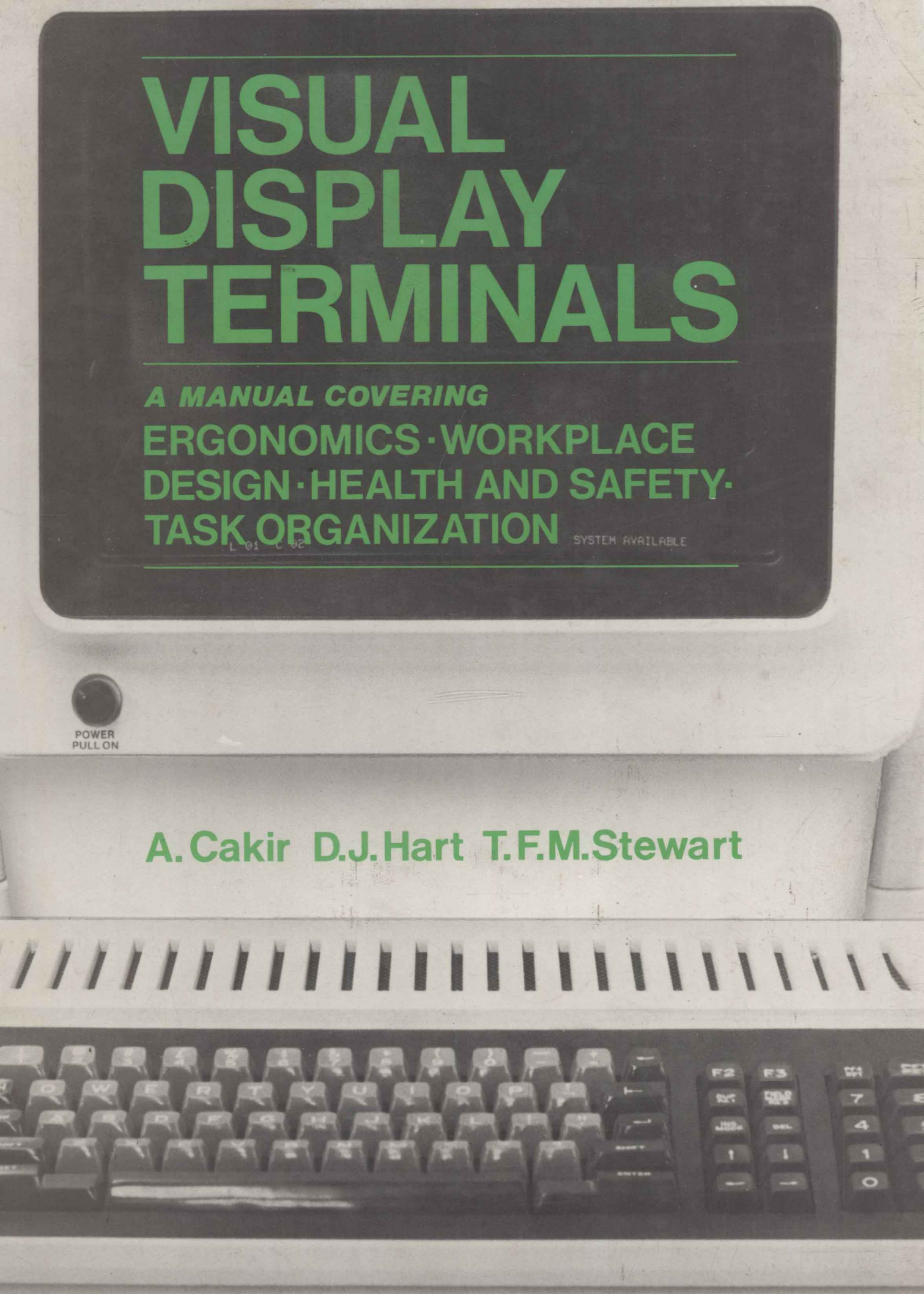
VISUAL DISPLAY TERMINALS

A MANUAL COVERING

ERGONOMICS · WORKPLACE DESIGN · HEALTH AND SAFETY · TASK ORGANIZATION



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TASK ORGANIZATION

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It is surprising perhaps, that in spite of the vast amount of literature that has been devoted to the subject of computers, very little has been written about the people who use them and the conditions under which they are used. The main purpose of this book is to provide the designers, planners and users of computer systems with the most comprehensive guide to the human aspects of the design of visual display terminals and workplaces. This guide is based on a large number of experiments and field studies conducted by the present authors and many others in recent years.

This book was originally prepared by the authors for the Inca-Fiej Research Association. However, because of the considerable interest shown by a wide range of users from industry, government etc. throughout the world it was felt that the book deserved international publication.

Foreword

It is surprising, perhaps, that in spite of the vast amount of literature that has been devoted to the subject of computers, very little has been written about the people who use them and the conditions under which they are used. And yet computers have been a familiar part of the working lives of many people, in many different walks of life for many years. Even if we, ourselves, do not come into direct contact with computers at work, the contact is most certainly there in one or other aspect of our daily lives, for example in the processing of wages and salaries, bank statements, the electricity bill, travel reservations etc.

At work, a computer can help take away the tedium and monotony involved in many types of repetitive data processing job. From an occupational standpoint, this is a respectable goal and one worth striving for. But in solving one type of problem, others are created. The ability of a computer to handle large volumes of data, quickly and reliably, usually means that fewer people are required to do a given amount of work. In some cases, the problem can be offset to some extent by the fact that these same facilities also make it possible to increase the amount or extend the types of work being performed. The fact remains, however, that computers are creating an increasingly more pressing social problem as far as employment is concerned.

In the early days of computers, the popular image of the computer as a giant adding machine, capable of performing simple arithmetic computations - albeit lots of them and very quickly was not too far from the truth. The computer of today, however, is a more sophisticated machine, both in construction and in terms of programming level. Computer designers have reaped a rich reward from the development of electronics technology. The development of computer terminals has improved the possibility and efficiency of access to computers. Storage and processing capacity has become cheaper, and this, coupled with the evolution of more advanced programming software, has meant that the computer of today can seek its applications in a much broader range of industrial environments than its less sophisticated and more cumbersome predecessors.

This spreading out of the umbrella of computer applications is bringing computers into contact with occupations associated with progressively higher levels of skill. From an industrial point of view, therefore, it is not only the number of people whose employment may be affected by the use of computers that is of concern, it is also the skill categories of those affected. Nowhere, perhaps, is this more apparent than in the printing industry.

Whilst it is not the object of this book to consider the social problems of computer technology, it is against this background that any book of this kind is written. The newspaper industry is currently in the frontline of computerisation. This helps to explain why it is that the initiative for a study of this kind should come from an industry that is not generally known to be in the frontline of technical research.

To many people, the prospect of working with computers and visual display terminals is a source of anxiety. For some, these anxieties stem from the fear of job insecurity and the prospect of redundancy. For many, however, anxieties have also arisen from a fear that working with a visual display terminal - the outpost of a central computer - might

pose some form of health or safety risk. Within the past two years, this has been the subject of considerable debate. And in spite of a great deal of research effort, the information which has hitherto been available has been largely uncoordinated and too sparse in many aspects to put this subject into practical perspective.

To help bridge these gaps in knowledge, the International Research Association for Newspaper Technology, IFRA, brought together two of Europe's leading authorities in the fields of man-computer interaction, computer ergonomics and human science in an attempt to analyse the ergonomic, health and safety aspects of working with VDTs. The outcome of this work is presented in this book, and it is with some pride that IFRA extends its thanks to the professors and staff of the Institut fuer Arbeitswissenschaft, University of Berlin, F.R.G., and the Department of Human Sciences, University of Loughborough in England for their guidance and unfailing efforts throughout the duration of this two-year exercise. In undertaking this investigation, the authors have sought the help of a great many people in medical centres, occupational health and safety authorities, universities, trade unions and in a wide variety of industries. Not least, the authors have also sought the help of a great many VDT and computer users. So many have contributed information and comment during this investigation that it would be impossible to credit them individually, but to these, the authors would like to express their most sincere thanks.

In dealing with a subject as broad and as complicated as this, an attempt has been made to write this book in such a way that those most concerned, i.e. the user him- or herself, can read, easily understand and apply the information that is given. It is an inescapable fact that the involvement of the people who will eventually be working with a computer system in its conception and installation is one of the best and most desirable safeguards against future dissatisfaction and complaints of discomfort. But however desirable this form of participation may be, the fact remains that neither those designing a system nor those using it can actively contribute without some fundament of knowledge. It is with this spirit in mind that this work has been undertaken, and it is with the same spirit that IFRA, and the authors of this book, sincerely hope to have contributed in some way by shedding light onto a subject that is of major concern to many computer and VDT users.

Preface

The main purpose of this report is to provide the designers, planners and users of computer systems with the most recent ergonomics knowledge relevant to the design and selection of VDTs and VDT workplaces. This knowledge has been derived from a large number of experiments and field studies conducted by the present authors and many others in recent years. Detailed references have not been given in the text because the primary aim of this report is to be useful and practical rather than academic. However, the bibliography lists the sources used and readers interested in greater detail on particular points are recommended to consult the original reports or articles.

Report Structure

This report covers five major areas. The first chapter starts with a basic description of *how a VDT works* and this is followed by a discussion of *the VDT as a systems component*. The second chapter deals with the basics of *light and vision* that is necessary if the reader is to fully appreciate the subsequent sections.

Chapter three covers the *ergonomics of VDTs* in some detail starting with displays and display legibility and ending with the ergonomics of keyboards. However, many of the ergonomic problems of working with VDTs stem more from the workplace and working environment in which they are used rather than from the equipment itself. Chapter four therefore discusses various aspects of *VDT workplaces* and covers such environmental issues as lighting, heating, air conditioning and so on.

Both chapters three and four contain considerable detail in the text. So in order to facilitate the easy use of the specific recommendations they contain, these are repeated in checklist form at the end of each chapter. The final chapter reviews the various issues raised in the earlier chapters in terms of their effects on the operator's health.

The report ends with a series of appendices which support the text in the five principal chapters. These present the main checklist, a glossary and bibliography, and a description of an eye test procedure for VDT operators.

How to Read the Report

The report has been written in such a way that each chapter can be regarded as more or less complete. As a result, there is a certain degree of overlap between chapters to ensure that any reader who is referring only to one chapter does not overlook important or relevant material in other sections. However one theme which emerges from the report is that there are many interacting factors involved in the design, selection and implementation of VDTs and VDT based systems. It is important to keep in mind, therefore, that interpreting the recommendations which are made in this report may involve considerable skill and compromise in specific applications. Indeed, in order to make the best use of the report, it is first necessary to consider the role of ergonomics in the design process.

The ergonomist has two main objectives when designing equipment, workplaces or working environments. The first is to ensure the well-being and safety of the operator at work, the second is to make the best use of his or her skills and abilities.

When the first objective is ignored or overlooked, the penalties may be high for both the individual and employer. Unsafe, dangerous and uncomfortable work should not only be avoided on humanitarian grounds but is increasingly being restricted by legislation in several countries.

The results of ignoring the second objective, however, are usually less dramatic although they may well be as costly in the longer term. Failure to design in such a way that the skills, abilities and other characteristics of the operator are adequately matched results in excessive errors, delays and other decrements in job performance. This, in itself, can also have an adverse effect on operator well-being. For example, a poor match between the facilities of a computer system - in terms of both hardware and software - and the needs of the individual user can be a major source of job dissatisfaction in addition to being counterproductive.

There are nevertheless times when 'unergonomic' design may not result in any apparent decrease in task performance. In situations such as these, however, the individual may over-compensate for the non-functional or relatively unusable features of the equipment by expending more mental or physical effort. This effort is not without cost and can also result in problems for the individual or his employer in the longer term. Performance measures such as speed or error rate, therefore, need to be supplemented with some measures of effort or strain in order to satisfactorily evaluate equipment or workplaces.

Ergonomic Requirements for VDTs

It follows from the above that the primary ergonomic requirements for a VDT is that it should perform all of the functions required of it. Whether or not these requirements are met not only depends on the design of the equipment and of the workplace, but also on the characteristics of the user(s) and of the tasks they wish to perform.

There is therefore no single 'ergonomic' VDT. Different user and task combinations generate their own specific requirements.

In the newspaper industry, there are a number of applications which may be relatively similar in different newspapers and which could, therefore, give rise to common requirements, e.g. for an editing or page make-up terminal. The exact ergonomic requirements of such a terminal will, however, depend on the detailed nature of the user's task. For this reason, this study on the human aspects of working with VDTs has placed great emphasis on the analysis of the various types of VDT task. It is hoped that specific detailed ergonomic requirements may eventually be established for the various types of VDT use. In the meantime, however,there are a number of general requirements which can be laid down and these form the basis of this report.

The relative importance of some of these requirements depends, of course, upon the user's task so that care should be taken in interpreting the recommendations which are presented in the master checklist. The 'best' answer is not always as obvious as it might seem.

Where general recommendations apply, the preferred answer is indicated in the master checklist. In many cases, however, the preferred answer will depend on the specific task in question so that only those involved with the planning of the system and

the users themselves can decide which is the preferred answer. For example, although illegible characters are undesirable for any task, this may not always be a critical factor, e.g. when reading the display screen is only an infrequent checking activity. If, on the other hand, reading the display is the predominant task activity, e.g. proofreading, good display legibility is an essential attribute of the VDT. In addition, not all facilities are necessary or even useful for all types of VDT task, so the VDT with the greatest number of facilities is certainly not the most obvious choice for any given task.

A second problem with such a checklist is that there are a wide range of individual differences among people in their psychological as well as their physical characteristics. There are many situations in which it makes sense to design to suit an 'average' man. Unfortunately, there are also situations where the result is that neither one end of the range nor the other receives satisfactory attention. Thus, for example, when the preferred seating height, the preferred screen format or the preferred workplace layout is indicated, this refers to the best compromise for a large proportion, typically 95%, of all users. This may be quite different from the height, format or layout that best meets the need of the individual user.

Designing for 95% of the population means that 1 person in every 20 would find it difficult or impossible to work with the equipment or at the workplace. In practice, this may be too great a proportion to ignore, especially for systems which are to be used by a large number of persons. In applying recommendations such as those contained in this report, therefore, there must remain a certain degree of flexibility. It is for this reason that, where possible, many of the recommendations are formulated in such a way as to indicate ranges of values and characteristics that will permit the user to design or have designed for him a working environment that is best matched to his or her own needs. It cannot be emphasised too strongly that it is the comfort and well-being of the real individual and not that of a 'hypothetical' average that is the primary concern of the ergonomist and of this report.

Contents

Chapter 1

VDT BASICS

Foreword

Ever since the development of the CRT display terminal a little more than a decade ago, visual display terminals or *VDTs* and the computer systems of which they are an integral part have found widespread application in graphics, text and data processing. The VDT as an input/output device permits access to and dialogue with the storage and processing capacity of a central computer. In other words, the VDT is a part of a *system* comprising a computer, terminals and other items of peripheral equipment, e.g. printers, controllers and a software package that is specifically tailored to the processing requirements of the application in question.

The key to the attractiveness of computer systems in most business applications is the rapid processing speed and large volume of data that can be handled. But in addition to the purely functional characteristics of the system, it is also necessary to consider the VDT as a piece of equipment to be used by persons with a wide range of physical characteristics, skills and individual or task-related requirements. This combination of *functional* and *human* requirements represents the ergonomic criteria which are among the most important factors to be considered in designing and specifying a computer system.

This chapter is intended to provide an introduction to the design and operational characteristics of VDTs and VDT systems and, in particular, to the role of the two main elements of the VDT - the display screen and keyboard. Much of this information provides a necessary background with which to better understand the subsequent chapters which deal with the ergonomic requirements of VDTs and VDT workplaces.