

A Second Survey of Domestic Electronic Digital Computing Systems

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A SECOND SURVEY OF DOMESTIC ELECTRONIC DIGITAL COMPUTING SYSTEMS

ABSTRACT

Based on the results of a survey, the engineering and programming characteristics of one hundred and three different electronic digital computing systems are given. The data are presented from the point of view of application, numerical and arithmetic characteristics, input, output and storage systems, construction and checking features, power, space, weight and personnel requirements, production records, cost and rental rates, sale and lease policy, reliability and operating experience, engineering modifications and improvements and other related topics. An analysis of the survey data, fifteen comparative tables, a discussion of trends, a bibliography, and a complete glossary of computer engineering and programming terminology are included.

This report supersedes HRL Report No. 971

ACKNOWLEDGEMENT

The personnel of the Computing Laboratory of the Ballistic Research Laboratories wish to extend their appreciation for the excellent spirit of cooperation displayed by the various representatives of government and industry who have devoted their time and effort toward submitting the data in this report.

Many valuable suggestions were received from the engineering, mathematical and administrative staff personnel of the Computing Laboratory. Much valuable assistance was given by Dr. Charles V. L. Smith, Chief of the Computing Laboratory, Mr. Richard J. Bianco, Chief of the Computer Research Branch and Lieutenant William O'Mara, United States Army Ordnance Corps.

The largest individual contribution to this report was made by Mr. William Bramer of the Computer Research Branch. An undertaking as comprehensive as this survey, requires that a large quantity of data be correlated, transcribed and checked. Particular attention must be paid to accuracy and detail. The author is heavily indebted to Mr. Bramer for performing a major role in all phases of preparation of this report.

This report does not constitute an indorsement of any of the products described within it. Comments and suggestions are welcome.

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CHAPTER I

INTRODUCTION

INTRODUCTION

PURPOSE OF THE SURVEY REPORT

Before any major decision can be made regarding the acquisition, installation, operation, improvement or retirement of computing equipment, first hand technical information must be obtained concerning the characteristics, availability, cost, operational problems, capability and useful life of available systems. Efficient management requires that the experiences of others be exploited where ever such exploitation is beneficial. The computing and data processing field is a dynamic one. The present trend in design is toward higher speeds, increased reliability and solid state electrical components. Nevertheless, only existing or readily available equipment may be utilized for the immediate solution of scientific and commercial data processing problems. Many persons in the computing and data processing field are continuously seeking the answers to many questions. Some of these questions are: Can present methods, practices and procedures used in a given organization be accomplished by automatic computing and data processing equipment? Will investment in such equipment reduce costs, provide improved service, conserve manpower or save time? When shall existing computing equipment be modified, supplemented or replaced? Of all available equipment, what type of system is best suited for the solution of a given problem or a given group of problems? Is the maximum possible return being obtained from a given investment in computing equipment? Does a given problem require specially built equipment or is a solution to be found with commercially available standard equipment? Should computing equipment be rented or purchased? The purpose of a surveillance and evaluation program is to provide answers to these and similar questions.

Government agencies, particularly Department of Defense agencies, and their contractors, require the latest technical information concerning computing and data processing equipment in order to properly establish their policy regarding acquisition, installation, operation, improvement and retirement of equipment. The purpose, therefore, of this survey report is to allow government agencies and their contractors to benefit from the results of the computing system surveillance and evaluation program conducted by the Ballistic Research Laboratories.

In 1955, a survey of electronic digital computing systems was conducted by the Ballistic Research Laboratories in order to provide technical data for the evaluation of the then existing computing machine complement of the Laboratories. The results of that survey were made available in BRL Report Number 971, M. Weik "A Survey of Domestic Electronic Digital Computing Systems". The report was well received by persons in government and industry. The U. S. Department of Commerce undertook further printing and distribution of the report under cover of Public Bulletin 111996, Office of Technical Services.

A new survey of electronic digital computing systems was conducted during October, November and December 1956 and January 1957 by the Computing Laboratory of the Ballistic Research Laboratories. This survey was conducted as part of the continuous surveillance and evaluation program of the Laboratory. This report covers the results of the new survey and supersedes BRL Report 971.

SCOPE OF THE SURVEY REPORT

The survey is limited to commercially available and existing operational electronic digital computing and data processing systems manufactured or operated within the United States. Large, intermediate and small scale complete systems are included, regardless of whether the determination of "scale" is based on size, weight, cost or storage capacity. An attempt has been made to include both general purpose and special purpose equipment. It must be borne in mind that there is no clear-cut line of demarcation between systems designated as special purpose computing machines and certain "on-line" control applications, in which a computer is used to determine operational control-commands, based upon data received by the system from instruments measuring the results of the commands. These systems usually have analog input and output with internal digital computation and transformation of information to and from digital form.

Among the items not covered by this report are analog computing systems, foreign systems or separate computing system components, such as analog-digital converters, storage units, arithmetic units, input-output units, and data recording units, except when these are associated with specific complete systems. Many recording media converters, such as magnetic tape-to-card converters, card-to-paper tape converters, etc., are not specifically covered, except again as they are used with specific complete systems. By a "complete system" is meant an electronic digital computing system with input, output, control, arithmetic and storage units.

PROCESSING OF THE SURVEY DATA

A consolidated system description was prepared from all available data. Information concerning each computing system was divided into the following sub-headings:

- Applications
- Numerical System
- Arithmetic Unit
- Storage
- Input
- Output
- Circuit Elements Entire System
- Checking Features
- Power, Space and Weight
- Production Record
- Cost, Price and Rental Rate
- Personnel Requirements
- Reliability and Operating Experience
- Future Plans
- Installations
- Additional Features and Remarks

Naturally, information from several sources can be conflicting, since each source may interpret the same question differently or statements taken out of context may give rise to erroneous impressions. These discrepancies were resolved and clarified by further inquiry at the sources. The large volume of technical data processed for this report will make errors unavoidable, particularly in correlating and transcribing information. It will be appreciated if errors are brought to the attention of the Ballistic Research Laboratories.

It may be mentioned here that opinionated and controversial statements, claims and criticisms were screened as much as possible. Every endeavor was made to insure that the information included in the survey report was factual. To a large extent certain superlative adjectives used in describing equipment, were deliberately eliminated in the report as a matter of fairness and in order to avoid implication in sales activities.

INTERPRETATION OF THE SURVEY DATA

The interpretation of the data is perhaps the most difficult aspect of all, therefore much of this activity is left to the reader. In Chapter II, the data are grouped under specific headings and correlated as much as possible. The charts and tables in Chapter III have been prepared in order to show various relative characteristics, features and trends. An analysis and interpretation of the data accompanies these tables. It must be emphasized again that data taken out of context or disassociated from other related data, can be misleading. Because of this, the information contained in this report, particularly the tabular data of Chapter III, must be used with appropriate caution.

It is recommended that the prepared tables in Chapter III be used only as generalizations to show trends. Data on specific systems should be taken from the systems descriptions rather than from the prepared tables.

USE OF THE SURVEY REPORT

As has been previously stated, the computing field is a dynamic and rapidly changing one. From a technological point of view, it may well be that some of the information contained in this report is obsolete, since certain computing systems may be obsolete when they are installed. However, in most cases, manufacturers are accepting orders and will continue to produce, the systems described in this report for quite a number of years. Chapter II contains engineering and programming descriptions of 103 different types of computing systems. Persons who are interested in the acquisition of systems will find useful information on applications, cost, personnel requirements, and power and space requirements for specific systems. Operators may find useful suggestions on modifications and improvements. The question of reliability, a particularly difficult one to resolve, has been answered to some extent under the sub-heading: Reliability and Operating Experience. Under each sub-heading, the source of information is given. When a source is not stated, the manufacturer is the source of data.

The reader's attention is directed to Chapter III in which an attempt is made to evaluate trends in the computer field with respect to the various technical aspects of computing systems. A List of References and a Glossary are given in Chapters IV and V.

It is hoped that enough general and specific technical data have been compiled in the following four chapters to permit anyone involved in the computing and data processing field to draw at least some general conclusions and answers to the questions which may be occupying his mind at the present time.


MARTIN H. WEIK JR.

CHAPTER II

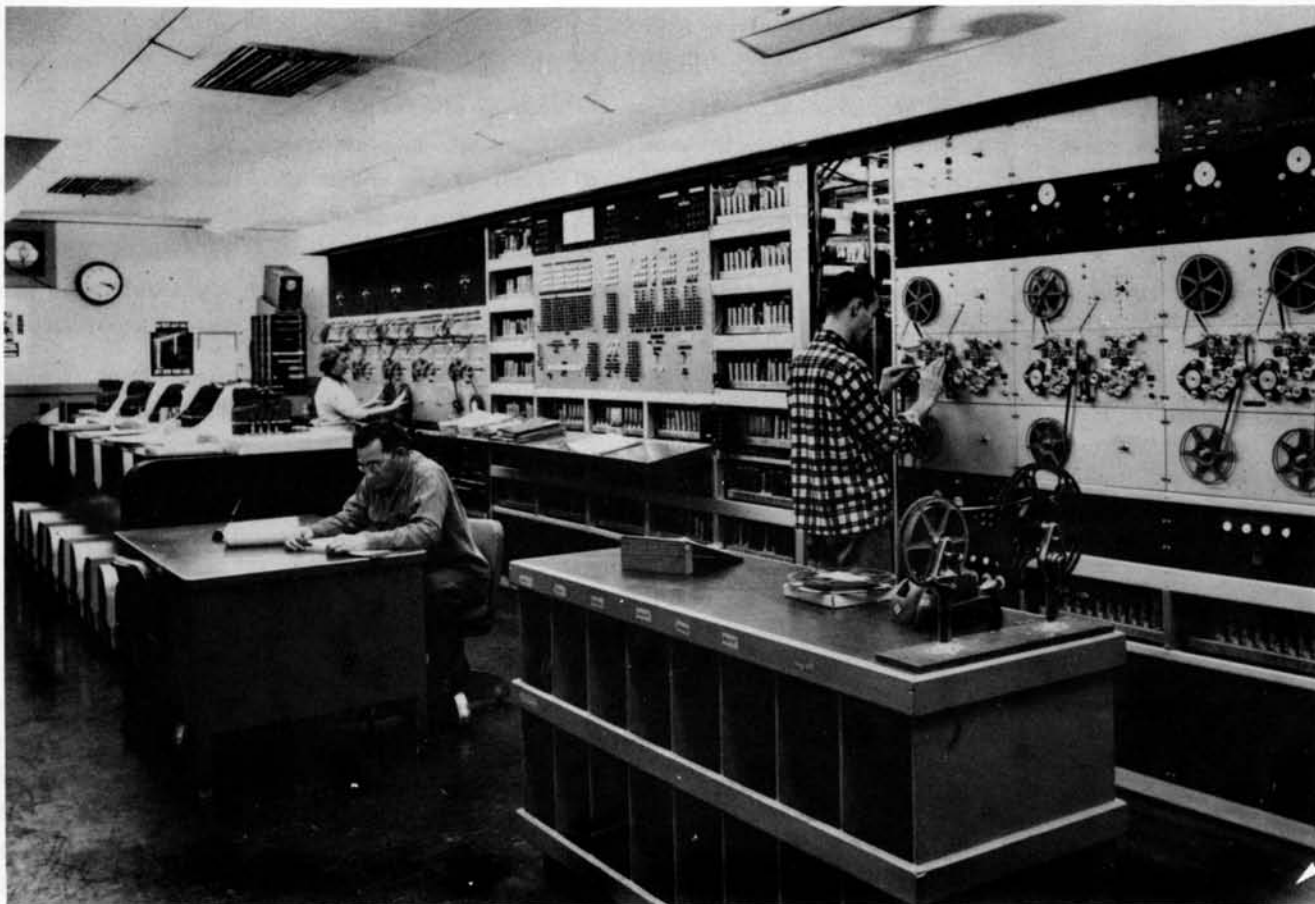
COMPUTING SYSTEMS DESCRIPTIONS

ADEC

Aiken Dahlgren Electronic Calculator

MANUFACTURER

Harvard University



Picture by U. S. Naval Proving Ground, Dahlgren, Virginia

APPLICATIONS

Ballistics, scientific calculations.

NUMERICAL SYSTEM

Internal number system	Bin coded dec
Decimal digits per word	16 + sign
Decimal digits per instruction	16
Instructions per word	1
Instructions decoded	13
Arithmetic system	Fixed point
Instruction type	Three address
Number range	0 to 10^{16}

ARITHMETIC UNIT

	Time	Microsec
Add (Includ. stor. access)		4,400
Mult (Includ. stor. access)		13,200
Construction		Vacuum tubes

Basic pulse repetition rate	30 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

System operates on a 30 Kc/sec clock. Storing of result overlapped with reading of next operands.

STORAGE

Media	Words	Digits	Access
Magnetic Drum	150	16 dec/word	4,400
Magnetic Drum	200	16 dec/word	4,400
Magnetic Drum	4,000	16 dec/word	80,000
Magnetic Drum	4,000	16 dec/word	4,400

The drums are used for the storage of constants, the storage of variables, for ten/twenty words per access, and the storage of instructions, respectively.



Picture by U.S. Naval Proving Ground, Dahlgren, Virginia

INPUT

Media	Speed
Magnetic Tape	5 words/sec

Eight units used.

OUTPUT

Media	Speed
Magnetic Tape	5 words/sec

Eight units used. Off-line printing from tape is available.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	5,000
Tube types	6
Crystal diodes	1,500
Separate cabinets	2

CHECKING FEATURES

Fixed	
Duplicate information on tape	
Illegitimate character check	
Parity check on instruction words	
Optional	
Identity check on operand registers.	

POWER, SPACE AND WEIGHT

Power, computer	40 KW
Space, computer	2,400 sq. ft.

Space, air cond.	30 cu. ft.	400 sq. ft.
The 2,400 sq. ft. includes the maintenance area.		
Capacity, air cond.	30 Tons	

PRODUCTION RECORD

Produced	1
Operating	1

COST, PRICE AND RENTAL RATE

Approximate cost of basic system \$600,000.
 Approximate cost of additional equipment \$50,000.

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
1-8 Hour shift	1	
3-8 Hour shifts	1	15

RELIABILITY AND OPERATING EXPERIENCE

Operating ratio (Good/Attempted to run) 0.80
 Figures based on period January 1955 to December 1955.
 System in operation since January 1951.

ADDITIONAL FEATURES AND REMARKS

Instructions and numbers are stored in separate storage units. Instruction tape preparation machine automatically inserts certain subroutines.