Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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A National Initiative with NSDC
APPAREL MADE-UPS HOME FURNISHING
SECTOR SKILL COUNCIL

Participant Handbook

Sector
Apparel

Sub-Sector
Apparel, Made-Ups & Home Furnishing

Occupation
Pattern Making

Reference ID: **AMH/Q1101, Version 4.0**
NSQF level: 5

Advanced Pattern Maker (CAD/CAM)

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> Skill development of the new generation is a national need and is the foundation of Aatmnirbhar Bharat

Shri Narendra Modi
Prime Minister of India

Certificate

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is hereby issued by the

APPAREL, MADE-UPS & HOME FURNISHING SECTOR SKILL COUNCIL

for

SKILLING CONTENT: PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/ Qualification Pack: **'Advanced Pattern Maker(CAD/CAM)'**

QP No. **'AMH/Q1101, NSQF Level 5'**

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The preparation of this handbook would not have been possible without the Fashion Industry's support. Industry feedback has been extremely encouraging from inception to conclusion and it is with their input that we have tried to bridge the skill gaps existing today in the industry.

This participant handbook is dedicated to the aspiring youth who desire to achieve special skills which will be a lifelong asset for their future endeavours.

About this book

Welcome to the "Advanced Pattern Maker (CAD/CAM)" training programme. This Participant Handbook (PHB) is designed to equip participants with in-depth knowledge of advanced pattern-making principles and digital drafting techniques using modern CAD/CAM systems. It emphasizes precision, innovation, and technical expertise essential for today's apparel production environment. The programme focuses on developing accurate patterns, modifying blocks, understanding garment fit, and applying digital grading and marker-making processes. Participants will gain practical exposure to software-based pattern development, production workflows, fabric utilization, and industry-standard digital tools required for efficient field operations.

This Participant Handbook is designed based on the Qualification Pack (QP) under the National Skill Qualification Framework (NSQF) and it comprises the following National Occupational Standards (NOS)/ topics and additional topics.

1. AMH/N1101.Pattern development through CAD/CAM
2. AMH/N1102.Maintenance of work area, machinery, tools and equipment
3. AMH/N0620. Promote and sustain safety, health, and security in workplace, while fostering Gender and Persons with Disabilities (PwD) Sensitization
4. DGT/VSQ/N0102: Employability Skills (60 Hours)

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1. Introduction and Orientation to Advanced Pattern Maker

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Unit 1.1 - Overview of the Apparel Industry and the Role of an Advanced Pattern Maker

Bridge Module

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Describe the size and scope of the apparel industry.
2. Describe various employment opportunities for a 'Advanced Pattern Maker' in the apparel industry.
3. Explain roles and responsibilities of a 'Advanced Pattern Maker'.
4. Describe the apparel production process and the role that the 'Advanced Pattern Maker' plays in the process.

UNIT 1.1: Overview of the Apparel Industry and the Role of an Advanced Pattern Maker

Unit Objectives

By the end of this unit, the participants will be able to:

1. Discuss the size and scope of the apparel industry.
2. Discuss various employment opportunities for an Advanced Pattern Maker in the apparel industry.
3. Describe the roles and responsibilities of an Advanced Pattern Maker.
4. Examine the apparel production process and elaborate on the role of an Advanced Pattern Maker in it.

1.1.1 Apparel Manufacturing Sector

The apparel manufacturing sector in India is one of the biggest industries in the country. It includes making clothes like shirts, pants, dresses, uniforms, and traditional wear. It also includes items we use at home, such as bed sheets, towels, curtains, cushion covers, and tablecloths. Many factories and small units across India manufacture these garments for both domestic consumption and export to other countries.

This sector provides employment to millions of people, particularly women and workers in rural areas. It includes many types of work such as stitching, cutting, embroidery, ironing, checking, and packing. India is renowned for its skilled workers and exquisite designs, which is why clothing made in India is in high demand worldwide.

The apparel industry in India is growing every year. With an increasing number of people purchasing clothes in India and other countries, there is a growing need for more workers and enhanced skills. New machines, better training, and government support are helping this sector grow fast. It is a strong part of India's economy and offers good job opportunities for skilled workers.

Market Size and Growth:

- **Current Value:** The Indian apparel market size was valued at USD 115.70 billion in 2024. The broader Indian textile and apparel market was valued at USD 222.08 billion in 2024.
- **Projected Growth:** The Indian apparel market is projected to grow to USD 171.60 billion by 2034, exhibiting a compound annual growth rate (CAGR) of 4% from 2025 to 2034.

Source: textileinsights.in

Fig. 1.1.1: Apparel manufacturing unit

India is known around the world for its beautiful embroidery, traditional designs, and skilled work. Because of this, there is a high demand for Indian-made clothes and home products in many countries.

The work in this sector is done by hand and by machines. It requires workers who are careful, skilled, and hard-working. Jobs like those of embroidery machine operators are crucial in maintaining the quality and design of products.

This sector helps many families earn a living and plays an important role in the country's growth.

Key Strengths and Growth Drivers of India's Apparel Industry

India's garment and textile industry is strong and growing fast. Here are the main reasons why:

1. **Plenty of Raw Material**

   India grows a lot of cotton, the highest in the world and is also the top producer of jute and jute products. India is also the second-largest producer of silk. India also produces and exports various types of blended and synthetic yarns.

Fig. 1.1.2: Cotton tree and pre-processed jute plant

2. **Large Domestic Market**

   India has a big population that buys clothes. People in India now have more money to spend and like to wear new styles. This means there is always high demand for new garments in the local market.

3. **Government Support**

   The government is giving help through special schemes like PLI and PM MITRA Parks. These programs help build better factories, support workers, and attract more companies to invest in India.

4. **Strong Export Business**

   India exports clothes and textiles to many countries, including the USA and those in Europe, making it the sixth-largest exporter of textiles and garments in the world.

5. **Use of New Technology**

   Modern machines and computers are now used in many factories. This makes the work faster, better, and more accurate.

Fig. 1.1.3: Advanced garment manufacturing technology

6. Focus on Sustainability

Many companies are now using eco-friendly methods. They are making clothes from organic cotton and trying to reduce waste. This is good for the environment and future generations.

Apparel, Made-Ups and Home Furnishing Sector Skill Council (AMHSSC)

The Apparel, Made-Ups, and Home Furnishing Sector Skill Council (AMHSSC) is an organisation that helps people acquire the necessary skills to work in the clothing and home furnishing industry.

AMHSSC (Apparel, Made-Ups and Home Furnishing Sector Skill Council) plays an important role in helping people learn and grow in the garment and home furnishing industry. It creates special training courses for different jobs such as embroidery machine operators, tailors, pressmen, fashion designers, etc. These courses teach workers how to do their jobs in a safe, fast, and correct way.

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Fig. 1.1.4: AMHSSC logo

AMHSSC also works with factories and companies to understand what kind of workers are needed. This helps ensure that the training aligns with what the industry is looking for. Trained workers can get jobs in factories, export houses, or even start their own small businesses. By learning the right skills, workers can make better-quality products, feel more confident, and earn more money. In this way, AMHSSC connects skilled workers with good job opportunities and supports their future growth.

1.1.2 Apparel Production Process and Role of the Advanced Pattern Maker

The garment production process involves several key steps to transform fabric into finished clothing. Trained workers do each step, and one of those key roles is the Embroidery Machine Operator. Here is how a garment is usually made:

- **Step 1. Designing:** First, the fashion designer or company decides what kind of garment they want to make. They create a design on paper or a computer. This includes the style, size, colour, fabric type, and sometimes embroidery patterns.
- **Step 2. Fabric Selection and Sourcing:** The right fabric is chosen based on the design. For example, cotton, silk, polyester, or denim. Then the fabric is purchased or brought to the factory.
- **Step 3. Fabric Inspection:** Before using the fabric, workers check it for any damage, stains, or colour differences. Good quality fabric is approved for use.
- **Step 4. Fabric Spreading:** Large rolls of fabric are spread evenly on long cutting tables. This helps in cutting the fabric properly.
- **Step 5. Cutting:** Patterns are marked on the fabric using chalk or a marker. Then, the fabric is cut into parts like sleeves, collars, front, and back.
- **Step 6. Embroidery (if required):** If the design includes embroidery, the cut fabric pieces are sent to the Embroidery Section.
- **Step 7. Stitching:** After embroidery, all the cut pieces are stitched together using sewing machines. This step forms the complete garment.
- **Step 8. Checking (Quality Control):** Every garment is carefully checked to make sure there are no defects like open stitches, stains, or missing buttons. If needed, small corrections are made.
- **Step 9. Finishing:** The garment is pressed, threads are trimmed, labels are attached, and it is folded properly.
- **Step 10. Packing:** The finished garment is packed in poly bags or boxes, ready for sale or delivery.
- **Step 11. Dispatch:** Finally, the packed garments are sent to shops, warehouses, or directly to customers in India or other countries.

1.1.3 Employment Opportunities for Advanced Pattern Makers

Advanced Pattern Makers are in high demand across the industry, especially as fashion cycles shorten and customised fashion gains traction.

Key Employment Areas

Sector	Type of Employment
Fashion Houses	Pattern Development, Design Interpretation
Export Houses	Bulk Pattern Grading, Fit Adjustments
Apparel Manufacturing Units	Technical Pattern Making, Sample Development
Freelancing	Custom Client Work, Made-to-Measure Solutions
CAD/Bespoke Software Firms	Digital Pattern Development
Retail & E-commerce Brands	Standard Size Patterning, Product Development Teams

1.1.4 Roles and Responsibilities of an Advanced Pattern Maker

In the dynamic and precision-driven world of apparel manufacturing, the Advanced Pattern Maker occupies a central and highly specialised role. As the vital link between creative design and technical execution, the Advanced Pattern Maker is responsible for translating a designer's vision into production-ready patterns that determine the structure, fit, and silhouette of a garment. This role goes far beyond basic pattern drafting; it requires a deep understanding of garment construction, fabric behaviour, sizing systems, and advanced techniques such as pattern grading, draping, and digital drafting using CAD tools.

With increasing demand for faster fashion cycles, customised fit, and sustainable production, the responsibilities of an Advanced Pattern Maker have become more complex and critical. They must not only ensure aesthetic accuracy and functional wearability but also optimise patterns for efficient material usage and seamless manufacturing. This requires collaboration with designers, sample makers, merchandisers, and production supervisors, making the role both technically intensive and collaborative.

Stage	Role of Advanced Pattern Maker
Design Conceptualization	Assists in technical feasibility assessment
Pattern Development	Creates accurate base and stylised patterns
Sample Development	Works with the sample maker to create garment prototypes
Fit and Size Grading	Adjusts for different body types while maintaining design
Fabric Cutting	Provides precise markers and layout plans

Table 1.1.1: Advanced Pattern Maker's Role in Each Stage

An Advanced Pattern Maker must exhibit a high level of problem-solving ability, attention to detail, technical knowledge, and creative thinking, as any inaccuracy in the pattern could lead to costly errors in production. An Advanced Pattern Maker translates a designer's vision into physical form through precise, technically sound patterns. They balance aesthetics with functionality and production feasibility.

Responsibility	Description
Design Interpretation	Understanding sketches/tech packs
Drafting and Draping	Creating patterns via flat pattern or draping methods
Pattern Grading	Adapting base patterns to multiple sizes
Sample Checking	Ensuring the sample garment fits as per standards
Fit Correction	Making modifications based on trial fittings
Coordination with Other Units	Communicating with designers, tailors, and production
CAD Software Usage	Using Gerber, Lectra, TUKAcad, or similar tools

Table 1.1.2: Core Responsibilities

Summary

- The global apparel industry is vast, fast-evolving, and a major contributor to employment and GDP, especially in countries like India.
- The industry comprises a structured workflow from design to dispatch, where each phase demands skilled coordination and technical precision.
- Advanced Pattern Makers are key professionals who convert design ideas into technically sound patterns ready for production.
- They ensure the right fit, balance, and construction of garments by interpreting spec sheets and correcting design flaws early in the process.
- Their collaboration with designers, merchandisers, and production teams ensures seamless product development.
- With growing digitalisation, pattern makers increasingly rely on CAD/CAM tools for speed, accuracy, and virtual prototyping.
- The Advanced Pattern Maker is both a creative and technical expert who plays a vital role in shaping high-quality, commercially viable apparel.

Exercise

Multiple-choice Question:

1. What is the primary role of an Advanced Pattern Maker in the apparel production process?
   a. Marketing apparel products
   b. Operating sewing machines
   c. Translating design concepts into accurate patterns
   d. Packing finished garments

2. Which of the following is NOT a key stage in the apparel production process?
   a. Fabric Cutting
   b. Sample Development
   c. Marketing Analysis
   d. Finishing & Quality Control

3. What is a key reason why the apparel industry is considered significant in India?
   a. It only serves the luxury segment
   b. It provides large-scale employment across rural and urban areas
   c. It relies exclusively on imported fabrics
   d. It operates mainly through online retail

4. What does CAD/CAM stand for in the context of pattern making?
   a. Computer-Assisted Drawing/Computer-Assisted Management
   b. Computer-Aided Design/Computer-Aided Manufacturing
   c. Central Apparel Design/Controlled Apparel Making
   d. Creative Apparel Drawing/Creative Apparel Management

5. Which of the following responsibilities best describes the Advanced Pattern Maker's contribution during sample development?
   a. Supervising export documentation
   b. Creating marketing visuals
   c. Preparing prototype patterns for trial garments
   d. Procuring raw materials

Descriptive Questions:

1. Describe the size and scope of the apparel industry in India. Include recent statistics and the importance of this sector in employment and exports.
2. Explain the roles and responsibilities of an Advanced Pattern Maker in the apparel value chain.
3. Discuss the key stages of the apparel production process and elaborate on how an Advanced Pattern Maker contributes at each stage.
4. Highlight the employment opportunities available for an Advanced Pattern Maker within the Indian and global apparel industry.
5. How has digital technology such as CAD/CAM influenced the role and efficiency of pattern makers in modern apparel manufacturing?

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/ddisteV3tOo?si=uFDW4QKnItoOKknY

Textile Sector in India

https://youtu.be/Jfeu-rBVm-o?si=P8oLTmvZHd2NPwQk

Explain the role and importance of a Pattern Maker and Marker Maker in the garment industry

https://youtu.be/BOFx1LB9IFY?si=W74OEfqLaAmT9He-

Pattern Making

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2. Prepare to Develop Pattern Through (CAD/ CAM)

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Unit 2.1 - Information Flow and Planning

Unit 2.2 - Pattern Development Using CAD

AMH/N1101

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Explain the spec sheet.
2. Coordinate with merchandiser to ensure clarity of information and resolve all misinterpretations.
3. Identify the tools and equipment required to develop the pattern.
4. Set the CAD machine.
5. Take the measurement from the specs sheet or download from the computer.
6. Draft the pattern on the CAD software as per specification given or digitize the manual pattern on the CAD software, if applicable.
7. Adjust the pattern specifications as per the standard and allowances required.
8. Check the developed pattern with the spec sheet.
9. Make changes wherever required.
10. Analyse the bill of material.

UNIT 2.1: Information Flow and Planning

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe the purpose and components of a spec sheet.
2. Coordinate with the merchandiser to clarify details and resolve misinterpretations.
3. Identify the tools and equipment needed for pattern development.
4. Analyse the bill of material to understand required components.

2.1.1 Meaning and Significance of the Spec Sheet

A Specification Sheet (spec sheet) is a comprehensive document that serves as a communication bridge between the design and production departments in the apparel industry. It outlines all the vital information related to the construction of a garment, including technical measurements, fabric details, stitching instructions, trims, finishing, and labelling. For an Advanced Pattern Maker, especially in a CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) environment, the spec sheet is the foundation upon which accurate digital patterns are created and modified. A specification sheet (commonly referred to as a spec sheet) is a detailed document that outlines all the critical components required for developing a garment. It acts as the blueprint for the pattern maker, guiding every stage of pattern development, especially in a CAD/CAM-based environment.

Component	Details
Style Number and Description	Identifies the design uniquely and gives a brief summary of the garment.
Flat Sketch	Technical drawing showing front, back, and side views of the garment.
Measurement Chart	Contains POMs (Points of Measurement) and tolerance levels for each size.
Construction Details	Instructions on stitching, seam types, finishing, etc.
Fabric and Trims Information	Lists fabric type, trims, accessories, and embellishments required.
Labelling and Packaging Guidelines	Specifies brand labels, size tags, and packaging instructions.
Fit Comments or Revisions	Any feedback from prior fit sessions or sampling rounds.

Table 2.1.1: Key Components of a Typical Spec Sheet

Why Is the Spec Sheet Crucial for the Advanced Pattern Maker?

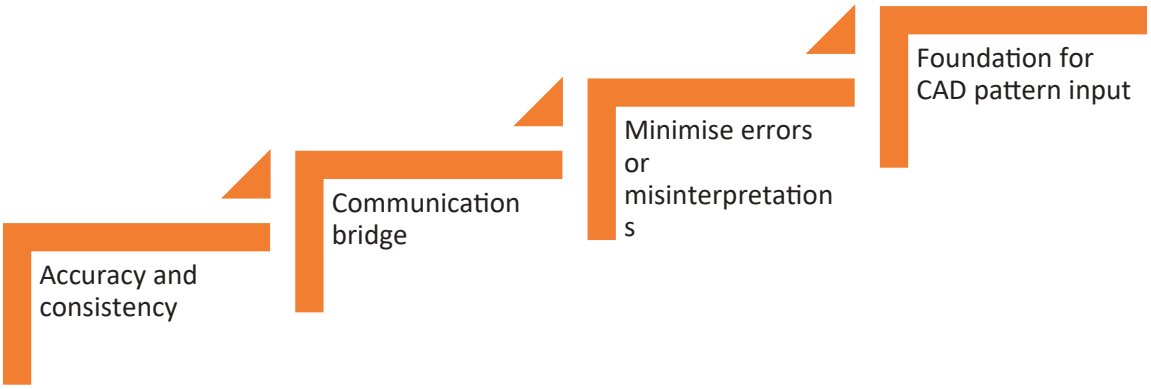


Fig. 2.1.1: Importance of Spec Sheet

- It ensures accuracy and consistency throughout the production process.
- Serves as the communication bridge between design, merchandising, and production teams.
- Helps minimise errors or misinterpretations, especially when collaborating across departments.
- Acts as the foundation for CAD pattern input, allowing digital translation of precise specifications.

2.1.2 Purpose of a Specification Sheet (Spec Sheet)

The primary function of a spec sheet is to translate a designer's creative concept into a set of standardised technical details that the production and sampling teams can follow. This reduces ambiguity, minimises errors, and ensures consistency across all stages of garment development. Spec sheets are particularly significant in mass production, where replicability, quality control, and adherence to brand standards are non-negotiable.

A well-prepared spec sheet typically includes:

- Garment sketch or technical drawing (flat or 3D renderings)
- Bill of Materials (BOM) - listing fabrics, trims, and accessories
- Garment measurements (size specs) across multiple sizes
- Construction details - stitching type, seam allowance, interlining, etc.
- Labelling and packaging requirements
- Fit and tolerance allowances
- Grading rules and instructions for size variations

In CAD/CAM systems, spec sheets are often integrated digitally, allowing pattern makers to reference critical measurements and guidelines in real-time while drafting or adjusting digital patterns. This enhances workflow efficiency, supports real-time collaboration between merchandisers and pattern makers, and enables faster iterations and approvals.

Moreover, spec sheets are also critical for:

Fig. 2.1.2: Significance of spec sheets

- **Sourcing:** helping suppliers understand exactly what materials are needed
- **Cost estimation and budgeting:** allowing merchandisers to estimate production costs accurately
- **Quality control:** serving as a benchmark for verifying final garment output
- **Legal compliance:** documenting requirements for international labelling and consumer regulations

2.1.3 Coordination with Merchandisers

In the apparel production process, merchandisers act as the central communication hub, connecting various departments such as design, pattern making, sampling, and production. For an advanced pattern maker, clear and timely coordination with merchandisers is essential to ensure accurate interpretation of style requirements, fabric specifications, trims, and construction details. Miscommunication at this stage can lead to costly errors in pattern development and delays in the production timeline. Merchandisers provide critical inputs such as tech packs, spec sheets, BOMs, and buyer comments, which guide the pattern maker during CAD-based pattern creation. Regular interactions help resolve ambiguities, clarify measurements or design intent, and maintain alignment with buyer expectations. Thus, strong collaboration between the pattern maker and merchandiser is key to producing precise patterns that meet quality standards and production schedules. Merchandisers play a pivotal role in ensuring the flow of accurate information between the design team, pattern makers, and production unit. Effective coordination reduces misinterpretations and ensures the pattern maker has all the necessary data before starting the CAD process.

Importance of Collaboration

- Merchandisers interpret design intent and customer specifications.
- Serve as the communication bridge between designers and the technical team.
- Provide clarity on fabric availability, trims, buyer requirements, and lead times.

Best Practices for Coordination

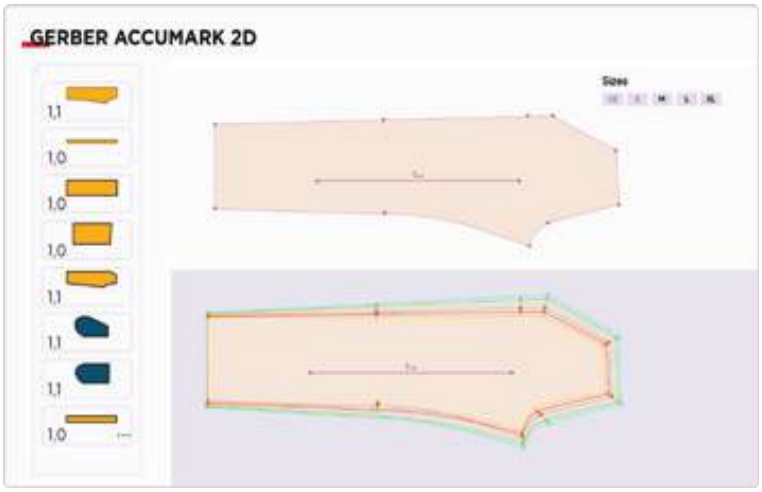
- Review the spec sheet with the merchandiser before starting pattern development.
- Clarify missing or ambiguous information such as stitch type, fabric weight, or measurements.
- Maintain written records (e.g., emails or meeting notes) of clarifications received.
- Use a checklist to verify that all pattern-related data is received.

2.1.4 Tools and Equipment Needed for Pattern Development

Pattern development requires a precise blend of traditional craftsmanship and modern technology. To achieve accurate and production-ready patterns, an advanced pattern maker must be well-versed in using both manual tools and digital systems. The toolkit includes essential items like tailor's curves, measuring tapes, muslin fabric for mock-ups, and marking tools, which are indispensable for initial drafting and adjustments. With the advent of CAD/ CAM technologies, digital tools such as pattern-making software, plotters, and digitisers have become crucial in enhancing efficiency, precision, and scalability. The choice of tools depends on the type of garment, the complexity of the design, and the production scale. Understanding the function and proper usage of each tool allows the pattern maker to transition seamlessly between design and development, ensuring that every pattern aligns with the intended fit, function, and aesthetics of the garment.

Developing a pattern through CAD/CAM involves specialised tools that enhance speed, accuracy, and repeatability. Knowledge of these tools helps the pattern maker prepare the workspace efficiently.

CAD Tools and Hardware

Tool/ Equipment	Purpose
CAD Software (e.g., Gerber, TUKAcad, Lectra) 	Digital drafting, grading, and marker making
Plotter/ Printer 	To print paper patterns from digital files

Tool/ Equipment	Purpose
Digitiser Board 	Converts physical patterns into a digital format
Computer System 	High-speed processor and large display for efficient work
Mouse/ Stylus Tablet 	For precise drawing and editing

Traditional Tools for Reference or Backup

- **1Pattern master or tailor's curve:** A pattern master or tailor's curve is an essential tool in the hands of any pattern maker, especially when precision and finesse are required in drafting or modifying garment patterns. This curved ruler, often made of plastic or metal, helps in drawing armholes, necklines, sleeve caps, hip curves, and other complex contours with consistency and accuracy. While digital software now allows curve generation, traditional pattern masters are still used for quick manual adjustments, corrections, or during the initial concept phase when sketching by hand. Their ergonomic shape ensures smooth, balanced lines that align well with human anatomy.

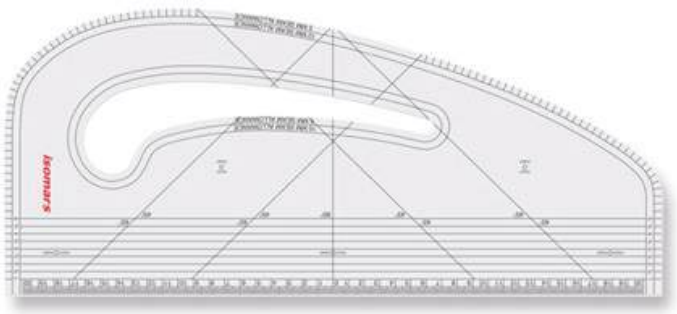


Fig. 2.1.3: Pattern master

- **Measuring tape and rulers:** Despite the digital age, measuring tapes and straight rulers remain fundamental tools for any pattern maker. A measuring tape, typically made of flexible fibreglass or cloth, is crucial for taking body measurements or measuring curved garment areas like bust, waist, hips, or inseams. Rulers, metal, plastic, or wooden, are used for marking straight lines, hems, seam allowances, and grainlines on paper patterns or fabric. These tools are indispensable in both drafting new patterns and in double-checking dimensions from CAD-generated files to ensure accuracy and proportionality.

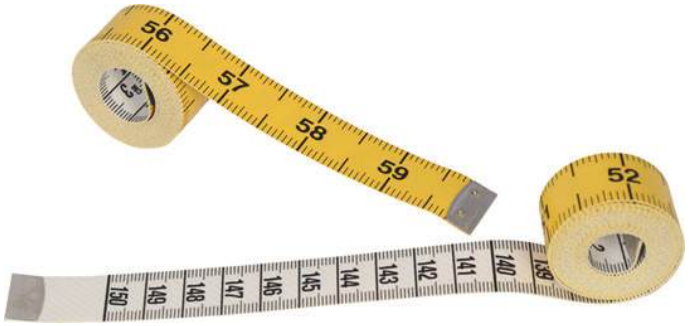


Fig. 2.1.4: Measuring tapes

- **Marking pens and notches:** Marking tools, such as tailor's chalk, air-erasable pens, tracing wheels, and fine-tipped markers, are used to transfer key information from pattern to fabric. This includes grainlines, darts, pleats, button placements, seam lines, and balance marks. Notches, small V-shaped cuts or marks on the edge of a pattern, serve as alignment guides during sewing. They indicate where two fabric pieces should meet or where details like sleeves, collars, or zippers should be inserted. These markers help maintain symmetry, alignment, and sewing accuracy, especially in complex garments.

Fig. 2.1.5: Marking pens

- **Muslin for mock-ups and draping:** Muslin, a plain-woven cotton fabric, is widely used in the fashion and garment industry for mock-ups or "toiles" before cutting into the final fabric. It is inexpensive, easy to manipulate, and behaves similarly to most standard garment materials. Pattern makers and designers use muslin to test the fit, proportion, and structure of a design. It also helps identify issues in the initial pattern, such as gaping, puckering, or imbalance, allowing for adjustments before production. For draping techniques, muslin is pinned directly onto a dress form to shape the garment, which is then translated into a pattern. This tactile process provides a three-dimensional understanding of how fabric flows over the body.

Fig. 2.1.6: Muslin fabric for draping

2.1.5 Analysing the Bill of Materials (BOM)

The Bill of Materials (BOM) is a comprehensive document that lists all the raw materials, components, trims, and accessories required to manufacture a garment. It acts as a central reference point for production teams, merchandisers, and pattern makers, ensuring all stakeholders are aligned with the technical and material requirements of a style. For the advanced pattern maker, analysing the BOM is a critical step before initiating pattern development, as it provides key information about fabric types, widths, trims, fasteners, and finishing elements. A well-prepared BOM ensures accuracy, reduces

miscommunication, and helps maintain consistency between the design concept and the finished product. By thoroughly reviewing the BOM, the pattern maker can proactively plan for material behaviour, production constraints, and garment specifications, leading to smoother downstream operations.

Category	Details Included
Main Fabric	Fabric type, composition, width, GSM
Contrast Fabric	Used for panels, lining, or design features
Interlining	Used in collars, cuffs, and waistbands
Trims and Accessories	Zippers, buttons, threads, hooks and loop tapes
Labels and Tags	Brand labels, care labels
Packaging Materials	Polybags, tags, hangers, cartons

Table 2.1.2: Structure of a BOM

How BOM Supports Pattern Development

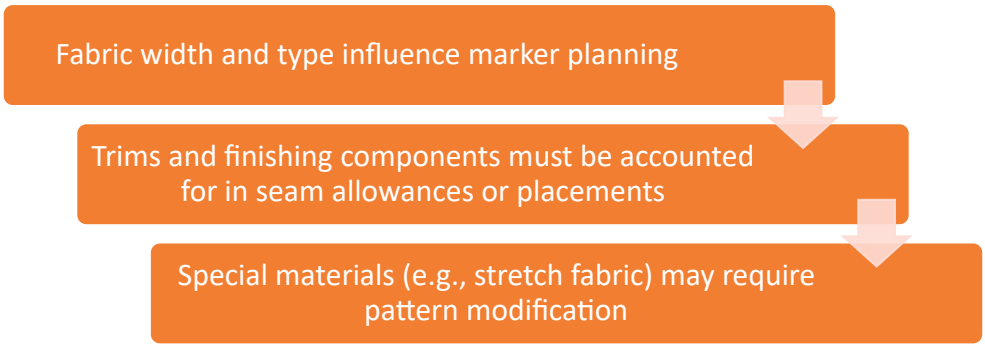


Fig. 2.1.7: BOM's Contribution to Pattern Development

- **Fabric width and type influence marker planning:** The fabric width (typically measured in inches or centimetres) is a critical factor in marker planning, which refers to the process of laying out all pattern pieces to minimise fabric wastage. If the fabric is narrow, the pattern maker must adjust the layout orientation of pieces, possibly splitting larger components or using more fabric length. Conversely, wider fabrics offer more flexibility and efficiency. The type of fabric, whether it's woven, knit, denim, silk, or chiffon, also impacts how patterns are developed. Each fabric behaves differently; for example, knits stretch, chiffon shifts, and denim is heavy. These behaviours affect seam placement, grainline orientation, and pattern shaping, so the BOM's details allow the pattern maker to make technically sound decisions tailored to fabric properties.
- **Trims and finishing components must be accounted for in seam allowances or placements:** The BOM lists trims and finishing materials such as zippers, buttons, lace, piping, lining, interlining, and tapes. These elements significantly affect pattern development because their integration into the garment requires precise allowances and placement. For instance, if the BOM includes a concealed zipper, the pattern must include additional seam allowance and a structured seam for proper installation. Similarly, decorative piping may require modified seam lines or bias-cut pattern pieces for smooth insertion. Without accounting for these elements, pattern alignment and final garment aesthetics may suffer. Hence, BOMs ensure that all finishing elements are seamlessly incorporated into the pattern structure.

- **Special materials (e.g., stretch fabric) may require pattern modification:** Certain fabrics listed in the BOM, such as stretch knits, spandex blends, or laminated textiles, necessitate specific pattern modifications. Stretch fabrics often require negative ease, meaning the pattern is made slightly smaller than the body measurements, so the fabric fits snugly when stretched. This involves altering the base pattern blocks and avoiding features like darts or pleats, which may distort under tension. In contrast, non-stretch or stiff materials may require ease additions, shaping features like darts or princess seams, and more generous seam allowances. If the BOM lists materials like leather, mesh, or technical textiles, the pattern maker must also consider fabric grain behaviour, thickness, and flexibility, ensuring accurate fit and construction techniques.

UNIT 2.2: Pattern Development Using CAD

Unit Objectives

By the end of this unit, the participants will be able to:

1. Set up the CAD machine for pattern making.
2. Take measurements from the spec sheet or retrieve them digitally.
3. Draft the pattern or digitise the manual pattern using CAD software as per given specifications.
4. Adjust the pattern as per required standards and allowances.
5. Examine the developed pattern in relation to the spec sheet.
6. Make necessary modifications to correct deviations or improve accuracy.

2.2.1 CAD Machine for Pattern Making

Computer-Aided Design (CAD) machines have revolutionised the pattern-making process in the apparel industry by introducing speed, precision, and repeatability. Unlike traditional manual drafting methods, CAD systems allow pattern makers to create, modify, and grade patterns digitally with greater accuracy. These machines support a range of functionalities—from basic design outlines to complex draping simulations—enhancing both efficiency and innovation. CAD tools help reduce material wastage by optimising marker layouts and ensuring consistency across production batches. They also enable seamless communication between design and manufacturing teams by offering standardised digital outputs. As the industry moves toward automation and mass customisation, proficiency in CAD-based pattern making has become an essential skill. The integration of CAD machines empowers pattern makers to bring creative ideas to life while meeting modern-day demands for quality and speed.

In setting up the CAD machine for pattern making, the first step involves preparing the CAD system, which typically includes:

- **Hardware Setup:**
  - Connecting and calibrating digitiser boards (for scanning manual patterns)
  - Setting up a plotter for printing full-scale patterns
  - Ensuring a working desktop or workstation with sufficient RAM and GPU support
- **Software Configuration:**
  - Launching industry-recognised pattern-making software such as:
    - **Gerber AccuMark:** Gerber AccuMark is one of the most established and widely used pattern-making systems globally. Developed by Gerber Technology, it is favoured by large garment manufacturing units for its comprehensive suite of tools. It allows pattern makers to create, digitise, grade, and optimise marker layouts efficiently. AccuMark also offers seamless integration with Gerber's cutting machines and plotters, ensuring a smooth transition from design to production. The inclusion of AccuMark 3D enhances the platform by offering virtual sample simulation, which significantly reduces the need for physical samples. Its robust database management and precise engineering make it a go-to solution for bulk and standardised production environments.
    - **TUKAcad:** TUKAcad, developed by Tukatech, is another popular CAD software, especially among small and medium enterprises (SMEs) and educational institutions. TUKAcad stands out for its intuitive user interface, affordability, and real-time pattern drafting capabilities. It supports both 2D pattern development and marker planning, and offers a cloud-based

collaboration environment for remote work. The software integrates smoothly with other Tukatech products, including virtual fit software and automatic cutters. Its cost-effectiveness, ease of learning, and extensive customer support make it ideal for emerging fashion designers, boutique manufacturers, and academic institutions teaching pattern-making skills.

- **Optitex:** Optitex is known for its strong emphasis on 3D visualisation and virtual prototyping. It provides advanced 2D pattern-making tools and allows users to simulate garment fit and fabric behaviour on customizable digital avatars. This capability significantly shortens the sampling process and is particularly valuable for fast fashion brands aiming to reduce time-to-market. Optitex supports fit analysis with tools like tension mapping, helping designers identify areas of strain or poor fit early in the development cycle. It also integrates with Product Lifecycle Management (PLM) systems, enabling better coordination across design, production, and supply chain teams.
- **Lectra:** Lectra Modaris is considered a premium solution for pattern development and is widely used by both luxury fashion houses and high-volume manufacturers. Its powerful 2D and 3D capabilities allow for intricate pattern adjustments and realistic garment simulations. The software helps streamline grading, notching, and annotation, while providing tools to optimise fabric usage and reduce waste. Lectra's ecosystem includes integrated cutting room solutions, making it a full-service platform for end-to-end apparel production. Companies that require high-level accuracy, detailed pattern customisation, and robust production control often turn to Lectra Modaris.

- Defining workspace parameters: unit (cm/inch), page size, scale, and grid settings
- Setting up tool libraries and measurement databases

Software	2D Patterning	3D Simulation	Grading	Marker Making	Integration
Gerber AccuMark	✓	✓	✓	✓	High
TUKAcad	✓	Limited	✓	✓	Medium
Optitex	✓	✓	✓	✓	High
Lectra Modaris	✓	✓	✓	✓	Very High

Table 2.2.1: Comparison Table

2.2.2 Taking Measurements from Spec Sheet or Digital Sources

industry. Advanced Pattern Makers frequently rely on specification (spec) sheets or digital sources to extract detailed garment dimensions and construction parameters. These sources offer standardised measurement data such as chest width, waist, hip, sleeve length, and more, ensuring precision and consistency throughout the production process. With the increasing integration of CAD systems and digital tools, measurements can now be accessed, shared, and interpreted in real-time, reducing manual errors. Understanding how to read and interpret these sources is essential for ensuring fit accuracy and production efficiency. A clear grasp of digital spec sheets also enables faster turnaround times and seamless collaboration across departments.

Accurate measurements form the base of a successful pattern. These can be:

- **Manually entered:** From a hard copy or PDF spec sheet that outlines body measurements and design specifics.
- **Digitally retrieved:** From ERP or PLM systems that maintain centralised data for different sizes and styles.

Measurement Point	Spec (Size M)
Chest Circumference 	94 cm
Waist Circumference 	78 cm
Hip Circumference 	100 cm

Measurement Point	Spec (Size M)
Back Length 	40 cm
Sleeve Length 	60 cm

The pattern maker must ensure all measurements are consistent with garment size charts and base size parameters.

2.2.3 Drafting or Digitising the Pattern Using CAD Software

Drafting or digitising patterns using CAD software marks a crucial step in modern apparel production, replacing time-consuming manual methods with precise digital techniques. In this process, a pattern can either be created from scratch using digital drafting tools or converted from a paper format using a digitiser. CAD software enables the user to design, modify, and grade patterns with exceptional accuracy and efficiency. Features such as measurement tools, seam allowances, and layering options streamline the development of complex garment components. Digitising ensures that legacy patterns or designer sketches can be preserved, edited, and integrated into automated workflows. This digital approach enhances communication, improves consistency across production runs, and reduces errors during manufacturing. As apparel production continues to scale globally, the ability to draft or digitise patterns through CAD is a vital skill for advanced pattern makers.

Drafting or digitising the pattern using CAD software involves two primary approaches:

1. **Drafting from Scratch:**
   - Using CAD drawing tools to draft blocks directly on-screen using the entered measurements
   - Tools used include:
     - **Point Tool:** For base locations (shoulder point, bust point)
     - **Line and Curve Tools:** For drawing seams, necklines, armholes
     - **Grading Tool:** For generating multiple sizes from a base pattern
     - **Seam Tools:** For adding seam allowances automatically
2. **Digitising Existing Patterns:**
   - Manual patterns are placed on a digitising board and traced using a puck (cursor device)
   - Once digitised, lines and curves are refined using CAD tools for accuracy
   - Digitised patterns can be saved, modified, and scaled without degradation

2.2.4 Pattern Adjustments and Seam Allowances

Pattern adjustments and seam allowances are essential components in ensuring garment fit, functionality, and production efficiency. Adjustments may be required to tailor patterns to different sizes, body shapes, fabric types, or specific design requirements. These modifications are carried out with precision to maintain the balance, proportion, and integrity of the original pattern. Seam allowances, the extra space between the stitching line and the fabric edge, are added to accommodate the assembly process during garment construction. Proper allocation of seam allowances is critical, as it affects ease of sewing, garment durability, and final appearance. Advanced pattern makers must understand how to adjust patterns while maintaining grainlines, notches, and alignment points. Whether manually or digitally applied, accurate adjustments and seam allowances contribute to high-quality garment production and minimise rework or material waste.

After drafting, the pattern must be checked and adjusted for:

- Correct seam allowances (e.g., 1 cm for side seams, 0.5 cm for necklines)
- Ease (for movement, fit, and comfort)
- Shape corrections such as dart adjustments, sleeve caps, and neck drops

Pattern Area	Recommended Seam Allowance
Side Seams	1.0 cm
Armholes and Necklines	0.5 cm
Bottom Hems	2.5 – 3.0 cm

Table 2.2.2: Seam Allowance

Each pattern piece should also have:

- **Notches:** Notches are small marks or symbols, usually triangles or short lines, placed on the edges of pattern pieces. Their primary purpose is to assist with the alignment and joining of garment sections during sewing. For example, when attaching a sleeve to an armhole or sewing a waistband to pants, notches ensure the fabric pieces' match precisely. There are different types of notches: single notches typically indicate the front of a garment piece, double notches signify the back,

and triple notches may be used for special instructions or design variations. In industrial settings, notches also aid in improving production efficiency by guiding sewing operators, reducing the chances of misalignment, and ensuring uniformity in mass production.

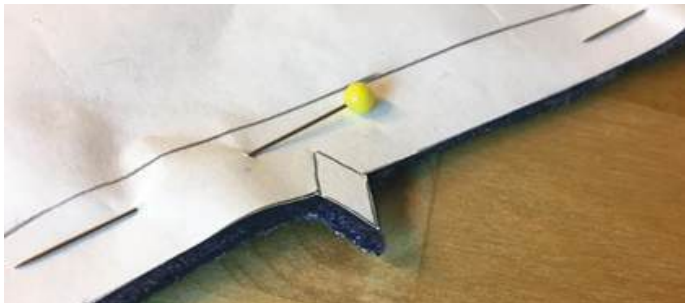


Fig. 2.2.1: Notches

- **Grainlines:** Grainlines are long arrows printed on pattern pieces to indicate the direction in which the pattern should be laid on the fabric. The grainline usually runs parallel to the selvedge (the finished edge of the fabric), ensuring the fabric drapes correctly and maintains its intended fit and shape. Incorrect grainline alignment can lead to twisted seams, poor garment falls, or distortion during wear and wash. Some patterns also include bias grainlines (diagonal) for garments that require stretch or a specific draping effect. Observing the grainline is particularly critical for garments made from striped, checked, or printed fabrics, where visual alignment affects the final look.

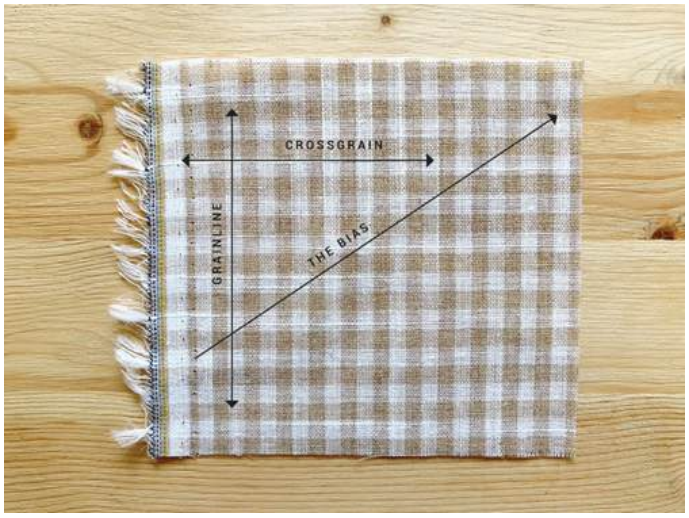


Fig. 2.2.2: Grainlines

- **Labels (e.g., front/back, size, style number):** Each pattern piece must include clear and consistent labelling. This typically involves the garment section name (e.g., front bodice, back bodice, sleeve), placement instructions (e.g., cut on fold, cut 2), and size information. Additionally, style numbers, version codes, or designer/ brand names are often included for inventory and identification purposes, especially in industrial production. Labels are critical for avoiding confusion when handling multiple sizes or styles and during quality control checks. Including the centre front or centre back notation, along with alignment marks, also assists in sewing precision and fabric layout.

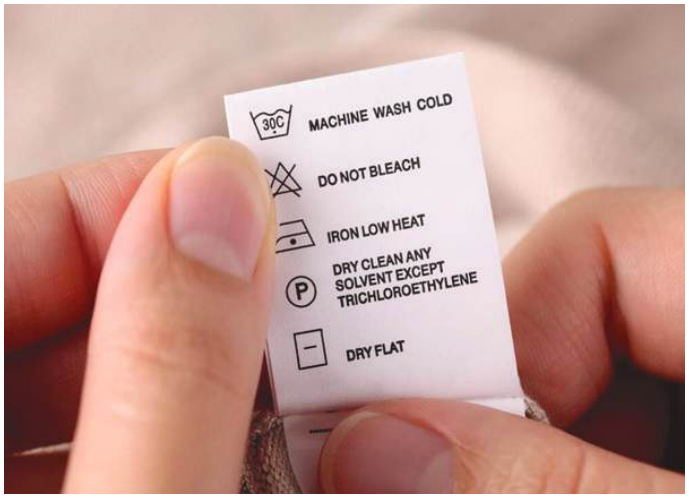


Fig. 2.2.3: Labels in garment

2.2.5 Examining the Developed Pattern in Relation to the Spec Sheet

Once a pattern has been drafted or digitised using CAD software, it must be meticulously reviewed against the specification sheet (spec sheet) to ensure that all design, measurement, and construction details have been accurately interpreted and implemented. The spec sheet serves as a blueprint that outlines every essential aspect of a garment, including dimensions, style elements, fabric requirements, trims, seam allowances, construction details, and finishing techniques.

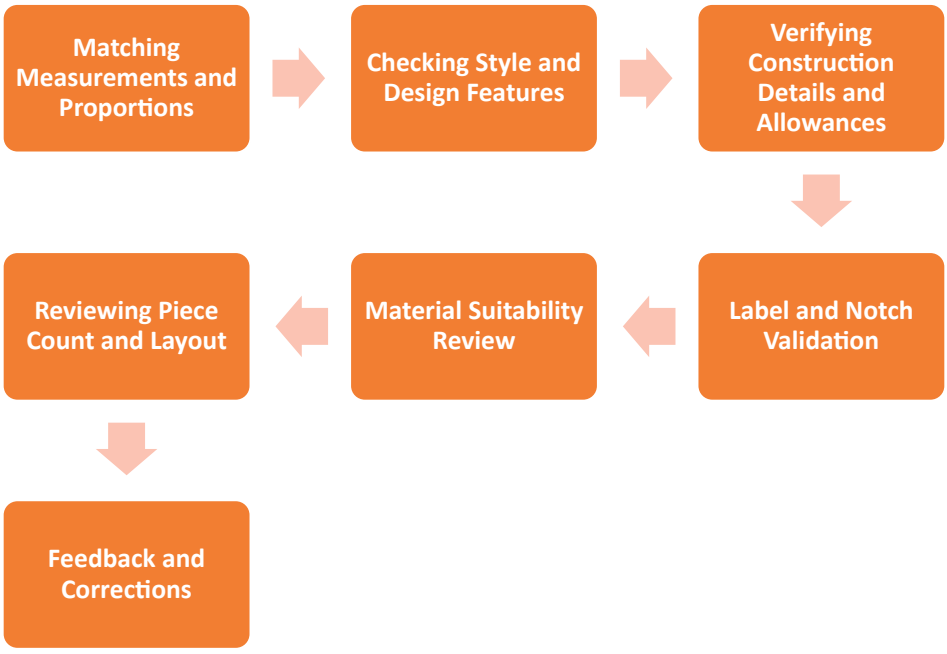


Fig. 2.2.4: Process of Examining the Developed Pattern in Relation to the Spec Sheet

1. **Matching Measurements and Proportions:**

   The first step involves verifying that the key measurements, such as chest, waist, hip, length, armhole depth, sleeve length, etc., on the developed pattern align with those listed in the spec sheet. Even a minor deviation can affect garment fit and production consistency. CAD software often includes digital measuring tools to streamline this validation process.

2. **Checking Style and Design Features:**

   The pattern should reflect all design elements described in the spec sheet, such as darts, pleats, pockets, panels, necklines, and hems. For instance, if the spec sheet calls for a princess seam or raglan sleeve, the developed pattern must include these features precisely in their intended proportions and placements.

3. **Verifying Construction Details and Allowances:**

   The pattern must include appropriate seam allowances, hemlines, plackets, facings, and other finishing components as per the construction specifications. These technical details are critical for assembly on the shop floor and influence garment durability and comfort.

4. **Label and Notch Validation:**

   It is essential to confirm that all pattern pieces are correctly labelled (e.g., front bodice, size M, cut 2) and that notches, grainlines, and fold lines are placed as instructed. These ensure proper alignment and ease during sewing and cutting.

5. **Material Suitability Review:**

   Certain materials behave differently based on stretch, drape, or thickness. The pattern's shape and ease must be checked for compatibility with the fabric type mentioned in the spec sheet. For example, stretch fabrics may require negative ease, while woven fabrics may need added allowances.

6. **Reviewing Piece Count and Layout:**

   Ensure that all necessary pattern pieces are present and properly laid out. Missing or duplicate components can cause delays in sampling and production. Marker plans, influenced by the BOM and fabric width, should also align with the pattern dimensions.

7. **Feedback and Corrections:**

   After examination, any deviations must be noted and corrected in the CAD file. Feedback loops between the pattern maker and designer or merchandiser may be necessary to resolve issues and approve final versions before moving to grading or sampling.

2.2.6 Necessary Modifications

After a pattern has been drafted using CAD and carefully compared with the specification sheet, it is common to identify discrepancies or areas for improvement. These differences may arise due to misinterpretation of design elements, misalignment with measurements, or technical challenges in translating a concept into a workable pattern. This phase is crucial to refining the pattern and ensuring it meets both aesthetic and production standards.

Modifications can be minor, such as redrawing curved lines (e.g., necklines, armholes) or adjusting seam placements for better balance and fit. These are usually straightforward and handled directly within the CAD environment. However, some situations demand major modifications, like redrafting entire pattern pieces, altering fit blocks, or resizing key components due to fundamental design changes or errors.

Particular attention must be paid to structural details such as darts, pleats, seam allowances, and points of ease, ensuring they are precisely placed and marked. If the pattern is intended for multiple sizes, proper grading rules must be applied and tested for consistency. At this stage, the goal is to finalise a technically sound pattern that is ready for downstream processes, plotting, cutting, or digital export. This step guarantees a seamless transition from digital design to tangible garment production.

Any discrepancies between the spec sheet and the developed pattern must be addressed:

- **Minor modifications:** Redrawing curves, adjusting seam positions
- **Major changes:** Redrafting pattern pieces, resizing blocks
- **Ensure that:**
  - Darts, pleats, and ease are correctly marked
  - Grading rules are properly applied across all sizes
  - Final pattern is ready for plotting, cutting, or exporting

Final steps involve:

- Saving the pattern file in a standard format (e.g., .dxf, plt, or software-specific)
- Creating marker layouts for cutting
- Sending files to plotting or cutting departments

Summary

- Pattern makers begin by interpreting spec sheets and coordinating with design and production teams.
- Merchandisers provide essential data that ensures accuracy and avoids miscommunication in pattern development.
- Both traditional tools and modern equipment are vital for precision in pattern drafting.
- The BOM guides fabric usage, trim placement, and seam allowances during pattern planning.
- CAD software like Gerber, TUKAcad, and Optitex streamlines digital pattern creation and modification.
- Developed patterns must match the spec sheet in terms of measurements, labels, notches, and grainlines.
- Discrepancies are corrected, grading is applied, and patterns are finalised for production.

Exercise

Multiple-choice Question:

1. Which of the following software is widely used for digital pattern making in the apparel industry?
   a. Adobe Illustrator
   b. Microsoft Excel
   c. Gerber AccuMark
   d. AutoCAD

2. What does a Bill of Materials (BOM) help determine in the pattern development process?
   a. Store inventory levels
   b. Fabric width, trims, and seam allowance planning
   c. Designer colour preferences
   d. Consumer buying trends

3. Which of the following is NOT a traditional tool used for manual pattern making?
   a. Pattern master
   b. Measuring tape
   c. TUKAcad
   d. Muslin

4. What must be included on each pattern piece for clarity during production?
   a. Washing instructions
   b. Designer's signature
   c. Grainlines and labels
   d. Barcode

5. Minor modifications during pattern correction include:
   a. Redrawing curves
   b. Resizing the entire block
   c. Creating a new BOM
   Exporting finished garments

Descriptive Questions:

1. Explain the significance of coordinating with merchandisers during the pattern development process.
2. Describe how CAD software enhances efficiency in modern pattern making compared to traditional methods.
3. What are the essential elements that must be marked on each pattern piece, and why are they important?
4. Discuss how the Bill of Materials (BOM) influences decisions made during digital pattern drafting.
5. Differentiate between minor and major modifications in CAD pattern correction with relevant examples.

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/BnfzbhvQ05k?si=1l_p0v0xBCVvRK8I

Clothing Tech Pack

https://youtu.be/1BOvn-IwAmU?si=QRMFZh6AzqPo-eLl

Evolution of CAD Tools

https://youtu.be/WrDu5rHAcIM?si=BbpaL6oOX7nN4v6K

Bill of materials

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE>IMAGINE FUTURE

APPAREL MADE-UPS HOME FURNISHING
SECTOR SKILL COUNCIL

3. Develop the Pattern Through (CAD/CAM)

Unit 3.1 - Pattern Development and Preparation

Unit 3.2 - Marker Efficiency and Cutting Execution

AMH/N1101

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Incorporate the shrinkage in the pattern.
2. Determine the cut ratio plan.
3. Grade the patterns as provided in the BOM (Bill of Material).
4. Identify the shrinkage required to be introduced as per the garment specification and the fabric to be used.
5. Identify the types of the markers best suitable for the specific style.
6. Plan the laying of the marker accurately.
7. Identify the most efficient marker (lay planning) according to the configuration intended.
8. Set the parameters on CAM as per required output.
9. Cut the design output

UNIT 3.1: Pattern Development and Preparation

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe the incorporation of shrinkage in the pattern as per garment specifications and fabric type.
2. Explain the process of grading patterns based on the Bill of Material (BOM).
3. Analyse and determine the cut ratio plan for accurate material allocation.

3.1.1 Incorporation of Shrinkage in the Pattern

In the apparel production process, fabric shrinkage is a phenomenon that cannot be overlooked. It refers to the reduction in fabric dimensions, either in length (warp direction), width (weft direction), or both, when the fabric undergoes various treatments like pre-washing, dyeing, drying, or finishing. If not accurately accounted for in pattern development, shrinkage can lead to ill-fitting garments and rejected lots, resulting in significant financial losses and material wastage. Fabric shrinkage is a critical consideration in garment manufacturing. Different fabric types shrink at varying rates during processes like washing, dyeing, or finishing. If this shrinkage is not accounted for during pattern making, the final garment will be smaller than intended.

Shrinkage Types and Causes

Shrinkage varies based on:

- **Fiber content:** Natural fibres like cotton and wool tend to shrink more than synthetics.
- **Fabric structure:** Knitted fabrics usually shrink more than woven fabrics.
- **Processing methods:** Heat-intensive finishing or dyeing processes accelerate shrinkage.

Fabric Testing for Shrinkage

To quantify shrinkage:

- A fabric swatch (usually 50 cm x 50 cm) is marked with precise dimensions.
- It is then subjected to standard washing and drying cycles (e.g., ISO 6330 or AATCC Test Method 135).
- After drying, the fabric is remeasured.
- Shrinkage is calculated using the formula:

$$Shrinkage\left(\%\right) = \frac{Original\ \ Dimension\ \ -\ \ Final\ \ Dimension}{Original\ \ Dimension} \times 100$$

Recording Shrinkage Data

The shrinkage is documented separately for warp and weft directions, as they often differ. For instance:

Direction	Original (cm)	After Wash (cm)	Shrinkage (%)
Warp	**50**	48	4.00%
Weft	**50**	49	2.00%

These values are recorded in a fabric test report or BOM and shared with the pattern-making team.

Shrinkage in Pattern Development

Using the test data:

- **Manual Method:** Pattern pieces are scaled up by the shrinkage percentage. For example, a 50 cm length with 4% shrinkage would be increased to 52 cm on the pattern.
- **CAD Method:** In software like Gerber AccuMark or Lectra, shrinkage allowances can be entered directly:
  - Shrinkage % for warp and weft
  - The software adjusts the pattern pieces proportionally
  - Helps ensure consistency across multiple sizes and fabric batches

Quality Assurance Check

After shrinkage is incorporated:

- A mock-up sample is often created using the adjusted pattern and tested fabric.
- The sample is washed again and measured to ensure it meets the spec sheet dimension post-shrinkage.

Process

- Shrinkage percentage is calculated using fabric test reports.
- The pattern is scaled accordingly to add the shrinkage allowance before grading or cutting.
- CAD software allows users to enter shrinkage percentages for both warp (lengthwise) and weft (widthwise) directions.

Example Table - Fabric Shrinkage Allowance

Fabric Type	Warp Shrinkage (%)	Weft Shrinkage (%)	Action on Pattern
Cotton Poplin	**3.0**	2.5	Add extra width and length accordingly
Denim	**2.0**	1.5	Modify the length and width of pattern pieces
Polyester Blend	0.5	0.3	Minor adjustment required

Table 3.1.1: Fabric Shrinkage Allowance Example

3.1.2 Grading Patterns Based on BOM

Grading is the process of creating different sizes from a base pattern. This is crucial for meeting market demands across various body sizes. The BOM (Bill of Materials) provides insight into fabric behaviour, required trims, and sizing breakdown, which influences how grading is approached.

Steps in CAD Grading:

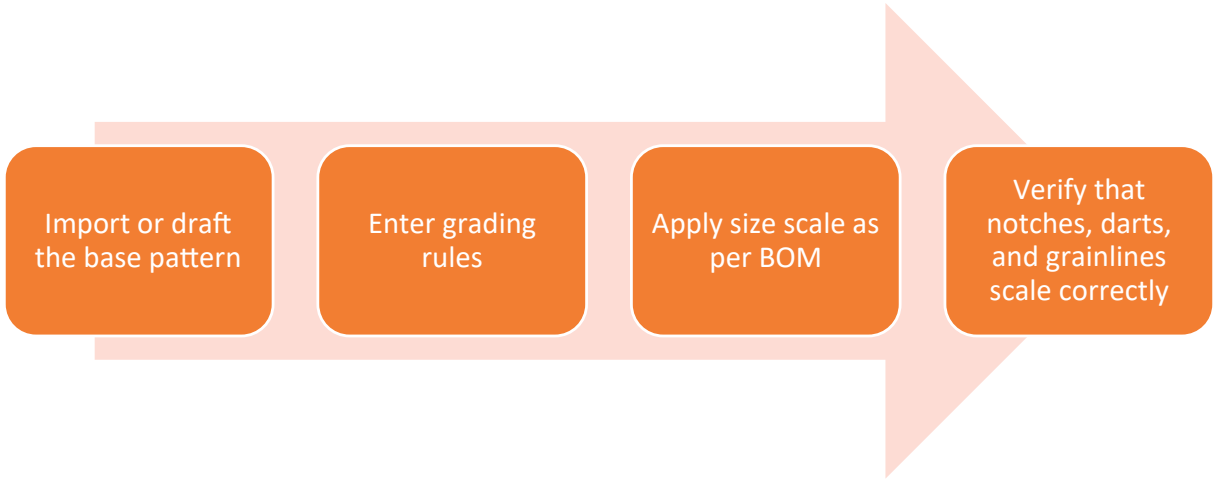


Fig. 3.1.1: Steps in CAD Grading

- Import or draft the base pattern.
- Enter grading rules (e.g., increase waist by 1", sleeve length by 0.5", etc.).
- Apply size scale as per BOM (e.g., S, M, L, XL).
- Verify that notches, darts, and grainlines scale correctly.

Measurement Area	Base Size (M)	Size S (-)	Size L (+)	Size XL (++)
Chest	38"	-1"	+1"	+2"
Waist	32"	-1"	+1"	+2"
Sleeve Length	24"	-0.5"	+0.5"	+1"

Table 3.1.2: Sample Table - Grading Increments

3.1.3 Determining the Cut Ratio Plan

A cut ratio plan outlines the number of garments to be cut per size from a single lay of fabric. This ensures optimised fabric usage and meets production requirements efficiently. The ratio is derived from the order quantity and the size demand. The cut ratio plan is a key aspect of production planning in the apparel industry. It involves calculating how many garments of each size need to be cut from a given quantity of fabric. This planning ensures that fabric is utilised efficiently, waste is minimised, and production matches the size-wise demand outlined in the order sheet. The goal is to align fabric consumption with the Bill of Materials (BOM) and production orders in a cost-effective, size-specific, and timely manner.

A cut ratio plan defines the proportion of sizes to be cut in one marker or lay. For example, a ratio of 1:2:2:1 for sizes S, M, L, XL means that for every 6 garments, 1 will be size S, 2 M, 2 L, and 1 XL.

Why is it Important?

- Balances production with market demand.
- Prevents over- or under-cutting of specific sizes.
- Helps optimise marker efficiency in CAD systems.
- Supports cost-effective and accurate material procurement.

Process of Determining a Cut Ratio Plan

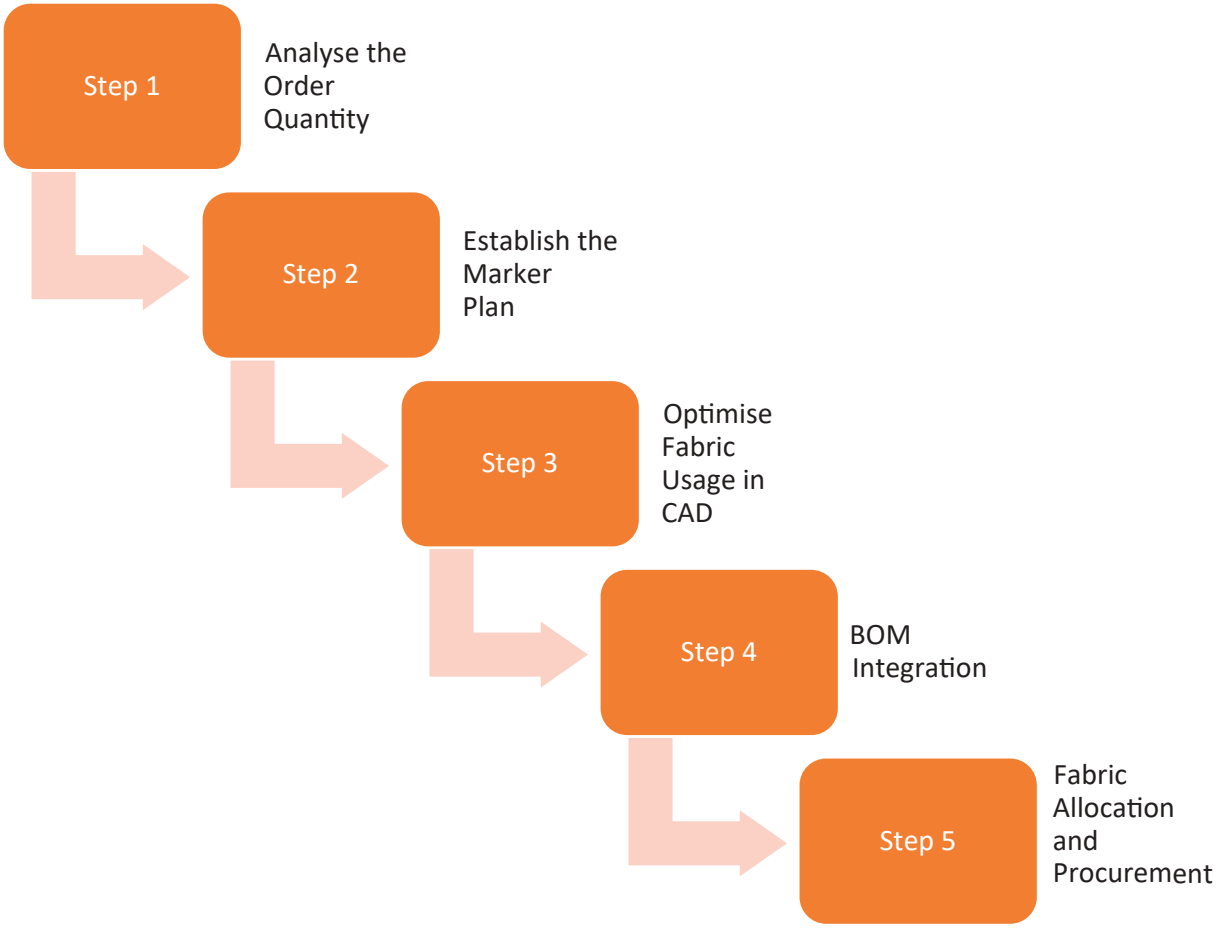


Fig. 3.1.2: Steps in determining a Cut Ratio Plan

Step 1: Analyse the Order Quantity

Suppose an order includes:

- S = 200 pieces
- M = 400 pieces
- L = 400 pieces
- XL = 200 pieces

This can be expressed in ratio terms as 1:2:2:1.

Step 2: Establish the Marker Plan

Using the cut ratio, decide how many layers of fabric will be laid to achieve the desired output in one cutting lot.

Size	Ratio	Pieces per Lay	Layers in Lay
S	1	10	20
M	2	20	20
L	2	20	20
XL	1	10	20
Total	-	**60 garments**	-

So, one lay of 20 layers will yield 60 garments in the desired size ratio.

Step 3: Optimise Fabric Usage in CAD

CAD software (e.g., Lectra, Gerber AccuMark) allows planners to:

- Input the cut ratio plan
- Generate marker layouts accordingly
- Maximise fabric utilisation based on pattern piece placement

Step 4: BOM Integration

Use the Bill of Materials (BOM) to verify:

- Fabric consumption per garment size
- Trims and accessories needed per size
- Total yardage required = Total garments x Fabric per piece

Step 5: Fabric Allocation and Procurement

Once the cut plan and BOM are aligned, procurement teams order the exact quantity of fabric required, including:

- Shrinkage allowance
- Marker wastage (e.g., 2-4%)
- Testing or sampling the yardage buffer

Cut Ratio Table Example

Size	Order Qty	Ratio	Cut per Lay	Total Lays
S	200	1	10	20
M	400	2	20	20
L	400	2	20	20
XL	200	1	10	20

Benefits of an Accurate Cut Ratio Plan

- Reduces fabric wastage.
- Enhances cost control.
- Ensures consistent quality across size sets.
- Facilitates smooth coordination between design, cutting, and procurement departments.

Unit 3.2: Marker Efficiency and Cutting Execution

Unit Objectives

By the end of this unit, the participants will be able to:

1. Identify and discuss the types of markers suitable for different styles.
2. Plan and examine accurate marker laying for optimal efficiency.
3. Assess and identify the most efficient lay planning method according to configuration.
4. Set and explain the parameters on Computer-Aided Manufacturing (CAM) for desired output.
5. Execute and cut the design output as per planned specifications.

3.2.1 Marker Types and Their Applications

Marker making is a critical step in apparel production that directly affects fabric utilisation, cost-efficiency, and garment accuracy. A marker is a diagram or layout showing how all the pattern pieces for a particular style and size range should be placed on the fabric for cutting. The type of marker used varies depending on the garment style, fabric type, production quantity, and cutting method. Selecting the right marker type ensures reduced fabric wastage and improved cutting precision. Markers are layouts of all garment pattern pieces arranged on the fabric width for cutting. The goal is to optimise fabric consumption and production time.

Marker Type	Application	Ideal For
Single-size Marker	All pattern pieces of only one size are laid out. Used when bulk orders in one size are required or for sample development.	Sampling, High-volume single-size cuts
Multi-size Marker	Contains pattern pieces of different sizes laid in a predetermined ratio (cut ratio plan).	Bulk production
Mixed-style Marker	Includes patterns for multiple styles laid out together for cutting.	Small-scale production or prototypes
Nap Marker (One-way)	Ensures all fabric pieces are placed in the same direction to maintain consistency, especially for fabrics with nap or directional prints.	Velvet, Corduroy, Satin
Non-nap Marker (Two-way)	Pattern pieces can be laid in either direction, maximising fabric efficiency.	Non-directional fabrics
Open Marker	Fabric is spread in a single ply, and marker is laid flat.	Checkered or striped fabrics
Folded Marker	The marker is designed to be used on folded fabric, ensuring symmetrical cutting.	Standard fabric cutting processes

Table 3.2.1: Types of Markers Based on Style and Fabric Requirements

Factors to Consider When Selecting Marker Type:

1. **Fabric characteristics:** Stripes, checks, nap, or sheen influence marker direction and alignment.
2. **Style complexity:** More intricate styles may require nap markers or mixed-style markers.
3. **Production quantity:** Bulk production benefits from multi-size markers, while small batches may use single-size.
4. **Fabric width and consumption:** Wider fabrics offer flexibility in marker types and layout.
5. **Marker length limitations:** Machines and table size define maximum allowable marker length.
6. **Cutting method:** Manual vs automated cutting systems affect marker planning.

3.2.2 Marker Layout for Optimal Efficiency

Marker layout is a critical step in the apparel production process, aimed at maximising fabric utilisation and minimising waste. It involves the strategic placement of pattern pieces on the fabric to ensure the most efficient use of materials during cutting. A well-optimized marker layout considers fabric width, garment sizes, pattern orientation, grainlines, and cutting allowances. Advanced software tools are often used to automate and enhance this process, offering multiple layout options for comparison. Efficient marker planning not only reduces production costs but also supports sustainability goals by reducing fabric waste. Pattern makers and cutting room professionals must balance precision, productivity, and material constraints while preparing markers. Properly executed marker layouts are key to ensuring consistency, cost-efficiency, and quality in mass garment production.

Marker efficiency is measured by how well the fabric is used in relation to the total fabric width and length.

Key Principles:

- Place larger pieces first (front, back).
- Nest smaller pieces in gaps between larger ones.
- Avoid gaps, overlap, and fabric edge wastage.
- Maintain grainline orientation and match prints where needed.

Marker Efficiency Formula:

$$Marker\ Efficiency\ (\%) = \frac{Total\ area\ of\ pattern\ pieces}{Area\ of\ marker\ (fabric\ used)} \times 100$$

Fabric Type	Target Efficiency
Woven – Plain	85–90%
Woven – Printed/Nap	75–80%
Knits (circular rib)	80–85%
XL	200

Table 3.2.2: Target Efficiency Benchmarks

Marker Layout Planning Process:

Step 1: Input Pattern

The first step in the marker layout planning process involves inputting the digital pattern into the CAD (Computer-Aided Design) software. These patterns are pre-finalized and include all necessary specifications such as seam allowances, notches, grainlines, and pattern labels. It is crucial to select the correct style number and ensure all required components, including main body, linings, and fusings, are included. At this stage, adjustments for shrinkage and fabric width must also be confirmed to ensure accurate planning downstream.

Step 2: Arrange Pieces

Once the patterns are loaded, the next step is to begin arranging the pieces on the virtual fabric layout. This can be done either manually or with the help of automatic nesting algorithms provided by CAD systems. Large and irregularly shaped components should be placed first to establish the structure of the marker, followed by smaller pieces that fill in the gaps. Care should be taken to make efficient use of fabric real estate while also ensuring pattern orientation and compatibility with the cutting method (e.g., blade or laser). Strategic arrangement helps in reducing fabric wastage and improves overall efficiency.

Step 3: Check Grainline

Grainline orientation is a critical factor in garment aesthetics and durability. In this step, each pattern piece is checked to ensure its grainline arrow is aligned correctly with the fabric's lengthwise grain (warp direction). This is especially vital for garments with directional prints, pile, or nap, which require all pieces to face the same direction (creating a one-way marker). For symmetrical components like sleeves or pockets, correct mirroring is essential to maintain garment consistency and structural balance.

Step 4: Adjust for Gaps

After arranging and aligning all pattern pieces, the layout is fine-tuned by adjusting gaps between them. The goal is to minimize these gaps to achieve high marker efficiency, ideally above 80%, while leaving enough buffer to accommodate cutting tools and fabric properties such as fraying or stretching. This step involves careful consideration of how closely pieces can be placed without compromising cutting accuracy or garment integrity. The type of fabric and cutting equipment often influence these decisions.

Step 5: Save Marker

The final step in the marker layout process is saving the completed marker for production use. The layout is checked one last time for errors or overlaps, and then saved under a standardised naming convention that typically includes the style number, version, and size range. The marker file is exported in a compatible format (e.g., .plt, .dxf, or .rul) for printing or uploading into CAM (Computer-Aided Manufacturing) systems. Additionally, a marker efficiency report is generated, which details the total fabric length used, percentage of utilisation, and estimated fabric consumption per garment, serving as an important document for production planning.

3.2.3 Lay Planning Methods for Maximum Output

In mass garment manufacturing, achieving high efficiency in fabric usage and cutting speed is essential to maintaining profitability and minimising waste. One of the most critical components in this process is lay planning, the method of preparing multiple fabric layers (or "lays") on the cutting table before the actual cutting begins. A lay is a spread of fabric layers on which a marker (a template that outlines all pattern pieces for a batch) is placed to guide the cutting process.

Lay planning determines how these fabric layers are configured in terms of length, width, number of plies (layers), and marker placement. Effective lay planning ensures optimum utilisation of fabric, reduction in production time, and alignment with daily cutting targets. It takes into account various factors such as order quantity, size ratio, fabric width, fabric defects, type of fabric (knit/ woven), directionality of the print or nap, and machine limitations.

There are multiple lay types, including single-size lays, multi-size lays, single-garment lays, and multi-garment lays, each suited for different production scenarios. Some lays are made for single-colour fabric, while others accommodate multiple colourways or different fabric qualities in one spread. The maximum output from a lay depends on how well these factors are synchronised with marker efficiency and the cutting plan.

In modern setups, lay planning is often aided by Cut Order Planning (COP) software and Computer-Aided Manufacturing (CAM) systems, which analyse constraints and automatically generate the most economical lay plan. Whether done manually or digitally, the goal remains the same: to minimise fabric consumption and labour costs while ensuring timely and accurate cutting for further assembly.

Lay Plan Type	Description	Use Case
Single Ply Lay	One layer of fabric; laser or manual cutting used	Prototypes, small runs
Multi-Ply Lay	20–200 layers stacked and cut at once	Bulk production
Block Lay	Groups of the same size laid and cut together	For easier bundling by size
Mixed Lay	Combination of sizes within a lay based on the cut ratio plan	Mass production with size variation

Table 3.2.3: Types of Lay Plans

Choosing the Best Lay Plan Depends On

- **Quantity ordered:**
  - The order quantity dictates the scale and complexity of the lay plan.
  - For small production runs, single-size or short lays may be sufficient, even though they result in slightly higher fabric wastage.
  - In bulk production, multi-size and high-ply lays are preferred because they optimise material usage and save time in spreading and cutting.
  - Higher quantities justify the use of automated lay planning software and high-speed cutting systems, maximising returns on machine usage and reducing manual labour.
- **Size ratio:**
  - The size ratio refers to the distribution of sizes (e.g., S:M:L:XL = 1:2:2:1) in the total order.
  - Lay planning must align the number of plies (layers) for each size to match the ratio, ensuring the correct quantity of each size is cut.

- Accurate ratio-based lays reduce surplus or shortage of sizes, minimizing the need for costly recuts.
- Efficient size grouping in the marker (e.g., arranging more frequently ordered sizes side-by-side) also aids in space and cost optimization.

- **Fabric type:**
  - Different fabric types come with unique characteristics that impact lay planning:
  - Knit fabrics often require tension-free spreading and shorter lays to prevent distortion, while woven fabrics allow for longer lays and tighter spreading.
  - Directional fabrics with nap, pile, or printed motifs (like velvet or one-way prints) require single-direction lay planning, which can reduce marker efficiency.
  - For fabrics prone to shrinkage or torque, lay length and layer count may be limited, and extra allowances must be built into the marker.
- **Cutting machine capacity:**
  - The capacity of the cutting equipment, whether manual, semi-automatic, or fully automated, determines the maximum lay height, width, and fabric type that can be efficiently cut.
  - Manual cutting machines typically accommodate fewer fabric plies and may be slower, making them suitable for short or customised orders.
  - Automatic cutters (CAM systems) can handle hundreds of layers, reduce cutting time, and improve precision, but they require well-optimised lay plans and proper alignment.
  - Machine limitations in blade height, cutting speed, and table length must be considered to avoid errors or equipment wear.

3.2.4 Setting Parameters on CAM Systems

Computer-Aided Manufacturing (CAM) tools control automated cutters and optimise cutting speed and precision. In the modern apparel industry, Computer-Aided Manufacturing (CAM) systems play a transformative role in automating the fabric cutting process, which is traditionally labour-intensive and prone to inconsistencies. CAM systems are integrated with CAD (Computer-Aided Design) outputs and use programmable settings to control cutting equipment, ranging from straight knife cutters to high-speed laser, water jet, or blade-based machines. The primary objective of setting parameters in CAM systems is to maximise cutting precision, improve productivity, minimise fabric waste, and ensure repeatability across large production runs.

Before cutting begins, the CAM system must be configured with key operational parameters to suit the specific characteristics of the fabric, the complexity of the marker, the number of plies, and the type of cutter. These parameters guide the machine in terms of how fast to move, how deep to cut, what path to follow, how to handle curves or notches, and how to avoid errors like fraying, drag, or fabric shifting.

CAM parameter setting is not one-size-fits-all; it is highly dependent on the type of fabric (knit, woven, laminated), marker layout, layer height, and whether the cutter supports single-ply or multi-ply cutting. A poor configuration can lead to defects such as inaccurate cuts, damaged fabric edges, or uneven layers, all of which can result in costly rework and delays in the production cycle.

Thus, setting the right parameters in CAM systems is a technical and strategic process, involving coordination between designers, production planners, and machine operators to align machine functionality with production goals. It ensures that cutting is fast, accurate, and consistent, without compromising the integrity of the garment components.

Parameter	Description
Fabric type	Adjusts pressure and blade type (woven, knit, etc.)
Plies per lay	Number of fabric layers spread
Cutting path	Sequence in which pieces are cut
Marker input file	Import marker layout from CAD
Speed and pressure	Machine feed speed and blade force
Piece notching and drill	Marks for stitching or accessories

Table 3.2.4: Key Parameters to Set in CAM

Common CAM Software/ Tools:

- **Gerber Cutter:** The Gerber Cutter, developed by Gerber Technology, is a globally recognized fabric-cutting solution that offers high-speed and multi-ply cutting capabilities. It integrates seamlessly with Gerber's CAD software, AccuMark, allowing for the efficient transfer of marker data. The machine is equipped with intelligent blade control, vacuum stabilization, and toolpath optimization, making it ideal for large-scale garment manufacturing, especially in industries dealing with diverse materials like denim, knitwear, and synthetics.
- **Lectra Vector:** The Lectra Vector, a product of Lectra Systems, is known for its energy-efficient and eco-conscious design. It is particularly favored in high-end fashion and fast fashion sectors due to its ability to perform precise cuts with minimal fabric waste. Integrated with Modaris CAD software, Lectra Vector also supports real-time diagnostics, predictive maintenance, and IoT-enabled features, making it a cutting-edge solution aligned with Industry 4.0 standards.
- **Bullmer:** Bullmer, a German-engineered CAM tool, is widely respected for its robust mechanical structure and exceptional performance in handling technical textiles and composite fabrics. Its cutting machines are compatible with multiple CAD platforms and provide consistent accuracy in cutting thick and layered materials. The brand's emphasis on precision engineering and automation makes it a preferred choice for industries like sportswear and industrial fabric applications.
- **Morgan Tecnica:** Morgan Tecnica, hailing from Italy, offers a comprehensive range of cutting solutions that stand out for their user-friendly design and technological innovation. Their systems feature intuitive touchscreens, ultra-sharp blades, and intelligent nesting algorithms that enhance material utilization. Morgan Tecnica machines also support both manual and automated workflows, allowing flexible use across various production scales.

Tool/ Brand	Strengths	Integration	Fabric Type Support	Ideal Use Case
Gerber Cutter	High speed, precision, wide adoption	AccuMark CAD	All (especially denim, knit)	Mass production, fashion and industrial
Lectra Vector	Eco-efficient, smart diagnostics	Modaris CAD	Fashion, leather, synthetics	Luxury fashion, fast fashion
Bullmer	Robust build, German engineering	Multiple CADs	Technical textiles, synthetics	Sportswear, composites

Tool/ Brand	Strengths	Integration	Fabric Type Support	Ideal Use Case
Morgan Tecnica	Innovation, user-friendly interface	Modular systems	General and special fabrics	Mid to high-volume garment production

Table 3.2.5: Comparison Table

3.2.5 Executing the Cut

The final stage is actual cutting based on the approved marker and lay plan. Executing the cut is the final and one of the most crucial stages in the fabric cutting process. Once the marker has been planned and laid over the layered fabric (the lay), the cutting operation begins based on the predefined specifications. This stage translates digital planning into physical results and must be carried out with precision to maintain garment accuracy, optimise fabric utilisation, and reduce material wastage.

Before cutting begins, the lay must be stabilised, either by vacuum suction or weights, to ensure that fabric layers do not shift, as even minor misalignment can lead to significant size or shape discrepancies. Cutting can be performed using manual methods like straight knives or round knives machines, or through automated systems like CAM (Computer-Aided Manufacturing) cutters, which follow the digital marker exactly.

During execution, careful attention must be paid to several parameters, including blade sharpness, machine speed, cutting depth (especially in multi-ply layers), and safety margins. Once the cutting is complete, pieces are bundled according to size and style and matched with their respective production orders for sewing.

Any errors at this stage, such as inaccurate cuts, fabric fraying, or mix-ups, can lead to production delays, increased costs, or even the rejection of garments. Hence, this step demands high attention to detail, skilled handling, and strict quality control protocols to ensure that the finished fabric pieces are consistent with the design and ready for flawless assembly in the subsequent stages of garment manufacturing.

Cutting Execution Steps:

1. **Lay Fabric Accurately:** Align edges, ensure no wrinkles or tension.
2. **Place Marker (Physical or Digital):** Align properly over spread lay.
3. **Initiate Cutting Machine:** Follow CAM program instructions.
4. **Quality Check:** Ensure all pieces are cut cleanly, accurately.
5. **Piece Bundling:** Sort and bundle cut parts size-wise and style-wise.

Cutting Best Practices:

- **Regular blade maintenance:** Proper and regular maintenance of cutting blades is essential for clean, accurate cuts, especially when working with multiple fabric plies. Blades that are dull or damaged can result in frayed edges, uneven cuts, and pattern distortion. This not only affects garment fit but also leads to fabric wastage and increased rework.

Maintenance includes:

- Routine sharpening using built-in sharpening stones (in straight knife machines) or external sharpening tools.
- Blade replacement when sharpening no longer restores optimal performance.
- Lubrication to prevent overheating and reduce friction, especially during long cutting operations.
- Inspection before each use to ensure there are no nicks, rust, or structural damage.

A well-maintained blade contributes to production efficiency, ensures consistency in pattern shapes, and reduces the chance of quality issues in later stages.

- **No shifting of plies during cutting:** When multiple fabric layers are spread (known as a lay), it is vital that the plies remain perfectly aligned during cutting. Shifting or displacement of plies can cause irregular cuts across layers, making the final garments inaccurate in size and shape. This misalignment can lead to poor-fitting garments, mismatched parts, and rejected products.

  To prevent shifting:

  - Use vacuum suction tables to hold fabric layers firmly in place.
  - Apply weights or pins strategically on manual tables.
  - Spread fabric carefully using automated spreading machines that maintain tension and grain alignment.
  - Avoid excessive machine vibration by maintaining appropriate cutting speed and using stable equipment.
- **Follow safety protocols:** Cutting tools, whether manual or automated, pose significant safety risks if not handled properly. Safety protocols are mandatory to protect the health and well-being of workers in the cutting room. These include:
  - Wearing personal protective equipment (PPE) such as cut-resistant gloves, aprons, and safety goggles.
  - Training all operators on machine handling, emergency shut-off procedures, and hazard awareness.
  - Maintaining a clear workspace to avoid tripping hazards or tool entanglements.
  - Using safety guards and sensors on cutting machines to prevent accidental injuries.
  - Regular safety audits to identify and rectify potential risks.

Summary

- Determining the number of garments to be cut per size based on order quantity and size demand ensures optimised fabric use and accurate fulfillment of production targets.
- Efficient marker making using CAD tools involves arranging pattern pieces with minimal wastage while maintaining grainline and alignment accuracy.
- The selection of lay plans depends on factors such as order quantity, fabric type, size ratio, and machine capacity to maximise material usage and cutting productivity.
- Computer-Aided Manufacturing (CAM) tools like Gerber, Lectra, Bullmer, and Morgan Tecnica automate the cutting process, requiring precise setting of parameters for speed, accuracy, and fabric compatibility.
- Actual cutting is performed as per the approved marker and lay plan, ensuring minimal deviation, clean edges, and layer stability across all plies.
- Key practices include maintaining blade sharpness, preventing ply shifting, and strictly following safety protocols to ensure high-quality output and operator safety.
- Effective use of CAD/ CAM systems enhances fabric efficiency, reduces human error, and supports high-speed mass production in modern garment industries.

Exercise

Multiple-choice Question:

1. What is the main purpose of a cut ratio plan?
   a. To reduce labour cost
   b. To determine the number of garments to be dyed
   c. To allocate fabric quantities per garment size efficiently
   d. To select fabric colour combinations

2. Which of the following is NOT a factor influencing lay planning?
   a. Quantity ordered
   b. Size ratio
   c. Brand popularity
   d. Fabric type

3. Which CAM system is widely used for automated fabric cutting?
   a. Canva
   b. Gerber Cutter
   c. Adobe Illustrator
   d. AutoCAD

4. What is the first step in marker layout planning?
   a. Save marker
   b. Check grainline
   c. Arrange pieces
   d. Input pattern

5. Which of the following is a best practice during fabric cutting?
   a. Overlapping plies intentionally
   b. Ignoring grainline direction
   c. Regular blade maintenance
   d. Speeding up cutting to save time

Descriptive Questions:

1. Explain the significance of the cut ratio plan in the garment manufacturing process.
2. Describe the step-by-step procedure involved in marker layout planning.
3. Discuss the key factors that influence the selection of a lay planning method.
4. Explain how Computer-Aided Manufacturing (CAM) systems are used in automated fabric cutting.
5. Describe the best practices to be followed during the fabric cutting process.

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/XcHqHLvdR9Y?si=IHeW9I79wDmCXFOt

Shrinkage Or Dimensional Stability to wash Test Process For Fabric

https://youtu.be/1lGMdpscPLk?si=VFG20fAzQ9mO6ZWz

Top 6 Best Fabric Marker Reviews In 2025

https://youtu.be/NBHYb29flXk?si=SPqK6GH0bJYtq47u

Basics of CAD, CAE and CAM

4. Take the Print-out Through (CAD/CAM)

Unit 4.1 - Processes Related to System Closure and Output Delivery

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Demonstrate shutting down of the down, CAD/CAM system.
2. Take the backup of the work done.
3. Set the CAM for taking the print outs.
4. Provide print out of mini marker to the merchandiser for reference.

UNIT 4.1: Processes Related to System Closure and Output Delivery

Unit Objectives

By the end of this unit, the participants will be able to:

1. Explain the procedure for shutting down the CAD/CAM system.
2. Describe the steps to take a backup of the completed work.
3. Set up the CAM system to prepare for printing.
4. Provide and present the mini marker printout to the merchandiser for reference.

4.1.1 Shutting Down the CAD/CAM System

In garment manufacturing, the final stage of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) processes involves safely closing the system and ensuring output delivery in a format ready for production or merchandising review. This step is crucial for data integrity, coordination across departments, and operational efficiency. Proper system closure avoids file loss or damage, while accurate mini marker printouts ensure alignment with production expectations. Before exiting the system, it is vital to follow a structured shutdown process to ensure no data is lost or corrupted.

Steps for Proper Shutdown:

1. **Close Open Projects**

   Before shutting down any CAD/CAM system, it is critical to save all ongoing work. This includes:

   - **Marker Plans:** Ensure that the final arrangement of pattern pieces on the marker is saved with an appropriate file name and version.
   - **Patterns:** All alterations or creations in the pattern design module must be saved.
   - **Reports:** Fabric consumption reports, cutting summaries, and other data outputs should be saved and verified.
   - **Verification:** Confirm that no data has been lost or saved under the wrong file. Many systems offer “Save All” or “Batch Save” features to streamline this step.

- **Exit Software Modules**

  After ensuring that all projects are saved, systematically close all running modules. These might include:

  - Pattern Making Software (e.g., Gerber AccuMark PDS, Lectra Modaris)
  - Marker Making Software (e.g., Gerber Easy Marking, Lectra Diamino)
  - Grading Tools and Plotting Tools

    Each module must be exited using the software’s recommended method, not forced shutdown. Improper closing may lead to file corruption or loss of unsaved work.

2. **Backup Prompt**

   Once all software modules are closed, initiate or confirm the data backup process:

   - **Automated Prompt:** Some systems prompt the user to back up data before shutting down.
   - **Manual Backup:** If there's no prompt, initiate backup manually. Data should be backed up to a secure location such as:
     - External drive
     - Cloud storage
     - Internal server with redundancy
   - A backup log should be maintained for tracking. This helps during future audits or file recovery operations.

3. **Power Down the Hardware**

   After confirming backup, the user should proceed to shut down the physical equipment:

   - **Workstations/Computers:** Use the operating system's shutdown command.
   - **Printers and Plotters:** Power off the devices after any pending jobs are completed.
   - **CAM Equipment:** If connected to cutters or spreaders, ensure the entire system has safely completed its current task before powering off.

   Follow the reverse startup sequence for safety, starting from peripheral devices and ending with the main system.

4. **Physical Disconnection (if needed)**

   This step is especially relevant when:

   - Equipment is being moved.
   - Maintenance is scheduled.
   - Risk of power fluctuation is present.

   Ensure:

   - All devices are safely unplugged from power sources.
   - Cables are labelled and stored to avoid confusion.
   - Devices are covered with dust-proof covers for protection.
   - Power switches are turned off from the wall outlet if applicable.

4.1.2 Taking Backup of the Completed Work

In any CAD/ CAM-based garment production environment, the security and preservation of digital work are of paramount importance. From intricate pattern designs and marker plans to consumption reports and cutting instructions, every file represents hours of technical effort, collaboration, and strategic planning. Therefore, taking a reliable backup of completed work is a critical step in ensuring the continuity, accuracy, and retrievability of production data.

Backup refers to the process of creating duplicate copies of essential files and storing them in a safe and accessible location, either on-site or via cloud-based platforms. It serves as a protective measure against data loss due to unforeseen circumstances such as power outages, hardware failures, software crashes, virus attacks, or accidental deletions. In high-paced garment production units where digital files directly guide automated cutting machines, any data loss can result in production delays, material wastage, and cost overruns.

Regular backups are essential to safeguard marker plans, lay reports, pattern files, and print settings. Most CAD/CAM systems allow manual or automatic backup scheduling.

File Type	Extension	Purpose
Marker Layout File	.mrk	For reprinting or editing marker later
Pattern File	.pat	Stores individual or grouped garment pieces
Consumption Report	.xls/.csv	Used for fabric planning and costing

Table 4.1.1: Backup Formats

Backup Methods

- **Local Backup - Save to hard drive or USB**

  Local backups involve saving files directly on a computer's internal hard drive, external hard drive, or USB flash drive. This is the most basic and immediate method of backup and is especially useful for individual users or smaller teams working on localized projects.

  - **Advantages:** Quick access, no internet required, full control over data.
  - **Best Used For:** Daily backups, working offline, temporary or short-term storage.
  - **Caution:** Prone to data loss due to device damage, theft, or virus attacks. Regular copying to secondary local devices is recommended.

  Example: A pattern master saves the final version of a pattern and marker file on both the desktop and a USB stick after completing work for the day.

- **Cloud Storage - Use integrated platforms or Google Drive/ OneDrive**

  Cloud storage refers to saving files on online platforms like Google Drive, Microsoft OneDrive, Dropbox, or specialized enterprise-level solutions (e.g., Autodesk A360 or Lectra Cloud). Files are uploaded via the internet and stored securely on remote servers managed by cloud service providers.

  - **Advantages:** Remote access from any location, version control, automatic syncing, and protection from local hardware failures.
  - **Best Used For:** Collaborative projects, mobile teams, long-term archiving, or when remote access is required.
  - **Caution:** Requires stable internet connection and sometimes paid subscriptions for large file storage.

  Example: A CAD operator uploads the final marker file and consumption report to Google Drive for the production team in a different location to review and download.

- **Network Drive - For large teams sharing a central server**

  A network drive is a shared storage space on a centralized server within the company's local area network (LAN). This method allows multiple users (e.g., pattern makers, merchandisers, cutters) to access, save, and collaborate on files from their individual workstations.

  - **Advantages:** Centralized management, secure access for authorized users, ideal for large-scale and synchronized operations.
  - **Best Used For:** Large production houses or design teams where multiple departments need access to the same files.
  - **Caution:** Dependent on internal server stability and security protocols.

  Example: After completing the marker plan, the operator saves the file to the company's designated network folder so the cutting room can retrieve it immediately for execution.

Backup Steps

Step 1: Save the Work

The first and most crucial step in the backup process is to save all completed digital work. In the context of CAD/CAM systems in garment manufacturing, this includes marker plans, pattern files, layout reports, consumption summaries, and related documentation. Each of these files contains critical data required for cutting, planning, and reference throughout the production cycle. The user should ensure that every update made during the design and marker-making stages is finalized and saved appropriately using the software's built-in save or export functions.

It is best practice to maintain a clear file naming convention while saving the work. For instance, a pattern file for men's formal shirts could be saved as "Mens_Shirt_Pattern_V1" and any updated version can follow the format "Mens_Shirt_Pattern_V2," and so on. This helps in version tracking and minimizes the confusion in retrieving the most recent file. Additionally, most CAD/CAM software allows saving in both native and universal file formats. Saving the data in formats like .rul, .plt, or .dxf ensures that they remain compatible with other systems and plotting hardware. This comprehensive saving process sets the foundation for reliable backup.

Step 2: Compress Files

Once the files are saved properly, the next step is to compress them into a single, manageable archive. Compressing files helps reduce their overall size and enables easy transfer and storage. It also ensures that multiple related files, such as marker files, pattern layouts, images, and spec sheets, are bundled together, reducing the chance of missing out on any component.

Compression can be performed using commonly available tools such as WinRAR, 7-Zip, or the built-in compression tool in most operating systems. Creating a zipped folder also provides the option to password-protect or encrypt the data, which adds an extra layer of security—especially when the files are being stored in shared or online locations. The naming of the archive should also follow a logical and clear structure, for instance: "Mens_Shirt_Backup_Aug2025.zip." By compressing the data before backup, users ensure both space efficiency and better file management.

Step 3: Choose Destination

Selecting an appropriate destination for backup is a strategic decision based on accessibility, team size, and data security needs. Broadly, three methods of backup are most common: local, cloud-based, and network drive backup.

In local backup, files are saved to an external storage device such as a USB flash drive, external hard disk, or even a local drive partition. This is suitable for individual designers or teams with low bandwidth. It offers quick access but is vulnerable to physical damage or loss of the device.

Cloud storage, on the other hand, is becoming increasingly popular. Platforms like Google Drive, Microsoft OneDrive, Dropbox, and integrated enterprise cloud systems allow users to store and access files from anywhere, using any device. Cloud backup offers the advantage of automatic version history, easy sharing, and scalability. It is ideal for mobile teams or situations where remote collaboration is needed.

Network drive backup involves storing files on a centralized server within the organization. This is the preferred method for large-scale production environments, where multiple departments (like cutting, merchandising, and planning) need simultaneous access to updated files. These servers are often managed by IT administrators who ensure regular backup, access control, and fault tolerance.

Choosing the right destination depends on the scale of operation, sensitivity of data, and workflow requirements. Often, a combination of local and cloud backup ensures both speed and redundancy.

Step 4: Upload or Transfer

Once the backup destination is selected, the compressed files must be uploaded or transferred accordingly. If a local backup method is used, users can drag and drop the files into the external storage device through the file manager. It is essential to ensure that the storage device has adequate space and is virus-free before transferring files.

In the case of cloud storage, users must log into their accounts and either manually upload the compressed folder or set up automatic syncing. Cloud platforms often come with desktop apps that allow seamless synchronization from local folders to cloud repositories. During upload, it is important to monitor the progress and ensure that the internet connection remains stable to prevent any file corruption.

If using a network drive, files can be copied into the designated folder or path using a secure connection within the organization's local network. Larger organizations may use FTP servers or enterprise content management systems for this purpose. Proper folder hierarchy and naming ensure that files are easily retrievable by other team members later.

This step finalizes the actual storage of data into a safe and accessible space. However, storing the file is not the end, it must also be verified.

Step 5: Confirm Integrity

The final yet often overlooked step in the backup process is verifying the integrity of the backup. Simply uploading or copying the file does not guarantee that it is complete or usable. It is vital to open the backup file from the destination location (not from the source), extract it if it is compressed, and confirm that all files open properly.

The confirmation process may include:

- Checking that the marker and pattern files open correctly in the CAD/CAM software.
- Verifying that all layers, measurements, and specifications are intact.
- Ensuring no file corruption or loss occurred during transfer.

For cloud and network backups, access permissions should be tested to ensure relevant team members can retrieve the files without issue. A quick confirmation email or report can also be sent to the merchandiser or team leader notifying them that the file has been backed up successfully.

4.1.3 The CAM System for Printing

Once the marker planning is completed and approved, the next crucial stage in the garment manufacturing process is setting up the Computer-Aided Manufacturing (CAM) system for printing. CAM software, in conjunction with integrated hardware like plotters and printers, allows for the generation of accurate physical outputs known as mini marker printouts or full-size markers, depending on the production requirement. These printouts are essential as they serve as visual blueprints for both merchandisers and cutting room personnel to guide the actual fabric cutting process.

The accuracy and readability of these printouts can have a direct impact on fabric efficiency, ease of handling, and the overall productivity of the cutting room. Therefore, proper configuration of the CAM system is paramount to ensure that the layout translates seamlessly from the screen to physical form without distortions, misalignment, or loss of data.

Importance of Printing in Marker Making

Printing a marker is not merely a clerical task; it is a highly technical process that ensures the virtual design is reproduced with absolute precision on paper, which is then laid over the fabric. This paper marker includes vital information such as pattern outlines, annotations, notches, grainlines, and bundle numbers, all of which assist the cutter in executing an error-free cut. Additionally, this printed layout helps avoid human errors in measuring and drawing, as was traditionally done before digital systems took over.

The mini marker, a reduced-scale version of the original marker, is particularly valuable during initial planning and for referencing by merchandisers. It provides an overview of how the pieces are arranged on the fabric width, helping stakeholders visualize the layout strategy and fabric utilization.

Pre-Printing Configuration Steps

Setting up the CAM system for printing involves several configuration steps. These include verifying marker dimensions, checking the alignment of pattern pieces, setting paper roll width and margins, ensuring correct file format compatibility, and loading the plotting equipment with the right paper type.

1. **Final Review of Marker File:**
   - Before initiating the print, a final check must be conducted to ensure all pieces are correctly placed within the fabric width.
   - Notches, labels, and pattern IDs must be visible and clearly marked.
   - The grainline direction must align with the production requirement.
2. **Defining Plotting Parameters:**
   - The operator should set the plotting length and width according to the size of the marker.
   - Margin settings must be adjusted to avoid clipping of pattern lines on the edges.
   - Some CAM systems allow the operator to select the line weight, colour, and style for better visibility, especially on longer markers.
3. **Choosing the Output Mode:**
   - Depending on the CAM software, users may choose to print a mini marker or a full-size marker.
   - Mini markers are generally used for approvals and reference, while full-size markers are used during actual cutting.
   - Output can be chosen in formats such as HPGL, DXF, or PDF based on the printer compatibility.

4. **Selecting Printer/ Plotter Device:**
   - The correct output device must be selected from the CAM software, whether it is a dot-matrix plotter, inkjet plotter, or laser printer.
   - Calibration of the device must be verified to ensure scale accuracy.
   - Roll width and paper quality must match the printing specifications.
5. **Paper and Ink Check:**
   - The printer should be loaded with the right size of paper rolls, typically 36", 48", or custom widths depending on the fabric width.
   - Ink or ribbon availability must be verified to avoid faint prints or interruptions mid-way.
6. **Test Run:**
   - A short section of the marker can be printed as a test print to verify alignment and clarity.
   - This reduces wastage of paper and time in case of configuration errors.

Monitoring the Print Output

Once the print command is given, the output must be monitored in real-time to ensure continuous feed, no jamming of the paper, and no skewing of the layout. Continuous supervision allows the operator to intervene if the plotter malfunctions or if print quality deteriorates. After printing, the marker must be properly rolled or folded and labelled with job details for easy identification.

Role of Mini Marker for Merchandisers

A mini marker is a compact, scaled-down version of the full marker plan. It is typically printed on A4 or A3 sheets and includes:

- Layout image
- Fabric width
- Number of pieces per size
- Cut ratio
- Style reference number
- Consumption metrics (fabric utilization %)

This marker is especially useful for merchandisers who are involved in sample approvals, production planning, and buyer communication. It acts as a summary of the production intent and can be used during pre-production meetings (PPMs) for alignment between departments.

Best Practices

To ensure an efficient and error-free setup of the CAM system for printing:

- Maintain a checklist of plotting settings.
- Standardise file-naming conventions for easy traceability.
- Back up the marker files before sending them to the plotter.
- Store a physical copy of the mini marker with the production documents.
- Regularly service the plotter for clean, uninterrupted operation.

Parameter	Details
Paper Size	A4/A3 or continuous plotter roll
Marker Length	As per the maximum fabric width and marker output
Marker Scale	Full scale or mini marker (usually 1:5 or 1:10)
Output Orientation	Landscape/portrait, based on marker layout
Machine Type Selection	Select a connected CAM-compatible printer or plotter

Table 4.1.2: Printing Configuration Checklist

4.1.4 Mini Marker Printout and the Merchandiser

In the apparel manufacturing process, precision and planning are crucial to ensure minimal wastage, accurate cutting, and timely production. One of the pivotal tools that bridges the design and cutting stages is the mini marker printout. This compact version of the full-scale marker is an essential communication and reference tool, especially for merchandisers, production managers, and cutting supervisors. It enables the team to preview how the fabric will be utilized and verify if the layout aligns with the planned specifications before the actual cutting takes place.

A mini marker is essentially a scaled-down version (usually printed in A4 or A3 format) of the full marker layout, generated from CAD systems. Unlike the full marker print used on fabric for cutting, the mini marker is not meant for operational use on the cutting table. Instead, it functions as a visual validation tool and documentation reference that outlines the pattern arrangement, fabric utilization, garment sizes, grainline orientations, and marker efficiency parameters.

This small but significant document supports better coordination between the CAD department and the merchandising and production teams. By offering a clear visual representation of the marker, it helps stakeholders confirm that the pattern pieces are correctly placed, the cutting ratios are adhered to, and no fabric wastage occurs due to overlap or misalignment. It is particularly important in bulk production scenarios, where even minor inaccuracies in the marker layout can lead to substantial fabric loss and affect the profit margins.

The process of providing the mini marker begins after the finalization of the marker layout in the CAD system. Once finalized, the marker is digitally exported and sent to a connected plotter or printer set to output at a reduced scale. The format usually includes the marker image, fabric width, number of layers or plies, sizes per ratio, pattern piece identification codes, and consumption data. This allows the merchandiser to quickly review the layout and detect any discrepancies or optimization opportunities.

One of the key advantages of the mini marker printout is that it reduces the communication gap between the CAD team and non-technical stakeholders. Merchandisers may not have access to or expertise in using CAD software. Therefore, having a physical or digital mini marker enables them to engage more effectively in decision-making, such as verifying that customer requirements are met, ensuring compliance with style guidelines, and confirming quantity specifications before cutting begins.

In modern apparel production settings, where speed and precision are paramount, the mini marker serves as a checkpoint for quality assurance. Many factories integrate this printout into their standard operating procedures (SOPs) and require the merchandiser's sign-off on the mini marker before initiating the cutting operation. This not only ensures accountability but also prevents costly errors, such as cutting the wrong sizes or misusing specialized fabrics.

Additionally, the mini marker printout is also a valuable archival document. It is stored as part of the production documentation for future reference, audits, or repeat orders. This helps in tracing the marker history, comparing marker efficiencies across styles, and enhancing marker planning strategies based on past data.

The delivery of the mini marker to the merchandiser can be done both physically (as a hard copy) and digitally (via PDF or image formats). In companies adopting Industry 4.0 practices, this process is often streamlined through centralised cloud platforms, where approved mini-markers are uploaded and shared across departments, enabling real-time collaboration.

Thus, the mini marker printout plays a critical role in bridging digital design and physical production in garment manufacturing. It empowers merchandisers and managers to visualise, verify, and validate marker layouts efficiently, thereby reducing fabric waste, improving cutting accuracy, and ensuring alignment with order specifications. As production volumes and complexities increase, this step becomes even more important in maintaining workflow integrity, reducing errors, and enhancing cross-functional communication.

Contents of a Mini Marker Printout

A mini marker printout is an essential document in the garment manufacturing process, especially in the pre-production and cutting preparation stages. It is a scaled-down version of the actual marker layout, printed for review and verification purposes. While the full-scale marker is used for actual fabric cutting, the mini marker acts as a visual and technical reference for various stakeholders, particularly the merchandisers, cutting room supervisors, quality checkers, and production planners.

The contents of a mini marker printout go beyond just a visual layout. It carries important technical, operational, and production-related information that helps in verifying if the marker is aligned with the planned specifications. A well-prepared mini marker ensures that the fabric is utilised optimally, sizes and ratios are followed correctly, and all pattern pieces are properly aligned and accounted for. Below are the major components typically found in a mini marker printout, each serving a distinct purpose.

1. **Header Information**

   The top portion of a mini marker printout generally contains a marker header, which includes basic yet critical details about the marker. These often include:

   - **Marker Name or Number:** A unique code assigned to the marker for identification and tracking.
   - **Style Number or Garment ID:** Indicates the specific garment design or product line.
   - **Buyer/Client Name:** Identifies the customer or brand for whom the garment is being manufactured.
   - **Fabric Type and Width:** Provides information about the type of fabric (e.g., cotton, polyester) and its usable width in inches or centimeters.
   - **Marker Length and Width:** States the physical dimensions of the marker in meters or yards, and fabric width it was designed for.
   - **Fabric Colour or Shade:** Important when the same design is produced in multiple fabric shades.
   - **Marker Efficiency:** Expressed in percentage, this shows how efficiently the fabric is being used in the marker.

   This header sets the context for the rest of the printout and allows for quick identification of the marker in physical or digital archives.

2. **Garment Size Breakdown**

   This section of the mini marker lists the sizes included in the marker and their respective quantities or ratios. For example, the breakdown might look like:

   - **Size S:** 2
   - **Size M:** 3
   - **Size L:** 3
   - **Size XL:** 2

   This helps merchandisers and planners ensure that the production quantity requirements for each size are accurately represented. It also prevents size mismatch errors during bulk cutting.

3. **Pattern Piece Layout**

   At the core of the mini marker is the visual layout of pattern pieces, arranged as they will appear in the actual full-scale marker. These pieces are organised within the constraints of the fabric width and marker length, aligned according to:

   - Grainline orientation
   - Symmetry or asymmetry of the garment
   - Fabric nap or pile direction (if applicable)
   - Fabric print directionality or repeat patterns

   Each piece in the layout is clearly labelled or coded, typically with a part name (e.g., front, back, sleeve), garment size, and sometimes a pattern number. This helps in cross-verifying that all required components are included and there are no overlaps or misplacements.

4. **Pattern Piece Identification**

   Each pattern piece is usually marked with:

   - Name of the part (e.g., Sleeve, Collar, Front Panel)
   - Size designation
   - Number of plies or layers to be cut
   - Cutting instruction symbols, such as “cut on fold,” “cut 2,” or “mirror cut”

   These identifiers are essential during the cutting process and serve as checks for the cutting team to ensure that all parts are cut in the correct quantity and orientation.

5. **Fabric Consumption Data**

   One of the most important purposes of a mini marker is to present data on fabric consumption. This includes:

   - **Marker Length:** The actual length of fabric required to cut one complete marker.
   - **Fabric Consumption per Garment:** This is derived by dividing total marker length by the number of garments produced in that marker layout.
   - **Waste Percentage or Marker Efficiency:** This helps in cost estimation and budgeting, ensuring that the most fabric is used with the least waste.

By analysing this data, merchandisers can calculate cost per garment more accurately and identify scope for further optimisation.

6. Additional Notes or Instructions

This section may contain special instructions or cautions for production, such as:

- Avoid mixing fabrics from different lots or dye batches
- Ensure all pieces are cut along grain
- Use shaded fabric only if permissible by buyer
- Stitching sequence changes due to modified pattern
- Cutting limitations based on machine or manpower availability

These notes provide clarity on any exceptions or customization that need to be considered during cutting and production.

7. Version Control and Approval Status

Professional setups often include:

- Version Number or Revision Date to indicate whether the marker is the most updated version.
- Prepared by / Checked by / Approved by fields which show accountability.
- Date of marker generation to support planning and batch tracking.

Such details are particularly useful in ensuring that no outdated or incorrect marker is mistakenly used for production.

8. Barcode or QR Code

In some advanced systems, a barcode or QR code is included that links to the digital file of the marker. This promotes traceability and integration in digital production environments.

Process of Generating and Using a Mini Marker Printout

1. Marker Finalization

This is the first step in the printout workflow. Once the marker planning process is complete—where all pattern pieces are arranged efficiently over a specific fabric width and length—the marker is finalized. This means:

- All adjustments to the marker layout have been made.
- Grainline alignment, fabric utilization, and pattern fit have been verified.
- Marker efficiency has been optimized for minimum fabric wastage.

The finalized marker is saved as the reference layout that will be used for both physical cutting and print generation.

2. Printing Setup

After finalizing the marker, the next step involves setting up the CAM (Computer-Aided Manufacturing) system to generate a physical output:

- The CAM system is linked with plotters or large-format printers.
- Printing preferences such as paper size, scale, resolution, and orientation are selected.
- Settings such as line thickness, pattern notches, grainlines, and annotations are adjusted as per factory standards.

This stage ensures the printer or plotter will reproduce the mini marker accurately.

3. Mini Marker Generation

A mini marker is a scaled-down version of the full-size marker. It is printed to provide a quick visual reference without using excessive paper or resources.

During generation:

- The finalized marker file is selected from the system.
- A reduced scale (e.g., 1:10 or 1:20) is applied to generate a small version.
- Important details such as style name, order number, fabric width, size breakdown, total pieces, and consumption data are included.

This printed mini marker acts as a snapshot of the full marker, useful for documentation and verification.

4. Merchandiser Review

Once the mini marker is printed:

- It is handed over to the merchandiser and other relevant stakeholders like the cutting in-charge or production planner.
- The merchandiser reviews the layout to verify:
  - That all style elements are included.
  - Fabric usage and size ratio compliance.
  - Any customer-specific requirements or comments have been addressed.

The merchandiser's sign-off acts as a checkpoint before proceeding to actual cutting. It provides traceability and cross-functional approval.

5. Feedback and Archival

This is the final step in the mini marker workflow:

- The merchandiser or quality team may suggest edits or request reprinting if any discrepancies are found.
- Once approved, the mini marker is archived in both physical and digital formats.
- It serves as a reference for future audits, quality checks, and reorders.

Additionally, feedback provided at this stage can be used to improve future marker planning efficiency and marker-making SOPs.

Summary

- Safely closing CAD/CAM systems prevents data loss and ensures hardware protection during power down.
- All work, including markers and patterns, should be saved and verified before exiting software modules.
- Before printing, all finalized marker data should be backed up using local drives, cloud storage, or network servers to prevent data loss.
- Individual tools like Marker Making or Pattern Design should be closed in sequence to avoid software glitches.
- Accurate setup of the CAM system ensures that the finalized marker is printed with the right scale, layout, and alignment.
- A scaled-down version of the marker layout is shared with the merchandiser as a visual reference for production planning.
- The printed mini marker is reviewed by merchandisers, and feedback is documented and archived for future quality improvements.

Exercise

Multiple-choice Question:

1. What is the first step in shutting down a CAD/CAM system?
   a. Unplugging devices
   b. Taking a printout
   c. Closing all open projects and saving work
   d. Exiting the power supply

2. Which of the following is NOT a valid backup method?
   a. Local Hard Drive
   b. Cloud Storage
   c. SMS Transfer
   d. Network Drive

3. The mini marker printout is primarily intended for which stakeholder?
   a. Machine Operator
   b. CAD Technician
   c. Merchandiser
   d. Maintenance Staff

4. In the backup process, what step should follow file compression?
   a. Save marker again
   b. Choose destination
   c. Shut down system
   d. Exit software

5. What is the purpose of confirming file integrity during the backup process?
   a. To increase file size
   b. To prevent unauthorized access
   c. To ensure data is not corrupted or incomplete
   d. To hide the files from users

Descriptive Questions:

1. Explain the complete procedure for shutting down a CAD/CAM system after project completion.
2. Describe the different types of backup methods available and their significance in data security.
3. What steps are involved in configuring a CAM system for marker printout, and why is each important?
4. Discuss the contents and purpose of a mini marker printout in the garment manufacturing process.
5. Illustrate the flow from marker finalization to feedback collection post mini marker printing.

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/Hx6DXuildSc?si=CFGCno1XnwpX6ZR4

What is computer Aided Manufacturing (CAM)?

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

5. Maintain Work Area, Machinery, Tools and Equipment

APPAREL MADE-UPS HOME FURNISHING
SECTOR SKILL COUNCIL

Unit 5.1 - Safe and Efficient Use of Tools and Equipment

AMH/N1102

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Maintain tools and equipment.
2. Demonstrate correct handling of the tools and equipment.
3. Identify the methods to minimize waste.
4. Clean the tools and equipment.
5. Work in a comfortable position with the correct posture.
6. Dispose of waste safely in the designated location.
7. Store cleaning equipment safely after use.

UNIT 5.1: Safe and Efficient Use of Tools and Equipment

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe methods to maintain tools and equipment.
2. Demonstrate appropriate handling techniques for tools and equipment.
3. Clean tools and equipment using suitable procedures.
4. Explain ways to minimise material and resource wastage.
5. Work in a stable and ergonomic position to ensure proper posture.
6. Dispose of waste responsibly at designated locations.
7. Store cleaning and maintenance equipment securely after use.

5.1.1 Maintenance of Tools and Equipment

The maintenance of tools and equipment is a fundamental aspect of efficient and safe operations in the apparel industry, especially in roles such as pattern making, cutting, and garment construction. Regular upkeep not only ensures the longevity of machines and tools but also significantly contributes to consistent product quality and worker safety. Tools such as scissors, measuring tapes, notching machines, and CAD systems, as well as equipment like cutting tables, sewing machines, and pressing units, require routine inspection, cleaning, lubrication, and calibration to function at their best.

Neglecting maintenance can lead to equipment breakdowns, production delays, compromised garment accuracy, and even workplace injuries. Therefore, adopting a proactive maintenance schedule, daily, weekly, or monthly, based on the equipment's frequency of use is essential. Additionally, documentation of all maintenance activities helps in tracking equipment performance and identifying recurring issues. Workers must be trained to recognize early warning signs of wear and tear and follow proper operational protocols.

Ultimately, maintenance is not just a technical necessity but a cost-saving and quality-enhancing measure that supports overall production efficiency. An organised, well-maintained workspace reflects a professional work ethic and sets the foundation for high-standard output in the competitive apparel manufacturing sector.

Maintenance plays a crucial role in ensuring smooth production operations, especially in garment manufacturing, where machinery like sewing machines, cutting tools, irons, and presses are frequently used. Regular and structured maintenance prevents:

- Unexpected breakdowns
- Production delays
- Safety hazards
- Increased operational costs
- Decline in product quality

Proper upkeep of tools leads to improved efficiency, worker safety, and a longer lifespan of equipment.

Types of Maintenance and Their Features

Type of Maintenance	Description	Frequency	Example in the Garment Sector
Preventive Maintenance 	Planned and routine actions to prevent tool failure before it occurs	Daily, weekly, monthly	Cleaning lint from the sewing machine, and oiling parts
Corrective Maintenance 	Performed after identifying a fault to restore the tool or machine	As needed	Fixing bent scissor blades or broken foot pedal
Predictive Maintenance 	Uses monitoring tools or performance data to schedule maintenance just in time	Periodic based on usage	Replacing needles after a specific stitch count

Maintenance Tasks - A Breakdown

Equipment	Routine Maintenance Tasks	Tools Required
Sewing Machine 	Oil moving parts, tighten screws, clean feed dog area, replace worn needles	Lint brush, screwdriver, oil can
Iron 	Descale, check for wiring issues, clean soleplate	Vinegar, soft cloth, tester
Scissors 	Sharpen blades, check alignment, and oil pivot point	Sharpening stone, oil

Equipment	Routine Maintenance Tasks	Tools Required
Cutting Machine 	Check blade tension, remove debris from the base, and lubricate moving parts	Allen key, lubricant

Maintenance Log Template

Date	Equipment Name	Maintenance Type	Performed By	Remarks
01-Aug-25	Sewing Machine 01	Preventive	Technician A	Oiled and cleaned
03-Aug-25	Cutting Table	Corrective	Maintenance Team	Replaced loose fixture

5.1.2 Handling Techniques for Tools and Equipment

Proper handling techniques for tools and equipment are crucial in ensuring safety, efficiency, and accuracy in the apparel industry. Whether working with manual instruments such as scissors, measuring tapes, and seam rippers, or operating sophisticated machinery like CAD systems, cutting tables, and sewing machines, skilled handling is essential to maintain both the integrity of the equipment and the quality of the final product. Mishandling not only risks damage to tools but can also lead to operator injuries, production errors, and increased material wastage.

Understanding the correct way to hold, operate, and store each tool forms the foundation of professional practice for pattern makers, garment technicians, and production staff. For example, sharp instruments should always be handled with care, pointed away from the body, and stored securely when not in use. Similarly, electrical equipment must be operated following safety protocols, ensuring plugs, switches, and wires are in good condition.

Moreover, ergonomic handling practices, such as using tools at the correct height and angle, reduce the risk of repetitive strain injuries and fatigue, promoting long-term worker well-being. Training in these techniques is vital and should be an integral part of skill development programs. Mastery of handling techniques not only increases operational efficiency but also instils discipline and professionalism in the workplace.

Improper handling can lead to:

- Tool damage
- Workplace injuries
- Increased downtime
- Decreased productivity

Trained handling techniques ensure safe usage, extend tool life, and help maintain a professional and hazard-free working environment.

Tool / Equipment	Correct Handling Technique	Safety Precaution
Scissors	Always keep it closed when carrying, hold it by the closed blades	Never run or pass scissors with blades open
Sewing Machine	Ensure the machine is turned off before threading or maintenance	Use finger guards; avoid distractions during use
Steam Iron	Store upright when not in use; never leave unattended	Do not touch the soleplate; use insulated gloves
Cutting Machines	Start with a test cut; ensure guards are in place	Wear cut-resistant gloves; follow operation protocol
Measuring Tape	Retract gently; do not stretch forcefully	Avoid snapping back suddenly to prevent recoil injury

Table 5.1.1: Best Practices for Handling Key Tools

Tips for Handling

Proper handling of tools and equipment is essential to ensure workplace safety, maintain productivity, and extend the life of the tools. Mishandling can lead to injuries, equipment damage, and costly downtime. Therefore, workers must be well-informed about safe handling practices and follow them consistently. From basic awareness to proper storage and regular inspection, each step plays a vital role in creating an efficient and secure work environment. The following tips provide a comprehensive guide to handling tools responsibly and professionally.

1. **Awareness**

   Being mindful of the condition and operational state of a tool or machine is crucial. For instance, check whether a sewing machine is powered on before approaching it or ensure a steam iron is not hot before moving it. This helps avoid accidental burns, cuts, or operational mishaps. Understanding a tool's current status (on/off, sharp/dull, hot/cold) prevents unsafe actions and ensures better control.

2. **Posture**

   Working in an ergonomic position means maintaining a stable and comfortable body alignment. When handling tools like sewing machines, scissors, or irons, sitting or standing with the correct posture reduces muscle strain, fatigue, and long-term injury risks. The work surface should be at an appropriate height, and frequent breaks should be taken to prevent repetitive strain.

3. **Storage**

   After use, every tool or piece of equipment should be returned to its designated storage area. This helps prevent clutter, accidents, and damage. For example, scissors should be stored in a closed, downward-pointing position in a tool rack. Proper storage also makes tools easy to locate when needed, improving workflow efficiency.

4. **Inspection**

   Before using any tool, a quick inspection should be conducted. Check for defects like loose parts, frayed cords, or dull edges. Early detection of wear and tear can prevent tool failure during operation and ensure user safety. For example, inspecting the plug of a steam iron for damage can prevent electrical hazards.

5. **Training**

   All workers, especially new or temporary staff, should receive proper training before handling any tool or equipment. Training should cover operation, safety precautions, and emergency procedures. For example, teaching a worker how to safely operate and shut down an industrial sewing machine helps avoid serious injury and equipment damage.

Safe Tool Handling

Following a systematic process for tool handling ensures safe, effective, and responsible tool handling. This approach not only extends the life of the equipment but also safeguards users, maintains workplace order, and supports high standards of productivity. Training workers in this process and reinforcing it regularly fosters a safety culture and professional discipline across all levels of operation.

1. **Pick Tool from Storage**

   The tool handling process begins with selecting the appropriate tool from its designated storage area. This step is not merely about grabbing any available tool; it requires a deliberate choice based on the nature of the task at hand. Organised tool storage systems, such as labelled cabinets, drawers, pegboards, or toolboxes, help ensure quick identification and easy access. Workers should be trained to return tools to their exact locations after use so that they can be retrieved easily later. Additionally, when picking a tool, it is essential to handle it carefully, especially if it is heavy, sharp, or delicate. Tools should be picked up with both hands if required, and attention should be paid to any safety instructions posted near the storage area. A well-maintained storage system minimises clutter, reduces the risk of tool damage, and ensures a smoother workflow.

2. **Inspect for Damage**

   Once the tool is picked, the next critical step is to inspect it thoroughly for any signs of wear, damage, or malfunction. This step is often overlooked but is essential for preventing accidents and substandard work. A visual and functional check should be conducted before using the tool. Look for signs such as cracks, chips, rust, broken parts, or loose components. For electrical tools, check cords for fraying or exposed wires. Blades, such as those on scissors, shears, or cutters, should be examined for sharpness and alignment. If any defects are found, the tool should not be used and should be either repaired or replaced. Reporting damaged tools to a supervisor or maintenance team is part of responsible workplace behaviour. This preventive measure ensures that tools are safe to use and reduces the risk of injury or further equipment damage during operation.

3. **Use with Precautions**

   After ensuring that the tool is in proper working condition, it should be used with all necessary precautions. Even the most basic tools can cause injuries or damage if not handled correctly. Users must follow standard operating procedures and manufacturer guidelines. For example, sharp tools should be held firmly and used away from the body to prevent accidental cuts. Electrical equipment should be plugged into safe, dry outlets and used in well-ventilated areas. The right personal

protective equipment (PPE), such as gloves, aprons, or safety goggles, should be worn depending on the tool and task. Additionally, the worker must maintain focus and avoid distractions while working with tools, particularly power tools. Tools should only be used for their intended purpose, using a screwdriver as a chisel or a wrench as a hammer can lead to both tool damage and injury. Caution and discipline during tool usage promote both user safety and work efficiency.

4. **Clean After Use**

   Once the task is completed, the tool must be cleaned properly before being returned. Cleaning is not only about hygiene but also about extending the life of the tool. Debris, dust, grease, fabric threads, or moisture residues can damage tools over time. For hand tools, a simple wipe with a clean cloth may suffice. For mechanical or electrical tools, specialised brushes or cleaning solutions may be used, as recommended by the manufacturer. Tools such as steam irons should be emptied of any remaining water, and their surfaces cleaned to prevent corrosion or mould. In the case of sewing machines, lint and thread clippings should be removed from the feed area and bobbin case. Proper cleaning prevents wear and tear, maintains tool performance, and upholds workplace standards. Importantly, tools should only be cleaned when they are unplugged or turned off to prevent accidents.

5. **Store Securely**

   The final and equally important step is to store the tool securely. Proper storage protects the tool from environmental damage and reduces the chance of accidents. Tools should be returned to their designated place, ideally in a clean, dry, and organised storage unit. Sharp tools must have blade guards or be kept in protective sheaths. Heavy tools should be stored on lower shelves to prevent injury from falling objects. Electric tools must be unplugged, and their cords neatly coiled to avoid tangling or damage. Labelling the storage area ensures others can locate and return tools easily. Furthermore, access to storage areas should be limited to authorised personnel to prevent misuse or loss. A well-maintained tool storage system reflects professionalism and encourages accountability among workers, which in turn improves overall workplace productivity.

Common Mistakes to Avoid

- Carrying sharp tools in pockets or loosely in hand
- Leaving hot tools unattended
- Using tools for purposes other than their intended use
- Ignoring signs of damage or malfunction
- Storing tools in damp or dusty conditions

Handling Checklist (Can Be Pasted Near Workstations)

- Is the tool clean and damage-free?
- Am I trained to use this tool?
- Is the workspace safe and clutter-free?
- Is PPE (e.g., gloves) worn if required?
- Has the tool been stored properly after use?

5.1.3 Cleaning Tools and Equipment

Regular cleaning of tools and equipment is essential in the apparel industry to ensure their longevity, efficiency, and consistent performance. Over time, dust, fabric lint, thread residue, oil, and other contaminants can accumulate on both manual and electronic tools. If not cleaned properly, this build-up can lead to decreased precision, machine malfunctions, or even complete equipment failure. Cleaning is, therefore, not just about hygiene; it is a preventive maintenance practice that supports the smooth operation of every stage in garment production.

For hand tools like scissors, measuring tapes, and chalk holders, simple practices such as wiping with a dry or slightly damp cloth, removing rust, and keeping them in dust-free containers go a long way. In the case of electronic and mechanical machines such as sewing machines, cutting machines, and CAD systems, cleaning must be performed carefully, often following manufacturer guidelines. This may include brushing out lint from moving parts, using compressed air, or applying machine oil where necessary.

Proper cleaning also contributes to worker safety by minimising hazards such as overheating or malfunctioning of electrical tools. Moreover, it maintains product quality by avoiding contamination of fabrics and patterns. In professional settings, a routine cleaning schedule should be established, and employees should be trained to follow safe and effective cleaning procedures for all equipment they use.

Regular cleaning of tools and equipment is essential in any industry, especially in garment production, to ensure durability, performance, hygiene, and user safety. Dirty or neglected equipment can lead to product defects, inefficiency, injuries, or even breakdowns.

Tool/ Equipment	Cleaning Procedure	Cleaning Agents Used
Iron Box	Always unplug the iron and allow it to cool. Wipe the soleplate gently to remove any burnt fabric or starch buildup. If stubborn stains remain, use a soft cloth dipped in diluted vinegar.	Damp cloth, vinegar (optional)
Sewing Machine	Begin by removing visible lint and threads from the bobbin area and feed dogs. Wipe the exterior body to remove dust. Finally, oil the moving parts as per the manufacturer's instructions to maintain smooth operation.	Lint brush, dry cloth, sewing machine oil
Cutting Tools	Wipe the blade area with a cloth after each use to remove fabric debris or glue. If dirty, wash with mild detergent and dry thoroughly to avoid rust. Apply a light layer of oil occasionally.	Mild detergent, soft cloth, machine oil

Table 5.1.2: Cleaning Methods and Materials

Steps for cleaning a sewing machine

Cleaning a sewing machine is essential for maintaining its functionality, extending its lifespan, and ensuring smooth stitching operations. Over time, lint, dust, thread fragments, and fabric particles accumulate inside the machine, particularly around the bobbin area and feed dogs. Regular maintenance and careful cleaning prevent mechanical issues and stitching errors.

1. **Removing the Needle and Presser Foot**

   Before beginning the cleaning process, it is crucial to turn off and unplug the sewing machine for safety. The first step is to remove the needle and presser foot. This not only protects these components from damage during cleaning but also allows better access to the inner parts of the machine. Removing the needle prevents accidental pricks, while removing the presser foot opens the way to clean around the feed dogs and throat plate thoroughly. Use a screwdriver if required to gently unscrew the foot and keep both the needle and presser foot in a safe container to avoid misplacement.

2. **Using a Lint Brush Inside the Bobbin Case**

   The bobbin case is a hotspot for lint and thread buildup. Using a small, stiff lint brush, often provided with the machine or purchased separately, one should gently brush out all dust and debris from the bobbin case, feed dogs, and surrounding area. Avoid using compressed air as it may push lint deeper into the machine's mechanisms. If your machine allows, remove the bobbin case and the throat plate for more thorough access. This step is critical as accumulated lint can interfere with the machine's lower thread mechanism, causing skipped stitches or thread breakage. Be gentle to avoid dislodging any small parts.

3. **Wiping the Machine Body**

   Once the interior is cleaned, attention should turn to the external parts. Using a soft, slightly damp cloth (never soaking wet), gently wipe down the entire body of the machine. This removes dust, fingerprints, and any minor stains. For stubborn grime, a mild soap solution or a small amount of vinegar diluted in water can be used. Do not allow any liquid to seep into openings or control panels, as this could damage the internal circuitry. Wiping down the machine helps maintain a professional appearance and ensures all parts remain free from external dust buildup.

4. **Oiling the Moving Parts**

   Lubrication is essential for a sewing machine's moving parts to function smoothly. Most domestic sewing machines require occasional oiling, especially in areas like the shuttle hook, gears, or other rotating parts. Only use sewing machine oil, never substitute with cooking oil or industrial lubricants. Apply a few drops to designated areas as specified in the machine's manual. Over-oiling should be avoided; as excess oil can drip onto fabrics during use. After oiling, manually turn the handwheel a few times to distribute the oil evenly. Proper lubrication reduces wear and tear, minimises noise, and prevents parts from sticking or overheating.

5. **Reassembling the Machine**

   Once all cleaning and oiling are complete, carefully reassemble the sewing machine. Insert the bobbin back into its case, screw the throat plate back on, and reinstall the presser foot and needle. While doing so, check if the needle is bent or dull, if so, replace it with a new one. Ensure all parts are properly tightened but not over-tightened. After reassembly, plug in the machine and run a few test stitches on a scrap piece of fabric to confirm smooth operation. This final step ensures that all cleaning efforts have paid off and the machine is in optimal working condition.

5.1.4 Minimising Material and Resource Wastage

Minimising material and resource wastage is a critical component of sustainable and cost-effective operations in the apparel industry. With growing awareness about environmental impact and rising raw material costs, efficient resource utilisation has become a priority for manufacturers, designers, and pattern makers alike. Wastage can occur at various stages of the garment production process, including fabric cutting, pattern making, stitching, and finishing, leading to increased production costs and ecological footprint.

Advanced planning, accurate pattern placement, and the use of digital tools such as CAD software can greatly reduce unnecessary fabric consumption. Marker efficiency, where patterns are laid out strategically to use the maximum fabric area, plays a vital role in minimising offcuts and scraps. Similarly, reusing leftover materials and recycling waste fabrics are practices that not only reduce waste but also support circular economy principles.

In addition, optimising power and water usage in the operation of machinery, avoiding overstocking or overproduction, and ensuring regular maintenance of tools can reduce indirect resource wastage. Training employees on waste reduction techniques and encouraging a culture of sustainability within the workplace are also essential. By implementing conscious strategies for minimising waste, organisations not only improve profitability but also contribute to environmental preservation and responsible production.

Efficient use of materials is not just cost-effective, it also promotes sustainable production and environmental responsibility. Reducing waste means using materials smartly and training workers better to avoid unnecessary losses.

Methods to Reduce Waste

1. **Measure Twice, Cut Once**

   This golden rule reduces cutting errors. Double-checking measurements ensures that the fabric is not wasted due to wrong sizing. Mistakes in cutting are often irreversible and can lead to entire garment panels being unusable.

2. **Use Pattern Layout Software**

   Specialised software like CAD (Computer-Aided Design) helps in planning pattern placements on fabric to optimise space and reduce wastage. By digitally arranging pieces in the most efficient layout, maximum fabric usage is achieved with minimal scrap.

3. **Sort and Store Scraps for Reuse**

   Scraps like leftover threads, trimmings, or small fabric pieces should be sorted by size and type. Many of these can be reused for patches, accessories, sample garments, stuffing, or even as fillers in quilting.

4. **Train Workers on Correct Techniques**

   Human errors can be minimized through proper training in cutting, sewing, and handling machinery. This includes instructions on:

   - Accurate measuring
   - Proper alignment of fabric
   - Correct stitching practices

A skilled worker is less likely to make mistakes that result in wastage.

Waste Management Hierarchy: Reduce → Reuse → Recycle

The Waste Management Hierarchy is a strategic model used globally to prioritise sustainable waste handling methods. It helps organisations and individuals identify the most environmentally responsible options for managing waste materials.

The hierarchy ranks waste management strategies in order of desirability and environmental impact, with Reduce being the most preferred and Recycle the least.

REDUCE - Prevent Waste at the Source

Definition: Reducing means avoiding the generation of waste in the first place. It is the most efficient and eco-friendly step because it minimises the need for materials, energy, and waste treatment.

Examples in Apparel or Manufacturing

- **Digital Prototyping:** Using computer-aided design (CAD) software before making physical samples.
- **Optimised Cutting Techniques:** Using fabric layout software to avoid off-cuts.
- **Bulk Purchasing:** Reducing packaging waste by sourcing materials in larger, reusable containers.

Benefits:

- Saves raw materials.
- Lowers energy and labour costs.
- Reduces environmental footprint.

Action	Impact
Digital patterns over paper	Less paper waste
Controlled material usage	Reduces over-ordering supplies
Minimalist packaging design	Reduces disposal burden

Table 5.1.3: Actions Taken in Reduction of Waste

REUSE - Give Materials a Second Life

Definition: Reuse involves finding new purposes for materials that would otherwise be discarded. Unlike recycling, reuse does not involve breaking materials down, making it more energy-efficient.

Examples:

- Using fabric scraps for patchwork quilts, accessories, or decor items.
- Repurposing old uniforms or garments into bags or cleaning cloths.
- Reusing containers for storage or sorting in production areas.

Benefits:

- Extends product life.
- Low energy usage compared to recycling.
- Encourages creativity and innovation in product design.

Reusable Item	New Purpose
Fabric off-cuts	Patchwork or appliqué designs
Old clothes	Cleaning rags or remade clothing
Plastic bins	Tool or fabric storage

RECYCLE - Transform Waste into Raw Materials

Definition: Recycling is the process of breaking down waste materials to recover usable raw materials. Although better than landfilling, recycling consumes energy and may result in downcycling, where the new material is of lower quality.

Examples:

- Sending fabric shreds to textile recycling facilities.
- Recycling metal parts from broken machines.
- Collecting plastic cones and packaging for plastic reprocessing.

Challenges:

- Sorting and cleaning requirements.
- Loss of original material quality.
- Energy and labour costs involved in the process.

Material Type	Recycled Into
Cotton Waste 	Recycled yarn or insulation
Metal Machine Parts 	Raw metal for casting

Material Type	Recycled Into
Plastic packaging 	Reusable plastic granules

Importance of Hierarchy

This hierarchy reflects the sustainability priorities in modern industries. When followed:

- Less waste reaches landfills
- Operational costs decrease
- Brand image improves due to environmental responsibility
- Compliance with environmental regulations becomes easier

Organisations that integrate this hierarchy into their operations not only support the environment but also build long-term cost-efficiency and resilience in resource use.

5.1.5 Ergonomic Working Positions

Maintaining proper posture and body mechanics in the workplace is essential for long-term health, especially in apparel and textile manufacturing, where repetitive tasks like sewing, cutting, and ironing are routine. Poor posture over time can lead to Repetitive Strain Injuries (RSI), lower back pain, neck strain, and reduced productivity due to physical discomfort or fatigue. By implementing ergonomic workstations and training workers on correct posture, both health and efficiency can be significantly improved.

Activity	Correct Posture	Common Errors	Health Risk
Sewing	Sit upright with a straight back, feet flat on the floor, elbows at 90°, eyes level with the needle	Slouching, leaning too close to the machine, elbows lifted too high or too low	Neck and shoulder pain, eye strain
Cutting	Use an adjustable-height cutting table, stand with a straight back, and avoid twisting the torso	Bending over low tables, reaching far across the table, twisting the spine	Back pain, wrist strain

Activity	Correct Posture	Common Errors	Health Risk
Ironing	Ironing board at elbow level, stand upright, shift weight between legs	Hunched over the board, too high/low a table	Lower back strain, poor circulation

Table 5.1.4: Ergonomic Guidelines for Common Apparel Tasks

Component	Ergonomic Feature
Chair	Adjustable height, lumbar support, and footrest if needed
Machine Height	The needle should be at elbow level when seated
Lighting	Focused, glare-free task lighting to reduce eye strain

Table 5.1.5: Seating and Workstation Setup for Sewing

Corrective Measures and Best Practices

Stretching and Micro-breaks

Regular short breaks can prevent fatigue and improve blood circulation. Workers should be encouraged to stretch their arms, shoulders, and neck every hour.

Worker Training

Workplace ergonomics training should be conducted regularly to help workers understand the right techniques for lifting, posture, and using ergonomic equipment properly.

Tool	Purpose
Anti-fatigue mats 	Reduces stress on legs during standing

Tool	Purpose
Adjustable chairs 	Aligns the worker's height to the table
Tilting cutting tables 	Reduces strain while cutting patterns
Height-adjustable ironing boards 	Prevents hunching

Table 5.1.6: Ergonomic Tools and Accessories

Case Scenario Example

Before Ergonomic Setup:

A worker sewing for 6 hours daily was experiencing neck stiffness and shoulder pain due to a low chair and poor back support.

After Ergonomic Setup:

With an adjustable chair, lumbar cushion, and correct table height, the worker reported reduced discomfort and better focus during tasks.

Importance of Ergonomics

- **Boosts Productivity:** Comfortable workers are more focused and efficient.
- **Reduces Absenteeism:** Prevents health-related absenteeism due to strain injuries.
- **Enhances Quality:** Better posture improves precision in tasks like stitching or cutting.
- **Supports Well-being:** Ergonomic practices show care for worker health and morale.

5.1.6 Waste Disposal Protocols

Proper waste disposal is an essential practice in any textile, tailoring, or garment production setting. It not only ensures a clean and organised workspace but also promotes environmental responsibility, compliance with regulations, and the safety of workers. Understanding how to categorise and dispose of different types of waste generated during work processes is critical for both operational efficiency and long-term sustainability.

Types of Waste and Disposal Methods

The nature of waste produced in tailoring or fabric workspaces varies widely, from simple fabric scraps to sharp objects and hazardous chemicals. Each type of waste requires a different method of disposal to prevent contamination, injury, or environmental harm.

Waste Type	Examples	Disposal Method
Fabric Scraps 	Cotton, polyester, and denim pieces	Collect in dedicated scrap bins; sort for reuse or recycling.

Waste Type	Examples	Disposal Method
Sharp Objects 	Broken needles, blades, pins	Store in puncture-proof containers clearly labelled as "Sharps Waste".
Chemical Waste 	Solvent residues, cleaning fluids	Dispose of via authorised hazardous waste handlers only.

Table 5.1.7: Types of Waste and Disposal Methods

Types of Waste

1. **Fabric Scraps**

   These are one of the most common forms of waste in tailoring units. While small, irregular pieces are often discarded, many can be repurposed or recycled.

   - **Reuse:** Larger or medium-sized scraps can be used creatively, for patchwork quilts, smaller clothing accessories (like pockets or badges), or sample testing.
   - **Recycle:** Materials unsuitable for reuse can be sent to textile recycling units where they are processed into insulation, stuffing, or industrial cleaning rags.
   - **Tip:** Label fabric bins by type (e.g., cotton, synthetic) to streamline recycling.

2. **Sharp Objects**

   Items like broken needles, pins, or worn-out blades pose a significant safety risk if left lying around or improperly discarded.

   - **Disposal Procedure:**
     - Use a sturdy, puncture-proof container such as a hard plastic box.
     - Label the container clearly with "Sharp Waste".
     - Once full, seal it securely and dispose of it through appropriate local sanitation guidelines or industrial waste collectors.
   - **Important:** Never throw sharp objects in regular trash bags, as they can cause injuries to sanitation workers.

3. Chemical Waste

Workshops may occasionally use chemicals for cleaning or maintaining tools and machines, such as solvent-based cleaners or lubricants.

- **Handling Tips:**
  - Store chemicals in clearly marked, leak-proof containers.
  - Never pour leftover chemicals into drains or onto the ground.
  - Contact certified hazardous waste disposal services to handle pickup and proper disposal.
- **Warning:** Mishandling chemical waste may lead to soil and water pollution and legal liabilities.

Waste Disposal Process

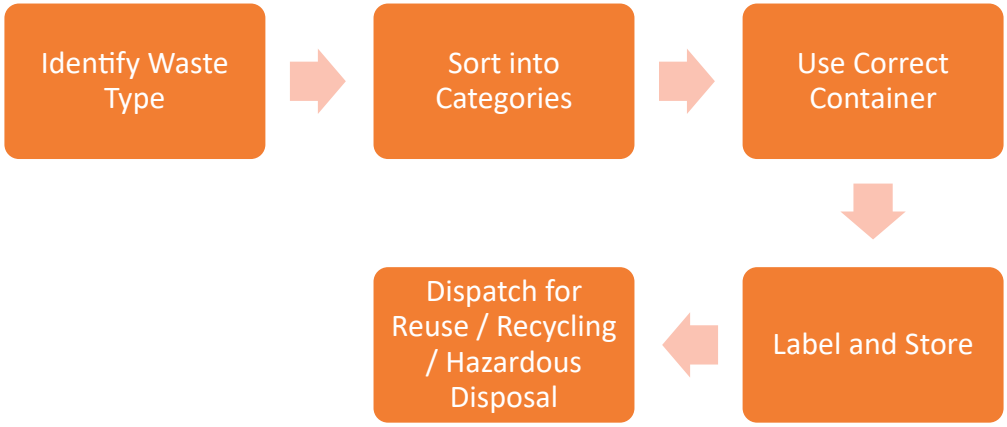


Fig. 5.1.1: Process of waste disposal

Best Practices in Waste Disposal

- Train workers regularly on waste categorisation and safe disposal procedures.
- Colour-code bins (e.g., green for fabric, red for sharps, yellow for chemicals).

Fig. 5.1.2: Colour coded bins

- Keep MSDS (Material Safety Data Sheets) for all chemical substances used.
- Schedule routine pickups with authorised recyclers or waste handlers.

Environmental and Safety Impact

- Improper disposal of workshop waste can lead to:
- Injury to staff and sanitation workers (e.g., needle pricks).
- Clogged drains and unsafe working conditions.
- Environmental degradation (e.g., pollution from solvent leakage).

5.1.7 Storage of Cleaning and Maintenance Equipment

Proper storage of cleaning and maintenance equipment is essential for ensuring workplace safety, operational efficiency, and the longevity of tools in the apparel industry. When such equipment is stored systematically and in designated areas, it minimizes the risk of accidents, prevents equipment damage, and facilitates quick access during routine cleaning or urgent repairs. Disorganised or careless storage can lead to cluttered workspaces, loss or misplacement of tools, and increased downtime, all of which negatively affect productivity.

Storage protocols should align with industry best practices and safety standards, including the use of labelled cabinets, secure wall-mounted racks, or lockable storage units, especially for items such as oils, lubricants, solvents, brushes, and electrical tools. Hazardous cleaning chemicals, in particular, should be stored in ventilated and temperature-controlled environments, away from direct sunlight or heat sources, and in compliance with Material Safety Data Sheet (MSDS) guidelines.

Additionally, storing equipment in a clean and dry condition after each use prolongs its service life and reduces the risk of malfunction. Routine checks and inventories of stored items ensure that tools remain in good working order and that replacement needs are identified promptly. Encouraging workers to return tools to their proper place after use fosters a culture of responsibility and cleanliness in the work environment.

Proper storage of cleaning and maintenance equipment is critical in any textile or garment unit to ensure safe, hygienic, and efficient operations. Poor storage not only causes tool damage but can also lead to accidents, contamination, and theft. Thus, a systematic approach should be followed.

Reason	Benefit
Prevents contamination	Clean tools ensure hygienic fabric handling and avoid staining or damaging materials.
Enhances longevity	Dry, well-kept equipment lasts longer and requires fewer repairs.
Reduces accidents	Organised storage prevents trips, falls, and mishandling of sharp tools or chemicals.
Boosts productivity	Workers save time finding tools and supplies, improving workflow.
Ensures compliance	Meets health, fire, and environmental safety regulations.

Table 5.1.8: Importance of Proper Storage

Guideline	Purpose	Implementation Tip
Label storage cabinets clearly (e.g., "Oils", "Cleaners", "Brushes")	Prevents confusion and misuse of supplies	Use waterproof, colour-coded labels

Guideline	Purpose	Implementation Tip
Store chemicals away from heat sources	Reduces the risk of fire or explosion	Place near ventilated, cool areas, away from electrical units
Keep tools dry and clean before storing	Prevents rust, corrosion, and bacterial growth	Wipe tools after use and let them air dry
Lock high-risk equipment when not in use	Prevents unauthorised access or tampering	Store sharp objects (blades, needles) in locked cabinets
Use designated compartments	Avoids cross-contamination and damage	Separate metal tools from oils/ solvents, use trays or tool racks

Table 5.1.9: Storage Guidelines

Area	Contents	Storage Tip
Top Shelf	Lightweight tools like brushes, cloths	Easy access, minimise reaching over hazards
Middle Shelf	Common items (machine oil, screwdrivers)	Place at eye level for regular use
Bottom Shelf	Heavy or rarely-used items	Prevents accidents from falling objects
Side Compartments	Sharp items (blades, needles)	Use lockable drawers or magnet tool holders
Wall-Mounted Rack	Cleaning sprays, labels	Saves space, keeps floor area clear

Table 5.1.10: Best Practices for Tool Cabinet Organisation

Checklist for Safe Storage

- Are all tools cleaned before storage?
- Are chemical containers sealed tightly and labelled?
- Are storage areas dry and free from leaks?
- Is PPE (gloves, goggles) stored near chemical agents?
- Are sharp tools stored in locked drawers?

5.1.8 Requesting System and Software Upgrades for Production

In the apparel industry, maintaining efficiency, accuracy, and quality often depends on how well systems, machines, and digital tools are maintained and updated. As part of workplace maintenance, employees and supervisors should not only ensure regular upkeep of physical tools and machinery but also keep a check on the digital systems and software used in operations such as design, production planning, inventory management, and quality monitoring.

Requesting system or software upgrades is a critical part of maintaining workplace efficiency in the apparel industry. It ensures that both physical machinery and digital tools work at optimal levels, support modern industry requirements, prevent downtime, and allow workers to deliver quality products consistently.

Situations Requiring Upgrade Requests

- When design or production planning software (e.g., CAD systems for pattern making) becomes outdated and cannot support new file formats.
- When ERP/MIS tools fail to generate accurate reports due to outdated versions.
- When machinery-integrated software (like programmable sewing machines or automated cutting machines) shows frequent errors.
- When security patches are no longer available for the existing system.
- When workflow is slowed down significantly due to obsolete technology.

Importance of Upgrading are as follows:

- **Efficiency:** Outdated software or systems may run slowly, leading to delays in design approvals, production planning, or data entry.
- **Compatibility:** New machinery or tools (e.g., computerised sewing machines, CAD/CAM systems, ERP software) often require the latest software to function correctly.
- **Accuracy:** Upgraded software ensures precision in pattern making, cutting, and inventory tracking.
- **Compliance:** Some upgrades may be necessary to meet national/international compliance standards (ISO, buyer audits, etc.).
- **Security:** Older systems are prone to data loss, cyberattacks, or software crashes, which can disrupt workflow.

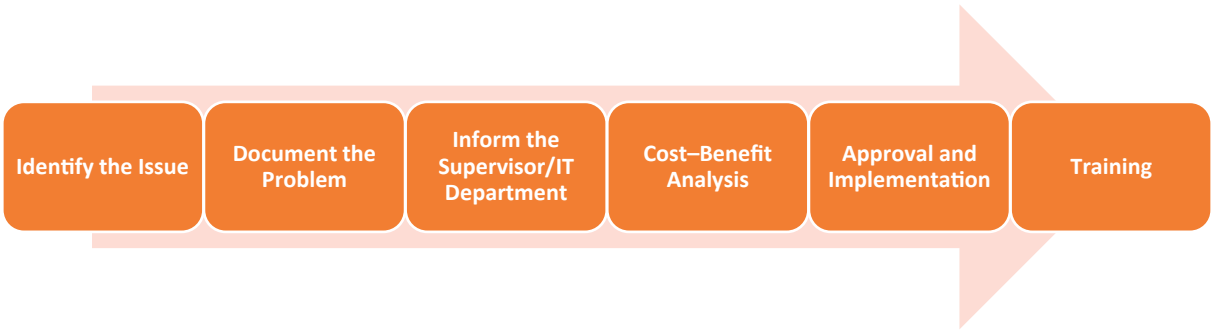


Fig. 5.1.3: Process of Raising a Request

5.1.9 Importance of Backup Files

Designers and production staff frequently work with computer-aided design (CAD) software and other digital tools to create patterns, layouts, embroidery designs, and technical packs. Since these files are critical to production, maintaining a backup file is essential for smooth operations.

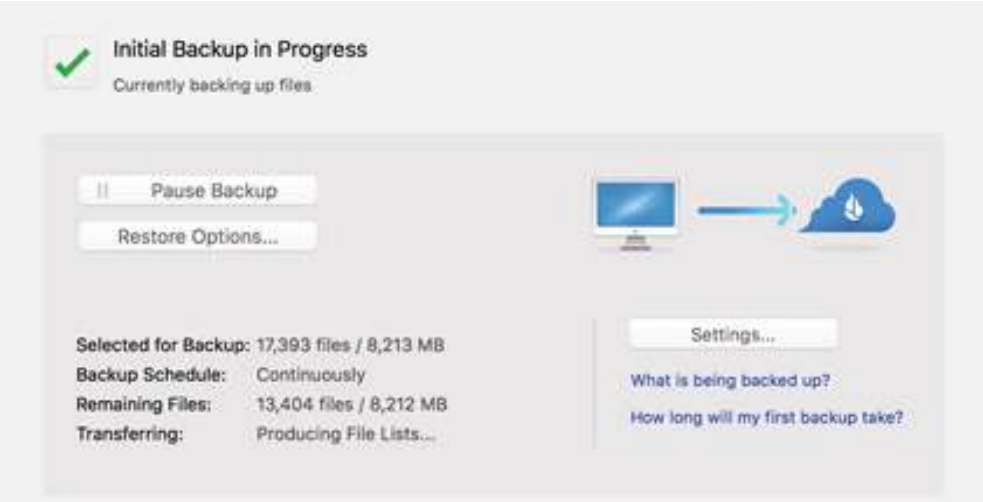


Fig. 5.1.4: Backing up Files and Documents in a Computer

Maintaining a backup file is not just a precaution, it is a professional necessity in the apparel industry. It safeguards creative work, prevents costly delays, supports collaboration, and ensures that valuable design data remains available for current production and future use.

1. **Preventing Data Loss:** Files can be lost due to sudden power failures, system crashes, or software errors. Backups ensure that the design work is not lost and can be retrieved without repeating the entire process.
2. **Protecting Against Corruption and Errors:** Sometimes files become corrupted due to software malfunction, improper saving, or virus attacks. A backup provides a clean version to continue working without delay.
3. **Supporting Collaboration:** Multiple people may work on the same design. If one version is accidentally overwritten, a backup ensures the original concept is preserved.
4. **Ensuring Client/Buyer Confidence:** Buyers often request modifications in design. Having a backup means the original version can always be referred to for comparison or to restore initial specifications.
5. **Saving Time and Cost:** Redoing a lost design wastes valuable time and increases production delays. Backup files reduce the risk of missing tight buyer deadlines, which is crucial in the fast-paced apparel industry.
6. **Compliance and Audit Requirements:** Some international buyers or certification audits require proper record-keeping of designs and production processes. Backups ensure documentation is available when required.

In the apparel industry, design files such as CAD patterns, embroidery layouts, fabric prints, and technical specifications form the backbone of production. Maintaining organized soft copies is essential for:

1. **Future Reference:** Helps retrieve past designs when buyers request repeat orders or modifications.
2. **Quality Consistency:** Ensures the original approved version is always available for comparison during production.
3. **Time Efficiency:** Saves time by avoiding re-creation of designs already developed.

4. **Buyer Communication:** Allows quick sharing of files with clients or overseas buyers for approval.
5. **Audit and Documentation:** Acts as proof of design ownership, useful in audits, legal matters, or compliance checks.
6. **Knowledge Repository:** Builds a digital library of designs for innovation, learning, and trend analysis.

Fig. 5.1.5: Hard Copy to Soft Copy Conversion

Summary

- Always inspect tools before use, handle them with care, and store them safely to prevent accidents.
- Follow the steps: pick, inspect, use, clean, and store, to ensure the longevity and safety of tools.
- Clean the machine regularly by removing the needle, brushing lint, oiling parts, and reassembling properly.
- Focus on reducing waste, reusing leftover materials, and recycling to promote sustainability.
- Maintain proper posture while sewing, cutting, and ironing to avoid long-term health issues.
- Use separate bins for different waste types and dispose of hazardous materials through safe methods.
- Store cleaning and maintenance tools in dry, labelled, and secure places to avoid damage and misuse.
- Timely upgrades of design, production planning, ERP/MIS, and machine-integrated software are essential in the apparel industry to maintain efficiency, accuracy, compliance, security, and compatibility with modern production requirements.
- Maintaining organized backup files of CAD patterns, layouts, and technical specifications safeguards against data loss, ensures quality consistency, supports collaboration, saves time and cost, and provides reliable references for future use and audits.

Exercise

Multiple-choice Question:

1. What is the first step in the tool usage cycle?
   a. Clean the tool
   b. Use the tool
   c. Pick the right tool
   d. Store the tool

2. Which of the following is a correct ergonomic guideline for sewing?
   a. Keep arms above shoulder level
   b. Sit upright with arms at 90°
   c. Stand while sewing
   d. Cross legs while seated

3. What should be done with broken needles in a garment unit?
   a. Thrown in a fabric bin
   b. Given to workers
   c. Disposed in puncture-proof containers
   d. Burned in the open

4. Which of the following falls under the 'Reduce' strategy in waste management?
   a. Donating scraps
   b. Sending fabric to recycling
   c. Avoiding waste creation
   d. Using leftover cloth for patchwork

5. Why should cleaning tools be kept dry before storing?
   a. To keep them warm
   b. To reduce noise
   c. To prevent rust and damage
   d. To avoid sharp edges

Descriptive Questions:

1. Explain the 5-step cycle for using tools safely and effectively in a garment production unit.
2. Describe the procedure for cleaning and oiling a sewing machine.
3. What is the importance of ergonomic posture while performing activities like sewing, cutting, and ironing? Give examples.
4. Discuss the waste management hierarchy (Reduce, Reuse, Recycle) with suitable examples from garment units.
5. Why is the proper storage of cleaning and maintenance equipment important? Describe any three good practices for safe storage.

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/4ZXfpfs09g8?si=l-Jc5_rRUdLDbgD6

Types of Maintenance

https://youtu.be/W_3M9lJ0yN4?si=GOiLaWisqzR42QDv

Basic Patterning Tools Every Pattern Maker Should Have

https://youtu.be/E1Y2mgUXGdM?si=nior_3vyt1foPF69

Start Fabric Waste Recycling Business

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

6. Promote and Sustain Safety, Health, and Security in Workplace, while Fostering Gender and Persons with Disabilities (PwD) Sensitisation

APPAREL MADE-UPS HOME FURNISHING
SECTOR SKILL COUNCIL

Unit 6.1 - Health, Safety and Environmental Practices

Unit 6.2 - Work Operations and Quality Compliance

AMH/N0620

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Follow health, safety, hygiene, and environmental management practices at the workplace, maintaining personal health, hygiene, and a lifestyle free from intoxicants.
2. Identify and report hazards, risks, accidents, unsafe conditions, and emergencies promptly, and respond appropriately to mock drills, shutdowns, and evacuation procedures.
3. Ensure the work area is hazard-free, set up tools and machinery correctly, and check that equipment is safe to use as per job requirements.
4. Handle equipment, tools, materials, and waste safely, minimising wastage, disposing of waste materials correctly, and returning reusable materials.
5. Obtain, check, and clarify work instructions, tickets, or job cards with supervisors, and ask questions when instructions are unclear.
6. Agree on and review work targets with supervisors, check for special instructions, and maintain workflow to meet production targets.
7. Work in conformance with company quality standards, legal requirements, and organisational policies, ensuring products meet quality parameters.
8. Carry out visual inspections to identify defects or non-conformance, and report defective tools, machines, or risks to the relevant person promptly and accurately.
9. Complete required forms, records, and documentation, including QC checks and inspection reports, to ensure accountability.
10. Leave the work area safe, clean, and secure upon completion of tasks to support ongoing workplace safety and efficiency.

UNIT 6.1: Health, Safety and Environmental Practices

Unit Objectives

By the end of this unit, the participants will be able to:

1. Explain health and safety practices applicable at the workplace and minimise risks to self and others.
2. List potential hazards, risks and threats based on operations and describe appropriate responses to accidents or emergencies.
3. Follow procedures for mock drills, shutdown, evacuation, and emergency scenarios.
4. Describe organisational procedures for safe equipment handling and machine operations.
5. Describe disposal systems for waste and by-products; minimise wastage and handle reusable materials appropriately.
6. Follow environment management system procedures and carry out walk-throughs to ensure hazard-free work areas.
7. Seek clarification from authorised personnel when unsure and report malfunctions or risks to relevant persons.
8. State the importance of hygiene, sound health, and describe the ill-effects of alcohol, tobacco and drugs to promote a healthy lifestyle.

6.1.1 Workplace Health and Safety Practices

Maintaining workplace health and safety is crucial for ensuring a secure, productive, and legally compliant work environment. Every organisation, regardless of size or industry, has a moral and legal obligation to protect its workers from harm. Effective safety practices not only reduce the risk of injuries, illnesses, and fatalities but also improve morale, efficiency, and the overall reputation of the business. Health and safety protocols include the use of personal protective equipment (PPE), adherence to standard operating procedures, and regular health check-ups. Additionally, identifying potential hazards, reporting unsafe conditions, and participating in mock drills are vital employee responsibilities. Employers must also conduct frequent safety audits and training programs to keep all staff informed and prepared. A proactive approach to safety creates a culture where employees feel valued and confident in their work environment.

Key Practices:

- Wear appropriate PPE (gloves, masks, ear protection).
- Use equipment and tools as per instructions.
- Maintain posture and ergonomics while working.
- Keep work area clean and hazard-free.

Safety Equipment & Purpose	
Gloves  Hand protection	**Mask**  Respiratory safety
Safety goggles  Eye protection	**Ear plugs**  Noise reduction
Safety shoes  Prevent foot injuries	

Table 6.1.1: Key PPE

6.1.2 Hazards and Emergencies

Hazards can range from physical risks like slippery floors and faulty machinery to chemical, biological, or ergonomic dangers. Recognising these threats early can prevent injuries, damage, or even fatalities. Employees must be trained to assess risks, report unsafe conditions, and take appropriate steps during incidents such as fires, electrical shocks, or chemical spills. Quick response procedures, including first aid, evacuation, and use of fire extinguishers, should be clearly communicated and practised regularly through mock drills. Employers are responsible for displaying emergency contact numbers, installing alarms, and ensuring clear exit paths. A vigilant workforce that is well-prepared to handle emergencies can significantly reduce the impact of unexpected situations and maintain workplace safety. All workers should be able to identify common hazards, understand associated risks, and know how to respond in case of accidents or emergencies.

Common Workplace Hazards:

- **Slippery floors (risk of falls):** Wet or oily floors, especially near entrances, kitchens, or restrooms, are a major cause of slips and falls. These incidents can result in bruises, fractures, or even head injuries. It is important to clean spills immediately and use proper signage to warn others.
- **Loose wires (electrical shock risk):** Exposed or dangling wires pose a high risk of electric shock or even fire. Workers should avoid handling electrical components without proper insulation and should report any damaged wiring to the maintenance team promptly.
- **Sharp tools (cut injuries):** Tools like knives, cutters, or metal edges can cause cuts and lacerations if mishandled or not stored safely. Employees should use appropriate protective gloves and follow handling guidelines to prevent such injuries.
- **Flammable substances (fire hazard):** Materials such as chemicals, oils, and cleaning agents can easily catch fire if not stored or used properly. These substances should be kept in designated fire-safe cabinets and away from heat sources. Fire extinguishers should also be readily accessible.

Emergency Response

1. **Raise Alarms Immediately:**
   - The first action in any emergency is to alert everyone nearby by activating the alarm system.
   - This can include pulling a fire alarm lever, pressing an emergency button, or shouting to warn others if no system is available.
   - Prompt action ensures others are aware of the danger and can take appropriate steps to protect themselves.
2. **Inform the Supervisor or Safety Officer:**
   - After raising the alarm, immediately inform the designated authority such as the floor supervisor, safety officer, or first aid team.
   - Provide clear and concise information: what happened, where, and if anyone is injured or trapped.
   - Timely communication helps the emergency response team act swiftly and appropriately.
3. **Evacuate Through Marked Emergency Exits:**
   - All workers should follow evacuation protocols by moving quickly but calmly to the nearest marked emergency exit.
   - Do not use elevators during emergencies, especially in fire or power outage situations.
   - Evacuation routes should be well-lit, unobstructed, and practised regularly through drills.

4. **Use a Fire Extinguisher If Trained:**
   - Only use a fire extinguisher if you have been properly trained and the fire is small and manageable.
   - Follow the PASS technique:
     - P – Pull the pin.
     - A – Aim at the base of the fire.
     - S – Squeeze the handle.
     - S – Sweep side to side.
   - Never attempt to extinguish a fire if it puts your safety at risk – evacuate immediately.

Emergency Type	Response Procedure
Fire	Evacuate, activate alarm, use extinguisher
Chemical spill	Alert, avoid the area, use the spill kit
Electrical failure	Inform maintenance, avoid contact
Injury	Apply first aid, report the incident
Wall-Mounted Rack	Saves space, keeps floor area clear

6.1.3 Mock Drills, Shutdown, and Evacuation Procedures

Mock drills, shutdown protocols, and evacuation procedures are essential components of a proactive workplace safety system. They are designed to prepare employees to act swiftly, calmly, and effectively during emergencies such as fire outbreaks, gas leaks, natural disasters, or chemical spills. Periodic mock drills help employees prepare for emergencies. Understanding shutdown and evacuation protocols reduces panic and ensures safety. Regularly rehearsed mock drills, efficient shutdown mechanisms, and well-defined evacuation plans are vital for minimising injuries, protecting assets, and saving lives. These measures build a safety-oriented culture in the organisation and ensure readiness for unforeseen incidents.

Mock Drills

Mock drills are simulated emergency exercises that train employees on what to do in the event of a real crisis. These drills:

- Help workers understand alarm sounds and emergency signals.
- Provide hands-on practice for using fire extinguishers, emergency exits, and first-aid kits.
- Familiarise employees with designated assembly points and safety officers.
- Improve coordination among teams and identify gaps in emergency planning.
- Mock drills should be conducted regularly and documented for compliance and learning.

Shutdown Procedures

Shutdown procedures involve safely stopping machinery, electrical systems, or production lines during a crisis. These are crucial to:

- Prevent further damage or escalation of hazards.
- Protect workers from accidents caused by operational equipment.
- Secure hazardous materials (e.g., turning off gas valves or isolating circuits).
- Employees responsible for critical equipment should be trained on shutdown protocols and have access to emergency switches or panels.

Evacuation Procedures

Evacuation procedures ensure the safe and orderly movement of personnel from the danger zone to a secure location. An effective evacuation plan includes:

- Clearly marked escape routes and emergency exit signs.
- Unobstructed pathways free from debris or locked doors.
- Appointed fire wardens or safety marshals to guide staff.
- Pre-assigned assembly points where all personnel must report for headcounts.
- Special considerations for differently-abled employees.

Steps for emergency response

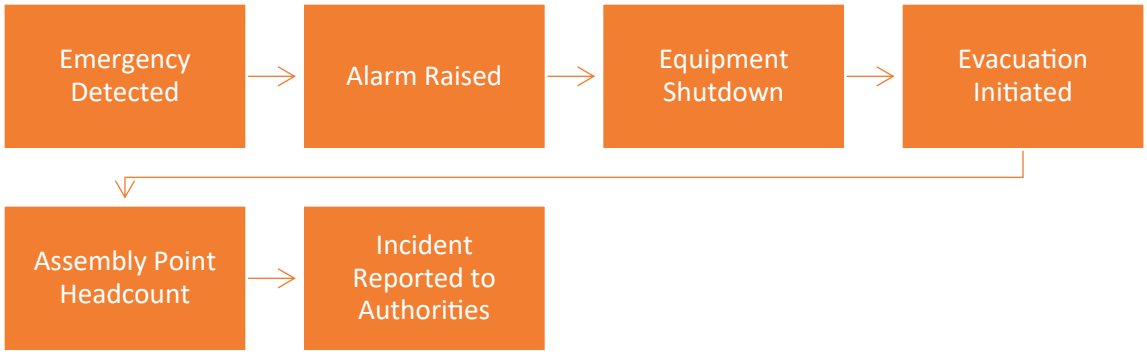


Fig. 6.1.1: Process of emergency response

Mock Drill Protocols

- Participate seriously and promptly.
- Follow the evacuation route without rushing.
- Assemble at the designated safe area.
- Listen to instructions from safety personnel.

6.1.4 Equipment Handling and Safe Operations

Safe and proper handling of workplace equipment is crucial for preventing injuries and maintaining smooth operations. Employees must be trained to follow standard operating procedures (SOPs), use personal protective equipment (PPE), and apply safety mechanisms such as emergency stop buttons and lockout-tagout systems. Regular maintenance checks and inspections help detect faults early and reduce the risk of accidents. Clear instructions, warning labels, and supervision also play a vital role in ensuring safe equipment use. Proper equipment handling prevents accidents and improves efficiency. Workers must understand operating procedures, maintenance checks, and safety locks.

Safe Equipment Use:

- Read operating manuals.
- Do not operate faulty machines.
- Shut down equipment before cleaning or servicing.
- Use guards and safety switches.

Equipment	Safe Handling Tip
Sewing machine	Turn off before threading the needle
Boiler	Monitor pressure gauges regularly
Cutting tools	Store in designated locked drawers

Table 6.1.2: Safe Equipment Use and Handling Areas

6.1.5 Waste Disposal and Minimisation Practices

Effective waste disposal and minimisation are key components of maintaining workplace hygiene, ensuring environmental sustainability, and meeting legal compliance standards. Every workplace generates different types of waste, such as general, hazardous, recyclable, or organic, and each type requires appropriate segregation and disposal methods.

Improper waste handling can lead to health risks, environmental pollution, and even legal penalties. For instance, sharp items like broken needles should be placed in puncture-proof containers, while fabric scraps should be collected in separate bins for recycling. Hazardous chemical waste must be disposed of only through authorised channels to prevent harm to workers and the ecosystem.

To promote safety and sustainability, organisations should implement clear waste segregation protocols and label bins accordingly. Regular employee training, audits, and awareness campaigns can help reduce unnecessary waste and encourage eco-friendly practices like reusing materials. By focusing on waste minimisation, companies not only reduce their environmental footprint but also improve efficiency and cost-effectiveness.

Managing waste is part of environmental safety and regulatory compliance. Waste must be disposed of based on type (hazardous, reusable, general).

Waste Type	Examples	Disposal Method
Recyclable	Paper, fabric	Collected in labelled bins
Hazardous	Chemicals, oils	Sent to a certified hazardous disposal unit
General	Food waste, dust	Regular municipal waste system

Table 6.1.3: Waste Types and Disposal

Waste Minimisation Tips

Effective waste minimisation is not only an environmentally responsible practice but also contributes to operational efficiency and cost reduction in the workplace, especially in industries such as textiles and manufacturing. The following waste minimisation tips, using materials efficiently, reusing scraps, and reporting leaks or spills immediately, are fundamental practices that all employees should follow to ensure a sustainable and safe work environment.

1. **Use Materials Efficiently**

   One of the primary steps towards waste reduction is using materials wisely and efficiently. When resources such as fabric, thread, paper, or packaging materials are used with care, the amount of leftover or unusable waste is greatly reduced.

   This begins with proper planning and cutting. For example, in a tailoring or garment production environment, the layout of patterns on fabric should be optimised to ensure the least amount of material is wasted. Advanced techniques like marker planning or CAD-based layout systems can help map out the most efficient use of fabric before cutting begins.

   Furthermore, proper storage and handling of materials help avoid damage or spoilage. Keeping materials clean, dry, and well-organised ensures that fewer items are discarded due to environmental exposure, mishandling, or pests.

   Efficient use also involves training workers to avoid overuse or unnecessary consumption of materials. For instance, using only the amount of thread or glue required for a job prevents excessive usage. Creating awareness and setting workplace norms or SOPs (Standard Operating Procedures) around material handling helps reinforce this culture of efficiency.

2. **Reuse Scraps Where Possible**

   Another highly effective strategy is reusing scraps and leftovers instead of immediately discarding them. In many industrial or craft-based workplaces, small leftover materials such as fabric cuttings, trimmings, paper remnants, or packaging waste are often treated as disposable. However, these scraps can be creatively repurposed or recycled.

   For example, in tailoring or garment production units, fabric scraps can be used to make accessories like hairbands, patches, cleaning cloths, or small sample pieces. Similarly, leftover packaging materials such as cardboard boxes or paper can be reused for temporary storage, shipping, or padding fragile items.

   Encouraging employees to find creative ways to repurpose and reuse materials not only reduces waste but also fosters innovation and resourcefulness. Companies can go a step further and establish dedicated scrap collection bins or reuse centres, where usable leftovers are sorted and made available for secondary use.

   In larger organisations, reused scraps can even be integrated into CSR (Corporate Social Responsibility) initiatives. For instance, fabric remnants can be donated to NGOs for training underprivileged individuals in sewing and crafting skills.

3. **Report Leakage or Spillage Immediately**

   Leakage and spillage of substances like oils, adhesives, chemicals, or water not only result in wastage but also pose significant health and safety hazards. If not addressed promptly, these issues can cause slippery floors, damage to electrical components, corrosion of machinery, or even fire hazards in case of flammable liquids.

   Prompt reporting of leakage or spillage ensures that corrective actions are taken without delay. Employees should be trained to identify signs of leakage, such as unusual smells, stains, puddles, or dripping equipment, and report them to the maintenance or safety supervisor immediately.

   Moreover, workplaces should install clear signage and instructions near machines or storage areas regarding what to do in case of a spill. Spill containment kits, absorbent materials, and emergency shutdown procedures must be easily accessible to handle such situations effectively.

   Developing a workplace culture where employees are encouraged to report faults and spills without fear of blame is critical. Often, workers avoid reporting minor leaks, thinking it will be fixed later or fearing consequences. However, a small leak today could lead to a major accident or expensive repair tomorrow.

   Regular maintenance of equipment and infrastructure also helps prevent leakage in the first place. Routine checks, servicing, and part replacements should be a part of the facility's waste and risk management plan.

6.1.6 Environmental Management Practices

Environmental Management Practices (EMPs) are essential in maintaining not just regulatory compliance but also a workplace that prioritises sustainability and long-term ecological responsibility. These practices are typically guided by an Environmental Management System (EMS), a structured framework that helps an organisation achieve its environmental goals through consistent review, evaluation, and improvement of its environmental performance. A well-implemented EMS can minimise the environmental footprint of industrial operations, reduce waste and resource consumption, and create a healthier workplace.

Objectives of Environmental Management Practices

- Ensure minimal negative impact on the environment.
- Promote sustainable use of resources.
- Create a health-conscious, eco-friendly workplace.
- Comply with environmental laws and standards.
- Encourage awareness among workers about environmental protection.

Key Practices Under EMS

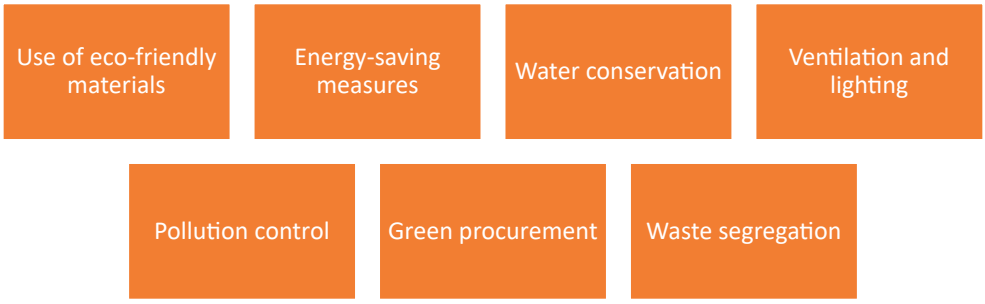


Fig. 6.1.2: Practices under EMS

Practice	Description
Use of eco-friendly materials	Switching to biodegradable, recyclable, or low-emission raw materials.
Energy-saving measures	Use energy-efficient equipment and turn off machines when not in use.
Water conservation	Fixing leaks, using water-efficient systems, and reducing water wastage.
Ventilation and lighting	Ensuring natural lighting and good airflow to reduce energy use and improve health.
Pollution control	Installing filters or scrubbers and reducing emissions or noise pollution.
Green procurement	Purchasing environmentally sustainable materials and products.
Waste segregation	Separating recyclable, hazardous, and biodegradable waste at the source.

Table 6.1.4: Key Practices Under EMS

1. **Use of Eco-Friendly Materials**

   Using environmentally friendly materials reduces harmful emissions and resource depletion. This includes biodegradable packaging, water-based paints, lead-free solder, and non-toxic cleaning agents. These not only benefit the environment but also reduce the risk of chemical exposure to workers.

   Example: In textile manufacturing, switching to organic cotton and natural dyes can reduce pollution in surrounding water bodies.

2. **Energy-Saving Practices**

   Energy-saving is a crucial part of any EMS. Turning off unused machines, using timers or motion sensors for lighting, and replacing old machinery with energy-efficient models can significantly reduce energy consumption.

   Best Practices:

   - Encourage the use of LED lights.
   - Implement automatic shutdown for idle equipment.
   - Maintain machinery to operate at optimum energy levels.

3. **Water Conservation**

   Water conservation measures are vital in both office and industrial settings. This includes installing low-flow taps, fixing leaks promptly, and reusing water where possible (e.g., in cooling systems).

   Quick Tips:

   - Place visual reminders near taps to avoid wastage.
   - Install rainwater harvesting systems if feasible.

4. **Ventilation and Lighting**

   Good ventilation prevents the buildup of fumes, dust, and heat, improving overall air quality and worker comfort. Natural lighting also reduces energy usage and enhances worker productivity.

Suggestions:

- Install exhaust fans and windows for cross-ventilation.
- Maximize daylight use through skylights or open layouts.

5. **Routine Walkthroughs and Audits**

   Environmental audits and walkthroughs help in identifying non-compliant practices or areas where environmental efficiency can be improved. These inspections often cover emissions, waste handling, storage of hazardous substances, and energy use.

   Frequency: Audits should be done monthly or quarterly depending on the risk level of operations.

6. **Pollution Control and Noise Management**

   Pollution control involves reducing the discharge of pollutants into air, water, and soil. Installing air filters, scrubbers, and noise silencers can make operations compliant with local environmental norms.

   Examples:

   - Use of dust collectors in manufacturing.
   - Noise barriers or soundproofing in noisy areas.

7. **Green Procurement**

   Choosing suppliers and products that are environmentally responsible is known as green procurement. This involves evaluating vendors based on their environmental practices and certifications (like ISO 14001).

8. **Waste Segregation and Disposal**

   Properly separating waste at the source reduces contamination and increases recycling. Bins should be labelled and colour-coded, blue for recyclables, red for hazardous, green for biodegradable, and black for general waste.

Benefits of EMS Implementation

- Improved compliance with environmental regulations.
- Enhanced brand image and corporate responsibility.
- Lower operational costs through reduced energy and material use.
- Reduced workplace risks and improved employee health.

Tool	Purpose
Checklists	Standardise walkthrough inspections
Monitoring systems	Track energy, water, and waste usage
Training workshops	Educate workers about eco-friendly practices
Environmental policy	Guide environmental actions and goals

Table 6.1.5: Tools and Strategies for EMS

6.1.7 Reporting, Communication, and Clarification

Effective communication is the cornerstone of maintaining workplace safety and operational efficiency. Workers must be encouraged to proactively report any unsafe conditions, unclear instructions, or deviations from safety standards. Clear and timely communication between workers, supervisors, and safety officers ensures potential hazards are addressed promptly and work is carried out smoothly.

By fostering a culture where questions and concerns are welcomed without hesitation, organisations can prevent minor issues from escalating into major accidents or disruptions. Workers should be trained and reminded regularly that reporting is not an act of fault-finding but a responsible contribution to collective safety.

When to Report:

- **Equipment Malfunction:**
  Any sign of faulty machinery, such as unusual sounds, overheating, smoke, or failure to operate, must be reported immediately. Operating malfunctioning equipment can lead to serious injuries, fire, or production losses.
- **Spillage or Leakage:**
  Liquid spills, especially of chemicals, oils, or lubricants, pose risks such as slips, fires, or toxic exposure. Workers must inform their supervisors as soon as they notice any leakage to ensure the affected area is cleaned and the source is repaired.
- **Safety Signs Missing:**
  Safety signs guide and warn workers about hazards (e.g., “Wet Floor”, “High Voltage”, “Exit Route”). Missing or damaged signage can lead to confusion and accidents. If any safety signage is not visible or legible, workers must alert the safety officer or maintenance team for immediate rectification.
- **Doubts in Work Instructions or Ticket Details:**
  If a worker is unsure about how to carry out a task, interpret a work order, or handle materials, they should seek immediate clarification from supervisors or team leads. Misunderstanding instructions can lead to errors, safety violations, and even accidents. It is better to confirm than to assume.

Best Practices for Reporting and Communication

- **Maintain a No-Blame Culture:** Encourage all workers to speak up without fear of punishment.
- **Use Standard Reporting Formats:** Implement checklists or digital platforms for easier hazard reporting.
- **Daily Briefings:** Conduct short safety meetings at the start of shifts to ensure everyone is on the same page.
- **Install Suggestion Boxes or QR Codes:** For anonymous reporting or feedback.
- **Feedback Loop:** Ensure that issues reported are addressed and outcomes communicated back to workers.

6.1.8 Personal Hygiene and Healthy Lifestyle

Maintaining personal hygiene and adopting a healthy lifestyle are essential not only for individual well-being but also for ensuring a safe, efficient, and harmonious workplace. Workers who follow hygienic practices and healthy routines are more alert, less prone to illness, and better equipped to handle physically or mentally demanding tasks.

Poor hygiene can lead to the spread of communicable diseases, unpleasant working conditions, and even absenteeism. Similarly, lifestyle choices such as alcohol or drug use can significantly impair judgement and reaction time, increasing the risk of workplace accidents. Promoting healthy habits contributes to a culture of discipline, respect, and shared responsibility.

Healthy Habits to Follow:

1. **Bathe Regularly and Wear Clean Clothes:**

   Daily bathing and wearing clean, well-maintained uniforms or workwear help prevent skin infections, body odour, and the spread of germs. Clean attire also reflects professionalism and maintains workplace decorum.

2. **Wash Hands Before and After Work:**

   Regular hand washing, especially before meals and after handling machinery or materials, reduces the risk of contamination and infections. This is particularly crucial in industries involving chemicals, dust, or biological agents.

3. **Avoid Alcohol, Tobacco, or Drug Use:**

   Substance abuse can severely impair concentration, coordination, and decision-making. Workers under the influence of intoxicants pose a danger to themselves and others. Organisations often have zero-tolerance policies toward alcohol and drug use. Tobacco use not only affects lung health but can also cause fires in combustible environments.

4. **Eat Nutritious Meals and Stay Hydrated:**

   Consuming a balanced diet helps maintain energy levels, enhances focus, and improves immunity. Skipping meals or eating junk food can lead to fatigue or illness. Drinking adequate water throughout the day, especially in hot or physically intensive environments, prevents dehydration and heat-related health issues.

Workplace Support for Hygiene and Healthy Living

- **Clean Facilities:** Provide accessible clean toilets, handwashing stations, and changing rooms.
- **Health Awareness Sessions:** Conduct regular training on hygiene, nutrition, and the dangers of substance abuse.
- **Access to Drinking Water:** Ensure that filtered drinking water is available near workstations.
- **Counselling Services:** Offer confidential support for those struggling with addiction or mental health issues.
- **Nutritious Canteen Food:** Promote healthy food options in workplace cafeterias.

Habit	Impact at Work
Personal hygiene	Prevents illness and contamination
No substance use	Improves concentration and safety
Adequate sleep	Enhances alertness and productivity

UNIT 6.2: Work Operations and Quality Compliance

Unit Objectives

By the end of this unit, the participants will be able to:

1. Obtain and interpret data from work tickets or job cards to perform duties aligned with job responsibilities.
2. Ask questions when instructions are unclear and agree upon work targets with supervisors, including special instructions.
3. Check tools and equipment for safety; select and use correct equipment as per job requirements.
4. Ensure the work area is hazard-free and set up machines like fabric checking machines accordingly.
5. Carry out tasks at a pace that maintains workflow and meets production targets.
6. Conduct visual inspections to detect product defects and ensure compliance with quality parameters.
7. Work in accordance with company quality standards, legal requirements and organisational procedures.
8. Complete required documentation accurately and leave the work area safe and secure after task completion.

6.2.1 Work Instructions and Job Responsibilities

Job responsibilities are assigned based on specific roles, and instructions like work tickets or job cards help guide employees in performing their duties. Clear interpretation of these instructions ensures alignment with production targets, safety standards, and quality expectations. When workers seek clarification for unclear steps or unusual requirements, it helps avoid mistakes and delays. This approach fosters accountability and promotes a smooth workflow on the shop floor. Every task in the workplace begins with understanding the job ticket or work card. These documents provide essential information such as:

- Job description
- Quantity required
- Quality standards to be met
- Special instructions, if any
- Deadline or delivery time

Importance of Clarifying Instructions

In any work environment, especially in manufacturing and production settings, clarity of instructions is crucial to maintaining efficiency, safety, and quality. Employees must have a clear understanding of the task at hand before starting their work. When instructions are vague, incomplete, or misunderstood, it can lead to serious consequences such as product defects, missed deadlines, wasted materials, or even workplace accidents.

Workers should feel confident and encouraged to ask questions whenever they encounter confusion or uncertainty in their job tickets, verbal instructions, or special directives. This proactive communication helps in several ways:

- **Avoids Costly Mistakes:** Misinterpreting instructions can lead to production errors or quality rejections, both of which can be costly in terms of time and resources. Clarifying the task beforehand helps prevent rework and waste.

- **Improves Efficiency:** Knowing exactly what to do and how to do it allows workers to plan their tasks better and manage their time more effectively. This improves overall productivity and workflow.
- **Builds Confidence:** When workers seek clarification and receive proper guidance, it builds their confidence in executing the task correctly. Over time, this promotes independence and mastery of their responsibilities.
- **Promotes Safety:** Unclear instructions, especially those involving the use of machines or hazardous materials, can lead to unsafe practices. Clarifying instructions ensures safety protocols are followed properly.
- **Ensures Alignment with Expectations:** Supervisors often have specific expectations in terms of output, timing, or quality standards. Clarifying these expectations in advance helps workers meet their targets without confusion or last-minute corrections.
- **Strengthens Team Communication:** Open dialogue between workers and supervisors fosters a collaborative culture where questions and feedback are welcomed. This improves overall team performance and reduces misunderstandings.
- **Adapts to Changes Quickly:** In dynamic environments, priorities may shift or new instructions may come in. If workers are in the habit of seeking clarity, they can adapt to changes more smoothly without disrupting workflow.

6.2.2 Pre-Operational Checks and Equipment Readiness

Before starting any task, especially in industrial, manufacturing, or technical settings, it is essential to perform pre-operational checks to ensure that all tools, equipment, and machinery are in proper working condition. These checks help identify potential issues such as wear and tear, malfunctioning parts, or missing safety guards before operations begin. Equipment readiness is not only vital for smooth production but also for maintaining the safety of the operator and those around them. Ignoring such checks can lead to accidents, equipment damage, and costly downtime. Performing these routine inspections demonstrates professionalism and a proactive approach to risk management. By ensuring everything is functional and safe at the start of a shift, workers contribute to efficient and hazard-free operations.

Before starting any task, it is critical to inspect the tools and equipment to ensure:

- They are safe to use
- They are appropriate for the task
- All safety guards and locks are in place

Routine Checks May Include:

Checkpoint	Purpose
Electrical wiring	Avoid short-circuit or fire hazards
Sharpness of tools	Ensure precise work and reduce effort
Calibration of machines	Maintain product accuracy and quality
Cleanliness	Prevent contamination or defect

Table 6.2.1: Routine Checks

6.2.3 Preparing the Work Area

A well-prepared work area is the foundation for productive, efficient, and safe operations in any industry, especially in sectors such as textiles, manufacturing, or technical trades. The process of preparing a workspace involves more than just tidying up; it is a deliberate effort to ensure the environment is free from hazards, ergonomically set up, and conducive to focused work. Proper preparation supports both safety standards and quality output, making it an essential part of operational routines.

Key Steps in Preparing the Work Area

1. **Keep the Workspace Clutter-Free**

   A cluttered environment increases the chances of tripping, knocking over equipment, or misplacing essential tools. Workers must remove unnecessary items from work tables, aisles, and walking paths. Materials should be stored in designated areas, and tools must be arranged systematically for easy access.

2. **Eliminate Spillage and Obstructions**

   Slippery floors or items obstructing movement can cause workplace injuries. Spills, whether from oil, water, or chemicals, must be reported and cleaned immediately. Tangled wires, misplaced tools, or bundles of materials in walking paths should be properly secured or removed.

3. **Correct Setup of Equipment and Machines**

   For operations involving machines like fabric inspection stations, sewing machines, or cutting tables, it is crucial to ensure:

   - Machines are placed on stable surfaces.
   - All components (lights, sensors, belts, needles, etc.) are correctly adjusted and functional.
   - Safety guards and emergency stop buttons are in place and working.
   - Calibration or alignment of the machines is done as per the work instructions.

4. **Ensure Adequate Lighting and Ventilation**

   Proper lighting enhances visibility, reducing strain on the eyes and helping workers detect defects or perform fine-detail work. Dim or flickering lights should be reported and fixed. Similarly, good ventilation maintains air quality, removes dust or fumes, and keeps the workspace comfortable. Exhaust systems and fans must be functional, especially in closed environments.

Benefit	Description
Reduces Risk of Accidents	Eliminating obstructions, checking machines, and cleaning spills prevent slips, trips, or equipment-related injuries.
Improves Work Speed	A clean, organised environment saves time otherwise wasted searching for tools or fixing issues.
Enhances Focus and Accuracy	Workers can concentrate better without distractions from clutter or discomfort, leading to higher-quality work.
Increases Comfort	Proper lighting, ventilation, and ergonomic layout make long working hours less tiring.
Maintains Professionalism	A neat work area reflects discipline, care, and respect for the workplace.

Table 6.2.2: Benefits of a Prepared Work Area

Best Practices for Work Area Preparation

- Perform a daily inspection of the workstation before beginning any task.
- Use checklists to verify that all aspects of preparation are covered.
- Communicate with teammates to coordinate shared spaces or equipment.
- Label materials and store them in their designated locations.
- Immediately report any maintenance issues or hazards.

6.2.4 Productivity and Pace in Executing Tasks

In any production or manufacturing environment, particularly in textile and apparel units, maintaining a steady workflow is essential. Workers are expected to complete their tasks in a manner that not only meets the required speed but also ensures accuracy and quality. Executing tasks efficiently means finding the right balance between speed and precision - neither rushing to the point of compromising quality nor being overly slow to cause bottlenecks in the production line.

Importance of Productivity and Pace

High productivity directly contributes to meeting organizational goals, customer deadlines, and cost efficiency. At the same time, maintaining an appropriate pace helps in reducing fatigue and mental stress. When employees learn to work rhythmically, the entire production process runs smoothly, ensuring that targets are met without compromising safety or quality standards.

Tips for Maintaining a Steady Workflow

1. **Follow a Routine or Sequence of Steps**
   - Developing a habit of following standard operating procedures (SOPs) or job-specific steps helps in minimizing confusion.
   - When every worker follows a consistent method, coordination becomes easier, especially in jobs involving multiple departments or individuals.
2. **Avoid Unnecessary Movements**
   - Excessive walking, reaching, or turning not only wastes time but also causes fatigue.
   - Tools, materials, and workstations should be arranged in a way that minimizes movement. This concept is rooted in ergonomics, which improves both comfort and efficiency.
   - Example: Keeping scissors, measuring tapes, and other tools within arm's reach can save time in garment inspection or cutting units.
3. **Use Both Hands When Possible**
   - Using both hands simultaneously - for example, one hand arranging fabric while the other operates a machine - can double efficiency.
   - This requires training and practice but significantly improves speed and productivity.
4. **Coordinate with Team Members**
   - In processes that involve teamwork, like sewing lines or quality inspection chains, coordination is vital.
   - Communicating changes, delays, or defects quickly ensures that the rest of the team can adapt without delays.
   - Example: If one worker notices a fabric defect, alerting the next station can prevent further time waste or quality issues.

5. **Time Awareness**
   - Keeping track of time spent on specific tasks can help workers self-monitor and adjust their pace.
   - Supervisors may set realistic time goals for certain tasks. Workers should aim to meet these benchmarks without sacrificing work quality.
6. **Use Breaks Strategically**
   - Taking short, scheduled breaks helps avoid burnout and maintain energy levels.
   - A well-rested worker is more likely to maintain consistent pace throughout the shift.
7. **Keep Distractions Minimal**
   - Personal conversations, mobile phones, and other distractions can interrupt flow.
   - Maintaining focus ensures a better rhythm and improves task completion time.

Benefit	Explanation
Increased Output	Higher productivity helps meet targets and manage large orders.
Improved Quality	Consistent pace reduces errors due to rushing or carelessness.
Better Team Synergy	When all members work rhythmically, the flow of materials and tasks is smooth.
Job Satisfaction	Completing tasks effectively gives workers a sense of achievement.
Reduced Fatigue	Streamlined movements and workflow lead to less physical and mental exhaustion.

Table 6.2.3: Benefits of Executing Tasks Efficiently

6.2.5 Quality Control During and After Task Execution

Quality control is a critical component of any production or service-oriented work environment. It refers to the systematic processes and procedures put in place to ensure that the output meets predetermined standards and customer expectations. During and after task execution, quality control becomes vital not only for ensuring the end product is free of defects but also for maintaining consistency, reducing waste, improving customer satisfaction, and safeguarding the reputation of the organisation.

In industries such as apparel, manufacturing, food processing, and electronics, quality is not just a benchmark but a competitive necessity. Any compromise on quality can lead to customer complaints, rework, loss of time, increased production costs, and in some cases, even legal liability. Thus, quality control is not limited to the final inspection; it begins right from the planning and continues throughout the entire execution of tasks. Workers must integrate quality checks as part of their workflow rather than treating them as separate steps at the end of production.

During task execution, operators must stay attentive to the details of the process. For instance, in a garment unit, checking for loose threads, uneven stitching, fabric flaws, or incorrect labelling must be done in real-time. Using visual inspection techniques and measurement tools ensures that immediate rectification can occur without halting the overall workflow. Mid-task corrections are often more efficient than reworking finished products. Moreover, consistent quality monitoring during task execution enhances worker accountability and reduces the chances of cumulative defects.

After the task has been executed, post-production quality checks act as the final gatekeeper before the product reaches the next stage or customer. These checks may include visual inspection, physical testing, measurement verification, packaging standards, and documentation audits. At this stage, it is

essential to verify not just the physical quality of the output, but also the accuracy of records, adherence to safety protocols, and completeness of related administrative work such as tagging or labelling.

It is important to understand that quality control is not only the responsibility of designated quality inspectors; every worker has a role to play in maintaining quality. This involves being familiar with the quality parameters of their specific job role, understanding defect types, maintaining workplace discipline, and reporting anomalies immediately. A culture of quality compliance must be instilled at all levels, where quality is seen not just as a requirement but as a shared value.

In essence, quality control during and after task execution ensures that the product or service consistently meets the defined expectations. It enables better resource utilisation, fosters customer trust, minimises risks, and aligns the output with organisational goals. Embedding quality consciousness into everyday operations transforms the workforce into the first line of defence against defects, making quality an outcome of diligence, attention, and proactive work habits.

A key responsibility of any worker is to ensure product quality. This involves:

- Conducting visual inspections for defects (e.g., holes, stains, misalignment)
- Checking measurements and fit
- Ensuring that components meet the company's quality parameters
- Notifying supervisors immediately if substandard materials are received or produced

Aspect	What to Check
Surface appearance	Clean, stain-free, no damage
Stitching/fitting	Tight, even, no loose threads
Measurements	Within tolerance limits
Material integrity	No shrinkage, tears, or deformities

Table 6.2.4: Common Quality Checkpoints

6.2.6 Adherence to Legal and Organisational Standards

In any professional work environment, particularly in manufacturing, apparel, logistics, or other operational sectors, adherence to legal and organisational standards is not only a responsibility but a necessity. These standards form the backbone of ethical, safe, and sustainable workplace practices. Failing to comply can lead to legal liabilities, reputational damage, penalties, and, most importantly, endanger the health and safety of workers and the environment.

1. **Following Standard Operating Procedures (SOPs)**

   Standard Operating Procedures are step-by-step documented instructions created by organisations to ensure consistency and quality in performing routine tasks. SOPs serve as an internal control mechanism that helps workers:

   - Understand task requirements and expected outcomes.
   - Reduce variation and errors by promoting uniform practices.
   - Ensure safety and efficiency in processes.
   - Improve training outcomes for new workers.

Importance in Practice:

For example, in a garment factory, SOPs for cutting, stitching, finishing, and packaging ensure that the right fabric, thread, and stitching methods are used uniformly. Workers must read, understand, and apply the SOPs relevant to their role, asking supervisors if clarifications are needed.

2. Complying with Occupational Health and Safety (OHS) Regulations

Occupational health and safety laws protect workers from workplace hazards and risks. These are often enforced by national legislation (such as India's Occupational Safety, Health and Working Conditions Code, 2020) and organisational safety policies.

Worker Responsibilities Include:

- Wearing personal protective equipment (PPE) as mandated.
- Following safety signage and instructions.
- Reporting unsafe conditions or equipment to supervisors.
- Participating in safety drills and training programs.

Real-World Impact:

Ignoring OHS rules can lead to serious injuries, fatalities, or long-term health issues. On the other hand, consistent compliance helps create a safer, more productive workplace.

3. Meeting Labour and Environmental Norms

Labour laws govern working hours, minimum wages, employee benefits, child labour restrictions, anti-discrimination policies, and more. Environmental norms regulate the use of resources, waste disposal, and pollution control.

Organisations and workers must:

- Ensure that work is done during permissible hours and in ethical conditions.
- Prevent child labour and forced labour.
- Handle waste materials responsibly and reduce environmental harm.
- Promote green practices such as reusing, recycling, or reducing material usage.

Why It Matters?

Many buyers, especially international clients, audit supplier factories for labour law compliance and environmental sustainability before placing orders. Non-compliance can result in order cancellations or legal action.

4. Respecting Customer-Specific Requirements

Some clients or customers impose additional standards that go beyond regulatory requirements. These may relate to:

- Product quality and packaging preferences.
- Ethical sourcing standards (e.g., Fair Trade or Organic certifications).

- Branding and labelling requirements.
- Timely delivery and documentation accuracy.

Example:

A European apparel brand may require that garments be free from certain dyes or chemicals, or that production units follow humane labour practices certified by third parties.

Worker Role:

Employees must be trained to understand these expectations and follow special instructions while handling such client orders.

Compliance Area	Key Requirements	Who Enforces/ Implements?
Standard Operating Procedures	Task consistency, process documentation, and internal discipline	Supervisors, QA teams
Occupational Health and Safety	PPE usage, hazard reporting, emergency readiness	Safety Officers, HR, Government agencies
Labour and Environmental Regulations	Fair wages, work hours, waste management, and child labour laws	Labour Inspectors, Environmental Boards
Customer-Specific Standards	Ethical sourcing, packaging, quality consistency, and delivery expectations	Clients, Export Auditors, Compliance Team

Table 6.2.5: Key Standards and Compliance Areas

6.2.7 Documentation and Safe Closure of Tasks

Once a task is completed, the process does not end with just finishing the physical activity. Documenting the task is equally crucial. It not only supports effective monitoring and supervision but also ensures accountability, traceability, and preparedness for future planning or audits. In production environments, especially in industries like textiles, garments, pharmaceuticals, or electronics, precise record-keeping can significantly influence quality control, rework rates, and operational efficiency.

Accurate documentation provides clarity on the task's status, identifies recurring problems, helps measure performance, and assists in forecasting future work requirements. It also protects both the worker and the organisation by providing written evidence in case of any inspection, quality audit, or customer complaint.

Furthermore, the safe closure of tasks involves more than just completing work. It includes shutting down machinery appropriately, cleaning the workspace, securing tools, and ensuring that all safety measures are followed before leaving the work area. A clean, orderly, and well-documented closure ensures a safe environment for the next shift and contributes to smooth handovers in a shift-based workplace.

Documented Item	Purpose
Quantity Produced	Helps in tracking productivity and assessing if targets were met
Time Taken	Useful for evaluating efficiency and time management
Issues Faced	Facilitates problem-solving and future prevention
Materials Used or Returned	Aids in inventory management and cost tracking

Table 6.2.5: Key Elements to Be Documented After Task Completion

Documentation Methods

- **Manual:** Job cards, notebooks, printed forms
- **Digital:** ERP entries, mobile applications, barcoding systems, tablets

Importance of Documentation

Documentation is a critical aspect of any industrial or organisational process, especially in production-related environments. It serves as a record-keeping tool that enhances transparency, accountability, traceability, and production planning. When workers complete a task, documenting the key details ensures that the work can be reviewed, repeated, corrected, or scaled effectively. The figure below outlines three core reasons why documentation is indispensable:

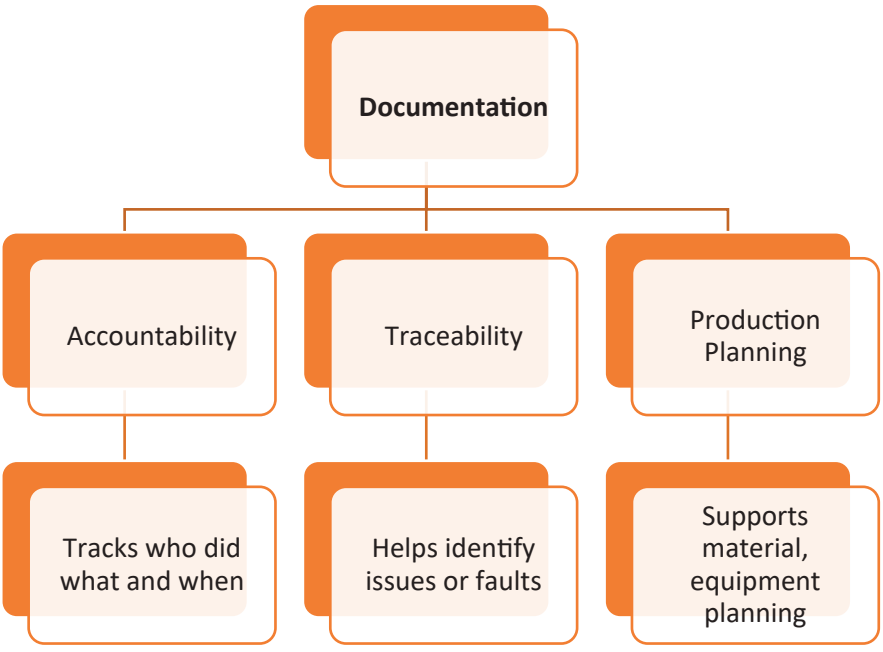


Fig. 6.2.1: Significance of documentation

1. **Accountability**

   Documentation ensures personal and team accountability. When a worker records the quantity produced, the materials used, the time taken, and any issues faced during the task, it creates a clear record of performance. This becomes important in:

   - Tracking who performed which task
   - When the task was completed
   - Whether it was completed as per the standards

Accountability helps supervisors assess performance, reward efficiency, and address any non-compliance or recurring issues. For instance, if defective products are found, documentation helps trace them back to the responsible shift or team for quick rectification.

2. **Traceability**

Proper documentation supports traceability, the ability to track the path of a product or process from start to finish. This is especially vital in quality control, audits, and process improvement.

- If a defect or safety issue arises, traceability helps locate the root cause.
- It aids in identifying which batch, machine, or operator was involved in the task.
- It also supports compliance with legal and industry regulations, which often require traceable records for product history.

In manufacturing, for example, if a customer reports a faulty item, documentation allows for tracking the production batch, sourcing raw materials, and evaluating operational steps that may have caused the issue.

3. **Production Planning**

Documentation plays a significant role in streamlining production planning. By having accurate records of:

- Output
- Resource consumption
- Machine usage
- Downtime or issues encountered

Managers can better plan the next stages of production. This includes resource allocation, inventory management, and equipment maintenance. It also helps in preparing reliable timelines and forecasts for delivery.

For example, if a particular machine consistently records downtime due to maintenance, planners can schedule preventive maintenance and adjust production timelines accordingly.

Task	Description
Record work data	Enter in job card or digital system
Shut down machines	Follow the shutdown procedure, ensure safety
Store tools	Return all tools to designated places
Dispose of waste	Segregate and discard properly (biohazard, sharp objects, etc.)
Clean work area	Remove clutter, wipe surfaces
Secure workspace	Lock drawers, shut cabinets, and turn off lights, if applicable

Table 6.2.6: Checklist: Safe Closure of Work Area

Aspect	Benefits
Work Continuity	Ease handover to the next shift or team
Efficiency	Helps track and improve performance
Safety	Reduces accident risks in the next operation
Compliance	Supports legal and regulatory adherence
Data Accuracy	Provides insights for audits, quality checks, and client reports

Table 6.2.7: Benefits of Proper Documentation and Safe Closure

Pro Tips for Workers

- Use consistent formats or templates for logging details.
- Double-check entries, especially quantities and times.
- Note any unusual observations (e.g., power cuts, material issues).
- Ask for clarification if unsure about what needs to be recorded.

Summary

- Workers must follow both internal rules (like Standard Operating Procedures) and external regulations (such as labour laws, environmental norms, and health & safety standards).
- Following Standard Operating Procedures ensures uniformity, quality, and safety in operations, reducing the risk of errors or accidents.
- Compliance with health and safety regulations protects workers from hazards and ensures a secure working environment.
- Employees must respect applicable labour rights and environmental laws, helping the organisation operate ethically and sustainably.
- In some industries, workers must also follow additional guidelines set by clients, especially in quality-sensitive production or service sectors.
- Documenting tasks helps in maintaining accountability, ensuring traceability of issues, and supporting efficient production planning.

Exercise

Multiple-choice Question:

1. Which of the following is NOT a reason for maintaining proper documentation?
   a. Accountability
   b. Traceability
   c. Entertainment
   d. Production planning

2. What is the purpose of following Standard Operating Procedures (SOPs)?
   a. To encourage individual work styles
   b. To increase confusion among workers
   c. To ensure consistency and safety in tasks
   d. To avoid teamwork

3. Which of the following is a key requirement under organisational standards?
   a. Personal decision-making without protocol
   b. Ignoring customer needs
   c. Following SOPs and health and safety norms
   d. Reducing documentation time

4. Why is task documentation important after completing work?
   a. To delete records regularly
   b. To support production planning and accountability
   c. To confuse supervisors
   d. To replace physical tools

5. Which one is NOT included in the checklist before leaving the work area?
   a. Record job details
   b. Leave machines running
   c. Secure workstations
   d. Dispose of waste correctly

Descriptive Questions:

1. Explain the significance of adhering to legal and organisational standards in a workplace
2. Describe the key components that should be documented after completing a task and explain why each is important.
3. Explain the significance of proper documentation in task execution and how it contributes to a productive and accountable workplace.
4. List and explain at least five checklist points workers should follow before leaving the work area.
5. How do compliance with health and safety norms and proper documentation practices contribute to a safer and more efficient working environment?

Notes

Scan the QR codes or click on the link to watch the related videos

https://youtu.be/ltW7KVYJ1go?si=m0Re9uMPKqVSZVr1

Personal Protective Equipment (PPE)

https://youtu.be/wc_YwajwWPg?si=KYaBhsPERVGNIMkR

Emergency Evacuation Procedure

https://youtu.be/Co9j_HKx9fw?si=RiyV4iP8bHZXOhcL

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& ENTREPRENEURSHIP

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APPAREL MADE-UPS HOME FURNISHING
SECTOR SKILL COUNCIL

7. Employability Skills

DGT/VSQ/N0102

Employability Skills is available at the following location

https://www.skillindiadigital.gov.in/content/list

Employability Skills

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE>IMAGINE FUTURE

APPAREL MADE-UPS HOME FURNISHING
SECTOR SKILL COUNCIL

8. Annexure

Module No.	Unit No.	Topic Name	Page No	Link for QR Code (s)	QR code (s)
Module 1: Introduction and Orientation to Advanced Pattern Maker (Bridge Module)	Unit 1.1: Overview of the Apparel Industry and the Role of an Advanced Pattern Maker	1.1.1 Employment Opportunities for Industrial Engineer	10	https://youtu.be/ddisteV3tOo?si=uFDW4QKnI-toOKknY	Textile Sector in India
		1.1.2 Apparel Production Process and Role of the Advanced Pattern Maker	10	https://youtu.be/Jfeu-rBVm-o?si=P8oLTmvZHd2NPwQk	Explain the role and importance of a Pattern Maker and Marker Maker in the garment industry
		1.1.4 Roles and Responsibilities of an Advanced Pattern Maker	10	https://youtu.be/BOFx1LB9IFY?si=W74OEfq-LaAmT9He-	Pattern Making
Module 2: Prepare to develop pattern through (CAD/ CAM) (AMH/ N1101)	Unit 2.1: Information Flow and Planning	2.1.1 Meaning and Significance of the Spec Sheet	33	https://youtu.be/BnfzbhvQ05k?si=1l_p0v0xBCVvRK8I	Clothing Tech Pack
		2.1.4 Tools and Equipment Needed for Pattern Development	33	https://youtu.be/1BOvn-IwAmU?si=QRMFZh6AzqPo-eLl	Evolution of CAD Tools

Module No.	Unit No.	Topic Name	Page No	Link for QR Code (s)	QR code (s)
		2.1.5 Analysing the Bill of Materials (BOM)	33	https://youtu.be/WrDu5rHAcIM?si=BbpaL6oO-X7nN4v6K	Bill of materials
Module 3: Develop the pattern through (CAD/CAM) (AMH/N1101)	Unit 3.1: Pattern Development and Preparation	3.1.1 Incorporation of Shrinkage in the Pattern	53	https://youtu.be/XcHqHLvdR9Y?si=IHeW9I79w-DmCXFOt	Shrinkage Or Dimensional Stability to wash Test Process For Fabric
	Unit 3.2: Marker Efficiency and Cutting Execution	3.2.1 Marker Types and Their Applications	53	https://youtu.be/1lGMdp-scPLk?si=VFG20fAzQ9mO6ZWz	Top 6 Best Fabric Marker Reviews In 2025
		3.2.4 Setting Parameters on CAM Systems	53	https://youtu.be/NBHYb29flXk?si=SPqK6GH-0bJYtq47u	Basics of CAD, CAE and CAM
Module 4: Take the print-out through (CAD/CAM) (AMH/N1101)	Unit 4.1: Processes Related to System Closure and Output Delivery	4.1.3 The CAM System for Printing	71	https://youtu.be/Hx6DXuildSc?si=CFGCno1Xn-wpX6ZR4	What is computer Aided Manufacturing (CAM)?

Module No.	Unit No.	Topic Name	Page No	Link for QR Code (s)	QR code (s)
Module 5: Maintain work area, machinery, tools and equipment (AMH/ N1102)	Unit 5.1: Safe and Efficient Use of Tools and Equipment	5.1.1 Maintenance of Tools and Equipment	100	https://youtu.be/4ZXfpfs09g8?si=l-Jc5_rRUdLDbgD6	Types of Maintenance
		5.1.3 Cleaning Tools and Equipment	100	https://youtu.be/W_3M9I-J0yN4?si=GOiLaWisqzR42QDv	Basic Patterning Tools Every Pattern Maker Should Have
		5.1.6 Waste Disposal Protocols	100	https://youtu.be/E1Y2mg-UXGdM?si=nior_3vyt1f-oPF69	Start Fabric Waste Recycling Business
Module 6: Promote and sustain safety, health, and security in workplace, while fostering Gender and Persons with Disabilities (PwD) Sensitisation (AMH/ N0620	Unit 6.1: Health, Safety and Environmental Practices	6.1.1 Workplace Health and Safety Practices	128	https://youtu.be/ltW7KVY-J1go?si=m0Re9uMPKqVSZVr1	Personal Protective Equipment (PPE)
		6.1.3 Mock Drills, Shutdown, and Evacuation Procedures	128	https://youtu.be/wc_YwajwWPg?si=KYaBhsPERV-GNIMkR	Emergency Evacuation Procedure

Module No.	Unit No.	Topic Name	Page No	Link for QR Code (s)	QR code (s)
		6.1.8 Personal Hygiene and Healthy Life-style	128	https://youtu.be/Co9j_HKx9fw?si=RiyV4iP8bHZXOhcL	Personal Hygiene and Healthy Living

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