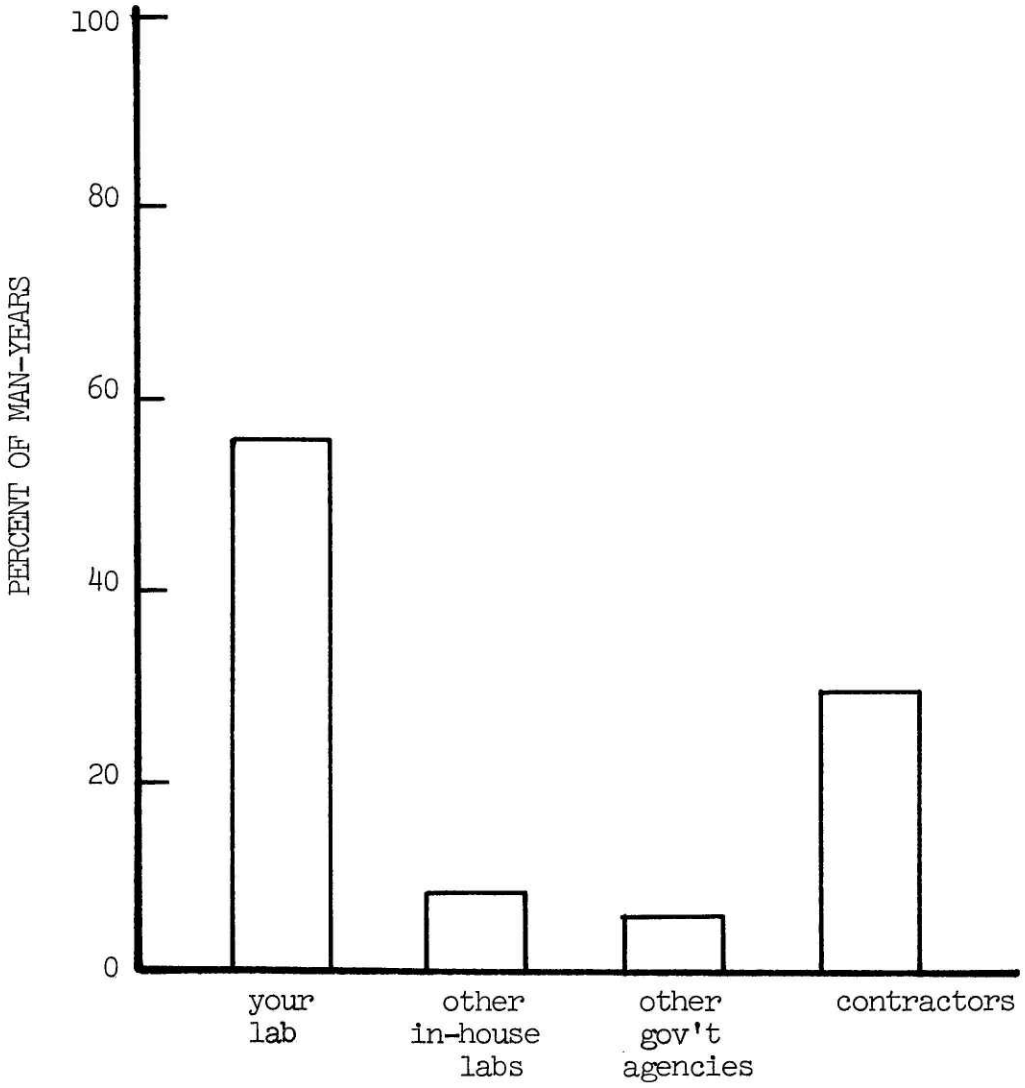
	ADEL	GEPL	C&PLSE
NUMBER OF TASKS	22	23	19
TOTAL MAN-YEARS	187.24	110.50	210.87

FIGURE V-4

PERCENT DISTRIBUTION OF MAN-YEARS

OF TECHNICAL WORK EXPENDED ON

TASKS (ALL LABS)

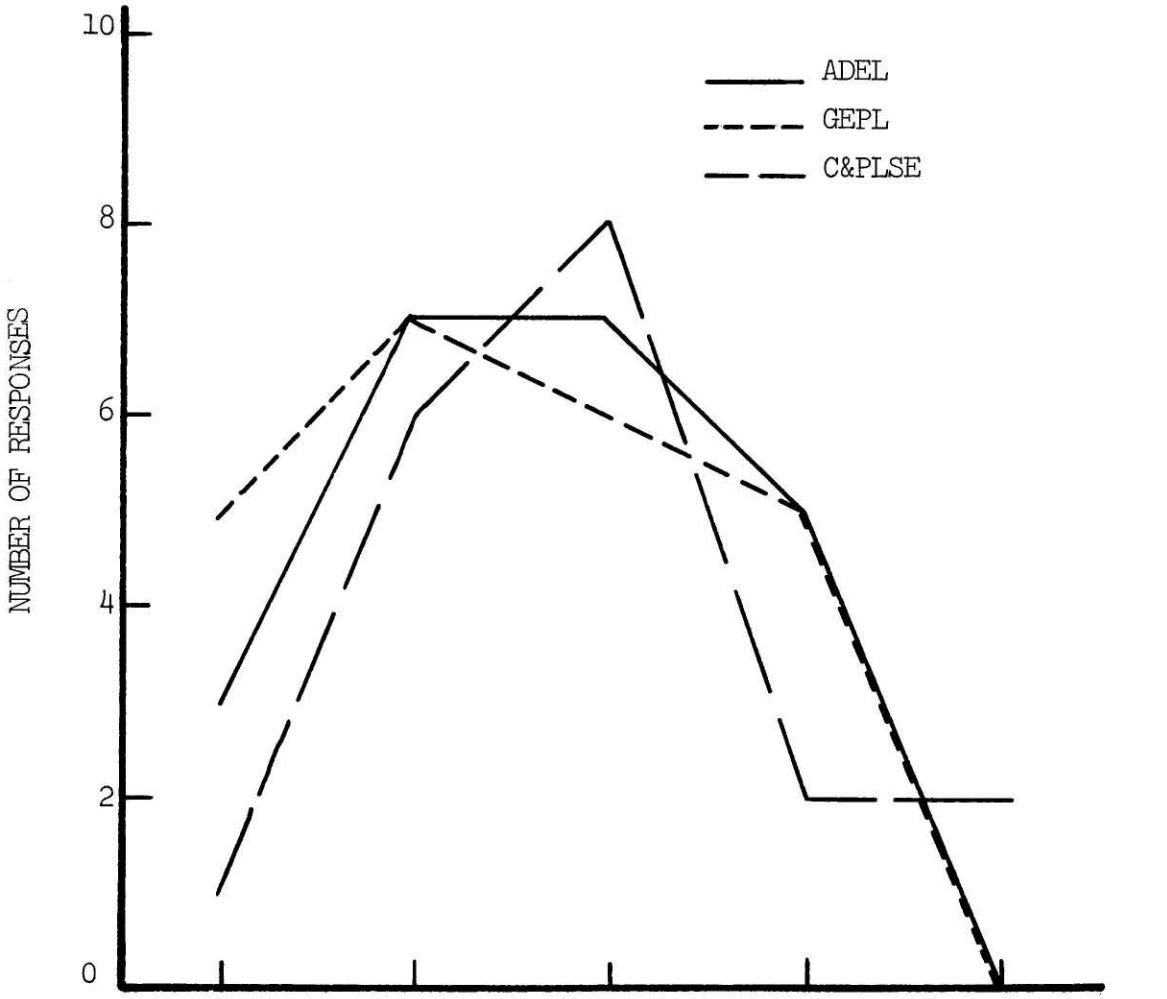


NUMBER OF TASKS 64
TOTAL MAN-YEARS 508.61

FIGURE V-5

COMPARISON OF LABS:

COMPLEXITY OF TASKS

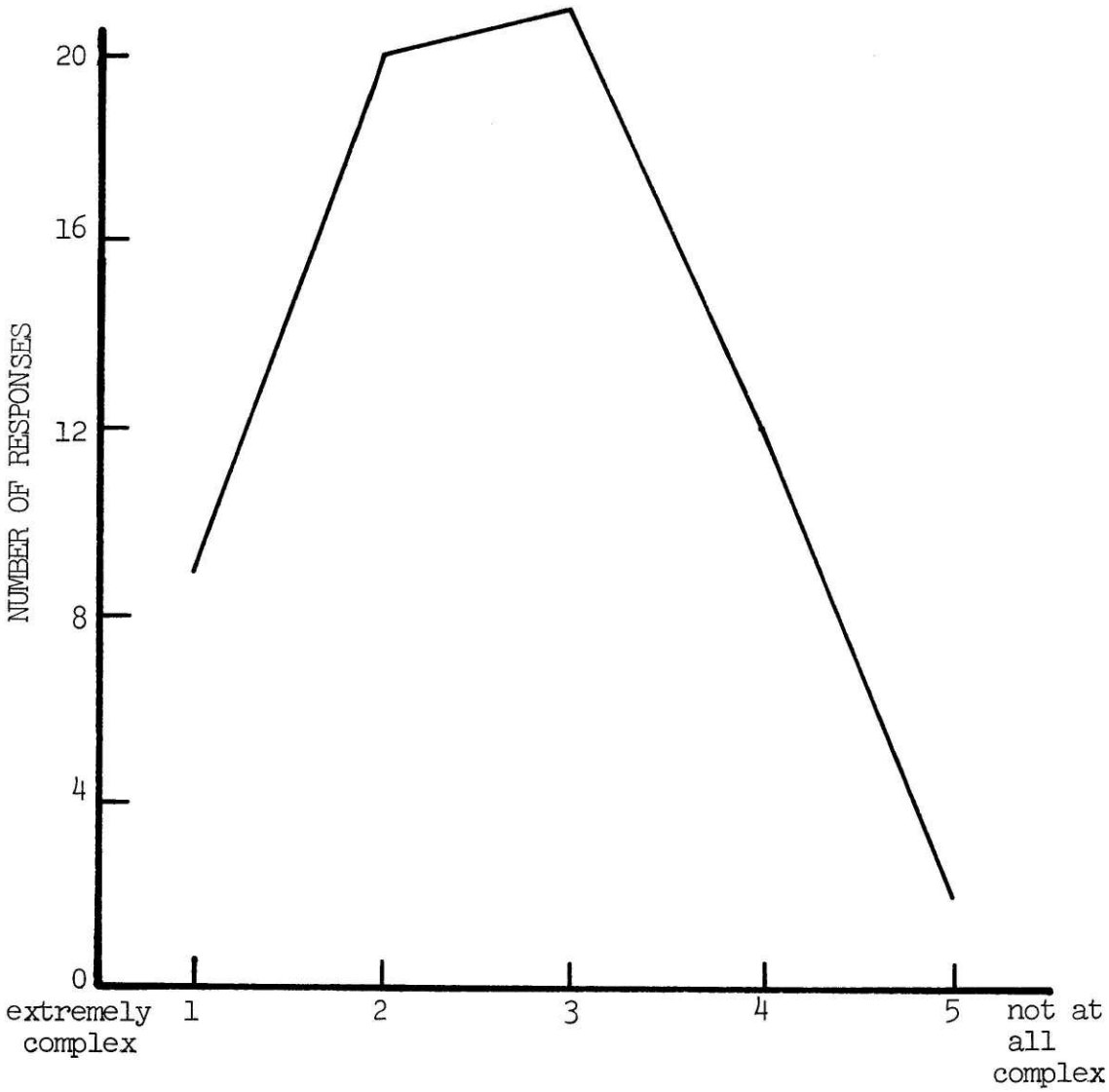


	ADEL	GEPL	C&PLSE
SAMPLE SIZE	22	23	19
CENTRAL TENDENCY	2.64	2.48	2.89

FIGURE V-6

COMPLEXITY OF TASKS

(ALL LABS)

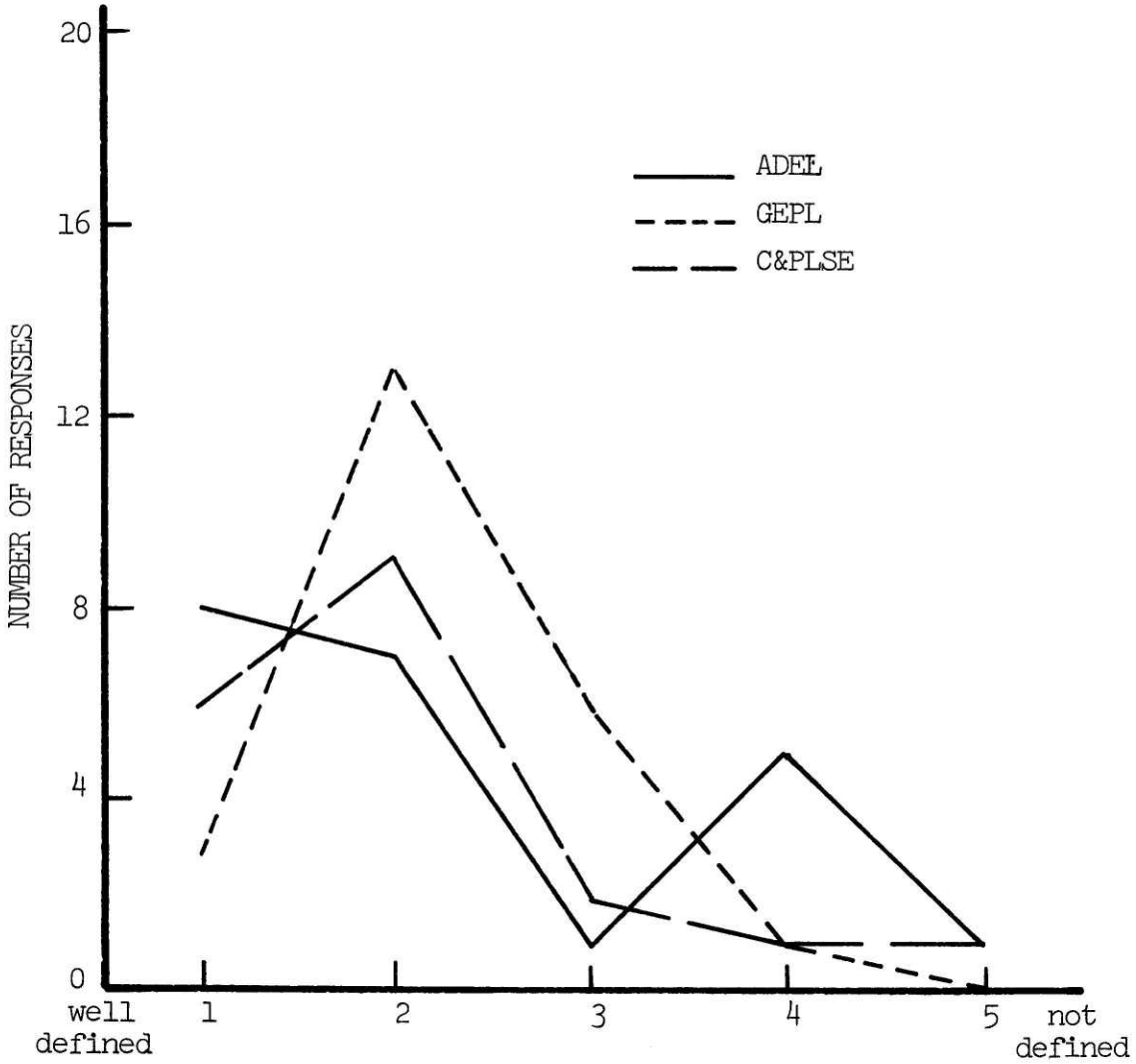


SAMPLE SIZE 64
CENTRAL TENDENCY 2.72

FIGURE V-7

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"How well defined were the major technical objectives at the start of the task?"

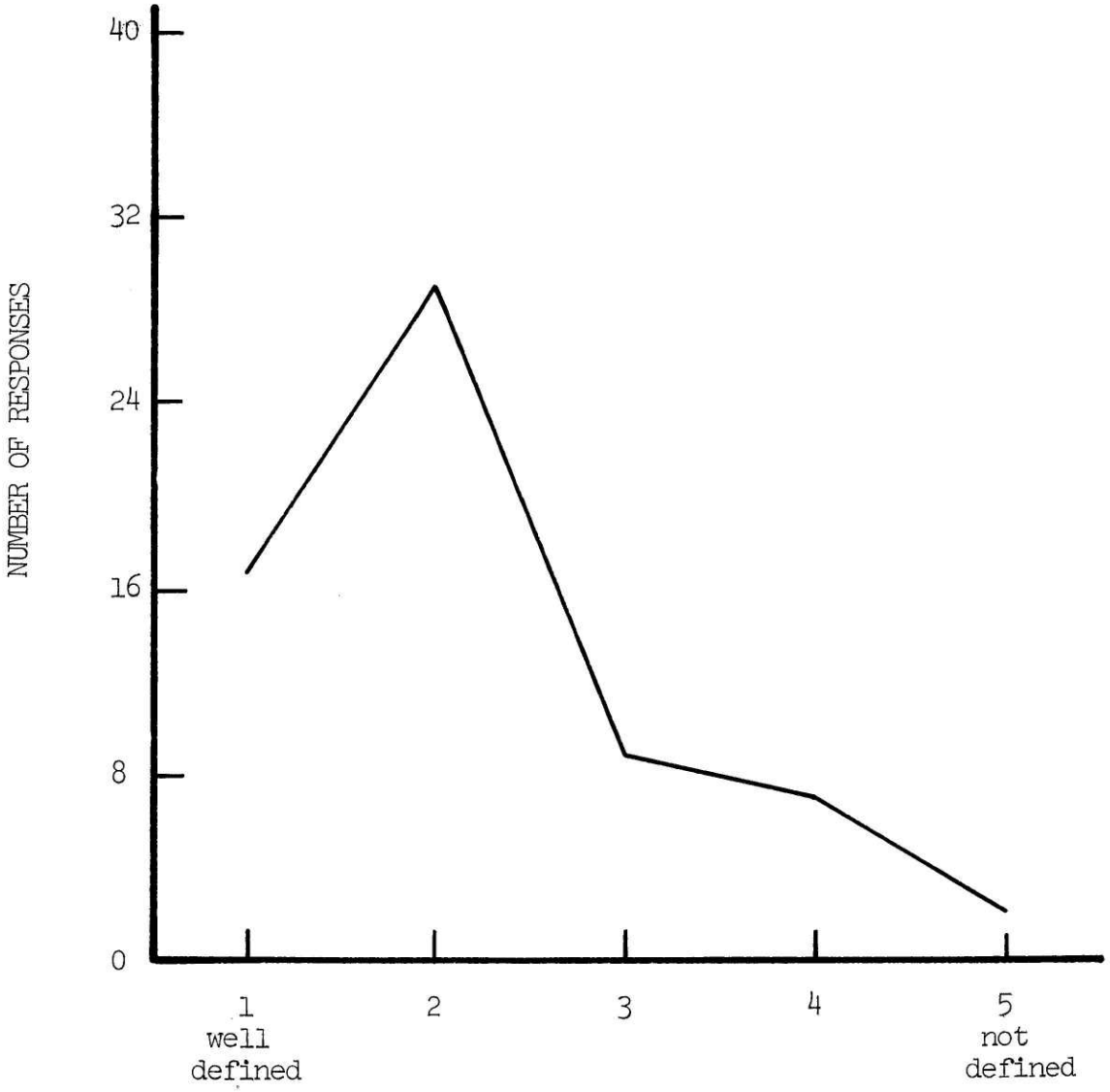


	ADEL	GEPL	C&PLSE
SAMPLE SIZE	22	23	19
CENTRAL TENDENCY	2.27	2.22	2.06

FIGURE V-8

HOW WELL MAJOR TECHNICAL OBJECTIVES

WERE DEFINED (ALL LABS)

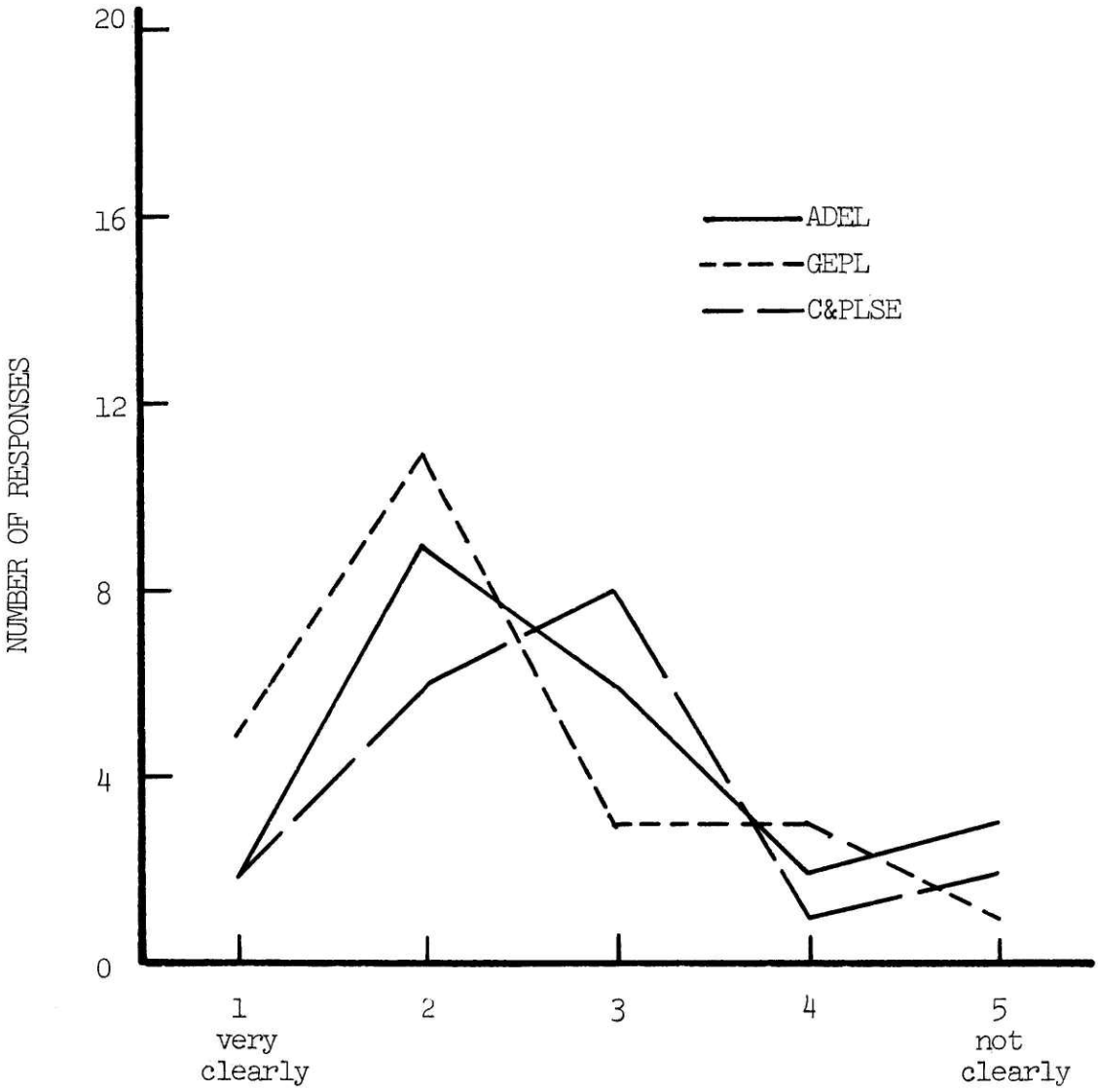


SAMPLE SIZE 64
CENTRAL TENDENCY 2.19

FIGURE V-9

COMPARISON OF LABS IN RESPONSE TO QUESTIONS:

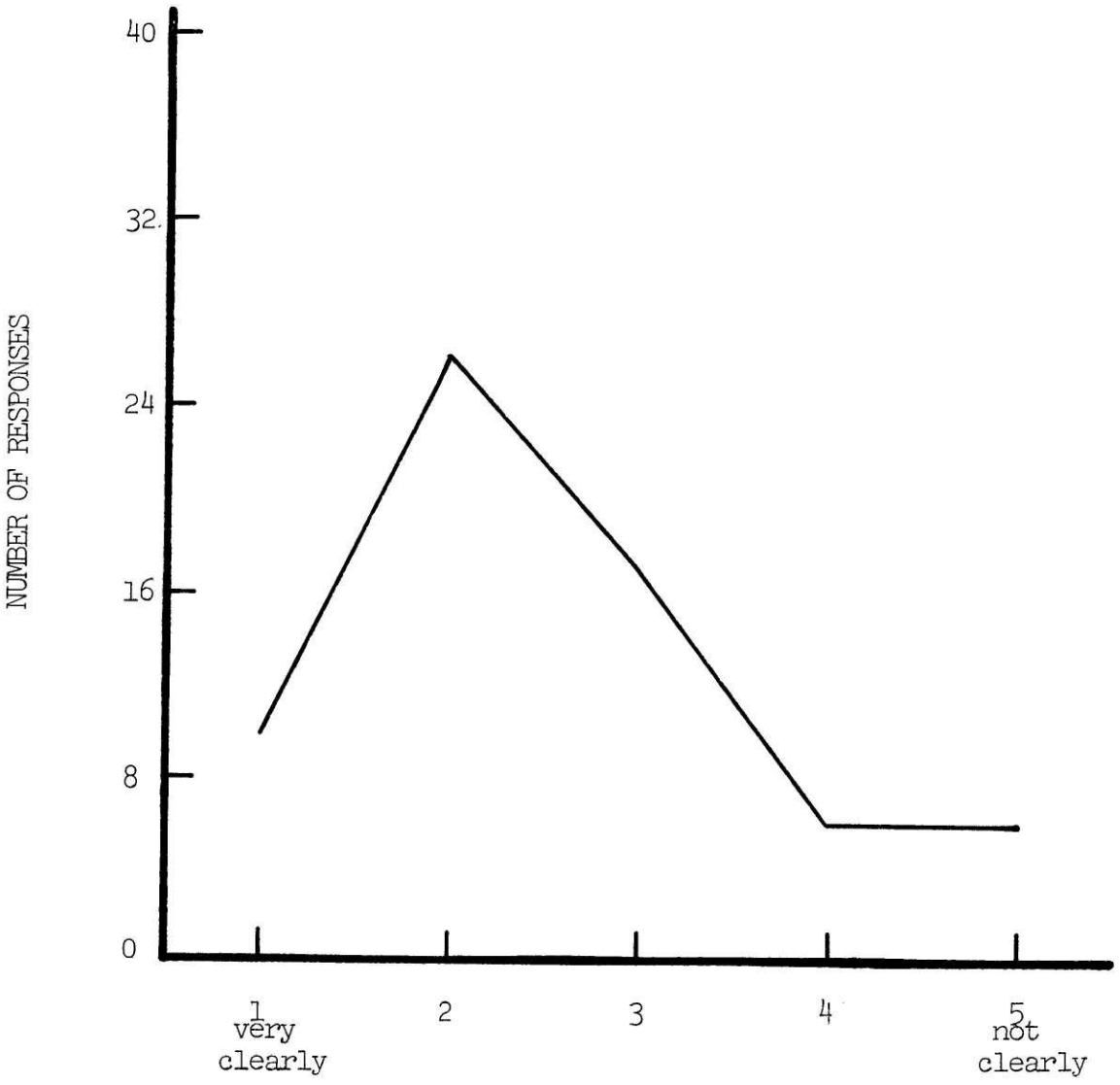
"How clearly were the major technical approaches set out at the start of the task?"



	ADEL	GEPL	C&PLSE
SAMPLE SIZE	22	23	19
CENTRAL TENDENCY	2.77	2.30	2.74

FIGURE V-10

HOW CLEARLY WERE MAJOR TECHNICAL APPROACHES SET OUT AT THE START OF TASKS (ALL LABS)

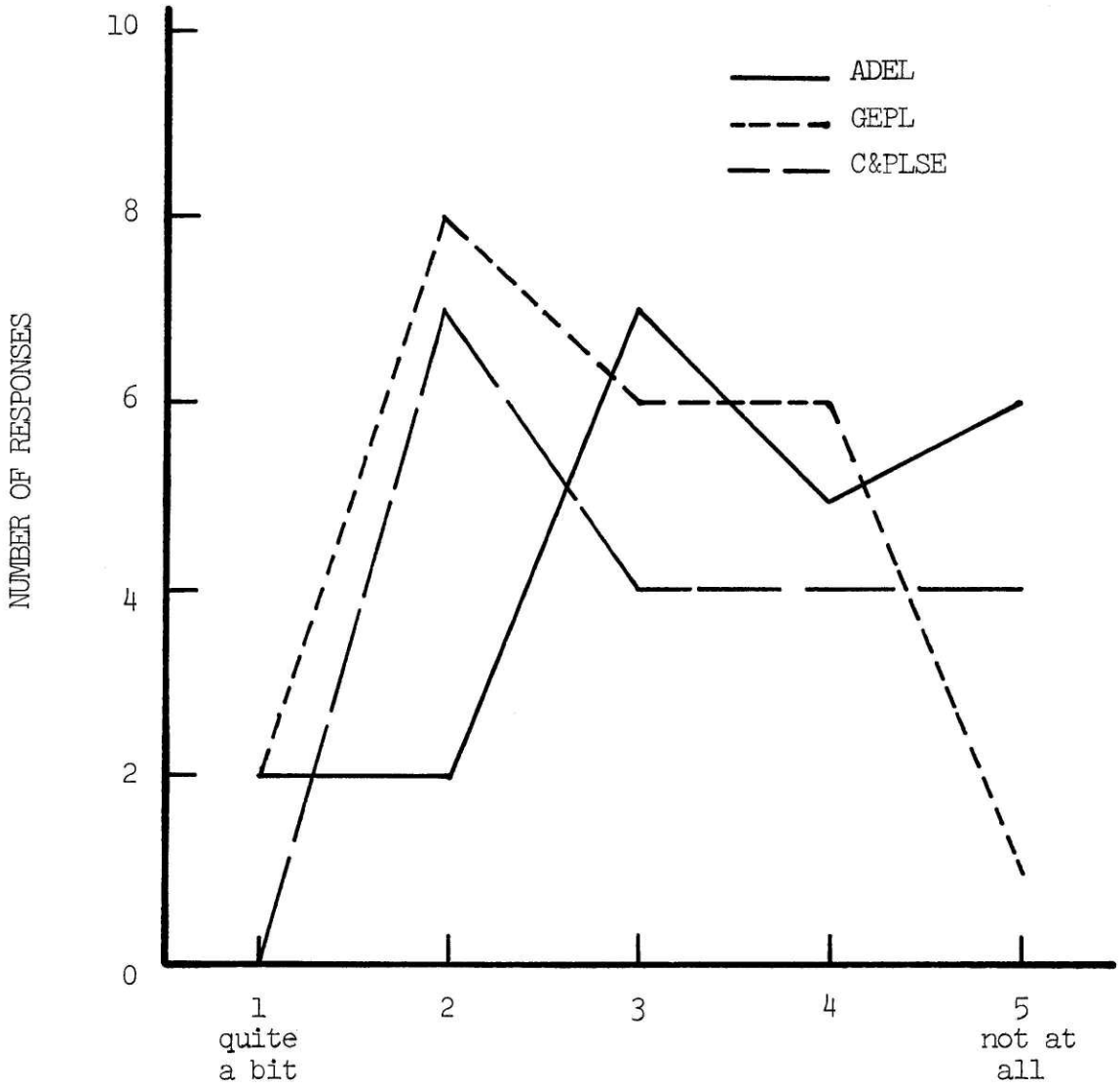


SAMPLE SIZE 64
CENTRAL TENDENCY 2.59

FIGURE V-11

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"To what extent did others contribute to the development and selection of the technical approaches finally used?"

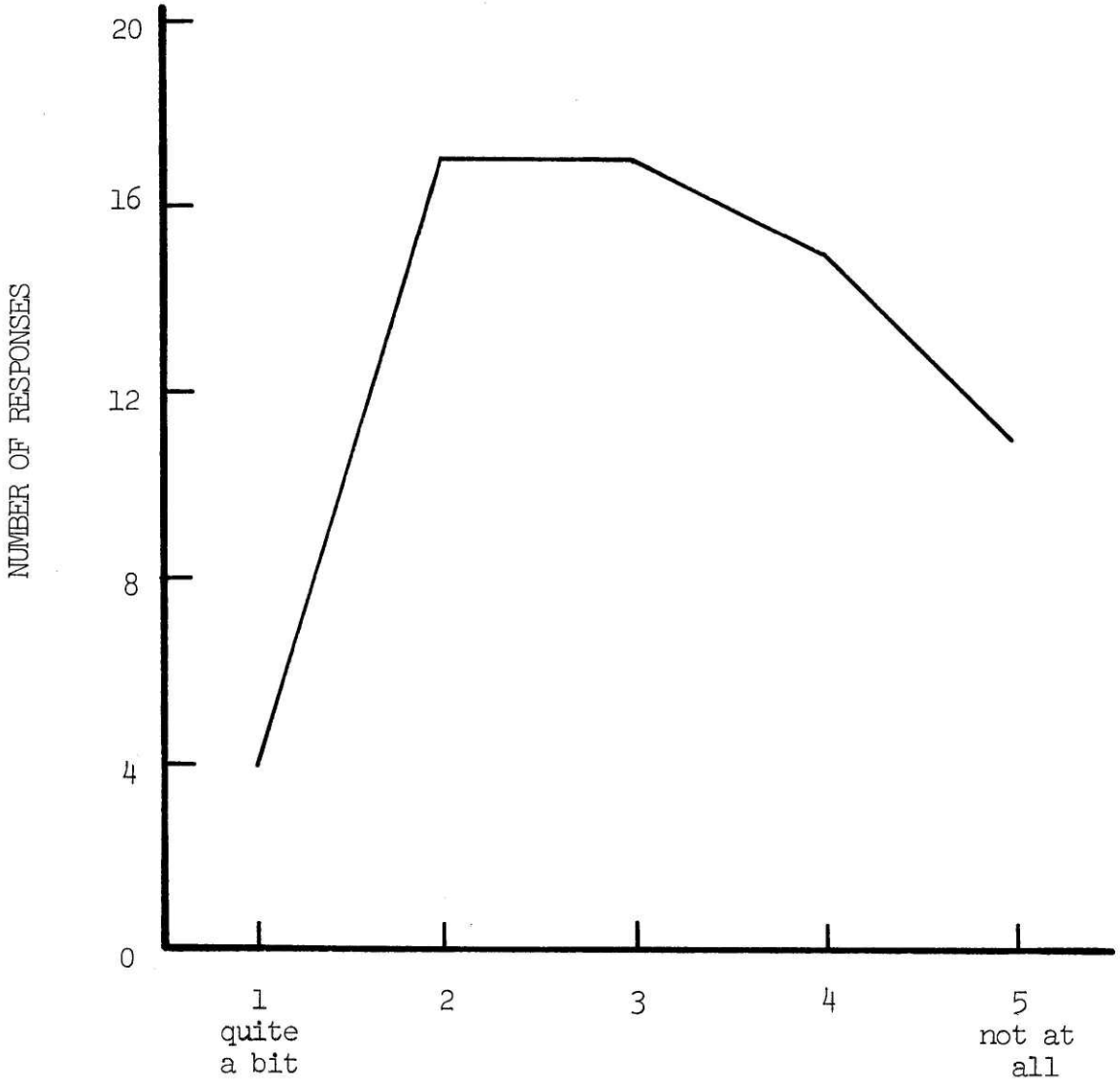


	ADEL	GEPL	C&PLSE
SAMPLE SIZE	22	23	19
CENTRAL TENDENCY	3.50	2.83	3.26

FIGURE V-12

THE EXTENT OTHERS CONTRIBUTED TO THE DEVELOPMENT AND SELECTION OF THE TECHNICAL APPROACHES FINALLY USED

(ALL LABS)

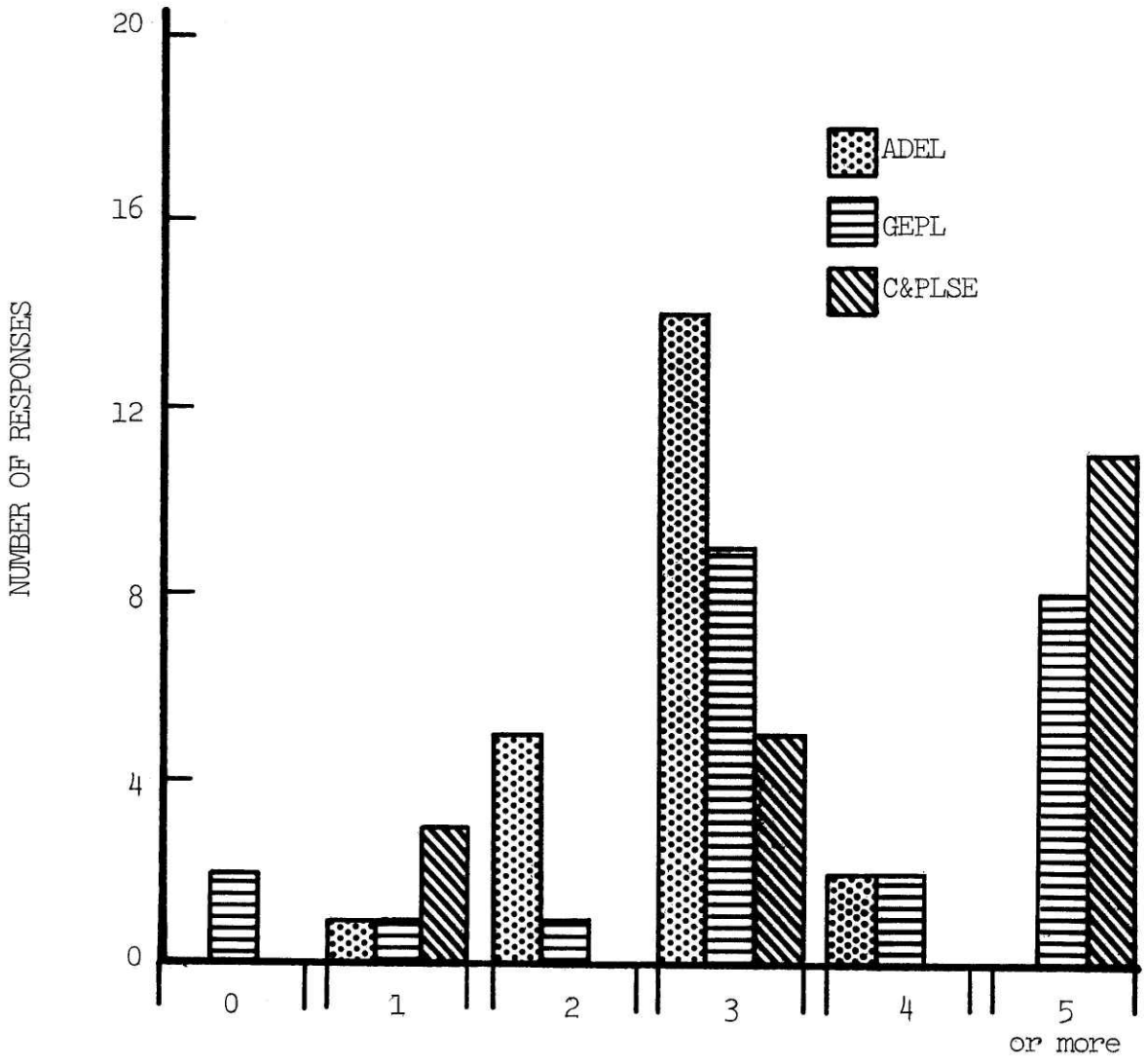


SAMPLE SIZE 64
CENTRAL TENDENCY 3.19

FIGURE V-13

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"At the time you were working on this task, how many other assigned tasks were you actively working on, concurrently?"



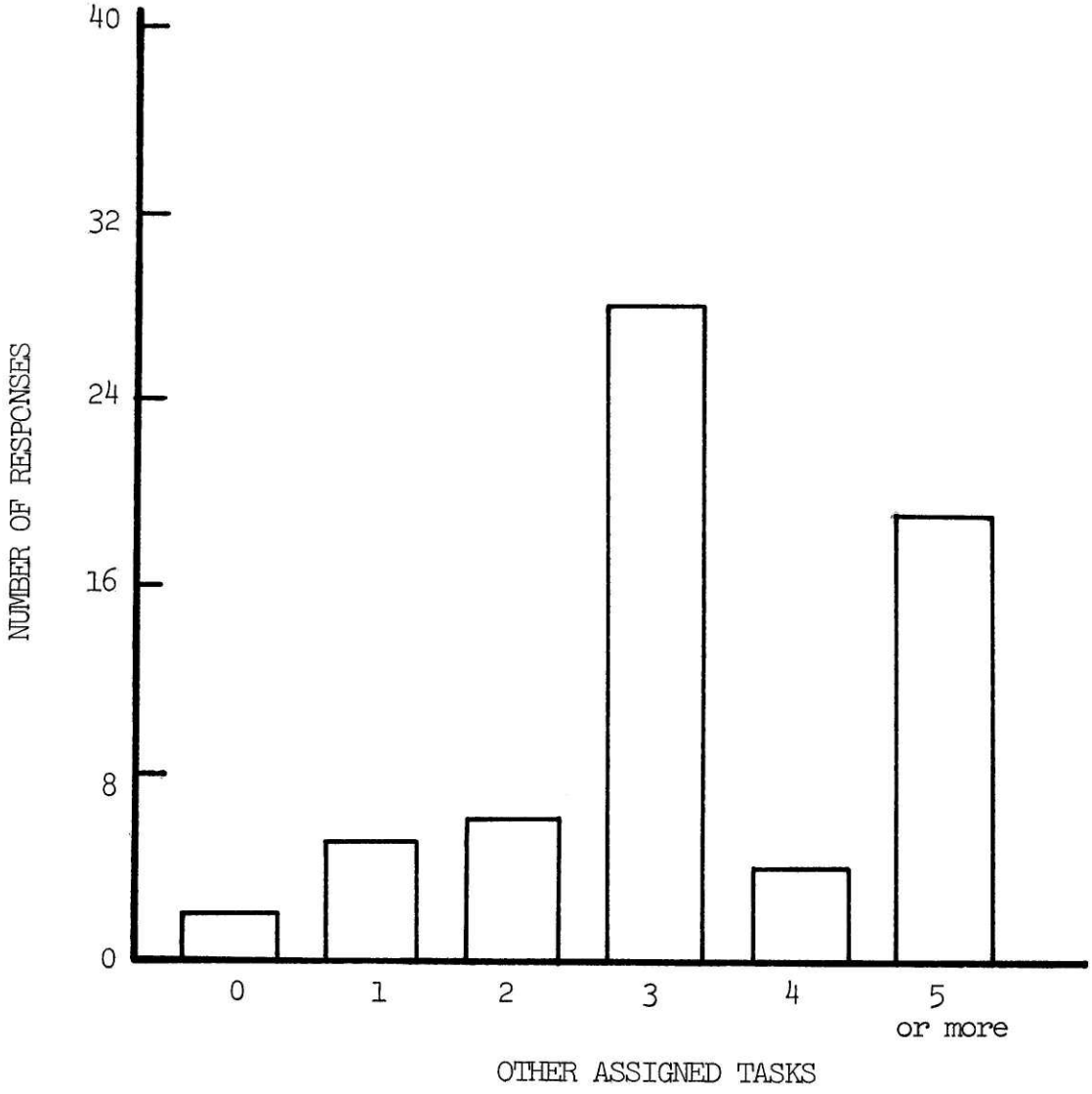
	ADEL	GEPL	C&PLSE
SAMPLE SIZE	22	23	19

FIGURE V-14

NUMBER OF OTHER ASSIGNED TASKS

WORKED ON ACTIVELY AND CONCURRENTLY

WITH TASKS REPORTED ON (ALL LABS)



SAMPLE SIZE 64

FIGURE V-15

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"On the average, what percent of your time was devoted to the task being reported on?"

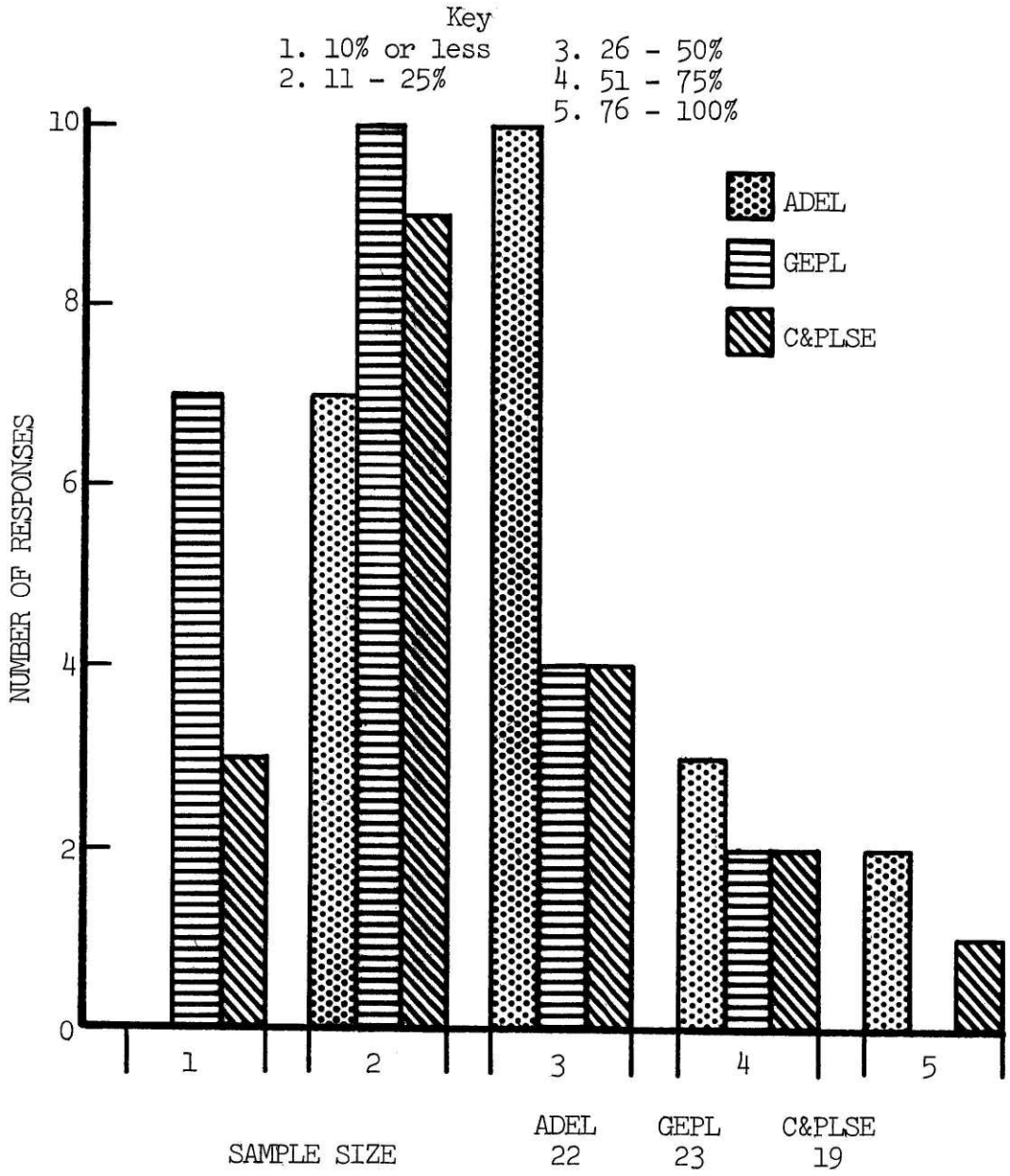
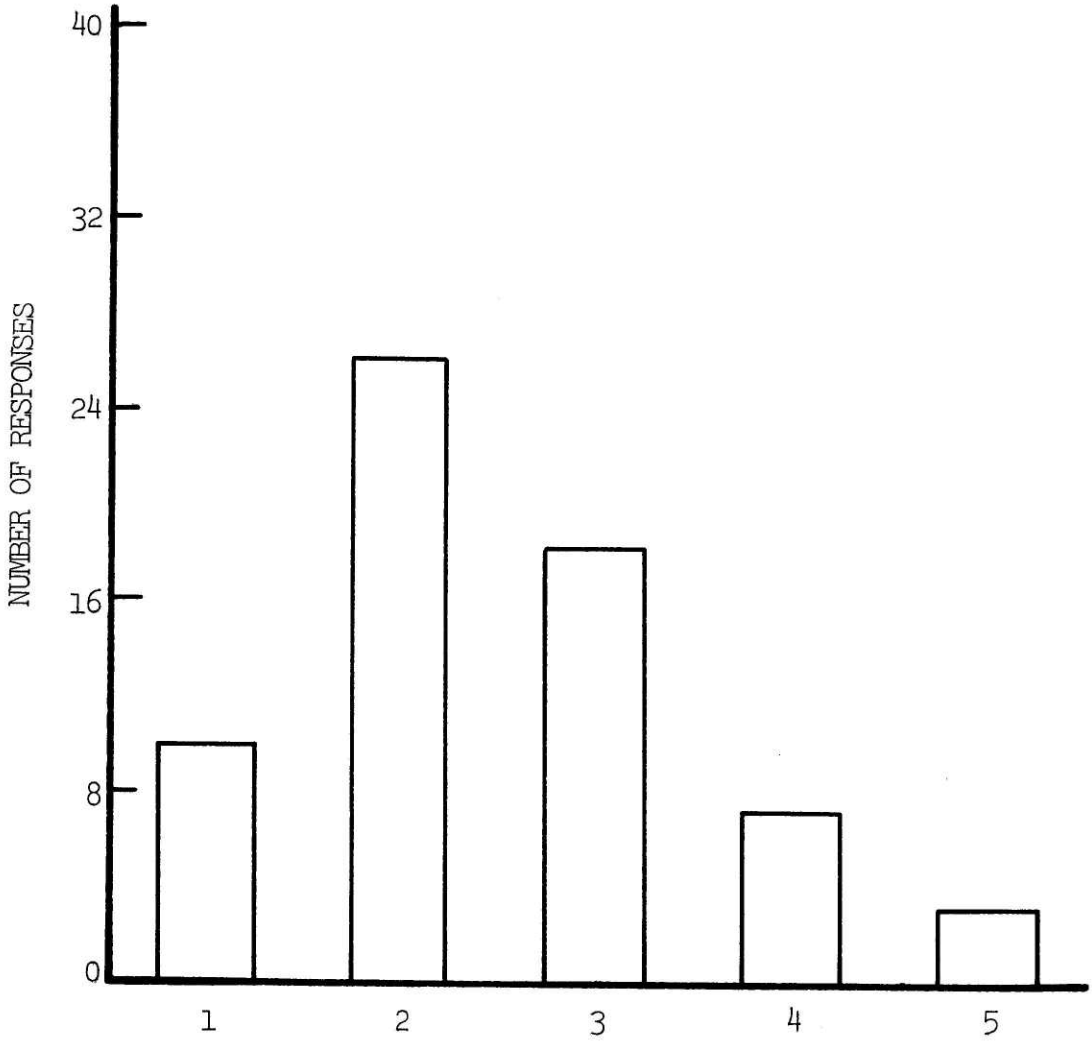


FIGURE V-16

AVERAGE PERCENT OF TIME DEVOTED
TO TASKS BEING REPORTED ON (ALL LABS)

Key

1. 10% or less
2. 11-25%
3. 26-50%
4. 51-75%
5. 76-100%



SAMPLE SIZE 64

FIGURE V-17

COMPARISON OF LABS:

PRIMARY FACTORS IN

UNDERTAKING TASKS

PRIMARY FACTORS	ADEL		GEPL		C&PLSE	
	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total	22	100	23		19	100
Technical factors	15	68	14	61	14	74
Technical opportunity perceived for a new or improved end-item or system						
User factors	7	32	9	39	5	26
Direct response to specific or perceived user requirements (needs)						

ALL LABORATORIES:	NO.	PERCENT
Total	64	100
Technical factors:	43	67
User factors:	21	33
Ratio of user to Technical factors:	0.49	

CHAPTER VI

DISCUSSION OF TASK OUTCOMES

This Chapter presents the results of the responses to question 12 through 15. These questions pertain to task outcomes in terms of schedule, funds, scope of work, and technical quality. These same outcome factors are used in question 16 to relate major problems encountered to task outcomes. In effect, the response to question 16 is used to explain the task outcomes discussed in this Chapter. The frame of reference or yardstick used in questions 12 through 14 is "as originally planned". In question 15, the reference point on a scale of five is three, "same as expected".

Schedule of Tasks

The response to question 12 on task schedules is presented in FIGURES VI-1, VI-2, and VI-3 in progressively more aggregate form. FIGURE VI-1 shows data by individual laboratory, FIGURE VI-2 for ALL LABS, and FIGURE VI-3 whether schedule was less, same, or greater than originally planned. The schedule overruns for each laboratory appear most frequently in the "1 - 1 1/4 greater than planned" range. Also for each laboratory, there are a fairly large number of tasks with schedules exceeding 1 1/4 greater than planned. The data show that on the average, schedule overruns are most frequently experienced in C&PLSE, less in GEPL and least in ADEL. Considering all laboratories together, 26 out of 64 tasks or about 40 percent of the tasks experienced overruns between one and one-quarter of that originally planned. When aggregating all responses in terms of less, same, and greater than

planned, FIGURE VI-3 shows that about 90 percent of all tasks experienced schedule overruns of some degree. Only 6 percent of the tasks were on schedule and some 3 percent were accomplished in less time than originally planned. In interpreting the responses, one should be cautioned that there are many good and sufficient reasons for schedules to be extended beyond the originally planned date. Many of these reasons are identified in the analysis of major problems encountered which is covered in the next chapter. Nevertheless , there is such a high frequency of schedule overruns, it would seem advisable for management to focus greater attention on this aspect of task accomplishment. It is conceivable that the core of the difficulty in maintaining schedules lies in such directions as:

1. Inadequate support to project officers
2. Unrealistic scheduling of various activities related to task accomplishment
3. Lack of local management control of major events in the life-cycle of tasks
4. Not enough incentives to motivate project officers to give scheduling greater priority and importance in the management of their tasks

Evidence of the fourth point can be seen in FIGURE IV-10 wherein scheduling was considered by only three percent of the project officers as being the most important regarding task accomplishment among the three factors; goals, schedules, and funds. The reason for the low priority

given cannot be that project officers are not aware of the importance that laboratories attach to schedules. For in FIGURE IV-12, over fifty percent of the project officers reported that they felt that laboratories regarded schedules as the most important factor of the three. This awareness no doubt results from the continued attention given by higher levels of management to task "slippages".

Amount of Funds Used

Data on the amount of funds used (question 13) on tasks are plotted in FIGURES VI-4 through VI-6. The same scale of parameters and levels of aggregration that are used for schedules are applied to the data on funds. There is a noticeable difference in the extent of overruns in funds among the three laboratories. On the average, FIGURE VI-4 shows that the fund overruns experienced in ADEL are the greatest, C&PLSE next, and GEPL least. All laboratories considered, the average overrun falls into the 1-1 1/4 greater than planned range. About 62 percent of the tasks experienced overruns of 1 1/4 greater than planned or less, while a little over 60 percent of the tasks experienced some amount of overrun. The response regarding funds is somewhat more favorable than that for schedules in that overruns are less. In comparison, this result is surprising since not one project officer reported funds as the most important factor to him in task accomplishment (FIGURE IV-10) and only 15 percent felt the laboratories considered funding as the most important factor (FIGURE IV-12). Again, a cautionary note is in order in interpreting too much from these figures on fund useage without reference to the major problems encountered (see Chapter VII).

Scope of Work

The response to question 14, "What was the scope of work accomplished under the task?" is presented in FIGURES VI-7 through VI-9. On the average, the scope of work accomplished on tasks in C&PLSE is less than planned, in ADEL about as planned, and in GEPL more than planned. It is interesting to note the relatively flat distribution of the responses for C&PLSE and that 8 out of 18 or about 45 percent of the tasks reported on by this laboratory, the scope of work was reduced. For GEPL, about 50 percent of the tasks experienced increases in scope of work, compared to about 25 percent for ADEL. For all laboratories, the responses are quite symmetrically distributed around, "same as planned". The scope of work for about 44 percent of the tasks is the same, 23 percent less, and about 33 percent greater than planned. Considering all laboratories as a single group, the deviations from "same as planned" are much less for scope of work compared to either the schedule or fund distribution (FIGURES VI-3 and VI-6).

Technical Quality

In question 15, project officers are asked to estimate the technical quality of the outcome of their tasks. Their responses are shown in FIGURES VI-10 through VI-12. Of the 61 total responses received, 36 or 59 percent estimated technical quality of task outcome to be higher than expected, 33 percent the same, and 8 percent lower than expected. For ADEL, alone, the responses are much more concentrated than the other two laboratories and on the average fall closer to the "much higher than

expected" end point. The distribution of responses for GEPL and C&PLSE shows a rather strong concentration around the "same as expected" mid-point and has a larger spread of data than the distribution of responses for ADEL. The rather small percentage of tasks (8 percent) falling within the "lower than expected quality" range is consistent with and partially explained by the great amount of importance project officers attach to "meeting technical goals" (FIGURE IV-10).

FIGURE VI-1

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"What was the approximate schedule of the task?"

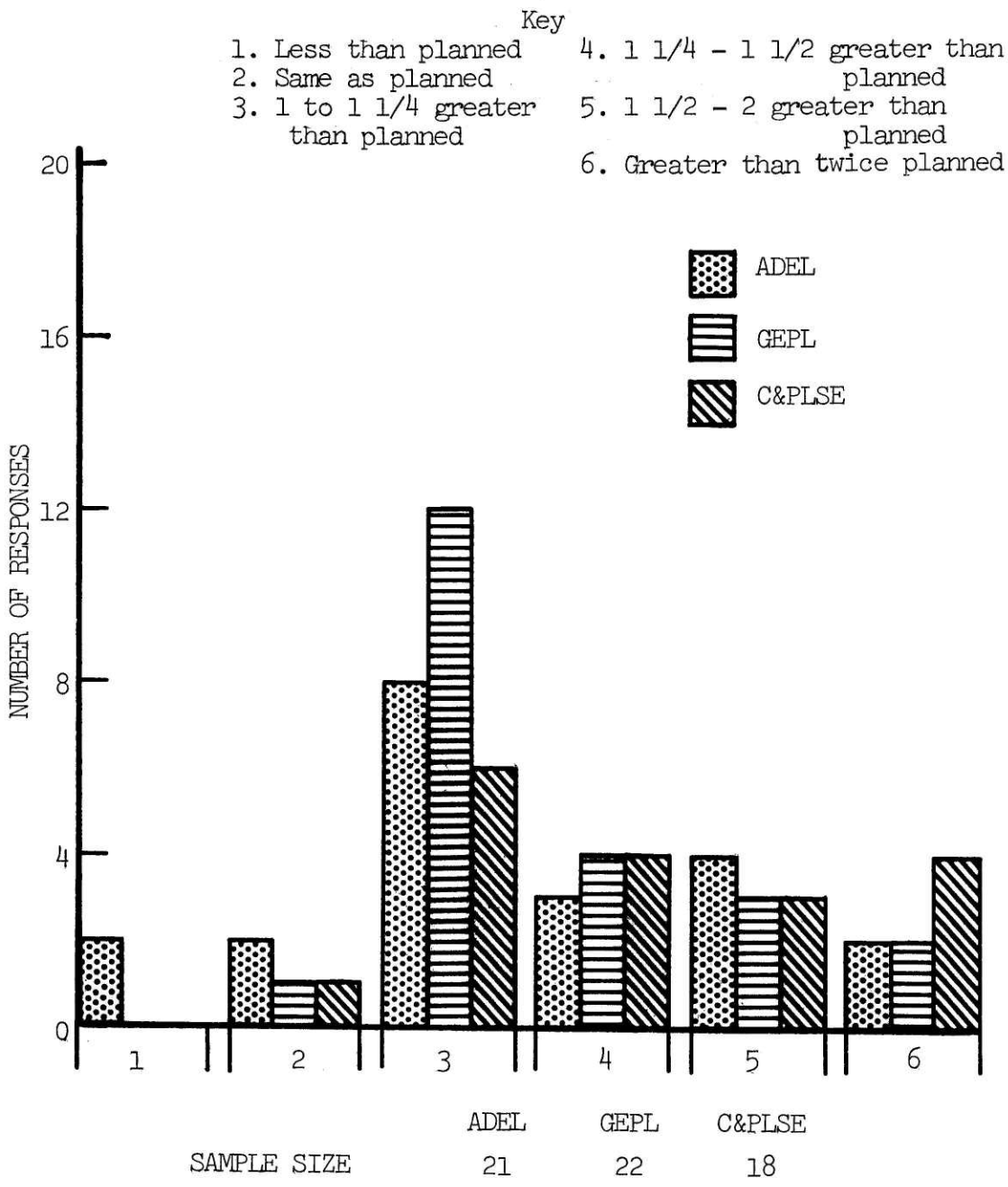
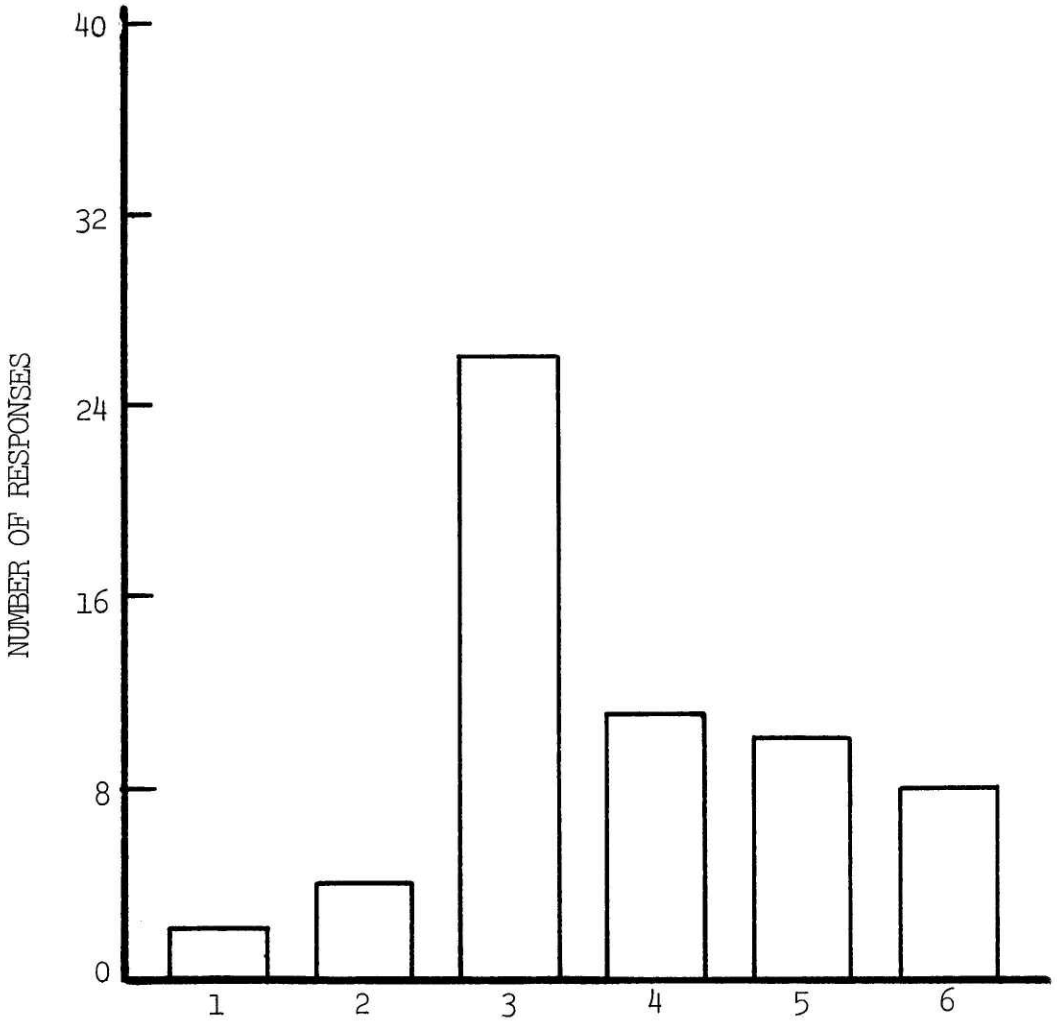


FIGURE VI-2

APPROXIMATE SCHEDULE OF TASKS (ALL LABS)

Key

1. Less than planned
2. Same as planned
3. 1 - 1 1/4 greater than planned
4. 1 1/4 - 1 1/2 greater than planned
5. 1 1/2 to 2 greater than planned
6. Greater than twice planned

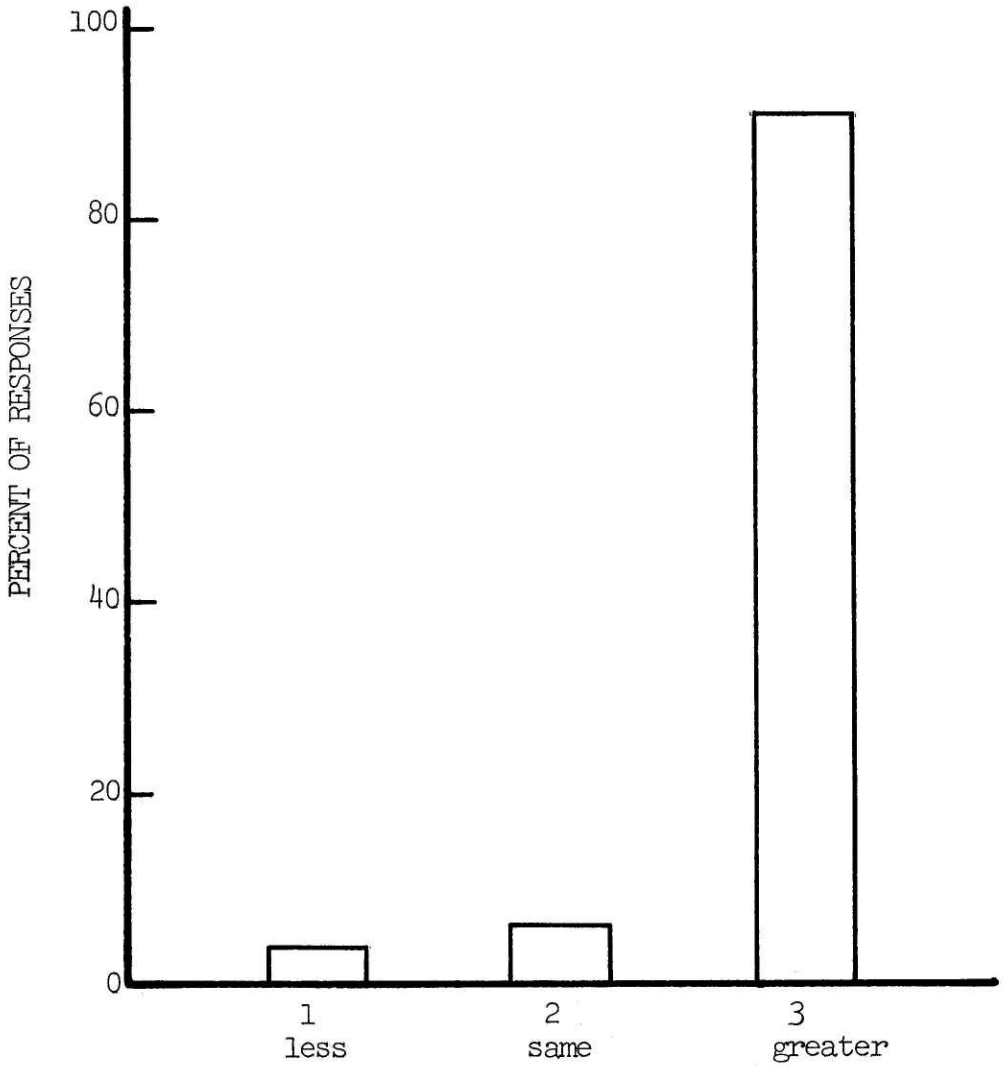


SAMPLE SIZE 61

FIGURE VI-3

OVERALL SCHEDULE OF TASKS (ALL LABS)

Key
1. Less than planned
2. Same as planned
3. Greater than planned



SAMPLE SIZE 61

FIGURE VI-4

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"What was the amount of funds used on the task?"

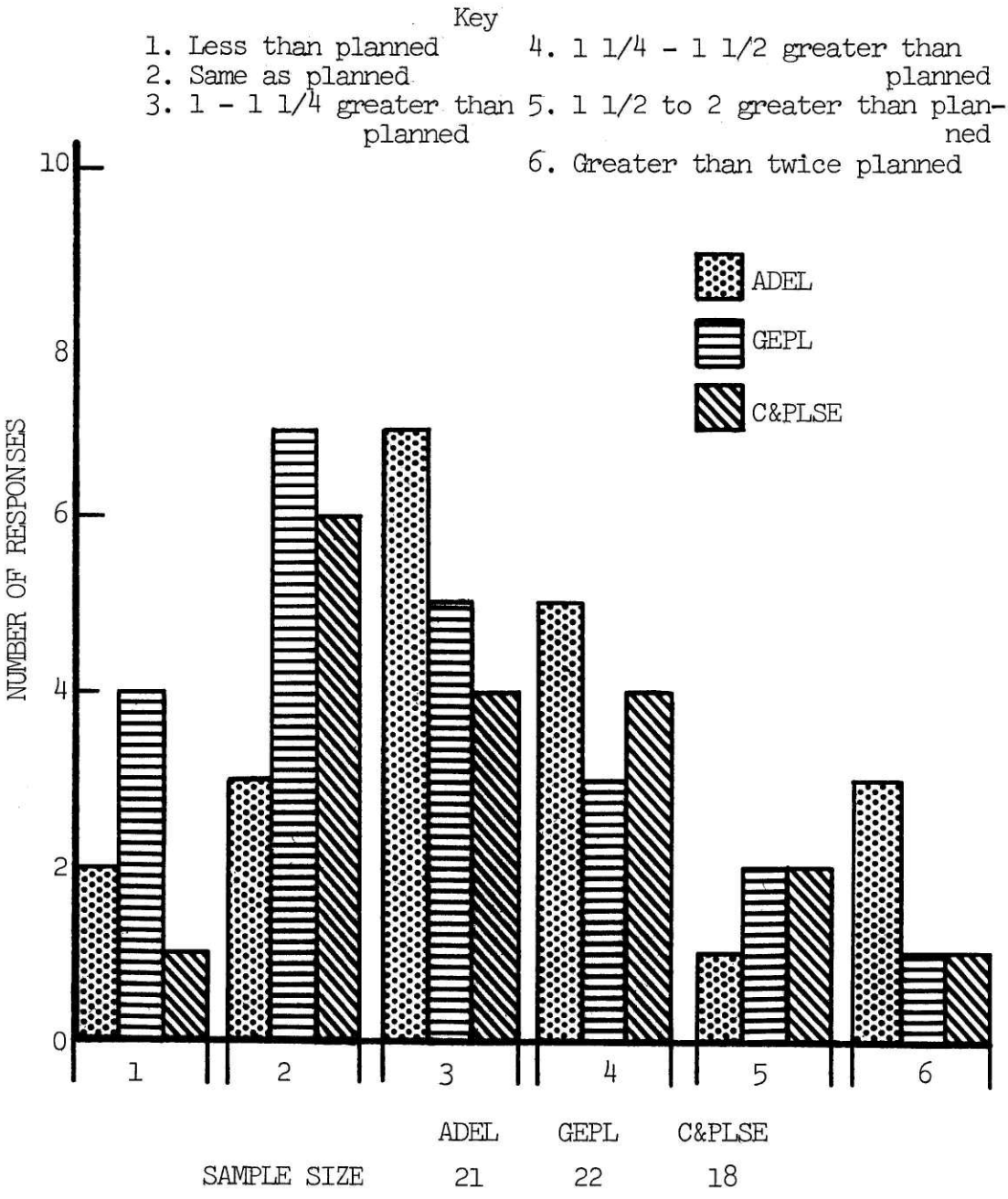
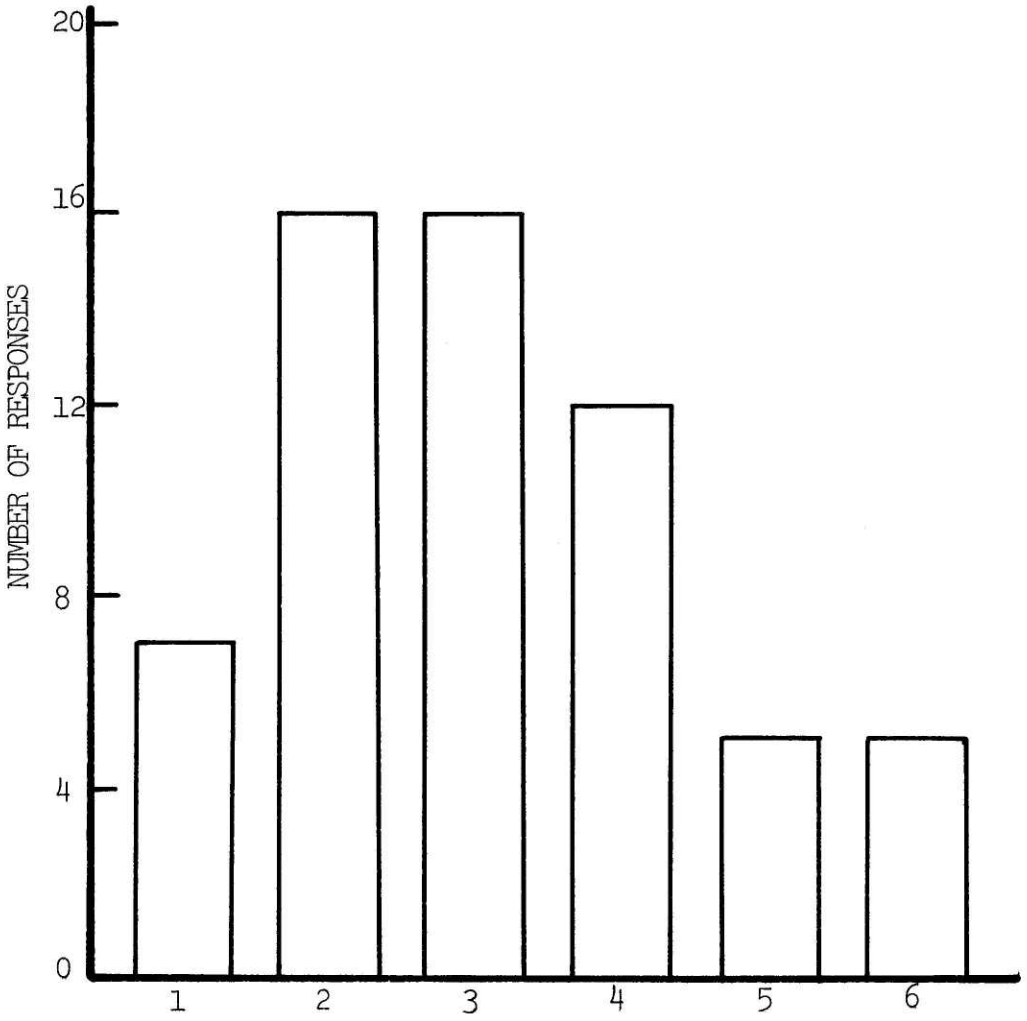


FIGURE VI-5

AMOUNT OF FUNDS USED ON TASKS (ALL LABS)

Key

1. Less than planned
2. Same as planned
3. 1 - 1 1/4 greater than planned
4. 1 1/4 - 1 1/2 greater than planned
5. 1 1/2 - 2 greater than planned
6. Greater than twice planned

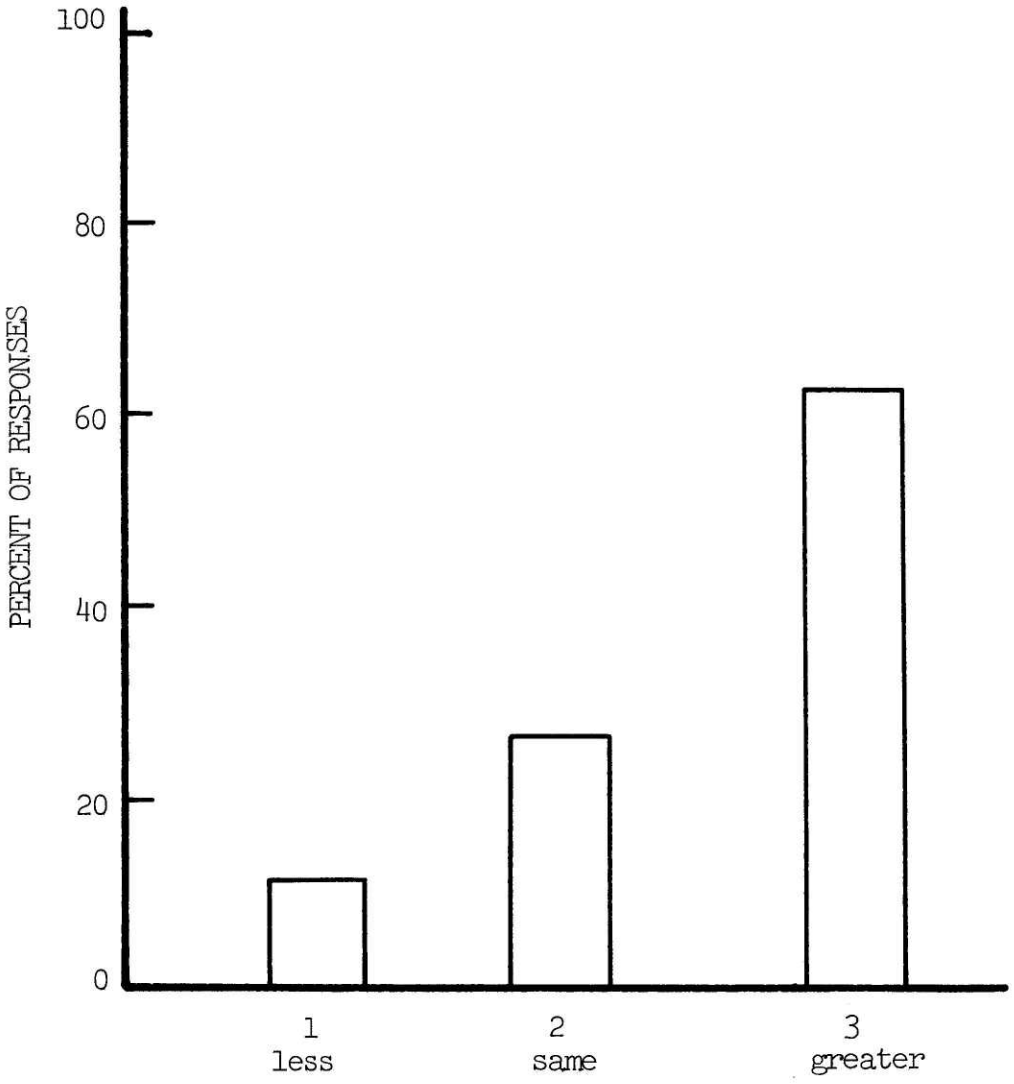


SAMPLE SIZE 61

FIGURE VI-6

OVERALL FUNDS USED ON TASKS (ALL LABS)

Key
1. Less than planned
2. Same as planned
3. Greater than planned



SAMPLE SIZE 61

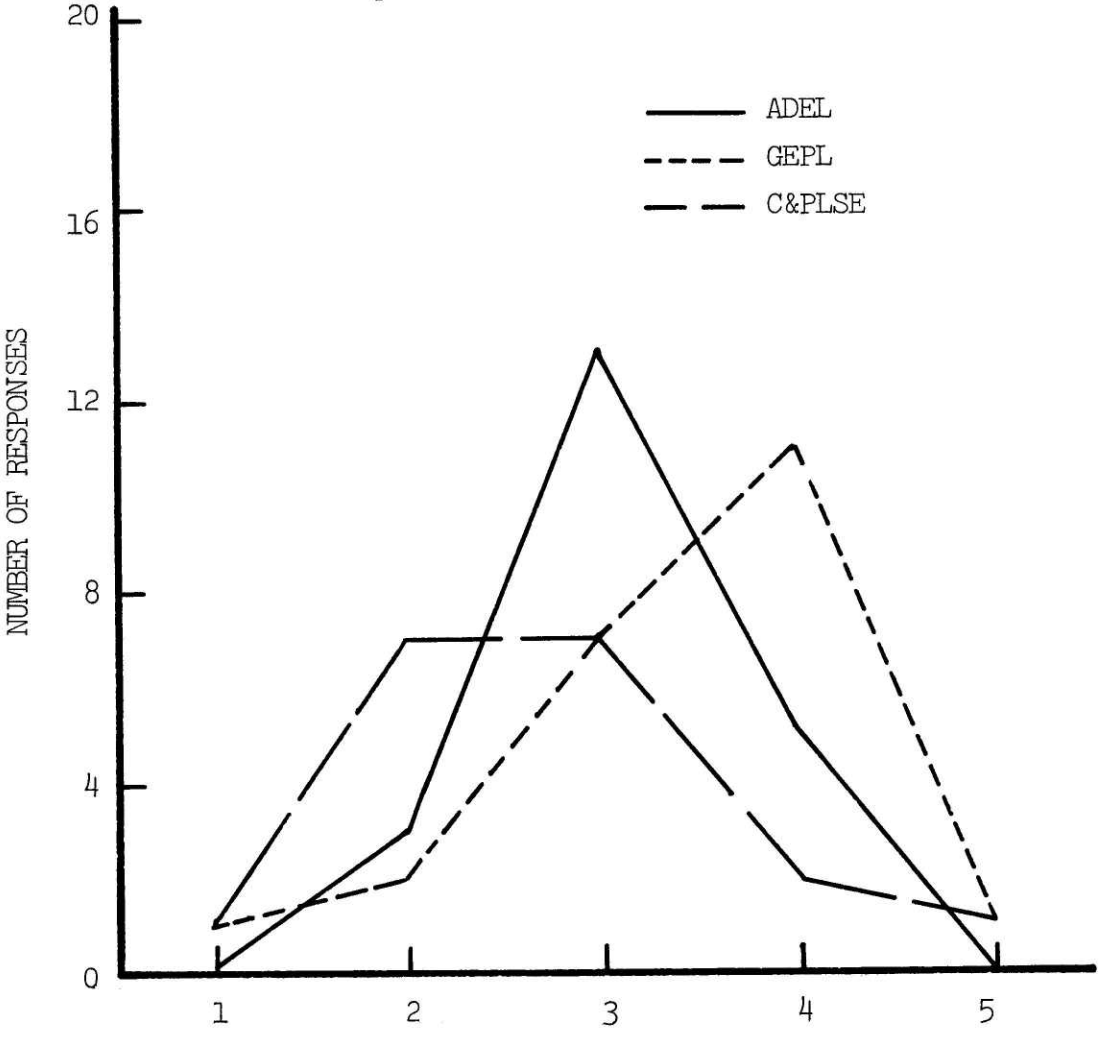
FIGURE VI-7

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"What was the scope of work accomplished under the task?"

Key

1. Much less than planned
2. Less than planned
3. Same as planned
4. more than planned
5. much more than planned



	ADEL	GEPL	C&PLSE
SAMPLE SIZE	21	22	18
CENTRAL TENDENCY	3.09	3.41	2.72

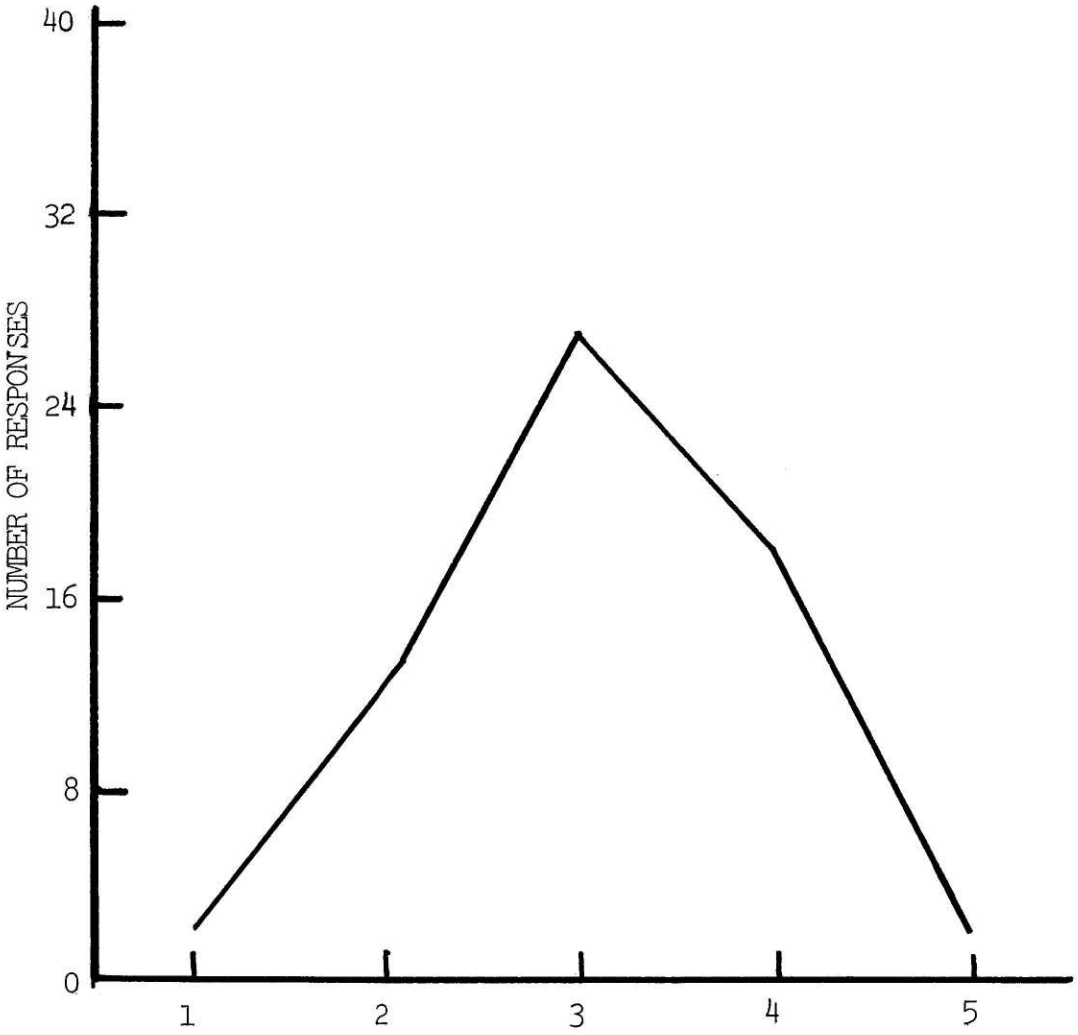
FIGURE VI-8

SCOPE OF WORK ACCOMPLISHED

UNDER TASKS (ALL LABS)

Key

1. Much less than planned
2. Less than planned
3. Same as planned
4. More than planned
5. Much more than planned

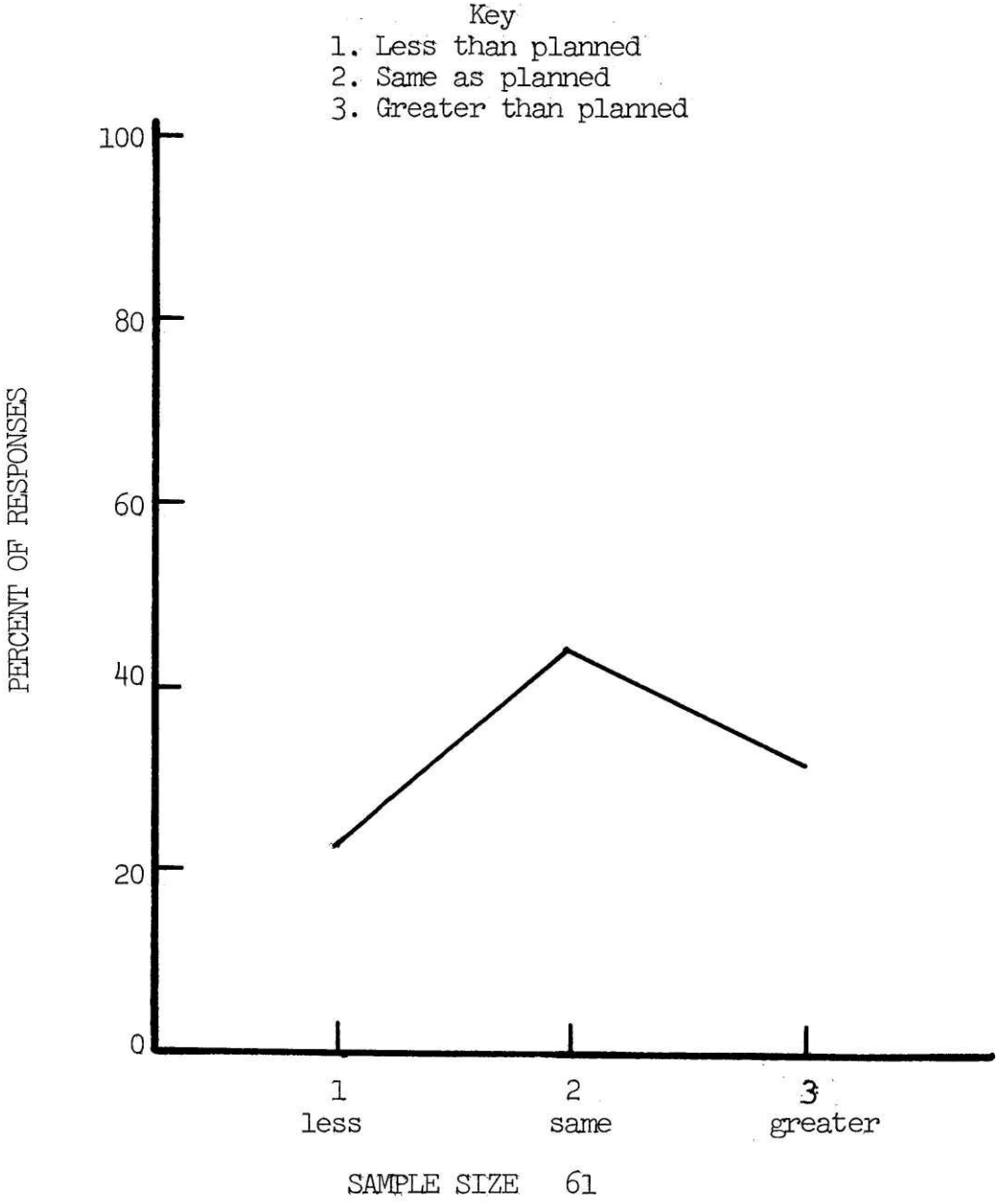


SAMPLE SIZE 61
CENTRAL TENDENCY 3.10

FIGURE VI-9

OVERALL SCOPE OF WORK

ACCOMPLISHED (ALL LABS)

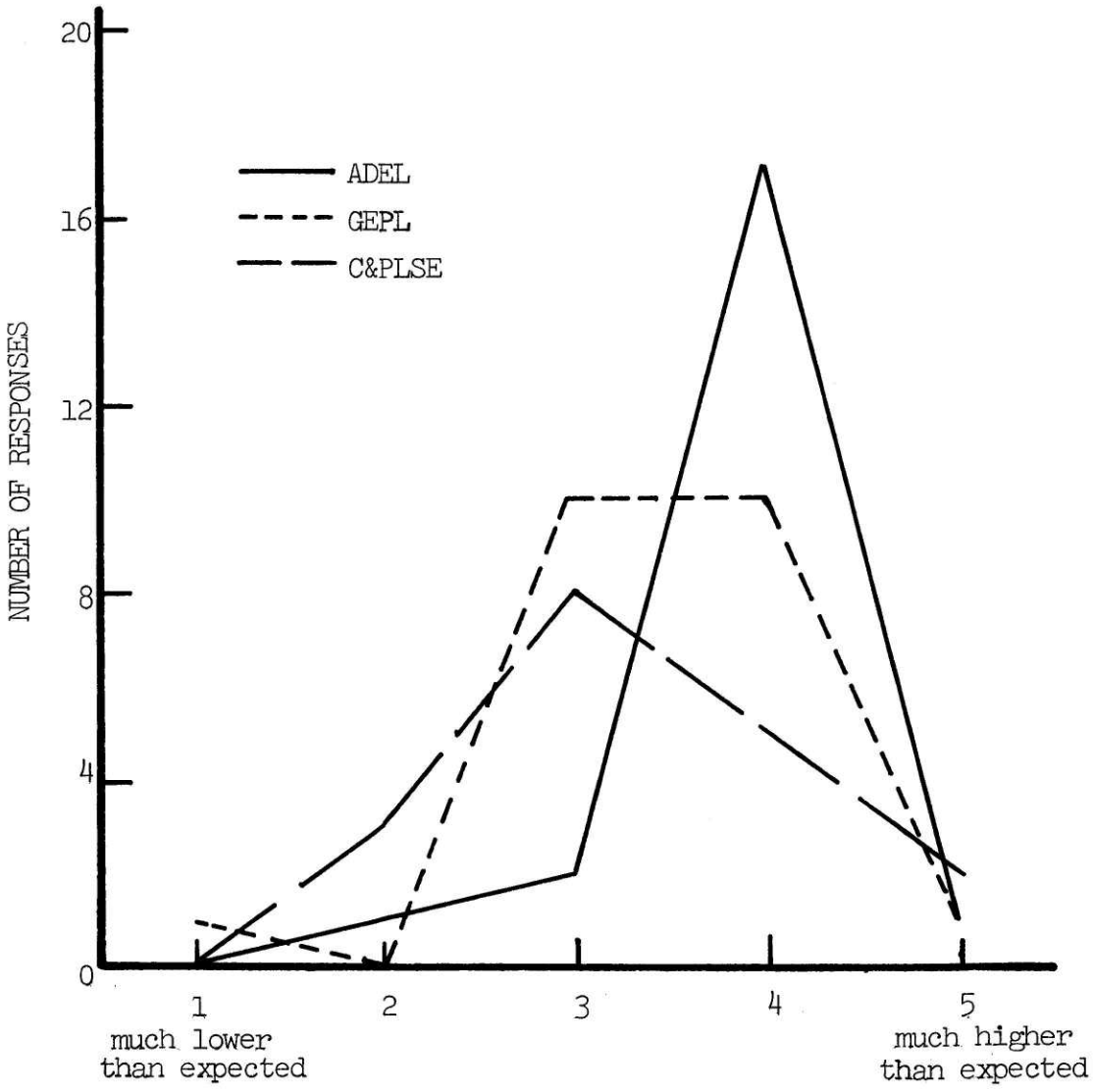


SAMPLE SIZE 61

FIGURE VI-10

COMPARISON OF LABS IN RESPONSE TO QUESTION:

"How would you estimate the technical quality of the outcome of the task?"



	ADEL	GEPL	C&PLSE
SAMPLE SIZE	21	22	18
CENTRAL TENDENCY	3.86	3.45	3.33

FIGURE VI-11

TECHNICAL QUALITY OF OUTCOMES

OF TASKS (ALL LABS)

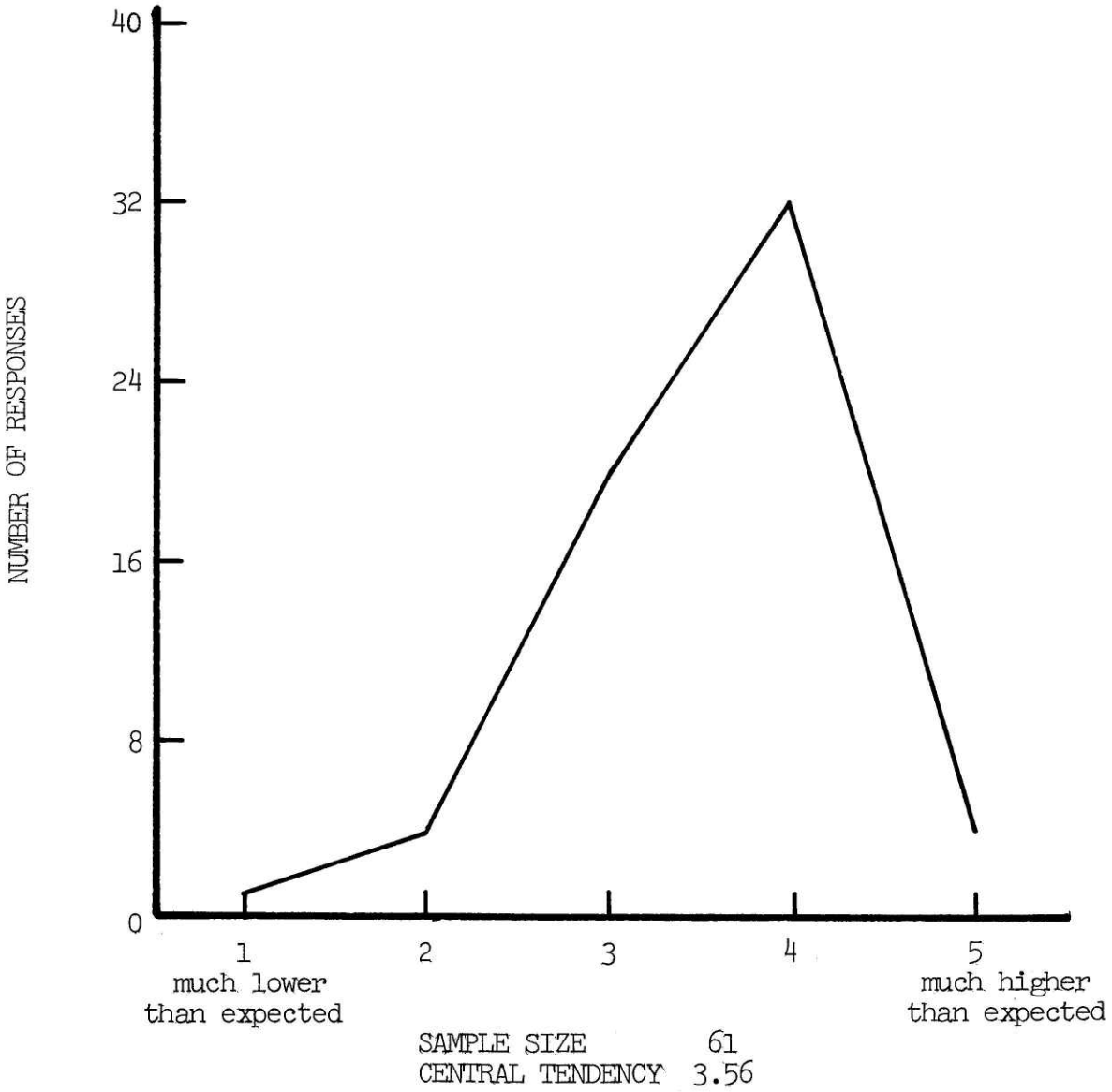
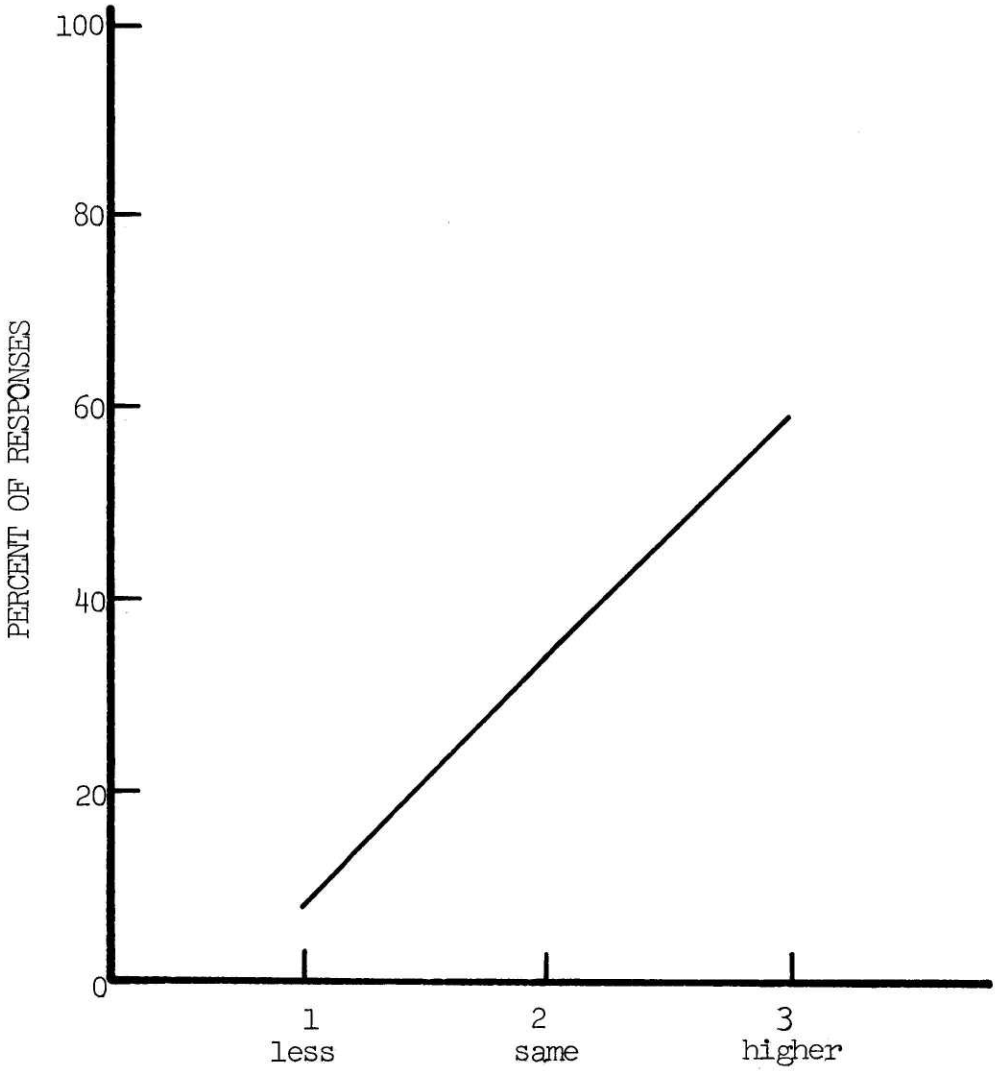


FIGURE VI-12

OVERALL TECHNICAL QUALITY OF

OUTCOMES OF TASKS (ALL LABS)

Key
1. Lower than expected
2. Same as expected
3. Higher than expected



SAMPLE SIZE 61

CHAPTER VII

ANALYSIS OF MAJOR PROBLEMS AND TASK OUTCOMES

This chapter is concerned with the identification and categorization of the major problems encountered by project officers during the life-cycle of their tasks and the relationship of these problems to task outcomes in terms of schedule, funding, scope of work, and technical quality. The data analyzed are chiefly the responses from question 16 of PART II of the Questionnaire. The responses from questions 12 through 15 that give data on overall task outcomes are integrated into the analysis of the responses to question 16.

The first part of this chapter deals with the identification and definition of problem categories and the development of a general problem category typology. The second part concentrates on the relationships between major problems encountered and task outcomes.

Definition of Problem Categories

The major problems reported in question 16 of PART II of the Questionnaire by all laboratories were studied to determine an appropriate grouping or categorization. The problems fell quite naturally into the following eight categories with little or no overlapping:

1. Technical Problems
2. Schedule Problems
3. Funding Problems

4. Personnel Problems
5. External Support and Coordination Problems
6. Internal Support and Coordination Problems
7. Hierarchy Problems
8. User Problems

The definitions of these problem categories are included as FIGURE VII-1. The categories are similar by title to those developed by Poust (8). However, they differ considerably by definition and were tailored to the particular R & D activity studied.

A General Problem Category Typology appears as FIGURE VII-2. The eight categories are used to group all of the problems listed in the responses. Duplications have been eliminated in FIGURE VII-2 but not in the analysis of the problems to follow. FIGURE VII-3 shows a further breakdown of problems encountered by individual laboratory. The number of different major problems encountered which have an adverse and significant impact on task outcomes is considerably greater for ADEL than for the other two laboratories. A possible explanation is that the tasks undertaken by ADEL are usually more complex, larger and technically difficult and require a greater amount of technical coordination with outside agencies. The absence of "Funding" and "Internal Support And Coordination" problems for GEPL is an unexpected and surprising result. It is more than likely that had the sample size from GEPL been larger, problems would have arisen under these two categories. There exists a strong similarity of the kinds of problems encountered

by each laboratory. This is more than coincidental. All laboratories are exposed to the similar R & D work environment and thus is expected that each would encounter approximately the same types of problems in the accomplishment of their tasks.

Frequencies of Major Problems

The frequencies of major problems encountered by project officers during the life-cycle of their tasks (question 16) are tabulated in FIGURE VII-4. The eight general problem categories previously developed (FIGURE VII-1) are used as the frame of reference. Responses are given for ALL LABS, as well as for each laboratory and are expressed in terms of both number and percent. Problems which are mentioned more than once are counted as individual responses.

The project officers, as a group, listed technical problems more frequently (a total of 48 times) than any other problem category. Schedule problems were ranked second (39 responses). User and External problems were ranked third and fourth respectively. However, there is only a difference of one between the latter two problem categories. Hierarchy and Funding problems which occurred about 9 and 7 percent of the time were ranked fifth and sixth. The first four problem categories (Technical, Schedule, User, External) represent about 73 percent of the total number of problem responses.

The ranking of the first four problem categories is in quite good agreement with the findings of Poust (8) if differences in definitions of problem categories are taken into account. Poust studied the management of thirty-two government-funded R & D projects. He found

that the frequency that project managers in industry encountered major problems was in accordance with the following rank order: technical first, schedule second, funding third, and contractual fourth. Poust defined the last problem category as problems caused by contract changes, amendments, and re-direction of effort. These problems correspond closely to the User problems of this study. It is not surprising that funding is reported as a more important problem area by contractor project managers than by government project officers because of the major impact of contract obligations on funding.

There are several significant differences among the three laboraregarding the categories and frequencies of problems encountered. The most frequently experienced problems for ADEL and GEPL were technical, whereas for C&PLSE they were User problems. For GEPL, over 60 percent of their problems occurred in the two categories of Technical and Schedule. Most of the remainder of their problems are distributed fairly evenly among External, Hierarchy, and User problems. No problems were reported in categories Funding and Internal and only one problem in the Personnel category. Technical, Schedule, and User categories account for a little over 50 percent of the probelms encountered by C&PLSE. The other 50 percent is distributed nearly uniformly over the remaining five categories. The problems most frequently experienced by ADEL are in four categories: Technical, Schedule, External and User. These four represent 70 percent of all problems encountered. The remaining 30 percent of problems are divided somewhat evenly among the categories

of Funding, Internal, and Hierarchy, with only 3 percent falling within the Personnel category.

Analysis of Problem Categories and Task Outcomes

FIGURE VII-5 shows the relationships between the eight major problem categories previously developed and task outcomes factored in terms of schedules, funding, scope of work, and technical quality. The frequency (number of responses) under each outcome factor was determined for the problems reported by grouping them in accordance with these eight categories. FIGURE VII-5 can be considered as a matrix that shows the interrelationships among the various problems encountered (through categories of problems) and task outcomes (schedule, funding, scope of work, and technical quality). It is significant to note the very strong cross influence or impact problems have on the individual factors of task outcomes.

The greatest impact of major problems on task outcomes occurs for categories Technical and User. Of the 48 technical problems encountered, 44 had an adverse and significant impact on schedule, 20 on funding, 29 on scope, and 14 on quality. For the User problems which totaled 29, 19 had an adverse and significant impact on schedule, 15 on funding, and 25 on quality.

Schedule

Four problem categories (Technical, Schedule, External, and User) have the greatest impact on the schedule task outcome factor. They account for 120 or nearly 80 percent of the responses. It is inter-

esting to note that the Schedule problem category only accounts for 25 percent of the responses under the schedule outcome factor. The Technical problem category has the greatest impact of any single category on schedule outcome. Hierarchy problems are next important in affecting schedules after the above four categories. The remaining problem categories have a lesser influence on schedule outcome, but their impact is nevertheless significant. Of all the problems experienced (197), 152 or 77 percent have an adverse impact on task schedule. A list of these individual problems can be seen in FIGURES VII-2 and VII-3. The sensitivity of schedule to so many types of problems explains rather well the very large percentage of task schedule overruns (90 percent) experienced by ALL LABS (FIGURE VI-3). It can also easily be appreciated why it is so difficult to maintain planned scheduling when it is so strongly influenced by so many types of problems, a large percent of which are usually beyond the control of the project officer. As can be seen by the data, those outside agencies supporting tasks, the user agencies, and higher headquarters are particularly in a favorable position to contribute to the reduction of schedule overruns of tasks. More realistic planning and attention to technical details by the project officer should also help a great deal to keep tasks on schedule.

Funding

Funding outcome of tasks is chiefly influenced by Technical, Funding, External, and User problem categories. The Funding category accounts for less than 20 percent of the responses under the funding

factor (task outcome). Technical and User problems account for nearly 50 percent of the responses. The rather small (4 percent) influence of Schedule problems on task funding is unexpected. It is normal to expect that funding is sensitive to schedule changes. Thirty-six percent (FIGure V-4) of the technical work was accomplished external to NLABS, and nearly 30 percent of it was by contractors. With this dependence on outside support, it would seem to follow that schedule difficulties would give rise to funding difficulties. The four problem categories mentioned above can be logically used to explain the task funding overruns experienced (FIGURE VI-6). As shown in FIGURE VII-5, 38 percent of all major problems encountered affected funding in an adverse and significant manner.

Scope of Work

The three problem categories which influence scope of work the most are Technical, User, and Hierarchy. The Technical and User problems account for about 67 percent of the responses under the scope of work outcome factor and the Hierarchy about 12 percent. Although the influence of Hierarchy problems is low relative to the other two problem categories, it is sufficiently large (10 responses) compared to the total number of Hierarchy problems experienced (17) to suggest that higher levels of management are to much involved in the details of the technical work accomplished. An explanation of the deviation from planned work as shown in FIGURE VI-9 can be found in the problems encountered in the above three categories. Some 40 percent of the total number of problems reported had an influence on the scope of work.

Technical Quality

The technical quality of task outcomes is most influenced by the Technical, User, and External problem categories. The remaining five categories each had about the same impact on quality. These three categories account for 60 percent of the total responses under quality. Even though all eight problem categories are shown in FIGURE VII-5 to have an influence on the quality of task outcome, only 8 percent of the 61 tasks reported on received ratings of "lower than expected" regarding technical quality (FIGURE VI-12). One explanation for this result is either the problems listed in question 16 did not to any great extent have an adverse impact on technical quality, or the estimates of technical quality given in question 15 were strongly biased toward a favorable response. A little over a third of all the problems encountered (FIGURE VII-5) had an impact on quality of task outcome.

FIGURE VII-1

DEFINITIONS OF PROBLEM CATEGORIES

A. SUMMARY

1. Technical
2. Schedule
3. Funding
4. Personnel
5. External support & coordination
6. Internal support & coordination
7. Hierarchy
8. User

B. DEFINITIONS

1. Technical Problems: This category includes those problems which arise in meeting performance (technical goals). It includes component & system failures; unexpected technical difficulties; inadequate design criteria and technical approaches; and introduction of new design requirements.

2. Schedule Problems: Schedule problems are those concerned with meeting key milestone dates. In general, all serious delays encountered in the life cycle of a task are included.

3. Funding Problems: These problems relate fo funding and cost difficulties experienced in terms of reduction in funds, funding delays, out-of-phase funding, unexpected increases in costs, cost escalations, and excessive costs.

4. Personnel Problems: Personnel problems include loss of critical skills, reduction in manpower, change in personnel, and lack of skills as related to both in-house and contractor assigned personnel.

5. External Support and Coordination Problems: These are problems which arise in the implementation and coordination of task activities with outside supporting agencies (government, industrial suppliers and contractors).

6. Internal Support and Coordination Problems: This category includes all problems which relate to support provided by other in-house organizational units. Included are problems relating to the lack of experimental facilities.

7. Hierarchy Problems: Hierarchy problems are those concerned with obtaining approvals and reporting through channels to higher levels of management and control.

8. User Problems: User problems relate to the development, routing, and revision of requirement (need) documents. This category also includes those problems that arise in the coordination of the R & D work with the user agencies in the Services.

FIGURE VII-2

GENERAL PROBLEM CATEGORY

TYPOLOGY (ALL LABS)

1. TECHNICAL PROBLEMS

Introduction of new flight safety requirements
Sub-system failure
Component failure
Unexpected technical difficulty - flight tests
Failure of commercial components
Unexpected technical difficulty
Poorly defined task objectives
Introduction of new safety requirements
Failure of initial production quantity
Inadequate design - need to rework
Lack of design criteria
Need for additional component testing

2. SCHEDULE PROBLEMS

Lack of testing priority - delay in testing
Delay in procurement
Delay in in-house approvals
Delya in test support
Under estimation of schedule sequences
Delay in out-of-house coordination and approval actions
Delay in In-Process Reviews
Delay in reproduction of report
Operating on too tight a schedule
Late delivery of component parts
Delays in responding to contractor's requests for extensions
Delay in coordination of requirements
Delay in In-house coordination & approval
Contractor delay in completing work

3. FUNDING PROBLEMS

Unexpected increase in test costs
Reduction in funding

Out-of-phase funding
Funding delay
Increase in cost of standard items & materials
Excessive overhead costs
Increase in manufacturing costs

4. PERSONNEL PROBLEMS

Loss of contractor critical skills
Reduction in manpower
Manpower shortage
Loss of critical skills
Loss of technical skills
Unskilled contractor personnel
Change in test personnel

5. EXTERNAL SUPPORT AND COORDINATION PROBLEMS

Poor contractor performance
Non-availability of test aircraft
Contractor not qualified
Inappropriate service testing
Default of contractor
Difficulties in procurement
Inconsistent responses from other government agencies
Limited availability of test aircraft
Non-availability of facilities at contractor site
Coordination difficulties with other Services
Non-responsiveness of other Government Agencies
Non-qualified supplier
Lack of suitable industrial fabrication equipment
Inadequate suppliers
Introduction of new coordination procedures with other Services
Excessive testing

6. INTERNAL SUPPORT AND COORDINATION PROBLEMS

Lack of in-house shop support
Lack of necessary in-house experimental facilities
Introduction of new in-house coordination procedures
Inadequate in-house technical support by other Divisions
Lack of typing support

7. HIERARCHY PROBLEMS

Low priority by higher level management
Non-responsiveness of higher headquarters
Lack of higher level guidance and task support
Unrealistic constraints imposed by higher headquarters
Inconsistent responses from higher headquarters
Introduction of new design approach by higher headquarters
Excessive paperwork
Excessive administrative requirements
Excessive procurement requirements
Lack of higher level guidance
Directed "quick-fix" solutions

8. USER PROBLEMS

Change in requirements
Excessive requirements
Lack of suitable doctrine
Coordination of user requirements with other Services
Inappropriate requirements (beyond state-of-the-art)
Inappropriate requirements

FIGURE VII-3

COMPARISON OF LABORATORIES:

GENERAL PROBLEM CATEGORY TYPOLOGY

A. AIRDROP ENGINEERING LABORATORY

1. Technical Problems

Introduction of new flight safety requirements
Sub-system failure
Component failure
Unexpected technical difficulty - flight tests
Failure of commercial components
Unexpected technical difficulty
Poorly defined task objectives

2. Schedule Problems

Contractor delay in completing work
Lack of testing priority - delay in testing
Delay in procurement
Delay in in-house approvals
Delay in test support
Under estimation of schedule sequences
Delay in out-of-house coordination & approval actions
Delay in In-Process Reviews
Delay in reproduction of report
Operating on too tight a schedule

3. Funding Problems

Unexpected increase in test costs
Reduction in funding
Out-of-phase funding
Funding delay

4. Personnel Problems

Loss of contractor critical skills
Reduction in manpower
Change in test personnel

5. External Support And Coordination Problems

Poor contractor performance
Non-availability of test aircraft
Contractor not qualified
Inappropriate service testing
Default of contractor
Difficulties in procurement
Inconsistent responses from other government agencies
Limited availability of test aircraft
Non-availability of facilities at contractor site
Coordination difficulties with other Services

6. Internal Support And Coordination Problems

Lack of in-house shop support
Lack of necessary in-house experimental facilities
Introduction of new in-house coordination procedures
Inadequate in-house technical support by other Divisions

7. Hierarchy Problems

Low priority by higher level management
Non-responsiveness of higher headquarters
Lack of higher level guidance and task support
Unrealistic constraints imposed by higher headquarters

8. User Problems

Change in requirements
Excessive requirements
Lack of suitable doctrine
Coordination of user requirements with other Services
Inappropriate requirements (beyond state-of-the art)

B. GENERAL EQUIPMENT AND PACKAGING LABORATORY

1. Technical Problems

Unexpected technical difficulty
Component failure
Need for additional component testing

Inadequate design - need to rework
Lack of design criteria

2. Schedule Problems

Late delivery of component parts
Delays in responding to contractor requests for extensions
Delay in coordination of requirements
Delay in procurement
Delay in in-house coordination & approval
Contractor delay in completing work

3. Funding Problems

None listed.

4. Personnel Problems

Manpower shortage

5. External Support And Coordination Problems

Non-responsiveness of other government agencies
Poor performance of contractor
Non-qualified supplier

6. Internal Support And Coordination Problems

Non listed.

7. Hierarchy Problems

Inconsistent responses from higher headquarters
Introduction of new design approach by higher headquarters
Excessive paperwork
Excessive administrative requirements
Excessive procurement requirements
Lack of higher level guidance

8. User Problems

Change in requirements

C. CLOTHING & PERSONAL LIFE SUPPORT EQUIPMENT LABORATORY

1. Technical Problems

Unexpected technical difficulty
Introduction of new safety requirements
Poorly defined task objectives
Failure of initial production quantity

2. Schedule Problems

Delay in procurement
Delay in coordination of requirements
Lack of testing priority - delay
Delay of in-house coordination and approval

3. Funding Problems

Increase in cost of standard items & materials
Excessive overhead costs
Unexpected increase in test costs
Reduction in funding
Increase in manufacturing costs

4. Personnel Problems

Loss of critical skills
Manpower shortage
Loss of technical skills
Unskilled contractor personnel

5. External Support And Coordination Problems

Lack of suitable industrial fabrication equipment
Inappropriate service testing
Inadequate suppliers
Poor performance of contractor
Introduction of new coordination procedures
Excessive testing

6. Internal Support And Coordination Problems

Lack of necessary in-house experimental facilities

Lack of shop support
Lack of typing support

7. Hierarchy Problems

Directed "quick-fix" solutions
Lack of higher-level guidance
Non-responsiveness of higher headquarters

8. User Problems

Change in requirements
Lack of suitable doctrine
Inappropriate requirements
Excessive requirements

FIGURE VII-4

FREQUENCIES OF MAJOR PROBLEMS
ENCOUNTERED BY PROJECT OFFICERS
DURING THE LIVES OF THEIR TASKS
(NUMBER AND PERCENT RESPONSES)

MAJOR PROBLEMS	ADEL		GEPL		C&PLSE		ALL LABS	
	No.	%	No.	%	No.	%	No.	%
1. Technical	22	23.4	16	38.1	10	16.4	48	24.4
2. Schedule	19	20.1	10	23.8	10	16.4	39	19.8
3. Funding	8	8.5	0	0.0	6	9.8	14	7.1
4. Personnel	3	3.2	1	2.4	5	8.2	9	4.6
5. External	17	18.2	4	9.5	7	11.5	28	14.2
6. Internal	7	7.5	0	0.0	6	9.8	13	6.6
7. Hierarchy	6	6.4	6	14.3	5	8.2	17	8.6
8. User	12	12.7	5	11.9	12	19.7	29	14.7
Total	94	100.0	42	100.0	61	100.0	197	100.0

FIGURE VII-5

COMPARISON OF PROBLEM CATEGORIES
AND TASK OUTCOME FOR ALL LABS
(NUMBER OF RESPONSES)

MAJOR PROBLEMS		TASK OUTCOME			
NAME	NO.	SCHED.	FUND.	SCOPE	QUAL.
1. Technical	48	44	20	29	14
2. Schedule	39	37	3	4	5
3. Funding	14	8	13	4	4
4. Personnel	9	6	1	0	5
5. External	28	20	11	5	11
6. Internal	13	7	6	4	6
7. Hierarchy	17	11	6	10	6
8. User	29	19	15	25	14
Total	197	152	75	81	65

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The preceding chapters have presented some descriptive and quantitative data on R & D task accomplishments. Discussed were project officer characteristics, task characteristics and task outcomes. An Analysis was also made of major problems encountered and task outcomes. This chapter contains a summary of the results obtained in previous chapters and recommendations for future work in areas related to this study.

Project Officer Characteristics

Most of the project officers fall into two age groupings: 31 to 40 and 51 to 60. The number of project officers in the age group of 30 years or less is conspicuously low. The level of education is high for project officers. Over 90 percent of them have B.S. or higher degrees. Of all the project officers, nearly fifty percent have taken a college course within the past two years. The number of project officers is about the same for all intervals between the range of zero to twenty years of experience, with a noticeable concentration at the 11 - 15 year interval.

About 97 percent of the project officers considered "meeting technical goals" to be the relatively most important factor to themselves regarding task accomplishment. Only 3 percent considered "meeting schedules" to be the most important factor. No one considered "staying within fund allocations" to be the most important factor. When asked what factor was most important to their laboratories, the results were:

"meeting technical goals" 33 percent; "meeting schedules" 52 percent; and "staying within fund allocations" 15 percent.

Most project officers felt that they were assigned to their area(s) of specialization. About 15 percent of them were not satisfied that they were assigned to areas where their competence could be fully utilized.

Task Characteristics

Together, exploratory and engineering development tasks account for 80 percent of the tasks. Nearly 70 percent of the tasks were completed satisfactorily. The total amount of technical work done in-house is about 65 percent compared to 35 percent out-of-house. On the average, tasks are not considered by project officers to be either "extremely complex" or "not at all complex". Technical objectives are considered by project officers to be quite well defined and major technical approaches clearly set out at the start of tasks. The aggregate response indicates that other or multiple sources are not frequently used by project officers in the development and selection of the technical approaches finally used. More often than not project officers are assigned either three or five or more additional other tasks to work on concurrently. About 56 percent of the tasks are worked on 25 percent or less of the time by project officers. Most of the stimulation for undertaking new tasks is the result of technical opportunities perceived for a new or improved end-item or system rather than the direct response to specific or perceived user requirements for end-items or systems.

Task Outcomes

Considering all laboratories together, about 40 percent of the tasks

experienced schedule overruns one and one-quarter greater than originally planned. When aggregating all responses in terms of less, same, and greater than planned, about 90 percent of alltasks experienced schedule overruns of some degree. A little over 6 percent of the tasks were on schedule and some 3 percent were accomplished in less time than originally planned.

The response regarding funds is somewhat more favorable than that for schedules in that overruns are less. All laboratories considered, about 62 percent of the tasks experienced overruns of "1 1/4 greater than planned" or less while a little over 60 percent of the tasks experienced some amount of overruns.

For all laboratories, the responses for scope of work are quite symmetrically distributed around "same as planned". The scope of work for about 44 percent of the tasks are the same, 23 percent less, and about 33 percent greater than planned. The deviations from "same as planned" are much less compared to either the schedule or fund deviations.

Of the 61 total responses received 36 or 59 percent estimated technical quality of task outcome to be higher than expected, 33 percent the same, and 8 percent lower than expected.

Major Problems and Task Outcomes

The major problems reported were grouped into eight categories as follows:

1. Technical Problems
2. Schedule Problems

3. Funding Problems
4. Personnel Problems
5. External Support and Coordination Problems
6. Internal Support and Coordination Problems
7. Hierarchy Problems
8. User Problems

The definitions of these categories were tailored to the particular corporate laboratory studied. A general problem category typology was developed for each of the individual laboratories considered and for all the laboratories taken as a group. In the listing of problems, duplications have been eliminated.

The frequencies of major problems encountered by project officers during the life-cycle of their tasks were tabulated. As a group, project officers listed Technical problems more frequently than any other category. Schedule problems were ranked second, User problems third, and External problems fourth. These four problem categories represent about 73 percent of the total number of problem responses (197).

The relationship between the eight major problem categories and task outcomes (expressed in terms of schedule, funding, scope of work, and technical quality) was summarized in tabular form. The greatest impact of major problems on task outcomes occurs for the Technical and User categories. Technical, Schedule, External and User problem categories have the greatest impact on the schedule task outcome. The funding outcome of tasks is chiefly influenced by Technical, Funding, External and User pro-

blem categories. The three problem categories which influence scope of work the most are Technical, User and Hierarchy. Finally, the technical quality of task outcomes is mostly influenced by the Technical, User and External probelm categories.

Future Study Work

There are three general areas of study for follow-on work which it is felt would be interesting and productive.

The first is to analyze major problems encountered and task outcomes at a more micro level i.e., a study based on individual problems rather than on problem categories. The study might very well take the form of a case study.

The second is to conduct a study using a larger sample of tasks and respondents. One direction of the study might be to include several Army installations whose R & D missions are similar. Another direction might be to include more laboratories within a single installation.

The third area that would be fertile for future study is the comparison of successful and unsuccessful tasks on the bases of both project officer and task characteristics such as age, experience, scope and complexity of task, and number of task assigned.

CHAPTER IX

RECOMMENDATIONS

Based upon the findings of this study, it is recommended that the Natick Laboratories project officers and management personnel consider the following proposed actions:

1. Adjust the recruitment program so as to bring in more young project officers in an effort to reduce the average age of 47 years and to assure a continuing supply of experienced project officers.

2. Determine what might be done to motivate project officers to give as much attention to "meeting schedules" as "meeting technical goals".

3. Encourage project officers to give more attention to the funding aspects of task accomplishment in order to stay within fund allocations.

4. Review the assignment of project officers to see what might be done to eliminate the reported 15 percent mismatch of skills and assignments.

5. More actively seek and utilize the expertise available in other in-house laboratories and other government R & D agencies.

6. Encourage the collaboration and communication among project officers in order to increase the opportunity for others to contribute to the development and selection of technical approaches for R & D tasks.

7. Spend greater effort in setting out major technical approaches and defining the technical objectives early in the life-cycle of a task.

8. Provide maximum effort through Department of Army to obtain adequate doctrine and requirements documentation in order to reduce User category problems in future tasks.

9. Give priority attention to the solution of problems in the Technical and User categories since they are most strongly linked with schedule, funding, scope of work and technical quality.

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APPENDIX

Q U E S T I O N N A I R E :

1. PART I - Some Facts About You
2. INSTRUCTIONS for PART II
3. PART II - Facts About One Of Your Typical Tasks

QUESTIONNAIRE

PART I - Some facts about you

1. What is your age? _____ years

2. Which is your most advanced education?

   (1) High School _____

   (2) College (less than B.S.) _____

   (3) College (B.S.) _____

   (4) College (Advanced degree) _____

3. How long since you last took a college education course? (Write N, if Never) _____

4. How long since you last took any formal course related to your career field? _____

5. What is your total experience as a project officer? (Include all Government Service) _____

6. How long have you been with NLABS? _____

7. How long have you worked in your current area of specialization? _____

8. How long since your last grade promotion? _____ years

9. Current G.S. rating _____

10. Rank (1, 2, 3) th following factors according to their relative importance to you regarding task accomplishment: (each number should be used once; 1 is the highest rank)

    1. Meeting performance (technical goals) _____
    2. Meeting schedules _____
    3. Staying within fund allocations _____

11. Rank (1, 2, 3) the following factors according to their relative importance to your Lab, regarding task accomplishment: (each number should be used once; 1 is the highest rank)

    1. Meeting performance (technical goals) _____
    2. Meeting schedules _____
    3. Staying within fund allocations _____

12. In what areas(s) of specialization do you consider yourself most competent:

13. Do you feel that you are assigned to the area(s) of specialization where you have the most competence?

    _____yes _____no

14. Laboratory where you work

(a) ADEL _____

(b) GEPL _____

(c) C&PLSE _____

15. How long have you been with your lab? _____ years

INSTRUCTIONS FOR PART II

1. Select two or three typical tasks which you have most recently worked on within the past five years and for which you were the assigned project officer. (Do not include currently active tasks.)

2. Where possible please include at LEAST ONE task which was terminated before work was completed.*

3. Report on each task using a separate PART II form.

*Work is considered completed if all planned activities have been accomplished. For R & D end-items, this generally means the end-item has been type classified; for studies, final report published; for exploratory work, feasibility has been demonstrated and/or design specifications developed; for end-item improvements, redesign features have been incorporated and related documents revised.

PART II-Facts about one of your typical tasks

1. Type of task

   (1) Exploratory development _____

   (2) Engineering development _____

   (3) Production engineering _____

   (4) Other: _____ _____

2. Planned work (task)

   (1) Completed _____

   (2) Not completed _____

3. Fiscal year task was initiated _____ Fy

4. What was the approximate number of man-years of technical work expended on the task by each of the following?

   (a) Your laboratory _____

   (b) Other in-house labs _____

   (c) Other Government agencies _____

   (d) Contractor(s) _____

5. Technical complexity of task (circle number)

Extremely complex	1	2	3	4	5	Not at all complex

6. How well defined were the major technical objectives at the start of the task? (circle number)

well defined	1	2	3	4	5	not defined

7. How clearly were the major technical approaches set out at the start of the task? (circle number)

very clearly	1	2	3	4	5	not clearly

8. To what extent did others contribute to the development and selection of the technical approaches finally used? (circle number)

quite a bit	1	2	3	4	5	not at all

9. At the time you were working on this task, how many other assigned tasks were you actively working on, concurrently?

_____

10. On the average, what per cent of your time was devoted to the task being reported on? _____

11. Prior to approval of the task, what was the primary factor which stimulated its initial undertaking?

(a) Recognition of user needs (response to specific or perceived requirements, etc.) _____

(b) Recognition of technical feasibility (technical opportunity perceived for a new or improved end-item, system, etc.) _____

For the next three questions (12, 13, 14) consider the "ORIGINALLY PLANNED" data to be that data reported when sufficient information was first available for a realistic planning estimate.

12. What was the approximate schedule of the task?

(1) Less than originally planned _____

(2) Same as originally planned _____

(3) 1 to 1 1/4 greater than originally planned _____

(4) 1 1/4 to 1 1/2 greater than originally planned _____

(5) 1 1/2 to 2 greater than originally planned _____

(6) Greater than twice originally planned _____

13. What was the amount of funds used on the task?

(1) Less than originally planned _____

(2) Same as originally planned _____

(3) 1 to 1 1/4 greater than originally planned _____

(4) 1 1/4 to 1 1/2 greater than originally planned _____

(5) 1 1/2 to 2 greater than originally planned _____

(6) Greater than twice originally planned _____

14. What was the scope of work accomplished under the task?

(1) Much less than originally planned _____

(2) Less than originally planned _____

(3) Same as originally planned _____

(4) More than originally planned _____

(5) Much more than originally planned _____

15. How would you estimate the technical quality of the outcome of the task? (circle number)

much lower than expected 1 2 3 4 5 much higher than expected

16. Because of the characteristics of R & D work, the administrative and technical problems that arise during a task are many and varied. The problems of interest in this study are those that affected in an adverse and significant way the outcome of the task. Outcome is defined in terms of schedule, funds, scope of work, and overall technical quality. Also of interest are whether the problems encountered were resolved and approximately when during the task the problems occurred.

USING THE FORMAT PROVIDED, PLEASE RECORD THE DATA OF INTEREST WHICH PERTAIN TO THIS TASK. PLEASE PRINT ALL ENTRIES.

Instructions for Format

(1) Nature of Problem - List the problems encountered as briefly and specifically as possible.

- Number problems in left-hand column

- A sample list of problems is provided for your reference. However, you should not consider it as a complete list of all possible problems.

(2) Solution - Check one of the three columns to indicate to what extent, if any, the problem was resolved.

(3) Phase - Check one or more columns to indicate when the problem occurred.

(4) Task Outcome - Check the appropriate column(s) to indicate that schedule, funds, scope of work, or overall technical quality were significantly affected.

- LEAVE the column BLANK if the problem had no significant impact on that one factor.

Sample List of Problems

- Change in requirements
- Delay in coordination of requirements
- Lack of suitable doctrine
- Excessive requirements
- Inappropriate requirements

- Inflexibility in the use of funds
- Reduction in funding
- Funding delay
- Out-of-phase funding

- Increase in cost of standard items and materials
- Excessive overhead costs

- Delay in procurement
- Delay in approval from customer
- Poor performance of contractor
- Change of contractor personnel from high to low caliber
- Lack of responsive bid
- Contractor not qualified

- Loss of critical skills
- Reduction in manpower
- Lack of higher-level guidance
- Difficulty in meeting quality assurance specifications
- Component failure
- System failure
- Unexpected technical difficulty
- Poorly defined task objectives and approaches
- Introduction of new safety requirements

- Non-responsiveness of higher headquarters
- Inconsistent responses of agencies at IPR's
- Lack of shop support (in-house)
- Delay in in-house coordination and approval

- In process review delay
- Lack of necessary in-house experimental facilities
- Disproportionate reporting requirement (be specific)
- Introduction of new coordination procedures

- Unnecessary service testing
- Inappropriate service testing
- Unexpected increase in test costs
- Lack of testing priority
- Non-availability of test aircraft

PROBLEM RESPONSE FORMAT

No.	Nature of Problem (1)	Solution (2)			Phase (3)			Task Outcome (4)			
		Resolved	Partially Resolved	Not Resolved	Begin.	Middle	End	Schedule	Funds	Scope of work	Overall Technical Quality

17. If the task was not completed, give main reason(s) why.

18. What other facts and information not covered in specific questions do you feel were important to task outcome?