STUDY MATERIAL FOR B.Sc. FASHION TECHNOLOGY

COMPUTERS IN FASHION INDUSTRY

SEMESTER – VI

ACADEMIC YEAR 2025-26

PREPARED BY

FASHION TECHNOLOGY DEPARTMENT

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UNIT - I

COMPUTERS IN FASHION INDUSTRY

Introduction

Computers have occupied a prominent place in all the apparel industries in this era. Computers technologies increases efficiency, saves time and produces valuable products as desired by the manufacturer, consumer or the buyer as the case may be. Computer is an electronic device that accepts data, processes data and the retrieves the same whenever needed. In this module the eminent presence of computers and its applications in the apparel industry is described briefly.

Applications of Computers in Apparel industry

The role of computers in the apparel industry is witnessed in many areas. They are listed as follows

Textile Design Systems – This includes designing and creating different weaves, knits and prints

Computer Colour matching systems – A colour matching system measures the depth of the colour and also compares the dyed fabric with the original sample. It can also suggest recipes for the dyes and chemicals.

Fabric Defect Checking Systems – The fabric is inspected for defects with the help of scanning device.

Garment Designing – The designer creates fashion sketches and adds varieties of texture to it. Digital fashions can be created in the 2 dimensional form and 3dimensional form. 2d garment designing is similar to the drawing of a sketch in a paper. In 3d designing the process is similar to the draping of fabric on a mannequin.

The mannequin or the human model in the 3d form can be animated to perform a ramp walk. The garment can thus be viewed in all the angles.

3D Body Scanning – 3D body scanners scans the human body and records the dimensions of the individual. The body measurements of the individual can be taken with greatest accuracy. This is a very important step that enables the designer to create garments with good fit.

PDS systems – Pattern making, grading and marker planning can be done using PDS systems. Patterns can be drafted with ease and accuracy using flat pattern techniques. The block patterns or basic patterns can be graded to different sizes. The marker planning or lay planning can be efficiently done in the computer and the same can be printed using a plotter.

Digitising systems – The manual patterns can be converted into the digital pattern with the help of the digitiser. The digital patterns can be graded and used for marker planning

Computerised Cutting – The cutting / marker plan made using the PDS system is loaded in automated cutting machine. The cutting takes place without a human hand. The computerised cutting machine cuts the fabric into pattern blocks as prescribed by the marker plan.

Computerised sewing machines – Sewing machines have programmed operations that help in increasing the production. It also aids in improving / maintaining the quality of the product.

Made-to-measure systems – this is ideal for tailored garments. The measurements are entered into the PDS software which prepares patterns and marker plan for the desired style. This aids in mass production of tailored garments. The full size patterns can be printed using plotters. The customer's measurement can be saved and used for manufacturing of other styles in future.

Embroidery Systems – New embroidery designs can be created in the system. The design can be tested for various colour combinations before finalising on a colour scheme. The CAD designs can be embroidered in the fabric using computer controlled embroidery machine in a few minutes.

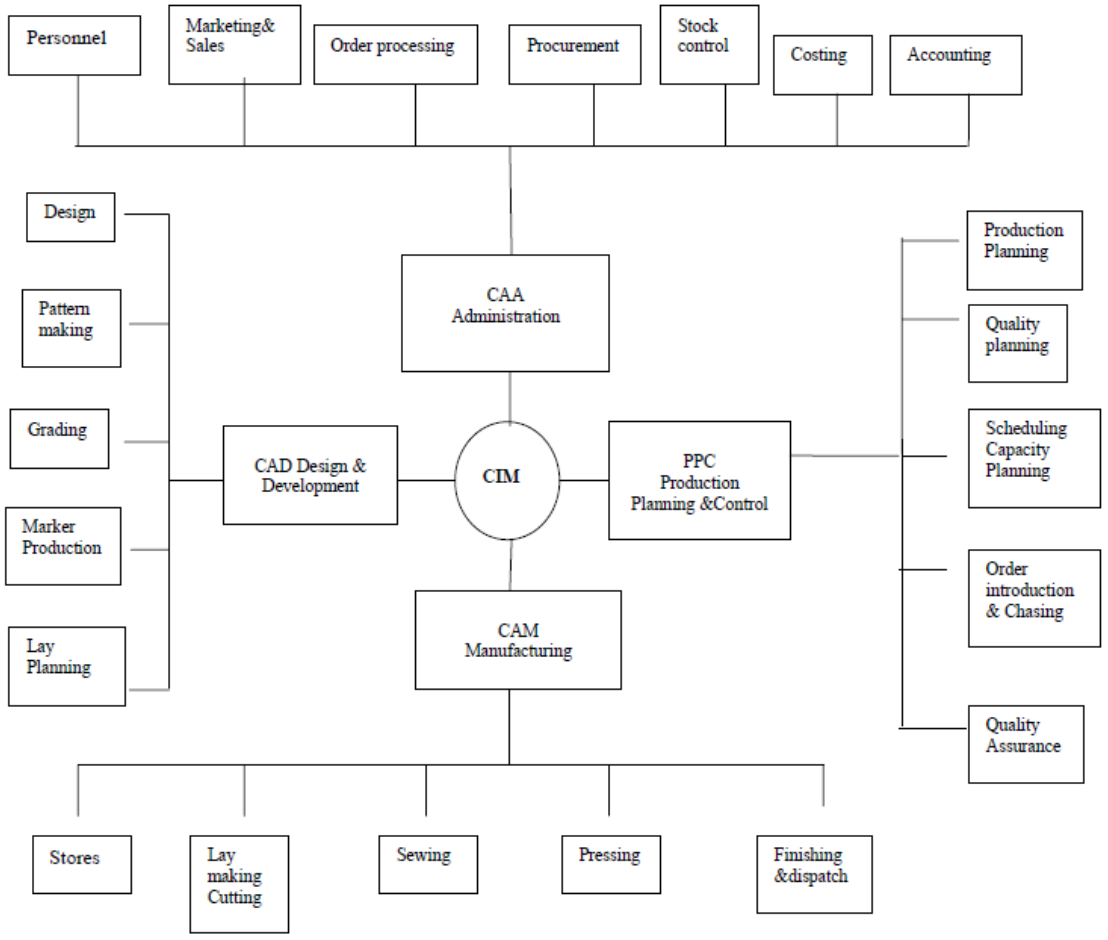
Administration – The work flow and the entire production plan can be created and maintained in the system. This helps in the effective co-ordination of different departments.

Virtual Marketing – Consumer gets to see the products displayed before they are developed virtual products in virtual stores. The internet is a form of virtual store. To market a product there in reality, there is no need to physically produce the product, what is needed is an electronic representation of the product.

Quick Response System – The designer is connected to the retailers where he gains information about the consumer's interest. Based on the response, the product can be eliminated or replaced or given more importance. Quick response reduces the lead time between the manufacturer and the retailer.

Internet and Information Explosion – This helps the fashion designers, fashion design faculty members / students, fashion leaders and fashion followers to be in line with the latest trend.

Flow chart of CIM in Apparel Industry



CIM=Computer Integrated Manufacturing,

CAA=Computer Aided Administration,

CAD=Computer Aided design,

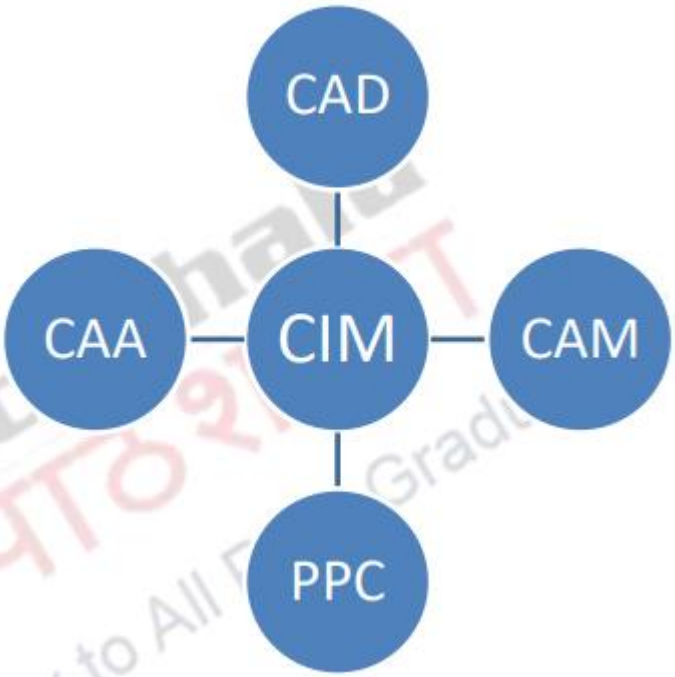
PPC=Production Planning and Control,

CAM=Computer Aided Manufacturing.

CIM – Definition and functions

Computer Integrated Manufacturing (CIM) integrates the functions of CAD/CAM and other activities like PPC and CAA. CAD and CAM comprise of designing and manufacturing. PPC refers to the production planning and control whereas CAA means computer aided administration. CAD and CAM systems are usually integrated. The garment unit has many departments and handles a variety of operations starting with receiving an order from the buyer to the production of garments and finally the shipment of goods. The production in a garment unit takes place in

various departments like sampling section, cutting section, sewing section, finishing section and packing section. The plan for the production cannot be a standalone operation. It involves coordination and data supply which is possible only when the activities are computerised and integrated. The illustration given below shows the working model of CIM.



Computer Aided Design (CAD) – computers are used for developing designs, pattern making, pattern grading, marker planning.

Computer Aided Manufacture (CAM) – computers are used for fabric inspection, spreading, cutting, sewing and pressing.

Computer Aided Administration (CAA) – computers are used for marketing, sales order processing and stock control.

Production Planning and Control (PPC) – Computers are used for planning the production of a product and monitoring the quality of production

The CIM thus serves as connectivity between departments. The entry of order obtained from the buyer is the first step. The order will give the all the details of the garments to be manufactured. This is made available to the sampling department where the patterns are prepared and graded. The marker plans are also created in the PDS system.

The details of the fabric inspection, the date, time and the number of defects makes way for spreading and cutting. The sampling section provides the cutting department with the marker/cutting plan. The sewing section will have a continuous supply of cut pieces for sewing. This stitched garment is trimmed in the finishing section and is moved to the pressing and

packaging departments In every department the work plan is created. All the plans will be synchronised and checked to avoid repetition of jobs and breaks in-between the production process. With this integrated plan the workflow is streamlined and number of persons working in the concern can be easily equated to the number required. This helps in preventing hiring of excess labour and shortage of labour.

CIM ensures that the materials required are available for the production through computerised Production Planning and Scheduling (PPC). CIM leads to the automation of the all the process / activities of the company.

CAD – Definition and Functions

Computer-aided design (CAD) can be defined as an activity where the designs are created using computers. The computerised designing involves the use of CAD software. The general purpose CAD software commonly used for garment deigning are paint brush, coreldraw, adobe Photoshop, AutoCAD, 3D studio max and so on. Garment designs can also be done on customised software like lectra, gerber, tukacad, vidhya etc., The following are the reasons for using a computer-aided design

The designer is able to create, recreate or modify designs faster and easier with CAD. In apparel industry CAD refers to garment designs, fabric designs, pattern making, grading marker planning etc.,

The designer can create a design and at the same time is able to provide variety of alternatives like variation in colour, texture and styles with ease. Thus quality and quantity of the design is enhanced with CAD

CAD designs can be stored for a longer period of time without damage. It can be retrieved whenever required. It is stored in a virtual space and hence does not occupy floor space.

The CAD designs also serve as data base for the manufacture the product though CAM.

Functions of CAD

A typical CAD system consists of the following components – One or more design workstations, processor, secondary storage and plotter and / or other output devices. Computer Aided Design (CAD) is used for developing designs, pattern making, pattern grading and marker planning.

Creation Designs – Textile designs for weaving, knitting printing, embroidery and garment designing (2D and 3D) can easily done with CAD.

Pattern Making – Patterns for garments can be drafted using Pattern Design Systems (PDS). Preparation of pattern making involves mathematical skills and is a complicated process by nature. Thanks to CAD this process is made easy.

Pattern Grading – This is also complicated process like pattern making involving x, y and z axis. The increase or decrease of patterns is simpler with CAD. In the apparel industry, the garments are manufactured for three or more sizes.

Marker Planning – Efficient marker plan helps in fabric reduction and therefore the fabric cost. Economic marker can be easily achieved by arranging and rearranging the pattern pieces in the specific width. The sizes to be cut and number of layers of fabric to be spread is determined in marker / lay planning.

CAM – Definition and Functions

When the manufacturing process is computerised or automated, it is termed as Computer-aided manufacturing (CAM). The main areas where CAM is used in the apparel industry are discussed as follows.

Fabric Manufacture – This include the creation of woven, knitted and printed fabrics in computer controlled machines.

Fabric Inspection – In this process the rolls of fabric are measured after subjecting it to fabric inspection. Here the computer scans the fabric and identifies the defects and presents the same as a report.

Cutting – computerised marker plans are loaded in the automated cutting machine, which operates without a human hand. This cutting head has cutting drill and notcher's in addition to the straight knife.

Sewing – In the Computer controlled sewing machines, the operator positions the fabric on the machine and the machine automatically sews the fabrics. The special functions like button-hole making, button fixing and bar tacking also can be done more precisely.

Embroidery – The CAD designs instructs the machine to in selection of stitches and colours and accordingly the design is embroidered.

Pressing – the pressing of the fabric under the specified temperature and pressure and finally folding the garment to the required size is made easier thanks to the CAM

Testing – The fibres, yarns and fabrics are tested for its physical, chemical and colourfastness properties in the digitised testing machines

The manufacture of woven designs, knitted designs and prints can be done faster and made easier with CAM.

CAA – Definitions and functions

Computer Aided Administration is inevitable in the office administration mainly for accounting, wages, and logistics etc., The functions of the CAA in the apparel industry may be listed as follows – Personnel, marketing, order processing, purchase, stock control, costing and accounting.

Order Processing:

Modern apparel distribution centres use computerized storage and picking system that they rely on bar-coding for storage and retrieval of garments when needed to fill orders. Computer system permits integration of many of the ordering and distribution process. In Customer order processing (COP) software, orders are entered into the computer and the COP system produces bar code labels that when scanned can produce packing slips, bills of loading or invoices. This system can stand alone or can be integrated with the apparel production and / inventory control systems such as these reduce administrative costs and assure more accurate delivery or products to the customers.

Purchasing:

Purchasing include the sourcing of fabric, accessories, and stationery. This procedure involves the preparing specifications of suppliers along with the cost for the goods. Accessories include sewing thread, laces, satin ribbon and buttons. Stationeries and other miscellaneous things needed for the execution of the order is also identified and procured.

Stock Control:

CAA provides information such as past due purchases, part due shipments to customers, out of stock items, over stock items, inventory turnover reports, vendor performance summary and shipper performance analysis. This includes the overall comparison between planned and actual inventory cost of purchase items. Based on the above information, the storage planning is made regarding the new policies to vendor's information on new technology.

Accounting:

Computerised accounting reduces the work of an accountant by inputting the data only once. When done manually the double entry system is followed. The accounting programs in the computer automatically provide the reports like trial balance, balance sheet, sales analysis and many more reports. This relieves the accountant from the strenuous and monotonous job of calculating 4, 5, 6 digit numbers all though the day.

Personnel Management:

CAA aids in maintaining a digital service register, which shows all the details like joining dates training period, termination date and so on. The job profile, pay details with the revisions and performance appraisal are frequently updated

Marketing:

Marketing strategies are developed based on the data available and the market need. A includes operational control activities, scheduling of sales, promotion activities, sales details and customers details. The data on the consumers, sales, and marketing personnel can be analysed using statistical tools and the same can be presented in the form of bar diagrams, pie charts and so on.

PPC – Definition and Functions

PPC stands for production planning and control. The production planning and control is more effective with CIM, where all the activities of the concern are computerised. The company's top most priority is to manufacture the goods ahead of the time prescribed in the order. The production plan should cover all the activities of the concern and schedule the sequence of work without breaks and overlaps. This also includes the arranging of man, machine and resources in right time, right quantity and right quality

Design department is the basis for planning because it holds standard designs and the pattern pieces, graded patterns and marker plan. The cutting plan and the daily production plan (number of pieces of garments to be stitched) and all the related activities can be planned accordingly. The computer analyses the time of delivering the goods from the date of production. It can plan the major plans like cut planner and sewing production, and the other related works of the other department like pressing and packing. It can analyse the floor production speed and the performance against the estimate.

In the case of stock control, a computer program can be used to assess the most economic maximum and minimum quantities of materials to hold, bearing in mind the capital cost of storing, the amount of money tied up, and the heat, light and space of the buildings involved. It can also consider the probability of being able to supply a customer's demands at any time. It is also possible to calculate the theoretical maximum and minimum batches. On a detailed plan it can take an inventory control and place orders for the necessary materials (fabric, thread, buttons etc) ahead of production

They compute the sales and examine the same with the past orders. This is the set target for the product's sales.

Computers in Production Planning

Introduction

Enterprise resource planning (ERP) systems integrate internal and external management information across an entire organization, embracing finance/accounting, manufacturing, sales and service, customer relationship management, etc. ERP systems automate this activity with an integrated software application. The purpose of ERP is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders.

Some of the Indian Textile Mills has started using an Information Technology for over the last 10 years in specific areas of service functions like payroll, purchase, store, accounting, establishment etc. Later on, the use of information technology has been extended to other fields in textile industry like development of data management system for production on-line data monitoring system provided on different control/monitoring systems on latest machines. For a most modern textile mills, one can think of application of information technology which can be

used right from the purchase of cotton from the fields as per specifications, fibers from factories, hire the places equipped with the machineries' as per the requirements, plan the production of different items as per schedule, maintain the quality of output product and lastly helps in selling the end product through internet.

The importance of efficient production management is well known in controlling overall profitability of an industrial unit. A production manager needs to have control over output of the factory, quality of goods produced and cost of production. In this information-centric age, the better you are informed the better is your performance. Computer information systems for production planning and control are aimed at equipping management with accurate information for making sound decisions.

The number of textile business houses, which make use of such systems, is very less. A use of such systems in unit shows that it helps them to be far ahead of their competitors in terms of capacity utilization, cost control and market share

What is ERP?

An Enterprise is a group of people with a common goal, which has some key functions and resources at its disposal to achieve that goal. Resources included are man, money, material and all the other things that are required to run the enterprise. Planning is done to ensure that nothing goes wrong. Planning is putting necessary functions in place and more importantly, putting them together.

So, ERP is a method of effective planning of all the resources in an organization. Enterprise Resource Planning (ERP) covers the techniques and concepts employed for the integrated management of businesses as a whole, from the viewpoint of the effective use of management resources, to improve the efficiency of an enterprise. ERP packages are integrated (covering all business functions) software packages that support the ERP concepts.

ERP software is designed to model and automate many of the basic processes of a company, from finance to the shop floor, with goal of integration information across the company and eliminating complex, expensive links between computer systems that were never meant to talk to each other.

As said earlier, an enterprise is a group of people with a common goal, which has certain resources at its disposal to achieve goal and here enterprise acts as a single entity. This view of a company or organization is drastically different from the traditional approach. In the traditional approach, the organization is divided into different units based on the functions they perform.

So we have the manufacturing or production department, the production planning department, the purchasing department, the sales and distribution department, the finance department, the R & D department and so on. Each of these departments is compartmentalized and has their own goals and objectives, which from their point of view are in line with the organizations objectives.

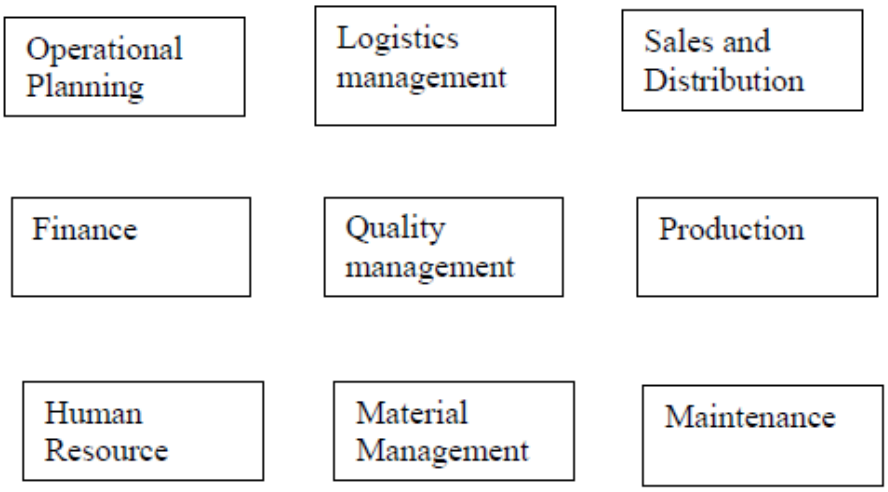


Fig: Pre Scenario of E.R.P

Each of these departments functions in isolation and have their own systems of data collection and analysis. So the information that is created or generated by the various departments, in most cases, is available only to the top management (that too summary report) and not to the other departments. The result is that instead of taking the organization towards the common goal, the various departments end up pulling it in different directions. This is because one does not know what the other does. Also, sometimes the departmental objectives can be conflicting due to this lack of information integration. But in the enterprise way, the entire organization is considered as a system and all the departments are its subsystems. The information about all the aspects of the organization is stored centrally and is available to all departments within a fraction or second.

This transparency and information access ensures that the departments no longer work in isolation pursuing their own independent goals. Each subsystem knows what others are doing, why they are doing it and what should be done to move the company towards the common goal. The ERP system helps to accomplish this task by integrating the information systems, enabling smooth and seamless flow of information across departmental barriers automating business process and functions and thus, helping organization to work and move forward as a single entity

ERP Modules

All ERP packages contain many modules. The number and features of the modules vary with the ERP packages. Here we will see some of the most common modules available in almost all packages.

- Finance.
- Manufacturing and Production Planning.
- Sales and Distribution.

- Plant Maintenance.
- Quality Management.
- Materials Management, etc.

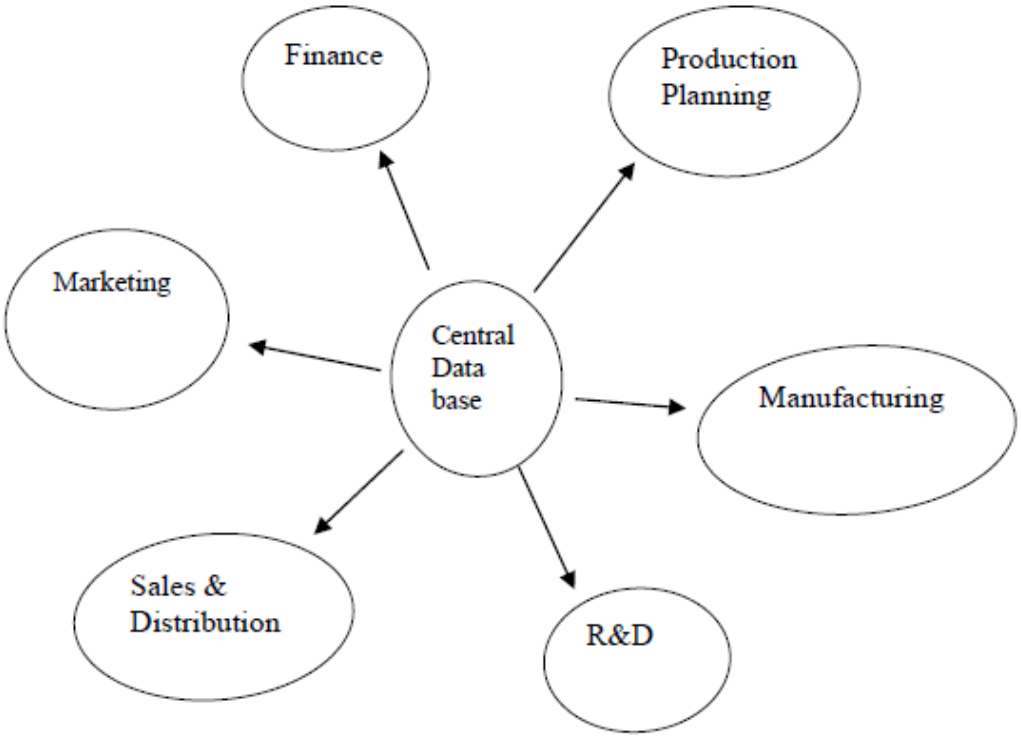


Fig: ERP modules

Benefits of ERP in Apparel Industry

Supplier benefit	Management benefit	Employee benefit	Customer benefit
Information in time about material to be provided	Cost savings, improvement in savings. Good customer relationships	Satisfaction in working and achieving goals with good team work	Good services, Good quality at cheaper price.

• ERP integrates all aspects of the business processes including: manufacturing, design, customer services, financial, sales and distribution. By integrating business processes and people anywhere in your company, you can enjoy more efficient work flow and improved productivity.

• Nowadays, retailers and consumers push for lower prices, better quality and quicker delivery. ERP implementation shows your determination to head for those directions. Confidence of your business partners and consumers will be increased.

• ERP provides the right information to the right people at the right time anywhere in the world, enabling you to improve productivity, enhance decision making and promote communication between co-workers, customers and vendors

• ERP software helps to reduce or eliminate duplicate work, and automates operational tasks and provides easy access to information. ERP, therefore, can deliver significant time savings.

• Advanced ERP software has the ability to be customized to the extent that screens can be remodelled, fields can be edited and the architecture modified through progressive installation processes. In addition, advanced ERP software can be operated in a secured, web-based environment. These features provide flexibility and convenience in implementation and operation.

• Some multi-lingual ERP software can perform automatic translation enables almost every style detail to be viewed in several languages including English, Chinese, and etc. It improves the effectiveness of communication.

• Manufacturing companies often find that multiple business units across the company make the same widget using different methods and computer systems. ERP standardizes the manufacturing processes and improve quality.

• ERP helps business process flow more smoothly and improves the efficiency of fulfillment process. It leads to reduced inventory. Eventually, it decreases the overall business cost.

At its simplest level, ERP provides a way to integrate all your business process. To get the most from the software, you have to get people inside your company to adopt the work methods outlined in the software. If the people do not agree with the method and the system has no flexibility to be customized, ERP projects will be failed. Therefore, you should choose ERP software wisely.

Computers in Production Scheduling

Computers revolutionize production scheduling by using software, AI, and algorithms to optimize resource allocation (machines, labour, materials), automate complex planning, and create efficient, real-time schedules, moving beyond manual methods like Excel for better efficiency, reduced waste, quicker adaptation, and improved customer service in dynamic manufacturing environments. They handle complex constraints, forecast needs, and provide data for continuous improvement in planning and control.

Key Roles of Computers in Production Scheduling:

- Optimization: Algorithms find the best schedules considering capacity, demand, setup times, and maintenance, leading to better resource utilization.

- Automation: Automate the creation and adjustment of schedules, minimizing human error and delays.
- Real-time Visibility: IIoT (Industrial Internet of Things) connects physical assets, providing live data for dynamic, reactive scheduling (e.g., handling unexpected breakdowns).
- Data-Driven Decisions: Analyze vast amounts of data to predict needs, identify bottlenecks, and improve future planning.
- Integration: Connect different levels of planning (strategic, tactical, and operational) and systems (ERP, MES) for cohesive operations.

How They Work (Tools & Technologies):

- Production Scheduling Software (PSS): Dedicated programs that manage tasks, resources, and timelines.
- AI & Machine Learning: Predict demand, optimize complex scenarios, and enable smarter r decision-making.
- Cyber-Physical Systems (CPS): Integrate computing with physical production for flexible, lean manufacturing.
- Quantum Computing: Emerging tech for highly complex problems like demand forecasting and massive synchronization.

Benefits:

- Increased Efficiency: Maximizes throughput, reduces idle time, and cuts costs.
- Greater Flexibility: Quickly adapts to changes in orders, resources, or market trends.
- Improved Accuracy: Reliable schedules reduce confusion and waste.
- Better Customer Service: Meets deadlines and handles complex product options effectively.

In essence, computers provide the sophisticated tools needed to manage the immense complexity of modern manufacturing, shifting from reactive to proactive and predictive scheduling.

Computer Colour Matching System (CCMS)

Computer Colour Matching (CCM) is the instrumental colour formulation based on recipe calculation using the spectrophotometric properties of dyestuff and fibers.

Fig: Computer colour matching system

The basic three things are important in CCMS:

• Colour measurement Instrument (Spectrophotometers).

• Reflectance (R %) from a mixture of Dyes or Pigments applied in a specific way.

• Optical model of colour vision to closeness of the colour matching (CIE L*A*B).

Functions of Computer Colour Matching System

The following works can be done by using CCMS

• Colour match prediction.

• Colour difference calculation.

• Determine metamerism.

• Pass/Fail option.

• Colour fastness rating.

• Cost Comparison.

• Strength evaluation of dyes.

• Whiteness indices.

• Reflectance curve and K/S curve.

• Production of Shade library.

• Colour strength

1. Colour Match Prediction:

The main function of CCMS is to predict the colour of a sample. In lab dip section it is necessary to match the shade of the sample. CCMS makes it easy to match the shade quickly. It also makes easy the work of a textile engineer who is responsible for it.

2. Colour Difference Calculation:

We know that, when a sample is put in sample holder of a spectrophotometer it analyses the colour of the sample. It also calculates the colour difference of the sample and dyed sample which is dyed according to the recipe of the CCMS.

3. Determine Metamerism:

CCMS also show the metamerism of the sample colour.

4. Pass / Fail option:

The sample which is dyed according to the recipe of the CCMS is it matches with the buyers sample that could be calculate by this system. If the dyed sample fulfil the requirements then CCMS gives pass decision and if can't then it gives fail decision. So, pass-fail can be decided by CCMS.

5. Colour Fastness Rating:

Colour fastness can be calculated by CCMS. There is different colour fastness rating (1-5/1-8). CCMS analyze the colour fastness and gives result.

6. Cost Comparison:

Cost of the produced sample can be compared with others. It also helps to choose the right dyes for dyeing.

7. Strength Evaluation of Dyes:

It is important to evaluate the strength of the dyes which will be used for production. All of the dyes have not same strength. Dyes strength effects the concentration of dyes which will be used for dyeing.

8. Whiteness Indices

Whiteness Indices also maintained in CCMS.

9. Reflectance Curve and K/S Curve:

Reflectance curve also formed for specific shade by which we can determine the reflection capability of that shade.

10. Production of Shade Library:

Computer colour matching system also store the recipe of the dyeing for specific shade. This shade library helps to find out the different documents against that shade. It is done both for the shade of sample and bulk dyed sample.

11. Colour Strength:

Computer colour matching systems also determine the colour strength of the sample.

Working Procedure of Computer Colour Matching Systems (CCMS)

Generally buyer gives a fabric sample swatch or Panton number of a specific shade to the producer. Producer gives the fabric sample to lab dip development department to match the shade of the fabric. After getting the sample they analyze the colour of the sample manually. In the other hand they can take help from the computer colour matching system.

At first it needs to fit the sample to the spectrophotometer which analyses the depth of the shade and it shows the results of the colour depth. At the same time it needs to determine the colour combination by which you want to dye the fabric. Then it will generate some dyeing recipe which is nearly same. Here it needs to determine the amount of chemicals which you want to use during dyeing.

After formation of dyeing recipe it needs to dye the sample with stock solution. I think you are also familiar with stock solution. Then sample should dye according to the dyeing procedure. After finishing the sample dyeing it needs to compare the dyed sample with the buyer sample. For this reason dyed sample are entered to the spectrophotometer to compare the sample with the buyer sample.

Then CCMS gives the pass fail results. If the dyed sample match with the buyer sample than CCMS gives pass results. After that, dyed samples send to the customer or buyer. After getting the approval from the buyer producer goes for the bulk production. If the dyed sample does not match with the buyer sample than the CCMS analyses the colour difference and correct the recipe. Then another sample dyeing is carried out for matching the shade of the sample.

Components of Computer colour matching

• A Spectrophotometer that senses the colour and analyses it.

• A well configured PC/Laptop/IPAD/Mobile device that is loaded with the necessary operating system to run the software.

• Colour Matching Software, that collects all the data required, analyses the data and displays comments about the overall appearance of colour of the sample, i.e. whether it is lighter/ darker, stronger/ weaker ,or whether it matches in different lights such as D65, CWF, andTL84.

• Colour match software consists of various programs such as quality control package for pass/fail of incoming and outgoing material, shade sorting, colour strength, whiteness and yellowness indices etc.

• Program for generation of colorant database is required for match prediction for variety of substrates, different class of dyes and different processes of dyeing taking into consideration the important process parameters such as time, temperature, dye-liquor ratio, auxiliaries and chemicals used for pre and post- dyeing.

• For predicting concentrations of colorants, one has to have the accurate colorant database which offers following characteristics:

a) Linearity: The function of reflectance used must be linear with colorant concentration

b) Additively: The function of reflectance must be additive in proportion to the concentration of components present in the mixture.

Colour match prediction and correction program

Mathematics for predicting the colorant formulation is now well known. Rolf G Kuehni's book on "Computer Colorant Formulation" is an excellent book on this topic and Eugen Allen's original papers on match prediction are the basis of match prediction software. Today, Industrial secrecy on this subject is no more existing. Almost all colour system manufacturers are using this mathematical model for match prediction with new mathematical tools.

If we are given the spectrophotometric curves of a colour (16 or 31 wavelength points) and three colorants to be used in matching it, the computation of concentrations of three colorants required for tri-stimulus match or spectral match can be performed using Allen's mathematical approach. If a mixture shade contains 3 colorants then three simultaneous equations will be required to solve for 3 unknowns. These will normally be wavelengths of maximum absorption of three colorants. For spectral match, one has to compute unknown concentrations using 16 or 31 wavelength points.

For full match prediction, it is ideal to compare two sets of spectral data, one of the standard colour to be matched, the other composed of a mixture of the matching colorants but both sets to be weighted by the way we see colour through the C I E X, Y, Z weighing co-efficient combined with specified illuminates D65 and CWF.

We have seen five or six generations of colour matching system. New generation spectrophotometers and computers have changed the scenario of modern colour control system. Most of the instrument manufacturers offer three range of desktop instruments (High end, Medium end and Low end instruments) and one or two models of portable instruments. New camera based instruments are extremely good, accurate and low cost.

Mobile computing and Internet technology have also influenced modern colour systems and new innovative concepts are being introduced. Programmers have to integrate the software

for new platforms such as new operating systems and web technology required for on-line access. This is the challenging area for software developer.

Leading colorant manufacturers offer "Ready Package" to their customers by giving database of their dyes. They give free CD of database of dyes to their customers as a technical service. It offers guideline solutions to customer for obtaining least metameric and least cost recipe for new custom colour. Some colorant manufacturers are giving facility of downloading the database and match program. Some service providers offer colour match service through e-mail as they have developed huge database of all dyes-substrate-process combination.

This involves no need of preparing calibration samples for database. These services are partly successful. Now, one can effectively offer better colour matching service based on internet technology as cloud computing is the latest and fastest tool available. Taking this into consideration, Wool Research Association (WRA), India developed a colour matching service package for small and medium dye houses who cannot afford to buy very expensive colour control system and they do not have laboratory equipped with automatic dye dispensing machines and process control dyeing machines. WRA recently launched this project in India at Amritsar and Ludhiana in Punjab where woollen industry is having a strong base.

Why one needs Internet based CCM?

Computer Colour Matching Systems (CCMS) used in textile industries are cost prohibitive and not affordable for small and medium dye houses. The two main components such as spectrophotometer and colour matching software are very expensive. Apart from that preparation of database requires very good laboratory facilities and most of the dyeing units are not equipped with good laboratory facilities such as automatic dye dispensing machines and lab dyeing machines with process controller. Colour experts are not available and salaries are increasing day by day.

Small dye houses cannot employ computer colour matching experts who can handle the colour technology problems and interpret colour science data. Taking all these factors into consideration, Wool Research Association has developed a very simple solution of internet based colour matching service for small and medium dye houses.

Main features WRA system and colour services are:

- Instant colour matching
- Any time colour matching (24 x 7)
- Affordable colour match service
- Low cost Instrument
- No need to prepare database.

Advantages of Computer Colour Matching System (CCMS)

Computer Colour Matching System (CCMS) has lots of great advantages in Textile Industry. See some examples below:

• Customers get the exact shade wanted with his knowledge of degree of metamerism.

• Customers often have a choice of 10-20 formulation that will match colour. By taking costing, availability of dyes, and auxiliaries into account, one can choose a best swatch.

• 3 to 300 times faster than manual colour matching.

• Limited range of stock colour needed.

UNIT - II

COMPUTERS IN CREATING FABRIC AND GARMENT DESIGNS

CAD in creating Designs

Introduction

Computer-Aided fashion Design is an electronic system for designing new products or altering existing ones, replacing traditional work done by hand. The heart of CAD is a powerful desktop computer and graphics software that allow a designer to manipulate geometric shapes. The designer can create drawings and view them from any angle on a display monitor. Computer-Aided Design (CAD) is a tool used in Computer-Integrated Manufacturing CAD has changed the textile industry by making it easier, faster and more cost effective to produce apparels and textiles designs. Textile manufacturers use the CAD to document the textile design process and optimize manufacturing capabilities, while textile designers find it easier and more appealing to create innovative designs with technical tools.

Significance of CAD

CAD is computer aided design. Any part of the design process that can utilize the computer as a tool fits under the CAD umbrella. Originally, the term CAD was used in various industries to refer primarily to function to required drafting of precision machine parts and working with highly technical specifications. In the textile and apparel industries, CAD has to come to include graphics applications used for purpose of visualizing design as well as technical specifications and function. Some systems are used for garment manufacturing of textiles and apparel as well as design segment. These are referred to as CAD/CAM systems. CAD, will be used to describe both the design and manufacturing segments.

CAD was originally developed on industry- specific or turnkey systems. This means the manufacturers of CAD equipment created their own proprietary hardware and software and sold the entire package to the apparel industry. These turnkey systems are used widely, but have also been prohibitively expensive for a small manufacture. As a result, industrious employees and entrepreneurs began simulating the properties and the potential of the turnkey systems with off-the shelf or commercially available software. As a matter of fact, many companies that do own turnkey systems supplement them with commercial software packages.

CAD is a mainstream tool; companies that hope to compete in the fashion market place, especially at the mass level, cannot prosper without some level of CAD technology. At this point, most companies have integrated some form of CAD technology into their design and production processes. An estimated 20,000 CAD systems are in place worldwide. Much of this technology lies in the realm of patternmaking and marker making, much in the arena of textile design and production. But the strongest trend is toward complete computer integration from design and product development through merchandising and business operations on a worldwide network.

Advantages of CAD

Textile and fashion designers

- More sketching ideas can be expressed through CAD than to accomplish by hand
- A fabric painting can take a full day to do by hand, whereas a dozen recolouring can be done in a day with the aid of computer
- Produce Innovative designs
- Cad textile designers are able to visualize the final product of their design without the need of producing it in physical form
- Saves time by modifying old designs
- See and save a copy of the design quickly
- CAD allows designers to view designs of clothing on virtual models and in various colours and shapes, thus saving time by requiring fewer adjustments of prototypes and samples later.
- The benefits are numerous- speed, accuracy, productivity, communication but only humans possess the most important tool of the trade- imagination.

Fashion Education

• CAD literacy is now a prerequisite for designers

• The manual methods of designing and clothing construction have been taken by digital technologies

• Most fashion design colleges, however, still teach traditional design methods, including manual flat pattern construction, draping and line drawing. No doubt that learning of these methods are essential for having a good idea about fashion design but Cutting-edge education also focuses on computer aided methods of design. Software can help students draw, create woven textures, drape models to create patterns, adjust sizes and even determine fabric colours. By Introducing this technological aspect will enable students to understand a lot better and try various combinations in their design. This also cuts down the time factor i.e. by use of CAD methods students can learn a lot faster and more software in less time

• Blend OLD and NEW

It's not that one should neglect the manual design methods and completely focus on CAD methods. State-of-the-art technology is important, but a sound understanding of the methods behind production is also essential.

Manually figuring size adjustments and cutting pattern pieces instils that knowledge. Software programs constantly evolve. A program used today may be obsolete within several years. Being trained on today's software does not guarantee it will be used when you are ready to go out into

the field. Understanding calculations is timeless, as is computer competency. Software, however, shifts rapidly.

Textile Manufacturers

• In textile manufacturing, mass production has been made less complicated through the automation advantages provided by CAD/CAM. Material consideration, fabric colour combination, less complex patchwork visualization and manipulations are carried out by CAD to produce textile materials of high calibre.

• Makes the task easier, faster, better and reliable

• Cuts the cost of product development

• CAD plays a vital role in textiles manufacturing by making it possible to achieve better target matching and efficiency in colour selection. Apart from textile designs CAD is also used in knitwear productions and printed fabric.

CAD in Fashion and Clothing Designing

Clothing construction and designing is a broad business which encompasses many distinctive areas. As with other fields of life fashion designing too has been influenced a lot from the advances in computer technology. Today most of the big guns in the fashion and clothing business depend on the use of computerized technologies in performing regular and unique tasks. The manual methods of designing and clothing construction have been taken by digital technologies. These technologies have made the tasks easier, faster, cheaper (in some areas), better and reliable. With the passage of time its demand is increasing and ten years from now computer aided systems will be the only possible way to do tasks. Companies who will not be equipped with such technologies will be unable to survive.

There are varied and wide applications of CAD/CAM in fashion designing. Almost any and every machine can be interfaced with computer to work smartly and efficiently. Uses of CAD/CAM technologies in fashion designing can be illustrated better by knowing the steps of clothing construction and fashion designing, because in each step use of CAD/CAM can improve the process.

1. Idea/Concept

The idea or concept generation is usually the first step in fashion designing. The idea can come from anywhere. A smart idea may lead to smart product; therefore the designer may usually give much more time to this step in order to bring positive results. Sometime the idea may come within an hour or two otherwise it may take days and weeks to think before act. In general a designer can get inspiration from large database that is available on internet. Images, videos, text and other sources on internet can help a designer in generating ideas and designing better collections. Previously designers took inspirations from books, travelling, places and people etc.

today all of these things are available on internet and the designer does not need to go places to take decision about the idea behind each collection.

CAD specifically helps designer in concept generation because while the designer is working on any concept he needs to draw and illustrate each of his thought and drawing in CAD which is much easier than on paper. By drawing concepts he can give life to his thoughts and can better understand what's better and what's not. Although this does not mean that people who do not know anything about drawing and are least creative can become designer by using CAD, it only means that CAD enhances the potential of the designer and brings to light what was thought impossible.

Taking inspiration from both modern and historical fashion can be a great way to introduce something new and fresh in your designs. A few ideas on how to adapt inspiration to fashion design.

• Look at the overall scale of an outfit and imitate it.

• Colour schemes are one of the easiest areas to adapt.

• Look at the lines of a garment and copy them in your designs.

• Fabric textures and patterns are another easy-to-mimic area.

Fig: Generating Idea /concept through inspiration

2. Sketching

After the designer is sure about the idea behind his collection he needs to draw sketches of the dresses and accessories. The designer starts drawing from rough sketches which he later needs to trim in order to decide about the final sketches. Sketching is one of the most important steps in designing because the designer has to work through his creativity and knowledge of the trends in order to create something unique yet acceptable. Every designer must have to be a very

good illustrator. In most of the fashion designing institutes sketching is taught to the students from the very beginning of the course and till the end to master all the skills and to become qualified illustrator.

CAD has made sketching faster and easier but the major advantage of using CAD in sketches comes from the many handy tools that are available in CAD software that are unable to be used in manual drawing method. Varieties of software's are available today for fashion sketching and it is not too much to say that a person who has never learnt sketching on computer can easily work with them because they are so explanatory and there are so many tutorials available many of them are free. In CAD the designer can draw and erase and then again draw and erase and mix 'n match and do and redo. These are only few of the advantages of using CAD for sketching as the designer starts using

CAD instead of manual method he becomes acquainted with loads of other advantages too.

Fig: Generating Idea /concept through inspiration

3. Visualizing the design

Before production of apparels when production starts the designer or the producer of the garments visualizes in mind the final product, how it will look and if there are any flaws in the sketches he can modify them. Not all designers have good vision and therefore most of them cannot foresee the end-product and the final product may prove a ruin.

Today there are software's which can enable designer to design the 3-D image of the product on computer screen and see the pros and cons of his idea. This technology is being used by so many fields because of its huge scope and benefits. The designer can design the whole dress with prints, colours, trims, accessories and embellishments on computer to look for any flaws in it. Machines which cut, sew, grade and mark fabrics can be interfaced with computer to work efficiently. The time taken to finish each of these tasks is reduced in this way and even less labour

is required because a single person can handle these machines; whereby in manual methods large number of labour is required to cut, sew or grade fabric.

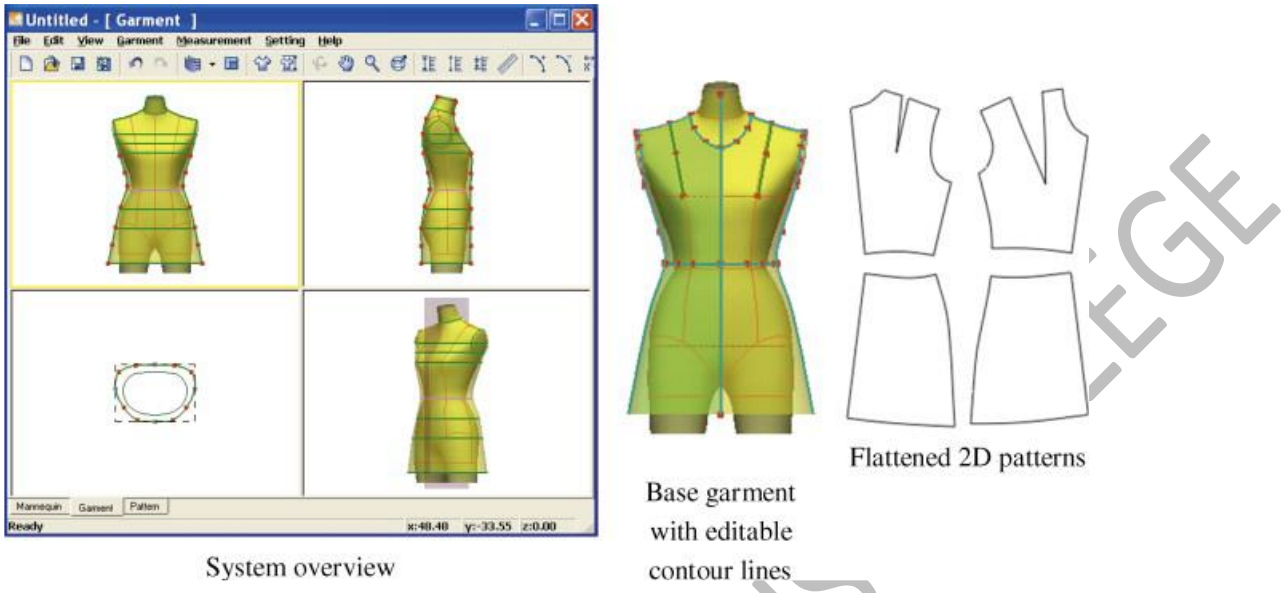


Fig: Visualizing the designs

4. Designing promotion resources

The designer might promote his product himself or he may hire a promotional company for this purpose. There are so many ways in which he can promote the product and get publicity too. He can design billboards, invitation cards for the fashion show, dress tags, carry bags, advertisement for print and electronic media, pamphlets, brochures, catalogues, and posters etc. There are various CAD software's which can easily support designing such promotional items and contain many interactive tools too. Designing graphics in CAD is easier than in manual method.

Essential Fashion designing Software

Nowadays, fashion design software has been adopted by different designing companies to design their product efficiently and beautifully. Selecting right fashion design software is essential to guide you from the initial step to the final production.

- It helps you to generate beautiful patterns, unique and beautiful sketches and patterns.
- It saves a lot of a time, money and energy
- Being a designer what you can do easily with this software is to select your old designs and give a new touch to the whole pattern by using the advanced modules. However, you will have to include your own innovative ideas to personalize your design.
- The software packages help the designer in experimenting with a number of textures, colours and patterns for producing the perfect design.

- Designs can be made faster and more accurately. There are a number of basic designs incorporated in the software, which the designer can make use of. Even 2D and 3D formats of a design can be created. These designs can be printed or sent to others through e-mail.
- Software helps the designer in creating a number of patterns and also in the repetition of patterns. They also help the designer in selecting the right texture for the garment. The designer can choose the right colour for the garment from the various colours available and can even customize them. It helps in the easy management of production.

The efficiency and productivity of the designer increases with the use of designing software. There are various fashion design software packages available in the market today, such as Adobe Photoshop, Adobe Illustrator and CorelDraw Adobe Illustrator and Adobe Photoshop are two of the most commonly used CAD (Computer Aided Design) software programs in the fashion industry due to their versatility and affordability. When used in combination with one another, these two programs provide just about all the tools an apparel designer needs to draw fashion design sketches, technical flat sketches, CAD presentations (rendered flat sketches), create and modify textile designs, repeats and colour ways, design embroidery, graphic artwork, and more

1. Adobe Illustrator

Adobe Illustrator is a vector-based program, which means that artwork can be scaled and printed at any size and resolution while maintaining full detail and clarity. This aspect makes the program ideal for producing fashion flat sketches, CAD sketch presentations, fashion illustrations and other images that are commonly resized and rearranged for various presentation purposes.

2. Adobe Photoshop

When combined with Illustrator, Adobe Photoshop adds to the versatility of your fashion design projects, allowing you to work with various bitmap images as well as imported Illustrator images. You can easily perform colour changes in fabric textures such as denim, twill, or sweater stitches, and add realistic shadows and highlights to presentations without losing texture detail. Complex patterns can be scanned to make simple colour modifications, and more realistic plaid repeats and colour ways can be created from scratch. Fashion designers can create original graphic artwork either through freehand drawing, or by applying various techniques like water colour, airbrushing, charcoal and other artistic effects to existing images.

3. Corel Draw

This software is a primary tool for fashion designers. Using CorelDraw, you can learn to design Fashion Illustrations from a scratch. This software is also used by graphic designers, illustrators and other design professionals across India. Knowledge in Corel Draw is a mandate for Fashion design professionals. A good understanding of the software will help you to translate all your ideas into great looking designs

Computerized Weaving

Implementation of Cad in Weaving

Today every coming generation is more fashion conscious so there is huge demand for new weave designs. With these conditions designers have difficulty in keeping pace with the fast changing trends of the market. Sometimes they find that they are not ready to cater the market needs. It is not easy to them to remain competitive, by merely depending upon the traditional way of designing, because today's design becomes out of fashion tomorrow. Hence they lose a share of market, so to keeping pace with fast shifting trends of market computer aided designing and manufacturing is very much required. "Creativity is one percent inspiration and ninety-nine per cent perspiration." but computers have confirm it wrong. They have made textile designing simpler, faster, more precise and enjoyable. The designer can create his motifs with a mouse or pen. Once the design is created, further process of editing the design i.e. clipping of certain parts, adding new shapes, changing the shapes, distortion, resizing, recolouration, colour reduction, replicating and combining as per the need can be done at the minimum possible time. Also, one part of design can be altered without affecting the rest. Various complicated weaves can be made easily, one need not to worry about the complicated drafting and peg plans, and the effect of supposed weave can be seen immediately before actual production. Computerized weaving uses computer-controlled looms and software to automate the design and production of textiles, enabling the creation of intricate patterns, 3D shapes, and technical fabrics with high efficiency and precision. This technology is a cornerstone of modern textile manufacturing and was historically a precursor to modern computing.

Key Aspects of Computerized Weaving

Design Software: Specialized software allows designers to create patterns and fabric simulations digitally. This software generates machine code (like W-code) or digital instructions for the loom's operation, replacing manual processes and physical punched cards. Tools like DigiBunai™ are open-source examples that support handloom and power loom techniques.

- **Automated Looms:** Modern looms integrate microprocessors to control and optimize various functions, such as warp let-off, cloth take-up, and weft insertion (e.g., air-jet, water-jet, or rapier systems).
- **Jacquard Mechanism:** The computerized Jacquard head is a crucial component that allows individual control over thousands of warp threads, making complex and large-scale patterns possible without physical pattern cards. This mechanism was an early form of binary control that inspired the development of computing.
- **Precision and Efficiency:** Automation provides higher accuracy and stability, reduces labor costs, and shortens the time required for design changes and setup, allowing for smaller, customized production runs.

- **Advanced Applications:** Beyond flat fabrics, computer-controlled systems are being developed for niche applications such as weaving 3D freeform surfaces (e.g., for aerospace, biomedical, and e-textile uses) and incorporating non-traditional materials like conductive threads and optical fibers.

  Computerized weaving enables greater design flexibility and the production of diverse, high-quality textile products efficiently.

  The working procedures for computerized weaving involve both a preparatory phase and the automated operation of the loom itself. The process relies heavily on computer-aided design (CAD) and microprocessors for control and optimization.

Preparatory Procedures

Before the actual weaving can begin, the yarn must be prepared and the design transferred to the loom:

1. **Yarn Preparation (Winding and Warping):** The raw yarn is wound onto appropriate packages (cones or beams) to ensure uniform tension and remove any faults. The lengthwise warp threads are specifically arranged and wound onto a large warp beam.
2. **Sizing:** Warp yarns are often treated with a sizing agent to increase their strength and resistance to abrasion during the weaving process.
3. **Drawing-In:** Each individual warp thread is drawn through drop wires (which stop the machine if a thread breaks), heddles (wires within a frame that raise or lower the thread), and dents in the reed (a comb-like device that spaces the threads and pushes the weft). This process can be automated by specialized computer-controlled machines.

Design and Programming:

- The desired fabric pattern and structure (weave type, color sequences, etc.) are created using Computer-Aided Design (CAD) software.
- This software generates a digital file containing machine instructions (e.g., for the Jacquard mechanism or heald frames).
- This data is transferred to the loom's integrated microprocessor control system, often via a network or data storage device

Loom Operation Procedures (Primary and Secondary Motions)

Once the loom is set up, the automated weaving process follows a sequence of continuous, synchronized motions controlled by the computer:

1. Shedding: The computer-controlled shedding mechanism (e.g., a Jacquard head or a series of heald frames) raises or lowers specific warp threads according to the programmed pattern data, creating a temporary vertical space called the "shed".

2. Picking (Weft Insertion): The weft yarn is inserted horizontally through the open shed by a carrier device (shuttle, rapier, or air-jet, depending on the loom type). The computer system ensures the correct weft yarn (e.g., a specific color) is selected and inserted at the right time.

3. Beating-Up: The reed, controlled by the loom's mechanism, automatically pushes (beats-up) the newly inserted weft yarn firmly against the already woven fabric (the "fell of the cloth") to achieve the required fabric density.

4. Take-Up and Let-Off (Secondary Motions):

Take-up: The woven fabric is constantly and uniformly wound onto the cloth beam, controlled by a motor to maintain the correct pick density.

Let-off: Simultaneously, the warp yarns are consistently and gradually released from the warp beam at a uniform tension, which is monitored and adjusted by sensors and servo motors to prevent breakage.

Monitoring and Quality Control

Throughout the process, microprocessors continuously monitor various parameters and auxiliary motions:

- **Stop Motions:** Sensors detect issues such as broken warp or weft threads, automatically stopping the loom to allow the operator (weaver) to correct the fault.
- **Data Analysis:** The control system provides data on production efficiency, defect occurrence, and maintenance alarms, allowing for optimal control of the manufacturing process.

Creating Weave Design in Photoshop

Step 1: Open Photo Shop and open a copy of the digital graph paper and a copy of your design image

Fig: Open and copy the design image

Step 2: Using the Lasso Tool select the design image and then using the Edit menu Copy & Paste the image onto the Graph Paper.

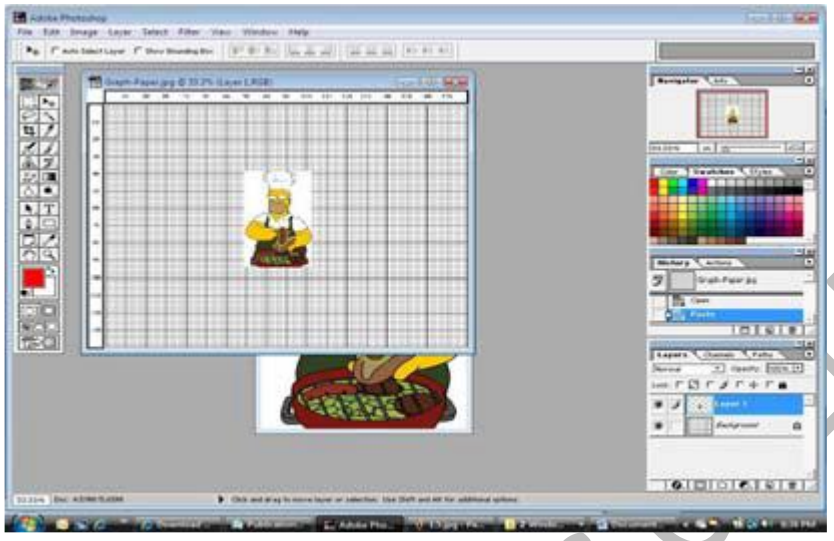


Fig: Copies the image onto the graph paper

Step 3: With the image pasted use the move tool to position the design image

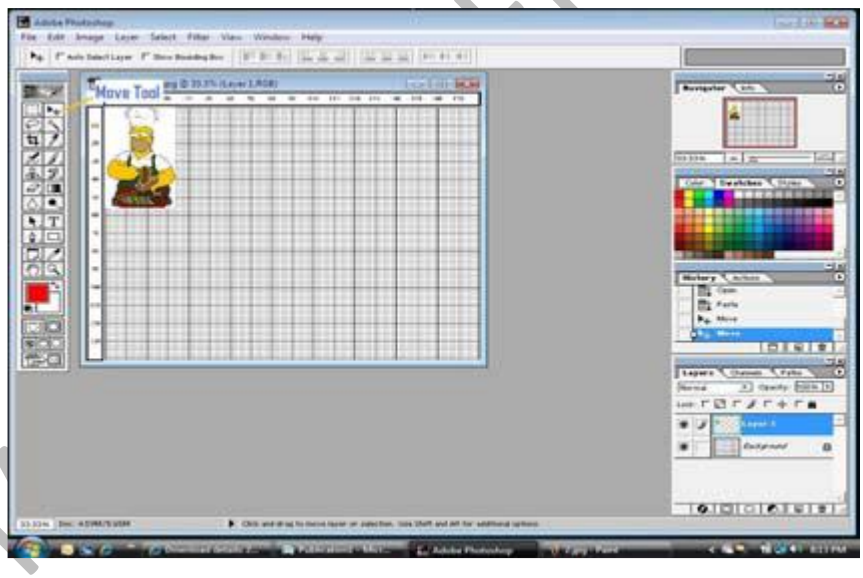


Fig: positioning the design image

Step 4: Next using the Magic Eraser Tool adjust the transparency of the design image to reveal the Graph Paper below.

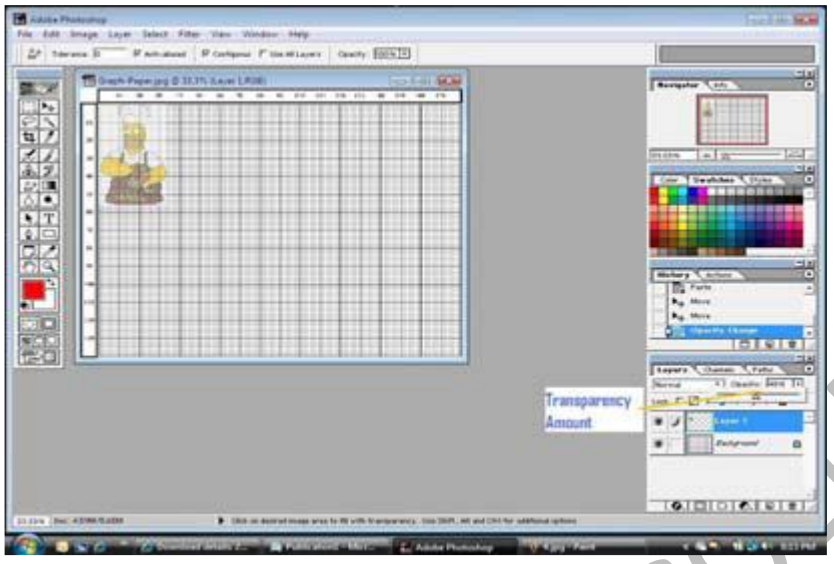


Fig: Revealing the graph paper

Finally save your composite image as a JPEG file.

Computerized Knitting

Computerized knitting uses specialized machines with computerized controls to automate the knitting process, allowing for precise control over stitch patterns, tension, and shaping to create complex, high-quality garments efficiently. This technology streamlines production by enabling digital pattern uploads and minimizing manual intervention.

Key Features & Benefits

- **Automation and Speed:** Computerized machines can operate for long periods with minimal human oversight, significantly increasing production speed compared to manual methods. This automation reduces labour costs and helps meet high demand.
- **Precision and Consistency:** The computer control ensures high accuracy and uniform quality in fabric production, minimizing human errors and material waste.
- **Design Flexibility:** Dedicated design software allows users to create or import complex patterns, textures, and jacquard designs with ease, which would be difficult or impossible to achieve manually.
- **Seamless & Fully-Fashioned Knitting:** Advanced computerized machines can produce complete, finished garments in one piece (known as whole-garment or fully-fashioned knitting), eliminating the need for post-knitting cutting and sewing processes, which saves time and material.
- **Variety of Products:** These machines can knit a wide range of items, including sweaters, collars, cuffs, socks, sportswear, and technical textiles using various yarn types, from fine threads to heavy-weight options.

Types of Computerized Knitting Machines

Computerized knitting machines are primarily categorized based on their needle bed configuration and knitting style:

- **Computerized Flat Knitting Machines:** These machines use two opposing flat needle beds (V-beds) that move back and forth. They are highly versatile, capable of shaping panels, performing intricate stitch transfers (like cables and intarsia), and knitting whole garments.
- **Computerized Circular Knitting Machines:** These machines have needles arranged in a cylinder to produce a continuous tube of fabric. They are known for high-speed production and are commonly used for items like socks, tights, and seamless body wear.
- **Computerized Warp Knitting Machines:** Unlike weft knitting where a single yarn makes a row of loops, warp knitting uses multiple yarns in a zigzag pattern along the fabric length. These are typically industrial machines (like Tricot and Raschel) used for fabrics requiring specific properties like run resistance

Notable Manufacturers

Leading manufacturers of industrial and home computerized knitting machines include:

- **Shima Seiki:** A major developer of WHOLEGARMENT 3D knitting machines and associated design systems.
- **STOLL (Karl Mayer Group):** Known for producing high-end computerized flat knitting machines.
- **Mastana Mechanical Works/Mastana International Private Limited:** Manufacturers of a wide range of computerized and semi-computerized flat knitting machines in India.
- **Bagga Engineering Works:** Offers various computerized flat knitting machines for applications like school uniforms and sweaters.

Working Procedures

The working procedure of a computerized knitting machine involves a seamless flow from digital design to automated production, primarily managed by integrated CAD/CAM systems.

Pre-Production: Design and Programming

1. **Pattern Creation/Import:** The desired garment or fabric pattern is created using specialized Computer-Aided Design (CAD) software. This software allows designers to specify complex stitch patterns (e.g., jacquard, intarsia), colors, textures, and even 3D shaping data.
2. **Programming (CAM):** The design data is converted into machine-readable instructions (a knitting program) for the Computer-Aided Manufacturing (CAM) system. This program

contains precise commands for every needle action, yarn feed, tension adjustment, and carriage movement.

3. **Data Transfer:** The program is transferred to the knitting machine's central control unit, typically via USB or a network connection.

Production: Automated Knitting Cycle

Once the machine is set up with the correct yarn types and colors, the automated process begins:

1. **Yarn Feeding and Tension Control:** Yarn is fed from cones on a creel, passed through a series of tensioners and guides to ensure consistent tension, and then directed to the yarn carriers/feeders near the needles. Sensors monitor the yarn for knots or breakages and will stop the machine if an issue is detected.
2. **Needle Manipulation (Carriage Movement):** The machine's carriage, containing the cam systems, moves back and forth across the needle bed(s).

   Cams physically interact with the butts of the needles, raising and lowering them through specific paths (tricks) according to the programmed pattern.

   For computerized machines, individual needles can be selected (or deactivated) by the computer at any point to create intricate patterns or shaping.
3. **Loop Formation:** As each needle is raised (clearing the old loop) and then lowered again, the yarn carrier places a new strand of yarn into its hook. The old loop slides over the closed latch and off the needle, and the new yarn is pulled through to form a new loop (stitch formation).
4. **Fabric Take-Down:** As new rows (courses) are formed, a take-down mechanism (usually rollers or weights) gently and consistently pulls the developing fabric downwards. This tension is critical for uniform stitch quality and prevents the fabric from bunching up.
5. **Shaping/Fashioning (Flat Knitting):** For shaped garments, the machine automatically performs operations like narrowing (decreasing active needles) or widening (adding needles) by transferring loops between needle beds or racking (shifting needle beds laterally). This creates panels to the exact shape, minimizing waste.
6. **Continuous Monitoring:** Sensors throughout the machine monitor the process for yarn breaks, needle collisions, or other errors, stopping the operation immediately if a fault occurs.

Post-Production: Finishing

Once the knitting program is complete, the fabric panel or complete garment is removed from the machine.

- **Fully-fashioned or Whole Garment products** require minimal post-production work, possibly just labelling or sewing a few loose ends.

- **Cut-and-sew panels** are sent for traditional cutting and sewing processes to assemble the final product.

Computerized Printing

Computerized printing, also known as digital printing, is a modern printing method that reproduces digital-based images directly onto various media substrates without using traditional printing plates. This technology offers key advantages like fast turnaround, cost-effectiveness for short runs, and high customization options.

How Computerized Printing Works

The process starts with a digital file, such as a PDF or JPEG, created on a computer using design software. This file is then sent directly to the printer, where a Raster Image Processor (RIP) translates the data into instructions the machine understands for applying ink or toner onto the desired surface.

The general process flow is as follows:

1. **File Preparation:** The image or design is created/edited on a computer and saved in a high-resolution digital format (e.g., PDF, TIFF).
2. **Data Transfer:** The digital file is sent to the printer, often via USB, Wi-Fi, or network connection.
3. **Processing (RIP):** The printer's internal processor (RIP) converts the digital file into a bitmap format, ensuring accurate color and layout reproduction.
4. **Printing:** The printer applies ink or toner to the substrate (paper, fabric, plastic, etc.) according to the digital instructions.
5. **Finishing:** The printed material may undergo post-processing steps like heating, cutting, binding, or laminating to ensure durability and the desired finish.

Types of Computerized Printing Technologies

Different types of printers use various technologies for specific applications:

- **Inkjet Printing:** Tiny droplets of liquid ink are sprayed directly onto the material to create detailed, high-resolution color images. It is versatile for printing on various materials like paper, canvas, and certain fabrics, making it popular for home use and fine art prints.
- **Laser Printing:** A laser beam creates an electrostatic image on a photosensitive drum, which then attracts powdered toner particles. The toner is fused to the paper using heat and pressure, resulting in fast speeds and sharp, precise text documents, ideal for office and high-volume use.

- **Dye-Sublimation Printing:** This method uses heat to transfer dye into synthetic fabrics or coated surfaces, resulting in vibrant, permanent, fade-resistant images, often used for custom apparel and merchandise.
- **3D Printing:** A specialized method that creates three-dimensional objects layer by layer from a digital file, using materials like plastic or resin. It is primarily used for prototyping and creating custom objects.

Advantages

- **Fast Turnaround:** Minimal setup time compared to traditional methods like offset printing, allowing for quick results.
- **Cost-Effective for Short Runs:** Eliminates the need for expensive printing plates, making small to medium print jobs more economical.
- **Customization:** Designs and data can be easily modified for each printed piece (variable data printing), enabling mass personalization.
- **Reduced Waste:** On-demand printing minimizes overproduction and material waste, making it a more environmentally friendly option.
- **High Quality:** Modern digital printing can produce sharp text and vibrant images, with quality continuously improving to rival traditional methods.

Computer application in Embroidery

Computer application in embroidery, also known as machine or computerized embroidery, involves using specialized hardware and software to automate the stitching of intricate designs onto fabric. This process offers speed, precision, and durability compared to hand embroidery.

Key Components

Embroidery Software (CAD): This is the core application where designs are created, edited, and converted into a digital format the machine can read (digitizing). Functions include:

Design Creation: Drawing from scratch or importing existing images (vector or raster).

Stitch Type and Density: Defining the type of stitches (running, satin, fill/tatami) and their density to achieve desired visual effects.

Color Management: Selecting thread colors and defining the stitching order.

Editing & Customization: Resizing, rotating, adding lettering, merging elements, and applying special effects (appliqué, sequins, cording).

File Formats: Saving the final design in machine-specific formats (e.g., .pes, .jef, .dst, .exp).

Computerized Embroidery Machine (CAM):

The machine that executes the digital design. Key features include:

Computer Control: The machine's movements are precisely guided by the computer program.

Hooping System: A frame or hoop holds the fabric taut and moves automatically beneath the needle(s).

Multiple Needles: Industrial machines often have multiple needles to accommodate various thread colors without manual rethreading for each color change.

Sensors: Electronic sensors can detect thread breaks or finishes, automatically stopping the machine.

Process Flow

The typical workflow involves several steps:

- Design Creation/Digitizing: The design is created or imported using specialized software, and stitches are mapped out.
- Design Transfer: The digital file is transferred from the computer to the embroidery machine (usually via USB drive or direct connection).
- Machine Setup: The fabric is secured in the appropriate hoop, and the machine is threaded with the correct colors and needle types.
- Embroidery: The machine automatically stitches the design, with an operator monitoring progress and quality.
- Finishing: The fabric is removed from the hoop, excess threads are trimmed, and any backing stabilizer material is removed.

TYPES OF COMPUTERIZED EMBROIDERY MACHINES

Computerized embroidery machines are primarily categorized by their intended use (home/domestic vs. commercial/industrial) and their mechanical design (single-head vs. multi-head or single-needle vs. multi-needle).

Based on Usage

Home/Domestic Machines: These are compact, user-friendly, and often combine regular sewing with embroidery functions. They are ideal for hobbyists, beginners, and small personal projects.

Examples:

Singer SE9185 Computerized Embroidery Sewing Machine,

Brother Innov-is NV880E Embroidery Machine

Commercial/Industrial Machines: Built for high-volume, continuous production, these machines are heavy-duty and focus on speed and efficiency. They are designed for large businesses, factories, and specialized production.

Examples:

Brother PR1055X Entrepreneur Pro X Single Head 10 Needle Computer Embroidery Machine,

Fully Automatic Industrial Multi Needle 4 Heads Embroidery Machine.

Based on Mechanical Design

Single-Head Machines: These machines have one embroidering head. Most home-use machines are single-head, and commercial models are also available for small businesses.

Single-Needle: Requires manual thread changes for each color in a design, suitable for simpler, one-off projects.

Multi-Needle (e.g., 6, 10, or 15 needles): Each needle holds a different color thread, automating color changes and increasing efficiency without the physical size of a multi-head machine.

Multi-Head Machines: These industrial machines have multiple heads (e.g., 2, 4, 6, 12, or more) that simultaneously stitch the same design onto multiple items, drastically increasing production volume. They are best for large, repeating orders.

Specialized Types

Cap Embroidery Machines: Feature curved frames and attachments specifically designed for embroidering on contoured surfaces like hats and caps.

Specialty Stitch Machines: Some commercial machines are specialized for unique effects, such as:

Sequin Embroidery Machines: Add sequin embellishments to designs.

Chenille Embroidery Machines: Create thick, textured, loop-pile designs.

Cording/Aari Embroidery Machines: Used for creating designs with cords or yarn.

Mixed Embroidery Machines: Combine several of these specialty functions (e.g., flat, sequin, and cording embroidery) into one machine.

Applications

Computerized embroidery is widely used across various industries:

- Apparel Industry: Adding logos to workwear (uniforms, caps, aprons), creating decorative elements on fashion garments, and producing personalized items like T-shirts and hoodies.
- Home Goods: Decorating bed sheets, towels, and cushion covers.

- Specialty Items: Creating patches, emblems, and items with special effects like appliqué, cording, or sequin work.

Benefits

- Speed and Efficiency: Significantly faster than hand embroidery, ideal for mass production and bulk orders.
- Precision and Quality: Ensures high accuracy and flawless replication of complex designs.
- Durability: Machine-made stitches are robust and resistant to frequent washing.
- Versatility: Capable of working with a wide range of fabrics and design complexities.

EMBROIDERY STITCH TYPES USED

Computerized machines create various stitch types:

1. Running Stitch

For outlines and detailing.

2. Satin Stitch

For borders, monograms, lettering.

3. Fill Stitch (Tatami/Stipple)

For large filled areas.

4. Zig-Zag Stitch

Used in decorative applications.

5. Specialty Stitches

Motif stitch

Cross stitch

Chenille loops

Sequin attachment stitches

Garment Designing with 2D & 3D Forms

1. Introduction

Garment designing combines artistic creativity with technical skills to develop clothing. Modern design processes use both 2D methods (flat patterns, sketches) and 3D methods (draping, digital modeling) to create accurate, well-fitting garments. Garment design uses both 2D and 3D forms in an integrated workflow. 2D patterns serve as the precise manufacturing blueprints, while 3D

technology enables virtual prototyping, fit testing, and realistic visualization on digital avatars before any physical samples are made.

The Garment Design Process: 2D & 3D Integration

The modern design process typically involves a combination of both 2D and 3D methods, often facilitated by Computer-Aided Design (CAD) software.

Traditional 2D Pattern Making

- Foundation: This method uses flat patterns (paper or digital 2D templates) for each segment of the garment (e.g., bodice, sleeve, collar).
- Process: A pattern maker creates a precise, annotated blueprint that dictates how fabric pieces are cut and assembled. This requires significant technical skill and experience to account for how a flat shape will translate to a three-dimensional body.
- Output: The final result is a production-ready 2D pattern used for manufacturing.

Modern 3D Garment Design

- Foundation: This approach involves creating digital clothing models directly on a 3D human model (avatar) in a virtual environment.
- Process: Designers can start with 2D patterns and "stitch" them together virtually on the avatar, or even design the 3D surface first and then flatten it into 2D patterns.

Benefits:

- Visualization: Provides a 360-degree view of the garment, including how different fabrics will drape and move.
- Fit Analysis: Software uses physics engines and "strain maps" to highlight areas of tension or poor fit, allowing for digital adjustments before physical sampling.
- Efficiency: Reduces the need for multiple physical prototypes, saving time, cost, and material waste.
- Output: Hyper-realistic 3D renderings for presentations or marketing, and data that can be converted back into optimized 2D patterns for production.

Key Software Tools

Specialized software helps bridge the gap between 2D and 3D forms:

- CLO 3D & Marvellous Designer: Industry favourites known for their realistic fabric simulation and intuitive 2D pattern-to-3D conversion.
- Browzwear (Lotta & VStitcher): A comprehensive solution for designers and pattern makers, offering robust modules for design and production.

- Blender: A powerful, free, open-source option with plugins available for fashion design.
- By integrating both 2D and 3D methods, designers can streamline their workflow, enhance creativity, and improve the final product's fit and quality.

UNIT - III

BODY MEASUREMENTS, PATTERN MAKING AND GRADING

3D Body Scanning System

1. Introduction

3D body scanning was introduced almost 30 years ago and was firstly introduced in the movie industry in the film Terminator 2 in 1991 when only computer graphics was not acceptable and there was a need for reality. It has started exploring its way in many industries like medical, military, textile, aeronautics, and many more.

In the apparel and clothing industry, in the beginning it was only introduced for military purposes and mostly for ergonomics. But after carrying out various experiments it was used in various retail shops, boutiques, etc.

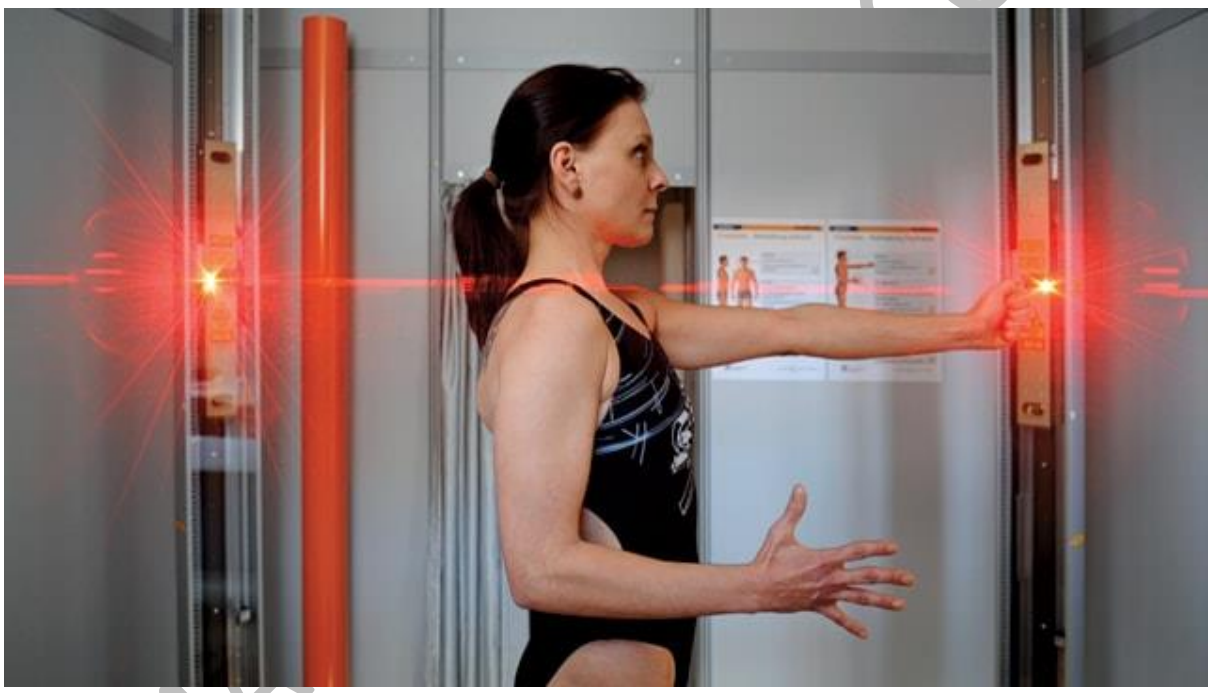


Fig: 3D body scanning by passing laser stripes

First 3D body scanner system for apparel was bought by the University of Loughborough (UK) in 1989. Since people differing from various geographical regions vary in body shape and proper fit of the garment with its valuable aesthetics is only accepted by customers. Therefore, many complications related to garment sizing including poor fit inconvenience were solved using 3D technology. And that is why well fitted garments came into demand. Hence 3D body scanning in apparel is considered as a 'Significant bridge' between Craftsmanship and CAD Technology-(Phoebe R. Apeagyei). In this article I will discuss on 3D body design and visualization in apparel industry.

Development of 3D Body Scanning Technology

In the apparel industry, fit is given utmost importance. And this was recognized when a team of astronauts had to cancel their spacewalk planned by NASA as a woman could not find a perfect fit spacesuit. Hence, change in movements of body especially during special missions in spacesuits, military clothing, sportswear and firefighter clothing have extreme postures and fit matters a lot in this condition. Because of this, it is a sole job of designer to also add movement data into patterns while designing performance garments. And that is why measurements are considered as fundamentals for clothing producers as well as buyers.

- **First 3D Scanner:** The earliest scanner was developed by CAESAR (Civilian American &European Surface Anthropometry Research Project). It was a very complex scanner weighing about 450kg and costing around US$350,000. This scanner is considered as complex as it took various scans for lighting scheme, coloring scheme, landmark detection scheme, and many more and it took about a week to collaborate all the scans together and get the final scan.

- **Portable Scanner:** Somewhere around 2000 a German based company ViaLux Germany produced Body Lux Scanner which was portable and comparatively cheaper. It is a combination of Micro mirror projection and phase encoded photography. And one of the major advantages over complex scanners was it almost took 50 sec to give the final output scans and also doesn't require special clothing. And also it was beneficial as it only weighs somewhere around 35kg and costs upto US$22,000. Also, it helped in calculations related to tailoring.

- **Further Development:** Further development in 3D body scanner was brought up by Artec3D, Luxembourg which developed the scanner ArtecEva in 2017 which weighed less than 1 kg and costing was around US$20,000 and are called as handheld scanners. With Booth type (static) scanners, sometimes it was difficult to measure parts especially for pressure garments. So it helped in measuring different body parts for Pressure garments. But these types of scanners are still new in the market.

Major disadvantage of both booth types as well as handheld scanners is that they require professionals and scanning is carried out at certain controlled conditions. So one of the company called MirrorSize (Mirrorsize.com) has a free download app which gives a 3D avatar in seconds and it can be used for virtual try-on. Hence, there are lot of low cost consumer devices like webcams, mobile phones which can be used to scan the body and create 3D avatar of yourself.

Now further attempts have been made to scan the body without using scanning devices. In one of the recent research papers by Molyboga and Makeev (2018) , they tried using 2D content of a human body from a single image of clothed persons. After applying filters and detectors to selected body parts of 2D contours, the 3D model is subsequently generated and gives out the measurements.

Textile manufacturing guide

To conclude this various attempts beginning from the heavy body scanners we have reached to scanning without scanning devices with the help of technology advancement. With complex and costly measurement technology consuming a lot of time is now being simple such that it can be handled by a particular individual and gives real time scans. But this technology is only used for performance garments and hence the future of this scanning can be targeted to online and offline retail operations and give a good service to customers.

Types of 3D Body Scanning: 3D body scanning can be carried out in basic three ways:

1. Light based System
2. Laser based System
3. Microwave based System

1. Light Based System - Light based system are further divided as

- Industrial storage solutions
- Shadow Scanning
- White Light Scanning System
- Light Emitting Diodes

a) Shadow Scanning System-

Companies- LASS (Loughborough Anthropometric Shadow Scanning), SYMCAD by Telemat. Advantage of using the Shadow scanning system is that there is no effect due to skin color as shadow is scanned. And it only requires a Camera, desk-lamp, pencil and a board with a grid. There is a screen faced by a camera illuminated by a halogen desk lamp. It can be turned 360°and also has an automated computerized 3D measurement system based on a triangulation system.

b) White Light Scanning System

Companies– Textile/Clothing Technology Corporation (TC^2), Wicks and Wilson Limited.

White light scanning system uses PMP (Phase Measuring Projection) technique. It has CCD which is linked to computer which detects body and deformed light strip is formed. An output is given from each view and has to be collaborated together to get the final output. Each view is combined with the exact view of another for exact orientation while collaborating. Final output is generated after processing it with filtering, smoothing, compressing, etc. One of the disadvantages is that it doesn't provide colour information but it is quite faster than shadow scanning.

c) Light Emitting Diodes

Companies– Hamamatsu

In this process, light is reflected from one object and collected in a detector lens. It uses InfraRed Light Emitting Diodes to obtain data. It gives the widest dispersion of the measurement values and thus larger circumference measurements can also be produced using the method.

2. Laser Based System

Companies– CyberWare, Human Solution, Vitronic, etc.

In this system various scan heads are placed and there is projection of laser lights on the body. And these projections are reflected into cameras located in scan heads. One of the advantages of this system is that it gives colour coded landmarks for data extraction by using RGB colour values. It is also called as Non-contact optical laser scanning system. It is highly versatile and manufactured as a portable tool for accurate scientific application. Among all of the above companies, Vitrus by Vitronic was the most advanced which automatically calculated body dimensions.

3. Microwave Based Study

Companies– Intellifit

It was developed by Pacific Northwest National Lab for the US Department of Energy for various materials and it was also tried for apparel and was found out to be successful. It rotates in 360° and gives the final output in less than 10 seconds and results in a high resolution 3D image and hence considered as one of the advanced systems from all of the above.

Advantages of 3D Body Scanning Technology

- Speed– Scanning is much faster than that of the traditional measurement tapes.
- Accurate– As there is a reduction in many body movements, there are less chances of error and hence more accurate than that of traditional one.
- Ease to tailor– Tailor can easily extract any measurement as there are infinite no. of measurements available and at any time.
- Ease to consumer– In future, it will be very easy for consumers to produce custom-fit garments once they have all their measurements after scanning.

Disadvantages of 3D Body Scanning Technology

- Obstruction– Hair can obstruct the measurements of neck and shoulder. And different reflection can be produced due to difference in hair color.
- Effect due to apparels– Reflections may vary due to apparels' fold. Light scanning technology and laser based systems have effects due to apparels. Loose garments may

produce large measurements and too tight garments may produce shorter measurements than they are. But this is not a disadvantage in Microwave system. There is no effect due to apparel in such systems.

- Invisibility of parts– Many parts are not visible by vision devices such as top of the shoulder, top of neck, crotch, etc.
- Cost– More sophisticated the system, the more cost is. Hence this system are more costly than manual measurements system
- This system requires physical landmarks or pre-marked landmarks.

Made-to-Measure Clothing (MTM)

In recent years, fashion has evolved dynamically, and Made-to-Measure has emerged as a game-changer. Unlike off-the-rack clothing, consumers find the idea of clothes specifically made for their fit and style appealing. Custom men's wear is made-to-order according to unique measurements and personalization in detailing, ensuring a perfect fit.

Every stylish man wants to look good in what they are wearing. However, comfort is a non-negotiable factor. The MTM clothing has become significant in reflecting a perfect fit and personality while maintaining the comfort level of the wearer. This article will explore the benefits of choosing made-to-measure garments for men.

What is Made-To-Measure Clothing (MTM)

Made-to-measure clothing involves the standardization and personalization of garments according to individual preferences. Every ready-to-wear garment starts with a base pattern. However, in MTM clothing, alternations and adjustments are done according to the customer's unique body fit.

Essentially, MTM starts with a ready-to-wear base pattern, which is then altered according to the client's measurements. In MTM, there is a base pattern and a salesperson or a tailor who operates the changes according to the limitations of the pre-programmed pattern software. Modifying the pattern results in quicker production and lower costs.

On the other hand, bespoke tailoring involves making a dress entirely from scratch, including design, detailing, fit, fabric, etc., according to the customer's choice.

Made-To-Measure Clothing Process

Measurement and Fitting

The secret to a well-dressed and stylish man is a perfect fit of his suit. When you wear clothes that are too big or too small for your body, you look unflattering. With detailed measurements and fitting sessions, clothes are tailored to fit your body perfectly. With precise measurements in the chest, waist, hips, sleeves, etc., you can achieve the desired fitting.

Customization

Once the measurements are taken, the next step is customization. This phase allows the client to personalize various aspects of the garment, including the choice of fabric, colors, patterns, and design details such as lapel style, pocket types, and button selections. The client's input in this stage ensures that the final product not only fits well but also reflects their personal style and preferences. Customization can also extend to the lining, stitching details, and even monogramming, adding a unique touch to the garment.

Adjustment and Production

After you customize all the details, the process is moved to the production stage. There is a set base pattern in which minor adjustments are made. The cutting, stitching, and assembly of the garment are done according to the base pattern. To ensure the highest level of fitting, fitting sessions take place before the final outcome.

Perfect Fit and Comfort

Precision Fit

One of the key advantages of made-to-measure (MTM) clothing is its precision fit. By taking exact measurements of an individual's body, MTM garments are made according to the wearer's unique shape and proportions of the customer. However, all the changes are made in the house style or the base pattern.

With multiple fits, common issues like baggy shoulders, too-tight waists, or overly long sleeves are eliminated. This precision fit not only enhances the garment's appearance but also boosts your confidence, knowing that you are dressed in clothing that complements your body perfectly.

Comfort and Mobility

With MTM clothing, you have the choice to choose fabric and get it stitched according to your exact measurements. The top-quality materials used feel comfortable against their skin and suit your lifestyle needs, such as breathable materials for warmer climates or more structured fabrics for formal occasions.

Hence, this clothing offers superior comfort and mobility. Whether it's a suit for a business meeting, a dress for an evening event, or casual wear for everyday use, MTM clothing ensures that the wearer can move freely and comfortably.

Personal Style and Customization

Wide Range of Options

One of the most attractive things about made-to-measure (MTM) clothes is the wide range of customization options. An individual can choose from a wide array of fabrics, colors, and patterns to produce a garment that matches their taste in fashion.

Thus, whether you are searching for a traditional woolen suit, a linen shirt perfect for hot summers, or an outstanding and unique design pattern, the choices are endless. This variety ensures that each garment is uniquely tailored according to the wearer's preferences.

Unique Details

You have total creative control over the design process from cloth to buttons to stitching, to lapels, to pockets and more. You can opt for a notched or peaked lapel or choose between various types of buttons, such as horn or metal. You can also decide on the number and style of pockets, like ticket pockets, flap pockets, or even custom embroidery. Additional detailing includes monogramming, lining patterns, stitching details, and cuff styles. These unique details add a personal touch to the garment, reflecting the wearer's individuality and taste.

However, keep in mind that made-to-measure is not bespoke. It is an advanced way of buying ready-to-wear with alterations in the base patterns. Some large-scaled brands like Ralph Lauren or Brooks Brothers only allow limited alterations and don't give too much power in the hands of salespeople to scale their business.

Quality Materials

The quality of materials used in made-to-measure (MTM) clothing is a standout factor that sets it apart from off-the-rack options. A person who is investing in a made-to-order suit will prioritize quality over everything. There are many premium fabrics like wool, silk, cotton and linen that make an amazing and comfortable piece of clothing and also contribute to its durability and comfort.

Craftsmanship

Made-to-measure is a category that depends upon the skills and knowledge of artisans. Craftsmanship is the most important factor that reflects the essence of MTM ensuring the highest standards of quality and fit with careful attention to detail.

Expert Tailoring

Since MTM is all about precise measurements and perfect fit. Experienced tailors play the most important role in achieving this goal of MTM. Their expertise ensures that the garment not only fits perfectly but also enhances the wearer's natural silhouette. Every cut, stitch, and seam is executed with precision, reflecting the tailor's skill and attention to detail.

Hand-Finished Details

Although MTM is not bespoke, it is totally handmade from scratch. However, MTM garments often feature hand-finished details that distinguish them from ready-to-wear options. Details like hand-sewn buttonholes, hand-stitched linings, and pressed seams reflect the craftsmanship and skill of the artisan.

Professional Appearance

Clothing that fits your body perfectly, representing your style, develops a sense of confidence in you. It gives you a polished and professional look, leaving a lasting impression on everyone who meets you.

Long-Term Value

Investing in made-to-measure (MTM) clothing offers significant long-term value that extends beyond the initial purchase. It offers

Durability

One of the primary advantages of MTM clothing is its durability. The use of premium fabrics and expert tailoring techniques results in garments that maintain their integrity and appearance over time, unlike mass-produced clothing, which may wear out or lose its shape quickly.

Timeless Style

MTM clothing is designed with timeless style in mind, ensuring that pieces remain fashionable, elegant and relevant, reducing the need for frequent replacements and contributing to their long-term value.

Cost-Effectiveness

While the initial cost of MTM clothing may be higher than off-the-rack options, the long-term cost-effectiveness is undeniable. This long-term perspective makes MTM clothing a wise investment, providing excellent value over time.

CAD in Pattern Making and Grading

Introduction

In the apparel industry, CAD systems are mainly used in various processes such as garment design, pattern preparation, pattern grading and marker making during the preproduction phase, which is labour-intensive. More accurate Patterns cause fewer manufacturing problems. Data generated from a pattern or marker can be communicated instantly to any department of a company, reducing time spent duplicating data for other functions.

Computerized Pattern making

Computers have been used by apparel companies since the early 1980's.Computer software programs are designed for both industrial and home use that can be used for patternmaking. CAD software can be purchased and loaded onto one's computer in order to help design new patterns or modify existing ones. Before the development of CAD software, manual patternmaking techniques involve series of tedious, time consuming steps, more skilled work force, large working and storing spaces and so on. To overcome these difficulties in the manual

method, computerized pattern making is quiet commonly used by all the large scale garment production industries.

Pattern Design Systems (PDS) have become invaluable tools to the patternmaker, assisting in much of the repetitive tasks associated with patternmaking. The process of constructing a pattern on the computer is similar to the traditional method of pattern construction, and it would probably take as much time on computer as it would manually.

Advantages

- All styles are stored on the hard drive, and can easily be retrieved and adapted to create a new style.
- By using pattern manipulation tool many design possibilities can be generated.
- Using mouse, patternmakers are able to add style details and make changes.
- It quickly and accurately builds patterns.
- The common functions such as splitting pieces or adding fullness can be reduced to simple, quick operations.
- Garment components such as linings and facings for production patterns can be generated easily from the main pattern.
- These programs allow the user to resize and alter patterns for a more custom fit or to modify patterns according to one's preference or need.
- The CAD will draw, adjust and calculate measurements for the pattern.

System Description

A CAD system for pattern making and grading typically consists of specialized software running on a computer workstation, often augmented by input and output hardware.

Key Components and Tools

- CAD Software: The core of the system, offering a range of modules for different tasks. Popular options include Gerber AccuMark, Lectra Modaris, Optitex, and Clo3D.
- Input Devices:
    - Keyboard and Mouse: For general system interaction.
    - Digitizer: A large electronic board and stylus used to trace and convert existing physical paper patterns into a digital, vector format.
    - 3D Scanners/Body Scanners: Advanced systems can use these to create accurate digital models (avatars) of a human body, which then serve as the basis for custom pattern generation.

- Output Devices:
  - Plotter: A large-format printer used to print full-size graded paper patterns or markers for manual cutting or verification.
  - Automated Cutting Machines: The digital patterns and markers can be sent directly to computer-aided manufacturing (CAM) systems for automated fabric cutting.
- Storage and Data Management: Digital patterns are stored in a library (often in the cloud or on a server) for easy retrieval, modification, and version control, eliminating the need for vast physical archives.

CAD in Pattern Making – Information Flow and Steps Involved

CAD in pattern making is a digital method used to develop garment patterns more quickly, accurately, and efficiently than manual processes. The information flow in CAD begins with the collection of inputs such as design sketches, technical drawings, measurement charts, and fabric details. These elements help the pattern maker understand the garment's style, silhouette, and fit requirements. The process starts with

Step 1: Input and Setup, where the designer enters all necessary data into the CAD system and selects or creates a basic block pattern.

Step 2: Pattern Digitization is done using a digitizer or camera to convert the patterns into accurate digital outlines.

Step 3: Pattern Drafting and Development, where the pattern maker uses CAD tools to draw, edit, and shape pattern pieces. Curves, darts, seam allowances, notches, and grainlines are added with high precision.

Step 4: Pattern Editing and Refinement, where adjustments are made to balance the pattern, ensure matching seams, and improve fit. In advanced CAD systems,

Step 5: 3D Fit Simulation may be used, allowing the digital garment to be tested on virtual mannequins to observe drape, tension, and comfort before making further corrections.

Step 6: Grading is performed to create a full size range from a single base pattern. CAD grading tools apply consistent rules to scale the pattern accurately across multiple sizes.

Step 7: Marker Making or Lay Planning, where the software arranges the pattern pieces efficiently on the fabric width to reduce wastage. This digital layout ensures optimal material consumption and follows fabric properties such as grain direction, nap, or prints.

Step 8: Output and Production Preparation completes the information flow. Patterns and markers are exported in digital formats or printed through plotters and can be sent directly to automated cutting machines for mass production.

Overall, CAD in pattern making enhances accuracy, speeds up the workflow, reduces material wastage, and ensures better communication from design to production. By combining structured steps with a smooth flow of information, CAD systems streamline the entire pattern-making process and improve the quality and efficiency of garment manufacturing.

Computerized Pattern Grading

Pattern Grading is the process whereby patterns of different sizes are produced from the original master pattern. This process can be performed manually or automatically by a computerized system. In order to produce garment that fits many body types and sizes, the pattern pieces must be increased or decreased geometrically to create a complete range of sizes. For example, the sample size 10 patterns must be made larger to accommodate sizes 12, 14 and 16 and smaller for sizes 8 and 6. Each company sets predetermined grade specifications, or rules. For example, a missy Manufacturer's grade rules might call for increments of one and a half inches in width and a quarter inch in length for each size. Computerized pattern grading is graphic data process applied to the grading of garment patterns. The data processing has three phases they are

1. Data collection
2. Data processing
3. Data presentation

1. Data collection

This is the input phase. The master pattern is inputted to the computer by digitizing or scanning. This is the process whereby each component is converted to an alpha numeric format. This information includes

- The range of sizes required
- The grading points of the pattern components
- The grade rule applied to these points
- The output form of the graded patterns

2. Data Processing

In this stage all the grading procedures are performed by the system. The results can be verified on a screen or by plotting them out on a miniature or full sized drawing. If necessary, alterations and modifications can be made at this before producing finished set of patterns

3. Data Presentation

The graded pattern data are presented to the output unit called plotter. It plots the graded components as individual or nested in full size or miniature scale.

System Requirement

- Central processing unit
- Disc drive
- Graphic display unit
- Digitizer
- Plotter
- Required software

A pattern may be graded with all sizes showing on the one sheet. This is called a "Nest" and finished pattern pieces will be taken from this at a later stage. For example the master pattern size 10 to make 8, 12, 14, and 16, without cutting out the previous size. Some of the commercial patterns are sold in this manner with sizes grouped together in a nest.

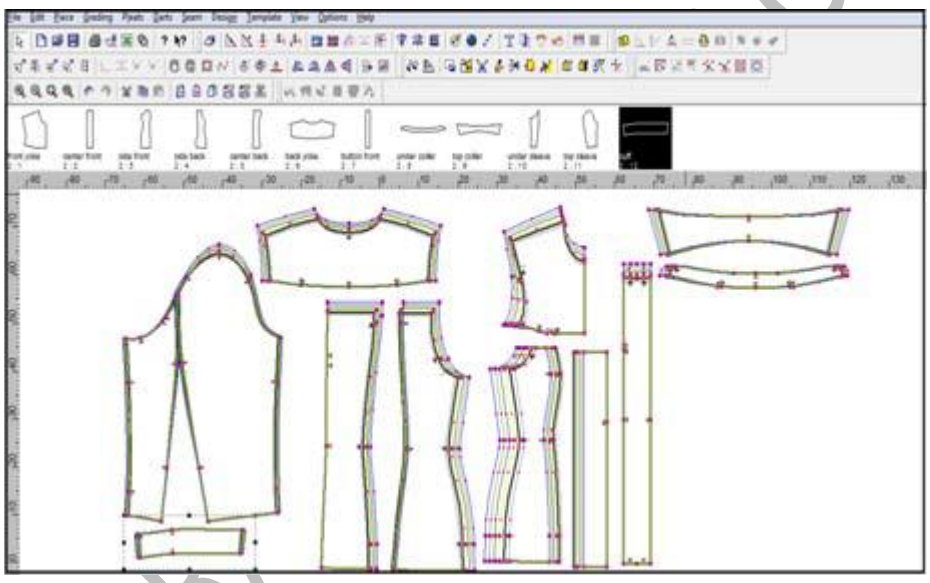


Figure: Pattern Grading

Another method of grading is grading one size at a time, the new pattern piece cut out and then used to make the next size etc. Before beginning to grade it is important to check the accuracy of the pattern, the amount of pieces and the pattern markings of the master pattern. Advances in technology made grading more efficient and quicker resulting in faster production. However, it is important that the operator of the computer must have the knowledge, skills and experience in both the principles and practices of Pattern Grading.

Steps Involved in CAD Pattern Grading

Step 1: Digitize the Master Pattern

- Scan or import the base pattern into the CAD system.

- Ensure all details (seams, darts, notches, style lines) are included.

Step 2: Define Grading Rules

- Enter size chart and grading increments (e.g., bust +2 cm, waist +1.5 cm, sleeve +1 cm).
- Specify rules for each garment part.

Step 3: Set Reference Points / Nodes

- Mark key points like shoulder, armhole, neckline, waistline, and hem.
- CAD software uses these to scale patterns proportionally.

Step 4: Automatic Grading

- Apply grading rules to generate new sizes.
- Software adjusts all lines, curves, and shapes according to increments.

Step 5: Review and Manual Adjustments

- Inspect the graded patterns for design accuracy and fit.
- Make corrections where automatic grading may distort curves or style lines.

Step 6: Finalize and Export

- Save graded patterns digitally.
- Export for plotting, printing, marker making, or integration into PLM systems.

Step 7: Optional 3D Simulation

- Some CAD software allows virtual fitting of graded sizes on a 3D avatar.
- Helps verify fit before cutting fabric.

UNIT - IV

COMPUTERS IN MANUFACTURING PROCESS

Computer Applications in Fabric Defect Checking

Introduction

Computer applications in fabric defect checking primarily involve automated visual inspection (AVI) systems that use computer vision, image processing, and deep learning (AI) techniques to identify and classify flaws in textiles, replacing traditional manual inspection which is prone to human error and fatigue. Fabric defect checking ensures the quality of textile products by detecting flaws that affect the aesthetics, durability, or usability of the fabric. Traditional manual inspection is slow, subjective, and inconsistent, whereas computer-based systems provide automation, accuracy, and efficiency.

Key Components of an Automated System

An automated fabric defect detection system generally consists of two main parts: an image acquisition system and an image processing system.

1. Image Acquisition System:

- Cameras: High-resolution line-scan cameras are commonly used for high-speed, continuous fabric production lines, while area-scan cameras are better for static or slow-moving fabrics.
- Lighting: A controlled and uniform lighting setup (e.g., fluorescent lights) is essential to ensure consistent image quality and minimize environmental interference like shadows.
- Hardware: This includes necessary hardware like frame grabbers, which transfer data from cameras to the computer without loss at high speeds, and edge devices (e.g., NVIDIA Jetson or DSP processors) for on-site processing.

2. Image Processing System:

- Computer/Processor: An industrial computer or embedded processor runs the detection algorithms.
- Software/Algorithms: Specialized software processes the captured images using various computer vision techniques to detect anomalies.

3. User Interface/Alert System: A monitoring dashboard and an alarm system (audible or visual) inform operators when a defect is detected, often including details like location and type.

Core Techniques and Methodologies

- Fabric defect detection methods are broadly categorized into several approaches:
- Statistical Methods: These methods analyze the statistical properties of texture, such as gray-level co-occurrence matrices (GLCM) or histograms, to differentiate between normal and defective areas.
- Spectral/Frequency Domain Methods: Techniques like Fourier transforms, wavelet transforms, and Gabor filters convert the image into the frequency domain to highlight repeating patterns. Defects disrupt these patterns and become more visible in the transformed image.
- Model-Based Methods: These approaches create a statistical or structural model of the defect-free fabric texture. Any deviation from the established model is flagged as a defect.
- Machine Learning and Deep Learning (AI) Approaches: Modern systems heavily rely on AI, particularly Convolutional Neural Networks (CNNs) and object detection models like the YOLO (You Only Look Once) series (YOLOv5, YOLOv8).
- Deep learning models can learn complex features directly from large datasets of labeled defective and non-defective images.
- They offer high accuracy and speed, even with varied or complex fabric patterns where traditional methods struggle.

Common Fabric Defects Detected

Computer vision systems are designed to detect a wide range of defects, including:

- Holes/Torn holes
- Broken ends/Broken picks
- Stains (oil, ink, rust)
- Yarn issues (slubs, thick/thin bars, missing yarn)
- Color issues (color bleeding, print mismatches)
- Structural flaws (snags, floats, creases, bad selvedge)

Advantages over Manual Inspection

Automated systems offer significant advantages over traditional human visual inspection:

- Increased Accuracy: Systems achieve high detection rates (up to 99.1% accuracy in some studies) and do not suffer from fatigue or subjective judgment, which limit human accuracy to about 60-75%.

- Real-time Operation: Automated systems can inspect fabric at high production speeds, ensuring timely quality control.
- Reduced Labour Costs: They significantly decrease the need for manual inspectors, allowing quality control staff to focus on other tasks.
- Data Analysis: Detected defects are logged in a database (e.g., CSV files) for traceability and statistical analysis, aiding in process improvement.

In essence, computer applications are transforming fabric defect checking by providing efficient, consistent, and highly accurate solutions that meet the demands of modern industrial manufacturing.

Marker Planning (Layout Planning)

Definition:

Computerized cutting marker planning involves using Computer-Aided Design (CAD) software to efficiently arrange pattern pieces on fabric to maximize material utilization and minimize waste. Key considerations include fabric type, grain orientation, and the combination of sizes to achieve high efficiency and accuracy. Marker planning is the process of arranging garment pattern pieces on fabric to minimize waste and ensure efficient use of material. Computers automate this process using CAD systems.

Popular Software:

- Gerber AccuMark
- Lectra Modaris & Diamino
- TUKAmark
- Optitex Marker

Key Principles and Considerations

- Fabric Characteristics: The software must account for fabric attributes such as width, symmetry (directional or non-directional fabrics like napped or piled fabrics), and design repeats (checks or stripes). Asymmetric or patterned fabrics require more complex planning and may result in lower efficiency if not handled correctly.
- Grain Orientation: Pattern pieces have a specified grain line that must be aligned with the fabric's warp (woven) or wales (knitted) to ensure proper drape and fit. CAD systems help enforce these constraints, though experienced operators can sometimes override for minimal (1-2%) adjustments without affecting garment quality.

- Marker Efficiency: This is the primary objective, calculated as the ratio of the total pattern area to the total marker area. The goal is to achieve the highest possible percentage, which directly impacts profitability by reducing fabric costs (often 50-60% of total cost).
- Sizing and Style Combination: Including a variety of sizes (e.g., a size ratio like 1 small, 2 medium, 2 large, 1 extra-large) and mixing large and small patterns often increases marker efficiency by allowing smaller pieces to fill gaps within larger ones.
- Marker Length and Width: Longer and wider markers generally result in higher efficiency. The marker width should match the actual cuttable width of the fabric.
- Cutting Quality: The marker plan should facilitate easy and accurate cutting, including clear lines and appropriate spacing between pieces for the cutting machine (manual or automatic) to navigate.
- Production Planning: Considerations such as the number of plies (fabric layers) in a spread and splice marks (points for fabric roll changes or flaw removal) are integrated into the marker plan.

Advantages of Computerized Planning

- Increased Accuracy: CAD systems ensure precise measurements and placement, minimizing errors common in manual methods like poor line definition or pattern piece omission.
- Higher Efficiency: Computerized systems consistently yield higher fabric utilization rates than manual methods, with basic styles often achieving 90-97% efficiency.
- Time and Labor Savings: Automatic marker generation is significantly faster, reducing time-consuming manual layout and tracing.
- Manipulation and Reuse: Digital markers can be easily adjusted, modified for new orders, and stored for future use, providing greater flexibility and shorter response times.
- Costing and Reporting: The software automatically calculates fabric consumption and marker efficiency, aiding in accurate cost proposals and material planning.
- Remote Transmission: Markers can be created in one location and electronically sent anywhere in the world for production.

Planning Process Notes

- Data Input: Digitize or scan pattern pieces into the CAD system, entering relevant parameters such as style number, size distribution, and specific fabric width.
- Interactive or Automatic Nesting: Use either interactive methods (operator manipulates pieces on screen) or automatic nesting (computer generates the most efficient layout) to arrange patterns.

- Optimization: Experiment with various configurations and nesting techniques to find the most efficient arrangement, reducing gaps between pieces.
- Quality Checks: The system includes built-in safeguards to ensure correct grain alignment, prevent pattern overlapping, and avoid piece omission.
- Finalization and Output: Once the marker is approved (often requiring checking for length, width, and efficiency), it is stored digitally and can be sent electronically to an automatic cutter or printed via a plotter on marker paper.

Fabric Spreading

Definition:

Spreading is the process of laying fabric in layers on the cutting table to prepare for cutting. Computerized fabric spreading involves using highly automated machines to lay multiple layers of fabric smoothly and precisely onto a cutting table, ensuring uniform tension, accurate alignment, and minimal waste. This process is crucial in mass garment production for efficient and accurate cutting.

Popular Computerized Spreaders:

- Gerber Spreader
- Lectra Vector Spreading System
- Eastman Automated Spreaders

Key Features and Mechanics

- Computerized fabric spreading machines are equipped with advanced technology to automate the entire process:
- Automatic Loading/Unloading: The machines can automatically load and unload fabric rolls, including heavy rolls (up to 300 kg or more), reducing manual labor and potential injuries.
- Tension Control: A positive feed system and automatic tensioning devices (which may use air floatation for delicate fabrics) ensure the fabric is spread without any stretch, wrinkles, or creases, which prevents shrinkage after cutting and sewing.
- Edge Alignment: Electronic edge sensors and auto-levelers monitor the fabric edges and automatically adjust the roll's position to maintain precise alignment (within a very small tolerance, like one-eighth inch).
- Fault Detection: Some advanced systems include defect scanners that use sensors to detect pre-marked fabric flaws (e.g., stains, holes). The machine stops, allowing the operator to mark or remove the defective section, ensuring only quality fabric is cut.

- Automatic Cutting: At the end of the lay, a built-in cutting device (often a small rotary knife) automatically cuts the fabric across its width.
- Programmable Settings: Operators can use a PLC touch panel to program the desired spreading length, number of layers (plies), speed, and spreading mode, allowing for precise control and repeatability.
- Spreading Modes: The machines can be programmed for various modes depending on fabric type and pattern requirements, such as:
- Face-One-Way (F/O/W): Each ply is cut at the end, and the fabric is oriented in the same direction (essential for napped or directional fabrics).
- Face-to-Face (F/F): The fabric is spread in alternating directions with a folding blade, which is faster and suitable for symmetrical or solid fabrics.

Advantages

The shift to computerized fabric spreading offers significant improvements over manual methods:

- Increased Productivity: Spreading fabric at speeds up to 100-150 yards per minute drastically reduces preparation time.
- Improved Accuracy and Quality: Automated controls ensure consistency in fabric alignment, tension, and flaw management, leading to higher quality cut components and finished garments.
- Reduced Labor Costs: One operator can manage the automatic machine, as opposed to the multiple workers required for manual spreading.
- Material Efficiency: Precision spreading and software integration with CAD/CAM systems help optimize fabric use, minimizing waste and improving fabric utilization.
- Enhanced Safety: Automation reduces the physical strain and risk of injury associated with manually handling heavy fabric rolls and repetitive tasks.

Spreading Surfaces

The spreading machines operate on specialized tables that complement the automated process:

- Vacuum Tables: These tables use suction after spreading a plastic film to compress the lay and prevent layers from shifting during the cutting process.
- Air Flotation Tables: Air jets facilitate the easy movement of the entire lay onto an adjacent cutting area or across the table, reducing friction and stress on the fabric or operators.
- Conveyor Tables: These surfaces carry the spread fabric directly to a computerized cutting machine, streamlining the workflow and saving time.

Computer Labelling Parts and Functions

1. Purpose of Barcode and QR Code Labelling

After cutting, each garment piece or bundle of pieces needs to be accurately identified and tracked. Barcodes and QR codes are widely used because they allow fast scanning, reduce errors, and integrate with digital systems.

Uses:

- Identify garment style, size, and color.
- Track pieces through sewing, finishing, and packing.
- Manage inventory efficiently.
- Collect production data for analysis and quality control.

2. Types of Codes Used

a. 1D Barcode

- Simple linear code with black and white lines.
- Stores limited information (usually a reference number).
- Scanned using standard barcode scanners.
- Example: UPC, Code 128.

b. 2D QR Code

- Square-shaped matrix code that stores more information than a barcode.
- Can include:
    - Style number
    - Size
    - Color
    - Fabric type
    - Cutting batch number
    - Production date
- Scannable with smartphones or specialized scanners.

3. How It Works in Garment Cutting & Labelling

Step-by-Step Process:

1. Design Stage

- CAD system assigns unique identifiers to each garment component.
- Example: “TSHIRT-M-BLUE-FRONT-001”

2. Code Generation

- Software generates a barcode or QR code for each identifier.
- Can be printed directly on labels or stickers.

3. Label Printing

- Labels may include:
    - Barcode/QR code
    - Text information (size, color, style)
    - Symbols (washing instructions)
- Printing methods:
    - Thermal printing
    - Inkjet printing
    - Heat transfer for fabric-friendly labelling

4. Attachment

- Labels are attached to each cut piece or a bundle.
- In some automated lines, robots can stick labels automatically.

5. Scanning & Tracking

- During sewing, finishing, and packing:
    - Pieces are scanned.
    - Data is updated in production management software.
    - Ensures traceability and minimizes mix-ups.

Advantages of Barcode/QR Labelling

Feature	Benefit
Accuracy	Minimizes human errors in sorting and assembly
Speed	Fast scanning saves time in production
Traceability	Every piece can be tracked through all stages
Data Integration	Works with ERP and inventory systems
Versatility	QR codes can store detailed information beyond simple identifiers

Computerized Sewing Machine

What does a computerized Sewing machine do?

A computerized sewing machine is a high-tech sewing device that uses computer technology to enhance the sewing experience of the sewers; whether you're a beginner or an experienced one, it offers convenience and versatility for various sewing projects.

Computerized sewing machines can offer you factors like a wide range of built-in stitch patterns, allowing you to customize the stitch length, width and tension; automatic functions such as one-step buttonhole stitching, control the sewing speed with precision; built-in memory or USB ports for saving and recalling custom stitch patterns, automatically adjust the thread tension, flawless Needle Positioning, eliminating the need for manual trimming of threads, you can limit the maximum sewing speed, and you can create intricate monograms and decorative designs on your projects.

In conclusion, using computerized sewing machines makes your sewing experience more fun, enjoyable, efficient and precise. It is a versatile sewing machine that can make any sewing project by quickly accessing the built-in memory and a time-efficient machine if indulged in multiple sewing projects at a time.

How Do Computerized Sewing Machines Work?

Initially, working with computerized sewing machines is a complex process, but it works pretty straightforwardly. It is where you can put your computer skills to work by just controlling the machine's functions, including the selection of stitches, the speed of sewing, and the needle position. The computer you use in computerized sewing machines is fixed in the head of the sewing machine, which connects other machine components by a series of wires. If you select a stitch option, the computer sends a signal to the motor to move the needle and feed dogs in a specific pattern that helps the machine do the stitching. It is an essential machine that is very

helpful in designing embroidery and fabrics with various stitching options, including customizable patterns.

Features of Computerized Sewing machines

- The sewing machine is attached with the computer, where the program can be installed.
- The program includes stitch type, stitch regulations, and it directs where the stitches fall.
- These new machines use an electronic loop stitching system whereby the needle only passes partially through the fabric. This creates a loop in the fabric.
- A series of controlled electronic gears move the needle along.
- A presser foot keeps the material steady while the feeder pulls it through. This allows for faster and more accurate needlework.
- A computerized machine contains a microprocessor that allows the machine to receive new information, typically in a card form.
- The sewing machine can then create patterns that have been loaded onto the card. Computerized machines typically have 150 to 250 different stitch styles-- everything from embroidery stitches to alphabet stitches for monogramming.
- They can also be connected to your computer for downloading custom stitches and patterns.
- These machines have a motorized work area that holds the fabric in place underneath the needle assembly.
- They also have a series of sensors that tell the computer how all of the machine components are positioned.
- The sewer simply loads a pattern from memory or creates an original one, and the computer does almost everything else.
- The computer prompts the sewer to replace the thread or make any other adjustments when necessary.
- A modern computerized sewing machine has many useful features. Common features include automatic needle threading, settings for many different fabrics including denim, and quilting functions.
- The machine may come with as many as 100 pre-programmed stitches.
- Some more advanced machines allow you to scan designs or create designs on a computer and then transfer them to the sewing machine's memory.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DEGITAL DESIGN AND AI IN FASHION

Introduction to Digital Design in fashion

Digital design in fashion refers to the use of computer-based tools, software, and technology to create, visualize, and develop clothing and accessories. Instead of drawing only by hand, designers now use digital tools to sketch ideas, make patterns, choose colours, create textures, and even simulate how a garment will look on a model.

This modern approach has transformed the fashion industry by making the design process faster, more accurate, and more creative. With software like Adobe Illustrator, CLO 3D, Browzwear, and Procreate, designers can create realistic 2D and 3D designs, test different fabrics, and make changes instantly without wasting materials.

Digital design also supports sustainability by reducing fabric waste and allowing virtual samples instead of multiple physical prototypes. Because of this, brands can bring new designs to market quicker, collaborate easily with teams worldwide, and provide customers with personalized fashion experiences.

Overall, digital design has become an essential part of today's fashion world, helping designers express their creativity more efficiently and professionally.

Digital design in fashion is a transformative field that uses computer technologies to create, develop, and present clothing and accessories in virtual environments. It moves beyond traditional hand-drawn sketches and physical prototyping, leveraging software for efficiency, creativity, and sustainability.

Key Concepts and Technologies

- 3D Modeling and Design Software: Digital design is powered by industry-standard tools like Adobe Illustrator and Photoshop for 2D graphics and pattern manipulation, and specialized 3D software such as CLO 3D, Marvelous Designer, and Optitex for creating hyper-realistic 3D garment simulations.
- Virtual Prototyping and Fitting: Designers can create virtual prototypes, simulate fabric properties (like drape, stretch, and texture), and conduct virtual fittings on customizable avatars. This significantly reduces the need for multiple physical samples, cutting down on time, cost, and material waste.
- Digital Textile Printing: This technology allows for intricate patterns and vibrant colors to be printed directly onto fabric with high precision, offering customization options not possible with traditional methods and minimizing waste through on-demand production.

- Augmented Reality (AR) and Virtual Reality (VR): AR allows consumers to virtually "try on" clothes using their mobile devices or smart mirrors, while VR is used for immersive experiences like virtual showrooms and fashion shows in the metaverse.
- AI and Machine Learning: Artificial intelligence is used to predict consumer preferences, generate design ideas, and create diverse AI fashion models for marketing campaigns, enhancing personalization and efficiency.
- NFTs and Digital-Only Fashion: Some digital garments exist purely in the virtual realm as Non-Fungible Tokens (NFTs), which can be worn by digital avatars in video games or social media, representing a new market for exclusive, data-based assets.

Impact on the Fashion Industry

The integration of digital design is reshaping the fashion industry in several ways:

- **Sustainability:** By minimizing physical sampling and enabling on-demand production, digital fashion offers a viable solution to the significant waste and environmental impact of traditional fashion.
- **Efficiency and Speed:** The design-to-market timeline is drastically reduced through streamlined digital workflows and enhanced collaboration among global teams.
- **Creativity and Experimentation:** Digital tools allow designers to experiment with designs, materials, and concepts that might be physically impossible or too costly in the real world (e.g., dynamic patterns that change color or form).
- **Democratization and Inclusion:** Lower barriers to entry, such as reduced material costs and the rise of virtual platforms, allow emerging designers to showcase their work globally and cater to diverse body types and identities through customizable avatars.

Tools and Software Used in Digital Fashion Design

2D Design Tools

- Adobe Illustrator – For fashion sketches, flats, logos, layouts
- Photoshop – For prints, textures, mood boards
- Procreate – Digital sketching on tablets

3D Digital Fashion Tools

- CLO 3D – For 3D garment design, draping, and simulation
- Browzwear (V-Stitcher, Lotta) – Professional 3D fashion visualization
- Marvelous Designer – For realistic garment draping

These tools help designers create lifelike clothing, test different fabrics, and see how garments will move.

AI in Fashion

The fashion industry is experiencing an Al revolution, with Artificial Intelligence fundamentally changing how designers create, predict trends and optimize workflows. What once took hours - sketching each outfit by hand - can now be done in minutes. Al tools offer a fresh edge, helping designers create patterns, explore styles and predict upcoming trends, all with just a few clicks.

But Al isn't here to replace designers. It functions as an intelligent creative assistant. It suggests ideas, matches colours and helps visualise what might be trending next. The designer still holds the reins - Artificial Intelligence simply speeds things up and brings more clarity to the process. From quick concept sketches to polished visuals, it turns imagination into design faster than ever before.

How Al Tools Transform Fashion Design Workflows in 2025

Al has evolved from experimental technology to essential daily workflow tools for fashion professionals. Fashion designers can integrate Al through various technological approaches including neural networks for style transfer, computer vision for fabric analysis and natural language processing for design brief interpretation. Popular Artificial Intelligence platforms like Adobe Sensei, CLO 3D and Optitex provide comprehensive solutions for different aspects of the design workflow.

Here are the key ways Al technology streamlines fashion design processes and improves brand efficiency:

• Al Trend Prediction: Identifying Fashion Trends before Market Adoption - Al tools scan social media, fashion blogs and online stores to find what people are loving right now. They track colours, patterns and even how often a certain style pops up. This helps designers know what's likely to trend before it hits the streets.

• Accelerated Design Process: Al-Powered Concept to Garment Creation - Designers can now use Al to build outfits from scratch. Just choose a colour, fabric and shape - the tool helps sketch it out instantly. It's quick, simple and great for trying new looks without wasting time or materials.

• Personalized Fashion Al: Machine Learning for Individual Styles - Al doesn't just work for designers. It helps shoppers too. When someone visits an online store, Al looks at what they've liked, clicked or bought before. Then it shows styles that match their taste. It's like a personal stylist that actually listens.

• Making the Back-End Smarter - Al checks what's selling fast and what's not moving at all. It predicts how much of each item a brand needs to make, helping stores avoid leftovers or delays. This keeps things moving smoothly and cuts down on waste.

• Helping the Planet while Designing - Sustainability matters, and AI is playing a big role. It helps brands choose better fabrics, plan smarter production cycles and avoid extra batches that end up in landfills. With data guiding the process, making eco-friendly choices becomes a lot simpler.

AI's Impact on Fashion Education and Student Learning

AI isn't just for tech experts anymore. It's now a big part of fashion design too. Major fashion brands report 30-50% reduction in design iteration time when implementing AI-assisted workflows. Companies like Zara, Nike and Adidas have successfully integrated AI for inventory optimization, trend forecasting and personalized design recommendations, demonstrating measurable ROI from AI investments. If you are a student, here are the key areas to pay attention to - simple, practical and real.

• Faster Design with Smarter Tools - Designing used to take days. Now, AI can help you build ideas in minutes. You can test out styles, change colours, switch fabrics, and tweak shapes all in one go. Want ten versions of the same dress with different necklines? Artificial Intelligence helps you try more, faster - without starting from scratch every time.

• How Trends are Predicted Today - Trend forecasting has changed. No more guessing what people will wear next season. AI now scans millions of photos, videos, product tags and even emojis from social media. It reads how people feel about looks, patterns or even colours. It then shows what's likely to go up or down. As a student, learning how this works can help you design things people actually want - not just what looks good on paper.

• Thinking about the Planet - AI tools use a lot of power. Some models need huge servers and constant updates. That means more electricity, more heat and more e-waste. Fashion students need to think about this. Just because it's smart tech doesn't always mean it's eco-friendly. Choosing lighter tools, skipping unnecessary processes and being mindful of digital waste matters as much as fabric waste.

• New Job Roles to Explore - AI is also creating fresh career options. You don't just have to become a fashion designer anymore. You can be someone who works with data to plan the next big trend. You could become a digital fashion curator who selects what works online. You can even focus on styling with AI tools - picking what looks best, faster. These roles need creative minds who understand fashion and tech together.

AI Fashion AI Challenges: Real Risks and Solutions for Designers

Artificial Intelligence can do a lot in fashion, but it's not all smooth sailing. Let's talk about the bits that need careful handling...

Let people stay in charge - AI can give many design ideas, but not all of them make sense. Some look good on a screen but won't work in real life. Sometimes, AI makes things up that don't even exist. Designers must take the lead. AI can suggest, but people must decide.

• Clear rules about who owns what - If AI makes a design, who owns it? The person using the tool? The company? Or the software maker? No one knows for sure. It can also use parts of other people's work without asking. This can cause big problems, especially in fashion where every design matters.

People notice when models aren't real - When Vogue used Al models, many people didn't like it. They wanted real faces and real stories. Fake images may look perfect, but they feel cold. Fashion still needs a human touch.

• Al needs a lot of power - Al may save fabric and time, but it also uses a lot of electricity. Big machines run for hours to keep it working. That's not always good for the planet. Fashion brands that care about the environment must think about this.

The Future of AI and Fashion

Artificial intelligence in fashion design is transforming how designers create, conceptualize and produce garments. Advanced Al-powered design tools now enable fashion professionals to generate realistic sketches, predict trends and optimize design workflows through machine learning algorithms and computer vision technology. Fashion design students and professionals can leverage Al tools like generative adversarial networks (GANs), pattern recognition software and automated fabric selection systems to enhance their creative process and improve design efficiency. While AI streamlines design processes, successful fashion industry professionals must balance technological capabilities with creative intuition. Leading fashion houses like Burberry and H & M demonstrate how Al-assisted design maintains cultural relevance while optimizing production efficiency and sustainable practices.

Ethical AI implementation in fashion design requires careful consideration of data sources, intellectual property rights and environmental impact. Designers should prioritize Al tools that use ethically-sourced training data, respect copyright laws and support sustainable fashion practices through optimized material usage and waste reduction. The future of fashion design lies in the strategic integration of artificial intelligence with human creativity. As AI technology continues evolving, fashion professionals who master these tools while maintaining their unique design perspective will lead industry innovation and create more sustainable, efficient design processes.

AI-Assisted Tools in Digital Fashion

AI-assisted tools are transforming digital fashion by automating design, accelerating prototyping, enabling virtual try-ons, and forecasting trends. These tools streamline the entire workflow from concept to marketing, enhancing creativity and sustainability.

Key Applications and Tools

AI tools are used across the fashion industry, primarily in:

1. **Design and Ideation:** Generative AI tools can create design variations, suggest color palettes, and transform rough sketches or text prompts into detailed 3D models or photorealistic visuals.
    - Tools: The New Black, Fashion Diffusion, and NewArc.ai specialize in rapid concept generation and visualization from text or image inputs.
2. **3D Prototyping and Virtual Sampling:** Designers can create lifelike 3D garment simulations that accurately represent how different fabrics drape and fit on diverse virtual body types. This minimizes the need for costly and wasteful physical samples.
    - Tools: CLO 3D, Browzwear, and Style3D AI are industry leaders in 3D garment creation and simulation.
3. **Virtual Models and Try-ons:** AI generates diverse, customizable virtual models to showcase clothing for e-commerce and marketing, eliminating the need for traditional photoshoots. Virtual try-on (VTO) features allow customers to see how clothes fit on digital avatars, which helps reduce return rates.
    - Tools: Botika, ZMO.ai, and Revery.AI focus on generating model imagery and VTO solutions.
4. **Trend Forecasting:** AI analyzes vast amounts of data from social media, runways, and sales reports to predict emerging trends and consumer demand.
    - Tools: Designovel and Heuritech use data analytics to provide actionable trend insights.
5. Supply Chain Optimization: AI streamlines inventory management, demand forecasting, and logistics, helping brands minimize overproduction and reduce costs.

Benefits

- Speed and Efficiency: AI dramatically accelerates the design-to-market cycle, turning concepts into visuals in hours or days instead of weeks or months.
- Cost Reduction: Brands save money by reducing the need for physical samples, photoshoots, and manual labor for repetitive tasks.
- Sustainability: By minimizing fabric waste and unnecessary sample production, AI tools support eco-conscious practices in the fashion industry.
- Enhanced Creativity and Personalization: AI acts as a creative assistant, providing new ideas and enabling brands to offer personalized shopping experiences and custom-fit garments at scale.

AI serves as a powerful assistant that augments human creativity and streamlines processes, rather than replacing designers entirely, allowing them to focus on artistic vision and innovation.

Sustainability and Ethical Considerations AI in Fashion

Artificial intelligence (AI) can significantly advance sustainability in the fashion industry by optimizing supply chains and reducing waste, but it also introduces critical ethical challenges such as data bias, intellectual property issues, and the risk of accelerating overconsumption

AI's Role in Sustainable Fashion

AI offers powerful tools to mitigate the fashion industry's substantial environmental and social impact, which traditionally involves high water consumption, chemical pollution, and significant labor issues.

- Demand Forecasting & Waste Reduction: AI analyzes past sales, trends, and even social media to predict consumer demand with high accuracy. This helps brands align production with actual needs, significantly reducing overproduction and the amount of unsold inventory that ends up in landfills.
- Sustainable Material Sourcing & Design: AI systems can recommend eco-friendly materials by analyzing their water usage, carbon footprint, and recyclability. Generative AI also enables digital sampling and virtual prototyping, which reduces the need for physical samples, fabric waste, and energy use associated with traditional design processes.
- Supply Chain Optimization: AI enhances logistics by optimizing distribution routes to minimize emissions and provides greater transparency by tracking materials from raw sources to the final product.
- Circular Fashion & End-of-Life: AI facilitates the circular economy by optimizing sorting and pricing for secondhand items, designing products for recyclability, and using virtual try-on systems that reduce product return rates and their associated transport emissions.

Ethical Considerations and Challenges

The integration of AI into fashion raises several ethical dilemmas that require careful management to ensure the technology is used responsibly.

- Algorithmic Bias and Inclusivity: AI models trained on limited or biased datasets can perpetuate harmful stereotypes, exclude diverse body types, and favor Western aesthetics. This can result in a lack of representation and reinforce inequality in marketing and product offerings.
- Intellectual Property (IP) & Creativity: Generative AI tools often train on existing images and designs without proper attribution or permission, raising concerns about plagiarism and the intellectual property rights of independent artists and designers.
- Labor and Job Displacement: While AI can automate tasks and increase efficiency, there are concerns about its impact on human workers, from the displacement of designers to

the potentially precarious working conditions of "ghost workers" who label data for AI systems.

- Data Privacy & Consumer Trust: AI-driven hyper-personalization relies on vast amounts of consumer data. The ethical challenge lies in ensuring transparency about data collection and usage, respecting user privacy, and building consumer trust by demonstrating a clear value exchange for their information.
- Greenwashing & Overconsumption: Brands may use AI as a greenwashing tool to project an eco-friendly image without making substantive improvements to core practices. Furthermore, AI's ability to precisely predict trends and personalize marketing can inadvertently fuel a culture of "ultra-fast fashion" and impulsive purchases, exacerbating the problem of overconsumption and textile waste.
- Energy Consumption: The training and operation of large AI models are highly energy-intensive, requiring massive data centers that consume significant power and water resources, posing an environmental cost in itself.

To navigate these challenges, experts call for the establishment of robust ethical AI governance frameworks that prioritize human oversight, data transparency, accountability, and the active integration of sustainability as a core principle.

Collaboration between Designers and Trends in Digital Design and AI

Collaboration between designers and AI is currently a dominant trend in digital design, shifting the designer's role from a manual executor to a creative director who works in partnership with intelligent systems. AI is used to automate routine tasks, provide data-driven insights into trends, and serve as a creative partner in ideation and content generation.

Collaboration between Designers and AI

Rather than replacing human creativity, AI enhances it by serving as a powerful tool and collaborator in the design process.

- Efficiency and Automation: Designers leverage AI to automate time-consuming, repetitive tasks such as image resizing, color correction, and background removal. This allows them to focus more time on strategic thinking, conceptual development, and creative problem-solving.
- Creative Partnership: AI tools like Midjourney, DALL-E, and Adobe Firefly act as creative partners, generating unique visuals, exploring different color palettes and layouts, and providing inspiration to overcome creative blocks. Designers guide the AI with prompts and then refine the AI-generated outputs with their unique human touch, emotional depth, and cultural context.
- Data-Driven Decisions: AI analyzes vast amounts of user data and market feedback to provide designers with insights into user behavior and emerging trends. This enables

designers to make more informed decisions and create personalized, user-centric experiences, such as adapting a website's layout based on individual user preferences.

- Seamless Workflow Integration: AI-powered features are integrated into existing design software (e.g., Adobe Sensei in Creative Cloud, plugins in Figma) to facilitate real-time collaboration among designers, developers, and stakeholders. This integration streamlines the feedback loop and design iterations.

Current Trends in Digital Design and AI

Several key trends define the evolving landscape of digital design in the AI era:

- Generative Design: The use of AI algorithms to generate numerous design alternatives based on predefined parameters is a major trend. This allows for the exploration of innovative and complex solutions that might not be humanly possible to create manually.
- Hyper-Personalization: AI enables the creation of highly customized digital experiences at scale, such as dynamic user interfaces that adapt in real-time to individual user preferences and interactions.
- Dynamic and Interactive Design: Static designs are giving way to dynamic and interactive content. AI is instrumental in creating sophisticated motion graphics, 3D models, and augmented/virtual reality (AR/VR) experiences, making content more immersive.
- AI for Accessibility and Ethics: Designers are using AI to automatically detect and correct accessibility issues (e.g., color contrast, font sizes), making designs more inclusive. However, there is a growing emphasis on ethical AI use to mitigate biases present in training data and address concerns around copyright and originality.

The future of digital design will be defined by this synergy, requiring designers to develop new skills in prompt engineering, data literacy, and strategic thinking to leverage AI effectively while maintaining the irreplaceable human element of empathy and storytelling.