An Introduction to CAD

Citation for published version (APA):
Oulton, D. (1993). An Introduction to CAD. In *World Review of Textile Design* (Vol. 749, pp. 39-42). Textile Institute.

Published in:
World Review of Textile Design

standard of excellence. It cannot be long before high-standard commercial colour communication around the globe catches up in speed and economy. There are good facilities for matching shades and for displaying patterns in virtual reality. As Richard Stoyles described in the first WORLD REVIEW OF TEXTILE DESIGN, carpet designs can be shown on a computer screen as they would appear in the setting of a room. Some progress has been made in imaging fashion designs, in order to show how a fabric will appear when made up into a garment - but more needs to be done here to get the right simulation of drape and movement.

More important are the human changes. Good CAD facilities are now becoming available in Universities and Colleges. A new generation of students will accept CAD as a natural way, indeed as the only way, to work. The days when people were frightened of computers are going. For the young, they are now a part of life; but even the old can adapt. Recently an eighty-year old friend of mine abandoned his ancient typewriter for a PC, and now happily uses word-processor and data-base programs for his interests in local history. More significantly, CAD companies, such as TCS, now employ not only engineers, but textile designers.

But we are not yet beyond the beginning. Designers are using computers to simplify and enhance conventional approaches to textile design. However, they have not started to explore the potentials for greater creativity, which I believe could come from an imaginative use of CAD linked to textile manufacture. Let me give two examples.

The first example concerns repeats. Although small pieces of fabric can be produced as individual pictures, traditional methods of making long lengths require the provision of a repeat, dictated by the diameters of print rollers, the length of jacquard cards, or other machine features. With computer-controlled jacquard weaving and knitting, this limitation has gone. The design need never repeat, but, as far as I know, designers have not exploited this opportunity. At most, there have been experiments with computer-generated random patterns. What is wanted is creative control by the designer, blending order and variability. Quasi-repetitive floral patterns would be a place to start. Within a general overall design, controlled variability could ensure that no two flowers, or leaves, or stems were exactly the same. Nature would be more nearly simulated and the design would have a richer interest. Similar opportunities will come in printing (although there would be particular problems for designs that have to join at fabric edges). At present, computer control is limited to the Millitron machine for carpets and upholstery and for illustrative printing of designs on paper. Computer-controlled machines are not yet available for apparel and household textiles; but they will come.

The second example exploits a similar approach to textile and fashion design. Traditionally, these are seen as separate activities. The textile designers produce a range of fabrics. The fashion designer creates the form of the garment and selects the fabrics. But there is now the technical opportunity for apparel to be designed in total, with colour and pattern fitted into the shape. The computer could then transform this into a set of instructions for the printing, weaving or knitting machines for the fabric manufacture - and cutting and sewing instructions for the maker-up. Taking it a step further, this could be matched to the individual purchaser.

I was optimistic about the prospects for textile CAD 25 years ago. The ideas put forward then still seem relevant today, but they have been slower in implementation than I had expected. Maybe a new generation of managers will provide the opportunities for designers to achieve commercial success through creative CAD. And so, at last, we may see a real motivation to get the three cultures - technical, artistic and commercial - working together productively and sympathetically. ●

An Introduction to Computer Aided Design

CAD systems for textile design use complex computers and are often described in 'computer speak' - to the confusion of all but computer professionals. David P. Oulton, MSc, BSc Tech AMCST, Lecturer in CAD and Computing at the Department of Textiles, UMIST, in Manchester (U.K.), aims to shed a little light on the problem with the following introduction to CAD and a glossary of common CAD terms.

CAD systems range from simple programs that can be run on an office personal computer (PC) to £500,000 super-computer systems. The actual computer may be attached to a unit designed to turn original artwork into a computer image (a **scanner** or a **camera***). It may use a high quality colour printer to produce colour proofs (**hard copy, inkjet, thermal wax** or **dye sublimation**). Each of these additional units are complex systems and can easily add £100,000 to the cost.

Further complications arise when people start talking of CAM (**Computer Aided Manufacture**). This refers to the ability of CAD systems to talk directly to knitting, weaving, engraving, screenmaking and printing systems, thus aiding the manufacturing process as well as the design process.

One stage beyond this is CIM (**Computer Integrated Manufacturing**). Nobody is quite sure what it is or how far it will go, but it looks forward to the day when all the individual computers and processes of manufacture will be thoroughly integrated together.

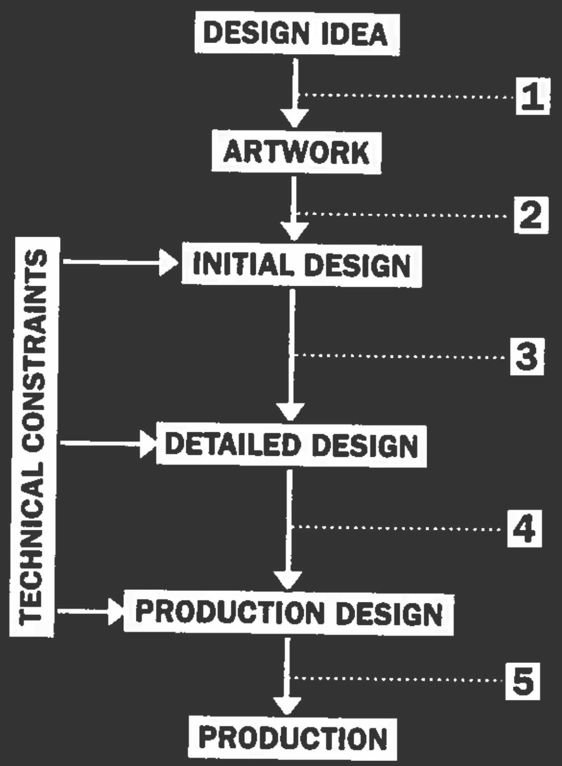
THE ESSENTIAL FEATURES OF CAD

The process of creating a design and turning it into a product can be viewed as a series of transformations. This is illustrated

** All the terms in bold are further explained in the glossary.*

The Essential Features of CAD

The process of creating a design and turning it into a product can be viewed as a series of transformations



1, 2 *etc are transformations of the design from one form to another*

diagrammatically in figure 1.
In manual systems, each transformation requires skilled reworking of the design, often in a succession of different media. In a CAD system, one or more of the transformations is performed electronically inside the computer. Let us take the transformations in order:

1 Idea to Artwork:

Here computers still have some way to go and most designers still prefer traditional methods of artistic expression. However, see **Bit Pad, Stylus** and **Drawing Package** in the glossary.

2 Artwork to Initial Design:

Many designers agree that CAD systems can do a remarkable job of capturing the essence of original artwork. Two things are important here. The design has to be safely transformed into electronic form where it can be further manipulated, stored, retrieved and processed. Secondly, the original has to be adequately preserved through the transformation.
A critical buyer of CAD systems will, of course, wish to establish how well the transformations can be achieved, at this and at all subsequent stages. See **Scanner, Screen Resolution, Colour, Texture** and **DPI**, in the glossary.

3 Initial to Detailed Design:

Technical constraints such as the number of colours, repeat size, expression of detail and production method are now added. Because the design is in electronic form, the transformation is easy. Calculations are performed, stored information such as weaves are added, and so forth. What is much less easy is controlling and interacting with the computer as it goes about its job.
We need to be able to:
1. Visualize the design and the changes made
2. Select and use tools to work on it
3. Store and retrieve work
4. Apply technical constraints
Visualization is via a computer screen and possibly printouts.
See **Screen Resolution, Colour, Printed Output**
Tools and their selection is a complete science in itself. Firstly we need a method of communicating with the computer: see **Mouse, Bit Pad, Stylus.**
Then we need to select tools: see **Menu, Icons, Buttons, Help Systems, Training.**

4 Detailed to Production Design:

This fourth step is rapidly being added to CAD/CAM systems. All the technical features of weaving, knitting, screen and roller engraving, colour separation and so forth are built into appropriate systems. The output of the CAD system may pass electronically directly to the loom, knitting machine or screen engraving machine. Alternatively it may be reproduced in traditional media, eg, separation film or punched cards.
At this point terminology becomes very process specific and usually only understood by professionals of, say, engraving.
CAD systems are developing rapidly into specialist areas. Technical designers say what tools they need and they are built-in. See **Screen Resolution, Electronic Communication, Networking.**

5 Production Design to Production:

The screens, jacquard controllers etc - often themselves computerized - turn the design into fabric form.

CORE FEATURES

At the core of all CAD systems is the ability to handle, store, manipulate and visualize designs.
If we wish to simulate point paper with a few thousand thread intersections there is no problem, even on a small PC. The full subtlety of a one metre square piece of detailed artwork is another matter.
Inside the computer, the design is represented as many thousands, usually millions, of coloured dots.
If we have, say, a 50cm square piece of artwork, and we need at least 30 dots per cm to represent the details, (ie 30 x 30 = 900 dots per square cm) then over 2,500 square cm, this gives an image of 2,250,000 dots.
Full detail is often represented at 50 dots/cm. For a one metre square design, we have 2,500 dots/sq.cm over 10,000 sq.cm = 250 million dots per image.
The whole, or at least a good working sample of the image, must be reproduced physically on the screen: see **Screen Resolution, Dot Pitch.**
It must also be stored in computer memory: see **RAM, Byte, Memory Size, Megabyte, Gigabyte.**
And it must be stored for easy retrieval: see **Disk, Hard Disk, Megabyte, Gigabyte.**
Perhaps most important of all, the image must be processed. Every single change to what is on the screen requires up to one million dots to be recalculated and redrawn. To process millions of dots we use millions of computer instructions per second. See **Processor Type, Processor Speed, Graphics, Graphics Processor.**
It is clear that differing design processes require differing tools, visualizations and transformations. In order to make sense of the bewildering array of CAD systems on offer it is necessary to know:
1. Exactly what the essential elements of your particular design process are.
2. How long it takes, and the cost for each production design.
3. Technical requirements of design production.
A series of trials and cost/benefit comparisons will then determine if an investment will be beneficial.
It is worth noting that CAD salesman often appeal to intangible benefits, such as increased value of designer's time, or quality of designs produced, or speed of response. Given a little thought, any or all of these should be quantifiable by some measure or another, and anyone who is asking for a six figure investment owes the management some justification.

GLOSSARY OF CAD TERMINOLOGY

Bit Pad: A designer works naturally with a sheet of paper on a flat surface. A bit pad is a large (up to one metre square) sensitive pad. It transforms movements, pressure, pen strokes etc into computer input and simulates the design environment quite well.

Buttons: A natural way of selecting something is to press a button. Graphic screens often include buttons to press via the bit pad or mouse. See *Menus, Icons, Options.*

Byte: A unit of electronic information. It will typically store a single character or numerical digit. You need millions of them to form a memory or storage disk.

CAD: Computer aided design. The use of computers to aid one or more of the processes of design.

CAM: Computer aided manufacture, as CAD, but it implies a link with production machinery.

Camera Input: Some CAD systems use colour TV cameras to transform artwork into a screen image. Detail resolution and scaling can cause problems. Scanners are in general a better choice.

CIE Colour Specification: An accurate numeric system for specifying and communicating colour.

CIM: Computer integrated manufacture. Design, production, machine control and computers become integrated into a single unit.

Colour: Most computers use colour screens. Colour can be used to assist point and select options and to indicate design features. A few CAD systems use accurate colour calibrated screens. This allows colours to be measured, manipulated and communicated easily.

Colour Communication: If colours are defined and simulated accurately it is possible to communicate your colour ideas easily. A good CAD system will provide print-outs in accurate colour, as well as correct screen colour.

Colour Gamut: Both the range of colours available and the number of colours vary enormously. For full tonal print design, up to 16 million colours in 256 depths are necessary at 300 DPI resolution. This is expensive.

Colour Printer: A wide range of print sizes (A4 to 1.2 metre square), colour technologies and dot-resolutions are available. Costs range from £1,000 to £100,000.

Colour Resolution: Some technologies use multiple dots to reproduce intermediate colours. This sacrifices design detail for greater colour detail (see Dithering.) The 'colour resolution' may thus be half or quarter of the 300 DPI printer capability.

Copier-Printers: Using photocopier technology, some systems can be used to scan artwork into the computer and produce high quality colour hard-copy output.

Cursor: A pointer on the computer screen. It shows where you are when pointing, selecting and drawing. See *Stylus, Mouse.*

Design Simulation: The computer holds an electronic simulation with full detail of the current design. To make it detailed, accurate and large enough requires a large memory and much disk space (see *Memory Size, Hard Disk* etc.)

Disk: A permanent magnetic or optical store for programs and data. As a general rule it is very easy to run out of disk storage space. Calculate how much you might need and double it.

Disk Back-up: Once you have committed hours or months of work to disk storage, it is VITAL to keep back-up copies in case the original is lost or destroyed. Make sure your supplier has a convincing policy.

Dithering: A process of producing many colours by combining groups of single depth primary colour dots. A 4 x 4 group gives 16 to the power of 3 = 4,096 possible colours. 8 x 8 dither gives 64 to the power of 3 = 262,144 colours.

Dot Pitch: Computer graphic screens are made up of coloured dots about 0.25 - 0.3 mm across (100 dots per inch). Check that any screen offered has small enough 'dot-pitch' to show the detail you need.

Dot Resolution: Like the screen, a printer has an ultimate smallest possible dot capability. 300 DPI is common. 600 DPI or more is - or soon will be - available.

DPI: Dots per inch. The image representing the design is made of dots and there must be enough dots to simulate all design features (say 300 DPI). On a 100 dot pitch screen, full detail is available at up to 3 times magnification (but see also *Screen Resolution.*)

Drawing: Computers are very good at generating straight lines, smooth curves, repeating motifs, circles and geometric figures. Using a good bit-pad and stylus high quality freehand drawing and painting are possible, working directly with the screen image.

Drawing Package: Nearly all CAD systems provide a set of tools and functions for freehand and geometric drawing. A mouse or stylus and bit pad turn hand movements into design elements. Many improvements have been made in simulating pen and pencil work.

Dye Sublimation Technology: Colour printing onto special paper by hot dye transfer. Each dot can be of 256 levels of each primary giving 256 to the power of 3 = 16.7 million possible dot colours at, say, 300 DPI. This produces photo quality glossy prints.

Electronic Communication: A CAD system may consist of a number of computers talking to each other by electronic signals. The links must be fast and robust. Test a system by moving large designs around and see how long it takes.

Electrostatic Colour Printing: The technology used in photo-copiers. It is capable of multiple depth dots like dye sublimation.

Gigabyte: A thousand million bytes.

Graphics: This is the specialized area of computing used to generate the visualization. It is an ideal application for modern high power microprocessors. The processor handles millions of dots on the screen to produce images.

Graphics Processor: Many CAD systems use a 'dedicated' microprocessor whose sole job is image production. It is often at least as powerful as the main processor handling all the other tasks.

Graphics Screen: Screens used to display an image are usually large - 22-24 inches across - and can display 1,000 to 1,600 individual dots across the width and 800-1,200 dots down the screen. You will often see '1024 x 768 resolution' quoted. If your business is fine woven design, this is the minimum you require. Work out how many dots will be allocated to showing detail of a single yarn at normal magnification.

Hard Copy: The term used for tangible, permanent printed output, usually on paper but also onto film for engraving or even onto fabric.

Hard Disk: This is the prime data storage medium of the CAD system. With designs running up to 100 Megabytes or more, you will need at least one large hard disk and possibly several. For example, a one Gigabyte capacity AND a method of making back-up copies.

Help Systems: Some CAD systems have built-in explanatory help. Select the help function and you get a (more or less) helpful comment on what you have just done. See also *Undo* and *Roll-back.*

Icons: These are little pictures on on-screen buttons to tell the

GLOSSARY OF CAD TERMINOLOGY

operator what they are for. They give access to individual tools and functions and if not properly designed they can be confusing.

Image/Design Storage: Once an image or design is in electronic form, it can be stored and retrieved from a permanent disk store. Libraries of designs and motifs can be used.

Image Size: The overall dimensions of typical artwork are an important factor in choice of a CAD system. If you use large repeats and metre square designs, a powerful computer and graphics system is essential.

Ink-jet Printing: A print system using many carefully placed microscopic drops of ink. Up to 16 drops may land on the same point giving limited dot depth variation. This is usually combined with Dithering to increase the available number of colours.

Job Flow: There is a natural flow to any series of operations. Its nature is only obvious to practical designers. Look for a CAD system that expresses YOUR job flow.

Megabyte: One million bytes. A design may need 100 of them.

Memory Size: A computer has working memory (RAM) and storage memory (Disk). Available capacity is going up rapidly. Working memory should be at least 4 Megabytes (Mb) and it is often 32 or 64 Mb. A separate graphics memory large enough to support screen operations is usually provided. Disk memory is much slower than RAM to read or write. As a general rule you need as much RAM and graphics memory as possible.

Menu: A CAD program may provide hundreds or even thousands of user selectable tools, options and commands. A good CAD system will group them into clear logical menus and guide you to the ones you want. It is worth noting that an easy-to-learn menu system may prove fussy and long-winded for an experienced user.

Mouse: A mouse is a small mobile object which converts hand movements and key presses into point and select commands for the computer. They require some familiarity training but are generally easy and intuitive to use. See also *Stylus*.

Networking: High speed electronic links or networks are used to link computers together. 'Ether net ' is one such system. They can be tricky to set up and run efficiently. If you are offered a 'network solution' make sure you see it in FULL operation before buying.

Optical Disk: The technology of audio compact disk (ID) has been successfully applied to computer optical storage disks. They are often of very large capacity.

Options: At any point in your work you will need to select new tools, new visualizations, commands etc. A good CAD system will provide these in an easy to use, accessible form.

Operating System: This is the computer's internal control and 'housekeeping' system. It makes sure programs, hardware, networks etc. all work together correctly. DOS (Disk Operating System) and UNIX are common examples.

Paint Package: Computers are very good at handling colour, simulating brushwork and producing pleasing colour effects. A paint package provides all the tools and functions. Unless you use calibrated screen colour and print-out you may find it difficult to communicate these effects.

Printed Output: Most decision makers are more comfortable with printed (hard copy) designs - or better still, fabrics. Substantial progress has been made in truly realistic print-outs on both paper and fabric.

Printing Inks: The inks used are the three primaries: Cyan (blue), magenta and yellow, plus black, sometimes referred to as CMYK printing. Some systems use dyes to print onto fabric.

Processor Speed: The central processor of a CAD system needs to process millions of instructions per second. This is indicated in Mega Hertz (MHz) and many processors are rated at 30, 50 or even 60 MHz, allowing approximately 10 million or more calculations per second.

Processor Type: Older types could only handle one byte at a time (8 bit processor). The common '38b' and '48b' processors handle four or more bytes per instruction.

RAM: This stands for Random Access Memory or working memory. Calculations and instructions using RAM are very fast, so it makes sense to do as much work as possible within RAM. Hence the need for as large a RAM as is possible.

Roll-back: A good CAD system allows you to undo at least the last thing you did to a design. Full Roll-back allows you to undo several operations and can be very valuable. See also *Undo*.

Scanner: The use of electronic scanning of artwork was a major advance for CAD. It is now possible to bring in detailed artwork in full colour, in sizes up to 1.2 metres square. An important feature is colour reduction. This should produce a design simulation in the computer with a limited range of colours, that is faithful to the original.

Scanner Input: Fully coloured artwork for printed, woven and knitted design can now be scanned electronically and reproduced faithfully on screen.

Scanner-Plotters: Very high resolution scanner plotters are available (1000 DPI) for high quality scanning and generating engraving quality colour separation negatives. See also *Copier-Printers*.

Screen Resolution: The number of dots per inch the screen can display. Unless you have a really expensive graphics processor this is often *lower* than the screen itself can handle.
Eg: Screen resolution is
1024 x 768 dots
Screen size 22 inches = 560 mm
ie. Minimum dot size = 560 divided by 1024 = 0.54 mm.
Thus a 0.25 dot pitch screen 22 inches wide could support 2240 x 1600 dot resolution, but few, if any, graphics processors can achieve this.

Stylus: A unit that looks like a pen or pencil, for working on a bit pad. It may be cordless (ie NOT wired to the computer), and pressure sensitive (ie capable of making thick or thin lines related to pressure).

Texture: If the computer image includes realistic textile texture it needs up to 4 times as many dots per inch. This is a rapidly developing feature of CAD systems, particularly print outs. Current screens are not really capable of showing full texture at normal magnification, which needs 300 DPI.

Training: It is vital to see an expert using the CAD system and also to receive adequate training. Quite often systems do not fulfil their potential if adequate training is not provided.

Thermal Wax Printing: Similar to dye sublimation but only capable of one level of dot intensity.

Undo: A valuable feature of working on a CAD simulation is the ability to undo mistakes and to try alternatives. An 'undo' function or full roll-back are valuable features to look for.

Visualization: A major feature of all good CAD systems is a large screen on which the current design is turned into a faithful visualization. Important features are available detail and colour.

Zoom, Pan: When working on a large design, it is necessary to move across, up, down ie. *pan* around the simulation, which is larger than the screen. You may also *zoom* in to greater or zoom out to lower magnifications.