AAMRL-TR-86-022

PROPOSAL AND JUSTIFICATION TO ESTABLISH A DEPARTMENT OF DEFENSE CREW SYSTEMS ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC)

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MONTEREY TECHNOLOGIES

SEPTEMBER 1986

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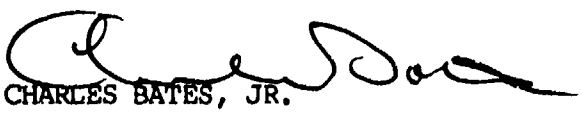

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UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

AD-A181 553

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) AAMRL-TR-86-022
6a. NAME OF PERFORMING ORGANIZATION Monterey Technologies, Inc.*	6b. OFFICE SYMBOL (If applicable)
6c. ADDRESS (City, State, and ZIP Code) Carmel, CA 93922	7a. NAME OF MONITORING ORGANIZATION AAMRL/HEA
	7b. ADDRESS (City, State, and ZIP Code) Wright-Patterson AFB OH 45433-6573
8a. NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)
	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F33615-84-D-0505
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
62202F	7184	26	08

11. TITLE (Include Security Classification)
PROPOSAL AND JUSTIFICATION TO ESTABLISH A DEPARTMENT OF DEFENSE CREW SYSTEMS ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC)

12. PERSONAL AUTHOR(S)
Hennessy, Robert T. and McCauley, Michael E.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Technical	FROM _____ TO _____	1986 September	106

16. SUPPLEMENTARY NOTATION
*Subcontract to Universal Energy Systems, Inc.

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Ergonomics, Crew Systems, Questionnaire, Human Factors, Information Analysis Center

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report proposes and justifies the establishment of a military Crew Systems Ergonomics Information Analysis Center (CSERIAC). Ergonomics is an integrative discipline devoted to understanding and quantifying human physiological and behavioral interaction with equipment and systems. Employment of ergonomic information is both essential and officially required during the design and development of military systems. To determine the need for a CSERIAC, 3705 potential users within DoD and industry were surveyed by a mail questionnaire. Four existing IACs and several centers of CSE research and development were visited to gain supplementary information. Eighty-seven percent (87%) of the 829 respondents agreed that a central source for CSE information services is needed and 67% agreed that a Department of Defense (DoD) CSERIAC was the appropriate mechanism to meet this need. Seventy-nine percent (79%) of the respondents work in research development, management or design. Ninety-seven percent (97%) use CSE information. Seventy-eight (78%) are willing to pay fees for CSERIAC services. Over 4000 requests per year for CSERIAC services would be made by the survey respondents alone.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS	UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL
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DD Form 1473, JUN 86 — Previous editions are obsolete. — SECURITY CLASSIFICATION OF THIS PAGE

EXECUTIVE SUMMARY

This report proposes and justifies the establishment of a military Crew Systems Ergonomics Information Analysis Center (CSERIAC). Ergonomics is an integrative discipline devoted to understanding and quantifying human physiological and behavioral interaction with equipment and systems. Employment of ergonomic information is both essential and officially required during the design and development of military systems.

To determine the need for a CSERIAC, 3705 potential users within DoD and industry were surveyed by a mail questionnaire. Four existing IACs and several centers of CSE research and development were visited to gain supplementary information.

Eighty-seven percent (87%) of the 829 respondents agreed that a central source for CSE information services is needed and 67% agreed that a Department of Defense (DoD) CSERIAC was the appropriate mechanism to meet this need. Seventy-nine percent (79%) of the respondents work in research and development, management or design. Ninety-seven percent (97%) use CSE information. Seventy-eight percent (78%) are willing to pay fees for CSERIAC services. Over 4000 requests per year for CSERIAC services would be made by the survey respondents alone.

Current CSE information sources are inadequate to the need. Major problems include difficulty in maintaining awareness of available CSE information, nonspecificity of information, the needed information does not exist, poor quality, and delays in obtaining needed information.

A full-service CSERIAC hosted by the Harry G. Armstrong Aeromedical Research Laboratory is the proposed solution to the CSE information problem. CSERIAC will provide CSE information services including topical reviews, special analysis reports, data, models, CSE design support software, and methodological assistance to the DoD and DoD contractors.

Keywords: Questionnaire; Man machine systems

Core funding requirements from the Defense Technical Information Center for CSERIAC are $750,000 the first year with escalation to $1,600,000 in the fourth year. User fees would contribute substantially to expanded CSERIAC services beginning in the second year.

PREFACE

This effort was conducted under Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL) Project 7184, "Man-Machine Integration Technology," Task 718426, "Tactical Aircraft Cockpit Development and Evaluation Program (TACDEP)," and Work Unit 71842608, "Crew Systems Ergonomics Information Analysis Center (CSERIAC) Planning Study," under technical management of Dr. Kenneth R. Boff.

This proposal was forwarded to the Office of the Undersecretary of Defense for Research and Engineering in September 1985. In December 1985, provisional approval was granted for this Information Analysis Center (IAC) to be established during FY87.

In September 1986, OUSDR&E gave full approval to establish the CSERIAC.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the contributions of many individuals and organizations whose cooperation and assistance materially benefitted this study. In particular, we wish to express our appreciation to the following individuals.

Dr. Kenneth R. Boff, AAMRL, for his active participation in all phases of this study. He contributed his expertise to the definition of the interests and specialties subsumed under the term crew systems ergonomics. He participated in the initial drafting and subsequent refinement of the survey questionnaire He arranged for meetings between the study personnel and managers of military organizations involved in crew systems development. Once the survey data were in hand, he made many useful suggestions that enhanced the interpretation and presentation of the results. From his liaison with Defense Technical Information Center and Armstrong Aeromedical Research Laboratory Headquarters came the understandings and agreements that were the foundation for the proposed implementation plan for a Department of Defense Crew Systems Ergonomics Information Analysis Center. A large measure of credit for the smooth execution and successful completion of this study is due to Dr. Boff's efforts, and the authors are sincerely grateful for his help.

Sgt Joseph Gregory, AAMRL, who spent many hours, after normal duty days, sorting, sealing, and organizing the questionnaire kits. Because of his diligent efforts, the survey materials were distributed in time to meet critical schedule requirements. Sgt Gregory undertook this necessary task at his own initiative, and by doing so made a substantial contribution to the success of this study.

Ms. Nancy P. McCauley for her excellent performance in dual roles as a research assistant and administrative secretary. As research assistant, she identified most of the major sources of mailing addresses used for the survey, screened and coded the return questionnaires, and supervised the production of the numerous graphs used in this report. As administrative secretary, she was responsible for all aspects of preparation of the final

manuscript, from typing to formatting and editing. A special debt of gratitude is owed her for compiling a master mailing list by removing duplicates from six lists of names with a total of over 8,000 entries. Anyone who has had the unfortunate opportunity to perform such a task will appreciate the depth and sincerity of our gratitude that she, and not we, did it.

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Section 1
INTRODUCTION

This report presents a plan and justification for the need to establish a Department of Defense (DoD) Information Analysis Center (IAC) focused on crew systems ergonomics. Ergonomics is an integrative discipline devoted to understanding and quantifying human physiological and behavioral characteristics important to the design and operation of equipment and systems. The effectiveness of military systems ultimately depends on the ability of its human crew members to correctly and efficiently employ equipment capabilities to accomplish mission goals. Moreover, maintaining the physical well being and integrity of crew members is essential to the survival and sustained operation of military crew systems. The tempo and lethality of modern warfare, as well as the increasing complexity of weapons systems, have placed such extreme demands on the crew that human performance and endurance are primary factors limiting the enhancement of military system effectiveness.

Employment of ergonomic information is both essential and officially required during the design and development of military systems. Ergonomic information consists of a synthesis of knowledge and data drawn from a variety of traditional scientific and engineering disciplines to meet the needs of a particular application. Although ergonomic information is latent in the broad base of scientific and engineering knowledge devoted to human physiological and behavioral characteristics, it is not readily accessible or compiled in a form most useful to particular engineering design and development efforts. Consequently, there is an apparent critical need for a central and authoritative source that can provide timely, complete and integrated crew systems ergonomic (CSE) information to DoD managers, scientists and engineers and DoD contractors involved in research and development of military equipment and systems.

To determine the validity of the need for a DoD center devoted to the analysis and dissemination of military CSE information, a survey questionnaire was mailed to a large sample of the community of potential users within the DoD and industry. Also, key DoD activities involved in crew

system research and development were visited to obtain more detailed information on current use and sources of CSE information, as well as the perceived value of a DoD IAC devoted to providing CSE information analysis services.

1.1 BACKGROUND

Knowledge of what the human crew member is capable of doing, the stressors that he or she can withstand, and constructing equipment that most effectively melds with human abilities and limitations is an important aspect of military systems development from the management planning stage to final, operational test and evaluation.

The Air Force Aerospace Medical Research Laboratory, now named the Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL), recognized the increasing criticality of CSE information to the aerospace programs of the Air Force and other DoD components. As a primary user, as well as a generator, of CSE information AAMRL has frequently encountered the difficulties and delays in formulating CSE information to meet the needs of its own divisions and the Air Force activities it supports.

Viewing the establishment of a CSE IAC as a potential means for solving a variety of CSE information problems, AAMRL decided to conduct a survey of the community of CSE information users. The purpose of the survey was to determine CSE information problems encountered, information services needed, currently available sources, CSE topics of primary concern, whether a DoD IAC would be considered an appropriate mechanism for providing CSE information and to what degree the IAC would be used and supported. Additionally, DoD organizations known to be heavy users of CSE information were visited to obtain more detailed insights on the subjects addressed in the questionnaire survey. Several IACs also were visited to learn of their current practices.

1.2 STATEMENT OF THE PROBLEM

In general, the problem is the lack of a means to identify and select from the large volume of potential sources the data necessary to formulate CSE information and to present it in a form that can be understood by the user and applied to a particular need. The sources for CSE information are primarily documents, but also include human performance and anthropometric models and data bases, as well as analysis methods that are important in the design process.

The CSE interests and needs of managers, scientists, engineers and designers differ in scope and emphasis. Moreover, most users of CSE information, other than research scientists, have been educated in engineering rather than the biomedical or behavioral sciences. Consequently, these users are unfamiliar with the primary source literature for CSE information and do not have the special training necessary to knowledgeably assess and interpret it in terms of their application needs.

The sheer volume of biomedical, behavioral and engineering information and data that exists and is being generated creates an immediate problem for those in need of CSE information. Moreover, this is a period of growth of new ergonomic modeling and analysis methods for applying CSE information. It is virtually impossible for an individual to keep abreast of developments except in a few specialty areas. Yet, by its very nature, the useful application of CSE information requires integration of knowledge and data across a broad range of human characteristics.

The Defense Technical Information Center (DTIC) provides copies of orginal source documents and specialized bibliographies based on key-word searches of CSE reports generated by DoD laboratories and DoD contractors. Although these are valuable services, the users of DTIC must decide what documents and bibliographic search strategies will yield the information that they need. A common problem is the uncertainty that the documents relevant to a particular need have been found. Moreover, users are burdened with the analytical and interpretive tasks of extracting, evaluating and integrating the information contained in the source documents. These tasks are

especially difficult for documents written by scientists or engineers whose specialties are outside the user's domain of expertise.

Also, obtaining copies of, or access to, computer data bases, and models such as the Computerized Biomechanical Man-Model (COMBIMAN, see section 3.3) and the Human Operator Simulator (HOS), as well as closely allied programming software such as Systems Analysis of Integrated Networks of Tasks (SAINT), is difficult at best. The number of human-related data bases and models potentially available, but practically inaccessible, number over 50 (Topmiller, 1981). Yet these are important tools that should be widely used to apply CSE information in crew system design work.

The need for a widely available mechanism to find, analyze, and disseminate CSE information to users within the DoD and its contractors was substantiated by the responses to the questionnaire survey (Appendix A). The following were identified as being the most frequent or important serious problems in fulfilling the needs for CSE information.

1. Difficulty in maintaining awareness of technical or analytical information that is available (59% of respondents).

2. Information not specific to particular needs (39% of respondents).

3. The needed information does not exist (37% of respondents).

4. Poor quality of the information (36% of respondents).

5. Delay time to obtain needed information (35% of respondents).

6. Information not clearly and succinctly presented (34% of respondents).

These results clearly support the allegation that there is a definite need for a means to improve the availability, specific applicability and quality of CSE information.

1.3 DoD IAC AS THE SOLUTION TO CSE INFORMATION PROBLEMS

As a matter of policy, the DoD recognizes the value of evaluation and analysis of scientific and technical information to the conduct of research and development efforts. Furthermore, the DoD endorses the institutionalization of these activities in the form of IACs when sufficient requirements or benefits are established (Department of Defense, 1984).

Twenty-one IACS have been established that specialize in either a discipline-oriented or mission-oriented area. The function of an IAC is prescribed by its definition given in the DoD regulation cited above:

> "Centers for Analysis of Scientific and Technical Information: A formal organization with a primary mission to acquire, digest, analyze, evaluate, synthesize, store, publish, and provide advisory and other user services concerning available worldwide scientific and technical information and engineering data in a clearly defined, specialized field, or subject area of significant DoD interest or concern. Information Analysis Centers (IACs) are distinguished from technical information centers and libraries whose functions primarily are concerned with providing reference or access to the documents themselves rather than the information contained in the documents."

CSE is clearly an area of significant concern to the DoD. The military standard MIL-H-46855B details the human factors and ergonomic requirements that must be addressed in the development of military systems. Yet, as noted by the National Academy of Sciences Committee on Automation in Combat Aircraft, "For a number of reasons this guideline has not been followed (Committee on Automation in Combat Aircraft, 1982, pg. 59)." One reason is the lack of CSE information distilled from the scientific literature and presented in a way useful to design engineers. This assertion was corroborated by the former director of the U.S. Army Aeromechanics Laboratory at a recent NATO symposium:

"The psycho-physiological literature is replete with data on specific laboratory experiments, but the results have seldom been focused on the design of a man-machine system and have never been conveyed in terms meaningful to the engineering user community. The terminology is often unfamiliar to the engineer, and the implications for design are not readily accessible. Consequently, the designer often fails to recognize the relevance of the information to his problem. Design engineers need to have the information in a form which is meaningful to system design problems. (Statler, 1984)"

The nature of CSE information is such that its analysis, evaluation and synthesis is a prerequisite to its useful application. The establishment of a Crew Systems Ergonomics Information Analysis Center (CSERIAC) is proposed as the most appropriate means to alleviate the problems of providing CSE information to DoD users and DoD contractors in a form that meets their needs.

1.4 STUDY APPROACH

The impetus for the present study was the recognition by specialists in the fields of human factors engineering and ergonomics of the difficulty of providing CSE information services to the large community of users among managers, scientists and design engineers within the DoD and DoD contractors.

A primary purpose of the study was to gather evidence on the prevalence and importance of this need, what CSE topics were most commonly of concern, what services in what form would best fulfill the needs for CSE information and whether a DoD IAC would be perceived to be the most appropriate means to meet these needs. Another important purpose was to discover whether existing sources provide the needed CSE information services.

Initially, known users of CSE information at AAMRL and other Air Force laboratories at Wright-Patterson Air Force Base were informally questioned about problems they encountered in obtaining CSE information, the kind of information they sought and what sources they used or know of. The

informal questioning was extended to CSE information users at other DoD installations and professional colleagues in industry.

A second step was to review mission statements of organizations known to be involved in scientific and technical information dissemination that includes, at least in part, CSE information. These included the Manpower and Training Information System (MATRIS), Defense Technical Information Center (DTIC), the National Technical Information Service (NTIS), the Defense Training Data and Analysis Center (TDAC), as well as existing DoD IACS.

The preliminary investigations confirmed that none of the known sources provided the primary types of CSE information users required. Based on these inquiries AAMRL formulated a conception of the scope of the topics and services envisioned to be within the domain of the proposed IAC.

AAMRL then decided to formally gather the necessary data and information needed to prepare the proposal and justification for establishing the CSERIAC.

The formal effort consisted of a questionnaire survey of a substantial proportion of the known users and generators of CSE information, and interviews with key personnel at DoD installations that have significant crew systems research and development activities. The data from the questionnaire survey and interviews were compiled and analyzed and form the primary evidentiary base of this report.

The questionnaire was mailed to 3705 individuals within the DoD and industry likely to have an interest in aerospace CSE. Eight hundred and twenty-nine (829) of the 1000 returned were useable for analysis. The background data on the respondents confirmed their interest and use of CSE information. Seventy-nine percent (79%) of the respondents work in research and development, management or design. Ninety-seven percent (97%) use CSE information.

The analysis of the questionnaire survey data is presented in detail in Appendix A. However, the principal outcomes are easily summarized. Eighty-seven percent (87%) of the 829 respondents agreed that a central source of CSE information services is needed and 67% agreed that a Department of Defense (DoD) CSERIAC was the appropriate mechanism to meet this need. Seventy-eight percent (78%) are willing to pay fees for CSERIAC services. Over 4000 requests per year for CSERIAC services would be made by the survey respondents alone. In addition to the questionnaire survey, four existing IACS were visited to learn of their method of operation in greater detail and to benefit from their experience in analyzing and disseminating specialized scientific and technical information. It was clear from review of the individual missions that only three of the twenty-one existing IACS potentially have any remote connection to CSE. These are the Tactical Technology Center (TACTEC), the Shock and Vibration Information Center (SVIC) and the recently established Survivability/Vulnerability Information Analysis Center (SURVIAC).

1.5 PURPOSE OF THIS REPORT

The principal purposes of this report are to detail the justification for establishing the CSERIAC and present a plan for its implementation. The evidence for the need for the CSERIAC, its scope of concern and the services it will provide is drawn primarily from the results of the questionnaire survey (Appendix A). Amplifications on the nature of CSE information, how it is used and by whom, as well as alternatives to CSERIAC are also presented.

This report excludes a discussion of the purposes and functions of IACs in general since these are well documented both in the implementing regulation (Department of Defense, 1984) and in the recent document, Proposal and Justification for the Establishment of an Aeronautical Systems/Target Nonnuclear Centers for Analysis of Scientific and Technical Information Survivability/Vulnerability Information Analysis Center (Bernier, Mower, and Horton, 1982). It should also be noted that this latter document contains a comprehensive review of the operations of sixteen IACs. Because of the recency of this information there appeared to be no purpose in conducting

survey interviews of IACs beyond the four visited. The information on IACs contained in the cited document was a valuable aid in formulating the implementation plan for the proposed CSERIAC.

Section 2
DETERMINATION OF NEED

Without adequate CSE information, system designers and developers are forced to rely on approximations or guesswork to predict the range of human responses to various design options. An expensive alternative is to perform part-task research to acquire the needed data. Good CSE data, therefore, supports the development of effective systems at reduced cost and equates to better system design for enhanced mission effectiveness and survivability.

2.1 WHAT IS CSE INFORMATION?

In general, CSE information is scientific and technical knowledge and data about human characteristics, abilities, limitations, physiological needs, performance, body dimensions, biomechanical dynamics, strength, and tolerances. It is also engineering and design data about equipment intended to be used, operated, or controlled by members of military crews. The human oriented data and knowledge come from research and affect future equipment and systems design and development; the engineering and design data are the lessons learned from existing equipment, both good and bad, that have proven what enhances and supports or degrades and debilitates crew performance and well being.

The domain of CSE information is the interaction of humans with equipment and how each affects the other. It extends in the human direction to include biomedical, physiological, behavioral, and cognitive characteristics and functions. It extends in the equipment direction to include the displays, controls, operational, and functional characteristics of mission subsystems and those intended to support the health, survival, and escape of crew members.

CSE information is highly specialized because it pertains to human characteristics as found in complex, real-world military situations and activities; these operationally relevant characteristics are usually different

from those determined in isolation in the biomedical or behavioral laboratory.

The terms "ergonomics" and "human factors" are nearly synonymous. Ergonomics is the term used in Europe to refer to the study of humans at work, with emphasis on the physical design of work areas and worker physiology. Human factors is the equivalent term used in the United States, although the emphasis is on the information processing requirements of the human during job performance. The objective, in either case, is to enhance the effectiveness of manned systems.

2.2 WHAT IS AVAILABLE AND WHERE?

The major sources of CSE information are professional journals, technical reports, unpublished data, handbooks and standards, computer models, expert consultation, methodological guidelines, and search and analysis services.

2.2.1 Journals

Currently, CSE information is available in several journals, such as Human Factors, Ergonomics, and Aviation, Space and Environmental Medicine. A large number of academic journals from experimental psychology, physiology, engineering, and computer science report basic information that contributes to the knowledge base of CSE. Journals are not available from the NTIS. They are normally procured through subscription or libraries.

2.2.2 Technical Reports

The largest single source of CSE information is found in government technical reports. Abstracts, bibliographies and copies of original reports are available through DTIC and NTIS. The former provides both classified and unclassified source documents produced for the DoD. The latter provides only unclassified documents but includes reports produced for all Federal Government Departments.

2.2.3 Test and Evaluation (T&E) Data

Valuable CSE information is generated during system development, test and evaluation. However, T&E reports and data, that represent valuable "lessons learned," are a resource only within the organizations that either requested or performed the T&E. These documents are not collected and archived by any single organization. Consequently, these CSE information resources are not readily available to CSE specialists or aerospace system design engineers.

2.2.4 Handbooks and Standards

There are several handbooks that consolidate human factors and ergonomics information for engineering design. These handbooks have the problems, however, of becoming dated and being presented in an inflexible format. Examples of major handbooks are Van Cott and Kinkade (1972) and Woodson (1981). Military Standard 1472-C (DoD, 1981), titled "Human Engineering Design Criteria for Military Systems, Equipment, and Facilities" also provides CSE guidance for systems design. The handbooks and standard are supplemented by textbooks in human factors such as McCormick and Sanders (1982) and Wickens (1984). All of these resources are useful for general guidance, but are inadequate for specific CSE design application needs.

2.2.5 Models

Much CSE information is summarized in mathematical and computer-based models of human operators. These models may address either anthropometric and biomechanical characteristics or perceptual-cognitive-motor characteristics of humans. Models are a means for tradeoff evaluations of human-system performance for various design alternatives. CSE models are useful tools for solving design problems However, most CSE models are developed and used in one location and are not readily accessible to the potentially large community of users.

2.2.6 Expert Consultation

One method of direct access to CSE information is to consult with a researcher or applied scientist who has been working specifically on a problem area. Four common sources for identifying such people are through journal articles and publications, membership lists of professional societies, the DoD Directory of Researchers for Human Research and Development Projects, and the Directory of U.S. Army Human Factors Engineering Specialists. However, the role of a consultant is generally limited to answering relatively simple questions. For more complicated issues, involving substantial time and effort, a contractual mechanism must be established to pay for the consultant's work. The length of time required to let a contract, particularly by the Government, will generally preclude use of a consultant unless the need was anticipated well in advance.

2.2.7 Methodological Guidelines

A wide range of empirical and analytical methodologies is used to solve CSE problems. They include techniques for test and evaluation and analysis of human-system interaction, task performance, time-line of activities, and imposed workload Other CSE methods involve computer modeling, user surveys, rating scales, checklists, and formal procedures to obtain expert opinions. However, information on these important CSE methods is not documented or collected in any systematic fashion.

The National Academy of Sciences Committee on Human Factors identified the lack of information on applied methodologies as a major problem. The committee concluded "There is a serious disparity between the importance of applied methodologies for human factors work, particularly systems and equipment design, and the efforts being made to document and codify them in a standard manner. (Committee on Human Factors, 1983, pg. 156)"

2.3 WHO NEEDS CSE INFORMATION AND WHY?

The broad spectrum of primary users of CSE information are the managers, scientists and engineers within the DoD, other Government organizations,

and DoD contractor industries that are involved in research and development of manned systems for aviation and space and require timely, reliable and specialized CSE information. Examples of DoD users are:

- Department of the Air Force

  Deputy Chief of Staff, Research, Development and Acquisition
  Deputy Chief of Staff, Logistics and Engineering
  Flight Test Center
  Tactical Warfare Center
  Operational Test & Evaluation Center
  Inspection & Safety Center
  Space & Missile Systems Organization
  Aerospace Medical Division
  -- School of Aerospace Medicine
  -- Armstrong Aerospace Medical Research Laboratory
  -- Human Resources Laboratory
  Rome Air Development Center
  Electronic Systems Division
  Aeronautical Systems Division
  -- Wright Aeronautical Laboratory
  Office of Scientific Research

- Department of the Navy

  Naval Air Systems Command
  Naval Air Development Center
  Naval Air Test Center
  Naval Weapons Center
  Naval Ocean Systems Center
  Naval Training Equipment Center
  Naval Aerospace Medical Research Laboratory
  Naval BioDynamics Laboratory
  Navy Personnel R&D Center
  Pacific Missile Test Center
  Office of Naval Research

- Department of the Army

  Deputy Chief of Staff for Research, Development, and Acquisition
  Aviation Research and Development Command
  Aviation Development Test Activity
  Aeromedical Research Laboratory
  Aviation Safety Center
  Human Engineering Laboratory
  Operational Test & Evaluation Agency
  Training and Doctrine Command
  Natick Research & Development Center
  Army Research Institute

Non-DoD Government users of CSE information include:

- National Aeronautics and Space Administration (NASA)

  NASA Headquarters
  Ames Research Center
  Johnson Space Center
  Marshall Space Flight Center
  Langley Research Center
  Jet Propulsion Laboratory

- Department of Transportation

  Transportation Systems Center
  U.S. Coast Guard

- Federal Aviation Administration

  FAA Headquarters
  FAA Technical Center

- National Transportation Safety Board (NTSB)

Industry users would include all major airframe firms and smaller firms performing DoD research and development contracts in support of the DoD. Major airframe companies that would use CSERIAC include:

- Bell Helicopters
- Boeing
- General Dynamics
- Grumman
- Hughes Aircraft Company
- Lockheed
- McDonnell-Douglas
- Northrop
- Sikorsky

Section 3
RECOMMENDED SOLUTION

Establishment of a full-service CSERIAC is the recommended solution to the problem of providing CSE information services to the broad community of users within the DoD and its contractors.

3.1 WHAT ARE ALTERNATIVE SOLUTIONS

Alternatives to CSERIAC for sources of CSE information fall into three categories; current practices, existing IACs, and other national information sources. These alternatives to a DoD CSERIAC must be considered in light of the problem of providing analyzed and evaluated information specific to a user's need.

Current practice is for users to obtain the information themselves from primary sources or recruit the services of in-house human factors and ergonomic specialists. The questionnaire survey (Appendix A) revealed that the common, current practice is to obtain CSE information from primary source documents, i.e., journals, technical reports obtained from the originator, DTIC and NTIS, handbooks and textbooks, or the user goes to a staff specialist or colleague. Data bases, local libraries, and outside consultants are rarely used as primary sources of CSE information.

The current resources have several serious deficiencies as providers of CSE information. Journals and technical reports must be reviewed and the applicable information extracted. This information in turn must be evaluated and analyzed in terms of its applicability to the particular problem. This task will devolve to the user and the ultimate quality, of the information will depend on the individual's knowledge of the fields from which the source material was drawn. Since a large proportion of end users are engineers and most CSE information is drawn from the life sciences and behavioral sciences, many users are poorly prepared to do the necessary evaluation and analysis.

If a human factors and ergonomics specialist is asked to compile CSE information, he or she must perform the same tasks as an IAC staff member but without the ability to tap as wide a range of source material as available to an IAC staff member. DTIC reports are limited to those produced at DoD expense and local libraries are not comprehensive in their document coverage of the relevant literature. Useful sources of CSE information such as models, computer-based analysis methods and design templates are generally unavailable from document sources. Furthermore, the individual tasked with meeting a CSE information requirement may not have a good current awareness of the particular problem area. In essence, the shortcomings of these alternatives are the common, prevalent problems currently encountered and part of the basis for justifying the establishment of the CSERIAC.

None of the existing IACs provide CSE information services as part of their mission. This was confirmed by the visits to the three IACs (SURVIAC, SVIC, TACTEC) that might have included some part of CSE in their data bases.

There are two existing national information sources that have some relationship to CSE information; the Defense Training Data and Analysis Center (TDAC), colocated with the Naval Training Equipment Center (NTEC) and the Army Program Manager, Training Devices (PM TRADE) in Orlando, Florida, and the Manpower and Training Research Information System (MATRIS) located at the Navy Personnel Research and Development Center (NPRDC), San Diego, California. However, neither is a source of CSE information, per se. TDAC focuses on training related behavioral and engineering information. In recognition of TDAC's mission, training information has been explicitly excluded from the proposed scope of topics for CSERIAC. MATRIS provides information about ongoing or completed research supported by the DoD that falls within the Congressional personnel reporting category of manpower and training. Substantive information is limited to unevaluated abstracts of work in progress or completed. Moreover, the Congressional personnel reporting category of human factors is more centrally related to CSE information than manpower and training.

In summary there are no existing alternatives to the proposed CSERIAC that provide the specialized CSE information services, i.e., specialized analysis, data bases, models, computer-based methodologies, and design templates necessary to support the needs of the DoD and its contractors.

3.2 CSERIAC MISSION STATEMENT

AAMRL developed a preliminary conception of the scope of subject matter and functions for the CSERIAC but did not produce a formal mission statement. It was believed to be more prudent to base the mission statement and functions on the interests and needs of the user community as expressed in the results of the questionnaire survey (Appendix A). The following mission statement was formulated based on the analysis of the questionnaire returns.

3.2.1 Proposed Mission Statement for a Crew Systems Ergonomics Information Analysis Center (CSERIAC)

CSERIAC's mission is to perform the functions of a full service Department of Defense (DoD) Information Analysis Center (IAC) as described in "Centers for Analysis of Scientific and Technical Information Regulation," (Department of Defense, 1984). It will provide scientific and technical information services to DoD organizations and their contractors. CSERIAC's scope of subject matter will be crew systems ergonomics for military systems.

CSERIAC's data bases will consist of biomedical, physiological, behavioral, and engineering information specifically derived from, or applicable to, crew systems research, development, design, test and evaluation. CSERIAC will also maintain current, computer-accessible, bibliographic data bases of its document holdings and provide access to other relevant data bases. It will review and summarize new information and disseminate it through bulletins, bibliographies, and reports.

CSERIAC also will serve as a repository and source of other forms of crew system ergonomics information and data, such as models, methodologies, and design support software. CSERIAC will maintain limited crew system design

support hardware necessary to provide specialized forms of crew systems information.

CSERIAC will be a focal point within the DoD for military crew systems ergonomic information.

3.3 CSERIAC LOCATION

AAMRL at Wright-Patterson Air Force Base (WPAFB), Ohio, is proposed as the host organization and physical location of the CSERIAC. AAMRL is the largest single DoD organization involved in aerospace crew systems research and development. AAMRL programs and its professional staff are involved in biomedical, physiological, behavioral, ergonomic, and engineering aspects of crew system development. Consequently, AAMRL has developed several CSE information and design products that could most effectively be provided to the user community through CSERIAC.

3.3.1 Anthropometry and Biomechanics

Anthropometric and biomechanical information exists in several forms at AAMRL. For researchers, the Biodynamics and Bioengineering Division of AAMRL maintains a bibliography of over 40,000 entries on biodynamics. For engineers involved in crew system design, the Computerized Biomechanical Man-Model (COMBIMAN) is a valuable tool. The heart of COMBIMAN is an anthropometric and biomechanical data base consisting of measurements taken from 10,000 Air Force men and women. COMBIMAN allows the designer to enter data on a proposed crew system configuration and then exercise the data base to determine such things as reach envelopes, lines of sight, and body fit for a variety of human sizes and postures. CSERIAC will be able to either provide COMBIMAN data developed for a user's application or Provide a copy of the model for installation on the user's computer system.

Anthropometric and biomechanical data from COMBIMAN and other sources can also be provided by CSERIAC in forms such as data tables, and drawingboard templates to meet a particular user's need.

3.3.2 Perception and Performance Information

The AAMRL Human Engineering Division is completing a major program titled "Integrated Perceptual Information for Designers (IPID)." One of its major products is the IPID Engineering Design Compendium, a comprehensive collection of human perceptual and performance data intended to be a major guide for engineering design of crew systems. This document, actually a collection of individual guides, is intended to be periodically updated. AAMRL has expressed the intent to have the proposed CSERIAC take responsibility for maintaining the configuration of the compendium.

3.3.3 Computer Aided Design Incorporating CSE Information

An AAMRL program, "Cockpit Automation Technology (CAT)," is developing a Computer Aided Design (CAD) system that incorporates ergonomic data and principles. Program personnel have endorsed the idea that the proposed CSERIAC maintain and disseminate the ergonomic data base that is the heart of the CAT CAD system.

3.3.4 Workload Assessment Methodology

AAMRL has developed a comprehensive workload test battery. Baseline performance data for the battery, as well as methodological information for using the workload test battery can be distributed to users upon request to CSERIAC.

3.3.5 Presence of AAMRL at Wright-Patterson Air Force Base

WPAFB itself is the largest DoD center for military aircraft research and development. Most of the laboratories and activities at WPAFB are concerned with aircraft and space vehicle systems development that would both draw on, as well as contribute to the CSERIAC data bases. A strong working relationship would easily develop between the professional personnel at WPAFB and the CSERIAC personnel as an extension of the existing relationship between AAMRL and the other WPAFB laboratories and offices. AAMRL personnel constitute a large potential pool of expertise that would be a

valuable resource for CSERIAC. Because WPAFB is near the geographic center of the continental U.S., on the average it would provide the greatest ease of physical access for individuals to use CSERIAC resources on site.

AAMRL has facility space available for CSERIAC. Moreover, the AAMRL computer facilities support programming languages for data base development, as well as accession and retrieval. These computer resources would be available for use by the CSERIAC staff during the start-up phase before CSERIAC's own data processing equipment is installed.

Section 4
CSERIAC SCOPE

The subject-matter scope of CSERIAC will encompass CSE information and data that bear directly on aerospace crew system research, development, design, and engineering. The data from the questionnaire survey (Appendix A) support the importance of the CSE topics listed in Table 1 to the respondents' work. The topics are grouped in five areas that reflect differences in emphasis of users of CSE information.

TABLE 1. PRINCIPAL CSERIAC INFORMATION TOPICS

BIOMEDICAL	HUMAN PERFORMANCE
G Loading	Sensory Factors
Stress and Fatigue	Perception
Motion and Vibration	Information Processing
Hypoxia and Gas Mixture	Cognitive Processes
Thermal Effects	Individual Differences
Hyperbaria	Learning
Chemical, Biological,	Motor Control
and Radiation Effects	Communication
Anthropometry and Biomechanics	

METHODOLOGIES	
Task Analysis	Performance Measurement
Workload Analysis	Test and Evaluation
Systems Engineering	Statistical Analysis
Function Allocation/Analysis	Human Performance Modeling

DESIGN AND ENGINEERING	
Displays	Ejection/Survival Systems
Controls	Personal Equipment
Multifunction Displays-Controls	Human-System Integration
Communications	Crew Station Layout
Voice Technology	Vehicle Handling Qualities
Life Support	Guidance and Control

SPECIAL TOPICS	
Simulators	Automation
Multi-Crew Member Interaction	Artificial Intelligence
Safety/Accident Prevention	Standards

A few of the topics require explanation. The topic, simulators, refers to engineering simulation to support research and development; training simulators are not included. Training related information is available from the Defense Training Data and Analysis Center (TDAC). Safety/Accident Prevention includes only information related to human error in system and equipment operation that implies a design fault. Automation and Artificial Intelligence are limited to the operational consequences for crew members; they do not include the mechanisms by which automation and artificial intelligence are achieved.

4.1 LIMITATIONS

The proposed CSERIAC will confine its domain of interests to CSE topics for military, aerospace, ground, and water based systems Specifically excluded are training and training effectiveness, maintainability, crew selection, tactics, mission analysis, medicine, and safety except as noted above.

The preponderance of information and data will be drawn from sources that deal specifically with military systems. However, the distinction between military and nonmilitary systems will not be applied to sources of basic or fundamental principles and data. While foreign CSE information is within the domain of CSERIAC, intelligence information will be excluded as required by the implementing regulation (Department of Defense, 1984).

4.2 FUNCTIONS

The essential operational functions for CSERIAC to fulfill its mission requirements are:

4.2.1 Operational Functions

1. Identify sources of existing documents and unpublished information and data, models, data bases, methodologies and software that are relevant to CSE. These sources include government and private organizations such as the Naval Air Development Center,

the Air Force School of Aerospace Medicine, the Army Human Engineering Laboratory, the Army Aeromedical Research Laboratory, Army Research Institute, NASA Ames Research Center, and Johnson Space Center, and major military system/subsystem manufacturers.

2. Identify potential sources of new CSE information and establish a relationship to assure the CSERIAC will receive it as soon as available. Test and evaluation reports and data relevant to CSE are particularly valuable types of CSE information that should be collected by CSERIAC.

3. Acquire all key CSE information essential for analysis and review purposes. These would include existing handbooks and standards, and descriptions of data bases, models and CSE related design software. Technical abstracts of potentially relevant technical reports would be obtained first for screening purposes. Physical acquisition of abstracts would not be necessary for those accessible as computer data bases.

4. Systematically screen, analyze and evaluate accessible documents for CSE relevance by topic area and abstract documents, as necessary, for CSE information purposes. Screen available data bases, models and methodologies for currency, validity, and relevance to crew systems research and development efforts.

5. Develop computer-based document and data bibliographic and retrieval systems with cross references and multiple indexes, e.g., keyword, topic, application.

6. Institute control procedures for access and release of classified and restricted information.

7. Develop procedures for updating and revising CSE information and data compilations and the purging of obsolete materials.

8. Provide required storage for classified, restricted, and unrestricted documents and data.

9. Establish liaison with other IACs and information centers that have some relationship to CSE. The IACs include SURVIAC, SVIC, TACTEC. Other information centers are TDAC and MATRIS.

10. Develop a file of expert consultants in the CSE topic categories who are available to assist in analysis and evaluation tasks or assist in responding to user inquiries.

11. Develop categorized lists of actual and potential CSE information users and generators.

12. Establish a user fee schedule for publications and services.

4.2.2 Service Functions

1. Publicize CSERIAC holdings and services through periodic newsletters, current awareness bulletins, and existing information dissemination channels within the DoD.

2. Publish current awareness and state-of-the-art reviews of CSE topics on a regular basis.

3. Conduct bibliograhic searches in response to user request and provide citations and/or abstracts as needed. CSERIAC will not reproduce or disseminate original source documents other than those it produces itself.

4. Develop special analysis reports requested by users.

5. Provide quick response to simple information inquiries.

6. Maintain configurations and provide access services and copies of special CSE computer-based models such as COMBIMAN as requested by users.

7. Upon request from a DoD agency, organize and conduct symposia, seminars, or workshops.

8. Provide users direct contact information to expert sources when requested.

9. Perform other necessary tasks to be responsive to user needs for CSE information and to appropriately disseminate CSE information, data base extractions, models, methodologies, and software to support DoD aerospace crew systems research, development, design, and engineering efforts.

4.3 START-UP AND DEVELOPMENT

The start-up of CSERIAC will be planned to provide CSE information services to the user community as soon as practical. An announcement of the existence, purpose and services of CSERIAC will be widely distributed two months in advance of the date established for CSERIAC to begin to provide services. Almost all respondents to the survey questionnaire provided their names and addresses to indicate they wished to be informed of the availability of CSERIAC services. This list, as well as others, will be used to distribute the announcement of the availability of CSERIAC's services.

Section 5
REQUIRED RESOURCES

The physical resources and personnel requirements to begin initial operations of CSERIAC are predictable from other IAC start-ups. The potential user community easily exceeds 3000 individuals from 500 or more DoD and DoD contractor organizations. Based on the results of the questionnaire survey (Appendix A), the expected number of requests per year to CSERIAC is approximately 4,000. Requests fulfilled during the first year are likely to be fewer because of the minimum user services available during the start-up phase. The potential number of documents containing CSE information is probably in excess of 20,000. However, those of greatest importance probably number between 1,000 to 5,000. Approximately 2,500 new documents per year will require screening. In addition, five to ten of the most well known and useful models of human performance and several types of CSE-related design methodologies and software packages will require screening. Based on the experience of other IACS, an initial staff of four persons should be adequate to meet start-up needs during the first year.

5.1 EXPERTISE

Operational and technical expertise will be required for CSERIAC. Operational personnel will consist of information specialists with experience in both manual and computer-based procedures for information storage, accession and retrieval functions. Technical personnel will be subject matter experts in CSE. To provide expertise across the range of disciplines that comprise CSE information, at least three individuals with education and experience in biomedical, behavioral, and engineering fields respectively, will be required eventually. The technical experts need not be full time employees of CSERIAC. A group of Government or non-Government experts can be used on a part-time basis. The amount of time required would vary with the nature of the requests received from the users. Having several part-time technical experts available on an "as needed" basis has the advantage of drawing on greater specificity of expertise for any particular CSE information request. Some form of consulting, subcontract or other

arrangement will be made in advance to allow rapid involvement of a part-time technical expert when required.

5.2 STAFFING

Existing IACS operate with from 5 to 35 personnel (Bernier, Mower, and Horton, 1982) plus help from part-time technical personnel. The estimated staffing requirements for the first year of CSERIAC operation are estimated to be 4 full-time personnel plus part time expert support equivalent to one additional person. The recommended staff for the first year would consist of the following (* indicates full-time; # indicates part-time)

Position	Responsibilities
* Facility Manager	Manager and lead technical expert
* Senior CSE Analyst	Customer point of contact; technical expert; security
# Head of Information Services	Information and Library Science expert; document acquisition, control, and indexing; bibliographic procedures
# CSE Information Specialist	CSE information location, abstraction and report development; bibliographic searches
* Data Base Programmer	Computer system data bases; entry, search, and accession programs; model configuration control
* Technical Secretary	Abstract and report typing; correspondence; publication mechanics; filing; mailing; telephone; bookkeeping

This level of staffing and mix of responsibilities has precedent in the recently established SURVIAC. Four full-time staff members including the facility manager plus part-time help equivalent to an additional person are necessary during the first year to bring the CSERIAC to operational readiness. The initial effort will essentially involve physical set-up, establishing procedures, preparing data base software, and obtaining and screening the initial source materials such as documents, compendiums, bibliographies, models, and design support software.

In the second year, the CSERIAC staff should expand to eight people to both continue the development of CSERIAC and provide user services. In addition to the four full-time personnel indicated above, the Head of Information Sciences, two CSE information specialists and an Administrative Secretary would become full-time employees. Part-time technical help, equivalent to two full-time personnel would be required for responding to user requests for analysis services, obtaining model derived data, copies of models or software, and information on CSE methodology. During the second and subsequent years, the presence of several CSE technical experts on the CSERIAC staff is justified because of the nature of CSE information. Almost all information requests will require significant analysis effort because CSE information is rarely available from original source documents in the form of tables, graphs, or other succinct formats. Responses to seemingly simple inquiries can involve substantial effort to search and evaluate the applicability of CSE information derived in a context that is similar, but not exactly the same as the one of concern. Also, providing the use of, or copies of human performance models and design software, as well as providing CSE methodological assistance will require the availability of special expertise.

After the second year, as the service demands and scope of services expand, additional staff members will be required. A reasonable estimate is a staff of fourteen people during the fourth year of operation.

5.3 FACILITIES

The facilities requirements include space for desks, document and other media storage and the computer systems, peripherals, and terminals. Approximately 3300 square feet of space will be required initially. Equipment requirements include standard office furnishings, the computer equipment, storage shelves, and telecommunication equipment. Since only a very limited amount of CSE information is expected to be classified, security storage requirements should be very modest. Also, since there is no foreseen need for electronic storage of classified information (it will be handled manually) the computer systems will not need to meet TEMPEST requirements.

5.4 MANAGEMENT

As a DoD IAC, CSERIAC will be administratively managed by the Defense Logistics Agency (DLA). DLA, through the competitive bid process, will select the contractor to run CSERIAC. If AAMRL becomes the host organization for CSERIAC, it will provide a program manager/technical director. A steering committee composed of representatives from the DoD user community will be established to provide technical guidance for the operation and functions of CSERIAC. The Facility Manager selected by the contractor will have responsibilty for the day-to-day management of CSERIAC and the important task of liaison with the user community both to maintain awareness of their needs and to make CSERIAC known to a wider range of potential users.

5.5 FUNDING

CSERIAC operations will be funded by two sources, DTIC-AI and users who pay fees for services. During the first several years of operation, DTIC-AI will provide core funds to sustain basic CSERIAC operations and services. Beginning in the second year, additional revenues will be generated from user fees that, in turn, will allow expansion of the scope of CSERIAC services. The core funding from DTIC-AI is expected to increase by approximately 25% from year to year during the first several years. The increases will be necessary to permit a more rapid expansion of services than would be possible if all growth were to be funded from user fees alone. Income from user fees is anticipated to nearly triple from the second to third years of opeation and to double from the third to fourth years of operation.

The results of the questionnaire survey indicate that 78.5% of the potential users are willing to pay reasonable fees for CSERIAC services. This high percentage of users willing to pay fees, coupled with the high usage expected (4,000 or more requests per year), means that the largest portion of funding to support CSERIAC operations should eventually come from user fees.

A lesson learned from the experience of other IACS is to aggressively pursue obtaining annual subscriptions from the user community for CSERIAC services and reports. Subscription fees, as well as core funding from DTIC-AI, are the dependable sources of income that allow operational stability and budgetary planning from year to year.

Section 6
IMPLEMENTATION PLAN

The descriptions of the phases of implementation and operation of CSERIAC are intended to outline a general, orderly process necessary for CSERIAC to attain its goal and objectives. The plans for these phases are certain to be developed in great detail by the contractor in the response to the Request for Proposal to operate CSERIAC.

Of great importance is the need to develop the CSERIAC resources and services in such a way that its credibility and quality of service to the user community are established at the outset and maintained in the years to come. It is better to gradually increase capabilities over the entire spectrum of CSE information services to be provided than to build full capabilities in some subareas early and others later. If CSERIAC initially provided services for only a subset of its range of topics or forms of information services it would discourage users with other topic interests or needs by fostering the erroneous impression that CSERIAC is limited in its topic coverage and types of services provided.

6.1 GOALS AND OBJECTIVES

The goal of CSERIAC is to provide the wide spectrum of aerospace CSE information services detailed in Section 4.2.2 to DoD and DoD contractors. Its objectives are to become the acknowledged central source for up-to-date, reliable CSE information provided in a timely manner in a form specifically tailored to meet a user's application needs. In achieving these objectives the CSERIAC will fulfill a long-standing critical need to improve the incorporation of CSE information in the aerospace crew system design and engineering processes. It will also assure greater usage of CSE information by relieving the burden on the user to seek, analyze, and interpret needed CSE information.

6.2 CSERIAC SET-UP PHASE

During the set-up phase, expected to be about one year in duration, the principal activities of the CSERIAC staff will be:

1. Physically prepare the facility including ordering of office furniture, computer system, storage shelves, etc. Facilities and computer resources provided by AAMRL will minimize the time required before user services can be provided.

2. Establish the key operational procedures, including the configuration of the data bases, source identification and access methods, in-house software requirements for entry, search, and retrieval, configuration control and use of models, testing of design support software, and handling of customer requests.

3. Develop a time-line plan for announcements, initial products and services to be provided.

4. Acquire core documents, such as CSE handbooks, Military Standards relevant to CSE, key technical reports and other documents in limited number. Install, or develop access methods for, available models such as COMBIMAN.

5. Identify sources of published CSE information, as well as unpublished test and evaluation reports relevant to CSE and initiate processes to receive documents, data, models, software, and other materials from these sources.

6. Identify major collections of existing CSE information and obtain, if possible, descriptions of holdings and access procedures.

7. Identify and establish access to existing CSE computer data base collections, models, and design support software.

8. Develop lists of potential users.

9. Begin systematic review of bibliographies, abstracts and documents for relevance to planned publications and anticipated user requests. Begin abstraction of documents and development of in-house bibliographies. Review model descriptions and reports and software that support CSE design efforts.

10. Establish agreements with part-time technical experts.

11. Solicit transfer of collections of documents, data, models, and software judged to be valuable resources for CSERIAC.

12. Distribute announcements in advance of initial service date with description of publications, products and services available.

13. Establish working relationship with other IACs.

6.3 CSERIAC INITIATION OF SERVICES

The main objective during this second phase is to establish the credibility and worth of CSERIAC by providing services and dissemination of publications, computer base models, software and methodological information. The plan for the second phase should include:

1. Offering of bibliographic and special analysis services in response to user requests.

2. Publication and dissemination of topical bibliographies, a newsletter, and one or more current awareness reviews of high interest topics.

3. Provide copies and/or access to use of models and design support software, and specialized data base extractions.

4. Continuation of the search, evaluation and abstraction of relevant CSE source documents and the development of indexed bibliographies. Continuation of the development and acquisition of data bases, models, and design support software.

5. Regular publication of a newsletter, current awareness reviews, and current awareness bibliographies.

6. Announcement of a subscription plan for publications and services, and initiation of efforts to encourage users to take advantage of the program.

7. Development and implementation of a mechanism to receive user opinions on the quality of service and topics of interest to improve CSERIAC services to the user community.

8. Establishment of a mechanism to permit direct telecommunication queries by users of data bases of unclassified and unrestricted documents.

By the end of the second phase CSERIAC should be a full service IAC providing needed CSE information services.

6.4 CSERIAC CONTINUED DEVELOPMENT

The activities outlined for the second phase will continue in successive years. Expansion of staff and services are likely to occur as demand for services and revenues from user fees increase. Additional activities CSERIAC could undertake in future years include:

1. Support of revision and development of Military Standards and Specifications relevant to CSE.

2. Conduct symposia and workshops on selected, high interest topics.

3. Develop standard descriptions and instructions for CSE methodologies.

4. Develop standard anthropometric and biomechanical and human performance models, and CSE design support software. Provide copies to users on request and establish telecommunication access methods to models resident at CSERIAC.

5. Publish a CSE Journal.

6. Update established key reference documents such as the IPID Engineering Data Compendium.

Section 7
BENEFITS OF A DOD CSERIAC

A DoD CSERIAC would provide several benefits to the DoD and other government and industry community of users.

1. Increase the utility and transfer of CSE technical information to researchers, system developers, and program managers.

2. Provide a centralized source of current CSE information, data, models, support software, and CSE methodologies for design and evaluation of aviation and space crew systems.

3. Serve as a repository of unpublished data from government test & evaluation programs and systems development tradeoff studies.

4. Minimize the duplication of CSE programs by serving as a DoD focal point for information on past and present programs related to CSE technology.

5. Provide analysis services for scientific and technical information in the CSE area.

6. Promote standards in the collection, analysis and use of CSE technical information, data, models, software, methodologies, and other CSE design support tools.

7. Develop new analytical methods for evaluating crew systems design.

8. Assist program managers and other decision-makers in evaluating the human-crew system interface.

9. Contribute to effective system design and evaluation through continued selection, analysis, and dissemination of pertinent CSE information.

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Appendix A

ANALYSIS OF QUESTIONNAIRE SURVEY TO DETERMINE THE NEEDS AND REQUIREMENTS FOR A CREW SYSTEMS ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC)

1.1 BACKGROUND

Early in 1985, a 14-item questionnaire was developed to survey opinions of the potential user community on the need for a Crew Systems Ergonomics (CSE) Information Analysis Center (IAC). The questionnaire solicited information on topics and services of interest, expected usage, and the work and educational background of the respondents. In May 1985, 3705 questionnaires, with an introductory letter and a description of purpose and services provided by IACs, were mailed to individuals likely to have an interest in CSE. Appendix B contains the complete questionnaire and the accompanying materials included in the mailing.

1.2 QUESTIONNAIRE OBJECTIVES AND DEVELOPMENT

The questionnaire was designed to determine if proposing the establishment of a CSERIAC would be worthwhile and to obtain the information necessary to justify its proposed mission, scope and level of operation. The implementing regulation for IACs (Department of Defense, 1984) was reviewed to be certain that the necessary supporting data would be obtained from the questionnaire returns. The specific objectives of the questionnaire were to determine:

1. Perceived need for a central source of aerospace CSE information services.

2. Scope of CSE topics of interest.

3. Nature of current problems with CSE information.

4. CSE information services desired.

5. Employment and educational background of respondents.

6. Expected volume of requests to CSERIAC and the effect of fees on usage.

A draft questionnaire was prepared that met the information objectives. To help maximize the number of returns, the questionnaire was limited to fourteen questions. The draft questionnaire was sent to seventeen individuals within the DoD and industry who are knowledgeable in both CSE and questionnaire construction. These experts were asked to comment on both the content of the questionnaire as well as its design. All seventeen provided written critiques. A final version was prepared based on the suggestions of these individuals and subsequently reviewed and approved by AAMRL.

1.3 DEVELOPMENT OF MAILING LIST OF QUESTIONNAIRE RECIPIENTS

The mailing list was generated from membership lists of four organizations; The Human Factors Society, Divisions 19 (Military Psychology) and 21 (Engineering and Applied Experimental Psychology) of the American Psychological Association, The Institute of Electrical and Electronics Engineers (subscribers to Transactions on Systems, Man and Cybernetics), and The Aerospace Medical Association (members who indicated to the association an interest in human factors). Individuals who were either student members of the professional organizations or had foreign addresses were excluded from the source lists.

The professional organization source lists were supplemented by a list of associates of the DOD Human Factors Engineering Technical Advisory Group and a list compiled from review of DoD organizational charts (positions likely to have some concern for CSE). All lists were cross-checked to remove duplicate names and addresses.

2.1 RESPONSE

2.1.1 Returns

The recipients were asked to complete and return the questionnaire within three weeks. By June 21, 1985, exactly 1000 (27%) of 3705 questionnaires distributed were completed and returned. The high percentage of returns was particularly gratifying since approximately half that number were expected based on past experience with questionnaires.

2.1.2 Screening the Questionnaire Data

The questionnaire response data were entered into a computer data base for analysis. The first step was to screen the questionnaires for relevance. Question 3 asked if the respondent ever uses CSE information and Question 4 asked if the respondent ever generates CSE information. One hundred and fifty-one (151) questionnaires were eliminated on the basis of either no response to questions 3 and 4 or because the respondent indicated that he or she both never uses CSE information and never generates CSE information. One questionnaire was eliminated because the respondent indicated "retired" on Question 12 - current employment. Since a major goal of the questionnaire was to classify responses by DoD and non-DoD employment categories, an additional 19 questionnaires were eliminated due to the absence of any response to Question 12 on Current Employment. Thus, the data presented in the accompanying tables and figures are based on a total sample of 829 questionnaires (22.4% of questionnaires mailed).

3.1 SUMMARY OF SURVEY QUESTIONNAIRE RESULTS

Of the 829 useable questionnaires (22% of the 3705 distributed) received, 30% were from DoD employees and 70% were non-DoD employees. Approximately 75% of the respondents are involved in Research and Development, Management or Test and Evaluation, and have educational backgrounds in either Behavioral Science, Engineering or Human Factors. The current work and educational background of the respondents did not appear to differ substantially by employment category. Ninety-seven percent (97%) of the respondents

indicated they use CSE information and over 70% indicated they generate CSE information. This result validated the assumption that the mailing would reach a substantial portion of persons concerned with CSE information. It also supports the contention that the respondents are potential users of CSE information services.

Eighty-seven percent (87%) of the respondents indicated a strong perceived need for a CSE information center and 67% agreed that it should be a DoD sponsored IAC. Twenty-two percent (22%) indicated they didn't know if the CSE center should be a DoD IAC. This implies they are at least open to the possibility that CSERIAC would be an appropriate means to provide needed CSE information services.

There is substantial interest in almost all of the 42 CSE topics that were listed in the questionnaire. Only 6 topics were of interest to less than 30% of the respondents. Three of the low interest topics are in the biomedical area. The other three are in the design and engineering category.

Journals and Technical Reports, obtained either by direct distribution or from DTIC or NTIS, are the major sources of CSE information. The most frequently cited problems with CSE information were lack of awareness of information available, lack of specificity to the need, poor quality of the information, and delay in receiving requested information.

State-of-the-art reviews and quick response to inquiries were the most frequently cited CSE information need and the most useful forms of CSE information was perceived to be topical reviews, special analysis reports, and study summaries.

Seventy-eight percent (78%) of the respondents would be willing to pay for CSERIAC services and about 75% would make one to ten requests to CSERIAC per year. Mean number of requests per year per respondent is 7; the median number of requests per respondent is 3.5. This implies that CSERIAC would receive over 4000 inquiries per year.

In general, among the 829 respondents to the questionnaire, there is a strong perceived need for aerospace CSE information services and two-thirds of the respondents endorsed the establishment of the DoD CSERIAC. The CSE information problems and needs indicated by the respondents are exactly the kind that can be alleviated and filled, respectively by CSERIAC. There was strong interest in almost all CSE topics considered to be within the scope of CSERIAC's area of concern.

The DoD and non-DoD respondents are predominantly users and generators of CSE information, work in research and development, management or test and evaluation, and have educational backgrounds predominantly in behavioral science, engineering, and human factors.

4.1 ANALYSIS OF RESPONSES TO INDIVIDUAL QUESTIONS

4.1.1 Presentation of the Data

The data presented in the Tables and Figures A-4.1 through A-4.20 at the end of this section are divided by DoD and non-DoD employment categories. The DoD employment category includes active-duty military and DoD civil service personnel. Because of the small number of respondents (31 or 5%) in the non-DoD Federal Government employee category, their response data are included in the non-DoD category. A preliminary examination of the data revealed that the patterns of responses of the non-DoD Federal employees did not differ appreciably from those of either the DoD employees or civilian personnel.

The graphical data are generally presented in terms of percent of responses within each of the two employment categories. The word labels on the abscissa of each graph are abbreviated versions of the response alternatives given in the questionnaire. The response data for each question are presented in descending order of total responses to each alternative for the DoD and non-DoD categories combined. Some graphs and tables include the category "Blank" to account for the absence of any response to a question.

4.1.2 Characteristics of Respondents

Five questions asked for information about the respondents employment, regular work, education, and their use and production of CSE information.

Question 12 asked: "Please indicate your current employment."

Two hundred and forty-nine (249) of the 829 respondents (30% of sample) are military or civilian employees of the DoD, and the remaining 580 (70% of sample) individuals are either in non-DoD civil service or are employed in civilian organizations. Of the DoD employees, 10% are active duty military personnel and 20% are civil service personnel. Of the non-DoD employees 49% are in industry, 12% are in academia, 5% are self employed, and 4% are in non-DoD, Federal Civil Service. See Table and Figure A-4.1.

Since there was no a prior knowledge of the percent of questionnaires mailed to individuals in the different employment categories, it is not possible to determine if there was a differential rate of return by employment category.

Question 10 asked: "Which of the following activities best describe your regular work?"

Research and Development is the predominant primary work of both the DoD (40%) and non-DoD respondents (51%). Management (28%) and Test and Evaluation (15%) were the second and third most frequently cited primary work categories by DoD employees. Design (16%) and Management (15%) were the second and third most frequently cited primary work categories by non-DoD employees. Research and Development (25%) and Test and Evaluation (18%) were the most frequently cited secondary work categories by both DoD and non-DoD employees. See Tables and Figures A-4.2 - A-4.3.

Question 11 asked: "Which of the following discipline areas best describe your formal educational background?"

Behavioral Science (35%), Engineering (25%), and Human Factors (22%) were the most frequently cited primary educational disciplines by both DoD and non-DoD employees. In aggregate, these three discipline areas account for the primary educational background of 82% of the respondents. Seventy-seven percent (77%) of the respondents indicated a secondary educational background. Based on the full sample of 829, the most frequently cited secondary educational disciplines were Behavioral Science (25%) and Human Factors (12%). See Tables and Figures A-4.4 - A-4.5.

Question 3 asked: "How frequently do you use CSE Information in your work?"

Almost all (97%) of the respondents indicated some use of CSE information. Sixty percent (60%) indicated they use CSE information frequently or very frequently. See Table and Figure A-4.6.

Question 4 asked: "Do you ever generate CSE information?"

About 73% of the respondents said they generate CSE information. See Table and Figure A-4.7.

4.1.3 Need for CSE Services

Four questions asked about the need for a central source of CSE information, how often requests for services would be made and whether potential users would be willing to pay reasonable fees for these services.

Question 1 asked: "Is there a need for a center to provide crew systems ergonomics information analysis services?"

Eighty-seven percent (87%) of the respondents believe there is a need for such a center. See Table and Figure A-4.8.

Question 2 asked: "If YES [to Question 1], should the center be a DoD Information Analysis Center (IAC)?"

Sixty-seven percent (67%) of the respondents (77% of those saying yes to Q1) support the idea of a DoD sponsored CSERIAC. See Table and Figure A-4.9.

Question 13 stated: "Fees would be charged to cover the costs of most services provided by a crew systems ergonomics information analysis center (CSERIAC). To what degree would this affect your use of CSERIAC?"

Sixty-nine percent (69%) of DoD employees and 83% of non-DoD employees respondents indicated they would be willing to pay reasonable fees for CSERIAC services. Eighteen percent (18%) of all respondents stated they would use CSERIAC services only if they were free. Two percent (2%) said they probably would not use CSERIAC services at all. See Table and Figure A-4.10.

Question 14 asked: "What number of times per year would you probably request services from CSERIAC?"

The estimated number of uses per year of CSERIAC ranged from 0 to 250. The mean number was 7 times per year and the median number was 3.5 times per year. Seventy-five percent (75%) of the respondents indicated they would use CSERIAC between 1 to 10 times per year. If these estimates are reliable, it implies CSERIAC would receive over 4000 requests per year from the questionnaire respondents alone. See Table and Figure A-4.11.

4.1.4 Current Sources of CSE Information

One question asked about sources of CSE information. Several of the alternatives were primary source documents, and responses to these items imply that the users must do their own search and analysis of these documents. Other alternatives were of a kind that would imply that some services similar to those that would be provided by CSERIAC were being used.

Question 6 asked: "Please check your THREE most important sources of CSE information."

Journals were the most often (54%) cited source of information followed by DTIC (36%), and technical reports obtained from the originating source (33%). There appear to be important differences in the response by employment category. DoD employees cited technical reports from the originating source (46%) more frequently as an important source of information than journals (36%). The reverse was true for non-DoD respondents. Sixty-two percent (62%) cited journals as a source of CSE information and technical reports were cited by 28% of the non-DoD respondents. In general, the responses indicated that much of the burden of finding and extracting CSE information from source documents was borne by the users themselves. See Table and Figure A-4.12.

4.1.5 Problems Encountered with CSE Information

Problems encountered with CSE information was the subject of one question. Responses to the various alternatives imply the primary types of information services that should be offered by CSERIAC. The question asked the respondent to rate the alternatives that apply on a scale from one (1) to (4). One (1) signifies a problem that is most important or is encountered most frequently. Four (4) signifies a problem that is least important or is encountered least frequently. To highlight the important or frequent problems, the ratings of an alternative with either a one (1) or a two (2) were counted (ratings of three or four were disregarded) and a percent figure computed for each employment category based on the number of respondents in each category (249 - DoD and 580 - non-DoD).

Question 7 asked: "Which of the following problems do you currently encounter with respect to CSE information?"

Awareness of information available was rated one (1) or two (2) most frequently (60%) by the respondents. The second and third most important or frequently encountered problems were lack of specificity (40%) and nonexistence (37%) of the required information. Where to obtain needed CSE information was the least often cited (25%) CSE information problem. See Table and Figure A-4.13.

4.1.6 CSE Services and Forms of Information Required

Two questions asked about CSE products or services required and the form of CSE information that would be most useful. Both questions asked the respondent to rate the alternatives that apply on a scale from one (1) to (4) as described in the previous section. Percent responses were computed based on the number of times an alternative was rated either one (1) or two (2) as previously described.

Question 8 asked: "Which of the following products or services do you require to satisfy your CSE information needs?"

The products and services most frequently cited were state-of-the-art reviews (64%), quick response to inquiries (42%), and technology briefs (38%). Training materials were rated least frequently as an important or frequently needed product or service (16%).

Question 9 asked: "With regard to your most frequent needs, how useful are the following forms for CSE information?"

Topical reviews (63%), special analysis reports (57%), and study or project summaries (51%) were most frequently cited as being the most useful form of information. Computer-based model data (21%) was least frequently cited as a useful form of CSE information. Non-DoD personnel cited the above forms of CSE information in the order given. However, DoD personnel cited special analysis reports (74%) as useful more frequently than any other form of CSE information. DoD personnel cited study or project summaries (55%) and topical reviews (54%) second and third most frequently, respectively.

4.1.7 Important CSE Topics

One question asked the respondents to check all CSE topics that were important in their work. The original list of 42 specific topics was based on the scope of concerns that define the aerospace crew systems domain. The topics were grouped in five categories: Biomedical, Human Performance,

Methodologies, Design and Engineering, and Special Topics. Differences in the number of responses among the categories would be an indicator of whether CSERIAC should more restrictively define its scope of concerns.

Question 5 asked: "Please check all the CSE topics below that are important in your work."

All 42 of the topics are considered to be important to the work of a substantial number of the respondents. However, there are some differences in the relative importance to the respondents among the five categories. Average number of responses per category (total responses within a category divided by number of items in the category) were computed. Sixty-seven percent (67%) of the respondents had interest in human performance and methodologies topics. Special Topics and Design and Engineering topics were important to 51% and 49% of the respondents, respectively. Biomedical topics was the category that was least frequently (34%) considered important to the work of the respondents.

Only 6 of the topics, considered individually, were of importance to less than 30% of the respondents. Three each of the low frequency of importance topics were in the biomedical area (Thermal Effects, Hypoxia and Gas Mixture, and Hyperbaria) and the design and engineering area (Guidance and Control, Vehicle Handling Qualities and Ejection and Survival Systems). Tables and Figures A-4.16 - A-4.20 present the response data for each of the five topic categories.

5.1 CONCLUSIONS

1. There is strong need for CSE information services both within the DoD and industry.

2. A DoD CSERIAC is perceived to be the appropriate mechanism to provide these services.

3. Potential users are willing to pay fees to obtain CSERIAC services.

4. All topics associated with aerospace CSE are of importance to potential users of CSERIAC.

5. There will be heavy demand for CSERIAC services.

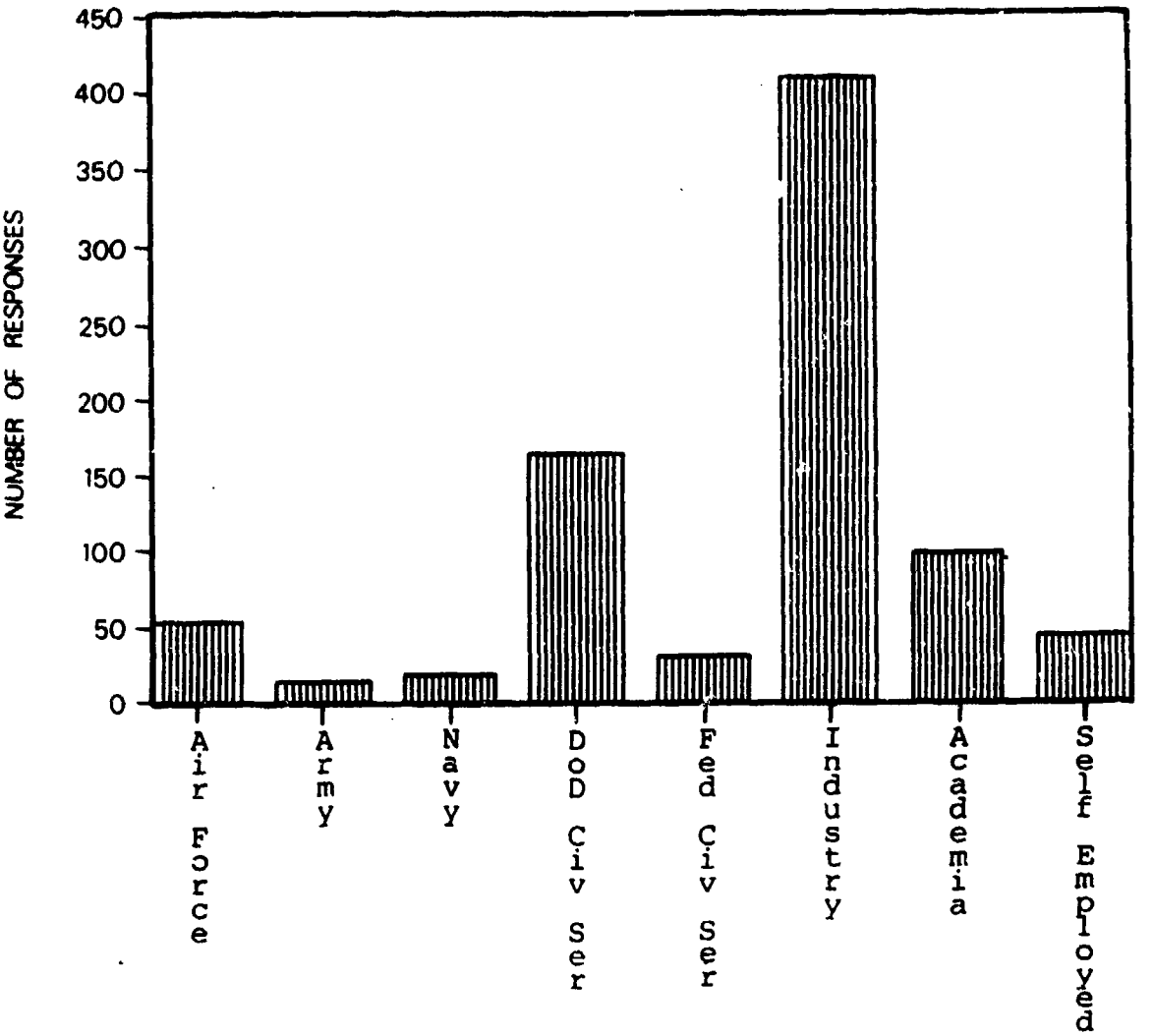

Figure A-4.1. Respondents' current employment.

Question 12: Please indicate your current employment.

TABLE A-4.1. Respondents' Current Employment.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	PERCENT OF TOTAL
Air Force	53	21.3			53	6.4
Army	13	5.2			13	1.6
Navy	19	7.6			19	2.3
DoD Civil Service	164	65.9			164	19.8
Federal Civil Service			31	5.3	31	3.7
Industry			408	70.3	408	49.2
Academia			98	16.9	98	11.8
Self-Employed			43	7.4	43	5.2
Total:	249	30.0	580	70.0	829	---

QUESTION 12: Please indicate your current employment. Check only one.

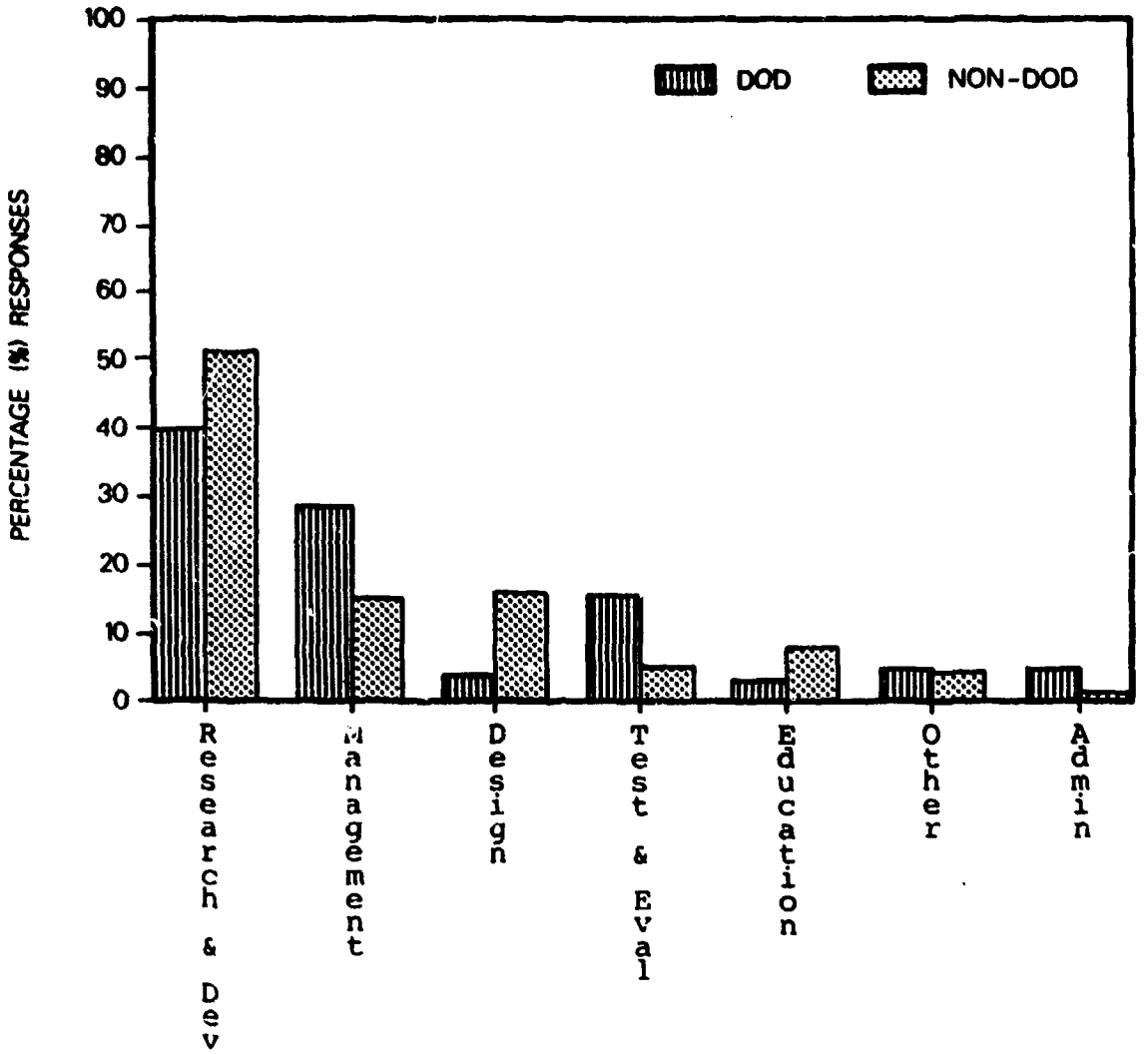

Figure A-4.2. Primary job activity of respondents.

Question 10: Which of these activities best describe your regular work? If more than one applies, please use 1 for primary and 2 for secondary.

TABLE A-4.2. Primary Job Activity of Respondents.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Research & Development	99	39.8	297	51.2	396	47.8
Management	71	28.5	87	15.0	158	19.1
Design	9	3.6	91	15.7	100	12.1
Test & Evaluation	38	15.3	28	4.8	66	8.0
Education	7	2.8	44	7.6	51	6.2
Other	11	4.4	25	4.3	36	4.3
Administration	11	4.4	7	1.2	18	2.2

QUESTION 10: Which of the (above) activities best describe your regular work? If more than one applies, please use 1 for primary and 2 for secondary.

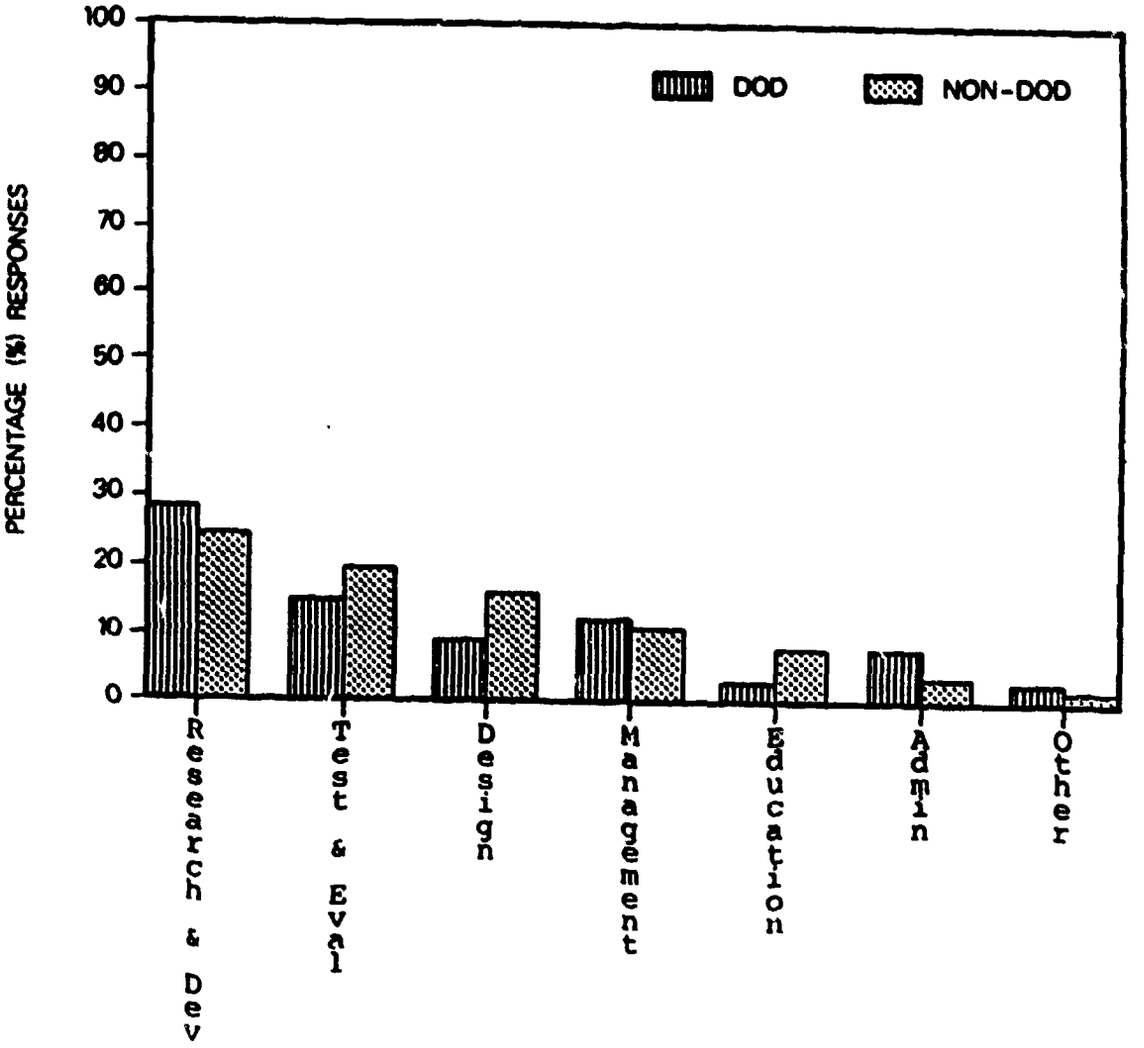

Figure A-4.3. Secondary job activity of respondents.

Question 10: Which of these activities best describe your regular work? If more than one applies, please use 1 for primary and 2 for secondary.

TABLE A-4.3. Secondary Job Activity of Respondents.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Research & Development	70	28.1	140	24.1	210	25.3
Test & Evaluation	36	14.5	111	19.1	147	17.7
Design	22	8.8	91	15.7	113	13.6
Management	30	12.0	62	10.7	92	11.1
Education	6	2.4	45	7.8	51	6.2
Administration	19	7.6	19	3.3	38	4.6
Other	6	2.4	8	1.4	14	1.7

QUESTION 10: Which of the (above) activities best describe your regular work? If more than one applies, please use 1 for primary and 2 for secondary.

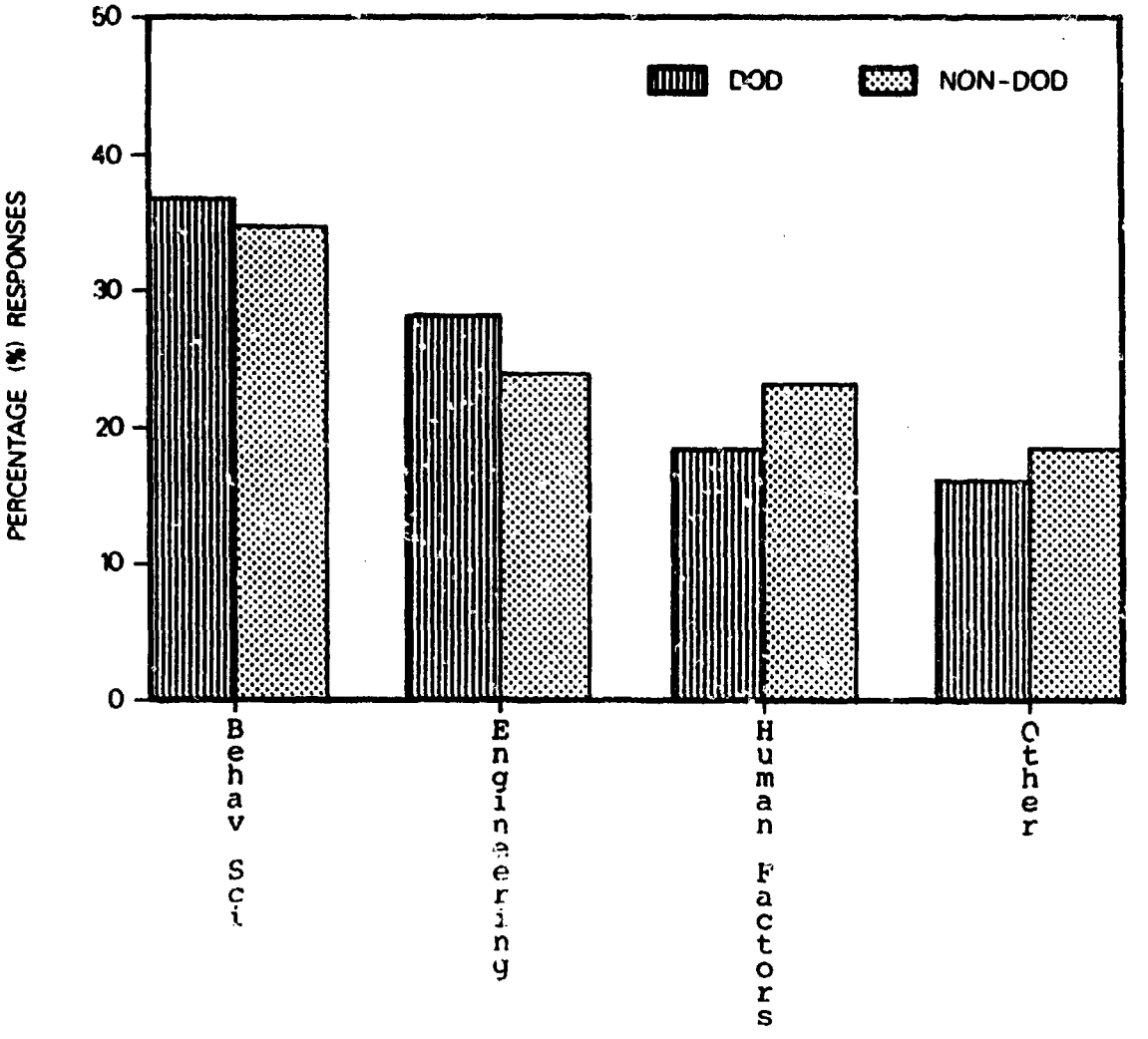

Figure A-4.4. Educational background of respondents - Primary

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Question 11: Which of these discipline areas best describe your formal educational background? If more than one applies, please use 1 for primary and 2 for secondary.

TABLE A-4.4. Educational Background of Respondents-Primary.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Behavioral Science	92	36.9	201	34.7	293	35.3
Engineering	70	28.1	138	23.8	208	25.1
Human Factors	46	18.5	134	23.1	180	21.7
Other	10	4.0	20	3.4	30	3.6
Physical Science	3	1.2	18	3.1	21	2.5
Medicine	3	1.2	14	2.4	17	2.1
Social Science	4	1.6	13	2.2	17	2.1
Physiology	6	2.4	9	1.6	15	1.8
Computer Science	0	0.0	13	2.2	13	1.6
Management	2	0.8	8	1.4	10	1.2
Mathematics	4	1.6	3	0.5	7	0.8
Operations Research	5	2.0	2	0.3	7	0.8
Biology	3	1.2	3	0.5	6	0.7
Information/Library Science	0	0.0	4	0.7	4	0.5

QUESTION 11: Which of the (above) discipline areas best describe your formal educational background? If more than one applies, please use 1 for primary and 2 for secondary.

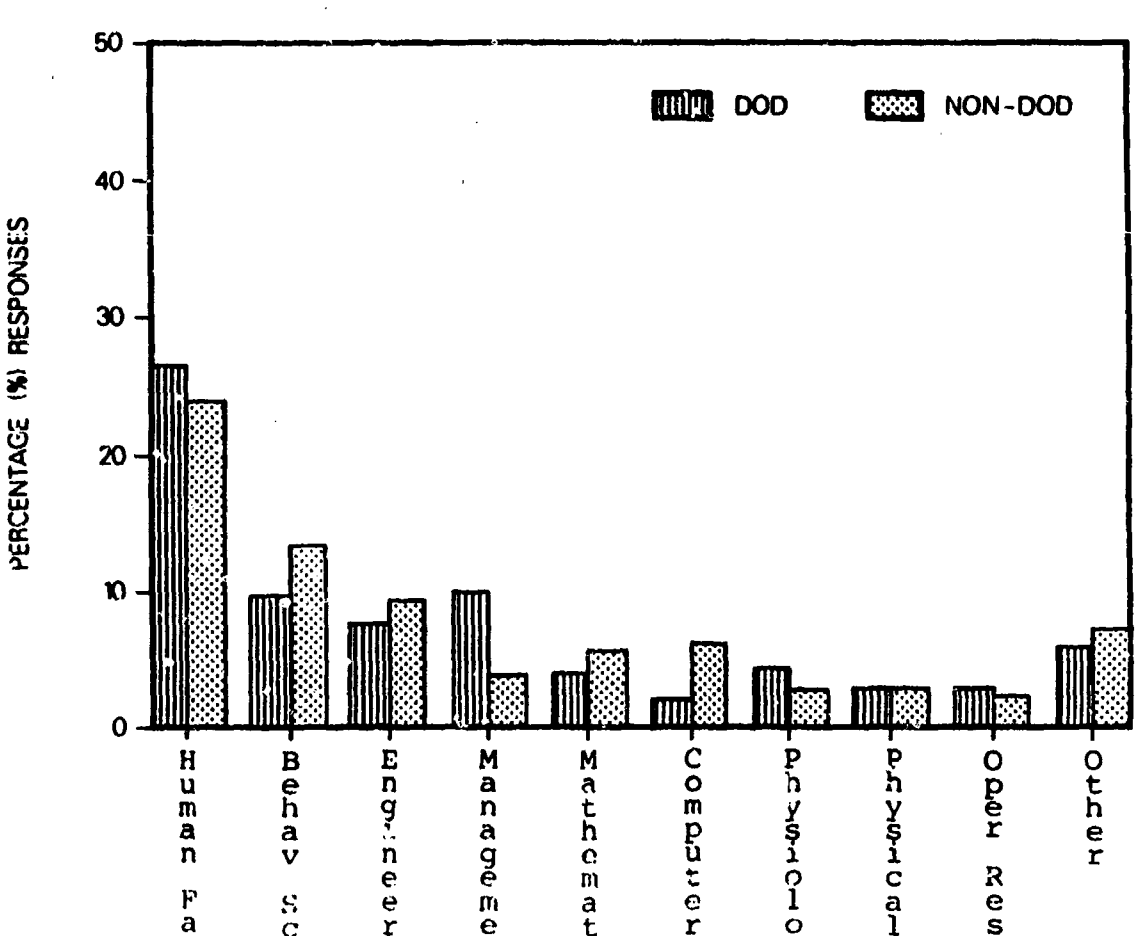

Figure A-4.5. Educational background of respondents - Secondary

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Question 11: Which of these discipline areas best describe your formal educational background? If more than one applies, please use 1 for primary and 2 for secondary.

TABLE A-4.5. Educational Background of Respondents-Secondary.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Human Factors	66	26.5	138	23.8	204	24.6
Behavioral Science	24	9.6	78	13.4	102	12.3
Engineering	19	7.6	54	9.3	73	8.8
Management	25	10.0	22	3.8	47	5.7
Mathematics	10	4.0	32	5.5	42	5.1
Computer Science	5	2.0	36	6.2	41	4.9
Physiology	11	4.4	15	2.6	26	3.1
Physical Science	7	2.8	17	2.9	24	2.9
Operations Research	7	2.8	13	2.2	20	2.4
Other	6	2.4	13	2.2	19	2.3
Social Science	7	2.8	9	1.6	16	1.9
Biology	2	0.8	8	1.4	10	1.2
Medicine	0	0.0	8	1.4	8	1.0
Information/Library Science	0	0.0	3	0.5	3	0.4

QUESTION 11: Which of the (above) disciplines areas best describe your formal educational background? If more than one applies, please use 1 for primary and 2 for secondary.

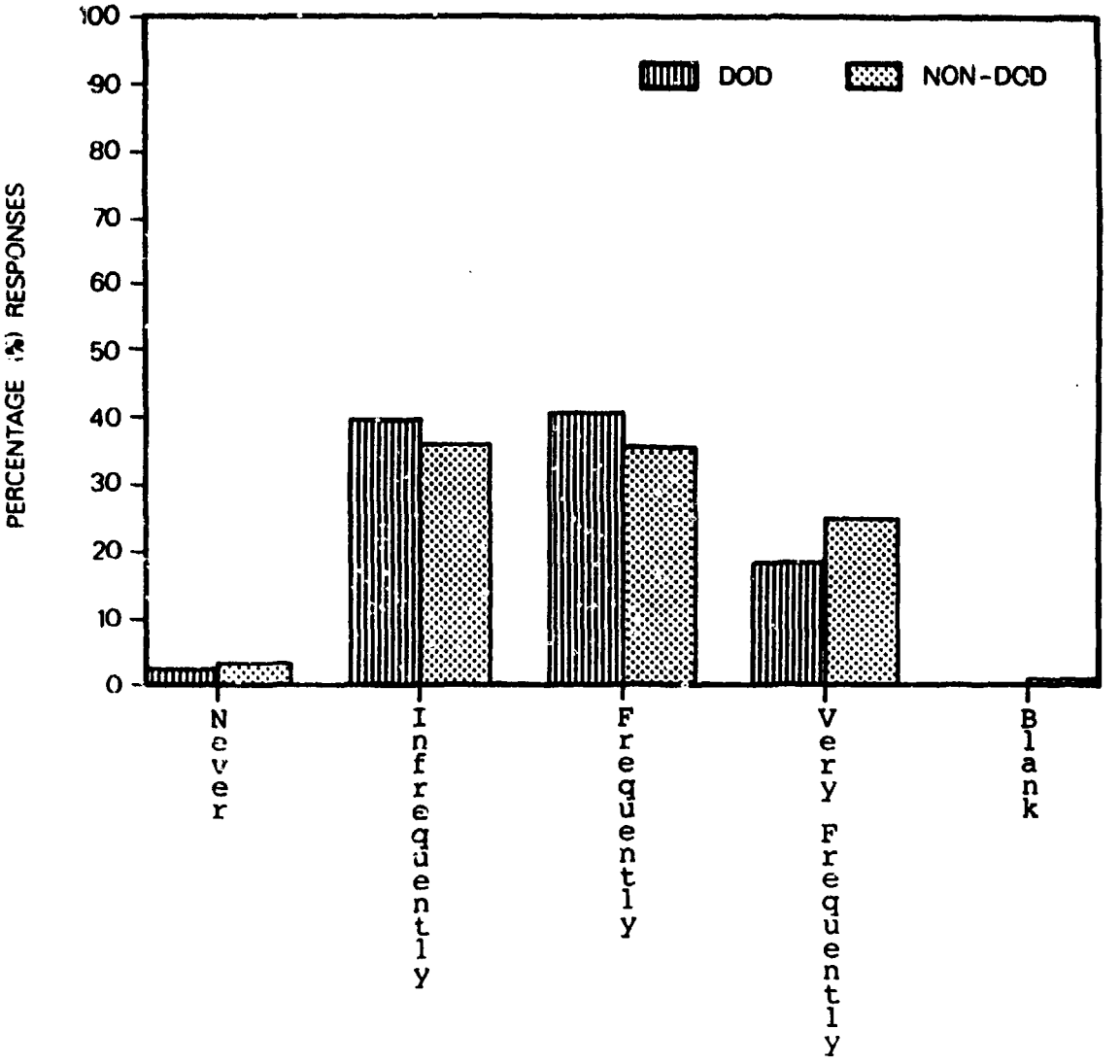

Figure A-4.6. Respondents' frequency of use of CSE information.

Question 3: How frequently do you use CSE information in your work?

TABLE A-4.6. Respondents' Frequency of Use of CSE Information.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Never	5	2.0	18	3.1	23	2.8
Infrequently	98	39.4	208	35.9	306	36.9
Frequently	101	40.6	207	35.7	308	37.2
Very Frequently	45	18.1	144	24.8	189	22.8
Blank	0	0.0	3	0.5	3	0.4

QUESTION 3: How frequently do you use CSE information in your work?

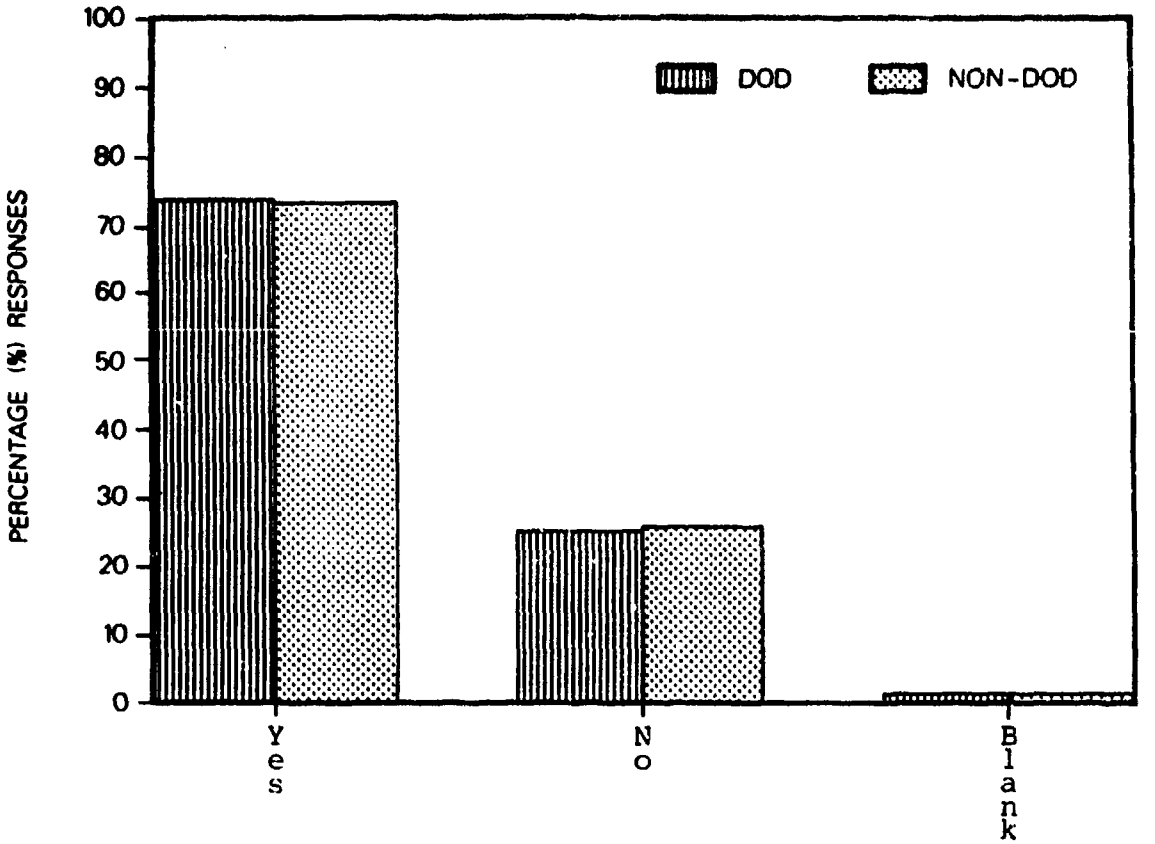

Figure A-4.7. Percent of respondents who do or do not generate CSE information.

Question 4: Do you ever generate CSE information?

TABLE A-4.7. Percent of Respondents Who Do or Do Not Generate CSE Information.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Yes	183	73.5	423	72.9	606	73.1
No	63	25.3	150	25.9	213	25.7
Blank	3	1.2	7	1.2	10	1.2

QUESTION 4: Do you ever generate CSE information?

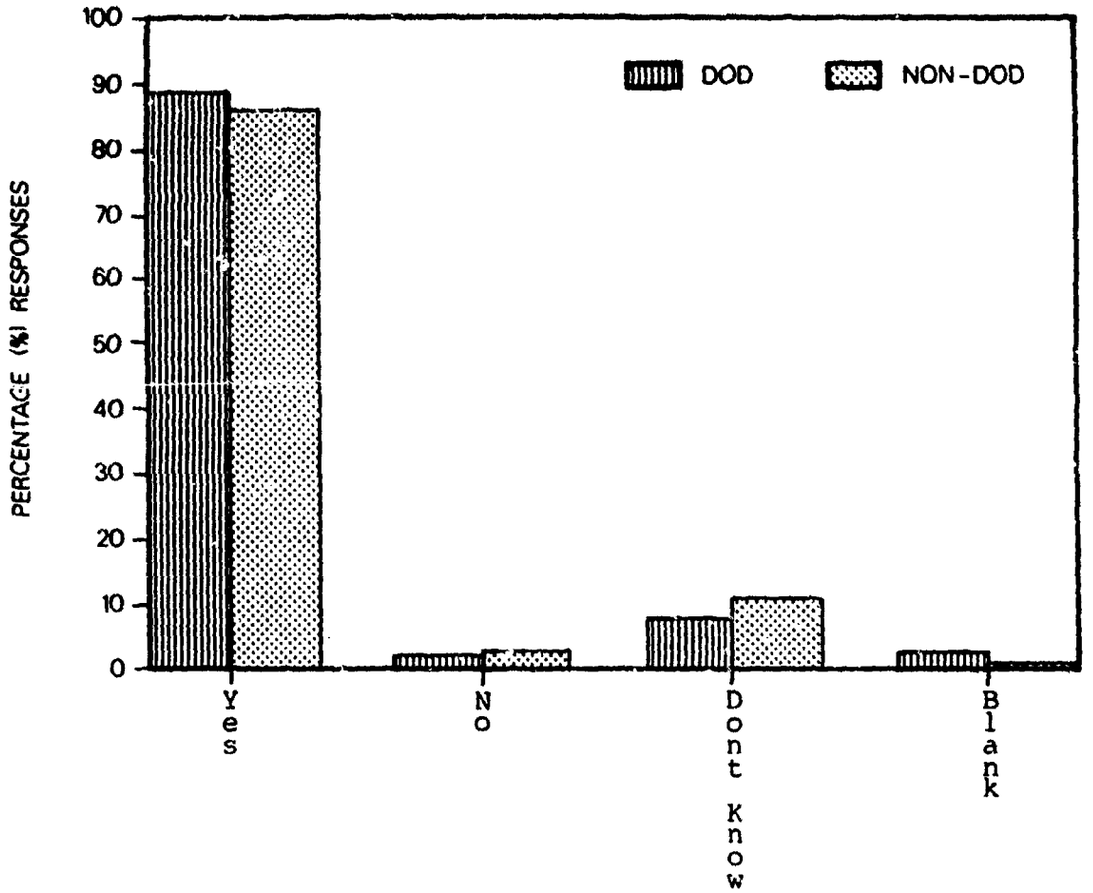

Figure A-4.8. Respondents' opinion about need for a CSE information center.

Question 1: Is there a need for a center to provide crew systems ergonomics information analysis services?

TABLE A-4.8. Respondents' Opinion About the Need for a CSE Information Center.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Yes	221	88.8	499	86.0	720	86.9
No	4	1.6	16	2.8	20	2.4
Don't Know	19	7.6	62	10.7	81	9.8
Blank	5	2.0	3	0.5	8	1.0

QUESTION 1: Is there a need for a center to provide crew systems ergonomics information analysis services?

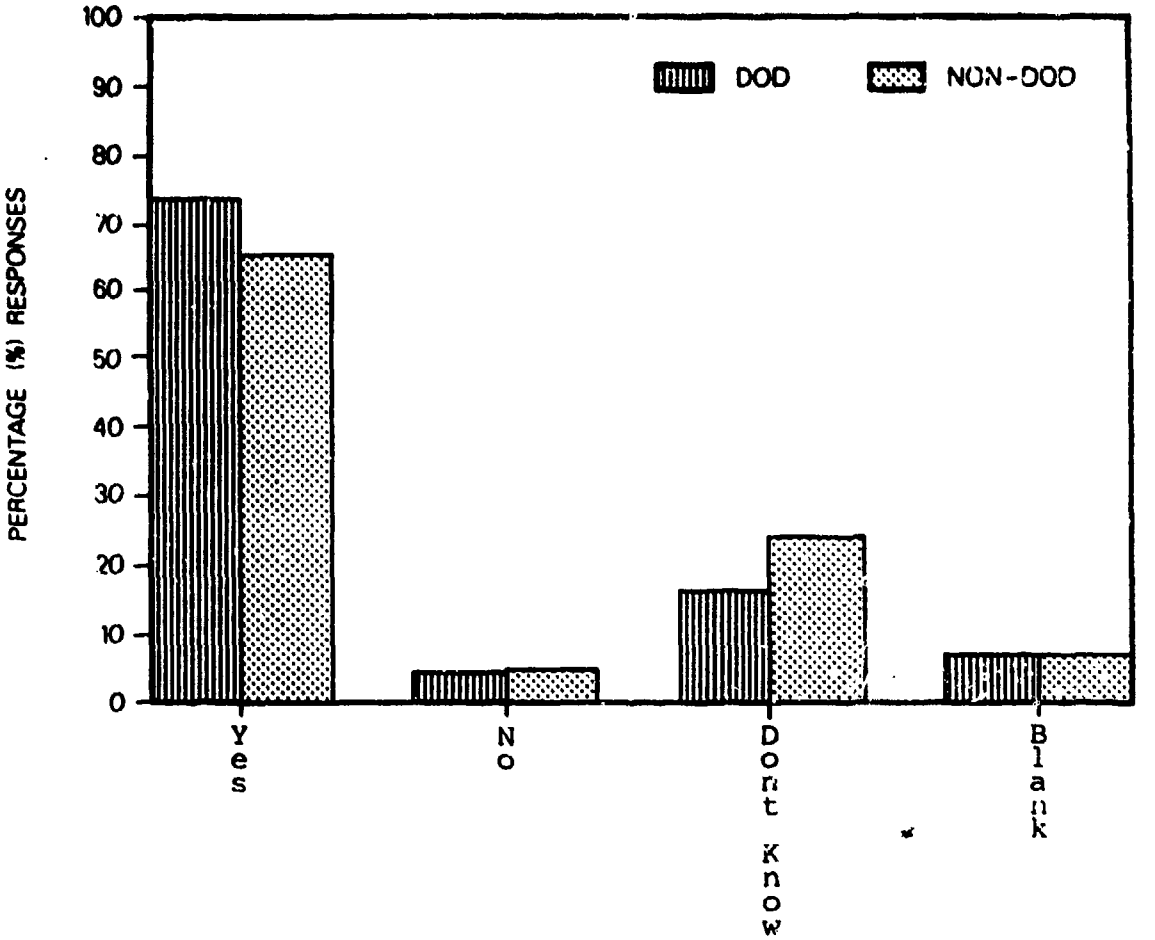

Figure A-4.9. Respondents' opinion about center being a DoD IAC.

Question 2: If YES (to question #1), should the center be a DoD Information Analysis Center (IAC)?

TABLE A-4.9. Respondents' Opinion About the Center Being a DOD IAC.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Yes	182	73.1	375	64.7	557	67.2
No	10	4.0	26	4.5	36	4.3
Don´t Know	40	16.1	139	24.0	179	21.6
Blank	17	6.8	40	6.9	57	6.9

QUESTION 2: If YES (to question #1), should the center be a DOD Information Analysis Center (IAC)?

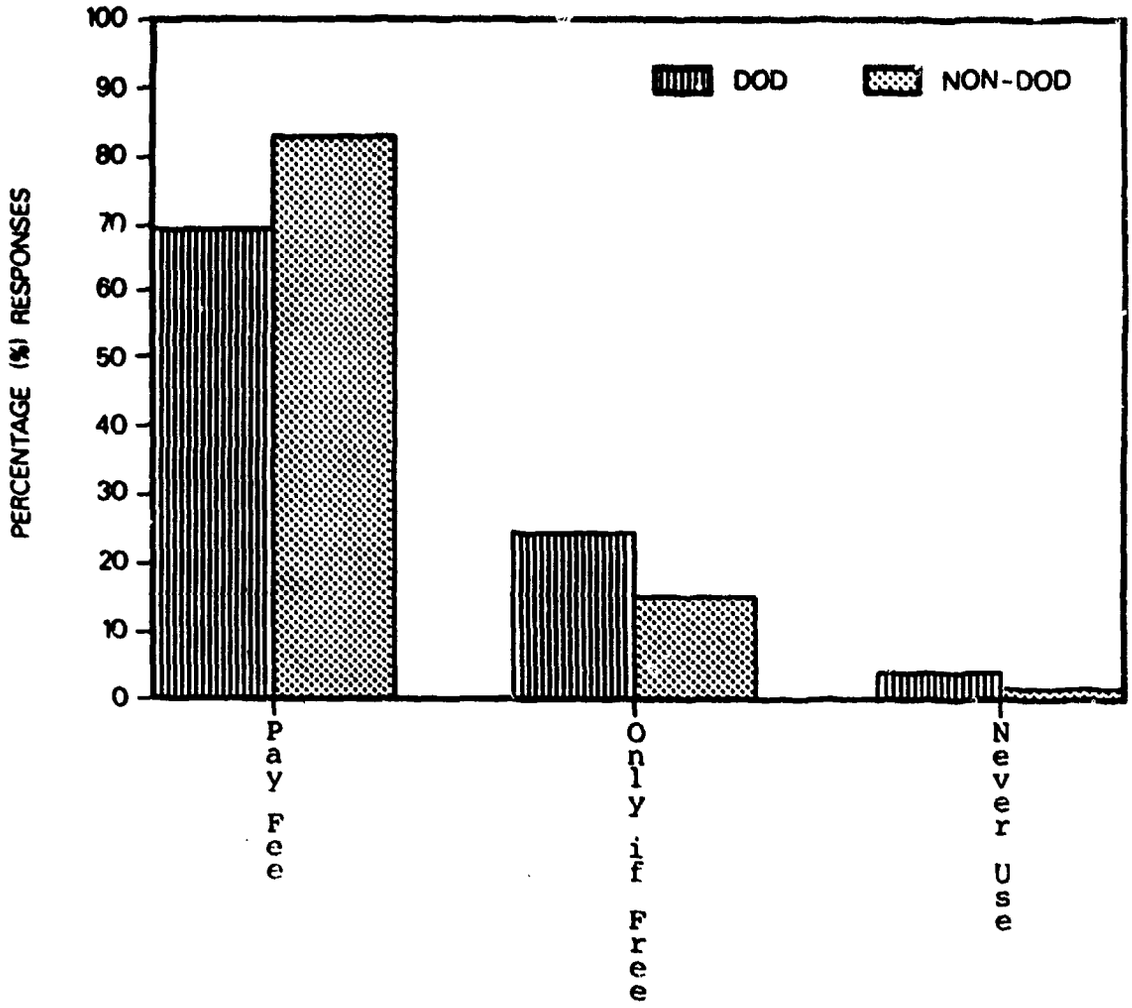

Figure A-4.10. Effect of fee structure on predicted use of CSERIAC by respondents.

Question 13: Fees would be charged to cover the costs of most services provided by CSERIAC. To what degree would this affect your use of CSERIAC?

TABLE A-4.10. Effect of Fee Structure on Estimated Use of CSERIAC by Respondents.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Pay Fee	172	69.1	479	82.6	651	78.5
Only if Free	61	24.5	87	15.0	148	17.9
Never Use	9	3.6	9	1.6	18	2.2

QUESTION 13: Fees would be charged to cover the costs of most services provided by a crew systems ergonomics information analysis center (CSERIAC). To what degree would this affect your use of CSERIAC?

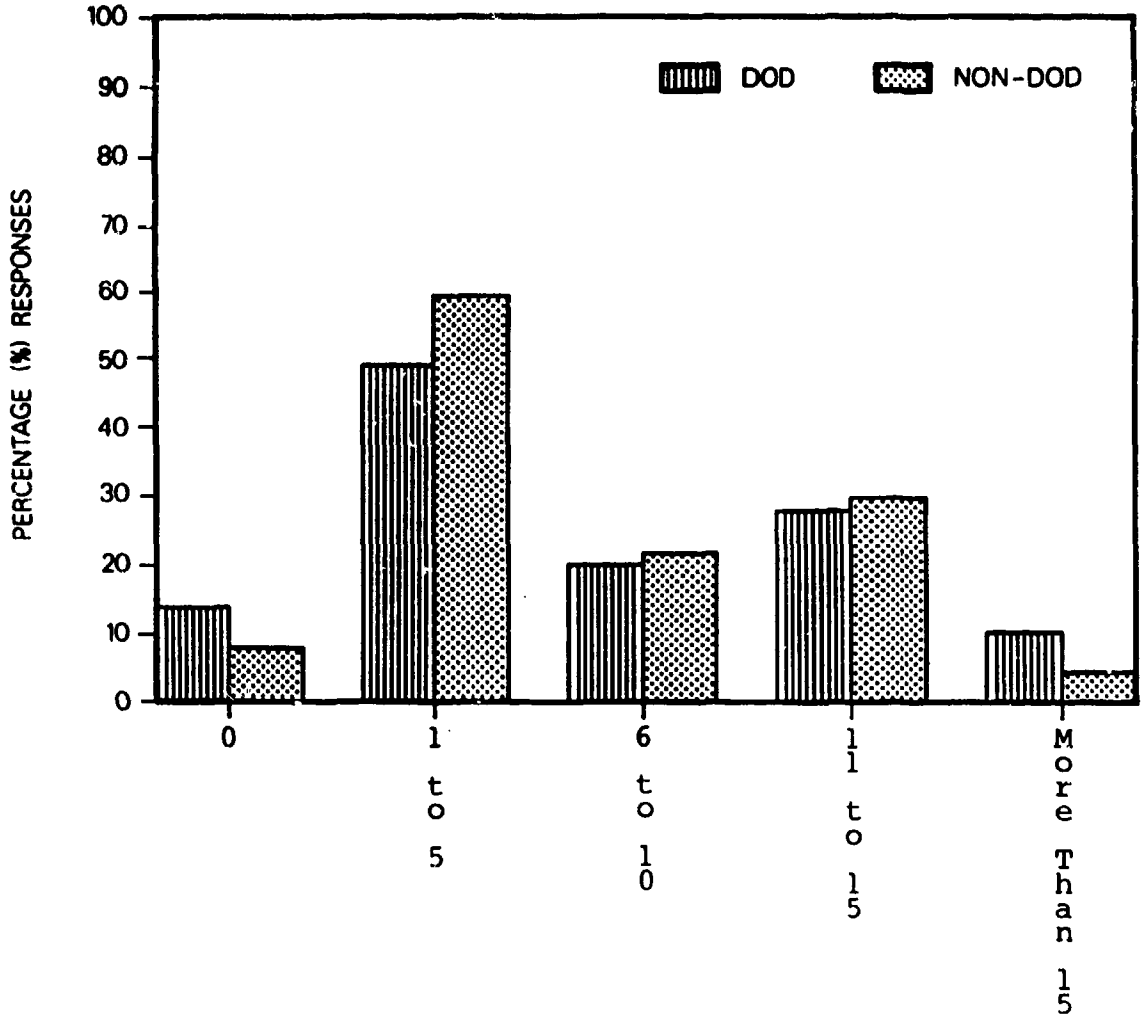

Figure A-4.11. Respondents' estimates of number of CSERIAC requests per year.

Question 14: What number of times per year would you probably request services from CSERIAC?

TABLE A-4.11. Respondents' Estimates of Number of CSERIAC Requests Per Year.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
0	34	13.7	44	7.6	78	9.4
1	11	4.4	25	4.3	36	4.3
2	37	14.9	88	15.2	125	15.1
3	28	11.2	87	15.0	115	13.9
4	31	12.4	94	16.2	125	15.1
5	15	6.0	48	8.3	63	7.6
6	24	9.6	66	11.4	90	10.9
7	2	0.8	4	0.7	6	0.7
8	4	1.6	17	2.9	21	2.5
9	3	1.2	5	0.9	8	1.0
10	16	6.4	31	5.3	47	5.7
11	1	0.4	0	0.0	1	0.1
12	11	4.4	34	5.9	45	5.4
13	1	0.4	2	0.3	3	0.4
14	0	0.0	1	0.2	1	0.1
15	6	2.4	10	1.7	16	1.9
16-20	10	4.0	6	1.0	16	1.9
21-25	5	2.0	6	1.0	11	1.3
26-30	2	0.8	3	0.5	5	0.6
31-50	1	0.4	5	0.9	6	0.7
51-100	4	1.6	1	0.2	5	0.6
More than 100	3	1.2	3	0.5	6	0.7

QUESTION 14: What number of times per year would you probably request services from CSERIAC?

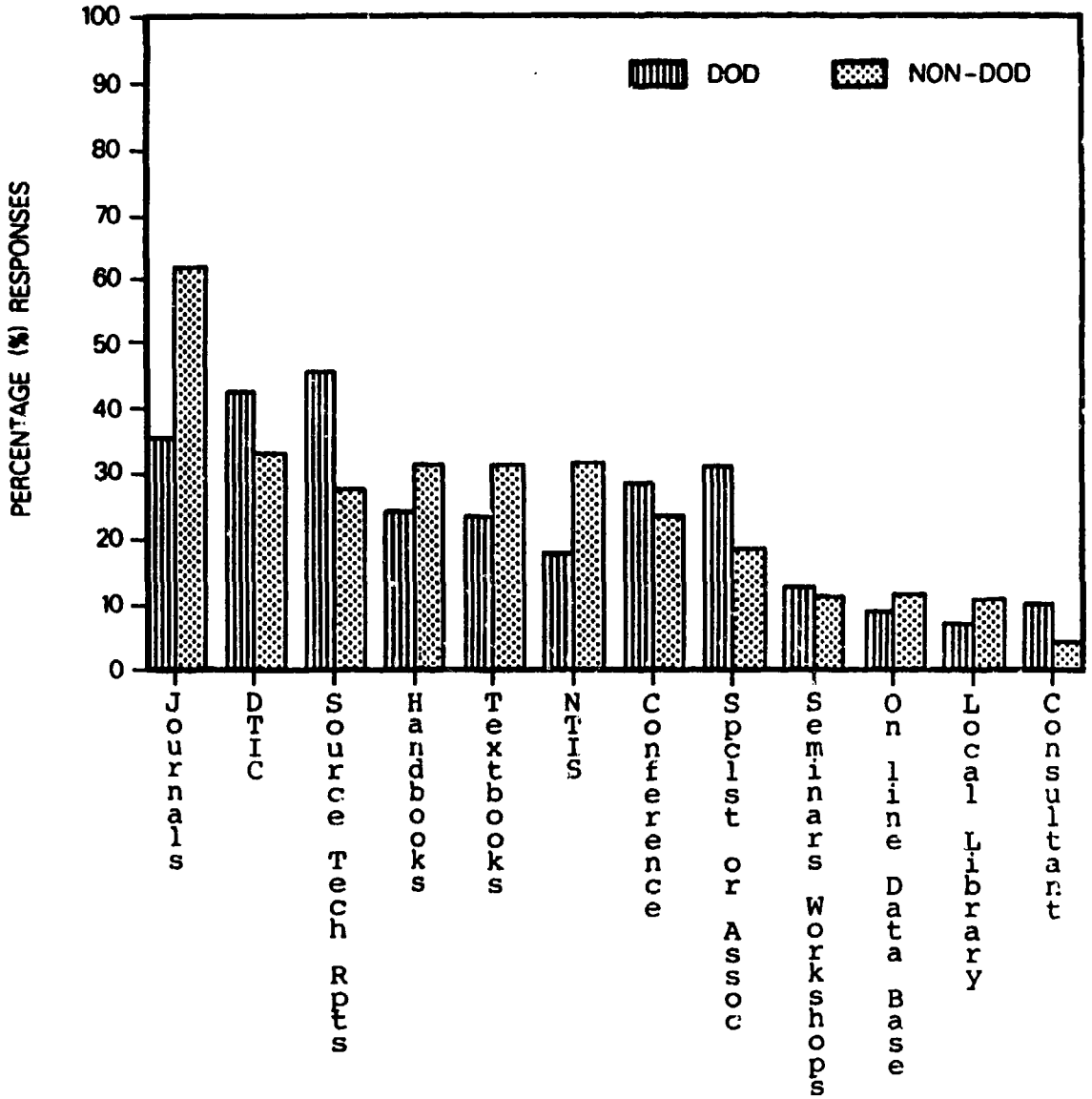

Figure A-4.12. Respondents' current sources of CSE information.

Question 6: Please check your THREE most important sources of CSE information.

TABLE A-4.12. Respondents' Current Sources of CSE Information.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Journals	89	35.7	358	61.7	447	53.9
DTIC	106	42.6	193	33.3	299	36.1
Source Technical Reports	114	45.8	160	27.6	274	33.1
Handbooks	61	24.5	181	31.2	242	29.2
Textbooks	59	23.7	182	31.4	241	29.1
NTIS	44	17.7	183	31.6	227	27.4
Conference Presentations	71	28.5	136	23.4	207	25.0
Staff Specialist or Colleague	77	30.9	108	18.6	185	22.3
Seminars/Workshops	32	12.9	65	11.2	97	11.7
On-line Data Base	22	8.8	66	11.4	88	10.6
Local Library	17	6.8	62	10.7	79	9.5
Consultant	25	10.0	24	4.1	49	5.9

QUESTION 6: Please check your THREE most important sources of CSE information.

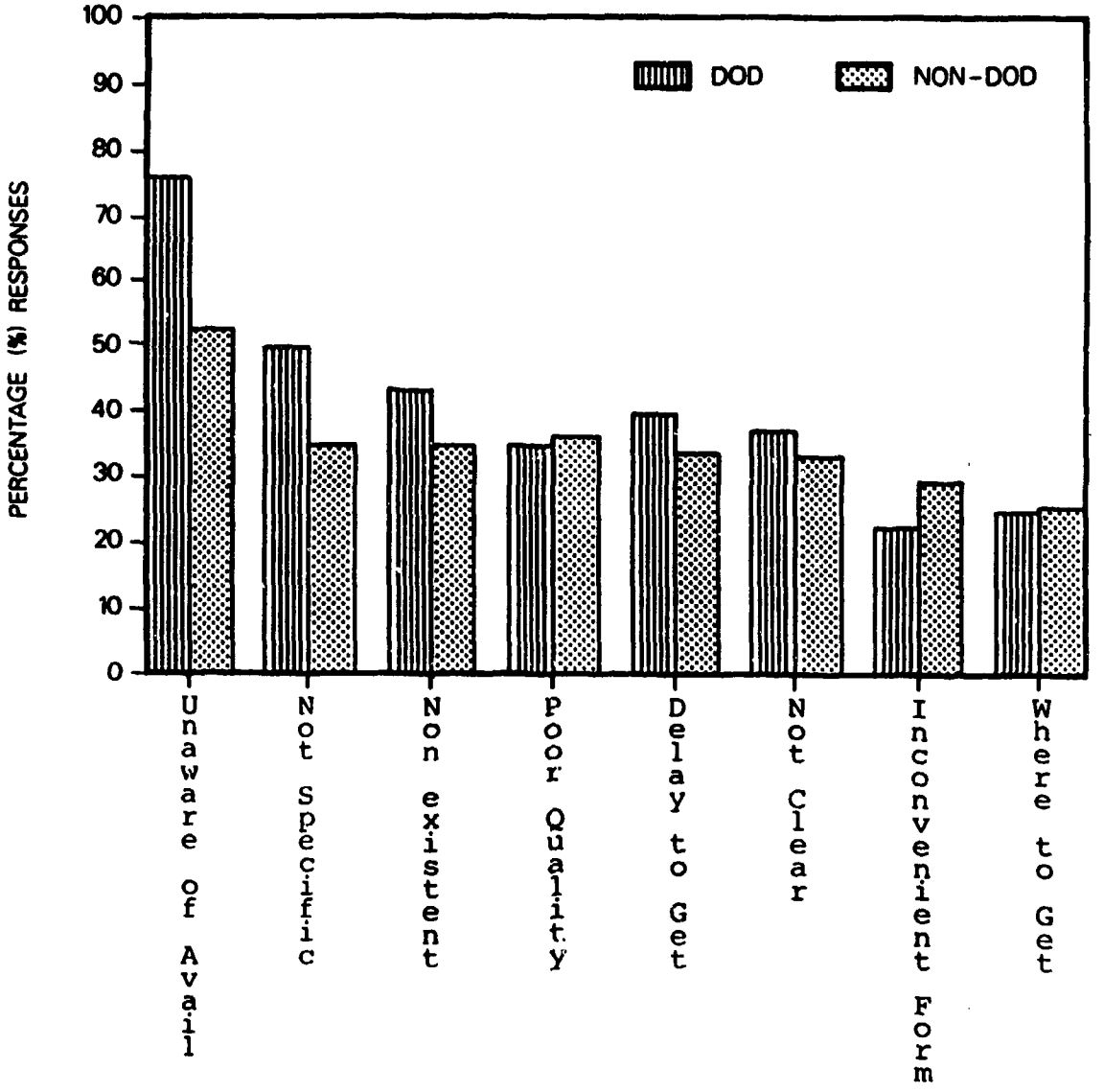

Figure A-4.13. Most important problems encountered by respondents in obtaining CSE information. (Percentages based on combined ranks of "1" and "2" only.)

Question 7: Which of these problems do you currently encounter with respect to CSE information? Rate each chosen item from 1 (most important or frequent) to 4 (least important or least frequent).

TABLE A-4.13. Most Important Problems Encountered by Respondents in Obtaining CSE Information.*

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Unaware of Available Info.	188	75.5	303	52.2	491	59.2
Info. Not Specific to Needs	124	49.8	203	35.0	327	39.4
Information Does Not Exist	107	43.0	200	34.5	307	37.0
Poor Quality of Info.	87	34.9	209	36.0	296	35.7
Time Delay in Obtaining Info.	98	39.4	194	33.4	292	35.2
Info. Not Clearly Presented	92	36.9	190	32.8	282	34.0
Inconvenient Form of Info.	55	22.1	167	28.8	222	26.8
Don't Know Where to Get Info.	61	24.5	145	25.0	206	24.8

QUESTION 7: Which of the (above) problems do you currently encounter with respect to CSE information?

* Percentages based on combined ranks of "1" and "2" only.

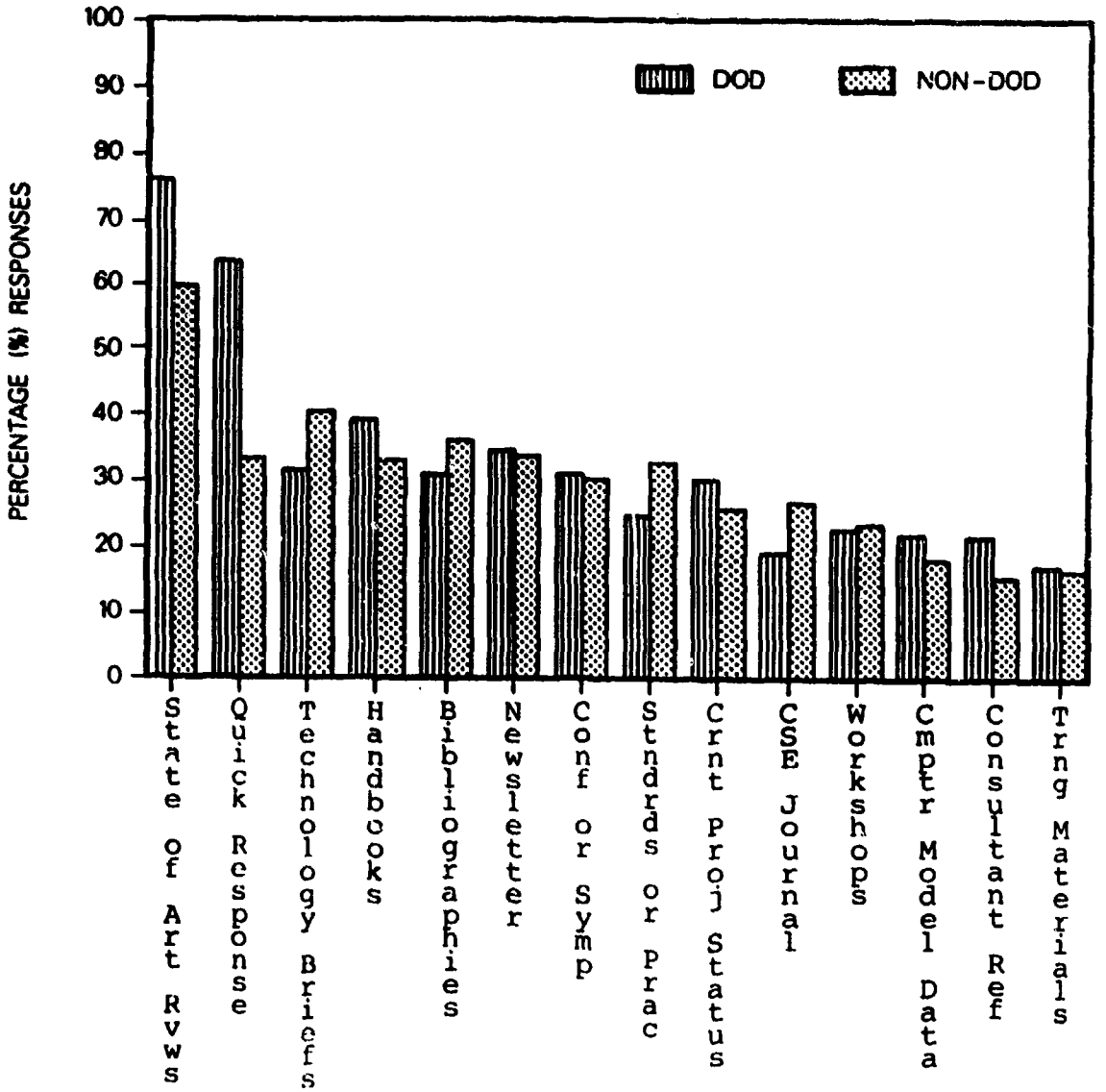

Figure A-4.14. Respondents' preferences of products/ services to meet their CSE information needs. (Percentages based on combined ranks of "1" and "2" only.)

Question 8: Which of these products or services do you require to satisfy your CSE information needs? Rate each chosen item from 1 (most important or frequent) to 4 (least important or least frequent).

TABLE A-4.14. Responders' Preferences of Products/Services for Their CSE Information Needs.*

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
State-of-the-Art Reviews	188	75.5	344	59.3	532	64.2
Quick Response to Inquiry	157	63.1	193	33.3	350	42.2
Technology Briefs	78	31.3	233	40.2	311	37.5
Handbooks	97	39.0	190	32.8	287	34.6
Bibliographies	77	30.9	210	36.2	287	34.6
Newsletter	86	34.5	196	33.8	282	34.0
Conferences or Symposia	77	30.9	175	30.2	252	30.4
Standards or Practices	62	24.9	189	32.6	251	30.3
Current Project Status	74	29.7	147	25.3	221	26.7
Dedicated CSE Journal	47	18.9	155	26.7	202	24.4
Workshops	57	22.9	135	23.3	192	23.2
Computer-based Model Data	54	21.7	106	18.3	160	19.3
Consultant Referral	53	21.3	90	15.5	143	17.2
Training Materials	42	16.9	94	16.2	136	16.4

QUESTION 8: Which of the (above) products or services do you require to satisfy your CSE information needs? Please rate each chosen item from 1 (most important or frequent) to 4 (least important or least frequent).

* Percentages based on combined ranks of "1" and "2" only.

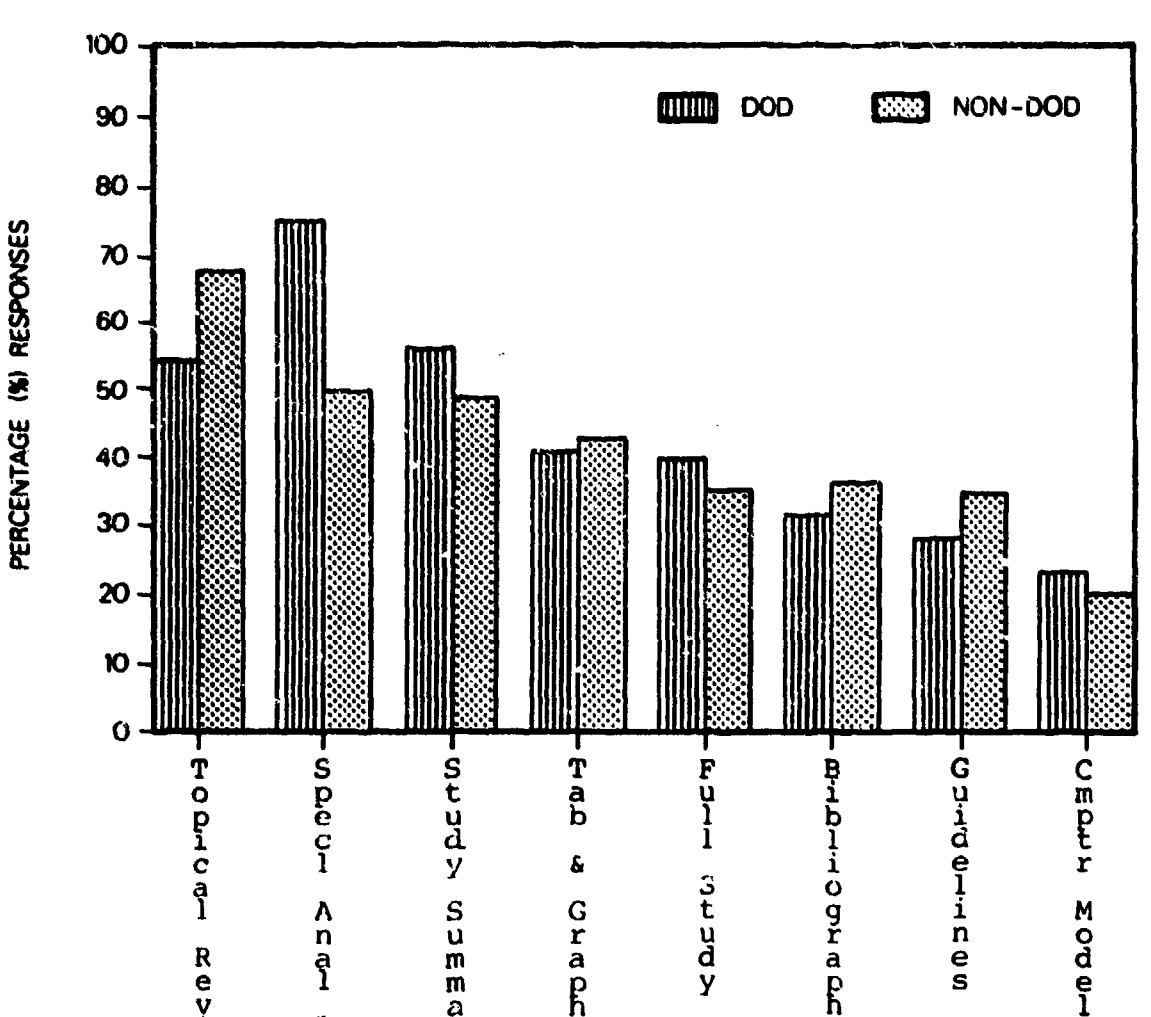

Figure A-4.15. Respondents' opinions of most useful forms of CSE information. (Percentages based on combined ranks of "1" and "2" only.)

Question 9: With regard to your most frequent needs, how useful are these forms for CSE information? Rate each chosen item from 1 (most useful) to 4 (least useful).

TABLE A-4.15. Respondents' Opinion of Most Useful Forms of CSE Information.*

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Topical Reviews	134	53.8	386	66.6	520	62.7
Special Analysis Report	185	74.3	286	49.3	471	56.8
Study or Project Summary	138	55.4	282	48.6	420	50.7
Tabular & Graph Data	100	40.2	246	42.4	346	41.7
Full Study Report	98	39.4	203	35.0	301	36.3
Bibliographies	78	31.3	210	36.2	288	34.7
Guidelines	69	27.7	198	34.1	267	32.2
Computer Model Data	57	22.9	117	20.2	174	21.0

QUESTION 9: With regard to your most frequent needs, how useful are the (above) forms for CSE information? Please rate each chosen item from 1 (most useful) to 4 (least useful).

* Percentages based on combined ranks of "1" and "2" only.

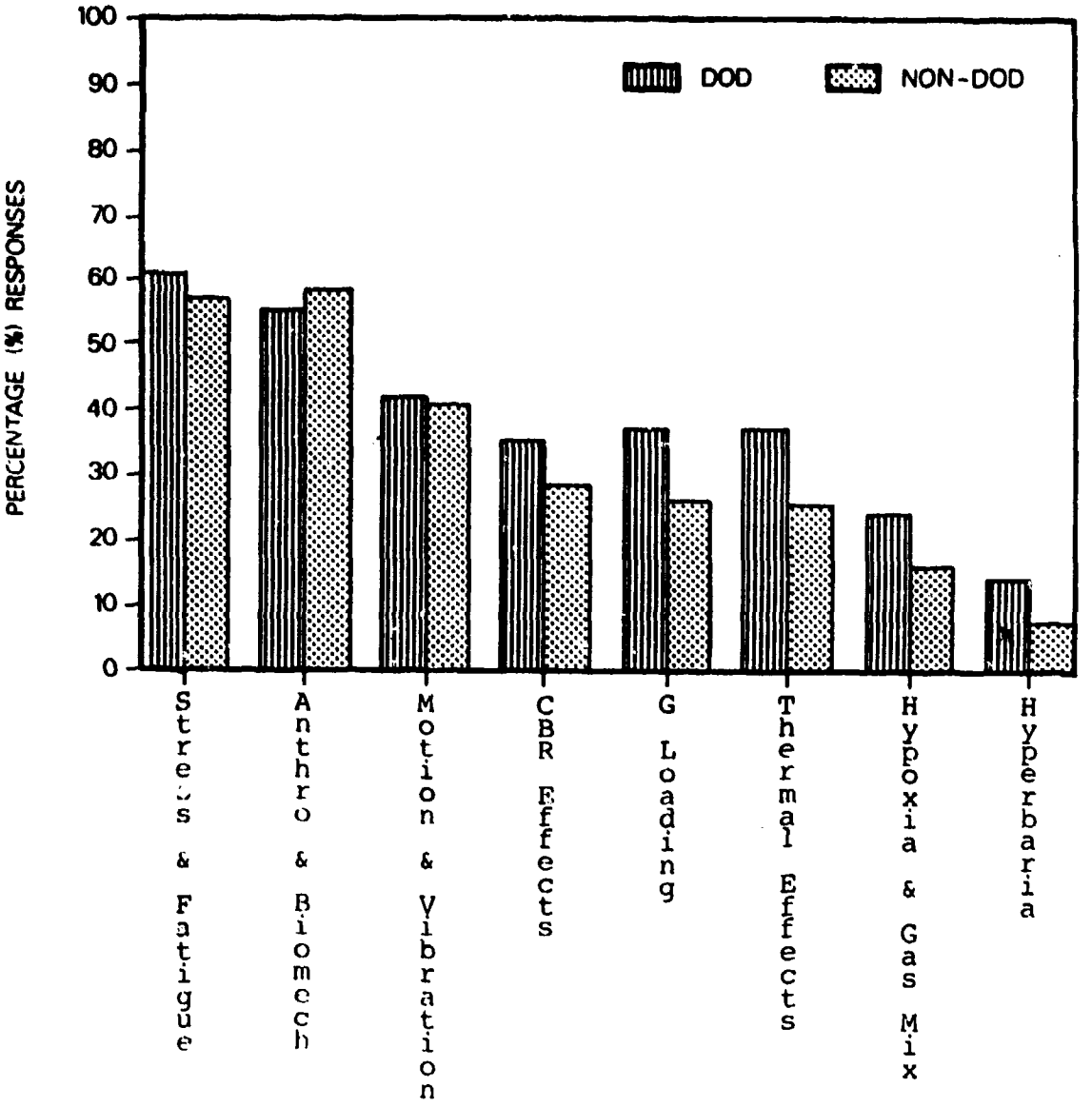

Figure A-4.16. Biomedical topics relevant to respondents' work activity.

Question 5: Please check all the listed CSE topics that are important in your work.

TABLE A-4.16. Biomedical Topics Relevant to Respondents' Work Activity.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Stress & Fatigue	153	61.4	333	57.4	486	58.6
Anthropometry & Biomechanics	138	55.4	339	58.4	477	57.5
Motion & Vibration	105	42.2	239	41.2	344	41.5
Chem., Bio., & Rad. Effects	89	35.7	166	28.6	255	30.8
G Loading	93	37.3	153	26.4	246	29.7
Thermal Effects	93	37.3	149	25.7	242	29.2
Hypoxia & Gas Mixture	60	24.1	92	15.9	152	18.3
Hyperbaria	35	14.1	43	7.4	78	9.4

QUESTION 5: Please check all the CSE topics (above) that are important in your work.

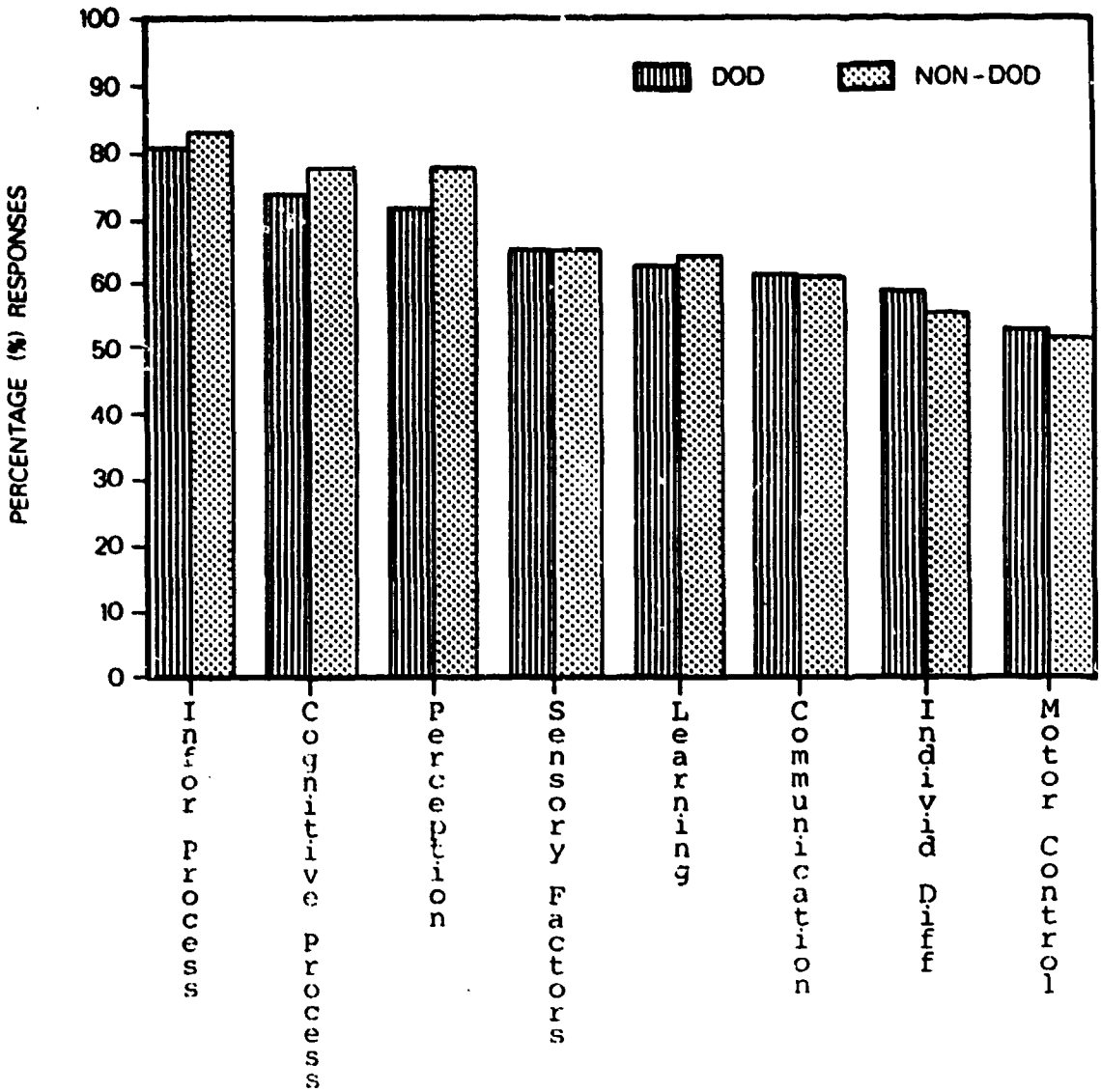

Figure A-4.17. Human performance topics relevant to respondents' work activity.

Question 5: Please check all the listed CSE topics that are important in your work.

TABLE A-4.17. Human Performance Topics Relevant to Respondents' Work Activity.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Information Processing	201	80.7	481	82.9	682	82.3
Cognitive Processes	184	73.9	450	77.6	634	76.5
Perception	178	71.5	450	77.6	628	75.8
Sensory Factors	162	65.1	377	65.0	539	65.0
Learning	155	62.2	370	63.8	525	63.3
Communication	153	61.4	354	61.0	507	61.2
Individual Differences	146	58.6	322	55.5	468	56.5
Motor Control	131	52.6	300	51.7	431	52.0

QUESTION 5: Please check all the CSE topics (above) that are important in your work.

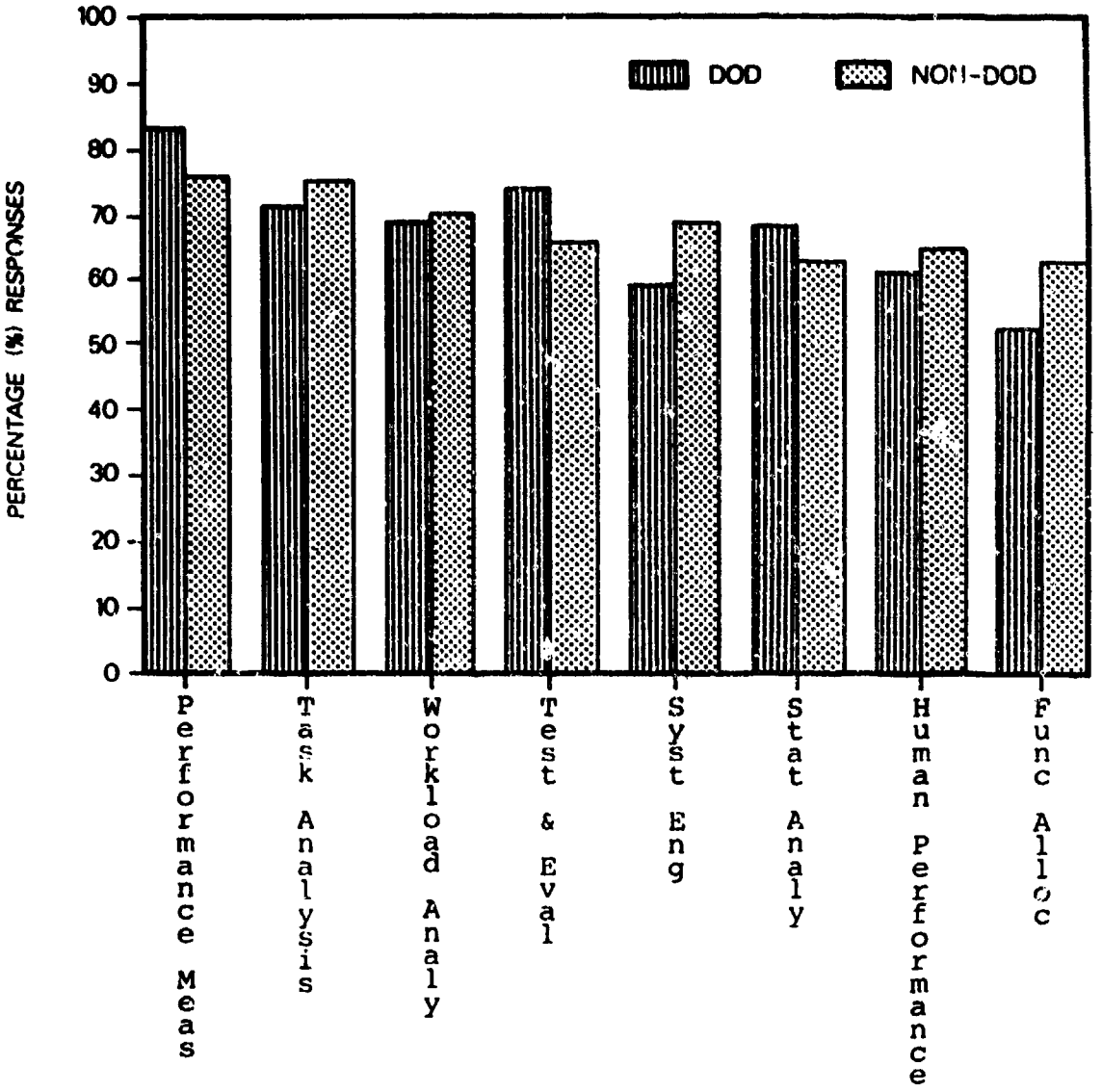

Figure A-4.18. Methodological topics relevant to respondents' work activity.

Question 5: Please check all the listed CSE topics that are important in your work.

TABLE A-4.18. Methodological Topics Relevant to Respondents' Work Activity.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Performance Measurement	206	82.7	437	75.3	643	77.6
Task Analysis	176	70.7	433	74.7	609	73.5
Workload Analysis	170	68.3	403	69.5	573	69.1
Test & Evaluation	183	73.5	377	65.0	560	67.6
Systems Engineering	146	58.6	394	67.9	540	65.1
Statistical Analysis	168	67.5	360	62.1	528	63.7
Human Performance	151	60.6	372	64.1	523	63.1
Function Allocation/Analysis	129	51.8	357	61.6	486	58.6

QUESTION 5: Please check all the CSE topics (above) that are important in your work.

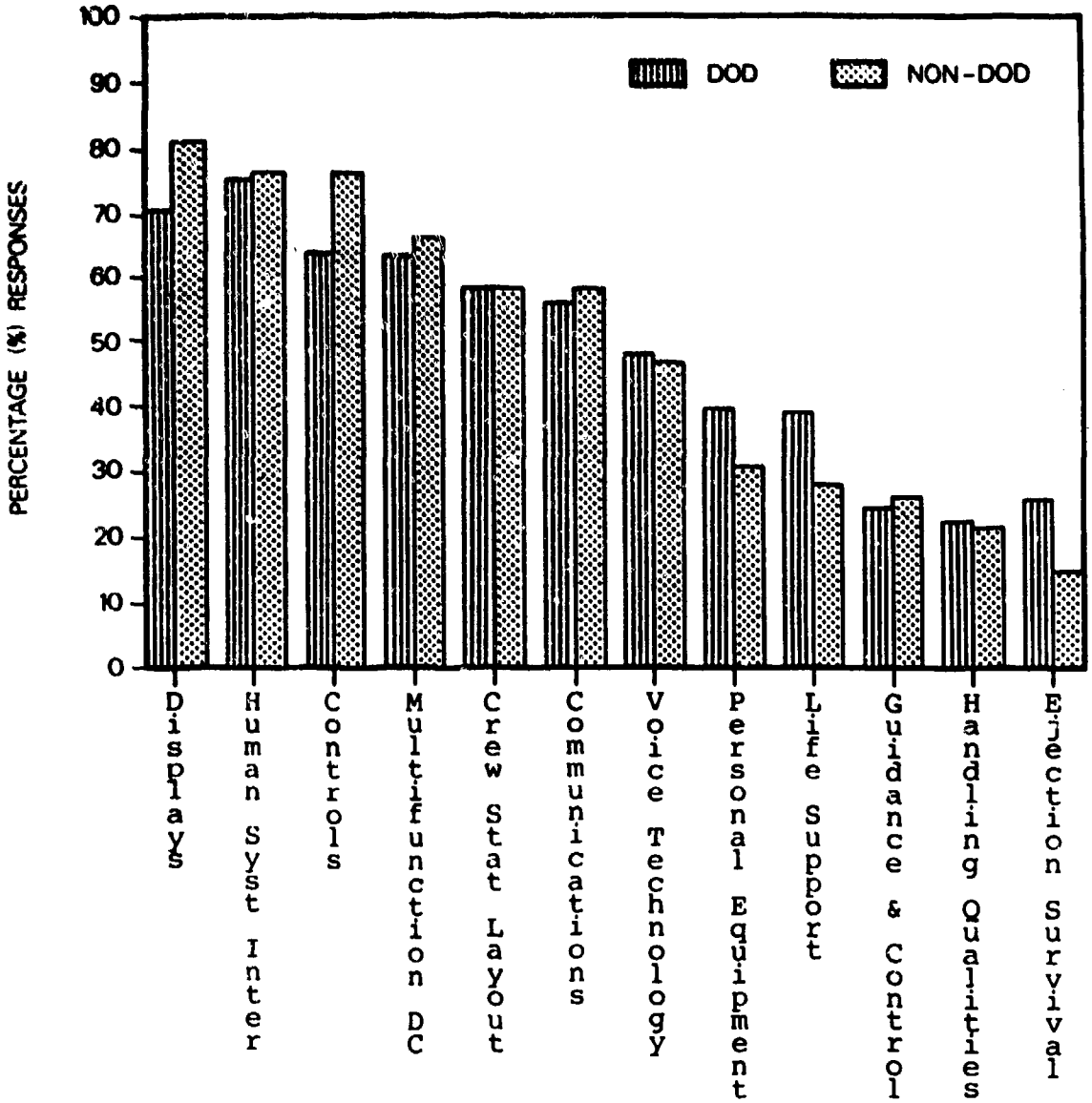

Figure A-4.19. Design & engineering topics relevant to respondents' work activity.

Question 5: Please check all the listed CSE topics that are important in your work.

TABLE A-4.19. Design & Engineering Topics Relevant to Respondents' Work Activity.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Displays	175	70.3	468	80.7	643	77.6
Human-System Integration	186	74.7	441	76.0	627	75.6
Controls	158	63.5	438	75.5	596	71.9
Multifunction Dsplys-Cntrols	157	63.1	383	66.0	540	65.1
Crew Station Layout	145	58.2	338	58.3	483	58.3
Communications	139	55.8	334	57.6	473	57.1
Voice Technology	120	48.2	273	47.1	393	47.4
Personal Equipment	99	39.8	180	31.0	279	33.7
Life Support	97	39.0	163	28.1	260	31.4
Guidance & Control	62	24.9	153	26.4	215	25.9
Vehicle Handling Qualities	57	22.9	126	21.7	183	22.1
Ejection/Survival Systems	64	25.7	88	15.2	152	18.3

QUESTION 5: Please check all the CSE topics (above) that are important in your work.

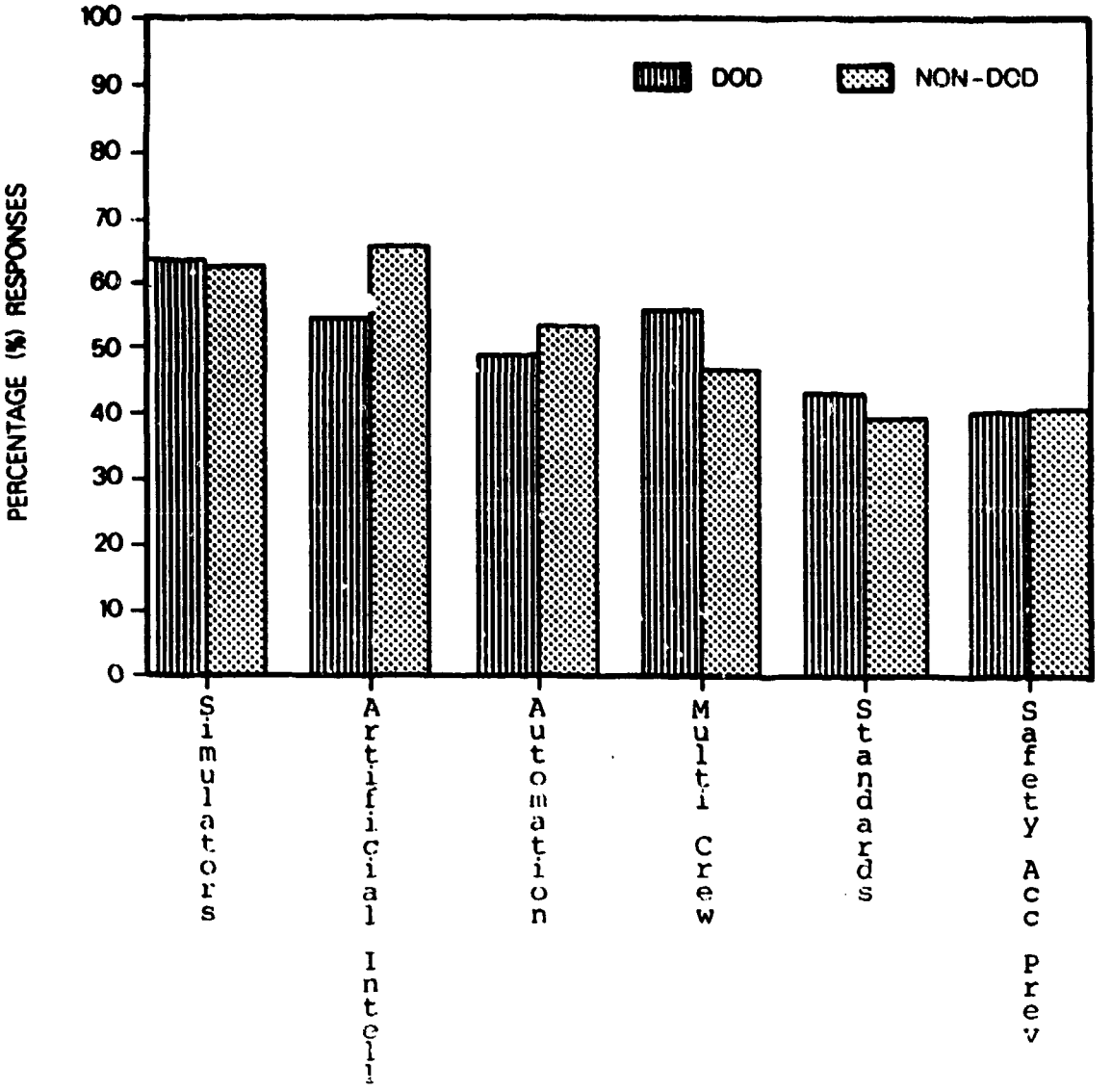

Figure A-4.20. Special topics relevant to respondents' work activity.

Question 5: Please check all the listed CSE topics that are important in your work.

TABLE A-4.20. Special Topics Relevant to Respondents' Work Activity.

	DOD NUMBER	DOD PERCENT	NON-DOD NUMBER	NON-DOD PERCENT	TOTAL NUMBER	TOTAL PERCENT
Simulators	158	63.5	361	62.2	519	62.6
Artificial Intelligence	136	54.6	380	65.5	516	62.2
Automation	123	49.4	311	53.6	434	52.4
Multi-Crewmember Interaction	139	55.8	272	46.9	411	49.6
Standards	108	43.4	230	39.7	338	40.8
Safety/Accident Prevention	100	40.2	237	40.9	337	40.7

QUESTION 5: Please check all the CSE topics (above) that are important in your work.

Appendix B

MAIL SURVEY QUESTIONNAIRE AND ACCOMPANYING MATERIALS

DEPARTMENT OF THE AIR FORCE
AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY (AFSC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6573

09 APR 1985

Dear Colleague

The Air Force Aerospace Medical Research Laboratory is considering the establishment of a Department of Defense (DOD) center that would provide ergonomic information analysis services to support research, design and development of aircraft and spacecraft crew systems. Information would be obtained from worldwide, behavioral, biomedical and engineering sources. The center would be called the Crew Systems Ergonomics Information Analysis Center (CSERIAC).

The Laboratory would appreciate your opinion of the value of establishing such a center, whether or not you would use its services, and if so, what products you would like it to provide. A brief questionnaire is attached for this purpose. If you return it within three weeks, you will do us a valuable service.

In the event that you are unfamiliar with Information Analysis Centers (IACs), a summary is attached to acquaint you with their purpose and functions.

Thank you for your participation in this questionnaire survey.

GEORGE C. MORSE, Colonel, USAF, MC
Commander

2 Atch
1. Description of Information Analysis Centers (IACs)
2. Questionnaire

AFAMRL ENHANCING MAN AND MISSION

INFORMATION ANALYSIS CENTERS (IACS)

Government managers, scientists and engineers, and government contractors extensively use the Defense Technical Information Center (DTIC). The DTIC stores and, on request, provides copies of documents produced by the Department of Defense (DoD). DTIC also supplies specialized bibliographies based on key-word searches of its data base.

Although these are valuable services, the users of DTIC must decide what documents and bibliographic search strategies will yield the information that they need. A common problem is the uncertainty that the documents relevant to a particular need have been found. Moreover, users are burdened with the analytical and interpretive tasks of extracting, evaluating and integrating the information contained in the source documents. These tasks are especially difficult for documents written by scientists or engineers whose specialties are outside the user's domain of expertise.

To alleviate these burdens, the DoD has instituted an information service that goes well beyond the basic document retrieval functions provided by DTIC. This service is provided through a network of organizations called Information Analysis Centers (IACs). Their function is to perform the time consuming and difficult search, analysis, and interpretation tasks that are usually the responsibility of the information user. The primary purpose of an IAC is to supply its users with up-to-date information, in the desired form, as rapidly as possible.

An IAC collects, stores, reviews, analyzes, and summarizes scientific, technical, and engineering information and data within its specialized area. The collection of source material, accessible by computer, is continually updated to incorporate the most current international research information within the specialized area, and analyzed and organized in a form to meet the expressed or anticipated needs of the IAC users.

There are many types of reports produced by an IAC including bibliographies, abstracts, state-of-the-art reviews, special analysis and evaluation reports, and current awareness newsletters. Except for its own products, an IAC does not copy and disseminate source documents; these functions are the responsibility of the DTIC.

IACs are staffed by professional analysts, expert in their subject areas. In addition, IACs use consultants for special projects and provide referral services to users who may wish to contact an organization or individual with particular expertise.

Communication with an IAC usually starts with a phone call from the user to an analyst who understands the user's request. Subsequent communications may be by phone, conventional mail or electronic mail. Direct access to the IAC data base via telecommunications is also possible. There are nominal fees, established on a cost recovery basis, for IAC services although some are free.

Currently, there are twenty-one IACs. The first was established over thirty years ago. Some of the existing IACs and a phone number for a point of contact are listed below.

Coastal Engineers Information Analysis Center (CEIAC)
(202) 325-7012

Chemical Propulsion Information Agency (CPIA)
(301) 953-7100, Ext. 3152, 7879, or 7803

Concrete Technology Information Analysis Center (CTIAC)
(601) 634-3264/3269

Data and Analysis Center for Software (DACS)
(315) 330-3395 (Autovon 587-3395)

DoD Nuclear Information Analysis Center (DASIAC)
(805) 965-0551, Ext. 395, or 200

Guidance and Control Information Analysis Center (GACIAC)
(312) 567-4519/4544

Infrared Information Analysis Center (IRIA)
(313) 994-1200, Ext. 214

Metals and Ceramics Information Center (MCIC)
(614) 424-6372/6376

Reliability Analysis Center (RAC)
(315) 330-4151 (Autovon 587-4151)

Survivability/Vulnerability Information Analysis Center (SURVIAC)
(513) 255-4840

Shock and Vibration Information Center (SVIC)
(202) 767-2221

Tactical Technology Center (TACTEC)
(614) 424-7010

More information on existing IACs can be obtained from the pamphlet "Information Analysis Centers Profiles" available free from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22314.

QUESTIONNAIRE

PLEASE COMPLETE AND RETURN WITHIN THREE WEEKS

The term Crew Systems Ergonomics (CSE) used in this questionnaire means the behavioral, biomedical, and human factors engineering information and data that affect, or result from, the design, development and operation of aircraft and spacecraft.

Please leave blank any question that does not apply to you or for which you have no opinion. Space for comments is provided on the last page if you wish to qualify or expand on any of your responses.

1. Is there a need for a center to provide crew systems ergonomics information analysis services?

____Yes ____No ____Don't know

2. If YES, should the center be a DoD Information Analysis Center (IAC)?

____Yes ____No ____Don't know

If your answer is NO to either or both questions 1 and 2, please give your reasons.

_____

_____

_____

_____

3. How frequently do you use CSE Information in your work? Please check only one.

____Never ____Infrequently ____Frequently ____Very Frequently

4. Do you ever generate CSE information? ____Yes ____No

5. Please check all the CLR topics below that are important in your work.

BIOMEDICAL

____G loading
____Stress and Fatigue
____Motion and Vibration
____Hypoxia and Gas Mixture
____Thermal Effects
____Hyperbaria
____Chem., Bio., and Rad. Effects
____Anthropometry or Biomechanics

HUMAN PERFORMANCE

____Sensory Factors
____Perception
____Information Processing
____Cognitive Processes
____Individual Differences
____Learning
____Motor Control
____Communication

METHODOLOGIES

____Task Analysis
____Workload Analysis
____Systems Engineering
____Function Allocation/Analysis
____Performance Measurement
____Test and Evaluation
____Statistical Analysis
____Human Performance Modeling

DESIGN AND ENGINEERING

____Displays
____Controls
____Multifunction Dsplys-Cntrls.
____Communications
____Voice Technology
____Life Support
____Ejection/Survival Systems
____Personal Equipment
____Human-System Integration
____Crew Station Layout
____Vehicle Handling Qualities
____Guidance and Control

SPECIAL TOPICS

____Simulators
____Multi-Crewmember Interaction
____Safety/Accident Prevention
____Automation
____Artificial Intelligence
____Standards

____OTHER _____

6. Please check your THREE most important sources of CSE information. Do not check more than three.

____Receive Technical Reports Directly from Originating Source

____Defense Technical Information Center (DTIC)

____National Technical Information Service (NTIS)

____Textbooks ____Handbooks

____On-line Data Base(s) ____Journals

____Conference Presentations ____Seminars/ Workshops

____Staff Specialist or Colleague ____Consultant

____Local Library

____Other _____

7. Which of the following problems do you currently encounter with respect to CSE information? Please rate each chosen item from 1 (most important or frequent) to 4 (least important or least frequent). Rate as many as are applicable. Rating numbers may be used more than once.

1_____2_____3_____4

Most important or frequent — Least important or least frequent

____Difficult to maintain awareness of technical or analytical information that is available.

____Needed information does not exist.

____Inconvenient form of information.

____Information not clearly and succinctly presented.

____Poor quality of information, i.e., unreliable, dated or not quantitative.

____Information is not specific to my particular needs.

____Delay time to obtain needed information.

____Don't know where to go to get needed information.

____Other _____

8. Which of the following products or services do you require to satisfy your CSE information needs? Please rate each chosen item from 1 (most important or frequent) to 4 (least important or least frequent). Rate as many as are applicable. Rating numbers may be used more than once.

1 Most important or frequent — 2 — 3 — 4 Least important or least frequent

_____State-of-the-Art Reviews
_____Current Awareness Newsletter
_____Current Awareness Bibliographies
_____Handbooks
_____Technology Briefs
_____Dedicated CSE Journal
_____Computer-based Model Data
_____Quick Response to Inquiry
_____Conferences or Symposia
_____Workshops
_____Standards or Practices
_____Training Materials
_____Current Projects Status
_____Consultant Referral
_____Other_____

9. With regard to your most frequent needs, how useful are the following forms for CSE information? Please rate each chosen item from 1 (most useful) to 4 (least useful). Rating numbers may be used more than once.

1 Most useful — 2 — 3 — 4 Least useful

_____Tabular and Graphic data
_____Topical Reviews
_____Bibliographies
_____Guidelines with Justifications and References
_____Full Report of a Study or Project
_____Study or Project Summary
_____Special Analysis Report Specific to Current Need
_____Data Generated from a Computer-based Model
_____Other_____

10. Which of the following activities best describe your regular work? If more than one applies please use 1 for primary and 2 for secondary. Do not mark more than two activities.

_____Management
_____Design
_____Administration
_____Test and Evaluation
_____Research and Development
_____Education
_____Other_____

11. Which of the following discipline areas best describe your formal educational background? If more than one applies, please use 1 for primary and 2 for secondary. Do not mark more than two areas.

_____Engineering
_____Behavioral Science
_____Mathematics
_____Physical Science
_____Computer Science
_____Information/Library Science
_____Management
_____Medicine
_____Operations Research
_____Human Factors/Ergonomics
_____Biology
_____Physiology
_____Social Science
_____Other_____

12. Please indicate your current employment. Check only one.

Active Duty Military: ___Air Force ___Army ___Navy ___Marines

Federal Civil Service: ___DoD ___Non-Dod ___Coast Guard

Private Sector: ___Industry ___Academia ___Self-Employed

Retired: ___

13. Fees would be charged to cover the costs of most services provided by a crew systems ergonomics information analysis center (CSERIAC). To what degree would this affect your use of CSERIAC? Please check only one.

____I would pay a reasonable fee for the CSERIAC services I need.

____I would only use the CSERIAC services that are free.

____I probably would not use CSERIAC services even if they were free.

14. What number of times per year would you probably request services from CSERIAC?
Please write in number. _____

Comments (You may consider, for example, other options to answer a question, how you would use a CSERIAC, preferred access method.) Please use additional sheets if you wish.

NAME AND ADDRESS (optional)

If you provide your name and address in the upper, left corner of the return envelope, they will be used solely to send you information about CSERIAC if and when it becomes operational. The questionnaires will be separated from the envelopes on receipt to maintain anonymity of all respondents.

Thank you for participating in this survey. Please return ONLY THE QUESTIONNAIRE AND ANY ADDITIONAL COMMENT SHEETS in the business reply envelope provided. No postage is necessary. Monterey Technologies, Inc. is under contract to the Air Force to compile and summarize the questionnaire data.

U.S. GOVERNMENT PRINTING OFFICE 1987 - /48-001/60/61