COMPUTER GRAPHICS

Techniques and Applications

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Foreword

About four or five years ago one began to hear about the enormous interest being taken in on-line consoles and displays. Nothing much was done with them, but computer men felt that this was the way computing ought to go: one might dispense with cards, and overcome many of the problems of man–machine communication. It quickly appeared that, as with computers, there had been a great underestimation of the amount of work involved, of the difficulties of programming, and of the cost. So it began to emerge that graphics was not the ultimate answer, in spite of superb demonstrations where one might watch a square being converted into a cube and then rotated.

But my mind goes back to 1951 and the first computers. There, there were demonstrations of arithmetic speed and storage facility; but not much idea of actual use. However, we now understand how to use computers, and in the last year or two, significant developments in the field of graphics have led to genuine applications, and economic benefits. The equipment is still expensive, but it is becoming cheaper, more uses are being found, and I believe that we are just at the stage when the subject is gaining momentum, to become, like computers, a field of immense importance.

This book, and the symposium at which the papers were first read, will generate ideas for new applications in the minds of those who could use graphics, and further steps will be taken in using the computer as a tool. For it is not only to the specialist, but to all who need the power inherent, but so often locked up, in the computer itself, that graphics is bringing its benefits.

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Preface

"One picture is worth a thousand words", and in computing it is certainly true that one picture can be considerably more valuable than several yards of lineprinter output. This is all the more true if a scientist or a business executive has to interpret the output and take further action on it with the computer.

The graphics terminal opens up a completely new range of fields of application for computers. For the first time an executive or engineer can have direct access to the power of a computer, communicating in visual terms which are natural to man.

The potential recently revealed for interaction between computer and user is vitally important for the greater application of these machines in all spheres of industry, commerce and scientific development. The interactive graphic terminal transfers the computer from a cumbersome specialist "tool" into a "colleague" helping to work out a solution to problems during a dialogue through the common visual link.

To gain the most immediate benefit from computer graphics it is essential for all who are involved to be informed about existing applications and about the trend of further development. These are the computer technologists designing for the future; the computer manufacturers producing for today; the researchers and designers in every field whose problems might be all the more easily solved by the new means available; and the industrial and technical managers who can now begin to think of computers as an accessible means of making their organisations more efficient. Only a combination of the thought and efforts of all these parties can ensure the speediest and most effective development of the new techniques and equipment.

For this reason the Computer Science Department, Brunel University, decided to organise an International Computer Graphics Symposium, where carefully selected themes were covered by foremost authorities from the USA and UK.

A glance at the Table of Contents will show how contributors were invited from the world's leading academic institutions, manufacturing firms, research establishments and industrial and commercial users.

The material for the Symposium (held at Brunel University, Uxbridge, England, in July 1968) was kindly made available and specially edited with relevant additions and amendments for this book. The aim has been to allow those people employed in the field to learn of each other's activities and for those who can benefit from their efforts to discover what facilities are being made available.

The book is in four parts.

PART 1 covers the systems, equipment and software, which can now be employed; the general stage of development in the USA and

UK; and the trends for the future. It serves as an introduction to the field for non-experts and also as a valuable résumé for the initiate.

PART 2 consists of specific applications in science and industry, with several case histories of successful installations. These cover many fields, from architectural design and costing to nuclear physics, aircraft engineering and stock control.

PART 3 is for the computer technologist and is a review of material which was presented and discussed at a Specialist Session which followed the Symposium.

PART 4 is devoted to computer graphics hardware, which is presently available. It includes manufacturer's descriptions of a wide variety of equipment.

A glossary has been provided to explain graphics terms used in the book, so that all interested readers can obtain maximum value from the ideas expounded, unhindered by unfamiliar terminology.

This book has been designed to cover the field of Computer Graphics in a logical and comprehensive manner. It can be read as a whole to review all the important aspects of the subject or studied piecemeal as a report on particular topics.

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ROBERT D. PARSLOW
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October 1968

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What Has Computer Graphics to Offer?

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The computing capability of second and third generation computers has far outdistanced the growth rate of accompanying input/output equipment. This statement is not intended to minimise the increased efficiency and flexibility of card readers, tapes, discs, key punches and printers. However, it is meant to point out the need for convenient new means of communicating with computers.

Two new and in some ways related developments have given computers a new dimension: time-sharing and graphic data processing. Time-sharing makes it economically feasible to give a single user access to a large computer on an immediate, local basis with quick response time and fast turn-around. Graphics allows the user to communicate with the computer conveniently and in his own terms. This makes it possible to provide to the computer information in its most natural form. Furthermore, it allows the computer to communicate information to the user in a form which is compact, descriptive and most appropriate for a given application. The application areas of computer graphics span the entire spectrum from engineering analysis and design to mathematical analysis and data reduction, and last but not least, to the use of computer graphics as an aid to computer programming and debugging. The other chapters in this book deal with the various aspects of computer graphics in some detail. The purpose of this chapter is to provide a basic frame of reference and some common background for the whole book. It will review some of the history, outline the advantages, describe the major concepts involved and indicate the areas most suitable for the application of computer graphics.

One can trace the beginning of computer graphics to the Jacquard loom where for the first time a digitised representation of a graphical form in punched cards was used to control a loom. Modern computer graphics had its beginning at the M.I.T. Lincoln Laboratory where Dr. Ivan Sutherland developed the SKETCHPAD program which allowed the user to sketch on a cathode ray tube. SKETCHPAD opened the horizons for industrial developments by illustrating the feasibility of having a designer construct rather complex diagrams with the aid of a computer. This work was first published in the Spring of 1963 at the Joint Computer Conference of the American Federation of Information Processing Societies.

What has happened in the five years since then?

A number of different hardware systems have been developed ranging from simple scopes with only text printing capability to elaborate