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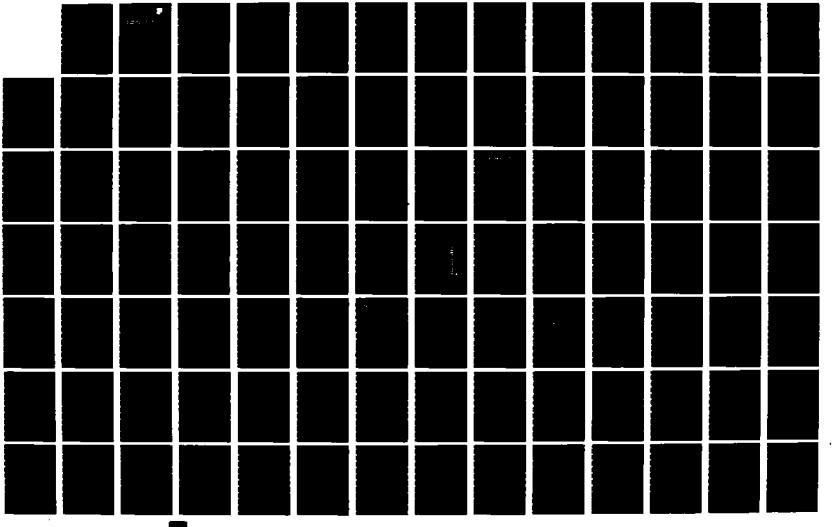

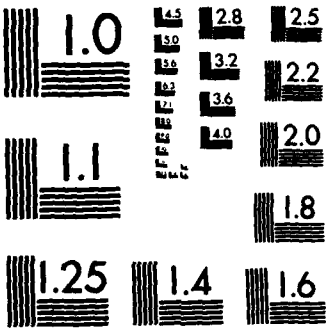

RADC-TR-83-132
Final Technical Report
June 1983

# DATA AND ANALYSIS CENTER FOR SOFTWARE: An IAC in Transition

IIT Research Institute

Shirley A. Gloss-Soler



ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, NY 13441

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APPROVED: John Palaimo

JOHN PALAIMO
Project Engineer

APPROVED:

JOHN J. MARCINIAK, Colonel, USAF
Chief, Command and Control Division

FOR THE COMMANDER: John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office

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The Data & Analysis Center for Software (DACS) was established to serve as a central source for data and information on software technology. The DACS was operated on a pilot basis for a 36-month period, then entered a 15-month transition period. This final report presents a detailed summary of the activities carried out, products produced, and services provided during this transition period. Details are also provided on enhancements to the STINFO databases, the Software Life Cycle Empirical Database (SLED),

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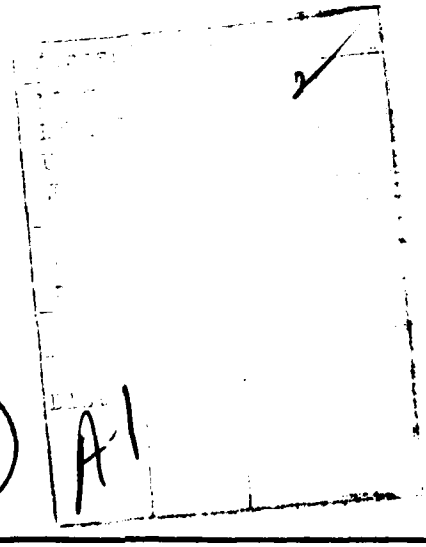
and the implementation and results of the DACS cost recovery program. A list of users of the DACS during this transition period is provided in an Appendix.



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# 1.0 INTRODUCTION

## 1.1 Background

The Air Force recognized the need for an information analysis center to serve the government, industrial, and university community as a focal point for software development and experience data in the early 1970's. In 1976 the Rome Air Development Center (RADC) contracted with IIT Research Institute (IITRI) to design a center that would acquire, analyze, synthesize, and disseminate information on software engineering technology (DUVA76). Subsequently, in August of 1978, RADC contracted with IITRI to develop such a center which was named The Data & Analysis Center for Software (DACS). The activities, accomplishments, and history of the development of the DACS during its 36-month pilot period from August 1978 through August 1981 were reported on in RADC-TR-81-385, Establishment of the Data and Analysis Center for Software (CARO82). One of the major accomplishments during this period was the demonstration that a full scale information analysis center was both feasible and desirable.

The DACS was designated a Department of Defense (DoD) Information Analysis Center (IAC) in January 1981 while still in its pilot period. At the end of the 36-month pilot period IITRI was awarded a contract to operate the DACS for an additional 14 month period. The primary focus of this effort was to provide an orderly transition from a pilot information center to a full scale IAC; from a center completely supported by Government funds to an IAC whose users are required to contribute to the support of those functions from which they obtain benefit.

This report provides a detailed summary of the activities carried out, products produced, and services provided during the transition period which actually extended from 4 September 1981 through 8 December 1982.

## 1.2 Objectives of the DACS

Broadly speaking, the DACS was established to serve as a focal point for software development and experience data, for the analysis, synthesis and dissemination of this data, and for scientific & technical information (STINFO)

concerning the field of software engineering. As implemented, the DACS provides a centralized authoritative source for current, readily usable data and information concerning software technology. The objectives of this software information analysis center are to:

- Encourage the exchange of software technology information among DoD, Civil Government Agencies, government contractors, the private sector, and academia
- Support software technology research by providing a centralized source of software life-cycle data
- Bring about higher levels of utilization of project results in a cost-effective manner
- Increase the productivity of software producers and the quality of th resultant computer software by improving the transfer of softwa engineering technology
- Assist in diffusing new technology throughout the U.S. industrial bas thereby expanding its capability and competitive posture
- Provide scientific and technical information analysis services to DoD, Civil Agencies, government contractors, and the private sector in areas relating to software technology needs, developments, and trends
- Minimize duplication of software technology research

## 1.3 Report Contents

This report provides a summary of the activities of the DACS which were performed with these objectives in mind. It contains eleven sections. The following is a short description of the topics covered and the specific sections in which they are discussed.

| | |
|---|---|
| Section I | Background and Objectives of the Center |
| Section II | Summary of Technical Progress and Activities involved in the operation of the center |
| Section III | Descriptions of the Data Acquisition Program and the DACS Software Experience Database |
| Section IV | Description of the Scientific and Technical Information Database, and of the Software Engineering Research Projects Database |
| Section V | Description of the Data Analysis Program |

Section VI Description of the Current Awareness Program including Newsletters, Bulletins and Technical Presentations

Section VII Discussions of the Various DACS Products and Services including Data Subsets, Data Compendiums, Technical Monographs, State-of-the-Art Reports, and Bibliographic Searches and Consulting Services

Section VIII Discussion of DACS Special Tasks including a Description of the Automated Metrics Tool Conversion and the ARRADCOM EPCS Study

Section IX An Evaluation of Center Effectiveness including a Description of Day-to-Day Operational Data Collected and the implementation of the automated User Profile Database

Section X Discussion of the Cost Recovery Program developed for the DACS

Section XI Conclusions and Recommendations for Improving Center Effectiveness

## 2.0 TASK 1 - OPERATION AND MAINTENANCE OF CENTER

### 2.1 Summary of Technical Progress and Activities

#### 2.1.1 Goals Set for the DACS

The activities of the DACS were oriented toward:

(1) The dissemination of state-of-the-art information on software technology of general interest to the software engineering community.

(2) The maintenance and expansion of the Software Engineering Library and Bibliographic Database containing information relating to all aspects of software technology.

(3) The maintenance and expansion of the Software Life Cycle Empirical Database (SLED) containing data descriptive of the development and maintenance processes of a variety of software projects, which has been made available to researchers.

(4) The preparation of a data analysis plan for the DACS and the analysis of part of the data contained in the SLED.

(5) The conduction of a user awareness program through publication of newsletters and bulletins, presentations at professional seminars, and at the sites of potential clients and active participation in professional and technical organizations.

(6) The preparation and distribution of products and services designed to meet the information needs of the DACS user community including the performance of special studies as required.

(7) The preparation and implementation of a cost recovery plan including the setting of prices and preparation of a user's guide and a brochure describing DACS products and services.

#### 2.1.2 Summary of Activities Accomplished

By the end of the contract period the major goals set for this transition period were accomplished.

The online bibliographic database was expanded by over 1000 documents, a supplement to the annotated bibliography was produced and the custom searches were enhanced in both appearance and in information content.

The SLED was expanded by the addition of operations and maintenance data on the PAVE PAWS Phased Array Warning System, the Architectural Research Facility's development data, and by updates to the NASA Software Engineering Laboratory's database. A data compendium summarizing all of the data held by the DACS was produced.

A DACS data analysis plan was developed and one of the proposed data analysis tasks was selected for implementation during this contract period, that one being an analysis of the productivity data held by the DACS. Two State-of-the-Art reports, one on data collection methodologies and the other on software tool systems were also produced during this period.

The user awareness program initiated during the pilot period was continued during the transition period. Four issues of the DACS Newsletter and seven issues of the DACS Bulletin were produced and distributed. Presentations at conferences and sites of potential clients were also continued although not as frequently as during the pilot period. In addition, paid advertisements were placed in professional journals and free publicity was obtained for the DACS and its products.

A cost recovery program plan was prepared and implemented and has begun to show results. A users guide, a brochure and price lists were developed and distributed to users.

The DACS user community continued to expand, the newsletter mailing list was increased by over 1700 names bringing the total to 4544 names. The precipitate drop in user activity encountered by other IACs during their transitions from providing services free to charging for services was also encountered by the DACS. The situation has begun to stabilize with user fees from May 1982 through November 1982 averaging $2453 per month*. The May through October period was chosen because the brochure summarizing DACS products and services and their costs was provided to all DACS users during May and was the first time during this contract period that all users were aware of all of the products and services offered by the DACS.

*This is discussed in Section 9 and shown graphically in Figure 9-2.

The total number of inquiries received and processed during this 15 month period was 707; it should be noted that the DACS did not process non-DoD user requests until January 1982. This necessarily limited the total number of inquiries processed.

# 3.0 TASK 2 - ACQUISITION OF SOFTWARE EXPERIENCE DATA

## 3.1 Introduction

This section of the report contains descriptions of the DACS data acquisition program and the resultant DACS Software Life Cycle Empirical Database (SLED). There is a real need to collect productivity and failure data on the development, operation and maintenance of software to support research in the software field. Data is needed which will allow researchers to isolate factors that contribute significantly to the costs, reliability and quality of the software, to measure achieved reliability, to predict development and maintenance costs, and to track the progress of a software development project.

## 3.2 Data Acquisition Approach

The means used to maintain the data acquisition program developed during the previous contract consisted of:

- o Identifying data sources and acquiring relevant data
- o Establishing procedures for automatic submission of data
- o Establishing procedures for processing, evaluating, and database entry
- o Maintaining the computer database

These procedures were documented at length in RADC-TR-81-385 (CAR082) and will not be reproduced here. The reader is referred to (CAR082) for full details.

## 3.3 Sources Identified

From September 1981 through December 8, 1982, a total of 95 inquiries were made with the intention of ascertaining the availability of software data. The majority of these inquiries were made by mailing letters as a result of announcements in the CBD. The DACS received 22 responses to its letter inquiries. Of the 22 responses, 10 were evaluated as not worth follow-up for reasons such as software not being developed, project cancellation, or the agency's declining to reveal information about the project. Twelve were

evaluated as being worth further follow-up activities. Such activities generally involved a request for additional information which took the form of another letter, a telephone call or a visit to the organization. In all, 98 follow-up letters or phone calls and 2 visits to potential data contributors were made during this time period. The most significant new acquisition resulting from these activities was the acquisition of the Architectural Research Facility (ARF) Dataset from the Naval Research Laboratory.

In addition, the Federal Aviation Administration (FAA) is planning a conversion of the majority of their airspace control software to run on another computer. DACS personnel have been in continuing contact with the FAA engineers responsible for writing the RFP for this conversion. The DACS was informed recently that the conversion data collection forms designed by the DACS would be included in the RFP soliciting bids on this conversion, and that data collection would be a requirement for the project. In addition, the data collected will be given to the DACS for incorporation into the SLED.

### 3.3.1 Automatic Submission of Data

During the 15-month period covered by this report, the DACS began receiving data from the PAVE PAWS programming agency in addition to continuing the arrangements previously made with NASA/SEL to submit data automatically to the DACS on a continuing basis. Most of the data submitted by the PAVE PAWS program office at Beale Air Force Base, CA is generated automatically by their program support library system. This makes two agencies from whom data is being submitted in machine readable form, greatly easing the processing load on DACS personnel.

## 3.4 Current Status of the DACS Software Life Cycle Empirical Database (SLED)

The DACS SLED presently consists of seven sets of data distinguishable by data source, data collection and acquisition methodology, life cycle phase represented and data parameters present. These datasets have been implemented on the RADC HIS 6180 computer system using the Management Data Query System (MDQS) to facilitate data retrieval and analysis. In that each set of data was the

result of a data collection effort which pursued individually specific objectives, the resulting datasets differ with regard to:

- o The time period represented by projects in a dataset
- o The portion of the software life cycle represented by the data
- o The aspects of the software development and/or maintenance processes measured by the data collection activity
- o The quality of the data as reflected in the verification and validation procedures used in data collection
- o The subsequent analyses supported by the data.

The SLED presently consists of seven sets of data. The data and the sources associated with them are shown below. Complete descriptions of the datasets can be found in the references provided.

(1) The DACS Productivity Dataset - Data collected from various government and private industry sources and complied by Richard Nelson of RADC. (NELS78)

(2) The Reliability Dataset - Data collected at Bell Laboratories, Whippany, N.J. and complied by John Musa. (MUSA79)

(3) The NASA/SEL Life Cycle Dataset - Data collected and contributed by the Software Engineering Laboratory (SEL) at NASA Goddard Space Flight Center. (BASI79)

(4) The Verification & Validation (V&V) Dataset - Data collected under several Independent V&V contracts then summarized and delivered to the DACS by Logicon Incorporated. (RADA81)

(5) The ARF Error Dataset - Data collected and analyzed on the development of the Architecture Research Facility (ARF) at the Naval Research Laboratories (NRL) by David Weiss. (ELOV79)

(6) The Baseline Software Dataset (BSDS) - Data collected on six defense software projects from various organizations. (DUVA79I), (DUVA 79II)

(7) The Operations and Maintenance O&M Dataset - Data collected on the operations and maintenance of the PAVE PAWS Phased Array Warning System. (IITR82)

The datasets were generated at different points in time and it is important to consider this when analyzing data of this nature. Figure 3-1 illustrates the periods of time represented by data in each of the datasets. Each of the datasets contains data from various software life cycle phases as depicted in Figure 3-2. Of these seven datasets, four are available in a standard format. The remaining three, the NASA/SEL, the BSDS and the O&M datasets, because of their extensive nature, have not been processed into a form which is readily usable and as such distribution is limited to customized versions of these datasets, prepared in response to individual requests. Each of the seven sets of data is discussed in detail in The DACS Data Compendium (TURN82).

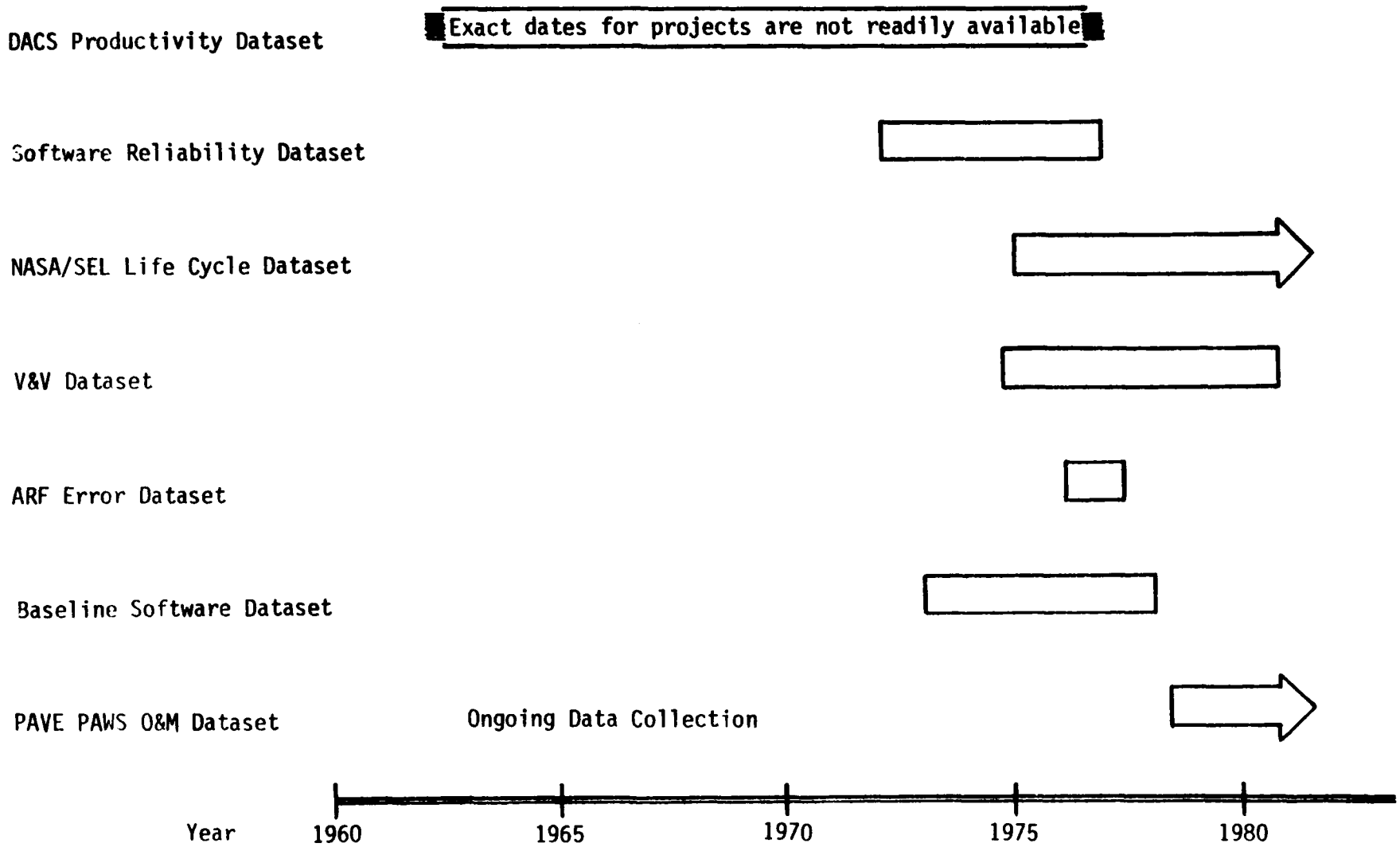


FIGURE 3-1: TIME PERIODS REPRESENTED BY SLED DATASETS

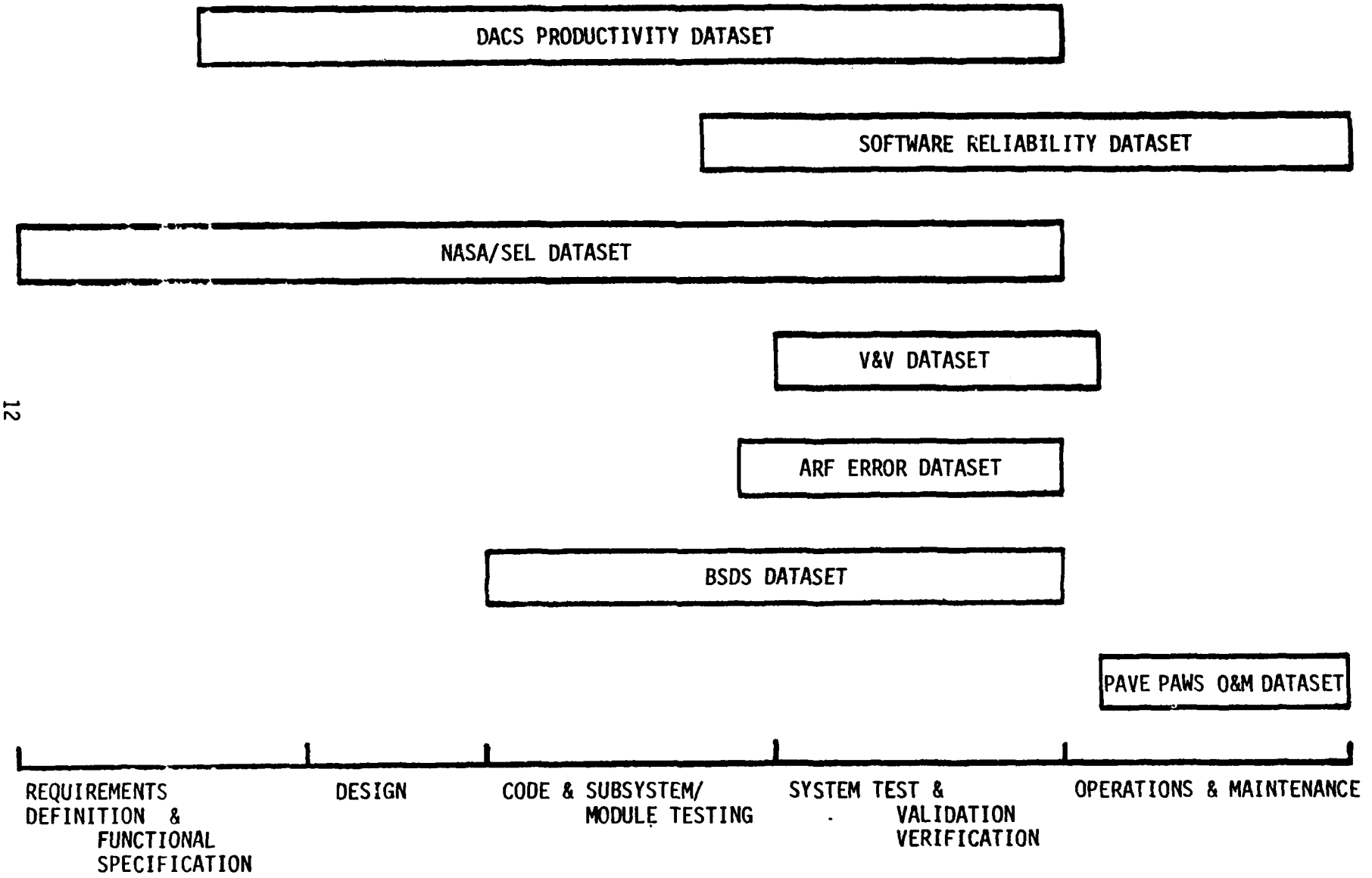


FIGURE 3-2: LIFE CYCLE PHASES DESCRIBED BY DACS DATASETS

# 4.0 TASK 3 - SCIENTIFIC AND TECHNICAL INFORMATION (STINFO) ACQUISITION

## 4.1 Introduction

Scientific and Technical Information (STINFO) consists of documented information concerning the state-of-the-art and technology aspects of the computer software field. STINFO usually includes technical reports, trade journal publications, proceedings of conferences and symposia, theses, texts, product descriptions and specifications. The DACS also includes as STINFO descriptions of on-going software technology research for which reports may not yet have been produced. These two types of STINFO serve as input to two information databases maintained by the DACS, the Software Engineering Bibliographic Database (SEBD) and the Software Engineering Research Projects (SERP) Database.

### 4.1.1 The Software Engineering Bibliographic Database (SEBD)

The DACS SEBD has been established to provide a readily accessible source of comprehensive information of the state-of-the-art in software engineering as well as a means of channeling that information to those people in the software engineering community who can make use of it in their day-to-day activities of developing, maintaining, and managing software. The bibliographic collection is composed of texts, technical reports, theses, journal articles, proceedings and other documents relating to software engineering, reliability, costs and quality factors, maintainability, and other topics deemed appropriate. The collection is computer-accessible and retrieval of information on documents can be made on any part of their citations or on assigned keywords.

The DACS personnel have maintained and refined systematic and orderly STINFO acquisition program which was established during the pilot operation of the DACS. During this contract period 1000 documents were added to the SEBD. Table 4-1 displays the current composition of the SEBD.

TABLE 4-1: DOCUMENT TYPES IN SEBD

| TYPE OF DOCUMENT | NUMBER OF DOCUMENTS | PERCENT OF COLLECTION |
|---|---|---|
| BIBLIOGRAPHY | 0018 | 00.5 |
| JOURNAL ARTICLE | 0936 | 28.0 |
| TECHNICAL REPORT | 0478 | 14.3 |
| TEXT | 0017 | 00.5 |
| PAPER | 1817 | 54.4 |
| STANDARD | 0021 | 00.6 |
| REGULATION | 0006 | 00.2 |
| SPECIFICATION | 0003 | 00.1 |
| INSTRUCTION | 0003 | 00.1 |
| DICTIONARY | 0002 | 00.1 |
| HANDBOOK | 0006 | 00.2 |
| DISSERTATION OR THESIS | 0012 | 00.4 |
| MONOGRAPHS | 0021 | 00.6 |
| TOTAL DOCUMENT CITATIONS ONLINE | 3340 | |

### 4.1.2 The Software Engineering Research Projects (SERP) Database

The DACS maintains the SERP to provide a computer-accessible source of information about recent and on-going research in the field of software engineering. Projects covered in this database are those involving software technology research, such as the development or evaluation of programming languages, models or software tools, and research related to software engineering methodologies such as modern programming practices. The database was developed during the pilot period of the DACS operation. During the current contract period, the information contained in the SERP database has been made available to the software engineering community both in a published report entitled A Directory of Software Engineering Research Projects and through custom searches of the database.

During the 15-month period which is the subject of this report 30 research projects were identified for entry into the SERP database. A sample of the information provided for each research project is shown in Figure 4-1. Figure 4.1 is a sample page from A Directory of Software Engineering Research Projects.

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YOHAY, J.S., U.S.ARMY,COMMUNICATIONS R & D COMND, FT.MONMOUTH, NJ
ADA LANGUAGE SYSTEM MAINTENANCE AIDS
SPONSOR: U.S.ARMY,COMMUNICATIONS R & D COMND, FT.MONMOUTH, NJ
CONTRACT NO. IN-HOUSE START-DATE: JUL 1980 END-DATE: JAN 1981

THE OBJECTIVE OF THIS EFFORT IS TO PREPARE A COMPREHENSIVE SET OF SOFTWARE TOOLS TO PROVIDE AUTOMATED MAINTENANCE/COMMUNICATION FOR THE ADA LANGUAGE SYSTEM DEVELOPMENT/MAINTENANCE EFFORT.

125

OSTERWEIL, L.J., FOSDICK, L.D., U. OF COLORADO,BOULDER,CO 80309
THE CONSTRUCTION AND EVALUATION OF TOOLS FOR TESTING AND VERIFICATION OF SOFTWARE
SPONSOR: DARCOM ARMY RSCH OFFICE,DURHAM RSCH TRI PK,NC 27709
CONTRACT NO. DAAG29-80-C-0094 START-DATE: FEB 1980 END-DATE: FEB 1982

THE OBJECTIVE OF THIS RESEARCH IS TO CONTINUE THE CREATION, DEVELOPMENT AND EVALUATION OF AN INTEGRATED SOFTWARE TESTING AND VERIFICATION SYSTEM. THIS RESEARCH HAS BROAD GENERAL RELEVANCE TO SOFTWARE PRODUCTION AND TESTING IN MOST ARMY LABORATORIES.

126

WEGNER, P., BROWN U., PROVIDENCE, RI 02912
COST EFFECTIVENESS AND TECHNOLOGY TRANSFER STUDIES OF ALTERNATIVE NAVY PROGRAMMING LANGUAGE POLICIES
SPONSOR: OFFICE OF NAVAL RESEARCH,QUINCY ST.,ARLINGTON,VA 22217
CONTRACT NO. N00014-78-C-0656 START-DATE: SEPT 1978 END-DATE: CONT

NAVY COMPUTING SYSTEMS HAVE NEED FOR MORE EFFICIENT PROGRAMMING LANGUAGES. THIS TASK IS DESIGNED TO ASSIST THE NAVY IN MAKING POLICY DECISIONS CONCERNING THE EFFECTIVE USE OF ITS PROGRAMMING LANGUAGE RESOURCES DURING THE 1980S AND BEYOND. THE APPROACH WILL BE BOTH QUALITATIVE AND QUANTITATIVE EVALUATION STUDIES TO DETERMINE THE RELATIVE COST EFFECTIVENESS OF CMS-2, TACPOL, JOVIAL, SPL-1, AND THE PROPOSED DOD RED AND GREEN LANGUAGES. CONTROLLED EXPERIMENTS WILL BE DESIGNED AND CONDUCTED TO DETERMINE LANGUAGE EFFECTIVENESS. TECHNICAL ISSUES OF LANGUAGE DESIGN AND EFFICIENCY OF IMPLEMENTATION FOR SPL-1 AND THE RED AND GREEN LANGUAGES WILL BE EXAMINED. PROBLEMS OF TECHNOLOGY TRANSFER AND EDUCATION INVOLVED IN INTRODUCING A NEW LANGUAGE WILL BE CONSIDERED.

FIGURE 4-1: A SAMPLE OF THE INFORMATION CONTAINED IN THE SERP DATABASE

# 5.0 TASK 4 - DATA ANALYSIS PROGRAM

## 5.1 Introduction

The large variety of software experience data available in the DACS database and the large collection of STINFO documents available at the DACS, places the DACS in a unique position to contribute to software technology research through data analysis. During the current contract period a data analysis program plan (TURN81) was developed and its implementation initiated. This program was developed to pursue the objectives of software technology research. These research objectives include:

- Provide a better understanding of the processes involved in producing, managing, and maintaining software
- Identify those factors which influence the cost, reliability, and quality of software
- Develop and improve methods and tools for use in producing and maintaining software
- Develop techniques for estimating costs, resource requirements, and schedules for future software projects
- Develop techniques to assist managers in the planning, measuring, and tracking of the development and maintenance of software projects

This section discusses the approaches used to develop the plan and progress made in implementing the Data Analysis Program planned for the DACS.

## 5.2 Development and Implementation of the Data Analysis Program

The processes used for the development and implementation of the data analysis program are displayed in Figure 5-1. This figure displays the inter-relationships that are involved in the development and implementation of a data analysis program. The figure is in the form of a HIPO chart showing the inputs to the processes of developing and implementing analysis activities, the processes involved, and the outputs generated by the analysis program. Since analysis of data is required to produce an analysis program plan, this process of developing the analysis program was actually one task of the analysis program. Note that

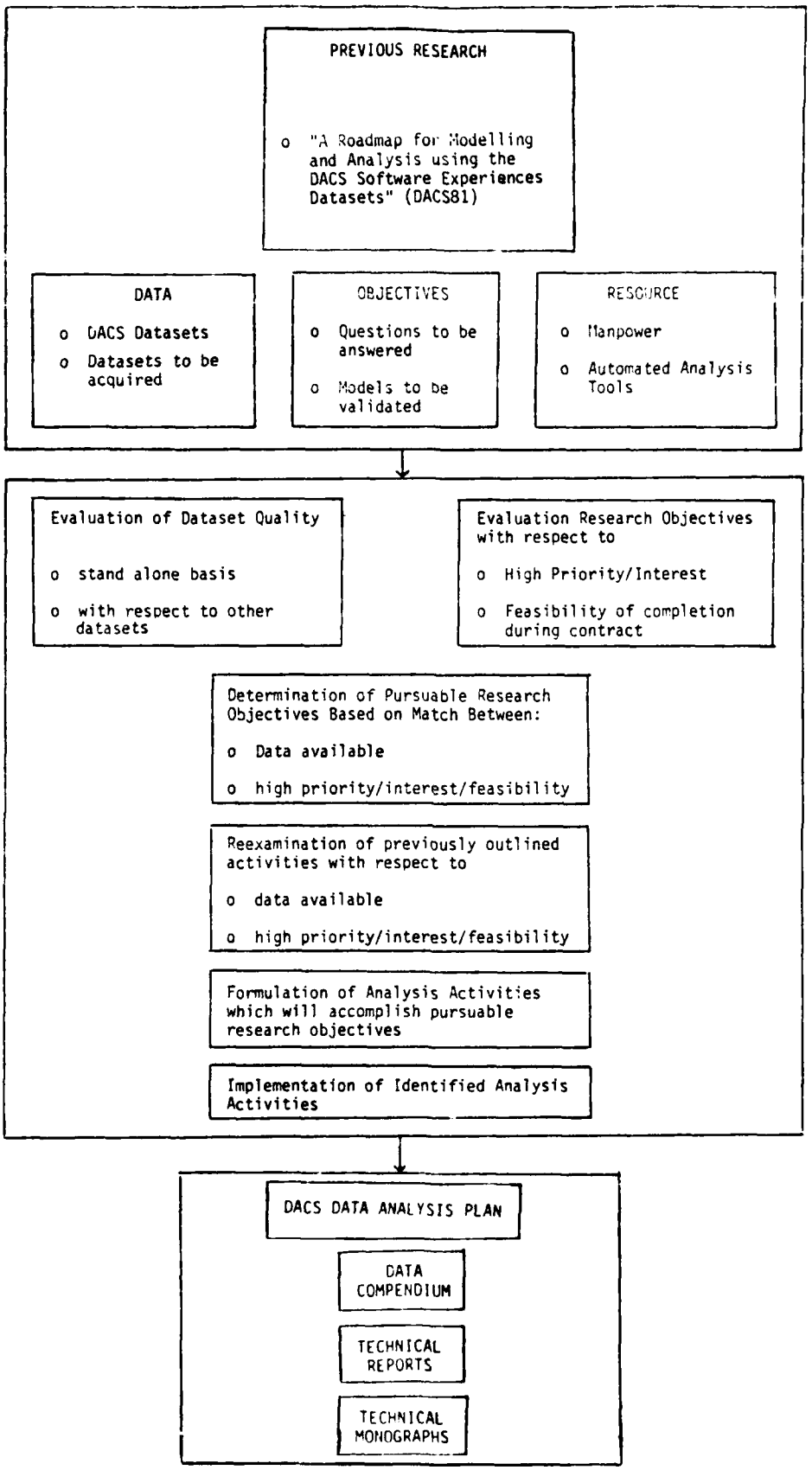



FIGURE 5-1: A CHART DISPLAYING THE PROCESS OF DEVELOPING A COMPREHENSIVE DATA ANALYSIS PROGRAM SHOWING THE INTER-RELATIONSHIPS OF THIS PROGRAM

while the production of a data compendium does not require a great deal of indepth analysis, it is appropriate to include it as an output of the development and implementation of a data analysis program. Since the data analysis program requires as input subsets of the DACS SLED, the Data Compendium was prepared as a guide to assist users of this database. The activities required by the production of the Data Compendium and implementation of the Data Analysis Program are highly inter-related. All of these outputs are considered as products and services and are discussed in Section 7.0.

The actual processes involved in the separate development, implementation and maintenance of a data analysis program are discussed below.

### 5.2.1 Data Analysis Program Plan

The DACS has developed a comprehensive data analysis program during the current contract period. The entire program is documented in (TURN81).

A considerable amount of effort has been expended during the past 15-months to perform some of the tasks documented in (TURN81). The DACS had earlier determined a set of possible research activities dealing with the software technology field, of varying degrees of interest, priority, and difficulty which employ proven analysis techniques familiar to DACS personnel. These activities were presented in a report entitled "A Roadmap for Modeling and Analysis Using the DACS Software Experience Datasets". This report provided input to the "Data Analysis Program Plan for the Data & Analysis Center for Software" which was produced by the DACS during the current contract period, and which outlines the data analysis program currently in place at the DACS. Some of the objectives outlined have been addressed during the current contract and these include:

- The performance of several statistical tests on two of the DACS datasets to determine the distributions of project size, development effort, error rates etc., for the projects in the datasets.
- An examination of the effects of various measures of MPP usage during the development of software on the measured productivity and error rates for the development.

- o Classification of projects by development environment, application, and language, and the determination of whether the distributions of various data elements for projects depend upon these classifications.

The DACS has also performed development and enhancement of automated analysis tools and has used the implementation of these tools on the RADC HIS 6180 computing system in performing analysis activities.

## 5.3 Implementation of the Data Analysis Program

The process of implementing the Data Analysis Program is depicted in Figure 5-2. This figure shows the inputs required by the implementation, the processes, and the outputs from the data analysis program. The outputs from the processes are some of the products and services provided by the DACS. These are discussed in further detail in Section 7.0. To a great extent, the level of detail presented in the Data Analysis Program Plan influenced the ease of implementation of the program.

### 5.3.1 Specific Analysis Activities Performed by the DACS

A monograph[1] produced during the previous contract compared the DACS productivity dataset with some of the data items recorded in the NASA/SEL dataset. Several relationships basic to identifying the data and measuring the development process were examined. An analysis conducted during the present contract involved an extension of the comparison between these two sets of data. The analysis included an extensive parametric and non-parametric comparison between these two datasets, and between groups of related projects within the DACS productivity dataset. Productivity observed over the development of each project was used as a performance measure in making comparisons between groups. The distributions of project productivities were then compared to determine significant differences between groups of projects. This analysis was documented in (ROME82A).

1 "A Comparison of RADC and NASA/SEL Software Development Data", DACS Technical Monograph Series, Christopher Turner and Gary Caron, May 1981.

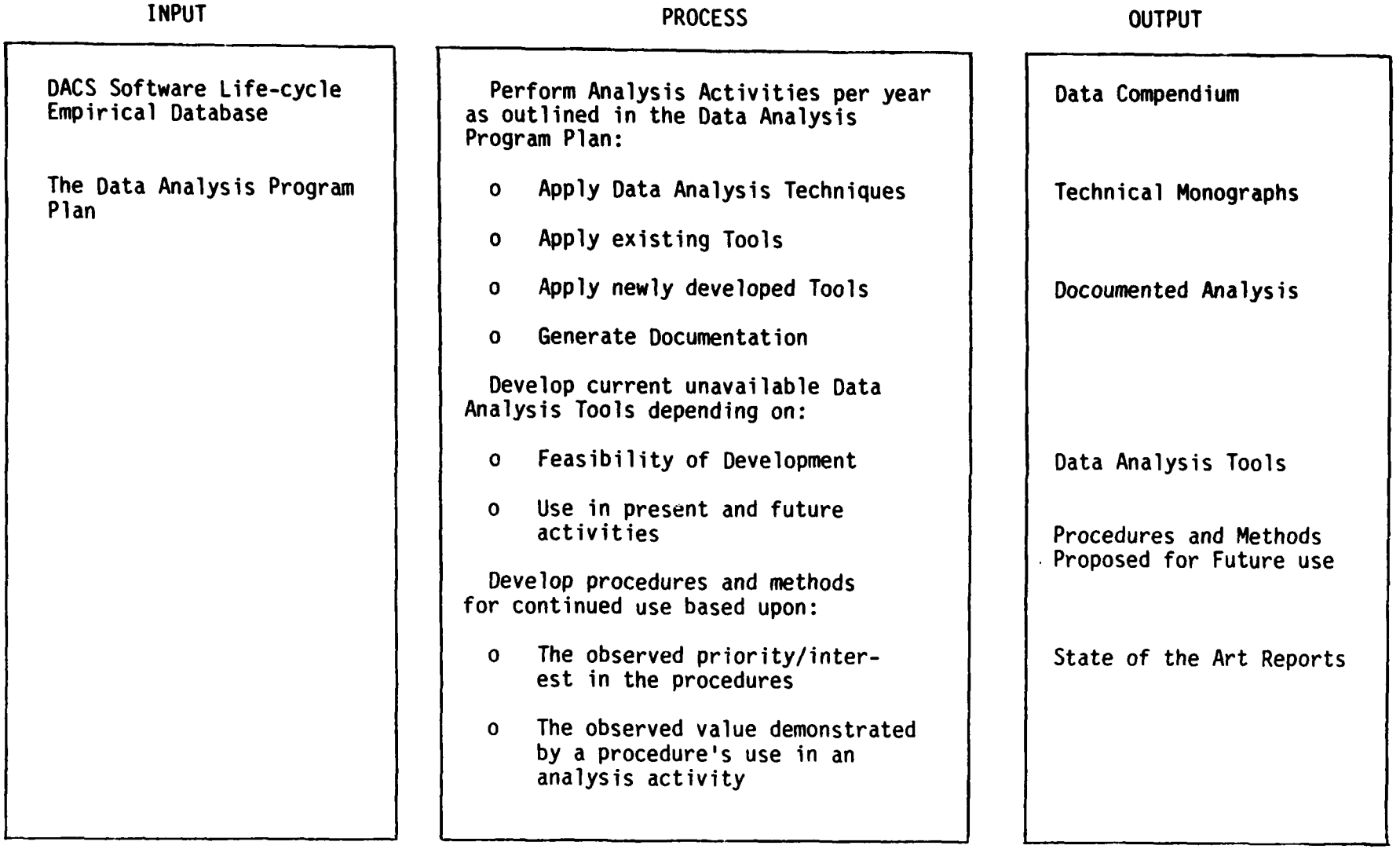



FIGURE 5-2: THE IMPLEMENTATION OF THE DATA ANALYSIS PROGRAM PLAN DISPLAYED IN THE FORM OF PROCESSES WITH INPUTS TO AND OUTPUTS FROM THESE PROCESSES

## 5.4 Evaluation of Non-Parametric vs. Parametric Analysis Techniques

Another of the tasks performed by IITRI/DACS personnel during the present year was the evaluation of equivalent parametric and non-parametric statistical tests with respect to their appropriateness for analyzing software engineering data. The table which follows illustrates a sample of these equivalent techniques and their purposes.

TABLE 5-1: EQUIVALENT PARAMETRIC/NON-PARAMETRIC STATISTICAL TESTS

| PARAMETRIC TEST | NON-PARAMETRIC TEST | PURPOSE |
|---|---|---|
| Pearson | Kendall Tau | Tests Correlation |
| Simple Linear Regression | Non-Parametric Regression | Tests Trends |
| Student's t Test | Wilcoxon | Tests Location |
| F Test | Siegel-Tukey | Tests Dispersion |

After thorough analyses of the data and of the previous results obtained by several researchers using the DACS-SLED productivity data, it became apparent that:

- o The statistical hypotheses upon which parametric models are based
  - normality of the data
  - homoscedasticity (equal variance of the residuals)

  were greatly violated, and,
- o The level of the measurement scale of the variables involved in the analyses (size, effort, productivity, Modern Programming Practices) attain, at most, an ordinal scale level. This is inferior to the necessary measurement scale level for which parametric models are designed.

As a consequence, analyses were reperformed using a non-parametric approach and the results obtained are valid and hold in spite of the fact that:

- o variables are not normally distributed
- o variances are dependent on the mean
- o outliers exist in the data
- o measurement errors exist in the data

Full details have been provided in the report produced by the DACS which documents this research (ROME82B). As a result of the work documented in (ROME82B), it has been determined that the range of statistical techniques classified as non-parametric are extremely useful in analyzing software experience data. The methods used to collect software engineering data, the accuracy of the data, the dissimilarity of data-item definitions and the actual distributions of some project level metrics, indicate that in many cases the data measurement level attains, at most, an ordinal scale as opposed to an interval scale. This suggests the use of non-parametric analysis techniques as these techniques are not dependent upon how the data being analyzed is distributed and these techniques are robust to the problems of measurement errors.

All of these conditions existed before and voided or gravely crippled the analysis results of previous researchers. The demonstration of the applicability of non-parametric analysis techniques provides another set of tools which can be used instead of or in a complementary manner to the traditional parametric analysis tools and techniques.

## 6.0 TASK 5 - CURRENT AWARENESS PROGRAM

### 6.1 Introduction

Concurrent with the establishment of the DACS, a comprehensive and vigorous current awareness program was established and maintained throughout the three-year pilot operation of the DACS. During the transition period this program was continued and expanded.

The program has had two purposes; (1) to keep the DACS user community informed of the latest and most significant developments in software technology and software engineering, and (2) to inform its current user community as well as potential users of products and services offered by the DACS as well as the benefits to be realized through use of the DACS. The DACS has utilized many means to implement the current awareness program. These include:

- Publication of the DACS Newsletter
- Publication of the DACS Bulletin
- Presentations at Conferences and Symposia
- Establishment of contacts throughout the software engineering community through active participation in professional organizations
- Placement of press releases, announcements, and paid advertisements concerning DACS products and professional activities in professional journals, newspapers, and magazines circulated to the software engineering community
- Publication and dissemination of informational materials designed and developed by the DACS staff

Activities relating to purpose (1) will be discussed in this section; the promotional aspects of the current awareness program are discussed under Task 8, cost recovery.

### 6.2 DACS Newsletter

In implementing the current awareness program, IITRI initiated the publication of the DACS Newsletter. The Newsletter is employed as the primary

means for the dissemination of current information to the DACS user community. It contains the following: synopses and critiques of significant, newly-acquired reports/articles, summaries of new R&D programs, listings of future conferences/symposia, summaries of significant technological break-throughs and significant new technological applications, and highlights of other outstanding developments within the Center's fields of interest. The DACS Newsletter is also used as a vehicle to announce new DACS products and programs to its user community. In general, one DACS product is featured in each issue with capsule summaries of other products featured as space permits.

The DACS Newsletter is distributed free of charge to both government and non-government personnel having an interest in the disciplines served by DACS. The DACS Newsletter is now sent to the more than 4,000 individuals on the mailing list and is also distributed at conferences attended by DACS personnel. Figure 6-1 illustrates a sample of the DACS Newsletter. The number of individuals on the DACS Newsletter mailing list has been expanded by over 1000 names during the current contract period.

## 6.3 DACS Bulletin

The first DACS Bulletin was published in April 1979 and since then 27 issues have been published. Figure 6-2 illustrates the first page of the May 1982 issue of the DACS Bulletin.

The Bulletin has been regularly distributed on a limited basis to RADC personnel. The DACS Bulletins are usually a treatment of a topic of high interest in greater depth than space allows in the Newsletter. Certain issues of particular interest to our general user community have been publicized in the Newsletter and distributed to requesting individuals at a nominal charge. Table 6-1 provides a list of the issues of the DACS Bulletins produced during the current contract period.

# DACS NEWSLETTER

## Data & Analysis Center for Software

RADC/ISISI
Griffiss AFB, NY 13441
315/330-0937
Autovon 587-3305

Volume III Number 7

December 1982

### EDITOR'S NOTES

This issue of the DACS Newsletter contains information on a new NBS report, a new IEEE standard and the DoD software initiative. Also included are announcements for two workshops and a conference. The featured service for this newsletter is the DACS custom bibliographic searches.

### CUSTOM BIBLIOGRAPHIC SEARCHES

DACS custom bibliographic searches provide the user with references to the latest available information relating to his or her need for specific information on software-engineering and software technology. The search topic can range from very narrow; (e.g.) "Fault Correction Costs," to the very broad; e.g., "Testing." Boolean searches on combinations of search terms can also be provided. Based upon a statement of specific user needs, DACS conducts a computerized search of its databases to identify applicable reports, project summaries, and journal articles. The search strategy may include any combination of the following data items:

> Subject terms (Keywords), personal author(s), corporate author, sponsoring agency, report date, report number, contract number, journal in which published, title or title fragment.

Bibliographies produced contain all of the above data elements in addition to an abstract describing the documents' contents for all citations retrieved.

The listing is produced by a high-speed printer. After the contents are reviewed by a DACS analyst for relevancy to the request, the listing is mailed to the requestor of the bibliography.

Ordering a custom bibliography can be accomplished with a letter, phone call or visit to the DACS. The charge for custom bibliographic searches is $50. For best results, please call or write the DACS for assistance in formulating your custom bibliographic search. More information about the mechanics of structuring a query are contained in the DACS publication "Users Guide to Bibliographic Services - Custom Searches" (BIBGUIDE). This guide also contains the DACS Thesaurus of keywords used for indexing and retrieving software engineering documents. BIBGUIDE is available from the DACS upon request.

### NEW IEEE STANDARD

The IEEE Standards Board formally approved the IEEE Standard Glossary of Software Engineering Terminology (IEEE Std 729-1982) on September 23, 1982, culminating a three-year effort led by Shirley Gloss-Soler of the DACS. Over 500 terms are defined in this glossary. The terminology was balloted in June and July of 1982 and 93% of the 147 member balloting group composed of members of the IEEE Subcommittee on Software Engineering and other concerned members of the IEEE Computer Society voted to approve the standard. Based on this high percentage of acceptance, the IEEE Standards Board approved the terminology as a full-use IEEE standard.

Over 100 concerned professionals contributed their efforts to the development of this standard. Special recognition is in order for the 15 members of the steering committee that was formed to coordinate the input from other members. Members of the steering committee were:

Russell J. Abbott, The Aerospace Corporation
Joan P. Bateman, Boeing Commercial Airplane Company
Stephen R. Beason, Digital Equipment Corporation
Milton E. Boyd, Jr., Digital Equipment Corporation
Kurt F. Fischer, Computer Sciences Corporation
Marilyn Stewart, Booz, Allen Hamilton, Inc.
Lt. Glenn C. Hughes, II, United States Army
John M. Ives, Air Force Weapons Laboratory
John J. McKissick, Jr., General Electric Company
Albrecht J. Neumann, National Bureau of Standards
John N. Postak, Doty Associates, Inc.
Jane W. Radatz, Logicon, Inc.
Alan N. Sukert, General Electric Company
Donald A. Woodmancy, NCR Corporation
David Yablon, Computer Sciences Corporation

Copies of IEEE Std 729-1982 will be available during the first quarter of 1983 from:

IEEE Service Center
445 Hoes Lane
Piscataway, NJ 08854

The cost will be $7.50 plus a shipping and handling charge of $2.00.

### DoD SOFTWARE INITIATIVE

On 8 October 1982, Dr. Edith Martin, Deputy Undersecretary of Defense for Research and Engineering (Research and Advanced Technology), announced that the U.S. Department of Defense has launched a major new initiative to improve the state-of-the-art in software technology and to exploit the advantages of computer technology through software. Activities in eight areas are included in the this initiative: human resources, project management, systems (including systems architecture, hardware/software synergy, and system reliability), application-specific aids, acquisition procedures, human engineering, support systems (including methods and automated environments), and measurement.

A document proposing a strategy and initial plan for the Initiative is available for distribution through DTIC, NTIS, and the DACS. This report consists of two volumes. Volume I provides an overview of the

*The Data & Analysis Center for Software is a DoD Information Analysis Center operated by IIT Research Institute*

FIGURE 6-1: NAME, FORMAT & CONTENT OF THE NEWSLETTER WERE DEVELOPED BY DACS PERSONNEL

DACS BULLETIN

Volume II, Number 11
May 1982

**Data & Analysis Center for Software**

RADC/ISISI
Griffiss AFB, NY 13441

315/336-0937
Autovon: 587-3395

DATA COLLECTION DURING
THE SOFTWARE OPERATIONS & MAINTENANCE (O&M) PHASE
by Douglas Cornwell

## Introduction

Data collection has been discussed as it applies to the development process, but seldom is discussed in terms of the maintenance functions. The maintenance function as applied to software includes activities directed toward the correction of faults as well as activities directed toward the incorporation of enhancements to the software. The results of a General Accounting office survey shows that approximately 48% of annual data processing (DP) hours are devoted to maintenance and enhancements to computer software, while only 46% is devoted to new software development. [GAO81] In a study recently completed by IIT Research Institute for Rome Air Development Center (RADC), 62% of the software maintenance effort was expended for enhancements to the PAVE PAWS Phased Array Warning System software and only 38% of the effort was expended for error corrections. [IITR82] Given the proportion of DP resources expended on software maintenance, both for fault correction and for enhancement, data collection during the maintenance phase becomes a growing concern.

This issue of the DACS Bulletin presents a brief review of data collection as applied to software development, discusses various reasons and advantages for developing a data collection methodology for software maintenance, and reviews selected tools and techniques that may be utilized during the software maintenance process.

## Benefits of Data Collection

Data collection has proven to be a worthy tool for the software development process. As a result of their study, T. A. Thayer, et al. concluded that there are a number of benefits to be gained from data collection. [THAY76] Data collection can:

- Assist in understanding the various factors and difficulties characterizing software and the software development process

*The Data and Analysis Center for Software is Operated by IIT Research Institute for the Rome Air Development Center*

FIGURE 6-2: THE DACS BULLETIN FOCUSES ON A SINGLE TOPIC OR REPORT

TABLE 6-1: SEVEN ISSUES OF THE DACS BULLETIN
WERE PRODUCED BY DACS STAFF MEMBERS

| ISSUE | TITLE | AUTHOR | LENGTH |
|---|---|---|---|
| November 1981 | ADA - A Suitable Replacement for Cobol? | D.W. Cornwell | 6 pages |
| January 1982 | A Summary of Recent Research on Software Cost Estimation Models | S.A. Gloss-Soler | 7 pages |
| February 1982 | A Software Data Collection Methodology (From the Viewpoint of David M. Weiss) | G. Brement | 4 pages |
| April 1982 | The Mythical Man-Month Revisited (Report on a Panel Session at Spring COMPCON '82) | L.M. Duvall | 5 pages |
| May 1982 | Data Collection During the Software Operations & Maintenance (O&M) Phase | D.W. Cornwell | 9 pages |
| August 1982 | Reflections on Software Research: Current and Past. A Panel Discussion on the Effectiveness of Research of Extending the State-of-the-Art in Software Engineering | C.S. Turner | 4 pages |
| October 1982 | Reflections on the Fifth Minnowbrook Workshop on Software Performance Evaluation | J.L. Romeu | 4 pages |

## 6.4 Technical Presentations

Five technical presentations were made at software related technical symposia and three at customer sites. The emphasis on technical presentations during the transition period shifted to presentations made at the sites of potential clients of the DACS from the previous emphasis on presentations at symposiums and conferences.

Technical presentations proved to be both an effective way to inform the technical community of the concerns and activities of the DACS, and to attract new users. They were also an effective way to identify new areas of concern in the community the DACS serves and to identify sources of data for the data acquisition program, as well as inputs for the Newsletters and Bulletins. In addition to technical presentations at client sites and technical symposia, several presentations were made at the DACS to persons or groups visiting Griffiss Air Force Base for meetings or workshops. A sample of these presentations can be found in Figure 6-3.

## 6.5 Summary

As a result of the vigorous conduct of the current awareness program, several benefits have accrued to the DACS.

- DACS personnel have established an elaborate network of contacts throughout the software engineering community and are regularly invited to make presentations at conferences and symposia
- DACS personnel continued to develop an in-depth knowledge of the needs and concerns of the DACS user community. This knowledge is needed in order to prepare and publish Newsletters and Bulletins which are both informative and useful
- DACS personnel have developed production and quality control procedures to assure that Newsletters and informational materials are of high quality in both appearance and technical content. Thus, the high quality of publications developed during the pilot period were maintained during the transition period.
- Through participation in technical symposia, workshops, and professional activities, DACS personnel have acquired a broad base of information regarding the activities of individuals and organizations in the field of software engineering, as well as a reputation for the DACS as a clearinghouse for such information.

| DATE | AUTHOR(S) | TITLE | PRESENTATION |
|---|---|---|---|
| November, 1982 | Carol Proctor | A Software Quality Metrics Study (Results of DACS Special Study) | Compsac 82<br>Chicago, IL<br>November 8-12, 1982 |
| July 1982 | Jorge Romeu<br>Christopher Turner | The Effects of Technology on Development Effort | Fifth Minnowbrook Workshop on Software Performance Evaluation<br>Syracuse University's Minnowbrook Conference Center<br>Blue Mountain Lake, NY<br>July 20-23, 1982 |
| April 1982 | Shirley Gloss-Soler | Data Collection Methodologies | Federal Aviation Administration<br>Washington, DC<br>April 16, 1982 |
| March, 1982 | Lorraine Duvall | Data Collection for Configuration Management | Naval Surface Weapons Center<br>Dalhgren, VA<br>March 14, 1982 |
| December, 1981 | Lorraine Duvall | The Products and Services of the DACS | National Security Agency<br>Washington, DC<br>December 1981 |
| December, 1981 | Christopher Turner<br>Shirley Gloss-Soler | Baselines for Space System Software | To representatives of USAF Space Division<br>DACS<br>December 1981 |

FIGURE 6-3: TECHNICAL PRESENTATIONS WERE MADE AS PART OF THE CURRENT AWARENESS AND PROMOTIONAL PROGRAMS

# 7.0 TASK 6 - PRODUCTS AND SERVICES PREPARATION AND DISTRIBUTION

## 7.1 Introduction

This section summarizes the results of the tasks to produce and distribute the DACS products and services. A characterization of these products and services is presented, along with summarized quantitative information on requests processed. The products distributed as a result of these requests are summarized in Table 7-1.

## 7.2 Data Services

Computer readable and hard copy subsets of the data contained in the DACS Database are produced and distributed in response to specific requests to aid in research efforts that require productivity, cost, complexity, error and change data. These datasets are used to validate and refine software reliability, maintainability, and estimation models and to aid in additional data analysis studies that require empirical data.

When a dataset is requested, the description of which data items and type, the sorted order, etc., must be known and, if not included in the request, DACS personnel contact the user directly. During the pilot period, a history of requests was kept and as patterns of use developed; standard options were identified to ease the processing load on engineering personnel. Parameterized HOL procedures were written so that for the standard options the data subset could be produced by clerical personnel. During the current contract period additional options have been identified and parameterized procedures for these additional datasets have been produced.

As of December 8, 1982, 104 copies of these datasets had been distributed in hard copy report format or on magnetic tape. In addition, 5 custom datasets produced to user specifications were distributed.

To facilitate distribution of these datasets and subsets of them, descriptive literature on the datasets comprising the SLED is provided to the potential purchaser along with an order form. Upon receipt of the order, the

TABLE 7-1: DACS PRODUCTS AND SERVICES PRODUCED
AND DISTRIBUTED THROUGH 12/8/82

| MONTH INITIAL DISTRIBUTION BEGAN | PRODUCT OR SERVICE | TOTAL DISTRIBUTED 9/4/81-12/8/82 | TOTAL DISTRIBUTED 10/78-9/3/81 | TOTAL NUMBER DISTRIBUTED TO DATE |
|---|---|---|---|---|
| October 1978 | Custom Bibliographies and Searches | 40 | 706 | 746 |
| | Consulting | 39 | 113 | 152 |
| | DACS Newsletter | 4510 | 4094* | 4510* |
| | Nelson Report on DACS Productivity Dataset | 21 | 339 | 360 |
| December 1978 | DACS Information Packet | - | 513 | 513 |
| April 1979 | BIB-1 (The User's Guide to Custom Searches) | 207 | 1162 | 1369 |
| | DACS Bulletin | 60* | 60* | 60* |
| | DACS Software Engineering Thesaurus | 207 | 1162 | 1369 |
| | Quantitative Software Models (SRR-1) | 91 | 921 | 1012 |
| July 1979 | DACS Productivity Dataset-Magnetic Tape or Hardcopy Format | 21 | 124 | 145 |
| | Gilb Report | - | 88 | 88 |
| December 1979 | Productivity Data Collection Forms | 68 | 348 | 416 |
| | The DACS Glossary | 178 | 1498 | 1676 |
| February 1980 | Software Reliability Dataset - Hardcopy Report | 36 | 313 | 349 |
| April 1980 | NASA/SEL Dataset | 1 | 3 | 4 |
| | Software Reliability Dataset - Magnetic Tape Format | - | 10 | 10 |
| February 1981 | Conversion Data Collection Forms | 51 | 16 | 67 |
| | Monograph on Data Collection with References | 1 | 15 | 16 |
| February 1982 | AIAA Tools Survey | 60 | - | 60 |
| | Custom Datasets-Computer Listing or Magnetic Tape | 5 | - | 5 |
| April 1982 | A Review of Software Maintenance Technology (SRR-2) | 59 | - | 59 |
| | DACS Technical Monograph - A Comparison of RADC and NASA/SEL Software Development Data | 37 | - | 37 |
| | V&V Dataset - Computer Listing or Magnetic Tape | 11 | - | 11 |
| | NASA/SEL Data Collection Forms | 70 | - | 70 |
| | The NASA/SEL Data Compendium | 21 | - | 21 |
| | Composite Productivity Dataset - Computer Listing and Magnetic Tape | 9 | - | 9 |
| | User's Guide to the DACS Products & Services (Supplants Information Packet used during pilot period) | 293 | - | 293 |
| May 1982 | A Directory of Software Engineering Research Projects | 64 | - | 64 |
| | The DACS Annotated Bibliography and First Annual Supplement | 39 | - | 39 |
| July 1982 | JLC Software Development Specification | 158 | - | 158 |
| November 1982 | Custom Software Tool Searches | 2 | - | 2 |
| December 1-8, 1982 | DoD Software Technology Initiative | 29 | - | 29 |

*Total Number of names on mailing/distribution list, not total number of copies distributed.

tape or hardcopy listing is generated. The data is then sent along with a data dictionary describing the data elements.

### 7.2.1 Data Compendium

During the contract period the DACS produced one data compendium in the form of a summarization of the data contained in the DACS SLED. The purpose of the compendium is to act as a guide to enable potential users of the data to determine the relevance of the data to their applications. Included among the features are a data dictionary and an evaluation of the completness of tne datasets by project and data type. An order form for the standard options is included in the compendium as well as the individual to be contacted for information on obtaining non-standard or custom datasets. This Data Compendium will be available for distribution in early 1983 to DACS users.

## 7.3 State-of-the-Art Summaries

An effective approach to stimulating user interest in the DACS is through the design, preparation and distribution of products that constitute authoritative sources of information needed throughout the software engineering community. State-of-the-art reports (SOARs) are intended to consolidate and synthesize information on a specific high interest technology area from multiple sources into a single document containing all pertinent information in a condensed, easy to assimilate form. To be useful, SOARs should cover topic areas that have received a substantial amount of attention by scattered researchers, and have broad interest, but for which findings have not been previously consolidated. In fast moving technologies, it may be appropriate to periodically update a SOAR.

Two such SOARs were produced during the contract period. One report, entitled "A Review of Software Data Collection Methodologies" was compiled from several separately published technical reports and papers. This report provides an overview of seven data collection efforts in six different environments together with an assessment of their stengths and weaknesses. The report will be

useful to both managers and researchers seeking to establish a data collection effort or to improve an ongoing data collection effort in their own environments.

The second SOAR is a survey of Software Tool Systems. This report was compiled from current literature and the collection of software tool directories at the DACS. This report presents an overview of software tool systems, their characteristics and uses and presents detailed information on 39 currently available tool systems.

### 7.4 Software Engineering Bibliography

Scientists and engineers depend upon well designed bibliographies for ready access to previous work and published literature. To serve this purpose, entries must be comprehensively indexed with terms that are pertinent and in common use within the community being served. Dissemination of the standard word list used for indexing DACS documents (the DACS Thesaurus), indices and the comprehensive bibliographies produced by DACS is of value to DACS users and helpful in terms of identifying pertinent sources of relevant information without the necessity of the turnaround time required for requesting a search, authorizing payment, and waiting for mail delivery. To satisfy this need, the DACS has published and disseminated the comprehensive volume of abstracts, bibliographic citations and indices on all of its document acquisitions during the August 1978 to August 1980 time period. This volume, which was produced during the pilot period together with the first annual supplement, produced under the pilot contract and updated during the current contract, cover the time period August 1978 to September 1981. The second annual supplement was produced during the transition period and includes holdings as of September 1982. Complete indices are supplied in the 2nd Annual Supplement in addition to the bibliographic citations and abstracts. As of December 8, 1982, 36 copies of the comprehensive volume and the first annual supplement had been sold, resulting in $4500 of user fees. The Second Annual Supplement has been prepared for distribution in 1983.

## 7.5 Bibliographic Services

Bibliographic inquiries to the DACS are received in many forms: by letter, telephone call, visit, or by use of the bibliographic request form contained in BIB-1. The information requests have ranged from the very specific to general questions on software engineering methodologies. The DACS received a total of 711 bibliographic requests or technical inquiries for which a bibliographic search was recommended during the September 1978 through August 31, 1981 time period. During the transitition period a charge of $50 per search was instituted for custom searches. This resulted in a precipitate drop in the number of custom searches ordered. Forty searches were performed during the transition period, an average of 2.6 per month as compared to 19.7 per month during the pilot period when searches were offered at no charge. The custom bibliographies produced during the transition period have been upgraded from the versions produced during the pilot period of the DACS operation. Abstracts are supplied with the custom bibliographies and their appearance has been greatly enhanced. Feedback from DACS users who actually obtained the new custom searches indicates that they provide good value for their cost. Custom bibliographies continued to be reviewed by a member of the technical staff of the DACS to insure that the material retrieved was pertinent to the subject of the request before the bibliography was sent to the user. In addition to upgrading the content of the custom searches by incorporation of abstracts, DACS personnel enhanced the boolean search capability provided by MDQS.

### 7.5.1 Custom Tool Searches

During this transition period, the DACS instituted a custom search service for software tools. The service was introduced with the publication of the September 1982 DACS Newsletter. A custom search involves automated and manual searches of the DACS tools database and the following tool directories: AIAA Tools Directory; Tutorial: Automated Tools for Software Engineering; TRW Tools Catalogue and Recommendations; and Software Tools Directory (Reifer Consultants, Inc.).

The information provided on each software tool includes: tool title and/or acronym, classification, features/functions, stage/date of development, applicability, implementation language, portability, size hardware, restrictions, availability, an abstract or summary, documentation, contact, and developer. The charge for a Custom Tool Search is $50. Two searches were performed during November 1982 and an order for one additional search was received by the end of the contract period.

### 7.5.2 IEEE Terminology Standard

During pilot period of the DACS operation a DACS staff member had been appointed chairperson of a working group chartered to develop in IEEE Standard for Software Engineering Terminology. The DACS provided support. This support was continued during the transition period and the terminology was completed in May 1982. The terminology was balloted in June and July of 1982 and 93% of the 147 member balloting group composed of members of the IEEE Subcommittee on Software Engineering and other concerned members of the IEEE Computer Society voted to approve the standard. Based on this high percentage of acceptance, the IEEE Standards Review Board voted to approve the terminology as a full-use IEEE standard. The IEEE standards Board formally approved the IEEE Standard Glossary of Software Engineering Terminology (IEEE Std 729-1982) on September 23, 1982. Over 500 terms are defined in this glossary. Copies of IEEE Std 729-1982 are available from the IEEE.

## 7.6 Technical Inquiries and Special Studies

### 7.6.1 Technical Inquiries

Technical inquiries to the DACS are received and processed on a daily basis. These inquiries are received in many forms: by letter, telephone call, visit, or by use of the bibliographic request form contained in BIB-1. The information requests have ranged from the very specific to general questions on software engineering methodologies.

A technical inquiry is answered in one or more of the following ways:

- o A custom bibliographic search on the subject area of interest is performed.
- o A preliminary analysis of the subject literature is made and summary information prepared.
- o A subset of the DACS database is produced.
- o Relevant DACS literature is distributed.
- o Referrals to other sources are provided.

Table 7-2 contains a listing of the technical inquiries received during the transition period for which a search of one of the databases was performed.

Certain technical inquiries of a very specific technical nature may not be answerable in terms of a dataset, a bibliographic search, or a published DACS product but may be answered relatively quickly by a DACS specialist. For such inquiries, DACS provides engineering services in the form of technical guidance accompanied by textual material from the DACS files when appropriate. As was the case with the bibliographic searches, the number of technical inquiries requested declined drastically with the advent of service charges. Answers to a total of 832 technical inquiries were provided during the 36-month pilot period; 75 during the 15-month transition period. This represents a decline from 23 per month to 5 per month. However, the number processed per month is increasing as shown graphically in Figure 7-1.

### 7.6.2 Special Studies and Projects

There are many problems related to software technology that can be solved through the full service capabilities provided by DACS. Many of these are sizeable, requiring a substantial expenditure of engineering resources to accomplish. It is firmly believed that it is in this area that DACS can make a significant contribution to increase the productivity of software engineers and researchers and at the same time make most efficient use of accumulated information and resources.

TABLE 7-2: SEARCH TOPICS FROM 4 SEPT '81 - 8 DEC '82

| BIB | SEARCH TOPIC |
|---|---|
| LIT | SEARCHES FOR-SE STANDARDS & SE DESIGN REQ/SPECS |
| LIT | SEARCH&CONSULTING-TECH TRANS FOR DOD SW TECH INITIVE PROG |
| LIT | SEARCH-ADV STATISTICAL S/W PACKAGES |
| LIT | SEARCH-ALL PUBLICATIONS ON SW RELIABILITY |
| LIT | SEARCH-ALL RADC TECH REPORTS-BY CONTRACT END DATE |
| LIT | SEARCH-APPLICATION-AVIONICS,EMBEDDED COMPT SYST,REAL-TIME |
| LIT | SEARCH-ARCHIT.ART.INTELL,DIST.PROC,REQMTS,VIRT.MACH,SW TOOLS |
| LIT | SEARCH-AUTO DOC & CONFIG MGMNT |
| LIT | SEARCH-AVIONICS |
| LIT | SEARCH-BROAD COVERAGE OF DATABASE MANAGEMENT |
| LIT | SEARCH-COMMUNICATIONS SYSTEM APPLICATIONS |
| LIT | SEARCH-COMPUTER AIDED INSTRUCTIONS & REFERENCES |
| LIT | SEARCH-CONFIG.MGMT. MOD. TEST,RELIA.EVAL&PRED,TEST DESIGN |
| LIT | SEARCH-COST BENEFIT-CICROCOMP/MINICOMP |
| LIT | SEARCH-COST ESTIMATING & S/W LIFE CYCLE MANAGEMENT |
| LIT | SEARCH-ERROR CORR & COSTS (FAULT CORR COSTS) |
| LIT | SEARCH-FIELD TESTED AUTOMATED TOOLS/DATA & CONTACT |
| LIT | SEARCH-INDUSTRIAL PROCESS CONTROL APPL-FOR ARRADCOM |
| LIT | SEARCH-JOVIAL & COMPILER-COMPILERS,S/W TOOLS |
| LIT | SEARCH-MAINTAINABILITY/MAINTENANCE/MAINTENANCE COSTS |
| LIT | SEARCH-MSG TRANSFER MODELS, CONVERSIONS,PORTABILITY |
| LIT | SEARCH-OPT DISK/DLMS/CARTOGRAPHIC |
| LIT | SEARCH-PROG DESIGN LANGUAGE (PDL) |
| LIT | SEARCH-QUICK INDICES |
| LIT | SEARCH-RELIABILITY |
| LIT | SEARCH-RELIABILITY, SW QUALITY, RELIABILITY, MODELS |
| LIT | SEARCH-REL.MODELS,PREDIC,ESTIM,MEAS;QUAL.ASSUR;QUAL.METRICS |
| LIT | SEARCH-REQ TRACEABILITY & AUTO MAINTAINING TRACEABILITY |
| LIT | SEARCH-SOFTWARE CONVERSION |
| LIT | SEARCH-SOFTWARE DOCUMENTATION |
| LIT | SEARCH-SOFTWARE PROJECT TRACKING-PROJECT TRACKING SYSTEMS |
| LIT | SEARCH-S/W ENG & TECH TRANSFER |
| LIT | SEARCH-S/W REL & SPECIF TOOLS & TECH |
| LIT | SEARCH-STANDARD QUERY LANGUAGES |
| LIT | SEARCH-SW ENG FACILITIES,SW TOOLS,MODERN PROG PRACTICES |
| LIT | SEARCH-TOPICS TO DO WITH QUALITY ASSURANCE |
| LIT | SEARCH-VERIF & VALIDATION |
| SERP | SEARCH-PROJECTS RELATED TO ASD AT WRIGHT PAT |
| SERP | SEARCH-PROJ. FUNDED BY NAVAL SURFACE WEAPONS CNTR OR AF/ASD |
| TOOL | SEARCH-CODE INPUT-HIGH LEVEL FUNCT-TRANS OUTPUT-INTERM CODE |
| TOOL | SEARCH-TOOL SYST FOR AUTOMATION OF DESIGNER/PROGRAMER TASKS |

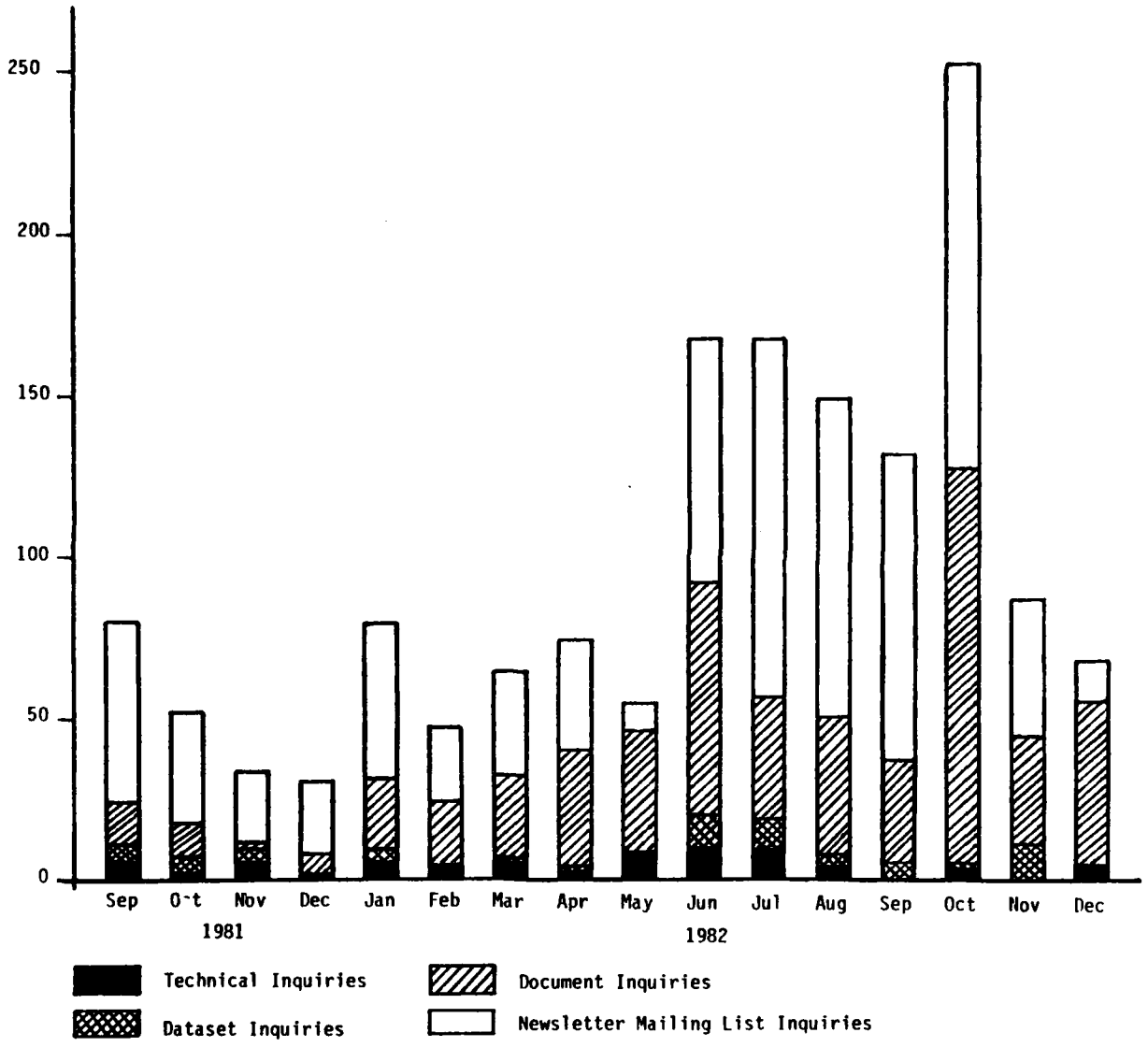



FIGURE 7-1: INQUIRIES/MONTH

The DACS can best serve its user community by identifying those government/industry areas for which there is a high need for the technological expertise and other resources of the DACS and performing special studies tailored to individual needs of particular organizations. Two special studies were perfomed during this contract period and are discussed below.

### 7.6.2.1 Dormancy Effects on Software Operational Readiness

A special study was conducted to determine the dormancy effects on Software operational readiness. The objective of this effort was to establish the reliability and maintainability requirements of Electronic Process Control System (EPCS) for Army Ammunition Plants which are imposed by layaway. Computer software guidelines for developing specifications/requirements to assure that capabilities conducive to operational readiness and reliability are designed into and established in new EPCS installations were prepared. A technical report summarizing the current status of existing software Data Item Deliverables (DID's), and the recommended associated DID's for EPCS applications was delivered to the U.S. Army ARRADCOM. Visits were made to three EPCS sites. Observations of the status of the resident software systems and initial recommendations were included in reports detailing each of these visits. A report containing the final set of recommendations and software design specification/requirements was also generated during this effort.

Through this effort DACS has gained knowledge and insight into the EPCS environment, the impact of the layaway concept on the software life-cycle, and finally the mechanisms which can be used to contractually ensure that an EPCS development project will result in a product which satisfies the requirements established for layaway. Thus, a fully operational, reliable and maintainable system can be reactivated and assure continual functionality and operation which satisfies the readiness and reliability requirements of the layaway concept.

### 7.6.2.2 Software Quality Metrics

The second study was performed for the Army Institute for Research in Management Information and Computer Sciences (AIRMICS). The purpose of the effort was to implement the Automated Metrics Tool (AMT) on a Plexus P25

microcomputer and to demonstrate the application of software quality factors, particularly the portability of a software product.

A set of software quality metrics was developed by the General Electric Company under contract to the Rome Air Development Center (RADC) to provide software acquisition managers with a mechanism to quantitatively specify and measure the level of quality in a software product. The Automated Metrics Tool (AMT) was recently developed to provide automated support to the application of this metrics concept. The AMT was designed to automatically collect and store the raw metric data, to allow for the storage of manually collected data, to automatically calculate the metrics ratings, and to provide for easy manipulation of this data.

The objective of this study was to demonstrate the application of software quality metrics to measure and predict the portability, flexibility, and maintainability of a software product. Experiments were designed and implemented to transport the Automated Metrics Tool (AMT) from the RADC HIS 6180 computer system to the PLEXUS P/25 microcomputer located at the U.S. Army Computer Systems Command, Army Institute for Research in Management Information and Computer Sciences, (AIRMICS), to incorporate enhancements to the tool, to collect metric data on the conversion and enhancement processes, and to analyze the data to determine the applicability of these metrics for software acquisition managers. By the completion of the project all except one of the AMT commands implemented on the HIS6180 version were operational on the PLEXUS version; a work around for that one command (which determined file existence) was implemented. Two non-critical functions (printing the date and time on reports) which were system-dependent on the HIS6180 version were eliminated. The PLEXUS AMT was successfully utilized in the creation of a simple metrics data base from the sample worksheets given in the original AMT USER's GUIDE. A metrics data base was created and all of the worksheets were input, via the Data Base Manager. The standalone Report Generation System was executed against this metrics data base and all of the reports presented in the AMT USER's GUIDE were replicated, validating the conversion.

Metrics data on the conversion and enhancement processes were collected to enable the analysis of the data to determine the applicability of these metrics to measure portability. This data will form the basis for a Metrics Database at the DACS.

# 8.0 TASK 7 - PREPARING, DISTRIBUTING, REVIEWING AND IMPROVING PRODUCTS AND SERVICES

## 8.1 Preparing and Distributing Products and Services

Eleven new products and services were introduced to DACS users during this contract period. These were the following:

- Custom Software Tool Searches
- Custom Datasets from the NASA/SEL Dataset
- AIAA Tools Survey
- V&V Dataset
- Composite Productivity Dataset
- Comparison of DACS and NASA/SEL Software Development Data (Technical Monograph 1)
- NASA/SEL Data Compendium
- DACS Annotated Bibliography
- A Directory of Software Engineering Research Projects
- JLC Software Development Specifications
- DoD Software Technology Initiative

Two of these (the JLC Software Development Specifications and the DoD Software Technology Initiative) were reproduced and distributed in the form in which they were received as a service to both the issuing organization and DACS users. Four of the products were reformatted and/or reorganized from the format in which they were submitted to the DACS before distribution to DACS users was begun. These four products were the NBS Tools Database which forms the basis for the Custom Tools Searches, the custom datasets derived from the NASA/SEL dataset, the AIAA Tools Survey, and the V&V dataset.

The remaining products were developed by DACS personnel from the data and STINFO contained in the DACS databases specifically for distribution to DACS users. Statistics on the distribution of these products were displayed in Table 7-1.

In addition to those products listed above, five new products were developed during this 15-month contract period for distribution during the subsequent contract period. These newly developed but as yet undistributed products include the following:

- Second Annual Supplement to the DACS Annotated Bibliography
- A Review of Software Data Collection Methodologies
- Parametric vs Non-Parametric Techniques in the Analysis of Software Engineering Data
- Software Tool Systems: A Survey of the State-of-the-Art
- The DACS Data Compendium

## 8.2 Improvement of DACS Products and Services

The products/services of the DACS have been reviewed and assessed on a continuing basis with the objective of enhancing both the DACS and its products and services. Concerns of the enhancement efforts extend to all facets of the DACS operations, including improvement of the technical quality of DACS products, increasing the scope of data coverage, improving analysis routines, improving data handling capability, operating more efficiently, and increasing services to the user community. During the transition period significant improvements have been made in several areas. These improvements include the following:

- Increasing the scope of data coverage by the acquisition of:
  - The Naval Research Laboratory's ARF Data
  - The PAVE PAWS Data
  - The FAA's Discrete Address Beacon System Data
- Improvement of Analysis Routines

- o Increased efficiency in record-keeping achieved by the development of the online user profile database
- o Streamlining the process for entry of bibliographic information into the bibliographic database
- o Review of technical content of final drafts by IITRI personnel who have expertise in software technology and who are not members of the DACS core group.
- o Review of the final draft of all planned publications with respect to style, clarity of writing, correctness of grammer and spelling, etc. by a technical editor.

## 8.3 Continuing Assessment of User Needs

When the DACS entered the period of charging for user services it became critical that user activities be accurately assessed on a continuing basis. There are several reasons for monitoring user requests for information and purchases of documents and data closely:

- o to determine if distribution of old products should be terminated
- o to pinpoint gaps in DACS services to be filled
- o to estimate and evaluate supply-demand curves for DACS products
- o to provide information needed to determine and respond to changing user needs
- o to generate reports/statistics on users of the center
- o to determine if user services are being provided on a timely basis, e.g., average turnaround time on technical inquiries
- o to determine if adjustments are needed to pricing policies

User profile forms and service requests forms were developed for the DACS during the pilot DACS operation. These forms were used to collect information which can be used for the above-mentioned purposes. As the DACS moved into the status of a DLA/IAC, DACS personnel automated the records of user service requests and document purchases so that the information necessary to operate the DACS in a cost-effective manner could be generated in the most efficient, time-saving manner possible. Samples of the summaries automatically produced using

the DACS User Profile Database (UPD) are presented as Figures 8-1, 8-2, 8-3, and 8-4. Benefits obtained by automating the record-keeping functions include:

- o automatic generation of status reports
- o decreased turnaround time in responding to user requests
- o automatic generation of document distribution summaries
- o automatic tabulation of subjects of technical inquiries

User feedback and user interaction with the DACS has provided and will continue to provide a large input to the process of improving the DACS and its products and services. Automating the records of user interaction has made it possible to generate these summaries of user interactions on a more timely basis than was possible in the past.

EXHIBIT A

DACS PRODUCTS AND SERVICES SUMMARY

DECEMBER 1-8 1982

| | | PREVIOUS TOTAL | NO. PROCESSED THIS MONTH | TOTAL TO-DATE |
|---|---|---|---|---|
| TOTAL INQUIRIES | | 653 | 54 | 707 |
| BIBLIOGRAPHIC SEARCHES | | 40 | | 40 |
| CONSULTING | | 35 | 4 | 39 |
| TOOL SEARCHES | | 2 | | 2 |
| DATASET DISTRIBUTION: | | | | |
| DACS PRODUCTIVITY DATASET | | | | |
| NELSON'S REPORT | | 21 | | 21 |
| COMPUTER LISTING/MAG TAPE | | 21 | | 21 |
| SOFTWARE RELIABILITY DATASET | | | | |
| MUSA'S REPORT | | 35 | 1 | 36 |
| MAG TAPE | | | | |
| NASA/SEL DATASET | | | | |
| COMPUTER LISTING/MAG TAPE | | 1 | | 1 |
| V&V DATASET | | | | |
| COMPUTER LISTING/MAG TAPE | | 11 | | 11 |
| STANDARDIZED PRODUCTIVITY DATASET | | | | |
| COMPUTER LISTING/MAG TAPE | | 9 | | 9 |
| CUSTOM DATASETS | | | | |
| COMPUTER LISTING/MAG TAPE | | 5 | | 5 |
| TOTAL DATASET DISTRIBUTION | | 103 | 1 | 104 |
| DOCUMENT DISTRIBUTION: | | | | |
| TECH MONOGRAPH-1 | | 37 | | 37 |
| NASA/SEL DATA COMPENDIUM | | 20 | 1 | 21 |
| DACS ANNOTATED BIBLIOGRAPHY | | 38 | 1 | 39 |
| DACS GLOSSARY | | 170 | 8 | 178 |
| A DIRECTORY OF SW ENG RES PROJ. | | 62 | 2 | 64 |
| AIAA TOOLS SURVEY | | 58 | 2 | 60 |
| NASA/SEL FORMS | | 70 | | 70 |
| PRODUCTIVITY FORMS | | 68 | | 68 |
| CONVERSION FORMS | | 51 | | 51 |
| QUANTITATIVE SOFTWARE MODELS | | 88 | 3 | 91 |
| REVIEW OF SW MAINTENANCE TECH | | 59 | | 59 |
| JLC SOFTWARE DEVELOPMENT SPECS | | 143 | 15 | 158 |
| DOD SOFTWARE INITIATIVE | | 1 | 28 | 29 |
| OTHER | | 10 | 1 | 11 |
| TOTAL DOCUMENT DISTRIBUTION | | 877 | 61 | 938 |
| GENERAL INFORMATION INQUIRIES | | | | |
| DACSGUIDE | | 271 | 22 | 293 |
| BIBGUIDE | | 185 | 22 | 207 |
| NEWSLETTER (APPROXIMATELY) | September 1982 | 4716 | 65 | 4781 |
| BULLETIN (APPROXIMATELY) | | --- | --- | --- |

NEWSLETTER MAILING LIST:

| | |
|---|---|
| PREVIOUS TOTAL | 4510 |
| ADDITIONS | --- |
| DELETIONS | --- |
| TOTAL-TO-DATE | 4510 |

FIGURE 8-1: SUMMARY STATISTICS ON PRODUCTS AND SERVICES ARE GENERATED AUTOMATICALLY FROM THE USER PROFILE DATABASE

BREAKDOWN OF DACS USERS AS OF DECEMBER 8, 1982

| CATEGORY OF | ORGANIZATIONS |
|---|---|
| INDUSTRY: | 501 |
| ACADEMIC: | 46 |
| AIRFORCE: | 65 |
| ARMY: | 26 |
| NAVY: | 40 |
| DEPT. OF DEFENSE: | 15 |
| OTHER GOVERNMENT: | 37 |

FIGURE 8-2: SUMMARY STATISTICS ON DACS USERS ARE GENERATED FROM THE USER PROFILE DATABASE

EXHIBIT C

TRANSACTIONS FOR JULY 1982

| CUSTOMER | | DATE | PRODUCT/SERVICE | QUANTITY | PRICE |
|---|---|---|---|---|---|
| SOHAR INCORPORATED | | | | | |
| LOS ANGELES | CA | 07/01/82 | CUSTOM DATASET | 1 | 75.00 |
| GOODYEAR AEROSPACE CORP | | | | | |
| AKRON | OH | 07/01/82 | SOFTWARE RELIABILITY DATASET/MAG TAPE | 1 | 50.00 |
| | | | DACS ANNOTATED BIBLIOGRAPHY | 1 | 125.00 |
| BATTELLE,PACIFIC NW LABS | | | | | |
| RICHLAND | WA | 07/01/82 | DACS PRODUCTIVITY FORMS | 1 | .00 |
| | | | DACS CONVERSION FORMS | 1 | .00 |
| | | | DACS ANNOTATED BIBLIOGRAPHY | 1 | 125.00 |
| | | | REVIEW OF SOFTWARE MAINTENANCE TECHNOLOGY | 1 | 15.00 |
| SCIENCE APPLICATION,INC | | | | | |
| LA JOLLA | CA | 07/01/82 | V&V DATASET/COMPUTER LISTING | 1 | 30.00 |
| | | | DACS PRODUCTIVITY DATASET/COMPUTER LISTING | 1 | 30.00 |
| | | | SOFTWARE DATA COLLECTION & ANALYSIS | 1 | 10.00 |
| | | | SOFTWARE RELIABILITY DATASET/HARD COPY REPORT | 1 | 10.00 |
| | | | STANDARDIZED PRODUCTIVITY DS/COMPUTER LISTING | 1 | 30.00 |
| MENKUS, BELDEN | | | | | |
| MIDDLEVILE | NJ | 07/02/82 | DACS PRODUCTIVITY FORMS | 1 | .00 |
| T J MCCABE & ASSOCIATES | | | | | |
| COLUMBIA | MO | 07/07/82 | REVIEW OF SOFTWARE MAINTENANCE TECHNOLOGY | 1 | 15.00 |
| MANUFACT HANOVER TRUST | | | | | |
| NEW YORK | NY | 07/07/82 | DACS PRODUCTIVITY FORMS | 1 | .00 |
| UNIV OF OREGON | | | | | |
| EUGENE | OR | 07/07/82 | DACS PRODUCTIVITY FORMS | 1 | .00 |
| DEF MAPPING AGEN AERO CT | | | | | |
| ST LOUIS | MO | 07/07/82 | NASA/SEL DATA COLLECTION FORMS | 1 | .00 |
| TEXACO INC | | | | | |
| HOUSTON | TX | 07/07/82 | DACS PRODUCTIVITY FORMS | 1 | .00 |
| SOUTH NEW ENGLAND TEL CO | | | | | |
| NEW HAVEN | CT | 07/08/82 | REVIEW OF SOFTWARE MAINTENANCE TECHNOLOGY | 1 | 15.00 |
| | | | DACS GLOSSARY | 1 | .00 |
| EG&G | | | | | |
| MANASSAS | VA | 07/08/82 | QUANTITATIVE SOFTWARE MODELS | 1 | 15.00 |
| | | | REVIEW OF SOFTWARE MAINTENANCE TECHNOLOGY | 1 | 15.00 |
| IIT RESEARCH INSTITUTE | | | | | |
| ROME | NY | 07/09/82 | DIRECTORY OF SOFTWARE ENGINEERING RESEARCH PROJECTS | 1 | 20.00 |

FIGURE 8-3: INDIVIDUAL TRANSACTIONS FOR A GIVEN TIME PERIOD ARE GENERATED AUTOMATICALLY FROM THE USER PROFILE DATABASE

CONSULTING TOPIC

CONSULT/CONCOM-SOFTWARE TOOL-OPER ON JOVIAL
CONSULTING/MECHANISMS BY WHICH DACS & AIA COULD INTERFACE ON QA DATA
CONSULT/INFO ON MINNOWBRK CONF
CONSULT/CONTACT FOR DATA AQ/CITATION FOR IV&V
CONSULTING/BENEFITS&PRESEN OF S/W DATA COLLECTION
CONSULTING/CONTACT FOR DATA AQ-RECEIVED INFO ON THEIR COST CTR
CONSULT/INFO ON IV&V AND CONTACTS
CONSULT/LOGICON DATA,NASA-SEL DATA DEF, EXPAN RATIO FORTRAN-ASSY
CONSULTING SOURES OF INFO ON AMIS OR LAMIS DATABASES
CONSULTING - WANTS TO AUTOMATE COMPT SCI LIB/TIE INTO DACS?
CONSULTING-INTERESTED IN QA COSTS-SENT WOODRUFF'S QA STUDY
CONSULTING-DEVELOPING ADVANCED DATA HANDLING SYSTEMS FOR INTELLI
CONSULTING-HOW TO PRESENT TO DLA DESIRABILITY OF OTHER IAC ADDIT
CONSULTING-INFO ON FEATURES OF AMT AND ITS AVAILABILITY
LIT SEARCH&CONSULTING-TECH TRANS FOR DOD SW TECH INITIVE PROG
CONSULTING-CAN THEY GET ON ARPANET & USE MULTICS MRDS?
CONSULTING-NEED DEFS ON ADA AS A PDL STANDARD & RELIA MEAS STAND
CONSULTING-NEED INFO ON DATA COLLECTION AND SANITATION-DA CONTAC
CONSULTING-SENT RADC BIBLIOGRAPHY
CONSULTING-INFO ON SECURITY SYST ON UNIVAC 1180
CONSULTING-CONCERNED W/SW IN EMBEDDED TACTICAL WEAPONS SYSTEMS
CONSULTING INFO ON TOOL THAT PRODUCES OC THAT WOULD RUN W/1750
CONSULTING-INTERESTED IN LIT ON SW COST ESTIMATING
CONSULTING-NEEDED STND-728 FOR WRITING INTERNAL SPERRY STANDARDS
CONSULTING-INFO ON CMS-2 (NAVY PROG LANG)
CONSULTING-LIST OF ALL GOV'T CONTRACTS-REF TO DTIC WUIS
CONSULTING-REF HARD DATA ON EFFECT MPP'S-PRES COMM PRIV SECT
CONSULTING-LOCATED VOLS ON HARDWARE FROM CCID-85
CONSULTING-INFO ON COSTS OF PROD A  LINE OF CODE-DOC CPY FR LIB
CONSULTING-AID IN LOC HW REL MODEL-AUTO TO SUPPORT MH 217
CONSULTING-REF TO PERSONS WORKING IN SW VERIFICATION

FIGURE 8-4: CONSULTING TOPICS FROM SEPT '81 - 8 DEC '82

## 9.0 TASK 8 - SERVICE CHARGES AND COSTS RECOVERY IMPLEMENTATION PLAN

### 9.1 Cost Recovery Study and Implementation Plan

DACS personnel prepared a report entitled Cost Recovery Study and Implementation Plan for The Data & Analysis Center for Software (GLOS81). This report presented detailed analyses of DACS products and services, the market for these products and services, and the charging policies recommended for DACS products and services. A promotional plan was also developed as part of the cost recovery study. Information regarding all of the DACS products and their costs was made available to all DACS users through the mailing of a six-page brochure to all individuals and organizations on the Newsletter mailing list. The brochure, the first page of which is reproduced as Figure 9-1, provides capsule summaries of all available DACS products and their respective costs. Distribution of this brochure resulted in a near tripling of document orders in the month following its distribution. In addition to the brochure, a more detailed user's guide has been prepared. This user's guide has been distributed to persons requesting more information than can be contained in a brochure and to persons requesting initial information on the DACS. This user's guide was included as Appendix B to (GLOS81) and has been updated as new products and services were added.

The DACS Newsletter continued to be used as a regular promotional device; in addition to critiques, conference announcements, book reviews, and state-of-the-art surveys, each newsletter contains capsule summaries of a few products and services offered by the DACS. In addition, new DACS products are introduced in the DACS Newsletter by a feature article. Comparing spikes in the graph of user receipts by month (Figure 9-2) with distribution dates of the DACS brochure and the quarterly newsletters indicates that the newsletter is an effective means of promoting DACS products and services.

### 9.2 Promotion to New Users

It is highly unlikely that all potential users of the DACS have been identified and are on the mailing list for its newsletter. Thus, a determination was made as to how best to reach those as yet uncontacted potential users.

# DACS

RADC/ISISI
Griffiss AFB, NY 13441
315/336-0937
Autovon 587-3395

## Products & Services Information

## Data & Analysis Center for Software

### BACKGROUND

The DACS is a Department of Defense (DoD) information analysis center sponsored by the Air Force Systems Command, Rome Air Development Center (RADC), and operated by IIT Research Institute (IITRI).

The DACS was established in response to a well recognized need for a facility to serve as a centralized source for current, readily usable data and information concerning software technology. A contract was issued to IITRI to organize, staff, and operate the DACS. The facility is located at the Rome Air Development Center, Griffiss Air Force Base, New York. Established in September 1978, the DACS was operated as a pilot facility until September 1981. User response during the pilot period indicated that expansion to full scale operations was a feasible undertaking. As of April 1981, the DACS was designated a Defense Logistics Agency (DLA) Information Analysis Center (IAC).

### THE DACS FUNCTIONS ARE . . .

- To develop and maintain a computer database of empirical data collected on the development and maintenance of computer software.
- To produce and distribute subsets of the database for use by software researchers.
- To maintain a software technology information base of technical documents, project status information, and evaluation data pertinent to the computer software field.
- To analyze the data and information and produce technical reports.
- To maintain a current awareness program which includes dissemination of technical information, assessments of technological developments, and publication of a quarterly newsletter.
- To provide technical assistance in the form of technical information and special studies of topics related to software engineering and software technology.

### PRODUCTS OF THE DACS

Typical products provided by the DACS include subsets of the Software Life Cycle Empirical Database (SLED), data compendiums, analysis reports, bibliographies, newsletters, a software engineering glossary, and technical monographs. DACS services include accumulating, maintaining, and tailoring data subsets for software technology research; bibliographic searches that provide rapid access to documents, reports, and papers concerning software engineering and software technology; and special technical studies which include technology assessments, critical reviews, and state-of-the-art surveys. Capsule summaries of currently available products follow.

### THE DACS SOFTWARE LIFE CYCLE EMPIRICAL DATABASE & RELATED PRODUCTS

The DACS Software Life Cycle Empirical Database (SLED) presently consists of five sets of data distinguishable by data source, data collection and acquisition methodology, life cycle phase represented and data parameters present. These datasets are described separately below.

Baseline Software Dataset. This dataset contains data describing software problem reports acquired by RADC from six large software development efforts, and consists of 26,594 Software Problem Report records, 2719 Run Analysis Report records, and 2591 Module Description records.

Software Reliability Dataset. This dataset contains failure data on 16 software systems collected during the phases of software test and operation.

DACS Productivity Dataset. This dataset contains summary information from over 400 software projects, incorporating productivity data, error data, project duration, total effort, language data, and information on the usage of various software implementation technologies.

NASA/SEL Dataset. The Software Engineering Laboratory (SEL), at NASA Goddard Space Flight Center, was organized in August 1976 to monitor existing software methodologies and to develop and measure the effectiveness of alternative methodologies. To accomplish these objectives, the SEL has been collecting data during the development of NASA/SEL software projects. The dataset contains over 45,000 records; the majority is from component status reports, and run analysis reports. The remainder is project comment information, change reports, resource summary reports, and component summary reports.

V&V Dataset. This dataset contains data collected during the independent verification and validation of five software projects. The dataset consists of general project development background information and nearly 1500 anomaly reports on these projects.

Standardized Productivity Dataset. Common elements of the DACS, NASA, and V&V datasets have been combined into one dataset using a standardized record format. This combined dataset contains those parameters which have been identified as most common across the three datasets.

At this time, the DACS is distributing copies of the Software Reliability Dataset, the DACS Productivity Dataset, the V&V Dataset, and the DACS Standardized Productivity Dataset in standard formats. The price lists at the end of this guide give prepaid prices for these standard DACS datasets. Subsets of the Baseline Software Dataset and the NASA/SEL Dataset are available at costs dependent upon processing time.

### RELATED PRODUCTS OF THE SLED

NASA/SEL Data Compendium. This DACS compendium provides specific information on 29 software development projects monitored by NASA/SEL during the 1976 - 1979 time

*The Data & Analysis Center for Software is a DoD Information Analysis Center operated by IIT Research Institute*

FIGURE 9-1: THE DACS BROCHURE PROVIDES USERS WITH AN OVERVIEW OF DACS AND ITS PRODUCTS AND SERVICES

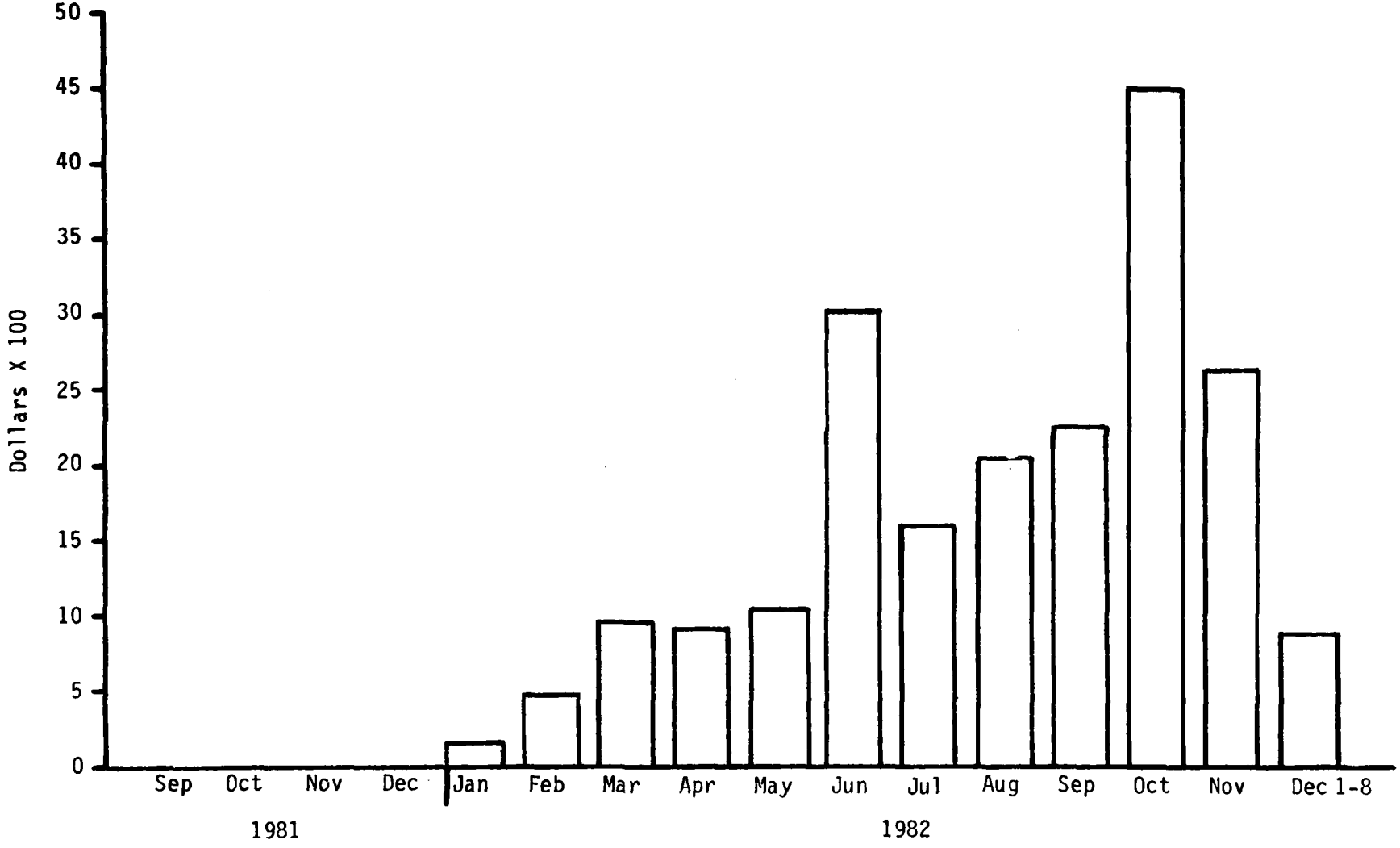



FIGURE 9-2: DACS USER RECEIPTS BY MONTH

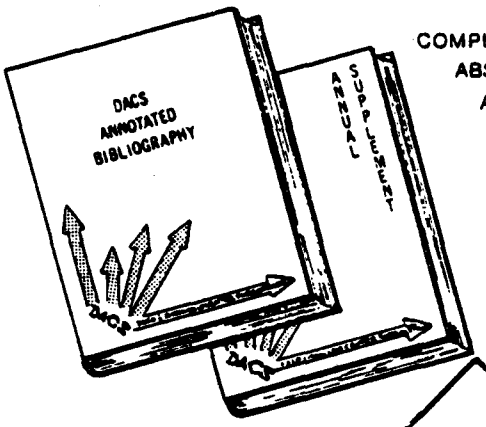
Promotion to persons who were not on the DACS Newsletter mailing list was planned to be accomplished through utilization of the following techniques:

- o paid advertisement in professional journals which are widely read in the software engineering community
- o placement of press releases and announcements in journals, magazines and newspapers
- o presentations at conferences and symposia
- o procurement of mailing lists to which brochures, catalogs or other promotional materials could be sent

### 9.2.1 Promoting the DACS in Professional Journals by Paid Advertisements

Figure 9-3 is a reproduction of the advertisement for the DACS Annotated Bibliography. The ad was placed in Computer Magazine and Special Libraries. Computer was chosen because it is mailed to all members of the IEEE Computer Society, a prime market for DACS Products and Services. Special Libraries was used because the Annotated Bibliography featured in the advertisement would be of particular interest to the corporate libraries of organizations concerned with software. The advertisements contained a coupon to be returned for further information on a given product or a free subscription to the DACS Newsletter and/or a DACS information packet. In addition coupons were coded so that the particular journal which prompted user inquiry could be identified. Both advertisements resulted in a significant number of additions to the mailing list and several orders for the Annotated Bibliography. It is not possible to quote exact numbers of sales due to each journal ad because most orders for the Annotated Bibliography were made on company ordering forms. Based on timing and the origin of orders it would seem that the placement of this particular advertisement in Special Libraries had a higher benefit/cost ratio than the placement in Computer. Due to funding limitations, these were the only paid advertisements placed during the fifteen-month transitional period. The next two sections describe other means utilized to promote the DACS and its products during this time period.

AT LONG LAST, SOMEONE HAS COME UP WITH A DATABASE THAT CONTAINS OVER 2200 SOURCES OF INFORMATION FOR THE SOFTWARE ENGINEER AND MADE IT AVAILABLE IN HARD COPY.




COMPLETE CITATIONS
ABSTRACTS
AUTHOR INDEX
SUBJECT INDEX
KEYWORD IN CONTEXT INDEX
ORDERING INFO FOR CITED DOCUMENTS

CITATIONS FOR:

- PAPERS FROM PROCEEDINGS
- TECHNICAL REPORTS
- JOURNAL ARTICLES
- THESES
- TEXTS

ALL THIS FOR ONLY $125.00!*

TOPICS:

- COST
- RELIABILITY
- DESIGN & DEVELOPMENT METHODOLOGIES
- QUALITY FACTORS
- MODELING
- SOFTWARE TOOLS
- MAINTAINABILITY
- CASE STUDIES

YOU GET

THE DACS ANNOTATED BIBLIOGRAPHY
PLUS THE FIRST ANNUAL SUPPLEMENT!

☐ MY CHECK IS ENCLOSED. SEND ME THE DACS BIBLIOGRAPHY(2 VOLUMES)

☐ SEND ME FREE INFORMATION ON OTHER DACS PRODUCTS AND SERVICES

MAIL ORDERS TO:

Data & Analysis Center for Software

Griffiss AFB, NY 13441
315/336-0937 Autovon 587-3396

NAME/TITLE_____

ORGANIZATION_____

ADDRESS_____

CITY/STATE_____ZIP_____

TELEPHONE_____

*At this time, DACS orders may only be distributed in the U.S.

PREPAYMENT IS REQUIRED! Please make checks payable to IITRI/DACS.

*The Data & Analysis Center for Software is a DoD Information Analysis Center operated by IIT Research Institute.*

FIGURE 9-3: AN ADVERTISEMENT WAS PLACED IN MAGAZINES

### 9.2.2 Promotion by Use of Free Publicity

There are several newspapers and magazines circulated free to software engineers which will print press releases and new product information at no charge to the producer. In addition to sending announcements, flyers and brochures to several of these journals, editors of other journals and magazines called the DACS to request information on the DACS and its services.

Specific instances of free publicity secured by these means include:

- The DACS and several of its products were discussed favorably in a 13 page article on Software Testing which appeared in the July 22, 1982 issue of Electronic Design. Between the appearance of that article and August 16 the DACS received over 200 requests for more information on the DACS and its products and/or addition to the newsletter mailing list.
- The capsule summaries of DACS products from the March DACS Newsletter were reproduced in the May 1982 issue of the Software Tools Newsletter.
- In return for substantial contributions of time to IEEE professional activities by S. Gloss-Soler of the DACS; F. Buckley was persuaded to reproduce the entire March 1982 DACS Newsletter and include it in a mailing to the 2,800 persons on the IEEE Software Engineering Standards Subcommittee mailing list.
- The DACS was profiled in the June 1982 issue of the Shock and Vibration Digest.
- The DACS Newsletter was described in the October 1982 issue of the Newsletter of the National Capitol chapter of the Association for Women in Computing.
- Honeywell Information Systems volunteered to and did distribute DACS promotional materials at its Large Scale Users Conference in Detroit, Michigan during October 1982.
- The 21 October 1982 issue of the DTIC Digest featured the DACS.

Figure 9-4 and 9-5 are two of the flyers produced during this period and mailed to sources which could provide free publicity. The success of this method of publicizing the DACS indicates that it is useful to continue to produce such flyers and/or announcements to be used to inform possible sources of free publicity as well as potential users of new products and services developed and offered by the DACS.

DACS

RADC/ISISI
Griffiss AFB, NY 13441
315/336-0937 Autovon 587-3395

Data & Analysis Center for Software

A DIRECTORY OF SOFTWARE ENGINEERING RESEARCH PROJECTS

A DIRECTORY OF SOFTWARE ENGINEERING RESEARCH PROJECTS is a hard copy formatted version of the Software Engineering Research Projects (SERP) Database. This directory contains a collection of completed or ongoing software engineering research projects that explore subjects such as:

- Data Collection and Analysis
- Development of Quality Metrics
- Analyses of Developmental Methodologies
- Development or Evaluation of Programming Languages
- Model Validation

One hundred and seventy-four research projects are listed in the directory each consisting of a citation and description. The citation contains the principal investigator(s); subject of research; sponsor of research; contract or grant number, if applicable; start-date and end-date. The description is a summary of the research aims, methods, and expected results.

To provide for efficient use of the project descriptions, the directory also includes the DACS Software Engineering Thesaurus containing subject terms assigned to the projects, a subject index, an index of research personnel and a keyword-in-context (KWIC) index of the project titles. The directory contains 126 pages.

The SERP Database is continuously maintained and is updated periodically to reflect new software engineering research projects. The directory will also be updated periodically to reflect new research projects maintained in the SERP Database. In order to update the SERP Database, Software Engineering Research Project Description Forms are provided within each directory that request descriptive information about software engineering research projects. These forms may be completed by research personnel and returned to the DACS where they will be reviewed for possible inclusion in the SERP Database and future updates of the directory.

For a low-cost of $20 you may obtain a copy of this valuable research tool. Complete the order form below and forward the form with your check to the DACS.

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

ORDER FORM

Enclosed find $_____

Please send me A DIRECTORY OF SOFTWARE ENGINEERING RESEARCH PROJECTS

PREPAYMENT OF ORDERS IS REQUIRED. Checks must be made payable to IITRI/DACS.

Send order and payment to:

Data & Analysis Center for Software
RADC/ISISI
Griffiss AFB, NY 13441

__ Please send me free information on the DACS.

Date_____

Name/Title_____

Organization_____

Address_____

City/State_____ Zip_____

Telephone_____

The Data & Analysis Center for Software is a DoD Information Analysis Center
Operated by IIT Research Institute

FIGURE 9-4: DACS PERSONNEL DEVELOPED FLYERS AND ANNOUNCEMENTS TO PROMOTE NEW DACS PRODUCTS

# DACS — Special Notice

## NEW MILITARY STANDARDS FOR DEFENSE SYSTEM SOFTWARE DEVELOPMENT

The Department of Defense (DoD) currently experiences a multitude of problems related to the acquisition and maintenance of embedded computer systems. In response, a tri-service group called the Joint Logistics Commanders (JLC) has established the Joint Policy Coordinating Group on Computer Resource Management (JPCG-CRM). The JPCG-CRM chartered a subgroup on Computer Software Management (CSM) to serve as a focal point for coordination of activities related to the acquisition of computer software used in support of defense systems. The mission of the CSM Subgroup is to review policies, procedures, regulations, and standards related to computer software and forward specific recommendations to the JPCG-CRM on critical areas related to software acquisition management including software development, quality, testing, and post-development support.

In reviewing current DoD policy and guidance implementation in the area of software management, it appeared that available information was often conflicting, redundant, or, in some cases, lacking. A JLC software workshop was held in April 1979 to review areas in which shortcomings were evident and to make appropriate recommendations for improvement and standardization of the DoD software acquisition process. One finding of this workshop was that there was no general policy defining a common software acquisition framework for the joint services. In addition, it was found that the services had each developed unique standards and Data Item Descriptions (DIDs).

You are invited to comment on a set of new and updated standards produced for the JLC/CSM by Rome Air Development Center (RADC) in a joint effort with the Army and Navy. These documents, in their final form, will provide the DoD with a clear and consistent set of standards and DIDs for application to defense system software development. The draft standards consist of the new MIL-STD-SDS, Defense System Software Development, updates to MIL-STD-483, MIL-STD-490, and a republished and updated MIL-STD-1521A. Sources for the MIL-STD-SDS include Navy MIL-STD-1679, the RADC Software Development Specification, and a series of technology studies to assure that the new and updated standards reflect the state-of-the-art in software engineering. This package of standards is aimed at providing a disciplined software development process for DoD software acquisition. In addition, a new set of DIDs has been developed which may ultimately replace those currently used to satisfy individual service unique requirements.

It is the intent of the JLC to promote full use of the new and updated standards within the DoD. The documents are presently out for review and comment within the services, and copies have been forwarded to focal points in the AIAA, NSIA, EIA G-33, and ADPA.

Copies of the draft documents described above may be obtained from the Data & Analysis Center for Software (DACS). Each set of the draft documents costs $30 shipped book rate or $35 shipped first class mail. These prices were established to recover costs of reproduction, handling, and mailing. Orders must be prepaid, and checks must be made payable to IITRI/DACS. Forward your order and check to DACS, RADC/ISISI, Griffiss AFB, NY 13441.

If you are not an active member of one of the professional organizations cited above, please forward any informal comments you may have to Major Larry Fry, HQ AFSC/ALR, Andrews AFB MD, 20331

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ORDER FORM

Enclosed find $_____

Please send me the DRAFT STANDARDS FOR DEFENSE SYSTEMS SOFTWARE DEVELOPMENT

PREPAYMENT OF ORDERS IS REQUIRED. Checks must be made payable to IITRI/DACS.

Send order and payment to: Data & Analysis Center for Software
RADC/ISISI
Griffiss AFB, NY 13441

☐ Please send me free information on the DACS.

DATE _____ PHONE _____

NAME/TITLE _____

ORGANIZATION _____

ADDRESS _____

CITY/STATE _____ ZIP _____

*The Data & Analysis Center for Software is a DoD Information Analysis Center operated by IIT Research Institute*

FIGURE 9-5: THE DACS USED FLYERS TO ATTRACT NEW DACS USERS AS WELL AS TO SELL SPECIFIC PRODUCTS

### 9.2.3 Presentations at Conferences and Symposia

This topic is more fully discussed under task 5, current awareness. It is only to be noted here that these presentations provided an excellent opportunity for one-on-one discussions as well as personal communication with groups of potential users concerning the DACS and its products and services. The success of this promotional method indicates that it is worthwhile to continue to use presentations at conferences and symposia as a vehicle for promoting the DACS.

## 10.0 OBSERVATIONS AND RECOMMENDATIONS

### 10.1 Observations

A preliminary cost recovery study had been done during the previous 3-year contract. A detailed cost recovery implementation plan was prepared early in this contract. The research for that study indicated many of the events that would be likely to occur. Most of them did. Research indicated that there would be a precipate drop in usage of the DACS when a policy of charging for products and services was instituted; that did occur. We had assumed that after a time, user resistance to charging would decline and revenues would begin to materially supplement the funding provided by the U.S. Air Force for the operation of the DACS. This also occurred, so that for the last 4 months of the fifteen month contract user receipts averaged $2879 per month; the average over the entire contract was $1400, less than half of the average for the last four months.

Conversations with other IACS indicated that if a policy of prepayment for products and services was followed, the clerical duties in order handling would be minimal. As it actually occurred, the processing load on clerical personnel for order processing was very burdensome.

For those users who overcame their resistance to the imposition of user charges for products and services, feedback indicates that purchasers feel that DACS products and services provide very good value in relation to their cost. This was also stated by the author of the feature on the DACS in Electronic Design.

Purchasers of DACS state-of-the-art reports (SOARs) frequently called back to inquire if the DACS had produced or planned to produce similar reports on other topics. These inquiries illustrate the need for the DACS to continue to produce new SOAR's and also provide input to topic selection.

DACS reputation as an information clearinghouse continued to grow. An increasing number of telephone calls begin with "I figured if anyone would know where to find ..., you would." In most cases a DACS staff member had the required information at hand or knew where to obtain it. User feedback indicates that the

clearinghouse function continues to be a valuable service of the DACS. Although it generates no revenue, it does generate good will which often leads to the sale of revenue-producing products and services at a later date.

## 10.2 Recommendations

Based upon the observations made above and the activities and achievements described in the preceeding chapters the following recommendations are made.

### 10.2.1 Efficiency Improvements

Many improvements in this area were made during the past fifteen months. Those still in need of attention are:

- Streamline data entry procedures for the STINFO databases. Some improvements have been made; other streamlining procedures have been designed. Their implementation is recommended.
- Streamline the order-processing procedures. Currently used procedures for order processing have been studied and areas where redundancy can be eliminated without sacrificing essential safeguards have been identified. It is planned to implement these improvements during the next contract period.

### 10.2.2 Expansion of Scope and Coverage

- The experience of the past fifteen months indicates that the need for information on software technology continues to increase. This implies the need to continually expand the STINFO database compiled during the past 4 years. The need is twofold; to provide up-to-date research materials from which the products and services of the DACS are to be developed and to have available the most recent information to supply to DACS users.
- Update and Expand the NBS Tools Database - user reactions to the distribution of the AIAA Tools Survey and the offering of Custom Tool Searches by the DACS indicates that this is an area where a central source of authoritative information is needed. The DACS can provide this source.
- Aggressively promote the value of software experience data collection and actively pursue sources of software development and maintenance data. Since the DACS itself does not have the resources to collect data and software developers are often reluctant to collect data because of the added costs involved, it is necessary to convince developers that

data is worth the effort to collect. This recommendation was made in the final report for the previous contract. The need to continue the effort is as great now as it was fifteen months ago. Based upon conversations with sources of potential data we feel that the real impetus for data collection will come from the government inserting data collection requirements into software development contracts.

- Continue to expand the scope of data analysis activities and disseminate the results of analysis activities to the software engineering community in a readily usable form.

### 10.2.3 Continued Development and Promotion

- Continue and expand the promotional program implemented during this transition period so that the maximum number of potential users of the DACS products and services are aware of their existence.

- Continue to solicite user feedback on the products and services offered by the DACS, to ensure that they will continue to provide the greatest possible usefulness to DACS users.

- Continue to track and tabulate user interactions with the DACS so that the optimum mix of products and services may be provided to the persons and organizations who support the DACS by purchase of its products and services.

During the 3-year pilot period, the need for a DACS was demonstrated. The experiences of the fifteen month transition period demonstrated that the need is great enough that people and organizations were willing to pay for the products and services of the DACS. The recommendations above are offered with the intention of improving the scope, efficiency, and ultimately, the usefulness of the DACS to the community which it was created to serve.

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# APPENDIX A

# LIST OF DACS USERS

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| ACADEMIC BOOK CTR, INC | | | | |
| PORTLAND | OR | | | 1 |
| ADVANCED INFO & DEC SYS | | | | |
| MOUNTAIN VIEW | CA | | | 1 |
| AID | | | | |
| OAK BROOK | IL | | | 1 |
| ALUMINUM CO OF AMERICA | | | | |
| ALCOA CENTER | PA | | | 1 |
| AMERICAN MGMT SYST INC | | | | |
| ARLINGTON | VA | | | 1 |
| AMERICAN SYSTEMS CORP | | | | |
| WINTER PARK | FL | | | 1 |
| ANALYSIS&COMPT SYST INC | | | | |
| BEDFORD | MA | | | 1 |
| ANALYTIC SCIENCES CORP | | | | |
| READING | MA | | | 2 |
| ANALYTIC SERVICES INC | | | | |
| ARLINGTON | VA | | | 1 |
| APPLIED AUTOMATION INC | | | | |
| BARTLESVILLE | OK | | | 1 |
| ARIEL SOFTWARE INC | | | | |
| HAUPPAUGE | NY | | | 1 |
| ARINC RESEARCH CORP | | | | |
| ANNAPOLIS | MD | | | 3 |
| ARTHUR ANDERSON & CO | | | | |
| CHICAGO | IL | 1 | | 1 |
| ARTHUR YOUNG & CO | | | | |
| WASHINGTON | DC | | | 1 |
| AUTOMATION INDUSTRY INC | | | | |
| SILVER SPRINGS | MD | | 1 | 7 |
| AVCO SYSTEMS DIV | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| WILMINGTON | MA | | | 1 |
| BABCOCK & WILCOX CO<br>LYNCHBURG | VA | | | 2 |
| BANGS, ALAN P<br>LOS ANGELES | CA | | | 1 |
| BANSOPHIC SYSTEMS INC<br>CLEARWATER | FL | | | 1 |
| BATTELLE<br>COLUMBUS | OH | | | 2 |
| BATTELLE,PACIFIC NW LABS<br>RICHLAND | WA | | | 4 |
| BECHTEL CENTRAL LIBRARY<br>SAN FRANCISCO | CA | | | 1 |
| BELL AEROSPACE<br>BUFFALO | NY | | | 1 |
| BELL LABORATORIES<br>HOMDEL | NJ | | | 2 |
| BELL LABORATORIES<br>WHIPPANY | NJ | | | 2 |
| BELL LABS<br>NORTH ANDOVER | MA | | | 1 |
| BENDIX ENCD<br>SOUTH BEND | IN | | | 1 |
| BOEING COMM AIRPLANE CO<br>SEATTLE | WA | | 1 | 1 |
| BOEING COMPUTER SERV CO<br>TUKWILA | WA | | | 1 |
| BORG-WARNER CORP RES CNT<br>DES PLAINS | IL | | | 1 |
| BTG INC<br>FALLS CHURCH | VA | | | 1 |
| BURROUGHS CORP<br>MISSION VIPJO | CA | | | 1 |
| BURROUGHS CORP | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|
| CITY OF INDUSTRY CA | | | 1 |
| BURROUGHS CORPORATION PAOLI PA | | | 2 |
| BURROUGHS CORPORATION DETROIT MI | | | 1 |
| CAE ELECTRONICS LTD QUEBEC CANADA | | | 1 |
| CHANG, KEE T MC LEAN VA | | | 1 |
| CHRISTIAN ROVS'ING CORP THOUSAND OAKS CA | | | 1 |
| COMPTEK RESEARCH INC VIRGINIA BEACH VA | | | 1 |
| COMPUNET INC INGLEWOOD CA | | | 1 |
| COMPUTER SCIENCES CORP FALLS CHURCH VA | | | 4 |
| COMPUTER SCIENCES CORP MOORESTOWN NJ | | | 2 |
| COMPUTER SCIENCES CORP SILVER SPRINGS MD | | | 2 |
| COMPUTER SCIENCES CORP SACRAMENTO CA | | | 1 |
| COMPUTER TECH ASSOC INC ENGLEWOOD CO | | | 2 |
| CONTEL INFO SYSTEMS FAIRBORN OH | | | 1 |
| CONTROL DATA CORP MINNEAPOLIS MN | | | 2 |
| CONTROL DATA CORP DAYTON OH | | | 1 |
| CONTROL DATA CORP ST LOUIS MO | 1 | | |
| CORVUS SYSTEMS | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| SAN JOSE | CA | | | 1 |
| CPT CORPORATION<br>MINNETONKA | MN | | | 1 |
| CREATIVE INVESTMENTS<br>OAKLAND | CA | | | 1 |
| CT GENERAL INSU CORP<br>HARTFORD | CT | | | 1 |
| CUBIC CORPORATION<br>SAN DIEGO | CA | | | 1 |
| CYTROL INC<br>EDINA | MN | | | 1 |
| DARCOM INTERN TRNG CNTR<br>TEXARKANA | TX | | 1 | 1 |
| DATA GENERAL CORP<br>WESTBORO | MA | | | 1 |
| DATA GENERAL CORP<br>RES TRIANGLE PK | NC | | | 1 |
| DATA SYSTEM ANALYSTS<br>PENNSAUKEN | NJ | | | 1 |
| DATAPOINT CORP<br>SAN ANTONIO | TX | | | 1 |
| DBA SYSTEMS INC<br>MELBOURNE | FL | | | 1 |
| DCASMA-BOSTON<br>BOSTON | MA | | | 1 |
| DCASMA-BOSTON<br>CANTON | MA | | | 1 |
| DCASPRO FORD AEROSPACE<br>PALO ALTO | CA | 1 | | 1 |
| DCASR-LOS ANGELES,Q<br>LOS ANGELES | CA | | | 2 |
| DECISION DATA<br>HORSHAM | PA | | | 2 |
| DELTA DATA SYS CORP | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| ARLINGTON | VA | | | 1 |
| DIGITAL EQUIPMENT CO HUDSON | MA | | | 1 |
| DIGITAL EQUIPMENT CORP NASHUA | NH | 1 | 1 | 1 |
| DLIC RALEIGH | NC | | | 1 |
| DOTY ASSOCIATES INC ROCKVILLE | MD | 2 | 1 | 1 |
| DPMA CONFERENCES TORRANCE | CA | | | 1 |
| DRAPER LABORATORY CAMBRIDGE | MA | | | 1 |
| DYNAMICS RESEARCH CORP WILMINGTON | MA | | | 1 |
| E I DU PONT DE NEMOURS C WILMINGTON | DE | | | 1 |
| EASTMAN KODAK CO ROCHESTER | NY | | | 1 |
| EATON CORPORATION MELVILLE | NY | | 1 | 4 |
| EGIG WASH ANALY SERV CNT ROCKVILLE | MD | | | 1 |
| EG&G MANASSAS | VA | | | 1 |
| ELECTRONIC ASSOC INC W LONG BRANCH | NJ | | | 2 |
| ELECTRONIC DESIGN BOONTON | NJ | | | 1 |
| ELECTRONIC IND ASSOC WASHINGTON | DC | | | 1 |
| EMERSON ELECTRIC CO ST LOUIS | MO | | | 1 |
| ENSCO INC | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| SPRINGFIELD | VA | | | 1 |
| ENVIRO CONTROL INC<br>LEXINGTON PARK | MD | 1 | | |
| ENVIROMENTAL RES INST MI<br>ANN ARBOR | MI | | | 2 |
| E-SYSTEMS<br>GREENVILLE | TX | | | 1 |
| E-SYSTEMS, INC<br>FALLS CHURCH | VA | | | 3 |
| ETHICON INC<br>SOMERVILLE | NJ | | | 1 |
| EXTEL CORPORATION<br>NORTHBROOK | IL | | | 1 |
| FAIRCHILD<br>LATHAM | NY | | | 1 |
| FAIRCHILD SPACE & ELEC C<br>GERMANTOWN | MD | | | 1 |
| FIORELLO,SHAW&ASSOCS<br>MCLEAN | VA | | 1 | |
| FMC CORPORATION<br>SAN JOSE | CA | | | 1 |
| FORD AEROSPACE<br>WEBSTER | TX | | | 1 |
| FORD AEROSPACE & COMM<br>SUNNYVALE | CA | | | 1 |
| FORD AEROSPACE & COMM CO<br>COLORADO SPRINGS | CO | | | 1 |
| FORD AEROSPACE&COMM CORP<br>PALO ALTO | CA | | | 1 |
| FREDERICK ELECTRONICS CR<br>FREDERICK | MD | | | - |
| GAW, STEPHEN T<br>FAIRFAX | VA | | | 1 |
| GE CORPORATE RES&DEV CTR | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| SCHENECTADY | NY | | | 1 |
| GENERAL DYNAMICS CLAYTON | MO | 1 | | 2 |
| GENERAL DYNAMICS CORP NORWICH | CT | | | 1 |
| GENERAL DYNAMICS CORP FT WORTH | TX | | | 1 |
| GENERAL ELECTRIC DAYTONA BEACH | FL | | | 4 |
| GENERAL ELECTRIC CINCINNATI | OH | | | 2 |
| GENERAL ELECTRIC PITTSFIELD | MA | | | 2 |
| GENERAL ELECTRIC BURLINGTON | VT | | | 1 |
| GENERAL ELECTRIC CHARLOTTESVILLE | VA | | | 1 |
| GENERAL ELECTRIC CO PHILADELPHIA | PA | | | 2 |
| GENERAL ELECTRIC CO BINGHAMTON | NY | 1 | | |
| GENERAL ELECTRIC CO SYRACUSE | NY | 1 | | |
| GENERAL ELECTRIC CO UTICA | NY | | | 1 |
| GENERAL RESEARCH CORP FT WALTON BEACH | FL | | | 1 |
| GEOSOURCE INC ERIE | PA | 1 | | |
| GIHIASSI, M. SANTA CLARA | CA | | | 1 |
| GOODYEAR AEROSPACE AKRON | OH | | 1 | 1 |
| GOODYEAR AEROSPACE CORP | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| LITCHFIELD PARK | AZ | | | 1 |
| GOULD INC<br>ROLLING MEADOWS | IL | | | 1 |
| GRUMMAN AEROSPACE CORP<br>BETHPAGE | NY | | | 2 |
| GRUMMAN DATA SYST CORP<br>ARLINGTON | VA | | | 1 |
| GRUMMAN DATA SYSTEMS<br>WOODBURY | NY | | 1 | |
| GTE LABORATORIES<br>WALTHAM | MA | | | 1 |
| GTE PRODUCTS CORP<br>MCLEAN | VA | | | 1 |
| GTE SYSTEMS<br>WESTBORO | MA | | 1 | 1 |
| HAMILTON, DENNIS E<br>PENFIELD | NY | | | 1 |
| HARRIS CORPORATION<br>MELBOURNE | FL | | | 6 |
| HARRY DIAMOND LABS<br>ADELPHI | MD | | | 1 |
| HEWLETT-PACKARD CO<br>COLORADO SPRINGS | CO | | | 1 |
| HONEYWELL<br>HOPKINS | MN | 1 | | 1 |
| HONEYWELL<br>BLOOMINGTON | MN | | | 1 |
| HONEYWELL<br>W COVINA | CA | | | 1 |
| HONEYWELL<br>PHOENIX | AZ | | | 2 |
| HONEYWELL INC<br>MINNEAPOLIS | MN | | | 1 |
| HONEYWELL INC | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| LEXINGTON | MA | | | 1 |
| HRB-SINGER INC<br>STATE COLLEGE | PA | | | 3 |
| HUGH L DRYDEN FLT RES CN<br>EDWARDS | CA | | | 1 |
| HUGHES AIRCRAFT CO<br>FULLERTON | CA | | | 1 |
| HUGHES AIRCRAFT CO<br>EL SEGUNDO | CA | | | 5 |
| IBM<br>ARMONK | NY | | | 1 |
| IBM<br>MANASSAS | VA | 1 | | 1 |
| IBM<br>POUGHKEEPSIE | NY | | | 1 |
| IBM CORP<br>SAN JOSE | CA | | | 1 |
| IBM RESEARCH LIBRARY<br>SAN JOSE | CA | | | 1 |
| IBM-FSD<br>WESTLAKE VLG | CA | | | 1 |
| IEEE RELIABILITY SOCIETY<br>GOODYEAR | AZ | | | 1 |
| IIT NORTH<br>CAPE CANAVERAL | FL | | | 1 |
| IIT RESEARCH INSTITUTE<br>ROME | NY | 11 | | 3 |
| ILLINOIS TOOL WORKS INC<br>CHICAGO | IL | | | 1 |
| INCO INC<br>MCLEAN | VA | 2 | | 1 |
| INDUS FABRICS ASSOC INTL<br>ST PAUL | MN | | | 2 |
| INFO SYS ARCHITECTS INC | | | | |

UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| VIENNA | VA | | | 1 |
| INFORMATICS INC<br>CANOGA PARK | CA | | | 1 |
| INPUT OUTPUT COMP SERV I<br>WALTHAM | MA | | | 1 |
| INST FOR DEFENSE ANALYSE<br>ALEXANDRIA | VA | | | 1 |
| INTELSAT<br>WASHINGTON | DC | | | 1 |
| INTERMETRICS<br>CAMBRIDGE | MA | | 1 | 4 |
| INTERMETRICS<br>HUNTINGTON BEACH | CA | | | 1 |
| INTERNATIONAL HARVESTOR<br>MELROSE PARK | IL | | | 1 |
| INTERTEL<br>ANDOVER | MA | | | 2 |
| IOCS<br>WALTHAM | MA | | | 2 |
| ITT<br>STRATFORD | CT | 1 | | 1 |
| ITT ADVANCED TECH CTR<br>SHELTER | CT | | | 1 |
| JET PROPULSION LAB<br>PASADENA | CA | | | 1 |
| JITCO SPEC BOOK DIST<br>ROCKVILLE | MD | | | 1 |
| JOHNSON CONTROLS INC<br>MILWAUKEE | WI | | | 2 |
| KEMPER GROUP<br>LONG GROVE | IL | | | 1 |
| KETRON INC<br>WAYNE | PA | 1 | | |
| KEYSTONE COMP ASSOC INC | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| FT WASHINGTON | PA | | | 1 |
| KINRA, MOHAN M<br>TULLAHOMA | TN | | | 1 |
| KURIHARA, THOMAS M<br>VIENNA | VA | | | 1 |
| LASHER, RICHARD<br>MAPLE GROVE | MN | | | 1 |
| LEAR SIEGLER INC<br>GRAND RAPIDS | MI | | | 2 |
| LIBRARY OF THE WANG INST<br>TYNGSBORO | MA | | | 1 |
| LINKANBIT CORP<br>SAN DIEGO | CA | 1 | | |
| LITTON DATA SYSTEM<br>VAN NUYS | CA | | | 1 |
| LOCKHEED CALIFORNIA CO<br>BURBANK | CA | | 1 | |
| LOCKHEED ELECTRONICS CO<br>PLAINFIELD | NJ | 1 | 1 | 1 |
| LOCKHEED MIS & SPACE CO<br>SUNNYVALE | CA | 1 | 2 | 2 |
| LOCKHEED MIS & SPACE CO<br>PALO ALTO | CA | | | 1 |
| LOCKHEED MISS & SPACE CO<br>AUSTIN | TX | | | 1 |
| LOCKHEED-MC-B-11<br>HOUSTON | TX | | | 1 |
| LOGICON INC<br>SAN PEDRO | CA | | | 2 |
| LOGICON INC<br>LOMPOC | CA | | | 1 |
| LOGICON INC<br>SAN DIEGO | CA | | | 2 |
| MAGNAVOX | | | | |

UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| FT WAYNE | IN | | | 1 |
| MAGNAVOX DATA SYS INC<br>FALLS CHURCH | VA | | | 1 |
| MANUFACT HANOVER TRUST<br>NEW YORK | NY | | | 1 |
| MARTIN E SEGAL CO<br>NEW YORK CITY | NY | | | 2 |
| MARTIN MARIETTA CORP<br>ROME | NY | | | 1 |
| MARTIN MARIETTA CORP<br>DENVER | CO | | 2 | 2 |
| MCCABE & ASSOCIATES<br>COLUMBIA | MO | | | 1 |
| MCDONNELL DOUGLAS AIRCRA<br>ST LOUIS | MO | | | 1 |
| MCLAIN, STEPHEN D<br>TUCSON | AZ | | | 1 |
| MDSI<br>ANN ARBOR | MI | | | 1 |
| MEDTRONIC, INC.<br>MINNEAPOLIS | MN | | | 1 |
| MENKUS, BELDEN<br>MIDDLEVILE | NJ | | | 1 |
| MERIDIAN CORPORATION<br>FALLS CHURCH | VA | | | 1 |
| MERLE COLLINS FOUNDATION<br>DALLAS | TX | | | 1 |
| MITEL CORPORATION<br>BOCA RATON | FL | 1 | | |
| MITRE<br>MCLEAN | VA | | 1 | 1 |
| MITRE CORP<br>BEDFORD | MA | | 1 | 5 |
| MITRE CORP | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| MCLEAN | VA | | | 3 |
| MODULAR COMPUTER CO<br>FT LAUDERDALE | FL | | | 1 |
| MOTOROLA INC<br>SCOTTSDALE | AZ | | 1 | 1 |
| MSP INC<br>LEXINGTON | MA | | | 1 |
| MULTIPARTS CORP<br>NEW YORK | NY | | 2 | 2 |
| NATIONAL CASH REGISTER<br>DENVER | CO | | | 1 |
| NCR CORP<br>DAYTON | OH | | | 1 |
| NETHEUS CORPORATION<br>HILLSBORO | OR | 1 | | |
| NON-PROCEDURAL SYSINC<br>RIDGEFIELD | CT | | | 1 |
| NORTHROP CORP<br>HAWTHORNE | CA | 1 | 1 | 2 |
| OCONNOR RESEARCH INC<br>DENVER | CO | | | 1 |
| ORBIT BOOKS CORP<br>POUGHKEEPSIE | NY | | | 4 |
| ORTHSTAR ENTERPRISES INC<br>ELMIRA | NY | | | 1 |
| PACIFIC ARCH & ENGINEERS<br>ARLINGTON | VA | | | 1 |
| PACIFIC-SIERRA RES CORP<br>LOS ANGELES | CA | | | 1 |
| PERKIN ELMER COMPANY<br>DANBURY | CT | | | 4 |
| PERKIN-ELMER CORP<br>NORWALK | CT | | | 1 |
| PITNEY BOWES | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| NORWALK | CT | | | 2 |
| PLANNING RESEARCH CORP<br>MCLEAN | VA | | | 3 |
| PLATEAU OIL COMPANY<br>ALBUQUERQUE | NM | 1 | | |
| POWER AUTH/STATE OF NY<br>NEW YORK | NY | | | 1 |
| PRATT & WHITNEY<br>EAST LYME | CT | | | 1 |
| PROFESSIONAL BOOK CENTER<br>PORTLAND | OR | | | 2 |
| PROSPECTIVE COMP ANALY I<br>ROSLYN | NY | | | 1 |
| QUALITY ASSURANCE INSTIT<br>ORLANDO | FL | | | 1 |
| QUANTITATIVE S/W MGT INC<br>MC LEAN | VA | | 1 | |
| RACAL-MILGO INC<br>PLANTATION | FL | | | 1 |
| RAMTEK CORPORATION<br>SAN JOSE | CA | | 1 | 1 |
| RAYTHEON CO<br>LEXINGTON | MA | | | 1 |
| RAYTHEON COMPANY<br>PORTSMOUTH | RI | | | 1 |
| RAYTHEON CORPORATION<br>BEDFORD | MA | | 1 | 1 |
| RAYTHEON SERV CO<br>ARLINGTON | VA | | | 1 |
| RAYTHEON SERVICE CO<br>MT LAUREL | NJ | | | 1 |
| RCA CORPORATION<br>MOORESTOWN | NJ | | | 1 |
| RCA CORPORATION | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| PRINCETON | NJ | | | 1 |
| RCA PRICE SYSTEMS<br>MT LAUREL | NJ | | 1 | |
| REACTOR CONTROLS INC<br>SAN JOSE | CA | 1 | | |
| REDIFFUSION SIMULATION<br>ARLINGTON | TX | | | 1 |
| REIFER CONSULTANTS INC<br>TORRANCE | CA | | 1 | 1 |
| RESEARCH COUNSEL OF WASH<br>WASHINGTON | DC | | | 1 |
| RESEARCH TRIANGLE INST<br>RES TRIANGLE,PRK | NC | | | 2 |
| ROCKWELL INTERNATIONAL<br>CEDAR RAPIDS | IA | | | 3 |
| SANDERS ASSOC INC<br>NASHUA | NH | | | 1 |
| SATELLITE BUSINESS SYST<br>MCLEAN | VA | | | 2 |
| SCIENCE APPLICATION INC<br>FALLS CHURCH | VA | | | 1 |
| SCIENCE APPLICATION INC<br>MCLEAN | VA | | | 1 |
| SCIENCE APPLICATIONS INC<br>ARLINGTON | VA | | | 1 |
| SCIENCE APPLICATION,INC<br>LA JOLLA | CA | | 1 | 1 |
| SEAGATE TECHNOLOGY<br>SCOTTS VALLEY | CA | | | 1 |
| SEMCOR INC<br>MT LAUREL | NJ | | | 1 |
| SEMCOR INC<br>NEPTUNE | NJ | | | 1 |
| SHEFTEL, DAVID | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| MCLEAN | VA | | | 1 |
| SILVAR-LISCO INC<br>PALO ALTO | CA | | | 1 |
| SINGER COMPANY<br>LITTLE FALLS | NJ | | | 1 |
| SINGER CO/KEARFOTT DIV<br>WAYNE | NJ | | | 2 |
| SINGER LINK DIVISION<br>HOUSTON | TX | | | 1 |
| SINGER-LINK DIVISION<br>BINGHAMTON | NY | | 1 | 2 |
| SOC FOR INFOR & DOCUMEN<br>WASHINGTON | DC | | | 1 |
| SOFTECH<br>TINTON FALLS | NJ | | | 1 |
| SOFTECH INC<br>DAYTON | OH | | | 2 |
| SOFTWARE A&E<br>ARLINGTON | VA | | | 3 |
| SOFTWARE A&E INC<br>MIDDLETOWN | RI | | | 4 |
| SOFTWARE ANALYSIS (TEOE)<br>ORGAN | NM | | | 1 |
| SOFTWARE ENTERPRISES COR<br>WESTLAKE VILLAGE | CA | | | 1 |
| SOFTWARE QUALITY ASSURAN<br>DAYTONA BEACH | FL | | | 1 |
| SOFTWARE QUALITY ENG<br>GOLDEN VALLEY | MN | | | 1 |
| SOFTWARE RESEAPCH ASSOC<br>SAN FRANCISCO | CA | | | 1 |
| SOHAR INCORPORATED<br>LOS ANGELES | CA | | 2 | |
| SOUTH NEW ENGLAND TEL CO | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| NEW HAVEN | CT | | | 2 |
| SPACE LAB ENGINEER DEPT<br>CHATSWORTH | CA | | | 1 |
| SPERRY ELECTRONICS SYS<br>CLEARWATER | FL | | | 1 |
| SPERRY SYS MANAGEMENT<br>GREAT NECK | NY | 1 | | 3 |
| SPERRY UNIVAC<br>BLUE BELL | PA | | | 3 |
| SPERRY UNIVAC<br>ST PAUL | MN | | | 5 |
| SPERRY UNIVAC<br>ROSEVILLE | MN | | | 1 |
| SRI INTERNATIONAL<br>MENLO PK | CA | | | 3 |
| STANFORD TELECOMMUNICATI<br>SUNNYVALE | CA | | | 2 |
| STATE OF THE ART SEMINAR<br>LOS ANGELES | CA | | | 1 |
| STUDENT BOOK COMPANY<br>WASHINGTON | DC | | | 1 |
| SUPPORT SYSTEMS ASSOC IN<br>NORTHPORT | NY | | | 1 |
| SUPPORT SYSTEMS INC<br>BURLINGTON | MA | 1 | | |
| SYSTEM DEVELOPMENT CORP<br>MCLEAN | VA | | | 1 |
| SYSTEMS DEVELOPMENT CORP<br>SANTA MONICA | CA | | | 3 |
| SYSTEMS & APPLIED SCIEN<br>ROCKVILLE | MD | | | 1 |
| TARTAN LABORATORIES<br>PITTSBURGH | PA | | | 1 |
| TAYLOR INST CO/SYBRON | | | | |

UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| ROCHESTER | NY | | | 1 |
| TECH DEV OF CALIFORNIA<br>ARLINGTON | TX | | | 1 |
| TECHNICAL DATA INC<br>XENIA | OH | | | 1 |
| TECHNOLOGY DEVEL OF CA<br>WOODSIDE | CA | | | 2 |
| TECHNOLOGY DEVEL OF CA<br>SANTA CLARA | CA | | | 1 |
| TECHNOLOGY MARKETING INC<br>IRVINE | CA | | 1 | |
| TECHNOLOGY SERVICE CORP<br>SANTA MONICA | CA | | | 1 |
| TECOLOTE RESEARCH INC<br>SANTA BARBARA | CA | | | 2 |
| TEKTRONIX INC<br>BEAVERTON | OR | | | 3 |
| TELEDYNE BROWN ENGIN<br>HUNTSVILLE | AL | | | 2 |
| TELEDYNE CAE<br>TOLEDO | OH | | | 1 |
| TELETYPE CORP<br>SKOKIE | IL | | | 1 |
| TELOS COMPUTING INC<br>SANTA MONICA | CA | | | 2 |
| TEXACO INC<br>HOUSTON | TX | | | 3 |
| TEXACO INC<br>HOUSTON | TX | | | 1 |
| TEXAS INSTRUMENTS INC<br>LEWISVILLE | TX | | | 2 |
| TEXAS INSTRUMENTS INC<br>RICHARDSON | TX | | | 1 |
| THE AEROSPACE CORP | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| LOS ANGELES | CA | 1 | | 3 |
| THE BDM CORP<br>MCLEAN | VA | | | 1 |
| THE BDM CORPORATION<br>DAYTON | OH | | | 1 |
| THE BDM CORPORATION<br>MCLEAN | VA | | | 1 |
| THE ERICSSON CORP<br>NEW YORK | NY | | | 1 |
| THE FOXBORO COMPANY<br>FOXBORO | MA | | | 1 |
| THE OSIRIS GROUP, INC<br>CHICAGO | IL | | | 2 |
| THE SINGER CO<br>SUNNYVALE | CA | | | 3 |
| THE SINGER COMPANY<br>SILVER SPRINGS | MD | | | 1 |
| THOMSON-CSF, INC<br>WHITE PLAINS | NY | | | 1 |
| TRACOR APPLIED SCIENCES<br>LEXINGTON PARK | MD | | | 1 |
| TRACOR INC<br>ROCKVILLE | MD | | | 1 |
| TRAVENOL LABORATORIES IN<br>MORTON GROVE | IL | | | 1 |
| TRIAD MICROSYSTEMS INC<br>ORLANDO | FL | | | 1 |
| TRW DEF & SPACE SYS GRP<br>REDANDO BEACH | CA | | 1 | |
| TRW INC<br>HILL AFB | UT | | 1 | |
| TTC<br>LOS ANGELES | CA | | | 1 |
| ULTRASYSTEM'S INC | | | | |

## UNITED STATES CORPORATIONS & INDIVIDUALS

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| IRVINE | CA | | | 1 |
| UNITED DATA SERVICES<br>UPPER MARLBORO | MD | | | 1 |
| UNITED TECHNOLOGIES<br>LONGWOOD | FL | | | 2 |
| US CUSTOMS<br>WASHINGTON | DC | | | 1 |
| VECTOR RESEARCH CO<br>BETHESDA | MD | | | 1 |
| WANG LABORATORIES INC<br>LOWELL | MA | | | 1 |
| WASHINGTON NICHIBEI CONS<br>WASHINGTON | DC | | | 1 |
| WESTERN ELECTRIC<br>LISLE | IL | | | 1 |
| WESTERN ELECTRIC<br>GREENSBORO | NC | | | 1 |
| WESTERN UNION<br>MCLEAN | VA | | | 1 |
| WESTINGHOUSE<br>ANNAPOLIS | MD | | | 1 |
| WESTINGHOUSE-HANFORD CO<br>RICHLAND | WA | | | 1 |
| XEROX CORPORATION<br>ROCHESTER | NY | | 1 | 2 |
| XEROX CORPORATION<br>EL SEGUNDO | CA | | | 1 |
| YEW, PEARL<br>CAMBRIDGE | MA | | | 1 |
| ZEITLIN & VER BRUGGE<br>LOS ANGELES | CA | | | 1 |

## UNIVERSITIES

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| ARIZONA STATE UNIVERSITY | | | | |
| TEMPE | AZ | | 1 | 1 |
| AUBURN UNIVERSITY | | | | |
| AUBURN | AL | | | 1 |
| BOSTON UNIV-BIB SERVICES | | | | |
| BOSTON | MA | | | 1 |
| BRADLEY UNIVERSITY | | | | |
| PEORIA | IL | | | 1 |
| CALIFORNIA STATE U-SACRA | | | | |
| SACRAMENTO | CA | | | 1 |
| CASE WESTERN RES UNIV | | | | |
| CLEVELAND | OH | | | 1 |
| COBB, SHARON | | | | |
| ROCHESTER | NY | | | 2 |
| GEORGIA INST TECHNOLOGY | | | | |
| ATLANTA | GA | 1 | 1 | 3 |
| HARVEY MUDD COLLEGE | | | | |
| CLAREMONT | CA | | | 1 |
| JOHN HOPKINS UNIVERSITY | | | | |
| LAUREL | MD | | | 2 |
| LIBRARY OF THE WANG INST | | | | |
| TYNGSBORO | MA | | | 2 |
| NORTHEASTERN UNIVERSITY | | | | |
| BOSTON | MA | | | 2 |
| OHIO STATE UNIVERSITY | | | | |
| COLUMBUS | OH | | | 1 |
| OK STATE UNIV-LIBRARY | | | | |
| STILLWATER | OK | | | 1 |
| PITTSBURG STATE UNIV | | | | |
| PITTSBURG | KS | | | 1 |
| RENSSELAER POLYTECH INST | | | | |

## UNIVERSITIES

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| TROY | NY | | | 1 |
| SACRAMENTO STATE UNIV<br>SACRAMENTO | CA | | | 1 |
| SYRACUSE UNIVERSITY<br>SYRACUSE | NY | | | 1 |
| UNIV OF MISSOURI-COLUMBI<br>COLUMBIA | MO | | | 1 |
| UNIV OF MISSOURI-ROLLA<br>ROLLA | MO | | | 1 |
| UNIV OF OREGON<br>EUGENE | OR | | | 1 |
| UNIV WISCONSIN-MADISON<br>MADISON | WI | | | 1 |
| UNIVERSITY OF HOUSTON<br>HOUSTON | TX | | | 1 |
| UNIVERSITY OF VIRGINIA<br>CHARLOTTSVILLE | VA | | | 1 |
| VANDERBILT MEDICAL CNTR<br>NASHVILLE | TN | | | 2 |

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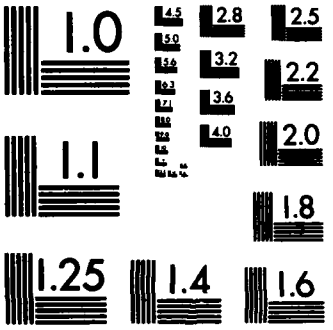
UNCLASSIFIED F/G 9/2 NL



## DEPARTMENT OF DEFENSE

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| ARMY AVIATION RES&DEV CO<br>ST LOUIS | MO | 1 | | |
| DEFENSE LOGISTICS AGENCY<br>ALEXANDRIA | VA | 1 | | |
| DEFENSE MAT SPEC&STAN OF<br>FALLS CHURCH | VA | | | 2 |
| MILPERCEN - DEPT OF ARMY<br>ALEXANDRIA | VA | | | 1 |

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| COMPTROLLER&SUPPLY OFFIC WASHINGTON | DC | | | 1 |
| DEPARTMENT OF THE NAVY WASHINGTON | DC | | | 1 |
| DEPARTMENT OF THE NAVY NEWPORT | RI | | | 1 |
| DEPARTMENT OF THE NAVY WASHINGTON | DC | | | 1 |
| DEPT OF THE NAVY DAHLGREN | VA | 1 | 3 | 1 |
| NAVAL AIR DEVELOPMENT CT WARMINSTER | PA | | 1 | |
| NAVAL AIR SYSTEMS COMM WASHINGTON | DC | 1 | | |
| NAVAL AVIONIC CTR INDIANAPOLIS | IN | | | 1 |
| NAVAL OCEANS SYS CNTR SAN DIEGO | CA | | | 3 |
| NAVAL POSTGRADUATE SCH MONTEREY | CA | | | 3 |
| NAVAL SURFACE WEAPONS CT SILVER SPRING | MD | 1 | 1 | 2 |
| NAVAL TRAINING EQUIP CTR ORLANDO | FL | | | 1 |
| NAVAL TRAINING EQUIP CTR WINTER PARK | FL | | | 1 |
| NAVAL UNDERWATER SYS CTR NEWPORT | RI | | | 1 |
| NAVAL UNDERWATER SYS CTR NEW LONDON | CT | 1 | 2 | 2 |
| NAVAL WEAPONS CTR CHINA LAKE | CA | 1 | | 1 |
| NDW WASHINGTON NAVY YARD WASHINGTON | DC | | | 1 |

## OTHER GOVERNMENT AGENCIES

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| DEF MAPPING AGEN AERO CT | | | | |
| ST LOUIS | MO | | | 1 |
| ELECTRONIC DATA SYS CORP | | | | |
| WASHINGTON | DC | | | 1 |
| FAA ARD-131 | | | | |
| WASHINGTON | DC | 2 | 1 | |
| FEDERAL AVIATION ADMIN | | | | |
| WASHINGTON | DC | | | 1 |
| FEDERAL S/W TESTING CNTR | | | | |
| FALLS CHURCH | VA | | | 1 |
| GERMAN LIASON OFFICE | | | | |
| WASHINGTON | DC | 1 | | |
| KAISER ELECTRONICS | | | | |
| SAN JOSE | CA | | | 1 |
| NASA GODDARD SPACE FLT | | | | |
| GREENBELT | MD | | 1 | 2 |
| OFF OF PERSONNEL MANGEMN | | | | |
| WASHINGTON | DC | | | 1 |
| PRC GOVERNMENT INFO SYS | | | | |
| SAN DIEGO | CA | | | 1 |
| RICHARDS, CAPT OTIS | | | | |
| HUBER HEIGHTS | OH | | | 1 |
| SYSTEM DEVEL CORP | | | | |
| LANGLEY AFB | VA | | | 1 |
| US DEPT OF HUD | | | | |
| WASHINGTON | DC | | | 1 |
| US DEPT TRANSPORTATION | | | | |
| WASHINGTON | DC | 1 | | |

## U.S. AIR FORCE

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| AFSC/ALK<br>AFSC/XRF<br>ANDREWS AFB | DC | 1 | | 1 |
| ARNOLD ENG DEV CNTR<br>ARNOLD AFB | TN | 2 | | |
| AF DATA SERVICES CTR<br>FAIRFAX | VA | | | 1 |
| RADC/CO<br>RADC/COEE<br>RADC/COTD<br>RADC/IRAE<br>RADC/IRDE<br>GRIFFISS AFB | NY | 6 | | 4 |
| AFDSEC/PG<br>AFASPO/PGCR<br>AFDSDC/LGL<br>GUNTER AFS | AL | | | 4 |
| ESD/DCJF<br>ESD/OCDR<br>ESD/TOET<br>HANSCOM AFB | MA | | | 3 |
| AFCMD/KRR<br>AFCMD/PKBD<br>KIRTLAND AFB | NM | | | 3 |
| USAF SPACE DIVISION<br>LOS ANGELES | CA | | 1 | 1 |
| OFFUTT AFB | NE | 1 | | |
| HUNTER, ED<br>ORANGEVALE | CA | | | 1 |
| AFGWC/ADC<br>PAPILLION | NE | | | 1 |

## U.S. AIR FORCE

| USER | | TYPE OF INQUIRY TECHNICAL | DATASET | DOCUMENT |
|---|---|---|---|---|
| HEADQUARTERS MAC/AD | | | | |
| SCOTT AFB | IL | | | 3 |
| AF SATELLITE CONTROL FAC | | | | |
| SUNNYVALE AFS | CA | | | 1 |
| AFCCPC/SKEM | | | | |
| ALC/MMHH (T) | | | | |
| OC-ALC/MMECE | | | | |
| OC-ALC/MMMLT | | | | |
| SKEM-L-93 | | | | |
| TINKER AFB | OK | 2 | | 3 |
| 4315TH COMBAT CREW (SAC) | | | | |
| HQ WEST SPACE & MISS CNT | | | | |
| WESTERN SPACE&MISSILE CT | | | | |
| VANDENGURG AFB | CA | | | 3 |
| HQ USAF/ACDT | | | | |
| WASHINGTON | DC | 1 | | |
| HQ USAF/MDA903-82-M-4186 | | | | |
| WASHINGTON | DC | | | 1 |

# *MISSION*
# *of*
# *Rome Air Development Center*

*RADC plans and executes research, development, test and selected acquisition programs in support of Command, Control Communications and Intelligence ($C^3I$) activities. Technical and engineering support within areas of technical competence is provided to ESD Program Offices (POs) and other ESD elements. The principal technical mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, ionospheric propagation, solid state sciences, microwave physics and electronic reliability, maintainability and compatibility.*


FILM
1-8