A COMPUTER AIDED DESIGN SYSTEM WITH

PARAMETRIC DIMENSIONING

A thesis presented

in partial fulfilment of the requirements

for the degree

of Master of Philosophy in Industrial Technology

at

Massey University

Brian Morris Meads

1987

ABSTRACT

This thesis develops the concept of a parametrically dimensioned CAD system. Conventional CAD systems require the actual dimensions of all objects drawn to be defined during the drawing process. To alter any dimension requires manual modification of all affected objects in the drawing. Parametrically dimensioned CAD systems would allow drawings to be constructed containing dimensions defined using variable parameters. These parametric drawings could then be fully specified at some later stage by supplying actual values for the parameters. Such systems would allow drawings of families of components (that varied only in their dimensions) to be easily produced from a single parametric drawing, would simplify dimensional modifications to drawings, and would permit the drawing production to be part of an automated design process.

The general requirements for such a parametric CAD system are developed in the thesis and the implementation of a limited package based on these ideas is described. On the basis of this work, it has been concluded that such systems are viable, could have successful user interfaces and would be a valuable extension to conventional CAD packages.

ACKNOWLEDGEMENTS

The production of this thesis has been made posssible by the co-operation and help of a number of people.

First and foremost, my sincere thanks go to my supervisor, Professor Mark Apperley, for his guidance and suggestions during the investigations into parametric CAD and for his helpful criticisms in the presentation of this thesis.

I would like to extend special thanks to Mr Len Chisholm for his assistance with the Assembler routines and the hardware interfacing in Paracad and for his helpful suggestions during the development of Paracad.

My thanks also go to Mr Ralph Ball and Mr David Morgan who took over a considerable amount of my lecturing related workload thus enabling me to devote sufficient time to carry out my studies towards this thesis.

Finally I would like to extend a very special thank you to my wife Eileen and my children Jason, Darron and Kirsty for their patience, love and understanding. For this I am truly grateful.

Brian Meads

CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Computer Aided Design (CAD) systems are responsible for major productivity gains in drawing and design operations. Up until the 1980's CAD systems ran only on mainframes and were expensive to purchase and run. This limited their use to such areas as the aerospace, automobile and electronics industries. Major increases in the performance of computer systems over the last decade have resulted in real time CAD functions that were previously only performed on mainframe computers migrating down through minicomputers to microcomputers. This has caused a substantial increase in the number of potential computers on which CAD packages can be run and has resulted in strong competition between CAD software suppliers. This competition is manifesting itself in increasingly sophisticated CAD features on microcomputer systems that are tailored to the end user's requirements becoming available **[Wohl. 1984, Myer. 1985]**. The basis of this thesis is the investigation of one such feature about which there has been little published research.

The three major areas of use of CAD packages are in electrical and electronic design, mechanical engineering design and architectural/layout design **[Merm. 1980]**. A common output from each of these areas is the production of a drawing from a plotter.

Many drawings that are produced in practice are similar, varying only in their dimensions. This is especially true of component drawings. As an example, consider the the two drawings shown in Figure 1-1. These show the front cabinet shape of two different sized television sets. The cabinets have different widths, heights, screen sizes and speaker cover sizes and placements.

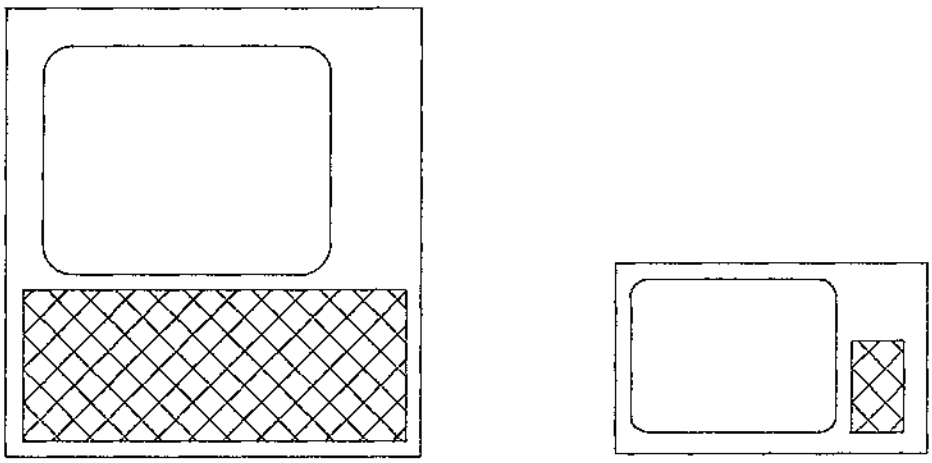

Figure 1-1   Front Cabinet of Two Different Television Sets

This thesis examines the feasibility of having a CAD package that allows a designer to prepare a template or "parametric" drawing with some or all dimensions defined in terms of variable parameters. Hereafter such a drawing will be referred to as a **parametric drawing**. Final specific drawings could then be produced by supplying values for each of the parameters for that particular drawing. Such a drawing will hereafter be referred to as a **particular drawing**.

A parametric drawing covering the family of television sets similar to those in Figure 1-1 might appear something like that in Figure 1-2. Each different model of television set would have its own particular drawing with the actual values entered for the various dimensions a, b, c etc. being different in each case.

In addition to allowing easy generation of particular drawings for families of components (or models) from a single parametric drawing, with the consequent time savings, parametric CAD could also be used as part of an automated design system. It could also permit rapid "what if" tests to be made on designs.

There appears to be no published evidence of research in the area of parametric dimensioning. It is suspected that this is because the only research in the area has been done by CAD software houses who wish to keep their results confidential. Because of the lack of published research in the area, this thesis attempts to lay general foundations for a parametric CAD system rather than concentrating on narrow specialised areas within such a system.

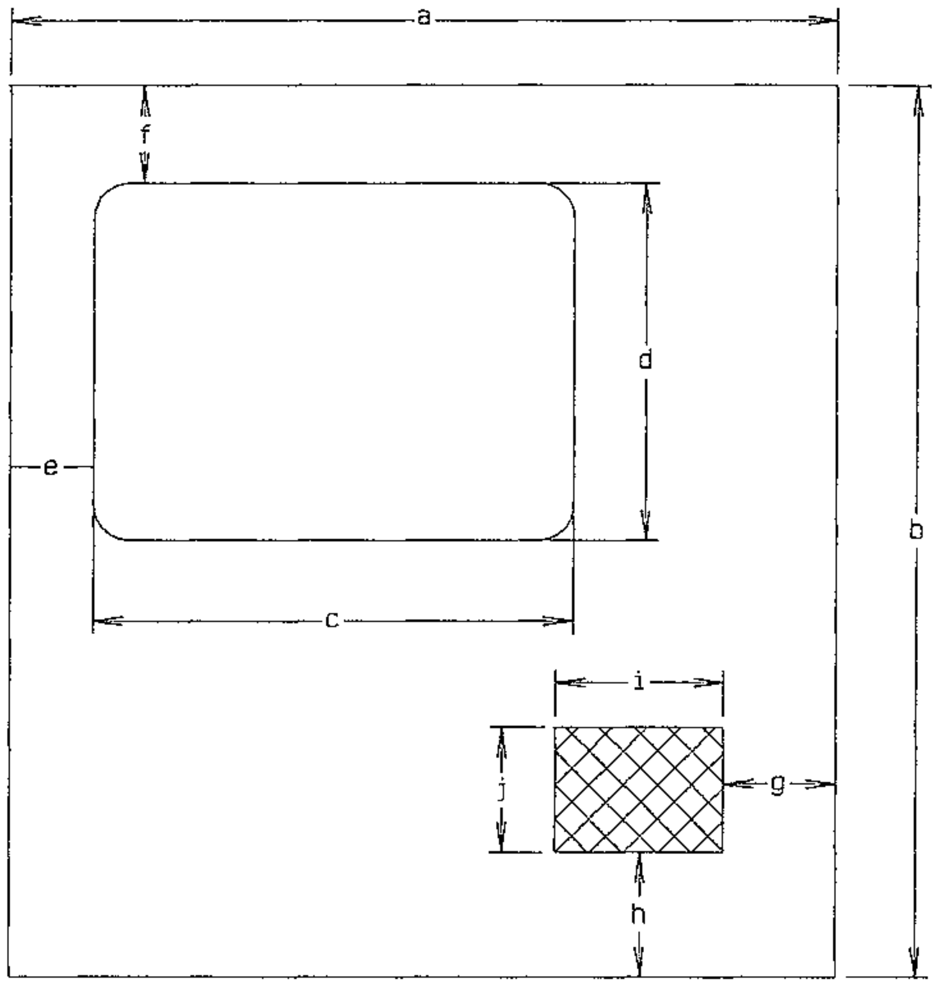

Figure 1-2 Parametric Drawing of Television Cabinet

In Chapter 2 the hardware and software features of conventional CAD packages are examined where these are relevant to a parametric CAD system.

In Chapter 3 the extra design considerations and decisions necessary for parametric CAD packages are considered and other non-essential but highly desirable additional features are contemplated.

In Chapter 4 design decisions for a specific implementation of a parametric CAD package known as **Paracad** are discussed. Paracad is used as a basis for investigating the feasibility of parametric CAD.

The Paracad environment is described in Chapter 5. This covers the hardware and software environment, interfacing between hardware elements, data structures used and the method of storing these data structures.

In Chapter 6 the interface between Paracad and the user is explored. This includes the way Paracad responds to user requests and the algorithms used to perform the actions required by the user.

The performance of Paracad is discussed in Chapter 7 in terms of its speed of operation and user friendliness. Future Paracad developments and areas for further parametric CAD research are also described.

In Chapter 8 conclusions are made as to the feasibility of parametric CAD and the advantages of such parametric CAD systems.

Appendix A contains a description of the notation used in the illustrations in this thesis.