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COMPUTER GRAPHICS

VOLUME II

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AN ANNOTATED BIBLIOGRAPHY TO THE NASA-MSFC DIGITAL COMPUTER GRAPHICS PROGRAM

Contract NAS 8-21227

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ABSTRACT

These 276 selected references were compiled by Lockheed Missiles & Space Company as a part of the literature search effort in support of Contract NAS 8-21227, "Digital Computer Graphics," performed for Marshall Space Flight Center of the National Aeronautics and Space Administration.

This literature provides a state-of-the-art review of the latest published literature in the area of computer graphics. Included are citations to some of the principle contributions in the literature during the period from 1960 to October 1967, including both open and Government sources.

The references are arranged alphabetically by personal author or title. An Author, Corporate Source, and a Subject Index have been included to assist in locating specific items of interest.

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PREFACE

Many important advances are being made in computer technology that enable man to use the computer on an interactive basis to solve complex problems significant to business, industry, and the scientific community. Graphic interface now permits direct communication between the specialist and the computing equipment.

Computer aided design is based on real time graphical dialogue between man and the computer in which man draws on a CRT display by means of graphical input devices such as light pens, joysticks, wand, keyboards, etc.

Many applications are being studied; Information retrieval, numerical controlled machining, structural analysis, shipbuilding, circuit analysis, logic design, aircraft and automotive design, are but a few of the areas being explored.

The references contained herein were selected to provide a compilation of the related efforts in computer graphics.

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DD FORM 1473 125

1. Abzug, I.
GRAPHIC DATA PROCESSING. Datamation, 11:35 – 37, Jan 1965.

This article describes graphic data processing equipment for use with the IBM System/360, which provides facilities for such tasks as computer-aided design, updating of microfilm files of engineering drawings, reduction of graphical data, (e.g., electrocardiograms) into digital form, and the preparation of statistical business graphs. The main elements of the system include visual display consoles with light pen and vector graphics capability, 35 mm film recorder and 35 mm film scanner.

2. Adamowicz, M.
GRAPH PAK I – A THREE-DIMENSIONAL MANIPULATION PROGRAM. Lab. for Electroscience Research, New York University, N. Y. Tech. Note No. 400-24(Grant NGR-33-016-038). NASA-CR-69665. 10 Sep 1965, 52p. N66-15984.

This report describes the development and use of Graph-Pak I, a 3-dimensional manipulation and plotting program. This program was written for a PDP-5 digital computer with a 4K memory and a CALCOMP digital plotter. It enables the user to describe an object in terms of points and straight lines and then obtain a perspective drawing of the object in any desired orientation. In addition, certain kinds of distortions and alterations can be made without having to redescribe the object; however, there is no provision for removing hidden lines.

3. Aleskerov, S. A. and T. A. Aliyev
ABOUT A GRAPHIC DATA TRANSFORMING INSTALLATION FOR INTRODUCTION INTO AN ELECTRONIC DIGITAL COMPUTER. Air Force Systems Command, Foreign Technology Div., Wright-Patterson Air Force Base, Ohio. Transl. into ENGLISH from Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Mat i. Tekhn, Nauk (Baku), no. 1, 1964, pp. 43 – 48. (FTD-TT-65-1992; DDC AD-645822). 29 Jul 1966, 11p. N67-22599.

A device is proposed for the introduction of graphs on paper tapes of any arbitrary width into the ETSVM in which the transformation of graphs is conducted by the

method of transverse approximation. For the approximation of graphs is used a series of sensitive elements – CHE, situated on one straight line called sensitive line-approximator. In dependence upon the content of computer S-chi at each given time moment one of the CHE will have a high level-questioned. With this are determined the abscissas of the point of graph t sub i in form of a corresponding memory address of the machine.

4. Allen, T. R. and J. E. Foote
INPUT/OUTPUT SOFTWARE CAPABILITY FOR A MAN-MACHINE COMMUNICATION AND IMAGE PROCESSING SYSTEM. Proc. 1964 Fall Joint Computer Conference, 387 – 396.

This paper is concerned with the extensive, flexible and powerful input/output software capability developed for the use of the IBM 7960 Special Image Processing System in the DAC-I system. The aim was to produce a set of general purpose, problem oriented subroutines and source language statements, each serving as a tool in the utilisation of the various input/output capabilities of the hardware. Descriptions are given, with typical examples of their application, of five representative utility subroutines (alphanumeric input, numeric input (2 subroutines), positional data input, and decision information input), and three source language statements (display format statement, record format statement, and generate format statement).

5. AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, FALL JOINT COMPUTER CONFERENCE, SAN FRANCISCO, CALIF., NOVEMBER 7 – 10, 1966, PROCEEDINGS. Washington, D. C., Spartan Books (AFIPS Conference Proceedings, Volume 29), 1966, 828p. $20.75.

6. Ammerman, A. B.
ANALYST ASSISTANCE PROGRAM (AAP) FOR ON-LINE COMPUTATIONS VIA 2250 GRAPHICAL TERMINALS CONNECTED TO AN IBM 360/40 COMPUTER. Technical memorandum, Naval Weapons Lab., Dahlgren, Va. Rept. no. NWL-TM-K-28/67. Mar 1967, 55p. DDC AD-855443.

The memorandum describes the implementation and utility of a computational tool called Analyst Assistance Program (AAP). AAP is a conversational computing facility used for performing small non-recurring numerical computations. The language was designed to make it possible for non-programmers to learn and use the system with a minimal amount of instruction (10 – 15 minutes). The system is implemented on an IBM 360/40 computer which consist of two user consoles, each with a cathode ray tube display, light pen and low speed printer.

7. Aranda, P., S. Hori, and R. N. Little
APT – PRESENT AND FUTURE. SAE – Paper 660354 for meeting, June 6 – 10, 1966, 12p.

APT (Automatically Programmed Tools) system was developed by M.I.T. and companies of Aerospace Industries Assn. of America; APT Long Range Program consists of community of participating organizations, plus technical staff comprising APT project; APT system converts APT language statements to signal codes for automatically directing numerically controlled machine and provides vocabulary for geometric definitions of parts, tool motion statements, auxiliary function and system commands; future developments include language of higher abstraction levels, on-line keyboard and graphics, and compatibility with computer aided design and analysis.

8. Argyris, J. H.
A LOOK INTO THE FUTURE – HOW COMPUTERS WILL INFLUENCE ENGINEERING. (Royal Aeronautical Society and Institution of Mechanical Engineers, Symposium on the Impact of Digital Computers on Engineering, London, England, Apr 20, 1966). Royal Aeronautical Society Journal, 71:244 – 252, Apr 1967; Discussion, p.261 – 270.

General discussion of digital computers and their languages, in relation to engineering analysis problems. Several examples from the matrix theory of structures are given, showing how the designer is allowed to refine his design employing advanced methods of analysis already programed for the machine. Having developed a tentative design after several "conversations" with the computer, the design/engineering team may request an automatic machine-tool output for the preparation of models at any scale desired or for templates to aid in building a full-size wood and plaster mock-up. Having finalized the design, the man/computer team may then request from the computer automatic machine-tool outputs for the production of prototype vehicles. Computer languages such as FORTRAN, COBOL, and ALGOL are discussed.

9. AUTOMATIC DRAFTING ON LOW-COST UNIT.
Iron Age. 193(11):148, Mar 12, 1964.

New drafting machine developed by Gerber Scientific Instrument Co., Hartford, Conn., turns out drawings from computer outputs or from manually programmed tapes; drawing speeds can be up to 200 ipm; new machine creates engineering drawings from punched tapes; it verifies machine tool cutter paths that are defined on tapes; working through its electronic logic system in other direction, unit called VP600, produces data displays from drawings, graphs, and maps.

10. Ball, N. A., H. Q. Foster, et al
A SHARED MEMORY COMPUTER DISPLAY SYSTEM. IEEE Trans. Electronic Computers, EC-15, Oct 1966, 750 – 756.

This paper discusses a display system which was implemented to provide a flexible test bed for man-machine interaction. The dicussion includes both hardware and software design concepts, and concludes with an evaluation of the system based on operating experience. The philosophy of design throughout was that hardware should not limit the programmer's flexibility. The two significant organizational feature of the display system are (1) the sharing of memory between a normal computer and a special picture computer (a modified display unit), and (2) the capability of the latter to execute subroutines. The display system consists of a modified Digital Equipment Corporation Type 340 Display (the picture computer) attached to a PDP-4 (the normal computer) which provides both system control and system memory. The PDP-4, which serves the immediate computational needs of the user, is connected to a larger, host computer, a CDC 1604A. The small computer and the display, together with manual intervention devices (knobs, pushbuttons, light pens, etc.), provide a general purpose facility for man-machine communication.

11. Balsam, M.
NUMERICAL CONTROL AND AUTOMATED MANUFACTURING PROCEDURES. Rubber World, 156(2):75-77, Sep 1967.

Numerical control applications have been significantly augmented by computer techniques. Process control and data processing become an integrated system combined with computerized decision making on many levels, result in the automated company of the future.

12. Barmack, J. E. and H. Wallace Sinaiko
HUMAN FACTORS PROBLEMS IN COMPUTER-GENERATED GRAPHIC DISPLAYS. Institute for Defense Analyses, Research and Engineering Support Div., Arlington, Va. (Contract ARPA-SD-50). (S234; IDA/HQ-66-4820; DDC AD-636170). N66-37087.

The study is a review of current practices in computer-generated graphic displays from the point of view of engineering psychology. Input devices, which are integral to man-computer systems, are also considered. Theories of cognition are examined with respect to their applicability to computer-graphics.

13. Baumann, D. M., S. J. Fenves, and L. A. Schmit, Jr.
THE IMPACT OF COMPUTER CONCEPTS ON ENGINEERING DESIGN. IN Am. Ordnance Assoc. Discussion Group on Computer-Aided Design and Doc. 1st Meeting and Subsequent Action Report, May 1965. Commission on Engineering Education, Washington, D.C. (Rept.-1), Mar 1966, 19p. X66-21696.

NOTICE: Available to U.S. Government Agencies Only.

This discussion describes the engineering design process, the present status of computers in engineering design, the interaction between the designer and the computer, the future use of computers in engineering design, and the educational implications.

14. Baughman, J. A.
NUMERICAL CONTROL PART PROGRAMMING USING COMPUTER-AIDED DESIGN. IN: AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS; SOUTHEASTERN ENGINEERING CONFERENCE AND TOOL EXPOSITION, ATLANTA, GA., OCTOBER 27-29, 1965. COLLECTED PAPERS. Dearbonr, Mich., American Society of Tool and Manufacturing Engineers, 1965, 10p.

Review of the development of a prototype graphical part programing system based on the concepts of computer-aided design (CAD). The CAD equipment is described and illustrated, and its suitability for numerical control application is studied. Advantages and disadvantages of the CAD concept are outlined, and its future prospects are discussed. It is anticipated that industry will derive increased efficiency, shorter span time, and lowered production costs through use of this new design concept.

15. Beach, F. J.
A FLEXIBLE AND VERSATILE DISPLAY FOR COMMAND AND CONTROL: THE BR-90.
Information Display, 4(3):62-66, May/Jun 1967.

The Bunker-Ramo Corporation's BR-90 (AN/FYQ-37) Visual Analysis Console was developed in conjunction with automatic information handling systems to provide rapid data display and operator communications with high-speed digital computers. System operators can query a computer by simple keyboard operations to selectively obtain information; this information when retrieved and transmitted to the console, is immediately displayed in textual or graphic form. In addition, the system operator can create his own displays off-line from the computer and subsequently up-date the computer information files or store the data for later use.

16. Beard, R. G. and A. E. Singfiel
COMPUTER PRODUCES PRECISION DRAWINGS.
Tool & Mfg. Engr., 56:76–77, Jun 1966.

This article describes how computers are being used to assist designers in producing comparator charts for parts inspection. These charts are precision drawings requiring placement of elements within 0.001-inch tolerance. Numeric and simple English-coded statements are keypunched for input to an IBM 7090. This computer generates instructions for input to an IBM 1401 coupled to a CalComp 546 plotter. The plotter produces a precisely drawn chart which is converted photographically into a positive transparency for use on a comparator.

17. Belt, S. L. and W. O. Galitz
UPGRADING THE MAN-COMPUTER RELATIONSHIP. Sperry Eng. Review, 20(2):24–30, 1967.

The ultimate goal of the man-computer relationship is a partnership in wich men will need concern himself only with his problem and not with the mechanics of computer operation. Through the use of typewriter like keyboards and cathode ray tube (CRT) display, man can now interact with computers easily.

18. Bennett, E., E. C. Haines, and J. K. Summers
AESOP: A PROTOTYPE FOR ON-LINE USER CONTROL OF ORGANIZATIONAL DATA STORAGE, RETRIEVAL, AND PROCESSING. Mitre Corp., Bedford, Mass. Report no. MTP-23, Nov 1965, 24p. Contract: AF 19(628)-5165, TR-65-145. DDC AD-632 320.

AVAILABILITY: Published in Proceedings – Fall Joint Computer Conference, pp. 435–55, 1965.

AESOP is an experimental on-line information control system serving as a prototype for a class of management or command information systems capable of giving the members of the using organization as much on-line control over system performance as possible. It is a CRT display-oriented system in that the user experiences the information system primarily through his CRT displays and exercises his control through his light pencil. The current version of the AESOP prototype operates on an IBM 7030 (Stretch) computer (65K memory with 64-bit words) with a 353 disk storage unit holding two million words. Each of the four user stations consists of an on-line data-display-13 display console with a photoelectric light pencil, an on-line typewriter,

and a Stromberg-Carlson 3070 medium-speed printer. The AESOP system is designed to take advantage of the range of capabilities implied by this central processor and the user station equipment.

19. Bental, L. J.
GRAPHICAL COMMUNICATION WITH DIGITAL COMPUTERS. Joint Computer Conference, Eastbourne. Instn. Elect. Engrs. Conf. Publ. (GB), No. 19, 227–35, 1966.

Graphical communication facilities considerably increase the power of digital computers and open new fields of application. A system, developed as part of a computer aided design progamme is described in some detail. In particular, requirements for picture manipulation are investigated. Finally, a number of applications are listed which indicate the very wide range of problems in which graphical input/output facilities can be used. It is suggested that such facilities will become standard in the scientific computer field.

20. Berg, K. J. and A. J. Schmitt
GRAPHIC DISPLAYS GENERATED FROM DIGITAL COMPUTERS. American Institute of Aeronautics and Astronautics, Annual Meeting, 3rd, Boston, Mass., Nov 29 – Dec 2, 1966, Paper 66-854. 6p.

Description of data processing activities and ancillary equipment developed and used in advanced techniques of computer-generated graphics for a weather observing and forecasting system. A major area of this activity supported the development of computer programs to convert input data to binary images for the graphic presentation of contours, alphanumerics, background maps, and isoshades. These programs, originally intended to prepare automated weather charts, were expanded to include a number of other areas, such as line plots, bar charts, engineering drawings, halftone pictures, geological controus, seismic traces, and war game maps that have application in industry and the military.

21. Bernholtz, A.
COMPUTER GRAPHIC DISPLAYS IN ARCHITECTURE. Sixth National Symposium on Information Display, New York, 1965 (North Hollywood: Western Periodicals Company, 1965), pp. 167–76.

Deals with the use of computer graphic displays as an aid in the synthesis of architectural form.

22. Bernholtz, A.
COMPUTER GRAPHIC DISPLAYS IN ARCHITECTURE. Information Display, 3(2):52–55, Mar – Apr 1966.

This paper deals with the use of computer graphic displays as an aid in the synthesis of architectural form. One of the major drawbacks in the historical process of designing an environment is that there is no way of pre-testing the effect of a form on those who will experience it. There is, therefore, no way of "correcting errors" in form synthesis, until the structure is actually built, and not readily susceptible to correction except at great expense. But using computer-generated perspectives and other three-dimensional views, we can simulate the visual experience of a projected environment under various conditions. By generating multiple views, of a form, from different positions, or successive views with varied viewing distances, and then producing standard or animated motion pictures of these views, we can simulate the visual experience of walking through the environment. Moreover, by generating stereo pairs of views, an illusion of real depth-of-space can be created. To test the effect of computer graphic simulation, various people can view the film produced while wearing a "head camera." This device records the actual film and at the same time superimposes on it a small spot of light bounced off the retina of one of the viewer's eyes, giving simultaneously, a record of his visual reaction and the object viewed. By combining this computer-assisted simulation of form with a computer-aided analysis of the design problem, environment forms of consistent functional and aesthetic merit can, we believe, be produced by the creative designer.

23. Bernier, J. C.
HOW TO DRAW PERSPECTIVES BY COMPUTER. Design Eng., 10(2):37–41, Feb 1964.

Description of method based on solid analytical geometry principles for automatic production of true perspective and axonometric drawings from orthographic coordinates of component points of given object; drawings are obtained automatically on XY plotter directly actuated by computer, or, alternatively, they may be rapidly plotted by hand from tabulated computer results.

24. Bernstein, M. I.
COMPUTER RECOGNITION OF ON-LINE, HAND-WRITTEN CHARACTERS. Rand Corp., Santa Monica, Calif. Oct 1964, 32p. (Contract ARPA SD-79; ARPA Order 189-61) (RM-3753-ARPA; DDC AD-451231). N65-16221.

A method is discussed for recognizing single, hand-written characters using an on-line graphical input device, such as a digitizing pantograph, a light pen, or the RAND Graphic Input Tablet, as the primary information source. Basically, the method consists of filtering and smoothing the input stream to eliminate as much redundancy as possible. Direction of the stylus movement is quantized into one of eight directions, allowing each stroke of a character to be described as a series of connected straight line segments. By eliminating various measures on the stroke, the description is size-, position-, and rotation-independent. In order to restore some rotational orientation and to discriminate between open, closed, and multistroke characters, end-point comparisons are added to the description.

25. Bial, W.
A COMPUTER CONTROLLED C.R.T. DISPLAY SYSTEM. Electronic Engng., 38:354–59, Jun 1966.

This article describes a cathode ray tube display system primarily intended as a fast output unit for a digital computer. It is designed mainly to display text and tabulated data rather than graphs or diagrams. Descriptions are given, in particular, of the circuits for digital to analogue conversion, coordinate drawing and character generation.

26. Bitzer, D. L. and H. G. Slottow
THE PLASMA DISPLAY PANEL – A DIGITALLY ADDRESSABLE DISPLAY WITH INHERENT MEMORY. Proc. 1966 Fall Joint Computer Conference, 541 – 547.

The Plasma Display, consisting essentially of a matrix of gas discharge cells, is a new device that, in contrast to the cathode ray tube, retains its own images and responds directly to digital signals from a computer. Its resolution is comparable to that of cathode ray tube displays, and in addition it can be interrogated by the computer. It also seems likely that images can be drawn directly on the display panel by means of a light-emitting pencil. This paper gives a brief description of the Plasma Display, which is still at an early stage of development, and discusses, on the basis of its known or estimated properties, the role it could play in future computer systems.

27. Black, G. and D. R. Judd
COMPUTER NETWORKS. Science Journal, 3(9): 35–40, Sep 1967.

Plans to establish nation-wide computer networks are now being considered in many countries. The aim is to provide the computer user with immediate access to a

wide range of computer facilities and to make direct man/computer communications easier. Graphic display of data is becoming increasingly important, especially in computer aided design.

28. Boehm, B. W.
TABULAR REPRESENTATIONS OF MULTI-VARIATE FUNCTIONS – WITH APPLICATIONS TO TOPOGRAPHIC MODELING. Rand Corp., Santa Monica, Calif. Report no. RM-4636-PR. Feb 1967. (Contract: F44620-67-C-0045). DDC AD-649 330.

An analysis of the computational spacetime tradeoff for various tabular representations of multivariate functions, particularly topographic representation techniques. Performance comparisons as related to terrain smoothness, terrain diversification, and accuracy of depiction are made of two contour methods, two uniform grid methods, and the Rand variable grid (microgrid) differential altitude method of tabular representation. The microgrid representation is found to be generally superior, but many problems have special properties which make other methods more efficient. The formulas given are upper bounds of time and cost for each method; they show whether or not it is necessary to analyze a problem for special structure to make it computationally tractable. Polynomial, statistical, and analog methods are discussed briefly. Graphic input devices, such as the Rand tablet, facilitate preprocessing and reduce costs in elapsed time and dollars. Appendixes give an algorithm and convergence theorem for the contour tree representation, and describe the Rand microgrid.

29. Boehm, B. W.
KEEPING THE UPPER HAND IN THE MAN-COMPUTER PARTNERSHIP. Rand Corp., Santa Monica, Calif. Apr 1967, 28p. (P-3533; AD-650371). N67-28963.

Contents: Augmenting creativity; Computer characteristics; Artificial intelligence; The AIAA computer subcommittee; Hardware trends; Large-scale integrated circuits (LSI's); Hardware performance; Computer organization trends; Man-Computer partnership On-Board; The on-board information explosion; Real time operations; Conversational computing; On-line systems and computer graphics; Implementation problems; Changing one's problem-solving methodology; The computer downstairs; Diversity and change; New directions; Social implications; Numerical analysis; Software; Systems analysis; Procrustean computer system; Maintaining relevance; Creativity aided, not replaced.

30. Brain, A. E., R. O. Duda, et al
GRAPHICAL DATA PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Quarterly Progress Rept. 5, 1 Jul – 30 Sep 1964.
Rept. no. 17, Oct 1964. (Contract: DA36
039AMC03247E). DDC AD-453 094.

Two groups of tests were run on the SDS 910 simulating the operation of MINOS II. In the first group, the operation of a single-bit output machine (the ninth output bit of MINOS II) was simulated and precessed a data tape that MINOS II had previously been trained on. Results indicate that the performance of MINOS II is presently comparable with that of a perfect equivalent machine in which a disturbing noise level of 1% has been introduced. The second group of tests was concerned with the behavior of MINOS II on the 5-bit parity problem, the standard checkout test. The simulation showed that states in which a cycle recurs endlessly (trap states) occur with a frequency comparable to that observed experimentally. A review is presented of the carrier drive design problem as it exists in MINOS II. There are basic difficulties, and an alternative approach is suggested. MINOS II and the SDS 910 use paper tape for permanent program and data storage. This medium has been found to be relatively constraining, but the limitation has now been virtually removed by the edit program which allos great flexibility in error correction and duplication.

31. Brain, A. E. and J. H. Munson
GRAPHICAL DATA PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Quarterly Progress Rept. No. 7, 1 Jan – 30 Apr
1965. Rept. no. 19, May 1965. (Contract: DA36
039AMC03247E). DDC AD-618 567.

A calculation was made of the positional errors arising from the simple plano-convex lens used as a collimator in the optical preprocessor. The performance is fully adequate to satisfy the demands of the present application. An extensive experimental investigation was carried out on hand-drawn military map symbols. 405 slides were prepared and read by the 100-image preprocessor on three separate days, the intermediate 100-bit code word being recorded from the ternary buffer onto paper tape. A total of 3240 code words were recorded, and subsequent training and analysis tests were made via the tape rather than the preprocessor. A program simulating MINOS II was run in parallel to provide for comparing the results that would have been given by MINOS II if it had been operating perfectly. The following conclusions were drawn: (1) the reproducibility of the observed behavior was sufficient to yield meaningful

results, (2) the data base was still too small for the training data to be fully representative of the test data, and (3) the particular choice of output codes had a substantial influence on the difficulty of training to a low error rate.

32. Brain, A. E., R. O. Duda, and J. H. Munson
GRAPHICAL-DATA-PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Quarterly Progress Report No. 8, 1 May – 31 Jul
1965. (Rept.-20;AD-623280), Aug 1965, 39p.
(Contract DA-36-039-AMC-03247(E)). N66-14396.

A method for making a mask-plate for the 1024-image preprocessor is described in detail. The masks are organized in pairs and with the appropriate circuitry function as edge-detectors. Recognition experiments on hand-drawn map symbols parallel to those previously reported for the 100-image preprocessor have been carried out using the 1024-image preprocessor. In order to extend the work on mask design by simulation, it is desired to input a low-resolution TV picture into the SDS 910 computer. The standards chosen are 24-line and 120-line. Seven methods for interfacing the TV camera output with the SDS 910 have been examined. The shift-register method has been selected for implementation.

33. Brain, A. E., R. O. Duda, et al
GRAPHICAL-DATA-PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Quarterly Progress Rept. No. 9, 1 Aug –
31 Oct 1965. Rept. no. SRI-R-21. Nov 1965,
39p. (DA-36-039-AMC-03247(E)). DDC AD-
627 335.

The experiments on the recognition of hand-drawn military map symbols, using the edge-detector mask plate in the 1000-image preprocessor, have been continued with each image being displayed in a series of 9 positions, plus a 10th view with the image somewhat larger. This gave a data set of 4050 patterns; 3240 were used for training, 810 for testing. The error rate was relatively higher for the training data as compared with previously reported results, but relatively lower for the test data. The piecewise linear structure performed significantly better than the committee machine. A brief account is given of the method used to display the characteristics of the dot product units in MINOS II. The shift-register interface between the TV camera and

the SDS 910 has now been complted and is operational. Illustrations are shown of the normal picture, quantized picutre, 120-line stored picture, and 24-line stored picture for the map symbols used in the tests described.

34. Brain, A. E. and S. W. Miller
GRAPHICAL DATA PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Rept. no. 14 (Quarterly Progress Rept. no. 2)
1 Sep – 31 Dec 1963. Jan 1964, 33p. (DA36
039AMC03247E, DA36 039SC78343). DDC AD-
600 331.

Modifications have been made to the design of the 1000-image preprocessor to improve the signal-to-noise ratio where this was marginal, and to provide better integration of the light transmitted by the masks. The study of the interface problem between the Burroughs B 5000 and MINOS II infers that cooperation between the two machines on a time-sharing basis is practical. The ramp generators used in the weight-changing algorithm and in the 100-image preprocessor are discussed in detail.

35. Brain, A. E., D. J. Hall, and J. H. Munson
GRAPHICAL DATA PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Rept. No. 15 (Quarterly Progress Rept. No. 3)
1 Jan – 31 Mar 1964. Apr 1964, 34p. (DA36
039AMC03247E, DA36 039SC78343). DDC AD-
601 742.

Several aspects of the practical procedures for using MINOS II are examined. The SDS 910 computer has been selected for use with MINOS II on the basis of an overall evaluation of characteristics. Some guidance is given on methods of input and output coding. The parity functions have been found useful for testing and check-out.

36. Brain, A. E. and J. H. Munson
GRAPHICAL-DATA-PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst. Menlo Park, Calif.
Rept. No. 22 1 Jun 1963 – 1 Jan 1966, Final
Report. Apr 1966, 91p. (DA-36-039-AMC-
03247 (E)). DDC AD-632 563.

The design and operation of MINOS II are briefly summarized, including the built-in algorithms, the method of weight-changing and the use of snake-in-the-box codes for treating analog parameters. The design of a 1024 image optical preprocessor is discussed in the light of its development from the 100-image preprocessor. An SDS-910 computer was installed to supervise MINOS II; when the ultimate objective of this project is reached the pattern-recognition equipment will be fully integrated into a data-storage and retrieval complex, and this was the first step toward that goal. A discussion is given of the experimental results starting from the early hand-drawn map symbol experiments with the 100-image preprocessor. Corresponding experiments were carried out with the 1024-image preprocessor using edge-detector masks occupying 8 percent of the retinal field as compared with 50 percent masks in the earlier equipment. A selective-attention experiment is described in detail. This isolated approximately ten map symbols appearing in the field simultaneously, in a manner which would permit them to be correctly categorized if the appropriate pattern-recognition function were provided.

37. Brain A. E. and J. H. Munson
GRAPHICAL-DATA-PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
First Quarterly Report, 1 Feb – 30 Apr 1966.
Rpt. 23. Jul 1966, 45p. (Contract DA-28-043-
AMC-01901(E)) (ECOM-01901-23; AD-634022).
N66-38516.

The hardware software, techniques and experience that were developed under the preceding Contract DA 36-039-AMC-03247(E) are briefly reviewed and are used in assessing the subject matter for further experiments. The criteria given most weight in evaluating the various types of graphical data are that the symbols be hand-drawn, that they be produced by a writing instrument that gives strokes of appreciable width, and that they occur in a situation that requires selective attention and the use of context. They are to appear in a free-field, i.e., a field without boundaries or special reference marks. The subject matter selected was computer coding sheets, where the computer language determines the character set and contextual relationship;

the chosen programming language was FORTRAN. A special input system has been built and tested, and some initial results on reading coding sheets are reported. The conclusions that have been drawn regarding preprocessor design from the experiments with the 1024-image preprocessor are briefly summarized; our present position is that we would like to use sample areas covering 0.1% to 1% of the field in our property detectors, and to have at least 10,000 samples. The limitations of the existing preprocessor in relation to the new requirements are discussed and the constants of two possible designs based on multiple cathode-ray tubes and tubes with a fiber-optic faceplate are examined.

38. Brain, A. E., P. E. Hart, and J. H. Munson
GRAPHICAL-DATA-PROCESSING RESEARCH STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Quarterly Rept. no. 3, 1 Aug – 31 Oct 1966.
Oct 1966, 33p. (DA-28-043-AMC-01901(E)).
DDC AD-645 996.

The results of experiments on piecewise-linear learning machines with handprinted characters are reported. The data, as before, consisted of three 46-character FORTRAN alphabets from each of 16 writers. The results of experiment 3, a nine-view experiment, were compared with seven, five, three, and one-view results on the same training and testing set. The test error rate on characters not included in the training set fell steadily from 42 percent with the single view to 24 percent when the category of the character was determined from nine views. Results are reported on the program, which includes both preprocessing and classification. It is based on contour following and the determination of features including connected subfigures, strokes, concavities, and enclosures. The particular problem treated is the separation of "6S" for "GS." A method of using the 1024-image optical preprocessor for the proprocessing of speech waveforms is described and some of the considerations that govern its practical implementation are discussed. The method is based on the determination of the amplitude coefficients of a FOURIER series.

39. Branin, F. H., Jr.
COMPUTER METHODS OF NETWORK ANALYSIS. International Business Machines Corp., Systems Development Div., Poughkeepsie, N. Y. IN: NASA, Electron, Res. Center Computer-Aided Circuit Design Seminar, 1967, pp. 3 – 5. Presented at the IEEE Intern. Conv., New York, 20 – 23 Mar 1967. (IBM-TR-00-1562). N67-22622.

The network problem concerned with predicting the behavior of a system of interconnected elements in terms of the elements in terms of the element characteristics and the manner of interconnection of these elements is discussed. The formulation of the network problem by a matrix-topological method; and analyses of the problem by the classical mesh, node, outset, and mixed methods, are briefly reviewed. The mixed method is applicable to dc and ac network problems as well as to transient problems. Numerical techniques for solving both linear and nonlinear dc problems, and ac problems, are discussed. The importance of the computer influence in these techniques is stressed.

40. Brending, D. O.
COMPUTERS AND TECHNICAL DOCUMENTATION – AUTOMATIC DRAFTING NOW. Graphic Science, 6(5):23–24, 26–31, May 1964.

Autographics, computer graphics and production programs that turn out drawings are described; time savings are held more important than labor savings; computers create wiring diagrams, assembly diagrams and drawings produced by modified high speed mechanical printer; drawings can be classified from crude to excellent; automatic drafting as integral part of design automation is stated to be proven concept.

41. Bridegam, A. D.
DIGITIZING. A PHASE I SOLUTION TO ENGINEERING AUTOMATION. Sandia Corp., SC-R-66-846, Feb 1966, 32p.

The paper describes use of a coordinate digitizer as a "programming machine" for automatic drafting, engineering analyses, drafting aids, and experimental N/C machining. It is intended to reveal an approach to the problem of initiating an engineering automation system. Basically the digitizer system consists of two devices to extract data from a drawing: the reading table, which is quite similar to a standard vertical drfating table and contains a movable reading head, and a set of readout

buttons which are attached immediately adjacent to the reading head cursor. The reading table is electrically tied to the digitizer control system. This control is a completely digital system which receives coordinate information from the reading table in increments as small as 0.001, and then, depending on various switch settings, transmits the information to a set of output devices. To the original graphical input record (the printed-circuit layout) there have been added layouts, part drawings, and sketches. To the original output (printed-circuit master tapes) there have been gained program decks for engineering analysis, point definitions for APT part programs, and N/C tapes for two-axis machine tools.

42. Brown, R. M.
ON-LINE COMPUTER RECOGNITION OF HAND-PRINTED CHARACTERS. IEEE Trans. Electronic Computers, EC-13, Dec 1964, 750 – 752.

This note describes simple stylus and platen which, via a modest computer program (written for the CSX-1) permits recognition of a wide range of alphanumeric and mathematical symbols. Contact between the metallic stylus and metal inserts in the platen activates logical circuits which transmit binary codes, different for each insert, to the computer input.

43. Burnaugh, H. and W. Moore
COMMAND RESEARCH LABORATORY: THE VARIABLE DISPLAY SYSTEM. Systems Development Corp., Santa Monica, Calif. 10 Aug 1964. (SP-1722/001/00; AD-606179). N65-14839.

With the computer programs, light pen, and display console of the Variable Display System, tasks can be performed on line that are traditionally done off line with card-sorting and reproducing machinery. Tabular data may be retrieved from up to 58,949 categories and manipulated on the display by selective application of the light pen to the surface of the cathode-ray tube. Data may be added, modified, deleted, and compressed; final or intermediate formulations may be printed out for later use.

44. Cameron, S. H.
GRAPHICAL LATHE PART PROGRAMMING SYSTEM. IIT Research Inst., Chicago, Ill. Final Report, 3 Mar – 30 Jun 1965. Prepared for Sandia Corp., Livermore, Calif. Jul 1965. (Contract AT(29-1)-789). (SCL-DC-65-86). N66-23127.

A proposed system (GLPPS) is described for the application of on-line graphical communication techniques to the area of N/C part programming. The system utilizes a light-pen/CRT input/output station, together with a general purpose digital computer. GLPPS is a system specifically directed at the problem of generating part programs for N/C lathes and is designed to interface with the APT Automatically Programmed Tools system. A discussion is given of some of the general relations between graphical communications techniques and languages, time-shared on-line access to a large-scale digital computer, and the problems of design and fabrication of lathe parts. Two descriptions are given of GLPPS; one from the viewpoint of the system designer and one from the viewpoint of the on-line user. An appendix describes an approach to the implementation of one of the essential features of GLPPS, the lathe simulator.

45. Cameron, S. H., D. Ewing, and M. Liveright
DIALOG: A CONVERSATION PROGRAMMING SYSTEM WITH A GRAPHICAL ORIENTATION. IIT Research Inst., Computer Sciences Div., Chicago, Ill. Sep 1966. (TN-109;AD-646857). N67-24822.

DIALOG is an algebraic language for on-line use with a graphical input-output console device. It is a computational aid for the casual user, which provides basic facilities for graphical and numeric input and display, on and off-line program preparation and storage, and hard copy presentation of results. Use of the system requires a minimum of experience or instruction, since the growth of an overlaying system control language has been prevented, and there are no processor-oriented statements, like variable type or dimension declarations. Moreover, in the on-line situation, the processor interacts with the graphical keyboard on a character by character basis so as to restrict the programmers choice of input symbols to those which are syntactically correct. DIALOG has been in daily operation at the IIT Research Institute since February, 1966.

46. Carlberg, E. F. (Boeing Co.)
N/C IS GOING ON LINE. Western Machinery
& Steel Worl, 28 – 31, Oct 1965.

The next significant forward step in the N/C field will be the replacement of the current punched-tape input with a weird connection directly to a nearby computer. Substitution of a telephone line for a punched tape could eliminate costs, errors, and delays of punched tape; transmit all data from design to machining, at electronic speeds; permit error recovery in minutes; and increase overall productivity. Such a system could be in production status by end of 1966.

47. CARTOONS BY COMPUTER. Information
Display, 4(4):102, Jul – Aug 1967.

Oba-Q, a comic hero currently enjoying great propularity in Japan, may one day take his place alongside Mickey Mouse in the World of Fantasy as the pioneer of a whole new generation of cartoons drawn by electronic computer. The gnomelike character was used by Mr. Takeo Miura of the Hitachi Central Research Laboratory, Tokyo, Japan, to illustrate two methods of generating cartoon animation by computer. Using conventional methods, an animated cartoon only 15 minutes long is an elaborate, expensive production requiring many man-hours of effort. Thousands of pictures must be drawn by hand, each incorporating slight changes in the positions of the figures so that when photographed in sequence they will appear to move. According to Mr. Miura, the computer promises to do away with traditional film animation techniques and produce cartoons in a fraction of the time at much lower cost. One method employs an analog computer. A picture consisting of a series of closed curves is represented by mathematical equations which are programmed into the computer. Movement is created for any or all of the curves by changing the constants of their corresponding equations and displaying the results on a cathode ray tube, similar to a TV screen. When the equations are changed rapidly by the computer according to a pre-programmed format the picture appears to move. The curve representing a mouth, for example, may be turned up for a smile or down for a frown. Another curve forming a body may be twisted and turned, and smaller curves for eyes, nose, hands, and feet may be wiggled or otherwise distorted to obtain a desired effect.

48. Casasent, D. P.
GRAPHICAL PROCESSING USING HYBRID
ANALOG-DIGITAL CIRCUITRY. Illinois
University, Department of Computer Science,
Urbana, Illinois. (Rept. -187; AD-623261).
30 Aug 1965. (Contract Nonr-1834(15)). N66-
14540.

By assigning analog voltages to the coordinates of a graph, drawings can be electrically displayed. By means of a sine-cosine potentiometer, resistance chains, and diamond gates with appropriate gate signals from digital counters, these drawings can be transformed (i.e., translated, rotated, magnified). Resistive summing networks and compensated current amplifiers provide the translation, while an ultralinear voltage amplifier achieves the magnification. This ultralinear voltage amplifier consists essentially of two two-stage amplifiers feeding a constant-current pre-output stage with negative feedback applied to the first stages. Thermal and nonthermal parameter variations are compensated for by a linearization of the used portions of the power dissipation and V_{eb} versus i_c curves, the constant current output stage, and circuit compensating transistor pairs. This topology produces an amplifier with a gain constant within 0.33 percent, a 20 volt output range, a drift and offset voltage of less than 9 mv, and a frequency response of d-c to 1 mc with a square wave input. It can supply 10 ma at all voltage levels with an error of less than 16 mv. Component replacement is possible with no loss of accuracy.

49. Chasen, S. H.
THE INTRODUCTION OF MAN-COMPUTER GRAPHICS INTO THE AEROSPACE INDUSTRY.
Proc. 1965 Fall Joint Computer Conference, Part 1, 883 – 892.

This paper discusses generally the implications of two-way man-computer graphic communication and, in particular, research at Lockheed-Georgia Company into this subject with a system including a UNIVAC 418 computer connected to a Digital Equipment Corporation 340 Scope. Capabilities of the system are listed, and accounts are given of work on two particular applications; complete mathematical definition of all surfaces of an aircraft envelope; and two-dimensional numerical control milling procedures.

50. Chasen, S. H.
DESIGN TECHNIQUES EMERGING FROM MAN-COMPUTER GRAPHIC COMMUNICATION.
Machine Design, 38(5):145, 148, 150, Mar 3, 1966.

Operation of computer-graphics program is briefly described: in contemplation of computer graphics possible application, current emphasis is placed on design process; two areas are investigated, namely, complete mathematical definition of all surfaces of aircraft envelope, and two-dimensional numerical-control milling procedures; implications of man-computer graphics are reviewed.

51. Chasen, S. H.
APT-LESS CONTOURING TAPES. Am. Mach./ Metalworking Mfg., 109(14):69–70, Jul 5, 1965.

Connection of Digital Equipment Corp 340 Scope with Univac 418 digital computer; data input is by light pen sketching on cathode ray tube with numerical information stored in from computer console; panel of 28 buttons inserts programmed functions, including fix point, draw line, change scale, rotate, and others; use of computer-aided design tape programming technique greatly reduces lead time and costs.

52. Chasen, S. H. and R. N. Seitz
ON-LINE SYSTEMS AND MAN-COMPUTER GRAPHICS. Astronautics and Aeronautics, 4:48–55, Apr 1967.

Discussion of ways and means of facilitating on-line computation and of the development of special man-computer interactive languages. The intent is to provide programing or problem-solving capability directly to the users in languages which are familiar to them. The systems discussed include the JOSS system – a streamlined programing and computation system designed primarily for teletypes or special typewriters, and the MADCAP and Klerer-May systems – two programing systems which utilize a special typewriter to simulate natural mathematical formatting of the computer's input and output.

53. Cheek, T. B.
DESIGN OF A LOW-COST CHARACTER GENERATOR FOR REMOTE COMPUTER DISPLAYS. Massachusetts Institute of Technology, Department of Electrical Engineering, Cambridge, Mass. Master's thesis. Rept. no. MAC-TR-26(Thesis). Feb 1966, 71p. Contract Nonr-4102(01). DDC AD-631 269.

A requirement exists for a low-cost remote display terminal with alphanumeric and line-drawing capabilities for use with time-shared computer systems. A survey of existing devices and character generation techniques was carried out, and a design approach was chosen which takes advantage of mass-fabrication techniques. This includes using a five-by-seven dot matrix raster and a resistor array "read-only" character memory for the 96 printable symbols of the Revised Proposed ASCH Code. Circuits designed included a dot matrix generator, and a resistor array memory with selection logic sense amplifiers, and a shift register output buffer. An experimental character

generator with an eight-word memory was built, largely using intergrated circuits and was found to work as desired. It is concluded that the design approach will yield a character generator that is of low enough cost to find wide use in remote computer terminals.

54. Chesler, L. and R. Turn
THE APPLICATION OF ON-LINE GRAPHICAL TECHNIQUES FOR PROGRAMMING AND OPERATING A "MOVING NETWORK" MONITORING DISPLAY. Rand Corp., Santa Monica, Calif. Rept. no. RM-5183-Pr. Jan 1967. (Contract F44620-67-C-0045). DDC AD-645 483.

The report describes the structure and operating procedures of experimental computer programs used to simulate a real-time moving network display of spacecraft checkout operations. Proposed in RM-4678-NASA (N65-35577) for use by the human monitor of an automated prelaunch checkout, the system dynamically shows, in network form, the successive and concurrent stages of a complex process. The programs were written in MAP for the IBM 7040/7044 computer system to be used with the RAND graphic Input Tablet and a cathode ray tube display screen. The Tablet is used for on-line construction of the initial network and for operation of the simulation programs.

55. Chesler, L. and R. Turn
SOME ASPECTS OF MAN-COMPUTER COMMUNICATION IN ACTIVE MONITORING OF AUTOMATED CHECKOUT. Rand Corp., Santa Monica, Calif. Rept. no. P-3522. Mar 1967. DDC AD-648 553.

Requirements for active participation by test personnel in monitoring automated checkout operations arise whenever hazardous conditions exist, tight time schedules must be met, and costs of failure are high. Under these circumstances the goals of a human monitor could be to maintain context with the progress of the checkout operations and to detect and react to malfunctions in checkout equipment, incorrect design or execution of the checkout programs, and unexpected events that the latter have not been designed to handle. The human monitor's effectiveness in performing these tasks depends directly on what information is available to him and how it is presented. Displays that use simple coding and formating to increase information extractability and that contain adequate anticipatory and alerting information may be essential for real-time interaction with automated checkout operations. As an example of extractable information presentation, a "dynamic network" display of checkout operations is discussed. Such a display permits a monitor to determine at a glance the status of the

checkout process. The programing task for the display can be greatly eased by use of a digital computer equipped with graphic input devices.

56. Christiansen, D.
COMPUTER-AIDED DESIGN. I – THE MAN-MACHINE MERGER. Electronics, 39:110–123, Sep 19, 1966.

Survey of the man-machine merger in computer-aided design (CAD) of circuits. CAD is defined as the use of a computer at one or more stages of the design process, in contrast to design synthesis, or the creation of a set of specifications describing a circuit, and design automation, which would include detailed specifications and the machine instructions needed to fabricate the circuit. The machine can assist the designer by performing repetitive calculations, evaluating changes in circuit parameters caused by component tolerances, drift, etc., studying the feasibility and cost of circuit optimization, simulating component failure, and developing optimum physical device layouts and circuit interconnections. Techniques, problems, and examples of CAD are discussed in detail.

57. Claffey, J. A.
COMPUTER-AIDED SHIP DESIGN AND CONSTRUCTION. Naval Research Reviews, 1 – 9, Sep 1967.

Graphic terminal can be used to communicate by means of a picture of a ship or one of its components. Such terminals would generally use Cathode-Ray Tubes (CRT) to display graphs or drawings of an object and often would be equipped with a "light pen" used to designate items on the CRT screen. Such a system could be used in designing a hull.

58. Coale, C. W. and K. J. Forsberg
DEVELOPMENT OF IMPROVED STRUCTURAL DYNAMIC ANALYSIS. VOLUME I: GENERAL SURVEY. Lockheed Missiles & Space Co., Lockheed Palo Alto Research Lab., Palo Alto, Calif. Rept. for Jul 1965 – Aug 1966. Rept. no. LMSC-L-30-66-1. Oct 1966, 120p. (AF 33(615)-3131). TR-66-187-Vol-1. DDC AD-645 461.

The stringent design requirements of modern aerospace vehicles have resulted in continuing demands for improvement of methods for structural dynamic analysis. Improved capabilities in this area will arise from increased analytical capability, more extensive techniques for structural synthesis and integration, and from efficient utilization of improvements in computer hardware. In this study attention has been given to three areas: (1) a review of the current state-of-the-art of structural dynamic analysis; (2) a discussion of the areas where attention should be concentrated to advance the present state-of-the-art, with particular attention given to those critical problem areas requiring long-term research; and (3) a discussion of the current and future developments in computer hardware. Particular attention is given to the exciting new field of computer graphics. It is anticipated that the field of active computer graphics will have tremendous impact on methods of structural dynamic analysis.

59. Cole, M. P., P. H. Dorn, and C. R. Lewis
OPERATIONAL SOFTWARE IN A DISK ORIENTED SYSTEM. Proc. 1964 Fall Joint Computer Conference, 351 – 362.

This paper discusses the systems software developed for the DAC-I system. The software requirements include: (1) establishing efficient storage and retrieval methods for handling large numbers of data arrays and subroutines; and (2) creating an environment within the computer to allow subroutines and associated data to be brought into memory, processed, overlayed, filed, etc., based on the operational demands made at the on-line console. The organization and maintenance of a magnetic disc file for storage of the data and subroutines is first considered and then the operating system based on a disc is described with both system and execution time features detailed. The objectives of this disc-oriented software system are to provide compiler level accessibility to the new hardware devices and minimize the impact of disc usage on the general programmer. The system provides all the necessary subroutines required in using the disc for data storage and retrieval, for scratch space during intermediate computation, and for the loading of subroutines based upon program needs.

60. Collins, G. O., Jr.
A STUDY OF THE USE OF COMPUTERS. Informatics, Inc., Bethesda, Md. Interim technical rept., TR-66-679-1. Sep 1966. (Contract CST-313). PB 175664.

A survey was made of more than 200 computer installations which were using the central processor capability through remote terminals. Techniques of the survey are described. Results of the repsonses are analyzed and discussed. Printouts of the response data are included in a separately bound Appendix.

61. Collins, G. O., Jr.
A STUDY OF THE REMOTE USE OF COMPUTERS. Informatics, Inc., Bethesda, Md. Interim technical documentary rept., TR-66-679-2. Dec 1966. (Contract CST-313). PB 175665.

Four computer systems with remote consoles were selected and studied in depth. The report consists of case study descriptions of the history, hardware, software and user experience of these four systems. The four systems selected were: (1) SDS 940 Time-Sharing System; (2) GE/Dartmouth BASIC System; (3) IBM Administrative Terminal Systesm (ATS); (4) General Motors Research Laboratories Computer Graphics System (DAC-1).

62. COMPENDUM OF VISUAL DISPLAYS (SECOND REVISION). Rome Air Development Center, Griffiss AFB., N. Y. Report no. RADC-Compendium-67-1. Mar 1967, 671p. DDC AD-817 131.

Contents: Large Screen Projection Displays; Alphanumeric Indicators/Panels and Graphic Displays; Special Display Panel Techniques and Devices; Computer Associated Display Equipment and Digitial Information Systems; Sensor Associated Display Equipment and Display Conversion Techniques; Television Equipment; Digitial Television-Special Scan-Slow Scan-Facsimile; Graphic Storage/Retrieval Systems and Hard Copy Generators; Photo Interpretation-Rectifying/Mensuration and Sensor Oriented Equipment; Printers; Plotters; Slide Projectors and Audio-Visual Briefing Aids; Simulation Displays; Aircraft and Cockpit Oriented Displays.

63. COMPUTER-AIDED DESIGN FOR NUMERICAL CONTROL SYSTEMS AND COMPUTER AIDED DESIGN OF ELECTRONIC CIRCUITS. Mass., Inst. of Tech., Electronic Systems Lab., Dept. Elect. Eng. Annual report 1964 – 1965.

64. COMPUTER AS DESIGN TOOL – MIT APPROACH. Electro-Technology, 72(5):112 112–15, 119, Nov 1963.

Techniques developed at M.I.T. and design programs are discussed based on graphical and human language input from design engineer, and fed into computer; engineers may use this system with no knowledge of computer programming.

65. COMPUTER CONTROLLED DISPLAY SYSTEM. Data Processing, 8:260–261, Sep – Oct 1966.

The main features are described of the CM 10009 display system developed by Information Displays Inc., for use in conjunction with the UNIVAC 490 computer and Bell Dataphone equipment, but which can be adapted for use with other computers. Basically the system consists of a display generator which includes a core store of 4096 30-bit words, an interface, logic circuits, a control panel and a keyboard; and a display console incorporating a 21-inch cathode ray tube, operating controls and a light pen.

66. THE COMPUTER IN N/C's FUTURE. The Iron Age, 199(23):100–101, Jun 8, 1967.

Complete computer control from original design through N/C production line? All the hearsay may turn into hardware sooner than machine tool users expect.

67. COMPUTER GRAPHICS. American Management Association, N. Y. 1966.

A book that attempts to examine the evolution of computer aids to engineering design activities and the place of computer graphics in that evolution.

68. COMPUTER PLOT. Mechanical Eng., 89(10):61, Oct 1967.

Rapid plotting of graphs by a computer on a display screen was demonstrated by a programmer from IBM Corp., at the 8th National Symposium of the Society of Information Display.

The experimental program, which permits a computer to "draw" a graph on a TV-like screen within seconds, was described. The new program eliminates the manual plottingof points and lines usually required to draw graphs.

Any numerical field can be plotted against any other numerical field, making the number of graphs which can be generated from the various combinations almost infinite.

Scaling – making the graphs the right size for the variables being plotted – is also done automatically by the computer. Several plots can also be shown simultaneously on one graph.

Information to be graphed is selected from the computer's files, or new information is put into the computer, by two keyboards and a light pen. The light pen is a light-sensitive device used to select information for graphing by pointing at items displayed on the screen.

69. COMPUTER PROGRAMMING TECHNIQUES FOR INTELLIGENCE ANALYST APPLICATION, Report No. 1 Griffiss AFB, N. Y., RADC. International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N. Y. Aug 1964. (Contract AF 30(602)-3303). (RADC-TDR-64-233; AD-605267). N64-29932.

This report discusses the computer program development, experimental studies, and designs of new facilities for investigations of each of the following tasks: (1) statistical prediction, discrimination, and classification technique; (2) integrated computer-oriented information retrieval techniques; (3) computer console input and display (textual and graphic); and (4) automated program debugging techniques.

70. COMPUTERS AND COMPUTING HAVE ALREADY FANTASTICALLY INCREASED OUR POWER TO KNOW, AS WELL AS TO DO. EDN, 12(9):29–33, Jul 1967.

Engineers are doing things with computers. This paper lists applications of computers for widely diverse engineering tasks.

71. COMPUTERS ARE LEARNING TO DRAW. Can Electronics Eng., 9(2):31–32, Feb 1965.

General Motors DAC-1 system for data processing of sketches, diagrams, and drawings; system consists of large-scale computer, man-computer communication console and image-processing equipment which enables computer to read and generate drawings; DAC-1 system applications to computer-aided design, graphic file maintenance, graphic data reduction, graphic documentation, and high speed recording are briefly discussed.

72. Coons, S. A.
COMPUTER GRAPHICS AND INNOVATIVE ENGINEERING DESIGN. Datamation, 12:32–34, May 1966.

At the beginning of an innovative engineering investigation, graphical modes of thought are natural. This article discusses how on-line man-machine graphical communication systems, such as SKETCHPAD, will facilitate engineering design, particular reference being made to the design of doubly-curved free-form shapes, e.g., aircraft, ships, and cars.

73. Coons, S. A.
OUTLINE OF REQUIREMENTS FOR COMPUTER-AIDED DESIGN SYSTEMS. Am. Federation of Information Processing Soc. (AFIPS) – Joint Computer Conference, v. 23, Spring 1963, pp. 299 – 304.

Work is discussed which was done at Massachusetts Institute of Technology Computer Applications Group and Design Div. toward realization of Computer-Aided Design as complete man-machine design system; analysis is made of design process to establish computer system requirements.

74. Corbin, H. S.
A SURVEY OF CRT DISPLAY CONSOLES. Control Engineering, 12:77–83, Dec 1965.

Discussion of data on 35 current CRT console models and of their features. Some pointers on console selection are given and various programing problems are considered. Available consoles range from the complex, relatively expensive, multipurpose varieties with optional features to the smaller, less expensive, limited-capability "inquiry" consoles. Inquiry type and multiple purpose CRT console of characteristics are tabulated. The multipurpose console includes status lights, control keys, function keys, light pen, cursor, background projection, vector drawing, alarms, and analog input. In selecting a CRT console, careful consideration should be given to the principal function for which the console is intended. Computer programing requirements for console effectiveness include software for large mass storage such as disks or drums, console executive control, flexibility and expansion, diagnostics and utility routines, and user-oriented language.

75. Corbin, H. S. and W. L. Frank
DISPLAY ORIENTED COMPUTER USAGE SYSTEM. Proc. 21st ACM Nat. Conference, 1966, 515 – 526.

This paper describes the software techniques for on-line information processing and man-machine communication which are provided by DOCUS (Display Oriented Computer Usage System) which has been implemented for a Control Data 1604B computer with a Bunker Ramo 85 display console. In the DOCUS concept, man-machine communication is accomplished by a series of related steps that constitute a conversational mode of operation. First the user performs an action (pressing a function key on the console, using a light pen or entering data via a keyboard); the computer responds to the user's actions and presents a display or turns on or off some indicator lights; the user examines the computer's message and performs another action.

76. Cordner, R.
DESIGN AUTOMATION. World Aerospace Systems, 3(7):199–204, Jul 1967.

Computer-based progressing schemes and the development of technological applications of computers, together with such ideas as microfilming are slowly but surely turning back the corners.

As with all frontiers, there are pioneers trying to establish and consolidate new ideas, often at a considerable financial penalty. Aerospace and automobile interests have taken the lead and in the U.S. the greater resources of the major companies have enabled them to produce pilot or operational schemes of a high order. At Lockheed there is a computerised parts record and progressing system addressable at 50 inquiry stations in design and production departments; at Boeing a system for the complete specification of an aircraft shape in mathematical terms and all the possible benefits of this, from speedily produced wind tunnel models using numerical machining to automatic drawing of sections and views: at Republic there is CRT graphic input/output for automation in design; and, in widespread use, microfilm recording systems.

77. Curtiss, D. A.
AUTOMATED DRAFTING WHERE ARE WE NOW? Graphic Science, 7(7):13–15, 20–2, 24–5, Jul 1965.

Method of drawing lines within specified tolerance with little or no human intervention using instructions to drafting machine in digital language on magnetic or paper tape is described; control system contains tape reader and translator; machine tool (drawing head) responds to signals and provides feedback; steps in computer encoding and real-time multiple access using light pens on cathode ray tube are included.

78. Curtiss, D. A.
NUMERICALLY CONTROLLED DRAFTING AIDS DESIGN ENGINEERING AT ROCKETDYNE.
Western Machy & Steel World, 54(5):46-8, May 1963.

Drafting machine described permits engineering to take fuller advantage of computer-produced calculations; machine controls include scaling control through which drawings can be made at quarter, half, full or twice size of information carried in punched paper tape; example of computer programs used in definition of airfoil of high speed turbine blade; machine is also used to back up manufacturing and quality control.

79. Curtiss, D. A.
UNIQUE PUNCHED TAPE DRAFTING MACHINE DOES EVERYTHING BUT THINK UP IDEA.
Design Eng., 9(2):43-5, Feb 1963.

Description of numerically controlled drafting machine with control system that will perform graphical presentation in minutes or hours instead of days and weeks; machine has horizontal drawing surface; drawing medium, which may be vellum, mylar, scribe coat, metal boards, etc., is held down by means of vacuum chuck; visual readout gives X and Y position of pen at any given moment with respect to starting position; basic input to system is punched paper 8-channel tape; post processor is used in conjunction with point data that exists within memory units of computer.

80. Damon, P. P. and J. Kolostyak
VISUAL WRITE-ERASE-NONSTORE AND ELECTRICAL READOUT ACCURATE TRACKING DISPLAY STORAGE TUBE. Sixth National Symposium on Information Display, New York, 1965 (North Hollywood: Western Periodicals Company, 1965), pp. 19-29.

A display storage tube is described which has high tracking accuracy between the four functions of visual write-erase-nonstore and electrical readout. A "light pen" may be employed to enter or read out information. This new approach may be utilized with any diameter display storage tube. Features are simplified economical construction, additional operational capabilities not now available in existing halftone display storage tubes, improved performance characteristics and simplification of system requirements.

81. DATA DISPLAY EQUIPMENT. Business Automat, 12:70–75, Sep 1965.

Tabulated characteristics of display equipment for digital computer system available from 14 American manufacturers.

82. Davis, M. R. and T. O. Ellis
THE RAND TABLET: A MAN-MACHINE GRAPHICAL COMMUNICATION DEVICE.
Rand Corp., Santa Monica, Calif. Aug 1964, 27p. (Contract ARPA SD-79; ARPA Order 189-61). (RM-4122-ARPA; AD-444103). N64-28464.

This report describes a low-cost, two-dimensional graphic input tablet and stylus developed to conduct research on man-machine graphical communications. The tablet is a printed-circuit screen complete with printed-circuit capacitive-coupled encoders with only 40 external connections. The writing surface is a 10 × 10-in. area with a resolution of 100 lines/in. in both x and y. Thus, it is capable of digitizing $>10^6$ discrete locations with excellent linearity, allowing the user to write in a natural manner. The system does not require a computer-controlled scanning system to locate and track the stylus. Several institutions have recently installed copies of the tablet in research environment.

83. Davis, M. R. and T. O. Ellis
THE RAND TABLET: A MAN-MACHINE GRAPHICAL COMMUNICATION DEVICE.
Proc. 1964 Fall Joint Computer Conference, 325 – 331.

This paper describes a stylus-tablet device developed at Rand Corporation for graphical communication with a computer. The device generates stylus position data and is connected to an input channel of the computer and to a CRT display. The display control multiplexes the stylus position data with computer-generated data in such a way that the display contains a composite of the current stylus position and the computer output. Pulses are supplied to printed circuit x and y lines on the tablet to provide Gray code position data which is sensed by the high-input-impedance, pen-like stylus from the epoxy-coated tablet surface. The stylus data is strobed, converted from Gray to binary code, assembled in a shift register and gated in parallel to an interface register.

84. Davis, M. R. and T. O. Ellis
RAND TABLET – MAN-MACHINE GRAPHICAL COMMUNICATION DEVICE. Instruments & Control Systems, 38(12):101–3, Dec 1965.

Low-cost, two-dimensional graphic input tablet and stylus have been developed for conducting research on man-machine graphical communications; tablet is printed-circuit screen complete with printed-circuit capacitive-coupled encoders with only 40 external connections; writing surface is 10 × 10 in. area with resolution of 100 lines/in.; control multiplexes stylus position information with computer-generated information in such way that oscilloscope display contains composite of current pen position and computer output.

85. Davis, M. R. and T. O. Ellis
THE RAND TABLET: A MAN MACHINE GRAPHICAL COMMUNICATION DEVICE. Information Display, 4(4):85–90, Jul – Aug 1967.

Present day user-computer interface mechanisms provide far from optimum communication, considerably reducing the probability that full advantage is being taken of the capabilities of either the machine or the user. In the development of man-machine studies at RAND, it was felt that the exploration of man's existent dexterity with a free, penlike instrument on a horizontal surface, like a pad of paper, would be fruitful. The concept of generating hand-directed, two-dimensional information on a surface not coincident with the display device (versus a "light pen") is not new and has been examined by others in the field. The RAND tablet device generates 10-bitx and 10-bity stylus position information. It is connected to an input channel of a general purpose computer and also to an oscilloscope.

86. Davis, R. M.
MAN-MACHINE COMMUNICATION. In: Annual review of information science and technology, Vol. 1, 221 – 254.

This article covers the developments in man-machine communications. The scope of coverage follows:

A. Defining concepts; Format of review; Time-sharing; Man-computer interactive languages; On-line man-machine applications; Man-machine interactive displays; Problem solving.

B. Applications of man-machine communications to specific user groups:

Education and teaching applications; Document-hundling applications; Management applications; Statistical modeling and grammar testing; Medical applications.

87. Dell, R. O.
APT TRAINING PROGRAM. A PROGRAMMED TEXTBOOK. Sandia Corp., SC-M-66-8, Apr 1966, 269p. $6.00.

A programmed textbook on APT (Automatically Programmed Tools).

88. De Lotto, I.
INNOVATIVE DESIGN WITH COMPUTER GRAPHICS. Alto Frequenza, 36:430-39, May 1967. (Italian)

Analysis of the use of computer graphics to generate surfaces. The parametric representation of a surface is chosen, instead of the well-known techniques used in the practical world. The geometric properties of the Coons surfaces are stressed, with particular reference to the original contributions of the authors. The implemented program is briefly described, and experimental results are discussed to show the flexibility of the method.

89. Denil, N. J.
A LANGUAGE AND MODEL FOR COMPUTER-AIDED DESIGN. Proc. 21st ACM Nat. Conference, 1966, 527 - 535.

This paper describes Design Language I (DLI), a prototype computer-aided design system for three-dimensional structures which uses a display console for communication with the user. The system is intended to provide the user with a language with which to describe and manipulate parts consisting of geometrical structures. Underlying the language is a processor which interprets what the user says to extent of its stored information of geometry and builds an internal representation of what the user is talking about. The system provides the user with the capabilities to perform the following functions: (1) define elements to any depth; (2) find out how an element is currently defined or interconnected; (3) change any element by adding new definers which override some or all of the previous ones; and (4) on the display, view his structure from any vantage and be able to sketch, identify things and input new information in any convenient view. DLI has been implemented on an IBM 7044 equipped

with a 7226 graphic unit consisting of a display console and recorder. The console is equipped with a light pen, function keys and an alphanumeric keyboard.

90. Department of Defense/American Ordnance Association
DISCUSSION GROUP ON COMPUTER-AIDED DESIGN AND DOCUMENTATION. Second Meeting and Subsequent Action Report, Jun 1966.

The mission of the AOA Committee for the Application of Computer-Aided Design Technology shall be to serve Government and Industry on all aspects of Computer-Aided Design. This includes hardware, and programming techniques, particularly those relating to computer graphics, specialized languages, data structures, man/computer interaction, and other similarly specialized computational features.

91. Dertouzos, M. L.
PHASEPLOT – AN ON-LINE GRAPHICAL DISPLAY TECHNIQUE. IEEE Transactions on Electronic Computers, vol. EC-16, Apr 1967, pp. 203 – 209.

A parametric display technique for on-line graphical output is presented. This technique is particularly useful for rapid display of continuous "smooth" data, through relatively few computer commands. Graphical data to be displayed are composed from primitive segments, each of which corresponds to one computer command that specifies starting and stopping point, final slope, and "curvature." Presented topics include the basic principle of operation, a class of hardware realizations, typical software requirements, and experimental results of a display prototype.

92. Dertouzos, M. L. and H. L. Graham
A PARAMETRIC GRAPHICAL DISPLAY TECHNIQUE FOR ON-LINE USE. IN: AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, FALL JOINT COMPUTER CONFERENCE, SAN FRANCISCO, CALIF., NOVEMBER 7 – 10, 1966, PROCEEDINGS. Washington, D. C., Spartan Books (AFIPS) Conference Proceedings, Volume 29), 1966, pp. 201 – 209.

Description of a graphical display technique designed for the display of complex curves in terms of relatively few computer commands. The basic components of the system include the interface, the storage registers, the word designator, digital-to-analog converters, and the intensity control unit. Experimental results and relevant software are discussed. It is pointed out that two advantages resulting from the system are small storage requirements for the translated curves and a relatively fast display time.

93. Devere, G. S., B. Hargreaves, and D. M. Walker
THE DAC-I SYSTEM. Datamation, 12:37 – 38, 40, 45 – 47, Jun 1966.

The General Motors Research Laboratories DAC-I System is an experimental facility for studying methods for incorporating a computer in the design process. This article deals with conclusions drawn from experience with DAC-I and is intended primarily for the computer specialist who may be writing specifications or programs for a "conversational" computer graphics system. The discussion covers: requirements of graphic display hardware and software; and fundamentals of graphic display programming.

94. DIAGRAMS DRAWN ON SCREEN READ BY COMPUTER SYSTEM. Computers & Autom., 15(8):32 – 33, Aug 1966.

Pictorial material "drawn" on its screen is sensed and remembered by MAGIC (Machine for Automatic Graphics Interface to a Computer), a research tool developed at the National Bureau of Standards (U.S. Department of Commerce) in work co-supported by NBS and the National Aeronautics and Space Administration. James A. Cunningham, Don E. Rippy, Donald E. Humphries, and Paul Meissner designed the

machine for investigation directed at facilitating man's two-way communication with computers and the operation of remote computer inquiry stations.

MAGIC's operator draws on the screen of the display device in somewhat the manner in which he would sketch a map for a fellow worker, with the assistance of computer operations for erasing, translating, rotating, adding additional information, and editing. The drawings created can be maps, plans, or schematic diagrams, for example. A completed drawing can be placed in the computer's memory and recalled for output or additional processing at a later time. This feature is of value for such applications as drawing routes on maps, charting courses, and mapping weather predictions. Capable of operating as a self-sufficient computer, MAGIC also can be used with other computers as an input-output interface with the operator.

95. DIGITAL PLOTTING ON A SHARED COMPUTER.

Prod. Eng., 116, Jul 17, 1967.

Engineering, testing, and other such developmental groups no longer must wait until they can afford their own computer to enjoy the benefits of computer conversion of data into graphic form. Now they can do it via data-processing time-sharing.

One such system is the new remote digital-plotting equipment offered by California Computer Products, Inc., Anaheim, Calif. It is programmed to provide two-way engineer-computer communication, which means that the engineer can feed his data into the system himself using an easy-to-learn computer language. He also can modify both the data and the results to determine the effects of altering the various parameters.

The engineer dials the computer using a standard data phone. Next, he enters all instructions, data, and plot programs through a teleprinter-type input-output terminal. The computer then prepares the plot program including identification codes for the particular plotter being used. It issues output signals either for on-line plotting, tabular printout, or both.

These signals then operate the plotter in the usual way, producing discrete incremental steps relative to the X-Y axes, with motor-driven pens providing the desired data points. The accompanying diagram illustrates the basic system configuration. The data plotter in the Calcomp system has a maximum speed of 280 steps per sec.

96. DISCUSSION GROUP OF COMPUTER-AIDED DESIGN AND DOCUMENTATION. FIRST MEETING AND SUBSEQUENT ACTION REPORT. American Ordnance Association, Washington, D.C. Mar 1966, 118p. Refs. sponsored in part by DOD. (AD-480631L). X66-21693.

NOTICE: Available to U.S. Government Agencies Only.

Contents include:

1. COMPUTER-AIDED DESIGN, R. W. Mann and S. A. Coons (MIT)
2. THE MANAGER, THE ENGINEER AND THE MACHINE, T. J. Moffett (Lockheed-Calif. Co.)
3. THE IMPACT OF COMPUTER CONCEPTS ON ENGINEERING DESIGN, D. M. Baumann, S. J. Fenves, and L. A. Schmit, Jr. (Commission on Eng. Education)
4. EFFECT OF COMPUTER AIDED DESIGN TECHNOLOGY ON PRESENT MILITARY STANDARDS GOVERNING PREPARATION OF TECHNICAL DOCUMENTATION, T. C. Pritchard (Lockheed Missiles & Space Co.)
5. EFFECTS OF COMPUTER-AIDED DESIGN AND DOCUMENTATION ON DATA SUBMITTALS, M. D. Prince (Lockheed-Ga. Co.)
6. DOD/AOA DISCUSSION GROUP ON COMPUTER-AIDED DESIGN DOCUMENTATION, 12 – 13 OCTOBER 1965. ITEM I: COMPATIBILITY CONSIDERATIONS, R. W. Mann (MIT)
7. THE CONVERSION OF DIMENSIONED DRAWINGS INTO DIGITAL FORM FOR COMPUTER-AIDED DESIGN USE, L. B. Lipson and M. D. Prince (Lockheed Ga. Co.)

97. DISPLAYING DATA GRAPHICALLY. Data Processing, 2(3):194 – 196, Jul – Sep 1961.

RD 900 system by Laboratory for Electronics, Inc., Boston, Mass., built for rapidly retrieving information at random from data store, decoding it and presenting it in graphic form on viewing screen; both printed and pictorial data can be displayed, and several different items may be superimposed for purposes of comparison; initially developed for military use, equipment can be employed in many commercial applications.

98. d'Ombrain, G. L., L Rozsa, and L. A. Cox
GRAPHICAL TO DIGITAL CONVERTER. IEEE Internat. Convention Record (USA), Vol. 14, Pt. 10, 66–73, 1966.

Two graphical-to-digital converters which prepare graphical information in the form of recorder traces as data for input to an IBM 7044 computer, are described. The first device, based on electromechanical scanning and using a computer program for interpretation, will accept up to 60 ft of 6 in-wide graph paper. A standard deviation of 0.007 inch in reading four inches is typical, the resolution is of the order of 0.01 inch. The second device, using only commercially available components, is based on a Vidicon camera unit and utilizes the computer to carry out a number of correction actions. The program corrects for the non-linearities present in the circuits and in the Vidicon, Also it corrects for misalignment of the graph axes with respect to the camera axes. The device accepts graphs up to 8-1/2 in. × 11 in.

99. Drattell, A.
THE SCOPE OF DISPLAY. Business Automation, 26 – 31, 38, Sep 1967.

Discussion of the recent uses of Data display devices in business on a large scale.

100. Duda, R. O. and J. H. Munson
GRAPHICAL-DATA-PROCESSING RESEARCH STUDY AND EXPERIMENTAL INVESTIGATION. Stanford Research Inst., Menlo Par, Calif. Quarterly report, 1 May – 31 Jul 1966. Aug 1966. (Contract DA 28-043-AMC-01901(E)). (ECOM-01901-24; Rept. 24; QR-2; AD-641647). N67-14987.

The report describes work in progress in each of the stages of the analysis of graphical data (specifically, the recognition of hand-printed FORTRAN test). These stages are: data preparation; input of data to the analysis system; preprocessing; classification; and contextual analysis. A preprocessing and classification method adapted from Jon K. Clemens of MIT was programmed and tested on characters from the data base. The best results were obtained for alphabetic characters only: 58% correct, 23% errors, and 19% rejects. The beginnings of work, directed at improving the recognition rate through the use of contextual relations among individually classified characters, are described. A small study showing that the recognition rate by humans of characters without context is on the order of 99%, and that the quantization performed during input to the system reduces this rate only slightly.

101. Duda, R. O., P. E. Hart, and J. A. Munson
GRAPHICAL-DATA-PROCESSING RESEARCH
STUDY AND EXPERIMENTAL INVESTIGATION.
Stanford Research Inst., Menlo Park, Calif.
Quarterly report, 1 Nov 1966 – 31 Jan 1967.
Mar 1967. (Contract DA-28-043-AMC-01901(E)).
(ECOM 01901-26; QR-4: Rept.-26, AD-650926).
N67-29551.

The report describes the continuing development of preprocessing, classification, and context analysis techniques for hand-printed text, which are advancing at an accelerating pace. Experiments were continued with the Piecewise-Linear learning machine, using the output of two preprocessors; the PREP 24A simulation of the 1024-image optical preprocessor; and the CALMMASK preprocesser, which employs both edge-detecting and corner-detecting masks. A new low test error rate for classification was achieved on hand-printed alphabets of FORTRAN characters. Statistics of the performance of the learning machine during a single testing iteration are presented, and shed light on several important questions, such as the distribution of rankings of the desired character category when it is not in first place. A discussion of the preprocessing methods used in the topological approach to preprocessing and classification is begun. The initial development of a FORTRAN syntax analyzer is described. A milestone was reached with the passage of a small sample of actual FORTRAN text from a coding sheet through the scanning, preprocessing, classification, and syntax-analysis programs.

102. Durbeck, H. R.
SOME VECTOR GENERATING TECHNIQUES
FOR CATHODE RAY TUBE (CRT) DISPLAY
SYSTEMS. National Aeronautics and Space
Administration, Goddard Space Flight Center,
Greenbelt, Md. Jun 1967. (NASA TM-X-
55828; X-521-67-271). N67-31302.

A general discussion is presented of vector generating techniques as is a description of two straight-forward line drawing schemes for cathode ray tube (CRT) display systems. Consideration is given to vector generating procedures for non-scan CRT displays in wide use today. In these systems, electrical signals are supplied to horizontal (X) and vertical (Y) deflection circuits and the electron beam is moved to a position on the CRT screen determined by the magnitude of the signals. A brief technical description is given of incremental point positioning v. stroke method, and an incremental point positioning method for vector generation. Schematics and a mathematical exposition typify the stroke type vector generator.

103. Eliezer, D. G.
SUBROUTINES FOR IBM SYSTEM/360 TO FACILITATE VISUAL DISPLAY AND MAN MACHINE RELATIONSHIPS. Naval Weapons Lab., Dahlgren, Va. 23 Aug 1966. (NWL-2074; AD-646895). N67-26499.

A group of subroutines is described which facilitates the utilization of the buffered IBM 2250 display terminal associated with an IBM System/360. The routines provide a means of displaying graphs and textual material and provide for efficient use of the light pen and other associated devices.

104. Elliott, W. J. and R. C. Hood
ON THE STRUCTURE OF HIGHER LEVEL LANGUAGES FOR AUTOMATIC DRAFTING. General Motors Corp., Allison Div., Indianapolis, Ind. Res. and Eng. Quart., 1965, pp. 9 – 29. N65-29830.

A two-dimensional numerically controlled engineering drafting machine, and the language structure designed for the machine are discussed. The machine is a continuous path contouring device capable of drawing straight lines only. Conic sections and continuous algebraic or transcendental functions are drawn by approximating the desired function with a series of chords whose deviation from the actual function may be as small as 0.001 inch. Drawing can take place on ordinary paper, mylar, cloth, or metal. The manner in which the tool moves in the two-dimensional space is a function of coded information made available to the drawing system on a punched paper tape medium. The machine permits a drawing at a maximum rate of up to 280 inches per minute while holding accuracy to ±0.005 inch overall on the 5 ft × 12 ft drawing surface. The structure, control, drawing operations, characteristics notation and coding for the language are detailed; and the nature of the language translator is discussed.

105. Ellis, T. O. and W. L. Sibley
ON THE DEVELOPMENT OF EQUITABLE GRAPHIC I/O. IEEE Trans. Human Factors in Electronics, HFE-8, Mar 1967, 15 – 17.

The desire for direct interaction between man and machine has led to the study of computer interpretation of free-hand motions of a stylus and the real-time responses to

these motions. An operating environment is discussed utilizing elements of pictorial and verbal languages.

106. English, W. K., D. C. Engelbart, and M. L. Berman
DISPLAY-SELECTION TECHNIQUES FOR TEXT MANIPULATION. IEEE Transactions on Human Factors in Electronics, HFE-8(1):5–15, Mar 1967.

Tests and analysis to determine the best display-selection techniques for a computer-aided text-manipulation system reveal that the choice does not hinge on the inherent differences in target-selection speed and accuracy between the different selection devices. Of more importance are such factors as the mix of other operations required of the select-operation hand, the ease of getting the hand to and gaining control of a given selection device, or the fatique of its associated operating posture.

Besides a light pen, several cursor-controlling devices were tested, including a joy-stick and an SRI-developed device known as a "mouse." The study was aimed directly at finding the best display-selection means for our own text-manipulation system but generalizations applicable to other types of on-line systems were derived.

107. Evans, D. C
GRAPHICAL MAN/MACHINE COMMUNICATIONS. Utah University, Salt Lake City, Utah. Semiannual progress report for period ending 30 Nov 1966. Nov 1966. (AF 30(602)-4277). DDC AD-805 134L.

Distribution: DOD only: others to Rome Air Development Center, Griffiss AFB, N. Y. 13440. Attn: EMLI.

108. Evans, D. C.
GRAPHICAL MAN/MACHINE COMMUNICATIONS. Utah University, Salt Lake City, Utah. Semiannual technical report for period ending 15 May 1967. May 1967. (Contract AF 30(602)-4277). DDC AD-816 220.

109. Evans, R. K.
COMPUTERS. Power, 109(12):51–532,
Dec 1965.

Review of electronic computer theory, hardware, software, glossary, gates, memory and logic elements; analog, digital and control are included; ALGOL and COBOL are discussed; pneumatic control, process control and power plant monitors; boiler-turbine direct digital control; graphics use of light pen; fluid logic devices.

110. Fano, R. M.
THE MAC SYSTEM: A PROGRESS REPORT.
Massachusetts Institute of Technology,
Cambridge, Mass. Presented at Symp. on
Computer Augmentation of Human Reasoning,
Washington, 16 Jun 1964. 9 Oct 1964. (Contract Nonr-4102(01). (MAC-TR-12; AD-609296).
N65-18045.

The notion of machine-aided cognition implies an intimate collaboration between a human user and a computer in a real-time dialogue on the solution of a problem, in which the two parties contribute their best capabilities. In order for this intimate collaboration to be possible, a computer system is needed that can serve simultaneously a large number of people, and that is easily accessible to them, both physically and intellectually. The present MAC System is a first step toward this goal. The purpose of this report is to present a brief description of the current system, to report on the experience gained from its operation, and to indicate directions along which future developments are likely to proceed.

111. Fellerman, K. D.
APOLLO DISPLAY SYSTEM. National Aeronautics and Space Administration, Goddard
Space Flight Center, Greenbelt, Md. IN:
Its Apollo System, Jun 1966, pp. 11–13.
N67-18995.

The display system serves as an interface between flight controllers and the high speed data processing equipment such as the telemetry and command computers and the PCM data handling equipment. This system permits the display of printed information and charts of real time data on a Cathode Ray Tube (CRT). The displays are unique in that there is the ability to write on any part of the CRT with direct access to the particular

X and Y coordinates that the character or vector are to appear at rather than a sweeping of the entire tube. In addition to the CRT displays the system consoles have event displays which are lamps driven by either the PCM stations or the computers via the Console Computer Interface Adapter (CCIA).

112. Fetter, W. A.
COMPUTER GRAPHICS IN COMMUNICATION.
New York, McGraw-Hill Book Co., 1965, 110p.
$2.50.

This monograph is designed to contribute to the enrichment of graphics instruction by making new concepts and applications in this field readily available to engineering students and educators. The objectives of this monograph: (1) to assess critically the purposes and objectives of graphics in engineering education; (2) to explore and develop course material which will enrich the educational experience of all engineering students; (3) to evaluate the role of graphics as an important component of the total engineering curriculum; (4) to prepare informative material which can be used as a source for engineering educators who may choose information on which to build and strengthen their courses.

113. Fitzgerald, E. L.
INTRODUCTION TO COMPUTER GRAPHICS.
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, REGION III CONVENTION, ATLANTA, GA., APRIL 11 – 13, 1966, PROCEEDINGS. New York, Institute of Electrical and Electronics Engineers, Inc., 1966, 5p.

Examination of the present and projected effect of digital-graphic computer terminals on data processing equipment. Digital/graphic techniques, which use the CRT as a cross-over medium between graphics and the digital computer, find applica- in three major areas – (1) computer-aided design, (2) computer-based research activities, and (3) special types of command and control systems. The impact of digital/graphic techniques on documentation and manufacturing procedures is considered.

114. Flanagan, D. L.
SURFACE MOLDING – NEW TOOL FOR THE ENGINEER. Astronautics and Aeronautics, 4:58–62, Apr 1967.

Discussion of Man-Computer Graphics (MCG) – a computer-controlled CRT which allows operator control through an oscilloscope by means of a light-sensitive pen. The usefulness of this tool in the design of contoured surfaces for aircraft production is outlined.

115. Fluhr, F. R.
LIGHT-PENCIL COORDINATE POSITIONER. Naval Research Lab., Washington, D. C. Mar 1965, 20p. (NRL-MEMO-1592; AD-460781). N65-31694.

A number of data-processing operations require the rapid and accurate extraction, control and coordination of position data from cathode ray tube information sources such as radar and IFF PPI repeaters and computer displays. A light pencil which detects and controls a position- and intensity-modulated marker presented on the cathode ray tube screen during the indicator retrace period has been devised. The coordinates of this marker may be used to position the video gate which extracts desired signals from the radar/IFF returns without requiring the operator to hold the pencil in position. The light pencil operates independently of the PPI repeater range controls and therefore requires no elaborate gain tracking devices in order to maintain a one-to-one light pencil motion to marker motion. Except for the light detection photomultiplier, the entire design is solid state.

116. Forsberg, K., and S. K. Ferriera
COMPUTER GRAPHICS – A POWERFUL NEW TOOL FOR THE STRUCTURAL DYNAMICIST. IN: AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, AND AMERICAN SOCIETY OF MECHANICAL ENGINEERS, STRUCTURES, STRUCTURAL DYNAMICS AND MATERIALS CONFERENCE, 8TH, PALM SPRINGS, CALIF., MARCH 29 – 31, 1967, TECHNICAL PAPERS. New York, American Institute of Aeronautics and Astronautics, Inc., 1967, pp. 413 – 427.

Application of a graphic display to a structural-analysis program. The problem of the dynamic response of a nonuniform beam is treated, using the standard techniques of lumped mass-spring representation of the structure. The forced response of the beam is based on the modal approach. A graphical input and output capability is attached to standard digital programs so that the input parameters can be displayed on the face of a cathode-ray tube and be modified, allowing the modal behavior of the beam to be calculated. The results, which are displayed graphically, can be reviewed, making it possible to return to the initial input data, make changes, and rerun the program.

117. Forsberg, K. J., and S. K. Ferriera
DEVELOPMENT OF IMPROVED STRUCTURAL DYNAMIC ANALYSIS. VOLUME II: COMPUTER GRAPHICS. Lockheed Missiles & Space Co., Solid Mechanics Group, Palo Alto, Calif. Final Report, Jul – Nov 1966. Mar 1967. (Contract AF 33(615)-3131). (AFFDL-TR-66-187, Vol. II; L-30-66-2; AD-650932). N67-29548.

The work is concerned with the application of a new tool (computer graphics) rather than the development of a new analytical technique. The problem of the dynamic response of a nonuniform beam was treated using the currently standard techniques of lumped mass-spring representation of the structure. A graphic input and output capability was attached to standard digital computer programs so that one can display on the face of a cathode ray tube the input parameters, modify these if desired, and then compute the modal behavior of the beam. The engineer can return to the initial input data, make changes, and rerun the program if he so desires. For the forced response problem, he can input his forcing functions, compute the forced response, and present the results in an animated display. This technique for communicating with the computer gives immediate reduction and interpretation of the results from the forced response program, a task which in the digital form requires many hours or even days.

118. Fulton, R. L.
PROGRAMMING GRAPHIC DEVICES. Computers & Automation, 14(11):17–19, Nov 1965.

General discussion article. The barriers to more rapid development of graphic data processing are essentially lack of communication with potential users and the failure to fully utilize existing devices through the development of computer programs for graphic devices.

119. Gattnar, K. D.
PROBLEMATIC SIMULATION OF HUMAN DESIGNING ACTIVITIES BY DATA PROCESSING SYSTEMS. SB Deutchen Akad. Wiss. Berlin, Kl. Math. Phys. Tech. (Germany), 1965, No. 1, 38pp. (In German)

Manifold problems and insufficient knowledge of the working of human brains make it impossible to completely substitute the human designer by a machine. To analyse the process of thinking and to resolve thought into elementary steps, the aid of mathematicians, linguists, psychologists, philosophers, etc. is indispensable. Observations of designers indicate iterative thinking processes, variation and substitution of elements in an approach to the solution of a design problem, and drawing of conclusions from the mutual interaction of such elements. However, designing also involves tedious, time-consuming calculation and manual work that can be better discharged by electronic data-processing systems (EDPS). For instance, the Siemens EDPS 2002 can provide data for wiring a board or for cable harnesses fully meeting customary specifications without human interference. The IBM Design Mechanization System can shorten the designer's time so that an equipment requires only three months from a mental image to series production. Other EDPS provide wiring diagrams, check the designer's ideas for logic and feasibility, are employed in ship and house building and in projecting of technological processes and other jobs characterized by repetitive operations and checking for errors. Thus the Automatically Programmed Tool (APT) of the Massachusetts Institute of Technology is being employed by virtually all aircraft industries in USA. Other EDPS, fed with easy-to-understand program language words, will execute drawings of even complex machine parts or else scan drawings and produce three-dimensional diagrams viewed from any angle desired (Sketchpad System). A human designer can draw the trussing of a bridge and indicate the total load whereupon the EDPS will almost immediately indicate the load to each single member of the trussing and the resulting deformation of the bridge.

120. Gellert, G. O.
AUTOMATION COMES TO DRAFTING. Iron Age, 190(3):89–92, Jul 19, 1962.

Numerous engineering and manufacturing activities in aerospace industry where large volumes of drawings and data plots are continuously prepared, are said to be fertile field for program controlled drafting machines; criteria for drafting machine; tape controlled machine called Orthomat draws at 200 ipm at Aero-Space Div., Boeing Co., Seattle; design and operation of machine.

121. GERBER SERIES 500 AUTOMATIC DRAFTING SYSTEM. Computers and Automation, 44, Jul 1967.

The advent of the high speed digital computer solved many problems and created certain others. Computers make computations and process programs so rapidly that conventional data output devices, operating at hundreds instead of millions of cycles per second, degrade computer operation to a totally unacceptable degree. The Gerber Series 500, from The Gerber Scientific Instrument Co., Hartford, Conn., is a computer output system that solves this problem, providing on-line graphic display yet permitting the computer to complete other tasks at its normal work rate.

Using micro-integrated circuitry throughout, the Gerber 500 uses priority-interrupt techniques to obtain data from the computer, mediating between the computer and the drafting table as a buffer to allow for most efficient computer operation and to provide continuous direction of the drafting process.

The computer may be programmed to pre-compute the graphic output data, store this data in core or on disc memory, then recall and output the data as called for by the Series 500. In this manner, the drafting program can operate at a low priority, as the 500 System will merely wait at completion of the last output until new data becomes available.

The Series 500 system is well suited for applications in which the output system time-shares the computer with a CRT console. In this way, hard copy output of the CRT operations may be obtained. Standard options permit adaptation to nearly any output requirement.

The Gerber Series 500, designed to operate with direct input from nearly any general-purpose digital computer presently available, forms a complete graphic output system when mated with any of the standard Gerber plotting tables and accessories.

122. Gilmore, J. T., Jr., F. S. Greatorex, Jr., and E. N. Chase
RESEARCH ON ADVANCED DYNAMIC ATTRIBUTE EXTRACTION TECHNIQUES. Adams (Charles W.) Associates, Inc., Cambridge, Mass. Final report, Apr 1962 – May 1965. 31 Jul 1965. (Contract AF 19(628)-453). (AFCRL-65-736; AD-625181). N66-19547.

Two main areas of effort are described. The first is the development of a color display system which allows for the definition and modification of data stored in a list structure. The second area is the development of a man-graphic communication system which utilizes a buffered display scope, light pen and push-bottom panel to provide the console user with the basic ability to draw charts, diagrams, curves, etc.,

on the face of the display scope. The drawings may contain graphic and alphanumeric information, which is reduced to a condensed digital format called an entity table. The table can be operated on by special-purpose software operators either during the drawing action or after the drawing is completed.

123. Goldberg, M. J.
DEVELOPMENT OF ON-LINE SYSTEM FOR COMPUTER-AIDED DESIGN OF INTEGRAL CIRCUITS. United Aircraft Corp., Norden Div., Norwalk, Conn. Interim Engineering Progress Report, 1 Mar – 31 May 1966. Rept., 1206-R-0004, 1966. (Contract AF 33(615)-3544). (IR-9-52-1(1); AD-485026). X66-23002.

Ground rules and system plans for the on-line system have been completed, and programming has started on the layout manipulation commands to be implemented via the light pen. The MOVE, BEND, ROTATE, EDGE, and JOIN commands have been analyzed to determine optimum methods and procedures for implementation via the light pen on the Graphic Display Console. Insight into man-machine communication problems has been provided by an Experimental Routing Module which is already operational on the computer. A sequence of photographs is used to describe a sample routing problem. Several improvements have been incorporated into the on-line system data structure to decrease core memory requirements and allow for more efficient, fast-response data retrieval. Studies are underway concerning supplied graphics software to meet on-line system software requirements. Experiments are being carried out on the previously developed off-line system to provide information on desired improvements to be incorporated in the on-line system; and also to thoroughly check out all off-line system functions under a wide variety of problems to prepare the system for release to qualified requestors.

124. Graham, H. L.
A HYBRID GRAPHICAL DISPLAY TECHNIQUE. Massachusetts Inst. of Tech., Electronic Systems Lab., Cambridge, Mass. May 1966. (Grant NsG-496; Contract Nonr-4102(01); Proj. MAC). (NASA-CR-78744; ESL-R-270). N66-39295.

An on-line graphical display technique and an experimental system prototype employing this technique are discussed. Unlike some methods, which display graphical data by point-plotting or by piecewise-linear segments, this technique employs a sequence

of curved segments. This approach results in compact storage of the digital commands that describe a complex curve at the expense of some computing time necessary to establish these commands. The prototype system, which is based on this technique, is relatively uncomplicated and inexpensive; therefore, it is suited for use at the remote consoles of a time-shared computer facility.

125. GRAPHIC COMPUTER INPUT SYSTEM.
Automation, 14(8):11, Aug 1967.

New type of graphic input system allows an operator to trace or sketch material from hard copy or projected images directly into a computer. It has been developed by the Data Equipment Div., of Bolt Beranek & Newman, Inc., Santa Ana, Calif. Interface logic in the new system permits the programmer to specify the rate at which the central processor is interrupted to input graphic data. System criteria prevent input of redundant data into the computer. Maximum resolution is 100 points per inch.

126. Grigor'yan, Yu. G.
EXPERIMENTS IN VISUAL SHAPE RECOGNITION BY A DIGITAL COMPUTER. Joint Publications Research Service, Washington, D.C.
Tech. Cybernetics, 19 Jun 1964, pp. 64 – 77.
N64-26381.

The problem of recognition of handwritten letters from 0 to 9 by a digital computer is investigated. The images have standard vertical dimensions and were placed approximately in the center of the field of vision. The principle of the shortest distance between shapes was used as the basis for the work. To do this a metric space is constructed – the space of a set of finite sets that, in particular, is considered to be a receptor space. The entire image is divided into a set theoretic sum of sets each of which sums is characterized by the corresponding tone. Such a representation permits deduction of the shape of the space between figures consisting of many tones. The important point in the given recognition algorithm is the calculation of the statistical relationship of one shape to all the rest by means of the spaces introduced between the figures. Experiments carried out on a digital computer showed a high percent of accuracy in recognition (93%).

127. Groner, G. F
REAL-TIME RECOGNITION OF HANDPRINTED TEXT. Proc. 1966 Fall Joint Computer Conference, 591 – 601.

This paper describes a symbol recognition scheme which allows an on-line computer user to print text naturally and have it recognized accurately, as he prints it. The scheme responds very quickly even though it recognizes a fairly large set of symbols. It imposes few constraints on style, speed or position of writing. It makes use of contextual information to distinguish symbols which cannot be distinguished by shape alone. The scheme has been used daily at Rand Corporation for writing computer code, drawing flow charts and editing. The symbol recognition scheme is written in IBM System/360 Assembly Language and runs on an IBM System/360 Model 40. The user communicates with the computer via a Rand Tablet in conjunction with a cathode ray tube which displays the pen's track.

128. Gruenberger, F. (Edit.)
SYMPOSIUM ON COMPUTER GRAPHICS. Held at University of California, Los Angeles, 1966; Publ. Acad. Press, 1967, 225p.

Computer Graphics; utility/production/art.

129. Gurley, B. M. and C. E. Woodward
LIGHT-PEN LINKS COMPUTER TO OPERATOR. Electronics, 32(47):85–87, Nov 20, 1959.

Photoelectric sensing device reads computer-controlled cathode-ray tube display to allow operator to direct progress of a program or control auxiliary equipment attached to the computer.

130. Halsted, C.
IMPROVING THE INFORMATION FLOW RATE BETWEEN MAN AND MACHINE. Electronic Industries, 25(4):62–66, Apr 1966.

This paper is concerned with the developments is visual displays, light pens and other input/output devices.

131. Hannom, T. J. B. and G. Kaskey
THE DIGITAL COMPUTER AS A DESIGN TOOL.
IEEE Internat. Convention Record (USA), Vol. 13, Pt. 6, 27–38, 1965.

Computer-aided design techniques may be classified into those which perform only the routine calculations associated with what were previously manual designs and those which provide a high degree of design automation by taking advantage of the special abilities of digital computers. As an example of the first approach, the computer-aided system design of an optimum position servo with nonlinear feedback is developed. The second category of techniques is illustrated by the development of a highly automated circuit analysis programme which writes and solves its own circuit equations from information presented in the form of a coded schematic.

132. Happ, W. W. and J. A. Dumanian
AVAILABILITY OF COMPUTER PROGRAMS FOR CIRCUIT DESIGN. Electronic Communicator, 2: 8, Jan – Feb 1967.

Brief description of five classes of automated general-purpose computer programs for circuit design analysis. The five programs are: NET-1, ECAP, CIRCUS, PREDICT, and SCEPTRE. They were developed respectively by Los Alamos Scientific Laboratory, IBM, the Boeing Co., and (both PREDICT and SCEPTRE) IBM-Owego. Sources to contact to obtain the programs (which are free) are given.

133. Hardway, C. L.
GRAPHIC DATA INPUT-OUTPUT EQUIPMENT. (In on-line computing – time-shared man-computer systems.) McGraw-Hill Book Co., New York, 1967, pp. 56–73.

This paper includes many firm numbers (e.g., "Character generation is available at rates ranging from 20,000 to 110,000 characters per second"), which will be useful to persons in the graphics area.

134. Hargreaves, B., et al.
IMAGE PROCESSING HARDWARE FOR A MAN-MACHINE GRAPHICAL COMMUNICATION SYSTEM. Proc. 1964 Fall Joint Computer Conference, 363 – 386.

This paper is concerned with the IBM 7960 Special Image Processing System designed and built for the DAC-I system. The system consists of a graphic console including a display tube, control buttons and lights, a card reader, an alphanumeric keyboard and a position indicating pencil; and an image processor which permits computer-controlled scanning of film images and computer-controlled recording on 35 mm film. The first part of the paper, by the IBM authors, describes the design of the special image processing components and the integration of these components into the system. The main functional requirements of the components are computer compatible image generation speeds and high image quality. The design shows how the diverse technologies of analogue circuits, cathode ray tubes, optics and film processing were successfully combined in the new image processing system. The second part, by the General Motors authors, reviews experience with the system as part of the DAC-I system.

135. Haring, D. R.
THE BEAM PEN: A NOVEL HIGH-SPEED INPUT/OUTPUT DEVICE FOR CATHODE-RAY-TUBE DISPLAY SYSTEMS. Proc. 1965 Fall Joint Computer Conference, Part 1, 847 – 855.

Certain limitations in the speed of response of a light pen system are indicated. The basic theory is then given of a beam pen system which has been developed to detect the electron beam causing the screen light rather than the light itself. Essentially, the beam pen is a conducting probe connected to a high-input-impedance amplifier and which is capacitively coupled to the beam when held near the cathode ray tube screen. A beam pen system built for use with a Project MAC display console is described and its performance is discussed.

136. Harris, L. A., J. C. Mitchell, and G. W. Morgan
COMPUTER-AIDED DESIGN FOR CIVIL ENGINEERING STRUCTURES. North American Aviation, Inc., Structural Sciences Department, Downey, Calif. In NASA, Marshall Space Flight Center Symp. on Technol. Status and Trends, 1966, pp. 147 – 160. N66-17722.

Described in this paper is the development by North American Aviation, Inc., of techniques for automating the design process. Computers have been used predominantly in the past to perform analysis. This coincides with the designer's historic position of designing by successful analytical iteration. Techniques are described by which the design iteration process is systematically programmed for solution on a high-speed

digital computer. The result is that more realistic design decisions relative to structural performance, cost, and schedule can be made. Computer-aided design would allow the civil engineer to improve design decisions by having available a larger mass of trade-off data and automatically produced drawings. The engineer inputs the design requirements and makes systematic variations in structural concept, materials, and design detail. The output is a set of designs which meet the performance requirements and design criteria. An example of the application to a multi-stage launch vehicle is described in the test. The text then illustrates how these same techniques could be used for civil engineering structures.

137. Houldin, R. J.
IBM GRAPHIC DISPLAY SYSTEM. Information
Display, 3(5):34–40, Sep – Oct 1966.

Computer displays with graphic capabilities have added a new dimension to data processing by making information more accessible and more easily assimilated. Summaries, graphs and charts can be quickly retrieved and viewed on many screens simultaneously. Several of the more advanced displays are beginning to link the creativity of man and the calculating power of the computer for design applications.

The IBM Graphic Displays are among such versatile systems – extending the data processing power of IBM System/360 to handle graphic and design information in scientific, engineering and management applications.

Computer-programmed line drawings and alphanumerics are stored in a local display buffer and displayed on a 21-inch CRT. Alphanumeric information can be originated or modified off-line from the computer by a keyboard. Application-oriented instructions can be sent to the computer by an overlay-coded Programmed Function Keyboard. A light pen gives the operator detection, tracking and sketching capabilities.

The display systems are available in models for single or multiple console installations. Multiple installations use control units, each attaching up to four display consoles.

138. Hauser, N.
COMPUTERS IN INDUSTRIAL ENGINEERING
DESIGN EDUCATION. J. Industr. Engng (USA),
18(1):86–89, Jan 1967.

Concerns the use of computers and mathematical optimization techniques as aids in Industrial Engineering design education. There are discussions on the concepts of analysis and design, analysis by computer, problem-oriented languages, time-sharing, graphic display, computer programming as design, and the factors affecting performance of a system.

139. HIGH SPEED INFORMATION DISPLAY SYSTEM. Data Processing, 8:352–55, Nov – Dec 1966.

The main features are described of the DIDS-400 display system developed by the Raytheon Company. The system, which can operate in conjunction with any type of digital computer, uses a monoscope and a cathode ray tube for the display of characters. Messages are composed and edited and the computer is interrogated by means of a keyboard.

140. Hill, L. S.
SOME IMPLICATIONS OF AUTOMATED DESIGN ON THE ENGINEERING PROCESS. Rand Corp., Santa Monica, Calif. Rept. no. P-3625. Prepared for presentation to the Symposium on Use of Computers in Engineering of the Annual Meeting of the American Association of Cost Engineers in Cleveland, Ohio, on 10 Jul 1967. DDC AD-655 065.

Advancements are now available for the partial mechanization of production drawings and even more in the area of schematics. Computers have been available for design calculations for more than fifteen years. Advancements are reflected in tape-controlled coordinate plotters. These and other improvements plus the possible automation of all phases of engineering design are considered in this paper.

141. Hobbs, L. C.
DISPLAY APPLICATIONS AND TECHNOLOGY. IEEE, Proceedings, 54:1870–1884, Dec 1966.

Discussion of several of the more important applications of computer generated displays, display systems design and characteristics, and display technologies which are the primary candidates for implementing the visual transducer portion of future display systems. Several problem areas are identified. Types of displays discussed, include indicators and character displays, individual or console displays, and group or large-screen displays. Applications described include command and control, management information, and on-line information systems, on-line graphics, information storage and retrieval, and editing and composition.

142. Hornbuckle, G. D.
THE COMPUTER GRAPHICS USER-MACHINE INTERFACE. IEEE Trans. Human Factors in Electronics, HFE-8, Mar 1967, 17 – 20.

In many instances, computer graphics can provide a powerful, rapid man-machine interface by proper application of simple pattern recognition techniques. The techniques briefly discussed are those used to classify real-time sequences of x, y coordinates such as occur with several graphical input devices, including the RAND tablet. Several examples show how graphics can improve a class of editors and debuggers generally operated with keyboard/printer consoles.

143. THE HUMAN USE OF COMPUTING MACHINES, (Proc. Symp. concerned with diverse ways of enhancing perception and intuition, Murray Hill, N. J., June 1966). Bell Telephone Labs., Murray Hill, N. J., 1966, 72p.

Contents include:

Brown, W. S.: Mechanizing symbolic algebra, 5–7.
Kaiser, J. R.: Graphs should be computer drawn, 9–14.
Denes, P. B.: Real-time speech research, 15–23.
Mathews, M. V. and McMahon, L. E.: Computers and English text, 25–29.
Pinson, E. N.: Graphics at the console, 31–35.
Kruskal, J. B.: Finding hidden structure in complex data, 37–46.
Knowlton, K. C., Noll, A. M., and Sinden, F. W.: Movies from the computer, 47–49.
Huggins, W. H.: Educational pantomimes, 51–61.
Schroeder, M. R.: Simulation with a block diagram compiler, 63–67.
Julesz, B.: Random patterns and visual perception, 69–72.

144. IBM DEMONSTRATES SYSTEM TO AID COMPUTERIZED DESIGN. Steel, 155(19):70–1, Nov 9, 1964.

Information displayed as sketches, drawings, diagrams, and graphs is handled by graphic data processing system utilizing power of computer; method of instantaneous exchange of information between man and machine provides freedom and flexibility to review, modify, and record information at any stage of development process; system will solve design problems in electronics, manufacturing, and aerospace, update and maintain microfilm files of blueprints, convert graphically recorded information, etc; equipment and operation described.

145. IDI TYPE CM10058 COMPUTER CONTROLLED DISPLAY/Information Displays, Inc. Computers and Automation, p. 42, Dec 1966.

This high capacity, solid state, computer controlled display system recently was delivered to Glasgow's National Engineering Laboratories where it is expected the equipment will be used for computer-aided design, and other man-machine applications. The system can generate up to 80,000 characters a second and features a light pen and keyboard by which the operator can query, add, delete, and edit displayed information. The equipment delivered to Scotland includes an interface which permits operation directly from a UNIVAC 1108, but the modular design permits adaptation to use with most other computers.

146. Iliopoulos, D. G. EUCLID. Frontier, 27(2):21–24, Summer 1966.

Scope and applications of a method of graphically programming a computer by an equipment comprising a stylus and 15 push button keys. Known as Electrosketch Usage for Computational Logic in Design, this constructs and displays coordinate geometric figures.

147. THE IMPACT OF DIGITAL COMPUTERS ON ENGINEERING. J. Royal Aeron. Soc., 71(676):235–270, Apr 1967. A Joint Symposium with the Institution of Mechanical Engineers.

A joint symposium with the Institution of Mechanical Engineers on "The Impact of Digital Computers on Engineering" was held at the Society on 20th April 1966. Five introductory papers were given: – "The Coming of Multiple-Access Computers" by Dr. M. V. Wilkes of the Mathematical Laboratory, Cambridge University; "Computer Graphical Design Aids" by W. H. P. Leslie of the National Engineering Laboratory, East Kilbride; "A Look Into the Future – How Computers will Influence Engineering" by Professor J. H. Argyris, Imperial College and P. C. Patton, Institut fur Static und Dynamic der Luft und Raumfahrtkonstruktionen, Stuttgart; "The Use of a Digital Computer for On-Line Control of a Jet Engine" by E. S. Eccles, Bristol Siddeley Engines; and "The Computer in the Stress and Design Offices" by I. C. Taig, BAC, Preston.

The Chair was taken by Professor R. J. A. Paul, who introduced H. G. Conway, Managing Director, Bristol Siddeley Engines Ltd. Opening the symposium, Mr. Conway said that as both an aeronautical and a mechanical engineer and as a member of both the Royal Aeroanutical Society and the Institution of Mechanical Engineers, he welcomed this joint meeting and thought it should be a useful one. Computers could be too much of a political "gimmick," but they were very necessary and were a great

facility. Collaboration between mechanical, aeronautical and electrical engineers in their use must be encouraged and more should be done to support their own British computer industry. He hoped this symposium would stimulate a useful discussion.

148. INFORMATION ANALYSIS USING CHART VERSIONS 3 AND 5. Lockheed Missiles & Space Co., Sunnyvale, Calif. Apr 1966. (LMSC-669737). DDC AD-481 646. N66-24555.

A general information concept is presented to demonstrate the similarity of problems in the management of both scientific and technical information. The use of computer and graphic display for processing and formatting engineering design, manufacturing, financial, technical and scientific data is considered in depth. No programming experience is assumed although access to computer facilities usual in aerospace facilities is required to implement the nine types of chart paper including log-log, probability, Weibull together with other formats useful in information analysis for pattern recognition or frequency distributions. The programs are general in nature and are not keyed to any system in producing output information for control, tracking or diagnosis.

149. INPUT FOR A COMPUTER: A PEN AND TRANSPARENT TABLE. Electronic Design, 11:96, May 24, 1967.

Hand-drawn information can be converted easily for computer storage and processing with a new computer input system. The operator merely marks the information with an electronic pen on a transparent conductive plate, and the system converts the result to digital and analog signals.

Reported to operate more simply than other graphic input devices, it depends on phase detection to convert the written information to electronic data.

150. INPUT-OUTPUT EQUIPMENT. Computers and Automation, December, Annual Pictorial Report.

December issues of this Journal include an annual report on Input-Output devices.

151. INSTANT DRAWINGS FROM FORMULAS.
Iron Age, 196(8):80, Aug 19, 1965.

New numerically controlled (N/C) drafting machine makes it possible to translate complex mathematical formulas within minutes into precise detailed engineering drawings; use of machine called Orthomat and N/C system called Decamatic-ESP control has extended to automotive industry; architectural, and civil and marine engineering fields; it is essential element in wide variety of computer-aided design applications.

152. Jacks, E. L.
A LABORATORY FOR THE STUDY OF GRAPHICAL MAN-MACHINE COMMUNICATION. Proc. 1964 Fall Joint Computer Conference, 343 – 350.

In order to investigate the use of digital computers in the graphical techniques of engineering design, a laboratory for graphical man-machine communication experiments was established at the Research Laboratories of General Motors Corporation. The Design Augmented by Computers (DAC-I) project undertaken by the laboratory had the initial object of developing a combination of hardware and software which would (1) permit "conversationa" man-machine graphical communication, and (2) provide a maximum programming flexibility and ease of use for experimentation. This paper outlines the objectives and organization of the system developed, and accompanying papers present approaches to solutions and examples of performance of the various hardware and software components of the system. The hardware consists of an IBM 7094 and an IBM 7960 Special Image Processing System designed and built specifically for the project. The supporting software includes a multiprogramming system, an algebraic compiler (NOMAD), a data channel command compiler (MAYBE), a dynamic storage assignment procedure, and extensive facilities for the storage, retrieval and editing of programs and data sotred on a disc storage device.

153. Jacks, E. L.
DAC-I-COMPUTER SYSTEM FOR STUDY OF GRAPHICAL MAN-MACHINE COMMUNICATION. Gen. Motors Eng. J., 12(2):2–8, Second Quarter, 1965.

Realizing nature and importance of graphical communication techniques, General Motors Research Laboratories placed into operation experimental facility for man-to-computer and computer-to-main graphic communication; system, known as Design Augmented by Computers (DAC-I), provides computer complex that permits rapid, high accuracy graphical input and output through high-speed computer and flexible programming system to enable convenient developmen t of man-machine communication experiments; how system is used by designer is described; details of system.

154. Johnson, R. W
DIGITAL DATA DISPLAY SYSTEMS: AN ASSESSMENT. Comput. Autom., 13(5): 12–17, May 1964.

This is a discussion of digitally driven CRT display equipment. The general characteristics of three arbitrary classes of displays are discussed in sufficient detail to be of considerable value in an initial study of digital CRT display systems.

155. Johnson, T. E.
SKETCHPAD III: A COMPUTER PROGRAM FOR DRAWING IN THREE DIMENSIONS. Proc. AFIPS 1963 Spring Joint Comput. Conf., Detroit, Mich., May 1963, 347 – 353. Spartan Books, Balitmore, Maryland.

This article describes certain of the external aspects of the MIT computer-aided design control console. It explains how it is proposed to permit drawing to be carried out in three dimensions on the surface of the CRT, using a lightpen, some push-buttons and some hand-rotated encoder shafts.

156. Johnson, W. B.
AUTOMATIC DRAFTING: NEW TRIUMPH FOR NUMERICAL CONTROL. Tool and Manufacturing Engineer, 51:47–49, Jul 1963.

Description of numerically controlled drafting machines that produce a highly accurate drawings in minutes. They can be applied to the graphic interpretation of machining routines programmed by computer and also to quality control. Design details and illustrations of the machines are provided. The machines can also draw centerlines and dash lines under numerical control and make additions on existing drawings.

157. Kaplow, R., J. Brackett, and S. Strong
MAN-MACHINE COMMUNICATION IN ON-LINE MATHEMATICAL ANALYSIS. In: Proc. AFIPS 1966 Fall Joint Computer Conf., 465 – 477.

The use of direct computer access by a number of simultaneous users has given rise to dialog programs of many types. Such a system, called MAP, has been devised to treat problems in mathematical analysis. The article does not describe, MAP in detail, but gives an example, which in some ways raises more questions than it answers. The problem in the example is to find the correct parameters for a curve fit in gamma ray spectroscopy. The procedure for finding the first approximation is given fully. It is emphasized that the procedure is intended for persons who are not experts in numerical analysis. However, the amateur approach initially described leaves one guessing how good and meaningful a result could actually be obtained, without the more sophisticated approach that is indeed possible in this technique, but which is probably no easier than conventional programming in, say, a high level language. The technique permits the use of graphical display hardware, including lightpens, for input and output.

158. Keast, D. N.
SURVEY OF GRAPHIC INPUT DEVICES FOR COMPUTER-AIDED DESIGN. Machine Design, 39(18):114–120, Aug 3, 1967.

The biggest step in adapting digital computers to the design process was the development of devices for "drawing" design data into the computer. The data, displayed graphically on some kind of screen, can be modified through an electronic "pen." Several types of graphic devices have been developed. This article tells what they are and how they differ.

159. Kennedy, J. R.
A SYSTEM FOR TIME-SHARING GRAPHIC CONSOLES. IN: AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, FALL JOINT COMPUTER CONFERENCE, SAN FRANCISCO, CALIF., NOVEMBER 7–10, 1966, PROCEEDINGS. Washington, D.C., Spartan Books (AFIPS Conference Proceedings, Volume 29), 1966, pp. 211 – 222.

This paper describes the implementation at Lockheed-Georgia Company of time-sharing a single central processing unit among several graphic display consoles for man-machine interaction in problem solving. The hardware includes a CDC 3300 computer configured to include a Digi-graphics display system with three 22 inch CRT devices for graphic I/O. All application and most system subprogram residency is made a function of console operator demand. That is, a subprogram is resident only when it is required to perform some computation in response to a demand made by the operator. Upon completion of the computation, the storage which it occupied during execution is promptly returned to the system for future use by the same or another application. All application programs are structured in a highly modular form such that an application consists of many small subroutines which are loaded only when called and are allowed to remain resident only during their period of active execution. Application programs therefore consist of sets of subroutines residing in a relocatable form on a peripheral random access high speed storage device. Associated with each application program (console) is a resident table in a form which is sufficient to allow the system to find subprograms when they are called and cause them to be loaded into an available block of storage just prior to transfer of control to them for execution. System subroutines are provided for interfacing applications wit the display consoles and all display drum I/O is handled by the system.

160. Kleiman, E. B
A SURVEY OF VARIOUS INFORMATION DISPLAY DEVICES. Naval Training Device Center, Orlando, Fla. May 1967. (NAVTRADEVCEN-IH-74; AD-653867). N67-33249.

The report represents a survey of the currently available display equipment that can be controlled by a digital computer. The equipment discussed ranges from simple incandescent readouts to cathode-ray tube displays. The report attempts to very briefly describe the various hardware characteristics and approximate costs of the readout and display field before setting out to design console equipment.

161. Koford, J. S., P. R. Strickland, et al.
USING A GRAPHIC DATA-PROCESSING SYSTEM TO DESIGN ARTWORK FOR MANUFACTURING HYBRID INTEGRATED CIRCUITS. IN: AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, FALL JOINT COMPUTER CONFERENCE, SAN FRANCISCO, CALIF., NOVEMBER 7–10, 1966, PROCEEDINGS. Washington, D.C., Spartan Books (AFIPS Conference Proceedings, Volume 29), 1966, pp. 229 – 246.

Description of a computer program that utilizes a graphic data-processing system to aid in the design of mask artwork for hybrid integrated-circuit modules of the type used in IBM System/360 Data Processing Systems. The system includes a small digital computer connected to a large-screen buffered display equipped with a light pen. A draftsman uses the light pen to assemble a circuit schematic on the display screen; simultaneously, a description of the schematic is entered into the computer memory. Thereafter, the draftsman can use the light pen to layout detailed artwork for fabrication of the circuit mask, subject to automatic checking against the stored schematic. When the layout on the display screen is complete, the corresponding mask artwork will be drawn by the computer via its digitally controlled plotter. The graphical manipulation on the display screen, the automatic checking operations, and the control of the digital plotter are all part of a FORTRAN program that employs graphical subroutines to communicate with the light pen, display, and plotter.

162. Krull, F. N. and J. E. Foote
A LINE SCANNING SYSTEM CONTROLLED FROM AN ON-LINE CONSOLE. Proc. 1964 Fall Joint Computer Conference, 397 – 410.

This paper describes an experimental system designed to facilitate the digitising of line images using the IBM 7960 Special Image Processing System of the DAC-I system. In this system, no fixed structure is assumed for the input document and a wide range of elementary functions are provided which the operator at the on-line console may call upon and combine in order to process a complex form. All decision capability and selection of functions is left to the operator.

163. Lang, C. A., R. B. Polansky, and D. T. Ross
SOME EXPERIMENTS WITH AN ALGORITHMIC GRAPHICAL LANGUAGE. Massachusetts Inst. of Tech., Electronic Systems Lab., Cambridge, Mass. Technical Memo. Rept. no. MIT-ESL-TM-220. Aug 1965. (AF 33(657)-10954). DDC AD-472 147.

This report describes the inner workings of the "May 6th Demonstration Program," a graphical language system using the ESL display console attached to the project MAC time-shared computer system. The program was written to demonstrate that picture languages, such as SKETCHPAD, do no require special techniques, but are processed by the same first-pass algorithmic theory of language as is used for programming languages in the AED family of compilers. The system is constructed around the AED Jr. system for defining and parsing languages, the pseudo pen program for precise light-pen action, the A-core/B-core system for controlling real-time display console action in the time-sharing environment, plus a number of routines to define the meaning of the graphical words.

164. Langefors, B.
AUTOMATED DESIGN. Int. Science & Technology, 26:90–7, Feb 1964.

Discussion and comparison of several techniques of using computers for design functions, such as "Sketchpad" developed at Massachusetts Institute of Technology Lincoln Laboratories and Scandinavian system of special computer language for giving object's form, structure and content data to computer; examples of application to airplanes, architecture, electric circuits, ship hulls, highways.

165. Lankford, E.
EXPERIMENTAL INVESTIGATION OF OPTICAL PRESENTATION OF THREE-DIMENSIONAL DISPLAY. Ling-Temco-Vought, Inc., LTV Astronautics Div., Dallas, Texas. Final Report. (Rept. 00.567; AD-610150). 6 Jan 1965. (Contract Nonr-4439(00)). N65-20611.

The objective was to design and develop two experimental prototypes of a volumetric three-dimensional display utilizing point-light images generated by cathode ray tubes, which are seen by an observer located in the real image field of a parabolic and plane mirror. Various approaches of image combining such as time-sharing and light-sharing were investigated. The investigation resulted in the verification of the feasibility of the 3-D display concept. Both light-sharing and time-sharing of multiple image presentations are possible means of reproducing images in three dimensions. The utilization of three dimensional presentation is restricted only by the quality of the data received for presentation, quality of the optic-electro-mechanical system and functional space. Recommendations for additional investigation as a continuation of this study are: investigation of vision threshold and fusion frequencies below 5 μsec regime, and continuation of the development of uses of cathode ray tube image production technique to present 3-D information with time and/or light sharing methods.

166. Larkin, F. M
COMBINED GRAPHICAL AND ITERATIVE APPROACH TO PROBLEM OF FINDING ZEROS OF FUNCTIONS IN COMPLEX PLANE. Computer J., 7(3):212–219, Oct 1964.

Automatic graph plotter used as digital computer output device for finding zeros of function in complex plane, and providing regional and global information on such

functions as starting point for zero finding iterations with high degree of confidence in their convergence; contour graphs are presented illustrating general features of complex function, especially near typical zeros.

167. Laschenski, J.
COMPUTER DATA PRESENTATION BY
DISPLAY UNIT. IBM Technical Disclosure
Bull,, 9:1339–1341, Mar 1967.

Maintenance requirements for large computers demand a fast visual presentation of the contents of internal registers and the status of control triggers of the system. The realization of such a presentation is described by means of a cathode ray tube display with a self-contained local storage having a number of permanent display formats. Scanning controls in the computer supply to the local storage, the data to be inserted in the format.

168. Lee, L. H.
CHARACTER DISPLAY SYSTEM. IBM Technical
Disclosure Bull., 9:372–73, Sep 1966.

A computer-controlled system for displaying information on a cathode ray tube is described. Only one horizontal sweep and one vertical sweep are used for the visualization of complete lines of characters.

169. Lehembre, P. Y.
ELECTRONICS CHARACTER DISPLAYS.
Electro Calcul, 7:67–73, Sep – Oct 1965.
(In French)

An account is given of the basic features of cathode ray tube character display systems.

170. Leslie, W. H. P.
COMPUTER GRAPHICAL DESIGN AIDS.
(Royal Aeronautical Society and Institution of Mechanical Engineers, Symposium on the Impact of Digital Computers on Engineering, London, England, Apr 20, 1966, Paper.)
Royal Aeronautical Society, Journal, vol. 71, Apr 1967, pp. 237 – 244; Discussion, pp. 261 – 270.

General survey of computer graphic aids. The earliest aid, the graph plotting machine, as well as trace analyzers and CRT instruments used in conjunction with light pens are described. The current applications of these instruments are examined. The advantages a multiaccess system with cathode ray display offers over a conventional digital computer operation organized in a batch processing mode are discussed.

171. Levine, S.
INPUT/OUTPUT EQUIPMENT FOR INFORMATION-HANDLING SYSTEMS. 1965 IEEE Int. Convention Record, Part 3, 86 – 89.

This paper is concerned with the use in on-line information handling systems of cathode ray tube display units (with associated input devices such as keyboards, light pens or writing tablets). Such units provide the flexibility required in message composition and display formats and facilitate the rapid correction of errors at the point of initial entry of data into the on-line system. Design requirements for such units are discussed and a typical cathode ray tube display and keyboard unit is described.

172. Lewin, M. H.
A MAGNETIC DEVICE FOR COMPUTER GRAPHIC INPUT. Proc. 1965 Fall Joint Computer Conference, Part 1, 831 – 838.

This paper describes a system and experimental model resulting from work initiated to develop a graphic input device which would require a minimum of associated circuits, while maintaining simplicity in the construction of the writing surface. The system utilizes the pen as the signal generator and the writing surface as the address detector. The pen contains in its tip a small magnetic head which periodically generates a localized magnetic field pulse. The writing surface contains a number of thin winding layers in a laminated structure. Each winding layer consists of a single, continuous wire pattern designed to detect one of the pen address bits.

173. Lewin, M. H.
AN INTRODUCTION TO COMPUTER GRAPHIC TERMINALS. Proceedings of the IEEE, 55(9): 1544 – 1552, Sep 1967.

The reader is introduced to some of the fundamental hardware and software aspects of typical CRT display consoles. Techniques for accomplishing display refresh are explained. The evolution of the CRT controller, from a device that simply includes a pair of digital-to-analog converters to a system that is a rather sophisticated, special-purpose hybrid processor (including analog function generators and digital control logic), is developed. Means by which a user generates display processor interrupts, particularly those associated with graphic input devices, are described. The use of electronic "pens" for user interaction with a display is then explained. Finally, the software structure for a typical graphic processor is discussed from a functional point of view. The linkage between a high-level symbolic picture description and the CRT "machine language" display file, via a set of generation subroutines, is described. The calling of picture modification programs by an interrupt analysis routine is also explained. Reasons for the need of a linked-list data structure are presented.

174. LINE DRAWING COMPUTER CONSOLE.
Digital Computer Newsletter, 19(3):9, Jul 1967.

A simple and economical console that displays line drawings, letters, and numbers in answer to problems submitted to a computer has been devised for use at Bell Telephone Laboratories. The consoles will be in or near scientific or engineering offices and tied into the time-sharing system of a high-speed computer.

Known as "Glance," the experimental console can display computed data such as graphs, plots, integrated circuit masks, and drawings. The console consists of a cathode ray tube display plus a teletypewriter linked to the computer. The computer interprets the problem entered on the teletypwriter and produces graphical instructions to display the answer. Picture signals are stored in a disc memory and sent to the console at a rate of 30 frames per second.

Simplicity and economy are achieved by supplying information from the disc to the console at a high bit rate (4 million bits/sec.), thereby eliminating the need for such console hardware as vector and character generators. Additionally, one magnetic disc memory will serve up to 32 consoles, each connected by only one coaxial cable.

Pictures are displayed on the 12-inch screen by using a matrix of 1024 × 1024 (more than one million) possible dot positions. The picture is formed by incremental dot commands, each of which cause the CRT beam to move one step left, right, up, down, or diagonally.

175. Lipson, L. B. and M. D. Prince
THE CONVERSION OF DIMENSIONED DRAWINGS INTO DIGITAL FORM FOR COMPUTER AIDED DESIGN USE. Lockheed-Georgia Co., Research Lab., Marietta, Georgia. In: Am. Ordnance Assoc. Discussion Group on Computer-Aided Design and Doc. 1st Meeting and Subsequent Action Rept., Mar 1966. 18 Mar 1966. X66-21700.

NOTICE: Available to U.S. Government Agencies Only.

The existing techniques for precisely inputing dimensioned drawings into a computer aided design system are reviewed. Three examples of special computer languages for off-line input preparation, APT, ALADDIN, and AUTODRAFT, are discussed. A new man-computer graphic system is described as an example of on-line input. A simple drawing was prepared for computer input by each of these four methods for comparative purposes and the results are described.

176. Loomis, H. H. Jr.
GRAPHICAL MANIPULATION TECHNIQUES USING THE LINCOLN TX-2 COMPUTER.
M. I. T., Lincoln Lab., Lexington, Mass.
Report no. 51G-0017, Nov 1960, 27p.

The results of an investigation into the use of a computer-controlled oscilloscope display for graphical manipulation, including symbol drawing and positioning of symbols to form a drawing, are reported. The structure and operation of a program to draw symbols and to use these symbols for the construction of a drawing are discussed. Finally, the type of program which would aid the logical designer in his logical circuit design by preparing and filling the drawings and analyzing the circuits for such items as signal delays and unit loading factors is discussed in brief.

177. Lourie, J. R., J. J. Lorenzo, and A. Bomberault
ON-LINE TEXTILE DESIGNING. Proc. 21st ACM Nat. Conference, 1966, 537 – 544.

This paper describes an on-line system using a cathode ray tube display with light pen for aiding the textile designer in the transformation of an artist's sketch into a woven fabric design.

178. LOW COST DISPLAY TESTED FOR COMPUTER "UTILITIES." Electronic Design, 15(14):36, 40, Jul 5, 1967.

MIT laboratory terminal gives graphic input and output on memory CRT linked to a telephone line.

179. Luh, J. Y. S., and R. J. Krolak
MATHEMATICAL MODEL FOR MECHANICAL PART DESCRIPTIONS. Assn. Computing Machy-Communication, 8(2):125–129, Feb 1965.

Advantage is taken of common information requirements of computer-aided engineering drawing, numerical control tape generation, and physical-characteristic computation; using English-like input language, subprograms will convert mathematical model into instructions for driving automatic drafting machines and numerically controlled machine tools; physical-part characteristics, such as center of gravity, can be computed by subprograms and used in dynamic analysis work.

180. Macaulay, M.
COMPUTER-AIDED DRAFTING. ASME – Paper 65-MD-36 for meeting May 17 – 20, 1965.

Digital computers can perform efficiently certain drafting tasks such as preparation of perspective views from orthographic descriptions, of stereo pairs and of animated drawings; in certain rigidly stylized areas, such as electrical schematics, piping diagrams, logic diagrams, etc., computer controlled drawing production is practical and economical; future holds promise of computer-aided design techniques to accelerate design and to diminish routing drafting.

181. Machover, C.
FAMILY OF COMPUTER CONTROLLED CRT GRAPHIC DISPLAYS. Information Display, 3(4):43–46, Jul – Aug. 1966.

Graphic displays...man-machine interface...these were terms familiar to the military long before they found widespread use in industry. Pioneer work with SAGE, 412L, 465L, and 473L laid the foundation for the current explosion of nonmilitary applications. Computer Controlled CRT Displays provide a prime example of civilian industry benefiting from military developments.

182. MAN-COMPUTER GRAPHICS (MCG)
Computers & Automation, 15(3):36,
Mar 1966.

Lockheed-Georgia Company has announced that for the first time in the aerospace industry, Lockheed-Georgia (Marietta, Ga.) is manufacturing airplane parts through the use of a new technology called MCG – Man-Computer Graphics. This is a new concept which ties together more closely the designer, the computer and the machine that produces the part.

The man sits at a computer console and communicates directly with the computer through a "display scope." The man draws the part itself, and guides the path which the machine tool-cutter should take, directly on the display. Precise dimensions are input numerically. The computer automatically prepares a tape. This tape is used to control the machine that cuts out the part. If an error should occur while the drawing is being made, the man at the computer console can make immediate corrections.

This new Lockheed-Georgia system completely bypasses the cumbersome APT (Automatically Programmed Tools) or other symbolic computer languages which have been used. Thus, the time needed to derive the tape is reduced by a factor of ten, and the probability of error in the tape is greatly reduced. This advance in technology will be employed in the Georgia aerospace firm's work on the Air Force's giant C-5A transport.

183. Mann, R. W.
THE "CAD" PROJECT. Mechanical Engng.
87:41–43, May 1965.

This article outlines the facilities provided by and advantages of Sketchpad, the man-computer communication system for the Computer-Aided Design (CAD) project at M.I.T.

184. Mann, R. W. and S. A. Coons
COMPUTER-AIDED DESIGN. Massachusetts Inst. of Tech., Cambridge, Mass. IN: Am. Ordnance Assoc. Discussion Group on Computer-Aided Design and Co. 1st Meeting and Subsequent Action Rept., Mar 1966. X66-21694

NOTICE: Available to U.S. Government Agencies Only.

This paper begins with a brief description of the conventional process of engineering design and shows that conventional use of computers does not lead to the kind of man-machine interaction implicit in the engineering design process. Both computer and

human attributes are described in terms of the engineering design process and mention is made of the efforts being devoted toward creating a new man-machine rapport. Examples given include computer time sharing, the Sketchpad program which provides a graphical link with the computer, and attempts at making computers teachable. The use of computer aided design to plan and develop stages of manufacturing process are discussed along with its impact on other disciplines and education and its socioeconomic implications.

185. Mann, W. C. and P. A. Jensen
A DATA STRUCTURE FOR DIRECTED GRAPHS IN MAN-MACHINE PROCESSING. Computer Command and Control Co., Washington, D. C. Annual Rept. Rept. no. 77-106-1, Jun 1966, 76p. (Nonr-4815(00). DDC AD-636 251.

This report describes research in information processing intended for application to man-machine communication processes. In order to allow a computer user to represent some problems more easily, we would like to let him name and define relations between information entities with which he deals, and then manipulate a large number of such relations stored by the computer. A set of statements on the relative desirability of various conditions is an example of a set of relations which the user might want to store and manipulate. The problem is that available representations for such sets of relations tend to be unwieldy and may require a great deal of processing for large numbers of relations. In order to make such a capability available, compact and easily-manipulated internal computer representations for large numbers of the various kinds of two-entity relations must be found. This report describes such a development for one basic logical form of relation, the transitive, anticommutative relation exemplified by "precedes," "iincludes," "is greater than," and similar phrases. The report describes a method for storing directed graphs (of transitive anticommutative relations) in a list-structured computer memory. There are three important features of this representation method: a method of dividing a graph into a number of strata based on the lengths of paths in the graph, a recursive decomposition technique which produces successively less complex versions of the graph, and a recursive search technique which utilizes the stratification and decomposition to extract information from the graph.

186. MAN-MACHINE COMMUNICATION SYSTEM.
Societe d'Electronique et d'Automatisme.
B. P. 1040306, 24 Aug 1966.

A man-machine communication system is described in which a pattern of information is displayed on a cathode ray tube screen and a photoelectric arrangement detects any selective masking of the pattern effected manually.

187. Marill, T., A. K. Hartley, et al.
CYCLOPS-1: A SECOND-GENERATION RECOGNITION SYSTEM. Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
IN its Studies in Autom. Pattern Recognition, 31 Oct 1963, pp. 1 – 15. Presented at AFIPS Fall Joint Computer Conf., Las Vegas, 12 Nov 1963. N64-19420.

Cyclops-1 is a working recognition system with the following capabilities: (1) The system can recognize all handprinted alphabetic and numeric characters; there are virtually no restrictions on the manner in which the characters may be printed, (2) The system can analyze complex visual inputs consisting of an arbitrary number of characters present simultaneously; the characters may be of different sizes and orientations; they may overlap, or be inside of one another; they may be superimposed on arbitrary backgrounds consisting of meaningless lines or spots or geometric shapes, (3) The repertoire of items recognized by the system may readily be enlarged to include shapes other than alphabetic or numeric characters. New items may be added without affecting the recognition of those already in the repertoire.

188. Marvin, T. and S. Ling
GENERAL ELECTRIC REACTIVE DISPLAY SYSTEM. IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS' REGION III CONVENTION, ATLANTA, GA., APRIL 11 – 13, 1966, PROCEEDINGS. New York, Institute of Electrical and Electronics Engineers, Inc., 1966.

Description of the objectives, system design, and data structure, and language of the G.E. reactive display system (GERD). The GERD system has two major objectives – (1) to expand and maximize the total user value derived from a computer system, including optimization of time-sharing procedures, and (2) to allow users to generate their own specific application programs within broad compatibility boundaries. The graphic language to be made available on a GERD system should include basic functions such as drawing lines, circular arcs, and mathematically described freehand curves; the application of constraints to drawings is also discussed. The general data structure of the system is considered, and the various and specific types of logic or mathematical operations to be performed are examined.

189. Maynard, H. M.
PHOTO READER AIDS PATTERN RECOGNITION STUDY. Electronics, 35(30):50, 52, Aug 3, 1962.

Photo - input device has been developed that enables photographic or graphical inputs to be supplied directly to general purpose digital computers; photo reader has contributed to research in automatic character recognition and photo interpretation.

190. Meadows, D. M.
APPLICATIONS OF COMPUTER GRAPHICS IN THE AEROSPACE INDUSTRY. IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, REGION III CONVENTION, ATLANTA, GA., APRIL 11 – 13, 1966, PROCEEDINGS. New York, Institute of Electrical and Electronic Engineers, Inc., 1966.

Description of a man-computer graphics (MCG) system designed for the development of an effective communications system between man and computer. An effective device for accomplishing the necessary graphical information match between man and the computer is provided by a digitally driven CRT display which is capable of accepting and presenting data in pictorial form. The hardware and software involved in an MCG system are described. Long-range studies backed up by actual experiments with the graphics system will lead to a more complete understanding of the processes involved in man-computer graphics applicable to engineering and manufacturing organizations. An engineer in this future setting would have at his command an enormous storage system which would deliver almost instantaneously any item which might pertain to his problem.

191. Mermelstein, P. and M. Eden
EXPERIMENTS ON COMPUTER RECOGNITION OF CONNNECTED HANDWRITTEN WORDS. Massachusetts Inst. of Tech., Research Lab. of Electronics, Cambridge, Mass. Repr. from Inform. and Control, v. 7, No. 2, Jun 1964, pp. 255 – 270. N64-29385.

An operational system is presented for the recognition of handwritten words when written on line on a special transducer. The system represents a new approach to

handwriting recognition, that of searching for the invariants of the patterns by consideration of the intrinsic movements that execute the handwriting. The handwritten words are analyzed by segmentation into strokes, recognition of strokes by the statistical likelihood of their belonging to preselected classes, and the use of constraints inherent in the script and word representations to limit the output sequences generated. Experiments carried out by computer simulation of the recognition system reveal that the system is capable of recognizing well-formed, legible handwritten words with a reliability that depends on the correspondence between the script of the test samples and that of the ensemble on which the machine's representation of handwriting is based.

192. Mitchell, J.
DESCRIPTION OF THE SYSTEMS DESIGN LABORATORY DISPLAY CONSOLES. Mitre Corp., Bedford, Mass. Rept. no. TM-03930; ASD-TDR-64-150. Feb 1965. (Contract: AF 19(628)-2390.) DDC AD-611 753.

Six display consoles were purchased for the systems design laboratory (SDL) to facilitate rapid, accurate communications between the SDL data processing facilities and the display operators. These consoles may be connected to any computer able to control IBM 729 series magnetic tape drives. Each console contains a 2048-word magnetic core memory for storing display data which is coded in a highly efficient manner. It also contains display storage in the form of a 64-frame film strip any frame of which may be presented on the display. Display generation is very rapid and is capable of showing alphanumeric and special characters, straight lines, and points. The appearance of a number of the special characters is under control of the data processor's program. The display operator is provided with switches, a light pencil, and a typewriter able to generate inquiries or statements for entry into the data processor's program.

193. Moffett, T. J.
THE MANAGER, THE ENGINEER AND THE MACHINE. Lockheed-California Co., Burbank, Calif. IN Am. Ordnance Assoc. Discussion Group on Computer-Aided Design and Doc. 1st Meeting and Subsequent Action Rept., Mar 1966. X66-21695.

NOTICE: Available to U.S. Government Agencies Only.

This article discusses the new challenges confronting the engineering manager in the face of rapid advances in automation, in particular, the emergence of graphic data processing or computer graphics. The capabilities of this real time man-machine system in engineering design are discussed together with its implications for scientific and technical advancement.

194. Moore, D. W. G. and M. J. Erickson
THE DISPLAY AS A RESEARCH TOOL.
3rd Australian Computer Conference, 1966,
395 – 398.

This paper describes the use of a high precision Type 346 display with light pen in a PDP-6 time-shared system. FORTRAN subroutines for graphical output with light pen control and some of their applications are described. Early steps toward providing suitable software for design problems which may be described schematically are discussed.

195. Ninke, W. H.
GRAPHIC 1 – A REMOTE GRAPHICAL DISPLAY CONSOLE SYSTEM. Bell Telephone Labs., Inc., New York. Presented at the Fall Joint Computer Conf., Las Vegas, Nev., Dec 1965. (MONOGRAPH-5113). 1965. N67-11138.

Graphic 1 provides flexible man-computer graphical communication in a time-shared central computer environment. Its console unit can be divided into two major units. The first unit consists of a control computer, which provides the local console computer power, and the console input devices. The second unit contains a display scope and an associated core buffer memory for storing display material. The main input device for the console system is a light pen. A standard teletype keyboard may also be used for input-output functions. Possible uses for the system are examined.

196. N-C TAPE MADE WITH VISUAL SCOPE.
Iron Age, 197(10):121, Mar 10, 1966.

Tapes can now be prepared without going through any mathematical language; engineer sits at scope, draws part with light pen and then moves pen along path that machine-tool cutter will have to take to machine part; by using this method time to produce numerical control tapes was reduced by factor of 10 at Lockheed-Georgia, Marietta, Ga.; computer-graphic technique is aimed at parts of two-dimensional line and circular geometry.

197. ON-LINE COMPUTERS CONTROL CIRCUIT PRODUCTION. Machinery (New York), 72: 91–95, Dec 1965.

An account is given of various applications of computers by IBM in the fabrication of circuits and production of logic modules for computers. An IBM 1620 and light-pen/ display unit is used by engineers designing circuits. Other computer systems perform electrical tests on silicon transistor and diode chips, and final logic tests on modules. IBM 7090 design automation programs assist in the creation of logic circuit cards. From the output of the 7090, an IBM 1401/1410 system extracts production and test parameters for every part number to be produced in a single day's operations, and these data are recorded on disc storage units for an IBM 1710 control system. This system uses the stored data to control production by identifying part numbers via machine-readable codes transmitted from the production line; sending numerical control instructions on a time-shared basis to banks of special drilling, hole-testing, circuit exposing and component insertion machines; monitoring copper-plating currents and chemical bath parameters; and detecting potential machine malfunctions before they become critical.

198. Owen, C. E. CRT DISPLAY CONTROL SYSTEM. IBM Technical Disclosure Bull., 9:593–594, Nov 1966.

A system is described which supplies characters to be displayed on a cathode ray tube from a computer store.

199. Owen, C. E DISPLAY SYSTEM. IBM Technical Disclosure Bull., 9:640–641, Nov 1966.

Arrangements are described whereby information stored in conventional form in the main memory of a computer can be displayed on a standard television receiver.

200. Pakulov, N. I. and E. F. Ul'yanchenko COMPUTER ELECTRONIC OUTPUT DEVICE. Automatika i Telemekhanika, 26(2):375–379, 1965. (In Russian), English Summary.

An electronic output device for computer alphanumeric information is described. The device uses a ferrite matrix for obtaining images of symbols on the screen of a cathode-ray tube. All the functions of obtaining raster on the cathode-ray tube screen,

of determining co-ordinates of symbols, and of scanning of the ferrite matrix are combined in co-ordinate counters with the addition of weighted resistances to them.

201. Palmer, A. H. and H. T. Blomquist
FABRICATION DRAWINGS BY COMPUTER.
Civ. Eng. (NY), 35(2):30–2, Feb 1965.

How digital computer can be combined with high-speed computer-plotter for production of detailed drawings of structural-steel framing members is discussed; necessary drafting programs were completed to produce beam fabrication drawings, and other programs are studied that will enable production of complete set of fabrication drawings; geometry, loads, and special design parameters are edited by system of programs to determine characteristics of individual components; system utilizes program which generates drafting instructions to direct computer-plotter to perform proper drafting operations.

202. Parker, D. B
SOLVING DESIGN PROBLEMS IN GRAPHICAL DIALOGUE. In On-line computing – time-shared man-computer systems, McGraw-Hill Book Co., N. Y. 1967, pp. 179–219.

This paper is a guide to non-experimental graphic hardware, and to the integration of such hardware into conversational graphic systems.

The paper gives a brief discussion of the major hardware choices (e.g., lightpen or RAND tablet). This section includes an example of a "sample engineering assembly drawing" with 6945 line and curve segments and 8912 characters of labeling.

The bulk of the paper is devoted to a proposal for a "basic" system. The hardware and user-visible software are explained; discussion of an area and centroid calculation completes this section.

A portion of the paper is devoted to discussion of data structures for graphical displays.

203. Petrenko, A. I.
FUNCTION GENERATOR OF GRAPHICAL DATA.
Air Force Systems Command, Foreign Technology Di., Wright-Patterson AFB, Ohio. In its trans. of the all Union Conf.-Seminar on the Theory and Methods of Using Mathematical Models. 13 Jan 1967, pp. 441–456. N67-26867.

The problem of direct automatic input of textual and graphic data into a computer is considered, and a graphic data function generator designed for this purpose is described. The proposed generator is based on the principle of a pulse servosystem which makes it possible to realize simultaneously the advantages of servo and scanning transformation methods. A reflected light beam technique is incorporated so that graphs and recordings can be used as input functions independently of carrier type and its dimensions. A schematic of the instrument is included, along with a diagram showing the operational principles. A specially designed unit converts the primary light pulses into secondary electrical pulses assuring a reliable reading during variations in the amplitude of input pulses.

204. Pfaltz, J. L.
PATTERN RECOGNITION VI – MANS. A MAP ANALYSIS SYSTEM. Maryland University, Computer Science Center, College Park, Md. Feb 1967, 132p. (Grant NsG-398). (NASA-CR-85580; TR-67-42). N67-30800.

A map analysis system, MANS, written in FORTRAN IV for use in facilitating the processing of maps and line drawings is presented. It was implemented primarily for the purpose of testing the suitability of various data structures for storage and retrieval of information about entities in a picutre. The present MANS version was also developed to simulate picture analysis in an on-line time sharing environment using a cathode ray tube display and light pen. Such a configuration gives the user the capability of modifying processing techniques in the light of intermediate results and provides an opportunity to evaluate processing techniques. The output of the MANS is in the form of displayed pictures created from the original picture, together with statements containing information about the displayed entities.

205. PICTURE LOOKS BRIGHTER FOR COMPUTER DISPLAYS. Electronics, 40(21):165–171, Oct 16, 1967.

Storage CRT's that provide long lasting images make display handy tools in applications ranging from airline reservation systems to seismic-plot analysis.

206. Pinter, H. R., W. B. Johnson, and R. Matthies
N/C COMPUTER PROGRAMS THEIR AVAILABILITY AND FUNCTION. ASTME Western Metal & Tool Exposition & Conference – Collected Papers 1966 paper MS66-720. 57p.

Development of computer programs such as AUTOPROPS, AUTOSPOT, CAMP I, PRONTO, SNAP, ADAPT, SPLIT, and SYMPAC; to show each segment of numerical control system in its proper relationship, functions of man, computer, processor, post-processor, controller and machine tool are described separately; survey was conducted to assess availability of each of above functions; with proper documentation, each of these functions can be utilized to provide continuous flow necessary for completion of assigned tasks.

207. Poole, H. H.
FUNDAMENTALS OF DISPLAY SYSTEMS.
Washington, D.C., Spartan Books, 1966, 415p.
$19.50.

The basic techniques, devices, and systems which comprise the field of information display are presented. Extensive treatment is given to the cathode ray tube and CRT techniques, with the inclusion of descriptive material on such tubes as the storage tube, shaped beam, light scan, flat, wave-modulated, multigun, and direct printing tubes. Special color techniques are also covered. Next, large-screen techniques and peripheral devices are described, including system design and applications. Covered under the area of large-screen techniques are photographic and electromechanical systems, and electroluminescent, incandescent, electronic, and electro-optical techniques. Finally, performance and future display techniques are thoroughly covered, including those still in the research stage. Examples of the display systems considered are: (1) television systems; (2) radar systems; (3) computer generated displays; and (4) miscellaneous applications, including data plotters, special-purpose oscilloscopes, photographic applications, moving map displays, contact analog displays, head-up displays, and spaceborne displays. Laser display, three-dimensional, and projection display techniques are investigated for their significance as display techniques of the future.

208. Pope, G. G., ed.
SYMPOSIUM ON THE USE OF THE DIGITAL COMPUTER IN AIRCRAFT STRUCTURAL DESIGN AND ANALYSIS. Royal Aircraft Establishment, Farnborough (England). Jul 1966, 101p. (RAE-TR-66239). X67-13791.

NOTICE: Available to U.S. Government Agencies and Their Contractors Only.

Conference papers on the use of the digital computer in aircraft structural design and analysis are presented along with an edited version of the discussions that followed the papers. The papers cover the digital computer's impact on the aircraft industry, practical developments of structural applications of computers, the digital computer in the drawing office and production engineering, the closer integration of the digital computer with design procedures, and the computer and the stress office.

209. Poppelbaum, W. J.
COMPUTER APPLICATION OF ELECTRO-OPTICS. Am. Federation of Information Processing Soc. (AFIPS) – Joint Computer Conference – Proc. v. 28, Spring 1966, pp. 1 – 15.

Principle of optical Fourier transform; associative fiber scanner utilizing fiber light conductors; phase-modulation matrix used as spatial filter; scanners (serializers) include ultrasonic deflector, Ardenne tube, and scansistor; storage and display devices including oscillating-cloud storage tube, electroluminescent display panels incorporating storage facilities, and paramosaic device using matrix waves; application to graphical processing using computers.

210. Poppelbaum, W. J., M. Faiman, and E. Carr
PARAMATRIX PUTS DIGITAL COMPUTER IN ANALOG PICTURE, AND VICE VERSA. Electronics, 40(18):99–108, Sep 4, 1963.

Prototype system uses digitally controlled analog circuits to handle preliminary transformation of graphic patterns cheaply and quickly.

211. Prince, M. D.
MAN-COMPUTER GRAPHICS FOR COMPUTER-AIDED DESIGN. Proc. IEEE, 54:1698–1708, Dec 1966.

This paper reviews the history, concepts, state-of-the-art and future directions of the use of man-computer graphics for computer-aided design. Computer-aided design is based on real-time graphical dialogue between the man and the computer in which the man draws on a display by means of a "light pen" or other input device. The computer "understands" the picture, makes calculations based on it, and presents the resuts pictorially to the user for his approval or revision. This man-computer graphical conversation has been made possible by recent advances in the speed of the digital computer, time-sharing programming, computer-driven display technology, and graphical input devices. The light pen is the most commonly used graphical input device, but keyboards, joysticks, flat matrix arrays, and other devices are also used. The programming state-of-the-art is a limiting factor in the implementation of graphical computer-aided design; much work remains to be done in systems programming, efficient time sharing, list structure concepts, file organization, and memory protection. A number of experimental equipment configurations in use in various laboratories are cited and the hardware state-of-the-art is reviewed. Several experimental and production applications of computer-aided design evolved at the Lockheed-Georgia Research Laboratory are described and illustrated by photographs of the DEC-340 display interconnected with a UNIVAC 418. The applications relate to structural analysis, dynamics, information retrieval, accounting and numerical control tape preparation.

212. Pritsker, A. A. B.
GERT: GRAPHICAL EVALUATION AND REVIEW TECHNIQUE. Rand Corp., Santa Monica, Calif. Apr 1966. (Contract NASr-21). (NASA-CR-74140; RM-4073-NASA). N67-31354.

A procedure for analyzing networks with stochastic and logical properties is developed to analyze a class of networks which has the probability that a branch of the network is part of the realization of the network itself, and has an elapsed time associated with the branch when the branch is part of the network realization. This Graphical Evaluation and Review Technique (GERT) consists of a set of branches and nodes, and derives both the probability that a node is realized and the conditional moment generating function of the elapsed time required to traverse between any two nodes. Components of stochastic networks are presented, along with an example that illustrates the integration of components into a network. An equivalent network is derived for series, parallel, and self-loop networks based on flowgraph theory. Concepts of confidence statements, sensitivity, and elasticity are presented; and a digital computer program for analyzing specific GERT networks is included.

213. PROCEEDINGS INDUSTRIAL SYMPOSIUM ON NUMERICAL CONTROL DATA. Department of Defense, held in Oklahoma City Air Material Area, Tinker AF Base, Oklahoma. Oct 3 – 6, 1966.

This is a report of minutes of the first Dept. of Defense-Industry Symposium on Numerical Control Data. The purpose of the symposium was "to review the commonality of numerical control systems and to determine capabilities for interchange of software and data for maximum return on Government and Industry investment."

214. Puckett, H. R.
COMPUTER METHOD FOR PERSPECTIVE DRAWING. J. Spacecraft & Rockets, 1(1):44–48, Jan – Feb 1964.

Drawing method using computer equipped with line plotter can produce perspective drawings useful to depict proposed structures prior to stress analysis, compare deflected structures with their unloaded configurations, show pressure or stress variations over surfaces, and improve spatial visualization; computer converts rectangular coordinates of "defining points" into those necessary for perspective view by rotating axes through arbitrary tilt and turn angles, translating axes to "center" origin, and computing shifting necessary for perspective projection.

215. Raffel, J. I.
GRAPHICS. Mass. Inst. of Tech., Lincoln Lab., Lexington, Mass. Semiannual Technical Summary Rept. for 1 Jun – 30 Nov 1965. Nov 1965. (AF 19 (628)-5167). ESD-TDR-65-561. DDC AD-625 567.

Recent efforts in the graphics program have concentrated on the development of a graphical service system, display routines compatible with the new time-sharing system, apex, and a universal translator, vital, which will be used to generate a graphical compiler. Programs for clipping and approximating conic segments have been developed and initial experiments which apply graphical techniques to procedure description have been attempted.

216. Raffel, J. I.
GRAPHICS. Mass. Inst. of Tech., Lincoln Lab., Lexington, Mass. Semiannual technical summary rept., 1 Dec 1965 – 31 May 1966. May 1966. (AF 19(628)-5167). ESD-TR-66-212. DDC AD-634 251.

Efforts in the graphics program have continued to concentrate on the development of the graphical service system and vital, a compiler-compiler. The latter program is now operational. Development of a debugging system which utilizes graphics as a central communications medium has been initiated. In an effort to improve the methods of generating points, lines, and general conic sections in display systems, a simple waveform generator has been designed, based on homogeneous coordinate mathematics. The hardware problems in the implementation of this design are being investigated. A three-dimensional ultra-sonic position-sensing device has been installed in TX-2 and initial evaluation is under way.

217. Raffel, J. I.
GRAPHICS. Mass. Inst. of Tech., Lincoln Lab., Lexington, Mass. Semiannual technical summary report, 1 Jun – 30 Nov 1966. 9 Dec 1966. (Contract AF 19(628)-5167; ARPA Order 691). (ESD-TR-66-583; AD-643821). N67-20003.

The new APEX display executive is operational. The compiler-compiler, VITAL, was used to generate a number of compilers, including one for a second version of CORAL. A CRT display sequence is being constructed which will incorporate both the newly designed conic waveform generator and a character generator, and will handle as many as ten display stations. The hardware and software for the first phase of the SDC network experiment are completed – experimentation is under way.

218. Raffel, J. I.
GRAPHICS. Mass. Inst. of Tech., Lincoln Lab., Lexington, Mass. Semiannual technical summary rept., 1 Dec 1966 – 31 May 1967. 31 May 1967, 8p. Contract AF 19(628)-5167. ESD-TR-67-275. DDC AD-653 191.

The objective the Graphics program at Lincoln Laboratory is the development of computer hardware and programs which will enable users to work on-line in an interactive

mode employing graphical techniques for the input, manipulation and representation of graphical data. The work includes the investigation of problems related to using a time-shared computer, such as TX-2, for graphics, and the design of general purpose system programs to provide graphics capability for a variety of scientific, military and control problems. During the last reporting period the following has been accomplished: A general-purpose fron-tend system has been designed based on the VITAL system. VITAL itself has been expanded to allow a compiler to control the scanning of a source program and outputing of messages. An ALGOL-like language, LABGOL, has been implemented; with the addition of means for building and manipulating a store of explicit relations between objects and their attributes, a new language, LEAP, has also been specified. The new hybrid conic generator has been operated successfully on-line.

219. Richemont, D. A.
NOTES ON APT III. Data & Control, 3:32–34, Nov 1965.

The paper discusses the numerical control of machine tools generally, and indicates some of the special features of APT III.

220. Rippy, D. E.
MAGIC: A MACHINE FOR AUTOMATIC GRAPHICS INTERFACE TO A COMPUTER. National Bureau of Standards, Information Technology Div., Washington, D. C. 29 Dec 1964. (NASA Order R-09-022-039). (NASA-CR-62897; NBS-8665). N65-25010.

Described is a machine that combines two large cathode ray display consoles joined together with a specially designed data processor organized around a magnetic-drum memory that acts as a remote display station in connection with a large automatic data processing system. The magnetic drum meory includes a general memory, consisting of 90 channels of 128 12-bit words each, and a display memory, consisting of 4 channels of 128 12-bit words each that act as display processors. A basic block diagram of MAGIC is shown and the programming and operating procedures are described.

221. Rippy, D. E. and D. E. Humphries
MAGIC – A MACHINE FOR AUTOMATIC GRAPHICS INTERFACE TO A COMPUTER. IN: AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, 1965 FALL JOINT COMPUTER CONFERENCE, LAS VEGAS, NEV., NOVEMBER 1965, PROCEEDINGS. VOLUME 27 – PART I. Washington, D. C., Spartan Books, 1965, pp. 819 – 830.

Description of the salient hardware, software and operational features, as of May 1965, of MAGIC, an operating display system. It is noted that preliminary design work on a Model II MAGIC is in progress and that final design and construction is scheduled for the fall of 1965. Model II will incorporate state-of-the-art hardware components and will be designed to eliminate the hardware deficiencies of Model I. This will result in greatly improved operating speed, display quantity and quality, and list manipulating capabilities. It will also be interfaced to the same central computer as Model I. The final design of the interface hardware for Model II will be dictated by what is learned from the implementation of the interface for Model I.

222. Ritchart, R. C.
FUNDAMENTALS OF COMPUTER GRAPHICS. Society for Nondestructive Testing, American Society for Metals, and American Society of Tool and Manufacturing Engineers, Annual Western Metal and Tool Conference and Exposition, 4th, Los Angeles, Calif., Mar 13 – 17, 1967, Paper WES 7-02, 24p.

Discussion of the role of computer programing or software techniques in relation to hardware elements of a computer graphics system. Typical "tools" for graphic construction and analysis which are provided to the system user are described.

223. Roberts, L. G.
THE LINCOLN WAND. Proc. 1966 Fall Joint Computer Conference, 223 – 227.

This paper discusses the Lincoln WAND, an ultrasonic position-sensing device which allows a computer to determine periodically the x, y and z coordinates of the tip of a pen-sized wand. The device can replace the light-pen and the Rand Tablet for two-dimensional work and extends the usefulness of such devices by virtue of the extra dimension available. The WAND uses four ultrasonic transmitters and one receiver. Each transmitter is pulsed periodically so that the four vector distances to the receiver are determined and its position in space can be calculated.

224. Roberts, L. G.
A GRAPHICAL SERVICE SYSTEM WITH VARIABLE SYNTAX. Commun. ACM, 9:170–175, Mar 1966; disc. 175–176. AD636364.

Man-machine interaction in many fields should be greatly facilitated in the near future through the use of interactive graphical languages. To provide a variety of display scope communication procedures, a graphic service system which functions as a generalised graphical language translator, is being developed to aid the definition as well as the use of new graphical languages.

225. Roberts, L. G.
GRAPHICAL COMMUNICATION AND CONTROL LANGUAGES. Mass. Inst. of Tech., Lincoln Lab., Lexington, Mass. Rept. no. MS-1173, 1964. (AF 19(628)-5167). ESD-TDR-65-600. DDC AD-626 882.

The future for computer processing of graphics is alleged to be manipulation of data files and programs external to the graphical package. Pictures are regarded as abstractions that are used as labels for external entities so that it is possible to create interconnect, and rearrange the entities with a 2-dimensional language rather than the normal 1-dimensional text stream. The CORAL (class-oriented ring association language) list structure system for graphical and other problems is described. The list structure concepts are similar to these used to implement sketchpad on the TX-2 computer, but storage space is reduced and a more complete list structure and language is generated. The CORAL list ties are formed as rings, each element in the ring requiring one 36-bit word and containing a 17-bit pointer to the next element. Blocks of elements are used that collect many ties together and allow the multi-dimensional associations required for graphical data structures. This paper also discusses storage, class structures, on-line problem solving by use of graphical techniques, and display consoles.

226. Rose, G. A.
"LIGHT-PEN" FACILITIES FOR DIRECT VIEW STORAGE TUBES – AN ECONOMICAL SOLUTION OF MULTIPLE MAN-MACHINE COMMUNICATION.
IEEE Trans. Electronic Computers, EC-14, Aug 1965, 637 – 639.

Techniques are presented which enable conventional light-pen tracking and pointing functions to be extended to the direct view storage tube. The schemes eliminate the high data transfer rates or considerable buffer storage required even for static displays when short persistence cathode ray tubes are used. Two solutions, a "quadruple photo-sensor pen" and the "potentiometer pen" (a transparent resistive sheet and stylus combination which covers the display), are described and compared.

227. Rose, G. A.
ECONOMICAL, GRAPHICAL COMMUNICATION TECHNIQUES FOR MULTIPLE CONSOLE OPERATION. Proc. 3rd Australian Computer Conference, 1966, 399 – 402, disc. 409.

This paper outlines the output and input sequences of an on-line, graphical communication system which links many users to a central processor via an interface computer. Output includes arbitrary graphics and symbols; input includes real-time freehand sketches and symbols, referenced symbol cells and image pointing. The paper cites a number of inefficiencies in the encoding, plotting and input tracking of graphics. It presents a compact incremental polar encoding which specifies a graphic either by a piecewise linear approximation or by linked sections of constant curvature. The logical structure is specified for a graphical interface computer, INTERGRAPHIC, which is responsible for detailed image generation input graphic encoding and vector string manipulation. The interface operates mainly in two high speed incremental modes – rectangular and circular – and is capable of incremental plotting rates of several Mc/s. The symbol generator shares the interface read-only microprogram control store and generates symbols from standard straight lines, quarter circles and quarter ellipses at a point plotting rate of 10 Mc/s. The paper emphasizes the need for simple, unifying concepts for graphical communication, and proposes that the flow of direction and curvature of a graphic with arc length is a useful basis for both recognition and display.

228. Ross, D. T.
IMPLICATIONS OF COMPUTER-AIDED DESIGN
FOR NUMERICALLY CONTROLLED PRODUCTION.
Mass. Inst. of Tech., Electronic Systems Lab.,
Cambridge, Mass. Rept. no. TM212, Sep 1964.
(AF 33(657)-10954). DDC AD-453 880.

Although the potential impact of computer-aided design techniques on the application of numerical control in a production environment is very great, changes in present practice will be evolutionary rather than revolutionary. There are three main portions of the computer-aided design concept: (1) combined verbal and graphical language, for making statements about problems; (2) the modeling plex, for storing in a consistent fashion all of the necessary information about a problem; and (3) generalized operators, for manipulating statements and models to perform useful mathematical and data processing functions. Man-machine console facilities, including graphical and verbal input/output facilities are needed and must be made economically feasible on a large scale. The combined hardware-software system can be applied to various new problem areas by boot-strapping new techniques and processes into the system using available facilities.

229. Ross, D. T., S. A. Coons, and J. E. Ward
INVESTIGATIONS IN COMPUTER-AIDED DESIGN
FOR NUMERICALLY CONTROLLED PRODUCTION.
Mass. Inst. of Tech., Electronic Systems Lab.,
Cambridge, Mass. Interim Engineering Progress
Rept. no. 1, 1 Dec 1963 – 30 May 1964. Dec 1964.
ESL-IR-221. (AF 33(657)-10954). NASA X65-14526.
DDC AD-459 055.

The M.I.T. computer-aided design project is engaged in a program of research into the application of the concepts and techniques of modern data processing to the design of mechanical parts, and the further development of automatic programming (APT) systems for numerically-controlled machine tools. The project is a cooperative venture between the computer applications group of the electronic systems laboratory and the design division of the mechanical engineering department. To assist in the dissemination of research results the project is establishing various cooperative contacts with other groups. Work with project MAC and ship design at M.I.T., and the AED-1 project, in which programmers from industry join in the research effort at M.I.T., are outlined. Technical topics include innovations in compiling and language processing for the AED-1 system, additions to AED-0 compiler capabilities, processing both graphical and verbal language by a single algorithm, generalized parameters surfaces.

230. Ross, D. T., S. A. Coons, and J. E. Ward
INVESTIGATIONS IN COMPUTER-AIDED DESIGN FOR NUMERICALLY CONTROLLED PRODUCTION. Massachusetts Inst. of Tech., Electronic Systems Lab., Cambridge, Mass. Interim engineering rept. no. 2, 1 Jun – 30 Nov 1964. Rept. no. MIT-ESL-IR-241, Jun 1965. (Contract AF 33(657)-10954). NASA X66-10980. DDC AD-467 764.

The M.I.T. Computer-Aided Design Project is engaged in a program of research into the application of the concepts and techniques of modern data processing to the design of mechanical parts, and the further development of automatic programming (APT) systems for numerically-controlled machine tools. Technical topics include innovations in compiling and language processing for the AED-1 System, additions to AED-0 Compiler capabilities, processing both graphical and verbal language by a single algorithm, generalized parametric surfaces, three-dimensional display in time-sharing, stress analysis and other design topics. This report begins with a five-year summary of the organization and progress of the Project. Later chapters describe modifications to the AED-0 Compiler System, plans for its distribution to industry, and its use in preparations for AED-1. Graphic language in time-sharing and for shape description is summarized, along with various mathematical techniques for mechanical design problems. Experiments in improved display console techniques are also described.

231. Ross, D. T., S. A. Coons, and J. E. Ward
INVESTIGATIONS IN COMPUTER-AIDED DESIGN FOR NUMERICALLY CONTROLLED PRODUCTION. Massachusetts Inst. of Tech., Electronic Systems Lab., Cambridge, Mass. Interim Engineering Progress Report, 1 Dec 1964 – 31 May 1965. Mar 1966. (Contract AF 33(657)-10954). (ESL-IR-262; IR-8-235-111; AD-482837). X66-20149.

Application of the concepts and techniques of modern data processing to the design of mechanical parts, and the further development of automatic programming (APT) systems for numerically controlled machine tools was investigated. Technical topics include innovations in compiling and language processing for the AED-1 system, additions to AED-0 compiler capabilities, processing both graphical and verbal language by a single algorithm, generalized parametric surfaces, three-deimensional display in time-sharing, stress analysis, and other design topics. The application of computer-aided design to practical mechanical design problems, such as surface

description and display as in the design of ship hulls and aircraft fuselages is described and display requirements for future time-shared computer systems are reported.

232. Ross, D. T., S. A. Coons, and J. E. Ward
INVESTIGATIONS IN COMPUTER-AIDED DESIGN FOR NUMERICALLY CONTROLLED PRODUCTION. Massachusetts Inst. of Tech., Electronic Systems Lab., Cambridge, Mass. Interim Engineering Progress Report, 1 Jun 1965 – 31 May 1966. Aug 1966. (Contract AF 33(657)-10954.) (IR-8-236-IV-V; ESL-IR-278; AD-802212.) X67-13861.

The M.I.T. Computer-Aided Design Project is engaged in a program of research into the application of the concepts and techniques of modern data processing to the design of mechanical parts, and the further development of automatic programming (APT) systems for numerically-controlled machine tools. Technical topics include: (1) Innovations in compiling and language processing for the AED (Automated Engineering Design) System to permit processing both graphical and verbal language by a single algorithm; (2) the successful beginning of the 1966 AED Cooperative Program with industry; (3) progress in developing the AED-1, CADET, AED JR., and AEDNET Systems; (4) the application of computer-aided design to mechanical design problems, such as surface description, display of surfaces having discontinuous slopes, and stress analysis; and (5) progress in display hardware for three-dimensional display in time sharing, including a DDA (Digital Differential Analyzer) rotation matrix, analog curve generation, and installation of a display buffer computer.

233. Ross, D. T. and J. E. Rodriguez
THEORETICAL FOUNDATIONS FOR COMPUTER-AIDED DESIGN SYSTEM. Am. Federation of Information Processing Soc., (AFIPS) – Joint Computer Conference, v. 23, Spring 1963, pp. 305 – 22.

Approach to Computer-Aided Design system is outlined, by authors associated with M.I.T. Electronic Systems Laboratory; algorithmic theory of language is described, along with transformation from language to "plex" models; example of servomechanism design is presented to illustrate design system in operation.

234. Sass, W. H.
GRAPHICS IN DESIGN ENGINEERING. SAE-Paper 660459 for meeting Jun 14 – 16, 1966, 24p.

Man and computer can work together on design of complex components and systems using graphic input/input devices, such as light pens, keyboards and displays; graphic interface permits conversational communication between specialist (frequency engineer) and computing equipment, in form of symbolic language having pictorial and alphameric elements; paper describes graphic application, implemented for design of digital computer circuit cards; step-by-step description of planned IBM Computer Design System shows general job flow, engineering sequences, specialized program areas, and concepts of computer-graphics design.

235. Schofield, B. E.
COMPUTER-AIDED DESIGN OF SKIN-STIFFENED COMPRESSION PANELS. IN: AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, AND AMERICAN SOCIETY OF MECHANICAL ENGINEERS, STRUCTURES, STRUCTURAL DYNAMICS AND MATERIALS CONFERENCE, 8TH, PALM SPRINGS, CALIF., MARCH 29 – 31, 1967, TECHNICAL PAPERS. New York, American Institute of Aeronautics and Astronautics, Inc., 1967, pp. 230 – 235.

A solution is presented for the design of integrally stiffened compression panels using the digital computer and graphic display of computer output. This technique is applicable to other skin and stiffener combinations common to aerospace compression structure. The optimum solution is obtained from the three basic equations: (1) applied stress, (2) local stability, and (3) general stability. These equations are expressed in a form compatible with a constant strain approach. A model is devised suitable for computer adaptation. General and local stability constants are discussed as to the amount of conservatism imposed on the solution. Provisions are made for nonoptimum factors: buckled skin, minimum skin gage, and minimum column length. The solution (integral section dimensions and properties, material properties, and panel weight) is graphically displayed on a cathode ray tube. Modification to the solution may be made with the use of an electronic light pen. Test results are provided for fully effective and buckled skin Y- and J-stiffened compression panels. Excellent correlation is shown between the calculated and test loads. Attachment criterion is presented to obtain monolithic panel behavior, and a design curve is proposed based on NACA and Douglas test results on 7075 aluminum compression panels.

236. Shannon, G. M., H. L. Kasnitz, and J. A. Drumheller
BASELINE: A MAN-MACHINE PROGRAM FOR DATA ANALYSIS. Mass. Inst. of Tech., Lincoln Lab., Lexington, Mass. Rept. no. TN-1966-4, Jan 1966, 132p. (AF 19(628)-5167.) ESD-TDR-66-19. DDC AD-628 494.

Baseline was designed to perform a statistical analysis of radar pulse data, previously read by the laboratory's high precision computer controlled film reader. A computer controlled display oscilloscope, a light pen and a set of function coded sense switches provide a real time interface between an analyst and the data reduction program in the computer. The computer performs all necessary display, computation and outputing functions. All operations are under direct control of the analyst. He sets the operating criteria, exercises the required judgments and steers the program through the required analysis. Analytical results are quickly available and rapidly documented. Output consists of a statistical distribution of the input data displayed on a large oscilloscope. This display may easily be documented photographically. Key parameters describing the statistical distribution may be output on the typewriter at the command of the analyst. A very large saving in data reduction time results since the necessity of repeated test runs through a large computer and subsequent study of the numerical printouts is eliminated.

237. Shumway, Jerry
DO-IT-YOURSELF DISPLAY BRIGHTENS THE OUTLOOK FOR LOW COST CAD. Electronics, 40(21):120–124, Oct 16, 1967.

Discussion of a simple interface unit designed by Friden, Inc. which turns conventional laboratory oscilloscope into an effective display for a computer. The resulting system is capable of displaying engineering drawings, design curves, and similar graphics.

238. Siders, R. A., et al.
COMPUTER GRAPHICS – REVOLUTION IN DESIGN. Am. Mgmt. Assn., New York, N. Y., 1966, 160p.

Introduction to use of computer to store drawings, designs and data to furnish designer by maintaining readily accessible and continuously updated master file of drawings; use of light pen to recall drawings and revise them; operating modes of computers; examples of contours and stress diagrams and electronic circuits; costs, use and management of computers for design.

239. Siegel, L.
DIGITIZING GRAPHIC RECORDS FOR COMPUTER ANALYSIS. IEEE Trans. Bio-Medical Engng., BME-14, Jan 1967, 7 – 10.

A method for digitizing graphic records is presented. First, the TRACER is described. This electromechanical device is used on line with a digital computer (LINC) having analogue-to-digital input channels. As the stylus on the TRACER is moved over the record to be digitized, its position is indicated by a unique set of resistance values. These are converted to voltages, which are forwarded to the computer as (X, Y) coordinate values. The computer stores these values, operates on them, and displays the converted record on an on-line oscilloscope. Associated computer programs are discussed as well as applications. A section on errors and a comparison with presently available methods is included.

240. Sinyakov, Yu.
CAN A MACHINE CREATE A DESIGN? Air Force Systems Command, Foreign Technology Div., Wright-Patterson AFB, Ohio. 23 Sep 1965, 7p.
Transl. into ENGLISH from Mosk. Pravda (Moscow), 5 Jul 1962, p. 2. (FTD-TT-65-1150/1 + 4; TT-65-64164; AD-622397.) N66-24455.

The use of computers for assistance in making architectural designs is related. Andrey Savchenko of the Moscow Architectural Institute is credited with using cybernetics in calculating the strength of structural slabs for roofs and for covering a winter stadium. The machine is said to be able to create design: by "reading" an architectural sketch into a computer, an image of all possible combinations of architectural forms is attained from which a selection maybe made.

241. Skinner, F. D.
COMPUTER GRAPHICS – WHERE ARE WE?.
Datamation, 12:28–31, May 1966.

This article discusses potential applications for cathode ray tube displays in the areas of customer service (answering inquiries by reference to large files), management information systems, information retrieval, programming, and engineering and mathematical analysis. The economic feasibility of using displays is then considered. Finally, experimental programs are briefly discussed for such functions as operating system support, data plotting, point line and arc generation, three-dimensional projection, alphanumeric page formatting, light pen selection, program debugging, data structuring, and two-dimensional graphical processing.

242. Smith, C. F.
GRAPHIC SYSTEMS FOR COMPUTERS. Computers & Automn., 14:14–16, Nov 1965.

The author outlines the graphic data processing system of the future which will link input/output units, such as film scanners, film recorders and display units to a computer and will provide integrated graphic input, manipulation and output, and indicates applications in design engineering and other fields.

243. SOCIETY FOR INFORMATION DISPLAY, NATIONAL SYMPOSIUM ON INFORMATION DISPLAY, 6TH, NEW YORK, N. Y., SEPTEMBER 29 – 30, 1965. PAPERS. Los Angeles, Society for Information Display, 1965, 185p. $10.00.

CONTENTS include:

VISUAL WRITE-ERASE-NONSTORE AND ELECTRICAL READOUT ACCURATE TRACKING DISPLAY STORAGE TUBE. Phillip P. Damon and John Kolostyak (Hughes Aircraft Co., Oceanside, Calif.), pp. 19–29.
METHODOLOGY FOR THE DEFINITION OF A SPACE VEHICLE DISPLAY SYSTEM. Neil J. Arntz (Boeing Co., Seattle, Wash.), pp. 111–135.
VISUAL DISPLAY TECHNIQUES IN VEHICLE STABILIZATION AND CONTROL, William W. Kingston (United Aircraft Corp., Norwalk, Conn.), pp. 147–154.
ALPHANUMERIC GENERATOR OPERATION, Willim J. Dunn, Elliot F. Linsky, and Robert A. Battaglia (Federal Aviation Agency, Atlantic City, N. J.), pp. 155–166.

244. SOCIETY FOR INFORMATION DISPLAY, NATIONAL SYMPOSIUM FOR INFORMATION DISPLAY, 7th, Boston, Mass. Oct 1966. $15.00.

Contents include:
Display Devices and Techniques
Information Processing as a Function of Display Format
The Observer-Human Factors and Performance
Display Systems
Display Standards and Measurements

245. SOCIETY FOR INFORMATION DISPLAY, NATIONAL SYMPOSIUM FOR INFORMATION DISPLAY, 8th, San Francisco, Calif., May 1967. Papers. Society for Information Display, Los Angeles, 1967.

The papers in these proceedings cover advanced materials, devices, techniques, and systems to provide a graphic portrayal of the state of the art and a portent of things to come.

246. Spiegel, J., J. K. Summers, and E. M. Bennett AESOP: A GENERAL PURPOSE APPROACH TO REAL-TIME DIRECT ACCESS MANAGEMENT INFORMATION SYSTEMS. Mitre Corp., Bedford, Mass. Rept. no. MTP-33, Jun 1966. (AF 19(628)-5165.) ESD-TR-66-289. DDC AD-634 371.

AESOP, a laboratory-based prototype of a general purpose, on-line, visually-oriented information system, is used to investigate ways of handling many different types and levels of command and management problems spanning organizational levels from the executive suite down through the staff and operations analysts to the actual system designers and programmers. In particular, it deals with those organizational activities that require highly flexible, direct-access capabilities. The system is configured for easy use by the inexperienced as well as by the sophisticated, and utilizes a variety of user station devices to facilitiate such flexibility, including a cathode-ray-tube display, a lightgun, a typewriter, and associated push-buttons. At each station, it is capable of generating, editing, and formatting information on-line, as well as building, executing, and debugging on-line the analytic and mathematical procedures and algorithms of both the users and the system itself, depending upon the organizational area or level of the user. Although the basic prototype system was developed for use in military command and management planning and information systems, its philosophy and concepts are applicable to industrial and academic organizations.

247. STEREOSCOPE/COMPUTER PROJECTS 3-D IMAGE. Product Eng., 38(21):174, Oct 9, 1967.

Representations of proposed product systems or components can be viewed in three-dimension with a standard laboratory stereoscope. Charles Strauss, graduate student at Brown University has applied the stereoscope to the graphic display unit of the 360 Model 50 computer.

248. Stifle, J.
A CATHODE RAY TUBE DISPLAY. Illinois Univ., Coordinated Science Lab., Urbana, Ill. Rept. no. R-357, Jun 1967. Contract DA-29-043-AMC-00073(E). DDC AD-653 525.

The report describes a cathode ray tube display unit designed for use as graphic output facility for a digital computer. The display features a self contained character generator, line generator, photographic unit, and a light pen. Data may be displayed in up to seven different modes. The maximum plotting rate is approximately 333,000 points/sec.

249. Stoodley, G. R. and J. S. Miller
DIGITAL COMPUTER GENERATED STEREOSCOPIC POINTILLE (MARKED BY DOTS) SURFACES. PART I: THEORY AND RESULTS. PART II: PROGRAMS. Grumman Aircraft Engineering Corp., Research Dept., Bethpage, N. Y.
Apr 1965. RM-275. N65-36461.

The theory and results of a study to generate by digital computer stereoscopic pointille surfaces are presented. The mathematical formulation for distributing points on a given surface is discussed. The methods for defining surfaces and locating points on these surfaces are outlined. The mathematical points are translated into a stereoscopic pair by a perspective program using an off-line digital incremental plotter. The stereo effect is achieved by viewing two perspective drawings obtained from different viewing positions. Several stereo drawings are given as examples. For complicated surfaces not exhibiting any overlap, the points present a vivid display of the surface. Placing the points uniformily on a surface eliminates the need for generating different sets of points for different orientations. Two computer programs written in FORTRAN II for implementing the techniques are described in detail. One program, MIT random points, uses four user-supplied boundary curves to define the surface that is then represented by dots. The other, grid random points, generates a surface from a grid of points.

250. Stotz, R. H.
MAN-MACHINE CONSOLE FACILITIES FOR COMPUTER-AIDED DESIGN. Proc. AFIPS 1963 Spring Joint Comput. Conf., Detroit, Mich., May 1963, 323 – 328. Spartan Books, Baltimore, Md. $10.00.

This article describes some of the external aspects of the MIT computer-aided design control console. It concentrates on the techniques of displaying three-dimensional figures using light-pen and CRT. The strong influence of the techniques applied to program-controlled machine tools, which took shape at MIT, is to be seen in the present application. Enough information is given in the paper for some on conversant with DDA, machine-tool control and CRT display techniques to embark on his own display project.

251. Stotz, R. H.
SPECIALIZED COMPUTER EQUIPMENT FOR GENERATION AND DISPLAY OF THREE DIMENSIONAL CURVI-LINEAR FIGURES. Massachusetts Inst. of Tech., Electronic Systems Lab., Cambridge, Mass. Mar 1963. (Contract AF 33(600)-42859.) (ESL-TM-167; AD-406608.) N64-28145.

Studies being conducted of computer-aided design of three-dimensional-shaped objects have shown the need for improved graphical man-computer communications, particularly faster displays. A straight-line-and-curve-drawing display system is proposed, which is capable of drawing two-dimensional axonometric projections of curvilinear three-dimensional figures at up to 100 times the speed of present point-plotting display scopes. The system, based on digital incremental computing techniques, consists of a line generator to produce time varying x, y, and z pulse-train signals proportional to the numerical input information; a rotation matrix to transform these signals into ones in the h and v coordinate axes of the scope; and accumulating registers (bidirectional counters) to hold the resultant data for the scope deflection amplifiers. The line generator is capable of producing straight lines and second-order curves of variable length.

252. Stratton, W. D.
INVESTIGATION OF AN ANALOG TECHNIQUE TO DECREASE PEN-TRACKING TIME IN COMPUTER DISPLAYS. Massachusetts Inst. of Tech., Cambridge, Mass. Master's Thesis, Mar 1966, 74p. Rept. no. MAC-TR-25. (Nonr-4102(01).) DDC AD-631 396.

Through the use of a CRT display and a light-sensitive pen, graphical material can be directly inserted into a computer by using the pen to control the position of the electron beam at the face of the CRT – a process called pen tracking. To reduce tracking time, an analog technique employing a four-point tracking pattern is proposed in this study, in which the amplitude response of the pen to corresponding pairs of points is used to determine the position of the pen relative to the center of the pattern. To study the method, one channel of the proposed two-channel analog tracking system was designed, constructed, and coupled to the horizontal channel of the project MAC – ESL display console. To avoid the phosphor-decay limitation, an experimental "beam" pen capable of detecting the electron beam rather than the phosphor luminescence was employed. The system includes a pattern generator, sample-and-hold gates, difference amplifier, envelope detector and noise filter, and a threshold-logic analog-to-digital converter.

253. Sutherland, I. E.
COMPUTER GRAPHICS. Datamation, 12:22–27, May 1966.

This article discusses ten unsolved problems which are of interest to those carrying out research in computer graphics, more specifically the on-line use of computer-generated pictures. The problems are as follows: (1) Building a display device for on-line graphical use which is of low cost, (2) Developing techniques to make on-line systems smooth in operation so as to be easy to use, (3) Coupling drawing programs to computing programs, (4) Facility to describe motion in an interactive graphical language, (5) Provision of half-tone pictures, (6) Languages which can represent and construct the structure of drawings, (7) Elimination of hidden lines in perspective drawings, (8) Display graphically the running of a computer program to make it more understandable, (9) Computer generation of a logical layout for drawings, (10) Computer generation of drawings representing abstract notions.

254. Sutherland, I. E.
COMPUTER INPUTS AND OUTPUTS.
Scientific American, 215(3):86–109,
Sep 1966.

Computer input and output is comprehensively described in such well organized and simple ways that the reader with casual interest in computers could not help but understand the subject quite thoroughly. The long introduction is followed, in order, by descriptions of ordinary input-output devices, historical treatment of programming of such devices, interrupt logic, operating systems, formatting, and then into the newer devices such as on-line graphical terminals and light pens.

255. Sutherland, I. E.
COMPUTER READS DESIGN SKETCHES. Iron
Age, 192(9):79–81, Aug 29, 1963.

Advanced computer system gives designer "magic" light pen that transfers 3-dimensional designs from his imagination to display scope; light pen concept evolved out of study made by M.I.T.; description of program called Sketchpad III which lets designer use pen to draw 3-dimensional shapes; it is shown how TX-2 computer, developed by Lincoln Laboratory of M. I. T., can do many individual tasks in computer-aided design.

256. Sutherland, I. E.
SKETCHPAD: A GRAPHICAL COMMUNICATION
SYSTEM. Mass. Inst. of Tech., Lincoln Lab.,
Lexington, Mass. Rept. no. TR296, Jan 1963.
(AF 19(628)-500.) ESD-TDR63 52. DDC AD-
404 549.

The Sketchpad system uses drawing as a novel means of communicating with a computer. The system contains input, output, and computation programs that enable it to interpret information drawn directly on a computer display. It has been used to draw electrical, mechanical, scientific, mathematical and animated drawings; it is a general-purpose system. Sketchpad has shown the most usefulness as an aid to the understanding of processes, such as the motion of link ages, which can be described with pictures. Sketchpad also makes it easy to draw highly repetitive or highly accurate drawings and to change drawings previously drawn with it.

257. Sutherland, I. E.
SKETCHPAD: A MAN-MACHINE GRAPHICAL COMMUNICATION SYSTEM. Proc. AFIPS 1963 Spring Joint Comput. Conf., Detroit, Mich., May 1963, 329 – 346. Spartan Books, Baltimore, Md., $10.00.

System described makes it possible for man and computer to converse rapidly through medium of line drawings; typed statements, except for legends, are eliminated; examples of application include drawing of general patterns, linkages, bridges, electric circuit diagrams etc; design answers obtained from computer are discussed.

258. Sutherland, W. R.
ON-LINE GRAPHICAL SPECIFICATION OF COMPUTER PROCEDURES. Mass. Inst. of Tech., Lincoln Lab., Lexington, Mass. 23 May 1966. (Contract AF 19(628)-5167.) (ESD-TR-66-211; TR-405; AD-639734). N67-15270.

A promising area of application for recently developed computer graphics techniques is computer programming. Two important considerations in using an interactive graphics system for drawing programs are (1) the form of a pictorial programming notation and (2) methods for making a computer execute the program once drawn. These topics are discussed in the context of an experimental graphical programming system running on the Lincoln Laboratory TX-2 Computer. This system uses a block notation for programs and can execute the drawn program with an interpreter. Improved graphical input languages for drawing programs and program notations which combine appropriate features of pictorial and written languages are needed before applications in this area are practical. The benefits to be expected from a graphical approach to programming include (1) automatic documentation, (2) debugging assistance, and (3) natural expression of parallel processes.

259. SYLVANIA DATA TABLET.
Computers & Aut., 56, May 1967.

An electronic ballpoint pen which translates graphic material to computer language as it writes and simultaneously transmits data to computer for storage or analysis has been developed at the Applied Research Laboratory of Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., Waltham, Mass. The pen and its electronic "note pad," known as the Sylvania Data Tablet, enable scientists to communicate with computers through written symbols and diagrams rather than by formal mathematical terminology. The system converts written symbols to digital and analog signals for transmittal to computers or over telephone lines for display at remote locations.

260. Taig, I. C.
THE COMPUTER IN THE STRESS AND DESIGN OFFICES. (Royal Aeronautical Society and Institution of Mechanical Engineers, Symposium on the Impact of Digital Computers on Engineering, London, England, Apr 20, 1966, Paper.)
Royal Aeronautical Society, Journal, 71:256 – 261, Apr 1967; Disc. 261 – 270.

Study of the current and projected use of the computer in aircraft design problems. Examples concerning the computer's merits as a time and labor saving device (dealing with internal load distribution and deformation problems, numerical analysis problems, loading calculation, modification and development stressing, and analytical technique development problems) are given. The use of the computer as a direct design aid is discussed, with accompanying examples illustrating the means by which the computer assists in the choice of design parameters. The possible application of computer techniques to the "discrete space element" approach and to the continuous surface approach, in regard to geometrical compatibility problems, is examined.

261. Taylor, R. W.
MAN-COMPUTER INPUT-OUTPUT TECHNIQUES.
IEEE Transactions on Human Factors in Electronics, HFE-8(1):1–4, Mar 1967.

There is discussion in this paper of some problems of terminology concerning multiple-access, on-line, interactive man-computer systems. It presents three viewpoints from which to examine man-computer interaction.

The first viewpoint is one of the internal representation of a problem within a machine. The second is concerned with the nature of the surface structure of the system through which the user and the computer interact. Applications provide the third viewpoint from which man-computer systems must be examined. The remaining seven paper of the issue are briefly discussed. This discussion raises questions of comparative evaluation and quantitative description of man-computer systems. Problems of instrumentation and measurement of man-computer systems are important problems upon which very little work has been done. It is concluded that in the seven years since Licklider's Man-Computer Symbiosis paper, there has been some progress but, for the most part, the progress has been limited to a few isolated examples. Beyond these examples we have today hundreds of people convinced of the value of the man-computer partnership and with these resources at work, impressive partnerships can become numerous over the next seven years.

262. Teiber, H.
MODERN DATA PROCESSING THROUGH GRAPHIC IMAGE REPRESENTATION WITH DIGITAL COMPUTERS. Deutsche Gesellschaft für Raketentechnik und Raumfahrt, Fort-schrittliche Systemtechnik Symposion, Munich, West Germany, June 9, 1967, Paper. (In German)

Description of two instruments for the production of visible results from digital computers. The first is an electromechanical device called a coordinatograph, while the other instrument is an electro-optical data-visualization unit. Following a brief description of the construction and operation of both instruments, the printing rate, reproduction accuracy and dynamic behavior of the devices are examined. Possible applications of the visual-display units in research and especially in space-environment problems are considered.

263. Trigwell, M. J.
AUTOGRAPH: AN AUTOCODE GRAPH PLOTTING SYSTEM. Royal Aircraft Establishment, Farnborough, (England). (RAE-TR-66238.) AD-644436. N67-14190.

Autograph is a program which enables computer programmers to produce a graphical output with the aid of a Benson-Lehner digital incremental plotter. This report contains a full description of the facilities available in the program together with instructions in the use of these facilities.

264. Trokhimenko, Ia. K.
AUTOMATION OF ELECTRONIC NETWORK DESIGN (AVTOMATI-ZATSHA RASCHETA RADIOELEKTRONNYKH SKHEM). Radioelektronika, 10: 5 – 14, Jan 1967. (In Russian)

Survey of literature on the application of digital computers to the analysis, design, and optimization of linear electronic networks. It is shown how a large-memory digital computer can be used to completely automate the design procedure of an electronic network with prescribed characteristics.

265. Van Dam, A.
COMPUTER DRIVEN DISPLAYS AND THEIR USE IN MAN/MACHINE INTERACTION. Advances in Computers, 7:289–290, 1966.

Digitally driven visual displays that handle graphical as well as alphanumeric data are considered; small-screen and CRT displays are emphasized; engineering parameters relevant to all displays discussed, and typical implementations (mechanizations) are detailed; requirements that make system technically and economically feasible in real time; applicability to nonlinear problems solved by iteration and varying parameters, optical alignment or digitizing of bubble chamber tracks and general curve fitting, pattern recognition, layout drawings for chemical plants and logical design.

266. Van Dam, A.
A SURVEY OF PICTORIAL DATA PROCESSING TECHNIQUES AND EQUIPMENTS. Pennsylvania Univ., Moore School of Electrical Engineering, Philadelpha, Pa. Aug 1965. (Contract Nonr-551 (40).) (Rept.-66-19; AD-626155.) N66-32195.

The material presented serves as a state-of-the-art report on pictorial data processing techniques and equipments; however, it is not an exhaustive report nor does it cover all the areas of pictorial data processing. The report is directed primarily to the present and future needs of the engineering data generator and user who wants to communicate in real or near real-time with his environment of digital processors. The areas covered include (1) display; consoles (and printer plotters); (2) transmission (facsimile); (3) storage and retrieval (analog); (4) optical pattern recognition; (5) graphical man/machine interaction.

267. Waddington, N.
SOME APPLICATIONS OF GRAPHIC DATA OUTPUT. Computers & Automn., 14:24–27, Nov 1965.

This article consits mainly of reproductions of outputs of the S-C 4020 microfilm printer-plotter, together with a brief functional description of the equipment and a list of some applications.

268. Ward, J. E.
SYSTEMS ENGINEERING PROBLEMS IN COMPUTER-DRIVEN CRT DISPLAYS FOR MAN-MACHINE COMMUNICATION. IEEE Trans. Systems Sci. & Cybernetics, Sec-3, No. 1:47–54, June 1967.

Computer-driven cathode-ray tube (CRT) displays are becoming an important means of on-line man-machine communication, particularly for graphical input/ouput in laboratory investigations of computer-aided design techniques. Their operation, however, often requires so much of the computational resources of the associated computer that they are not yet considered economic or practical for general industrial use. This paper discusses the system engineering problems in designing and using display systems, with emphasis on the hardware-software tradeoffs. As an example, a display specifically developed for computer-aided design applications is described which has unusual special-purpose computing capabilities for dynamic picture manipulations, including rotation, scaling, and translation of 3-dimensional images. It is concluded that there is much work ahead, and that the proper hardware-software organization for these complexes of computers, communication links, terminals, and men is a fertile field for the systems engineer.

269. Washburn, R. P.
METHODS OF AUTOMATING DRAFTING OPERATION. ASME-Paper 64-MD-8 for meeting May 11 – 14, 1964, 13p.

Summary of methods and processes used to draw simpler drawings encountered in drafting; most of equipment utilizes computer to perform routine chores and to prepare output instruction tape for autmated drafting machine; several devices use no computer and still achieve significant savings; futuristic systems of "Sketchpad" type are described along with conventional plotting tables and high speed cathode ray plotters.

270. Watson, W. A.
DATAPLOT: A SYSTEM FOR ON-LINE GRAPHICAL DISPLAY OF STATISTICAL DATA. Information Display, 4(4):23–28, Jul – Aug 1967.

The Dataplot Subsystem is one of a number of software packages in the Bunker-Ramo On-Line System. It was designed to provide the user with the capability for generating a variety of statistical graphs based upon file data. Dataplot was developed out of the conviction that the usefulness of such descriptive graphical methods as genuine cognitive tools has heretofore been limited by the sheer effort they entail. The

system was designed to relieve the operator of the necessity for making trivial decisions, but to still provide ample opportunity for manual intervention.

271. Weisberg, D. E.
COMPUTER-CONTROLLED GRAPHICAL DISPLAY: ITS APPLICATIONS AND MARKET. Comput. Autom. 13(5):29–31, May 1964.

This report summarizes many military and commercial applications of computer-driven cathode-ray tube display systems. Estimates of the present and future commercial CRT display market are presented without classification of type usage.

272. Westwood, D. H.
CADRE – COMPUTER AIDED DESIGN AND RELIABILITY ENGINEERING. IN: ADVANCED COMMUNICATIONS FOR THE 1970's. Camden, N. J., Radio Corporation of America, 1967, pp. 34 – 37.

Study of the application of digital computers to management of data associated with communications equipment components and subassemblies in their design and development phases. The primary use of this method to date has been for documentation of experimental work and furnishing of data for technical proposals.

273. Wigington, R. L.
GRAPHICS AS COMPUTER INPUT AND OUTPUT. 1966 IEEE Int. Convention Record, Part 3, 86 – 90.

This paper briefly surveys the recent literature on graphic input and output for computers.

274. Windes, F. V.
GRAPHIC DATA PROCESSING. Graphic Science, 7(12):22–4, 29, Dec 1965.

New and dynamic techniques being developed give designer, draftsman and engineer ability to communicate directly with machines, exchanging graphic information on real-time basis to achieve optimum combination of human judgment, computer speed and accuracy, resulting in minimum of routine effort and maximum use of human

creativity and time; description of IBM's System/360 graphic processing component, including No. 2250 display unit.

275. Woo, P. W.
A PROPOSAL FOR INPUT OF HAND-DRAWN INFORMATION TO A DIGITAL SYSTEM. IEEE Trans. Electronic Computers, EC-13, Oct 1964, 609 – 611.

This note discusses a system for facilitating the exchange of information between man and machine. More specifically the system is designed to convert freehand, graphical information on a real-time basis into digital form which can be stored in a computer memory. A square glass tablet serves as a drawing medium and as an ultrasonic delay line through which mechanical vibrations are transmitted periodically and alternately by stationary transducers along two adjacent edges of the tablet. The vibrations are detected by a transducer built into a "pen" used to draw on the tablet. The output of the pen transducer is converted into digital form and stored in a computer memory. The information from the memory is converted back into graphical form and projected by a cathode ray tube system to the back of the glass tablet so that the user can see what he has drawn.

276. Young, A. W.
COMPUTER-AIDED DESIGN. Iron Age, 195(18): 87 – 94, May 6, 1965.

Comments on developments and projects at various companies concerning role of computer in engineering; use of computer-controlled cathode-ray screen on which designs are drawn with "light pen" for making layouts and diagrams; description of systems employing light pen in automobile, business machine, optical and other industries; how computers can do great deal of analysis on machine components and structures; example of "miniumum weight and minimum cost" developed with aid of computer.

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This literature provides a state-of-the-art review of the latest published literature in the area of computer graphics. Included are citations to the principle contributions in the literature during the period from 1960 through October 1967, including both open and government sources.

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