Sigma Technical Press

J W Fellows

All about Computer-aided DESIGN and MANUFACTURE

A Guide for Executives and Managers

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ALL ABOUT CAD/CAM

A guide for senior or mid-level management

BY

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Sigma Technical Press

ISBN 0 905104 61 7

Published by:

SIGMA TECHNICAL PRESS,
5 Alton Road,
Wilmslow,
Cheshire,
UK.

Distributors:
Europe, Africa:
JOHN WILEY & SONS LIMITED,
Baffins Lane, Chichester,
West Sussex, England.

Australia, New Zealand, South-East Asia:
Jacaranda-Wiley Ltd., Jacaranda Press,
JOHN WILEY & SONS INC.,
GPO Box 859, Brisbane,
Queensland 40001, Australia.

Printed and bound in Great Britain by
J. W. Arrowsmith Ltd., Bristol

ACKNOWLEDGEMENTS

The author wishes to thank all of the companies, both CAD/CAM sytems suppliers and system users, who supplied much of the information contained in this book.

A special thanks to the individuals and their companies who made a direct contribution to Chapter 9 of the book. These were:

I.C. Massey, Group Engineering Director, Mather & Platt, Division of Wormald Machinery Group and M. G. Holt, Engineering Systems Manager, Rotating Machinery Department.

M. J. McClelland, Director & Chief Designer, Ricardo Consulting Engineers Ltd.

B. Jordan, Director of Research & Development and R. Philpot, Design Services Manager, Crosfield Electronics Ltd.

D. Drudy, Chief Designer, Sacol Powerline Ltd.

F. Heaton, Engineering Director, Hydratight Ltd.

and to the following companies for illustrations:

CIS Products Ltd

Computervision

Delta CAE Ltd.

Tangram CAE Ltd.

Ferranti Cetec Ltd.

Fegs International Ltd.

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INTRODUCTION

If you were informed that effective from tomorrow's date you were to be responsible for the implementation of CAD/CAM within your company, how would you react? Suddenly you are faced with the responsibility for:

* evaluating your company's requirements for CAD/CAM;

* selecting the system to meet those requirements;

* justification for the planned level of capital investment;

* the planning of the layout and necessary services for the CAD/CAM operating site;

* planning and managing the selection, training and supervision of the personnel who will operate the CAD/CAM system.

Would you feel confident and well enough informed to undertake these responsibilities, or would you immediately have to put yourself through an intensive period of learning to fill the gaps in your personal knowledge of what would be involved?

This is exactly the predicament in which many executives and managers of engineering companies now find themselves. The technical press, engineering seminars, short courses, plus the UK Department of Industry's CAD/CAM Awareness Programme, which has probabably generated an awareness of the potential and a basic appreciation of what is involved. In addition, visits to companies already using CAD/CAM and discussions about their experiences will have heightened your awareness of the type of problems you will be faced with.

Opportunities are now available to gain 'hands-on' experience at one of the Department of Industry's designated centres and such experience can greatly enhance your appreciation of the potential.

All of this information, however useful, is somewhat fragmented, presented in terms of a simple problem in an idealised situation and with very little direct consideration of the particular problems related to your own operation or products.

Whilst all of these presentations are well planned, they are aimed at the general engineering fraternity and do very little for you and your particular problem. In the main, seminars and courses last one to three days and only so much information can be covered in that length of time. Short courses offered by engineering colleges tend to do a good job covering the theory and operation of CAD/CAM systems, but show very little insight into the problems that are faced in the real world of an operating engineering company. Hands on experience sessions are usually fairly short and by the time you can find the way round the system, you are only able to work with some simple engineering example, as opposed to experiencing in depth the problems likely to be faced in dealing with your own company's products. Both 'hands-on' experience and short courses may demonstrate systems other than the ones suitable for your application and are only superficially relevant.

Information on systems available comes to you primarily from the system vendors themselves, who have a vested interest in extolling the virtues and capabilities of their particular system and who often resort to hard sell, high pressure sales tactics to win your order. Another source of information on the systems available are the users themselves, who of course can supply extremely useful information about problems they may have encountered. However in many cases these users are not willing to talk about their experiences to other companies who may be competitors in the same industry.

Summing up the situation for executives and managers, charged with the responsibilities described earlier in this introduction, they have been exposed to a lot of information relative to CAD/CAM which they would like to see collected together into a quick ready reference. A ready reference that did not dwell upon the technicalities of what goes on behind the scenes in the system equipment, but rather everything relative to using a system and applying CAD/CAM in the real world environment of a commercial engineering company.

A reference that would cover all those details so that, if you had known of it in advance, you could have reaped more benefit from hands-on experience and discussions with experienced users.

A reference that went through all tasks that have to be completed before you can get started on applying your CAD/CAM system, a memory jogger that will mention those little items that can get overlooked and lead to compromising situations.

A reference that will provide a quick guide to all the aspects of matching requirements to systems available, selecting the right system for your needs, considerations for siting and furnishing the CAD/CAM operating area, training and maintenance considerations, planning for future growth and system expansion.

This book is aimed at providing such a reference, a book that hopefully can answer the many questions that face those who suddenly find themselves faced with selecting and implementing a CAD/CAM system within their company. The book will cover the broad spectrum of activities that can be described as computer-aided-engineering and those currently referred to as Computer-Aided-Design and Computer-Aided-Manufacturing, so that the reader can appreciate the relationships for future system expansions. The functional aspects of CAD/CAM capabilities, hardware configuration options, software packages, systems available, user experience, system selection, installation, training and maintenance, will all be covered without resort to jargon and unnecessary technicalities.

Chapter 1
THE BROAD PERSPECTIVE

1.1 In the Beginning

Computer-aided-engineering in the broadest sense of the meaning covers any application of computers to the solution of engineering problems and this whole field of computer applications is one that expands continually, slowly moving towards the day when a total concept in computer-aided-engineering will be possible. The list of currently known applications is extensive and it is almost certainly true that it is in no way exhaustive due to the fact that for the companies involved these applications provide a competitive edge in business and are unreported.

In design engineering, particularly in the high technology industries such as aircraft and aerospace, companies have, for a long time, used computers to solve design problems and to mathematically model designs for performance analysis. The move in other industries did not start until the advent of the lower cost minicomputer and more recently the microcomputer, it has also gained impetus from the development of sophisticated methods of graphics input and display.

1.2 The Importance of Computer Graphics

The big breakthrough for computer-aided-engineering came with the development of graphics techniques and the associated hardware, that allowed engineers to deal with engineering problems in the familiar format of the engineering drawing and still use the processing power of the computer. Engineering drawings have always been the means of communicating complex engineering information and although the paper output requirement may one day disappear, the pictorial method of conveying concise engineering information to the human engineer will prevail.

The old saying that a picture is worth a thousand words still holds true and the human eye can feed more information to the brain, in the form of pictures, faster than by any other language means. A computer naturally works best with numerical data but graphics are without any doubt the best man/machine interface available for our current computer technology.

This rapid progress of computer technology, both at the hardware and software level, has created the basis for the unifying of many computer applications to engineering problems. Whilst the design of a product is the logical point at which all engineering information starts to be generated and all subsequent information is generated as a consequence of the original design information, the information flow with traditional engineering practices is not so logical.

Information is duplicated and produced in parallel from several different sources and information does not flow from the logical source in an efficient loop. For this very reason, the application of computers to engineering problems has developed in a haphazard way with little thought for the external relationships to other applications and the requirements for compatibility. All of the developments outside of those currently described as CAD/CAM have been the result of localised pressures within a specific industry, or company, and have followed a strictly unilateral path of development dictated by the limits of hardware technology and software expertise.

1.3 Emergence of Computer Aided Design in Various Industries

In the electronics industry, as an example, the financial strength of the companies involved and the complexity of the engineering problems they had to deal with led to their early adoption of computer aids as and when they became available. Starting with mathematical modelling and circuit analysis, there was a progression to:

* logic design, simulation and analysis;
* design and layout of Large Scale and Very Large Scale Integrated circuits;

* printed circuit board design and layout;
* preparation of circuit, logic and wiring diagrams;
* the preparation of parts lists and bills of materials;
* the preparation of instruction and maintenance manuals;
* programming of microprocessors and solid state memory devices.

The mechanical industries were much slower in reaching for the power of the modern computer, with the possible exception of the aircraft and defence industries of the USA followed later by the car industries, most felt that the high capital investment would not be justified. With this attitude prevailing for many years, computing power became the prerogative of the accounts department.

In those early days, the aircraft industries and some high technology defence industries were using computers for mathematical analysis. Also, special purpose analogue computers were being built for the modelling and simulation of mechanical systems; development in this area declined with the development of increased capabilities in the digital computer.

It should be pointed out that in the early days of digital computers, interactive working was not available and the typical form of input was a pile of punched cards. Both electronics and mechanical engineering had to wait for the development of a more flexible man/machine interface before engineering applications could really be justified.

Mechanical engineering applications progressed from modelling and simulation to include:

* finite element stress analysis;
* thermal and fluid flow analysis;
* kinematic design and analysis;
* vibration and noise analysis;
* mechanical system layout and design;
* the 3-dimensional modelling and emulation of mechanical systems;
* process plant layout and design;
* layout and design of piping systems;

* design of engineering structures in steel and reinforced concrete;

* the preparation of engineer drawings, diagrams, parts lists and bills of materials;

* the preparation of instruction and maintenance manuals.

* mechanical system performance testing;

* vibration and impact testing;

* environmental testing.

1.4 Manufacturing Processes and their Relevance to Operating Systems

Manufacturing includes:

* production and stock control;

* process engineering;

* numerically controlled machining processes;

* robotics and automation;

* numerically controlled inspection and measurement.

Because each of these applications have been developed independently of the others, they are, in the main, incompatible with each other, even though the different applications are closely related. To a very large degree the majority of these engineering application programs could usefully employ the information generated by other programs, but are unable to access this information, or transfer information, without some form of interfacing program. The problem does not end there; in general, these applications have been developed on a wide range of different computing machines, running under different operating systems.

In the past, operating systems were developed, by computer manufacturers, to satisfy particular spheres of commerce and industry. As a result, no real compatibility exists. To run a program under a different operating system, to that under which it was originally implemented, usually requires a certain amount of rework on the original program. Since operating systems in the past have been indigenous to a particular computer manufacturer, there has been little possibility, until recently, of finding the same operating system on several different computing machines.

Therefore in order to build up an integrated system from any group of application programs previously mentioned, will require a considerable amount of investment in terms of time and technical resources to develop the various interface programs and to modify the application programs themselves to run under a common operating system. A lot of this work is already being undertaken by system companies, particularly in certain areas of CAD/CAM. Some examples for instance are:

* The interfacing of 3-D modelling system to an automatic FEM mesh generator Computer-Aided Design System, so that the component geometry can be accessed directly from the design file.

* The interfacing of 3-D modelling system to an automatic FEM mesh generator and FEM analysis system, so that the geometry description of a component can be passed on to where a mesh pattern can be generated for the component automatically ready for the analysis program. (Finite Element Method for stress, deflection and vibration analysis)

* The interfacing of a Production Control System to a Computer-Aided Design System so that Parts Lists and Bills of Materials can be directly accessed from the design system files.

* The interfacing of a FEM analysis system to a vibration test system, so that theoretical predictions of expected tests results can be obtained to determine the characteristics of a component or structure and examine the effect of design changes indicated by the test results.

No doubt, in time, new versions for many of these application programs will be developed that are fully compatible with each other, without the need for a special interfacing program, but it is going to be a slow process.

The problems of the different operating systems will have at least one solution with the spread in popularity amongst computing professionals of the UNIX operating system* which is already available on a number of different computer systems.

One should be able to get an application program running under UNIX and then move it to other different machines that are running under the UNIX operating system. Currently not too many engineering programs implemented under UNIX have been announced, but it is also certain that engineering system software houses have development projects under way in this area. Since engineering software is predominantly written in FORTRAN, and since FORTRAN 77 is available under UNIX, the problems are minimal.

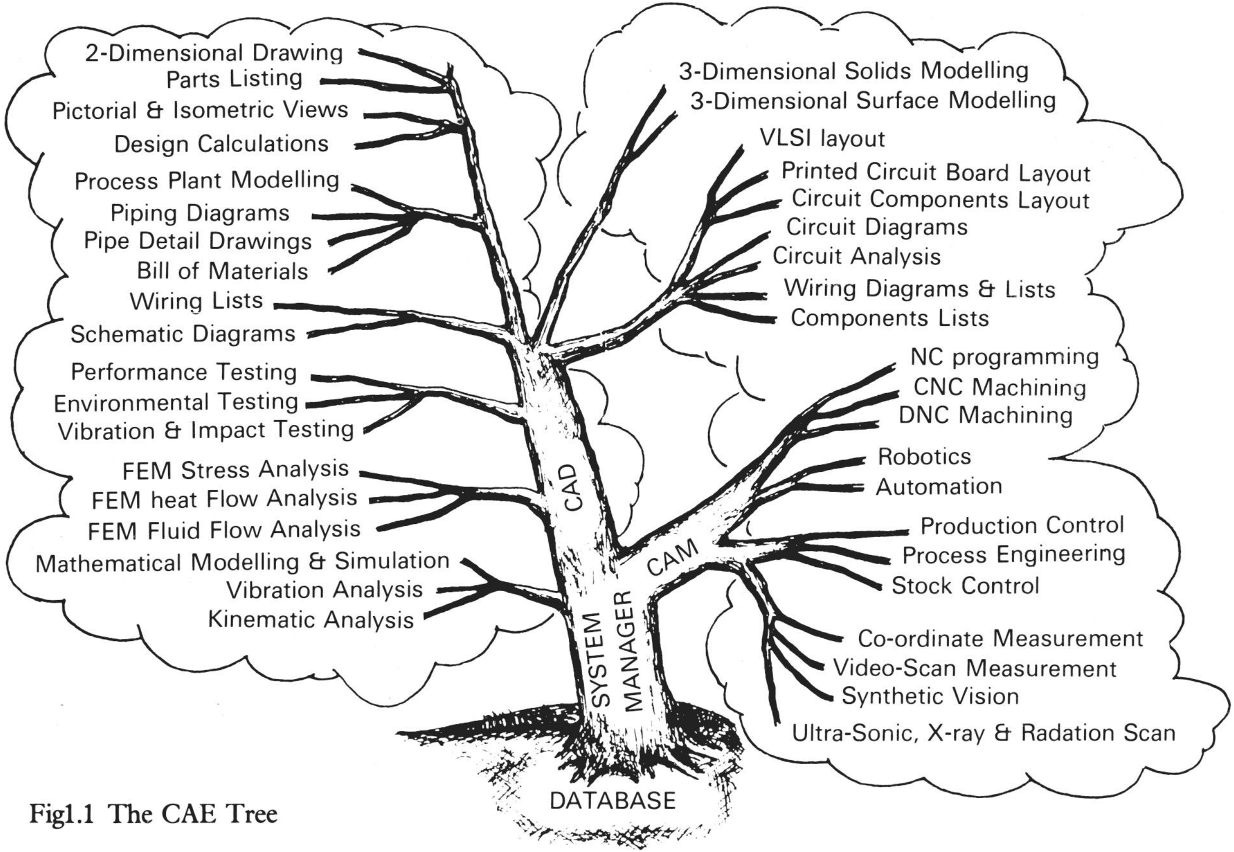

Fig1.1 The CAE Tree