A Glossary of Common Terms used in Apparel Production

Apparel Manufacturing Terminologies

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A Glossary of Common Terms Used in Apparel Production

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Apparel manufacturing terminologies has provided most accurate information possible. Terms explained in the book are from personal learning and experience. Some terms are referred from the trusted sources. The author and publisher will not be held liable for any damages resulting from us of this book.

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Introduction

Thank you for downloading this eBook.

It is pleasure to me to see you on the reading spree and learning the new things about inside the apparel-manufacturing sector.

As the book title named, this eBook contains common terminologies used in the apparel production. Apparel production is a stage in the apparel supply chain, where the fabrics are converted into wearable garments through numerous processes and activities. Many processes and human activities involved in garment manufacturing that brings beautiful apparel items for the global market.

In this eBook, we have put together the terms and definition with examples, images where applicable and available. Each term is explained briefly. But if you like to know more about the terms, you can check it in my blog and read the blog Online Clothing Study. For the quick access to full article, I have given link to the related articles.

Enjoy reading the book!

If you love reading this book, share it with your friends.

Prasanta Sarkar
Online Clothing Study

List of Terms

1 Agile Manufacturing

Agile manufacturing is the ability of the manufacturing unit to improve specific areas of responsiveness, shortened system changeover, product customization, cost and time, and efficient scaling up and down of operations. An agile manufacturing strategy integrates Just in Time (JIT) system and Total Quality Management (TQM) to respond with agility to the uncertainties in the market demand. The need of decreasing lead times and being flexible in fast fashion introduced involvement of suppliers in the process as being crucial to their ability to attain high levels of customer satisfaction.

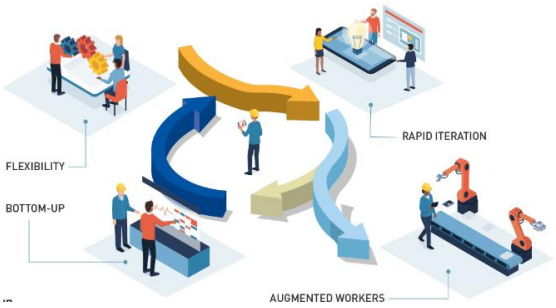


Figure 1: Fundamentals of Agile Manufacturing

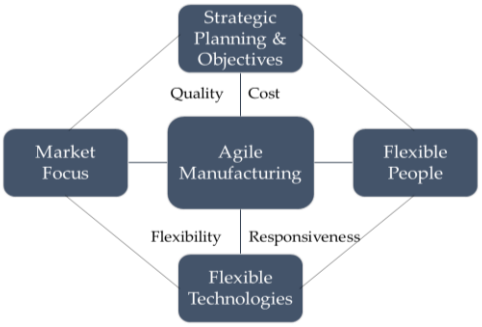


Figure 2: Paradigms of Agile Manufacturing

2 Allowance

Allowances, in work-study, refers to the time added to the basic time to obtain the standard time for a job. Operations in the apparel-manufacturing units do require the expenditure of human effort, and are dependent on other factors like working conditions, human skills, and machinery. Without an allowance, operators will not produce more but, on the contrary, the operator cannot maintain their rating of 100% during the working day. Since operators accumulate fatigue day after day, some allowance gives them recovery from fatigue and provides relaxation. The various types of allowances considered include machine allowance, relaxation allowance, process allowance, contingency allowance, special allowance.

Benchmark Allowances (JUKI Corporation, Japan)		
Category	Benchmark Rate (%)	
	Large Vol. Production	Small Vol. Production
Work Allowance	10.1 – 19.3	11.3 – 18.6
Workshop Allowance	3.5 – 5.9	3.8 – 7.8
Fatigue & Physiological Need Allowance	2.6 – 3.4	1.6 – 5.2
Others (Negligence)	0 – 1.5	0 – 0.3

Figure 3: Standard Benchmark Allowance (JUKI)

3 Andon Light

ANDON lights are lighted status-display station, which provide instant, colour coded visual, and audible alerts to the manager immediately regarding any specific problem.

These can indicate the following: Stop in production, Machine problems, Quality problems, Operator away from the machine, or Production in progress without any problem.

There are various types of ANDON lights such as steady with buzzer, steady and flashing with buzzer, wall mounted with/without buzzer, rotating/flashing/strobe beacons with buzzer, wireless ANDON light, Ethernet-based ANDON light.

An example of ANDON light installed in an apparel-manufacturing unit is shown, where the colours indicate the following:

- Red- machine problem
- Amber- quality problem
- Green – raw material problem

Figure 4: Andon Lights on Sewing Floor

4 AQL – Acceptance Quality Limit/ Level

Acceptance Quality Limit/Level (AQL) is associated with statistical sampling. It is the "minimal standard for a satisfactory process or product average." It represents the maximum number of defective units acceptable in a lot, beyond which the lot is a reject. In the apparel industry, generally, for low price items and children's wear AQL of 6.5 and 10.0 may be quite appropriate, while for higher price items appropriate AQL may be 2.5 and 4.0. Lower the AQL value, stricter is the norm.

Lot or Batch size	Sample size Code Letter	Sample Size	Acceptable Quality level					
			2.5		4.0		6.5	
			Ac	Re	Ac	Re	Ac	Re
2 – 8	A	2	0	1	0	1	0	1
9 – 15	B	3	0	1	0	1	0	1
15 – 25	C	5	0	1	0	1	0	1
26 – 50	D	8	0	1	1	2	1	2
51-90	E	13	1	2	1	2	2	3
91-150	F	20	1	2	2	3	3	4
151-280	G	32	2	3	3	4	5	6
251-500	H	50	3	4	5	6	7	8
501-1200	J	80	5	6	7	8	10	11
1201-3200	K	125	7	8	10	11	14	15
3201-10000	L	200	10	11	14	15	21	22
10001-35000	M	315	14	15	21	22	21	22

Figure 5: AQL Table

Learn how to read AQL chart

5 ASN – Advanced Shipping Notice

Advanced shipping notice (ASN) is a document that provides detailed information about a pending delivery. The purpose of an ASN is to notify the customer when shipping occurs and provide physical characteristics about the shipment so the customer can be prepared to accept delivery. ASNs facilitate the rapid flow of goods across the entire retail supply chain as receiving can be planned in advance. With the ASN, it is easier to determine which trucks contain the vendor products, so staffing becomes easier. It is sent electronically through EDI transaction set 856 allowing the companies to reduce paperwork requirements.

Header	ASN Number Inbound Delivery Number Delivery Date (ETA) Ship-from Location Customer Location Ship-to Location Document Date Shipping Date
Status	ASN Status Validation Status 3rd Party Order Processing Indicator Inbound Delivery Status
Shipping Details	Means of Transport Weight (gross and net) and Volume
Item Data	Quantity PO Details

Figure 6: Fields in an ASN

6 Assembly Line

An assembly line is the manufacturing process where in distinct tasks are assigned to a set of workstations and the parts are assembled into a product in a sequential manner. The set of workstations are linked together by a transport mechanism under detailed assembling sequences specifying how the assembling process flows from one station to another. Different operators carry out different operations in an assembly. An assembly line is advantageous as there is standardization in production, consistency in quality can be obtained, and there is a lot of scope of special machines, attachments, and work aids.

Figure 7: Sewing Assembly Line

7 Attachments

Attachments are mechanisms attached to a sewing machine, which can be removable and do not alter the original frame of the machine.

Attachments facilitate operator to perform their work effectively and reduce complexity of an operation. For example, sewing machine attachments that fold fabric, control or guide fabric and enable a relatively unskilled operator to sew quickly and with a high level of accuracy.

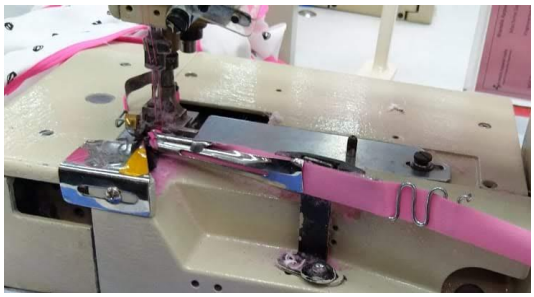


Figure 8: Folder for Binding

Figure 9: Guide for Lapped Seam

8 Auditor

An auditor could be internal, customer, or external. Auditors assess the quality facilities, procedures and systems providing an independent assessment of the factory's quality systems and an independent view of the facility's precision in producing consistent quality products. An internal auditor is the organisation's own employee but works independently to check non-conformance issues to take corrective action, as a preparation for second party (Customer/ Buyer) or third-party audit. A customer auditor is the employee of the organisation's customer/ buyer. A third-party auditor is hired or approved by the customer to verify their process standard and certify the manufacturer for a certain period.

Audits done for:

- Quality – AQL standard for cutting, sewing, packing
- Surplus and Rejects
- Factory Behaviour - 5S, Safety, Lean Process

Example of an Audit Sheet Format:

Audit Sheet						
Date ☐ Line ☐ Team ☐ Auditor ☐						
No.	Depart -ment	Audit Action	Rate/ Point	Y	N	Rem- arks
1	Cutting	Quality Rejects				
2	Sewing	Cleanliness				
3	Sewing	Maintain WIP				
:						
Total						

Figure 10: Audit sheet format

9 Auxiliary and Primary Documents

Export documents are classified in a way as commercial and regulatory documents. The commercial documents for export are classified are auxiliary and primary documents. In order to enable the physical transfer of goods from the manufacturer (exporter) to the buyer (importer), these commercial documents are required for realisation of export proceeds.

There are 16 commercial documents under auxiliary and primary heads.

Primary	Auxiliary
Commercial Invoice	Proforma Invoice
Packing List	Intimation for Inspection
Bill of Landing/ Air Way Bill	Shipping Instructions
Certificate of Inspection/ Quality Control	Insurance Declaration
Certificate of Origin	Shipping Order
Bill of Exchange	Application of Certificate of Origin
Transport Document	Mate's Receipt
Insurance Certificate	Letter to Bank

Figure 11: Types of Documents

10 AWB – Air Way Bill

AWB stands for Airway Bill. It is an airfreight consignment note made out by or on behalf of the shipper, which evidences the contract between the shipper and carrier for the carriage of goods over routes of the carriers. It is a contract just for transportation and does not cover the merchandise value. It is a non-negotiable export document.

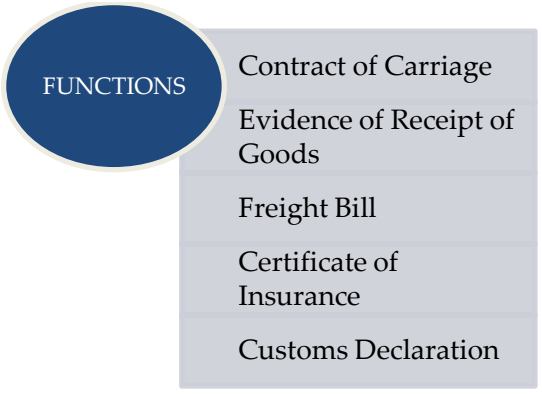


Figure 12: Functions of AWB

1 Balancing Loss

Balancing loss is the quantification of the lack of balance in a production line, defined as the percentage of time not used for productive purposes with the total time invested in making a product. In apparel manufacturing, balancing loss occurs when there is a difference between the calculated number of machines (based on operation SAM and production target per day) and the number of machines actually allocated (nearby round number is allocated).

Balancing loss can be expressed as percentage.

Equation:

$$Balancing\ Loss = \frac{(No.of\ Allocated\ Machine - No.of\ Calculated\ Macine)}{Number\ of\ Calculated\ Machine} \text{ X } 100$$

Read more about the balancing loss.

2 Basic Time

Basic time represents the observed time the elements would take to perform by the operative working at a standard rate. Basic time does not include allowances. To obtain basic time, the observed cycle time is multiplied with operator performance rating.

Equation:

$$Basic\ Time = Cycle\ Time\ X\ \frac{Performance\ Rating}{100}$$

Or

$$Basic\ Time = Standard\ Time - Allowances$$

3 Bed Type

The bed of a machine is the part on which the material rests. There are variations in machine shape available to enable easier movement of the materials around the machine. The variations in the bed of a machine are the bed types. The most common bed type is flat bed. Cylinder bed, raised bed, monoblock, post bed, feed-up-the-arm and feed-of-the-arm are the other alternatives.

Figure 13: Bed types (flat, cylinder, raised, monoblock, post-bed, feed-up-the-arm, feed-of-the-arm)

4 BOM

BOM stands for 'Bill of Materials', which is a list showing all raw materials or components required to make a garment and make it ready for shipment as per buyer's requirement. A BOM normally includes items description, consumption with a defined unit of measure, projected cost per unit and total cost of each.

BILL OF MATERIALS									
Buyer:							Prepared By:		
Style:							Date:		
PO#:									
Order Qty:									
Sr. No.	Item Desc.	Consumption	Extra	Qty.	Unit of Measurement	Rate (Rs.)	Unit of Price	Amount (Rs.)	Remarks
						Total Amount			
Approved By:					Sourcing Depaertment:				

Figure 14: BOM Format

5 Bottleneck Operation

A bottleneck operation is that operation which holds up subsequent operations and possibly previous operations, as there is an accumulation of garments behind it. For example, situations like an insufficiency of a plant or labour, increasing throughput of one section, may create bottlenecks during production. This affects efficiency of the line, and labour productivity adversely. Ways to reduce WIP at bottlenecks are by: improving method, sharing the capacity, using additional operator or machine, improving workstation layout, improve operator allocation.

Figure 15: Bottleneck Operation Leading to High WIP

6 Bit Loom

Bit loom is fabric development sample. The term is used for a swatch that is a yarn-dyed fabric. In the sample development loom, Fabric is not made in full width (regular) in this loom. Only required width and sufficient length is made to represent fabric look for approval from the buyer.

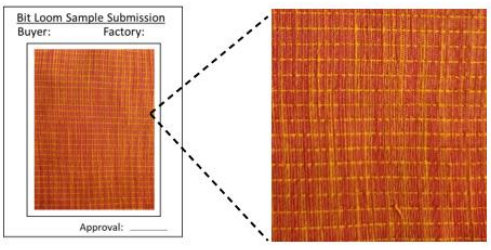


Figure 16: Bit loom swatch

7 Bundle System

With bundle system of manufacturing, the WIP is in bundles of small batches of garments that move from one workstation to another in a controlled way. Bundle system is of two types – conventional and progressive. In the conventional bundle system sewing machines are arranged in lines and the workflows from the central (store) area to the first machine, from the first machine back to the store, and then on to the next machine, and so on. In the progressive bundle system (PBS), the sewing operations sequentially arranged, and each operator receives a bundle, does his work, reties the bundle and passes it to the next operator. This system is the most widely used system in the garment industry.

Figure 17: Bundle System in an Assembly Line

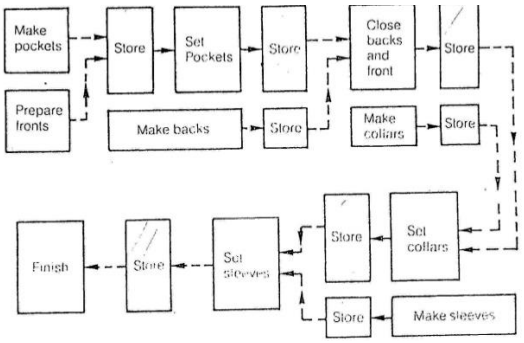


Figure 18: Process Flow

8 Bundling

Bundling is an activity of the cutting department. It is carried out after the activities quality control of cut components, recut of faulty components, the numbering, and sorting of the cut components. Bundling involves tying cut components with fabric strips to fix them together and to prevent their loss during transportation to the sewing line. Bundling is done of a full set of components of each cut style; grouped by size and by colour if several different coloured fabrics are laid in one spread. Bundles formed may all be the same size (ten units, one dozen, two dozen, etc.), or they may vary depending on the way the fabric has been spread.

Figure 19: Bundling after Cutting

1 CAD – Computer Aided Design

CAD, or computer-aided design and drafting (CADD), is technology for design and technical documentation, which replaces manual drafting with an automated process. It is an essential tool for pattern making, marker planning, and related jobs in the garment industry. CAD provides several advantages as it makes design changes and revisions quick and efficient, and patterns are more accurate with less chance of mistakes. One of the important characteristics of the computer-aided marker planning process is the higher material utilisation and minimal fabric wastage. The computerised pattern grading process could improve the capacity to make several garment pattern sets in a given period, thereby reducing the cycle time.

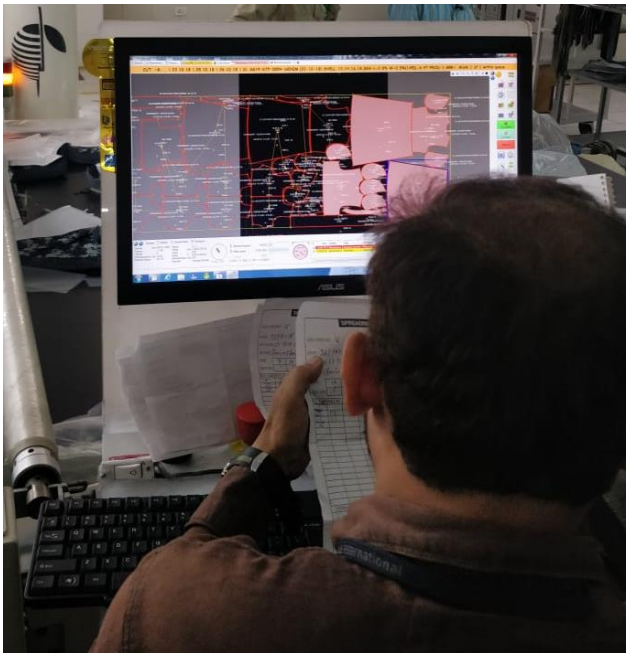


Figure 20: Marker Planning using CAD

2 Callout

Callouts is a section of the tech-pack, which includes important details not mentioned in the spec list. If required, arrows should be made use of, and any specifics that the patternmaker will need to create the pattern of the garment should be clearly legible. Construction callouts include stitch and seam types. The image below shows the callouts/ comments/ instructions section.

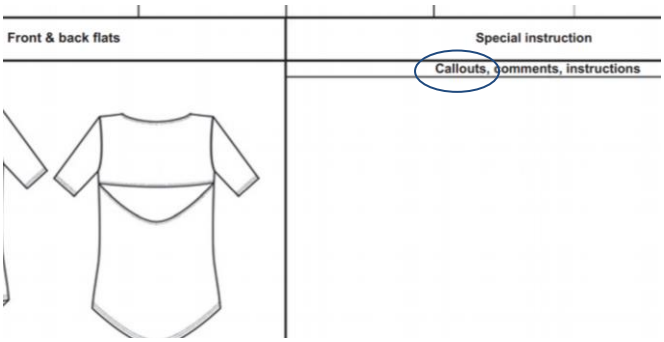


Figure 21: Callout Section in Tech-Pack

3 Capacity

Capacity is the maximum amount of work that an organization is capable of completing in a given period. It is the theoretical maximum (or installed) capacity, with the assumption that operators are capable of working full 60 minutes per hour, which is practically not possible. Capacity depends on the availability of resources such as man, machine, time, space, and facilities that require capital investment by a firm.

Potential Capacity	Maximum capacity adjusted for expected efficiency
Committed Capacity	Total hours formerly allocated for production for a certain time
Available Capacity	The difference between committed and potential capacity
Required Capacity	It is garment SAM necessary to manufacture a specified volume in a certain period of time

Figure 22: Types of Capacity

4 Capacity Planning

Capacity planning is the process of determining the production capacity needed by an organization to meet changing demands of its products. Capacity planning is a major activity of the Production Planning and Control (PPC) department. They decide how much order they should accept, allocate capacity to the order out of the total factory capacity. Discrepancy between the capacity of an organization and the demands of its customers results in inefficiency in either under-utilized resources or unfulfilled customers. Proper capacity planning minimises this discrepancy.

Calculation parameters:

- No. of Machines Available
- Shift or Working Hours
- Product(s) SAM
- Average Line Efficiency

5 Closed Marker

A closed marker consists of one-half of the pattern set. This type of marker may be generally for symmetric garments. The fabric is folded lengthwise on the table after spreading it in face-to-face mode. The subsequent cut components obtained from a pair of successive plies are the right and left garment panel i.e. both sets of pattern pieces produced from one patter.

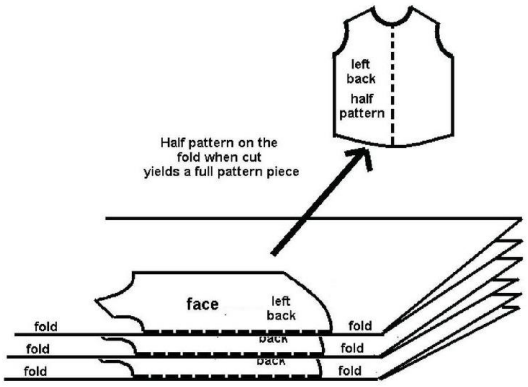


Figure 23: Closed Marker Placement

6 CMT

CMT is the abbreviation for Cut Make Trim.

- Cut – cutting of garment patterns from fabric role
- Make – stitching the complete garment with necessary trims
- Trim – trimming of uncut threads tails, cleaning loose thread from the garment after stitching and doing the checking, finishing, and packing the garment.

CMT contractors are firms contracted to cut, make, and trim a product from fabric, findings and cutting marker. It is one of the elements in garment costing as well.

In CMT manufacturing, apparel buyer pays the manufacturers for the cut-make-trim process. It is calculated based on the SAM of the operation, labour cost/min, and efficiency.

Figure 24: CMT Factory

Learn more about CMT factories.

7 Colour Cabinet

Colour cabinet is a testing instrument used for visual inspection of coloured material to judge colour consistency. Standard light sources provide an identical environment for visual assessment for accurate testing and inspection. The viewing plate is inclined at an angle of 45 degree. It is also known as shade matching booth. The user can select among the standard light sources for visual assessment.

Light Source:
D-65 (Artificial Day Light)
CWF (Cool White Fluorescent)
TL-84/83 (Triphospher Fluorescent Lamp)
UV (Ultra Violet Light)
Tungsten Filament (Incandescent Light

Figure 25: Colour Cabinet and Light Sources

8 Colour Classification Report

A colour classification report is report format of the fabric inspection department. The report contains the details of rolls of fabric that are grouped based on shade matching, and comments for the approval, rejection, or keeping on hold in terms of colour consistency of the rolls.

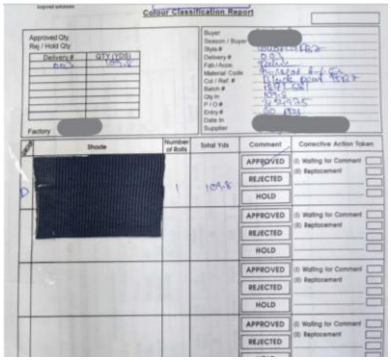


Figure 26: Colour Classification Report

9 Compliance

Compliance refers to the action of conforming in accordance with specified standards. The apparel industry is expected to maintain certain environmental, social, and governance compliance. Conforming to recognized standards of production is one of the most important steps in order to produce high-quality products while achieving production goals and maximizing profits.

Environmental	Environmental laws and regulations
Social	Labour laws, working hour, holiday, equal remuneration, antidiscrimination, no child labour, health and safety, etc.
Governance	board diversity, executive pay and business ethics

Figure 27: Compliance and Laws/ Regulation

10 Consumption

Consumption refers to the amount of raw material required to make a garment. The amount calculated is required for cost estimation. It is very crucial to calculate the fabric consumption accurately as fabric usually represents around 70% of the total garment cost. Wastage percentage is also accounted when calculating the consumption.

Calculation of Fabric Consumption –

(i) based on marker

(ii) mathematically by length and width of components

Calculation of Thread Consumption –

(i) measuring the actual amount of thread consumed

(ii) using thread consumption ratios

11 Critical Path

A sequence of activities is a 'path,' and the longest-path in the diagram is the critical path. A delay in any of the activities in the path will cause a delay in the project. In order to maintain the deadlines, project acceleration or re-sequencing needs to be done. The time and action calendar should have the same activities as that in critical path. Critical Path Management (CPM) is a systematic approach to reduce manufacturing time through the earliest start and finish time and provides a scientific method for product manufacturing and production management.

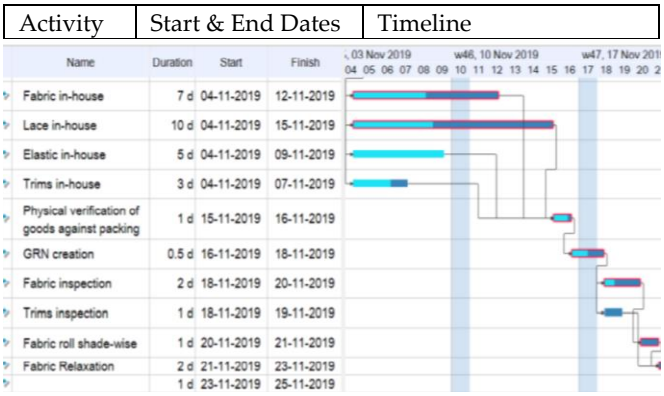


Figure 28: Critical Path (shown in red)

12 Cross Training

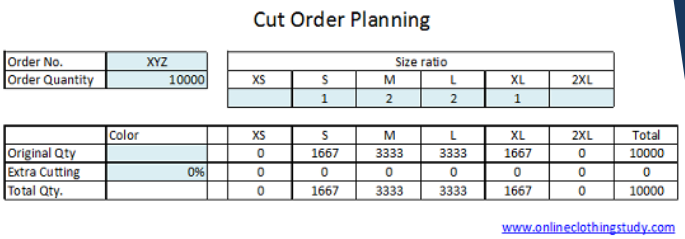
Cross training is one of the core areas of managing the workforce with the aim to improve productivity, and optimally utilize the available work force, machinery, and equipment. Weekly sessions are during the lean period of production (between styles).

Advantages of Cross Training:

- Makes the operators multi-skilled
- Motivates operators to perform better
- Contributes to personal growth
- Improves working method
- Solves balancing problems

13 Cut Order Plan

Creating a cut-order plan is one of the most vital activities that take place in the cutting section. Cut order planning is the activity of planning the purchase order for the process of cutting, as input into the marker making stage. A purchase order (PO) by the buyer usually contains the details – total order quantity, list of sizes/colours, and size-wise/colour-wise quantity ratio of garment. The quantity of garments per size is calculated and parameter fabric consumption is optimised to create the cut order plan. A cut-order plan suggests the arrangement or combinations of markers and spread lays for a particular garment style order.



Cut Order Planning

Order No.	XYZ
Order Quantity	10000

Size ratio					
XS	S	M	L	XL	2XL
	1	2	2	1	

	Color		XS	S	M	L	XL	2XL	Total
Original Qty			0	1667	3333	3333	1667	0	10000
Extra Cutting	0%		0	0	0	0	0	0	0
Total Qty.			0	1667	3333	3333	1667	0	10000

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Figure 29: Example of Cut Order Plan Sheet

14 Cut-to-Ship Ratio

'Cut to Ship Ratio' is one of the key performance indicators of a garment manufacturing company. Here 'cut' means total pieces cut by a factory for an order (Information collected from cutting room records), and 'ship' means total pieces sold to the customer (buyer) of an order (Information collected from final packing list). Cut to ship ratio demonstrates the percentage of garments dispatched out of a total number of garments cut for a particular style or order. A ratio around 98% will be considered very good, which means that only 2% of garments are rejected in the style.

Equation:

$$Cutting\ Quantity = Order\ Quantity\ (1 + Extra\ Cutting\ Percentage)$$

$$Shipping\ Quantity = Actual\ No.\ of\ Pieces\ Shiped\ to\ Buyer$$

$$Cut\ to\ Ship\ Ratio = \frac{Cutting\ Quantity}{Shipping\ Quantity}$$

15 Cutting

Cutting is the first stage in manufacture of garments. Production is considered as started once the cutting starts. It is the process that takes place after spreading of fabric where in the spread is separated into garment components as a replica of pattern pieces on a marker. Cutting involves transferring marks and notches from the marker to garment components to facilitate sewing.

The cutting process is frequently done in two stages: rough/ block cutting and the final accurate/ fine cutting.

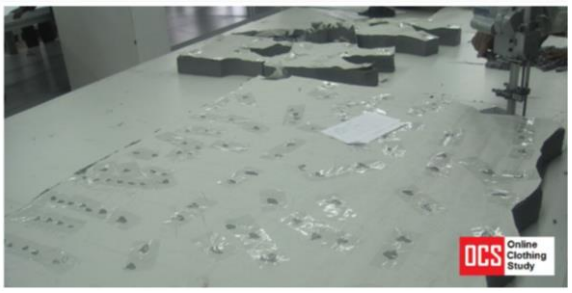


Figure 30: Cutting using Straight Knife

Read more details cutting process and download an eBook on cutting process in garment manufacturing that covers cutting technology, machine and equipment used in cutting etc.

16 Cycle Time

The cycle time is the time taken by an operator to perform one cycle of the operation. It includes the time between pick-up (when an operator starts a process) and next pick-up (when the operator pick-up the next garment and starts next cycle). To control WIP, the cycle times are to be kept low by following FIFO procedure for every cut.

For capacity study on the production floor, work study engineers measure cycle time of each operations in a style. Garment factories those do not have industrial engineering department, can estimate average time for doing an operation through cycle timing.

Date	Style	Employee	Operation	Produced Quantity	Hours Worked	Average Cycle time
11-02-19	Style-1	E-1001	Operation-1	186	8.00	2.58
11-02-19	Style-1	E-1002	Operation-2	983	8.00	0.49
11-02-19	Style-1	E-1003	Operation-3	799	8.00	0.60
11-02-19	Style-1	E-1004	Operation-4	177	8.00	2.71
11-02-19	Style-1	E-1005	Operation-5	192	8.00	2.50
11-02-19	Style-1	E-1006	Operation-6	968	8.00	0.50
11-02-19	Style-1	E-1007	Operation-7	559	8.00	0.86
11-02-19	Style-1	E-1008	Operation-8	555	8.00	0.86
11-02-19	Style-1	E-1009	Operation-9	274	8.00	1.75
11-02-19	Style-1	E-1010	Operation-10	282	8.00	1.70

Figure 31: Example of Cycle Time Captured

Labour costing is also estimated using average operation cycle time.

1 Daily Production Report

The daily production report (DPR or PR) is one of the MIS tools for operation management used in the manufacturing industry. It shows the nature of the production floor and summarises the reasons for the day's losses due to various reasons. DPR is made department wise as well as a combined report is made including the production of all major processes.

In a DPR, one can customise the details to record based on their requirement. Usually, the work loading quantity, processed quantity or production (on an hourly basis), and WIP level at the end of the shift/ day are captured.

DPR formats are for stitching section, cutting section, finishing section, from cutting loading to order shipment.

Fields in a DPR are:

- Style No.
- Description
- Colour
- Order Qty.
- Cut Plan Qty.
- (Hourly & Days) Production Pieces
- Total Target
- Balance

2 Design (Garment)

A garment design is created by a fashion designer by integrating all the design elements such as colour, texture, space, lines, pattern silhouette, shape, proportion, balance, emphasis or focal point, rhythm, and harmony. A confirmation of the correct choice of fabric, components and manufacturing technology should be considered as a whole. Each of these contribute to achieve a garment that is aesthetic, functional, psychologically comfortable, and economical to produce, for the intended end-user. Fashion designers can design garments with different patterns and fabrics easily on an interactive garment design system before the real garments are produced.

Figure 32: TUKATECH 3D Garment Designing

3 DHU – Defects per Hundred Units

DHU stands for defects per hundred units. DHU is the number of defects detected per 100 garments checked. To measure DHU of any process, one needs to record the number of total pieces checked and the number of total defects is detected in the inspected garments.

Equation:

$$Defects\ per\ Hundred\ Units = \frac{Total\ Defects\ Found}{Total\ Garments\ Inspected}\ X\ 100$$

Read more about DHU calculation.

4 Dispatch

Dispatch is the final process in the manufacturing unit wherein the garments are generally packed in cartons with the dimensions specified by the buyer and shipped to the buyer. Dispatch takes place once the factors of right merchandise, at the right time, in right quantity, and at the right price is fulfilled.

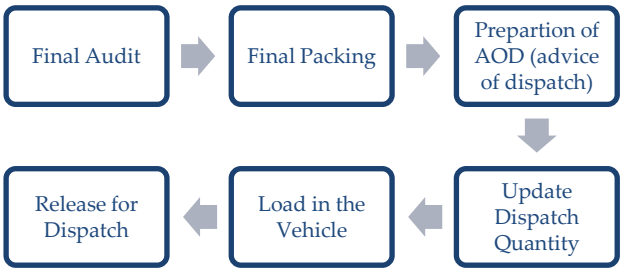


Figure 33: Dispatch Process

5 Down Time

Downtime is defined as the period during which an equipment or machine is not functional. Down time events are unplanned stops that are long enough for each occurrence to be assigned a reason. In practice, down time is any unplanned stop that is five minutes or longer. When the machine is idle for events that occur for less than 5 minutes, are small stops that lead to OEE performance loss. For reducing downtime, downtime should be tracked accurately, categorised with reasons, exposed in real-time, and the largest sources of downtime need to be tackled.

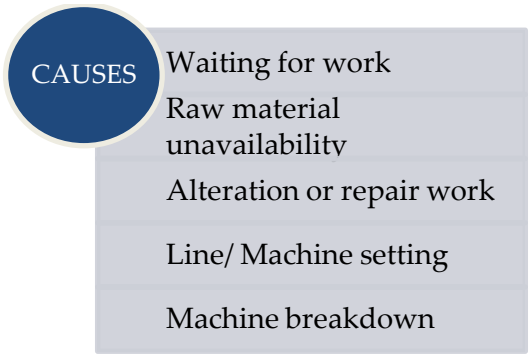


Figure 34: Causes of Downtime

6 Drill Marks

For the ease of sewing, reference marks are required at certain places that are away from the edge of the garment. For example, to position pockets, darts, and similar features, a hole is often drilled through all the plies of the fabric in the lay. These are called drill marks.

The drill marks can be created by a cold drill, hot drill (to slightly scorch the fabric for visibility), hypodermic ink, or by passing a long thread through the lay. A motorised drill behind the cutting head of cutting machine can provide drill holes as required.

Figure 35: Drill Marks using a Cold Drill

Figure 36: Drill Marks Indication Symbols on Pattern

7 Dyed-to-Match

DTM is the abbreviation for Dyed-to-Match. This phrase is most commonly used for specifying that a trim is to match the fabric colour rather than any colour code Pantone card. Trims (such as thread, buttons, laces, zippers, etc.) may be dyed to match the colour and shade of the fabric of the garment.

Figure 37: Dyed-to-Match Thread and Button

8 Dynamic Balance

Line balancing by allocation of operators to operations that they can do the best (high rating) is called dynamic balance. In a dynamic balance, the number of operators required is less and leads to better operator utilisation, but operator movement is more, and so is the warming up loss. The WIP management is difficult.

Dynamic Line Balancing Cases:

- When there is heavy operator absenteeism
- To cover-up production loss
- When requirement of a short-term change in capacity arises.

1 Efficiency

Efficiency is a way of representing the productivity in terms of how one is performing against a target expressed as time per garment or a required level of production. The efficiencies commonly assessed in a manufacturing unit are - Line efficiency, Factory Average efficiency, Operator efficiency.

Equation:

$$Efficiency = \frac{SAM\ Produced}{Hours\ worked\ x\ 60} X\ 100$$

Or

$$Efficiency = \frac{Achieved\ Production}{Target\ Production} X\ 100$$

Read this article to learn about efficiency calculation methods.

2 Embellishments

Embellishments are a value addition to a garment that impart aesthetics to the garment making it visually engaging. Embellishments could be done on a garment panel (before sewing) or on a stitched garment. Various types of embroidery, print, bows, cord, or rhinestones are embellishments on a garment.

Figure 38: Embroidery and Print on Fabric

3 End Loss

End loss refers to the portion of the fabric lay that is left uncovered by the marker. It is unavoidable that a little quantity of fabric is wasted at the ends and hence while layering fabric on the cutting table, an allowance is taken – termed as end loss. This extra fabric left is required to ease cutting. However, the end loss of a fabric for a lay need to be standardised and kept to a minimum, which is usually 2 cm per end or 4 cm per ply.

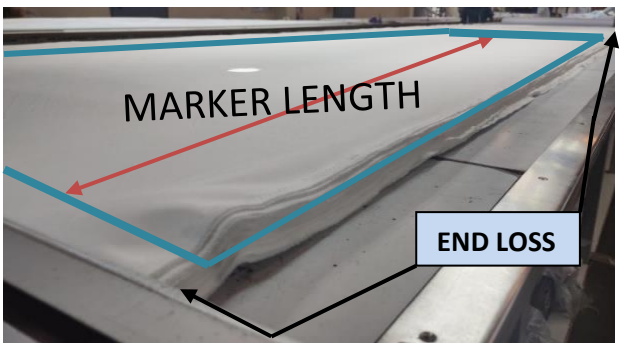


Figure 39: End Loss in Fabric Lay

4 Ergonomics

Ergonomics refers to the interaction between people and machines and the factors affecting their interaction. It particularly involves understanding the anatomical, physiological, and psychological factors to improve working conditions for the operator and man-machine interaction. In the workplace, occupational safety and workplace ergonomics has an effect on the production quality and quantity, labour turnover, and increased absenteeism resulting from workers' dissatisfaction. In an apparel manufacturing unit, ergonomics considerations need to be done for all departments right from fabric storage to finishing in terms of worker posture, lighting, noise, and vibration.

Department	Example of Points to Consider
Fabric Store	Storage of fabric at appropriate reachable height (manual or fork-lift) Movement of heavy items using trolley
Spreading & Cutting	Roll handling using pneumatic devices Correct body posture when spreading fabric & deploying 2 operators Handle plies using clamps
Sewing	Ergonomic workstation Proper lighting Use of work aids
Finishing & Packing	Proper table height and sloped surface Provision of body support for standing operators

Figure 41: Workplace Ergonomic Considerations

5 ERP

ERP, an enterprise-wide system that integrates the business functions and processes of an organization, typically includes manufacturing, logistics, distribution, inventory, shipping, invoicing, and accounting. An ERP helps in storing information in synchronization across multiple disparate systems. ERP seamlessly manages the entire apparel process - across multiple devices - from procurement to payment. It can also have business intelligence (BI) features to assist managers in all of their decision making with graphics-based up-to-the-minute data.

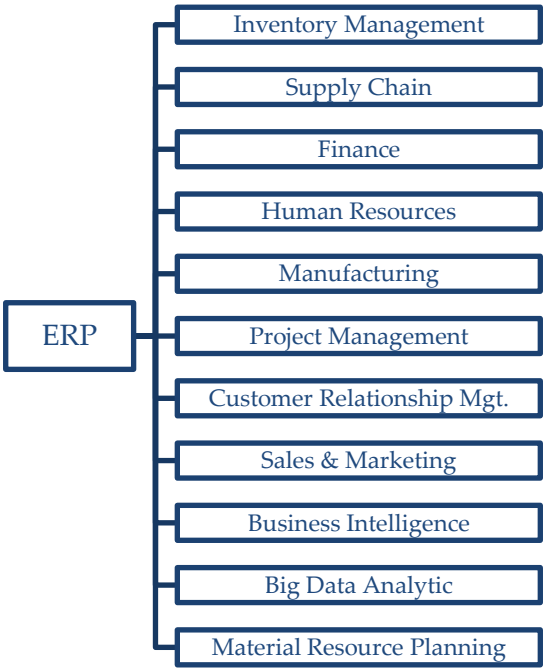


Figure 40: Functions of ERP

6 Ex-Factory Date

Ex-factory date is the date on which the supplier (here an apparel manufacturer) needs to keep the shipment ready and need to dispatch the shipment out from the factory and hand it over to the shipment forwarder. Packing and garment inspection need to be done prior to the ex-factory date.

According to the ex-factory date, the garment manufacturer plans its production schedule, pre-production, and material-sourcing schedule.

Figure 42: Shipment ready before despatch

7 Ex-Works and FCA

Ex-Works (EXW) is an Incoterm used to describe the delivery of goods by the seller to the agreed place of delivery (usually the factory or sellers' warehouse). Here, the buyer is obliged to undertake export procedures (such as obtaining of licenses, security clearance, etc.). This term is more favourable to the seller, and the buyer bears the risk from the moment the seller has informed the buyer that the finished goods are ready and set aside.

If the buyer cannot handle the export process, FCA shipping is used. FCA stands for Free Carrier. Here, the seller is responsible for export clearance, and delivery of goods to the carrier at the named place of delivery. A carrier could be any person or company who undertakes the carriage, such as a shipping line, airline, trucking company, railway, or freight forwarder.

	EXW	FCA
Seller clears goods for export	✗	✓
Seller loads goods onto truck	✗	✓
Seller pays for trucking to origin port	✗	Depends on FCA terms
Used for LCL, FCL, and air	✓	✓

Figure 43: Comparison of EXW and FCA

1 Fabric

Fabric is the major raw material for the garment. Fabrics used in apparel are made from different materials such as cotton, linen, wool, polyester, nylon, acrylic, etc. The fabric cost constitutes 60 to 70 percent of the total garment making cost. Therefore, in the fashion production process, fabric is the most valuable material. Know more about different type of knitted fabrics and woven fabrics.

Figure 44: (a)Woven (b) Knitted (c) Non-woven Fabric

2 Fabric Inspection

Fabric inspection is the process of identification, evaluation, and analysis of defects that a fabric roll may have. It is carried out based on various standards and acceptance or rejection of roll is done accordingly. The fabric faults that are identified, are labelled and recorded in a fabric inspection form.

Figure 45: Fabric Inspection

3 Fabric Inspection: 4-Point System

4-point system is a fabric inspection system performed in accordance with ASTM D5430-93. It is the most widely used in the industry. In this system, defect/ demerit/ penalty points are assigned to fabric defects according to the severity. The fabric quality is evaluated by unit points/100 sq. yds. Normally fabric roll containing 40 points per 100 square yards are acceptable. Example is shown here.

Equation:

$$Points\ per\ 100\ sq.yd. = \frac{Total\ points\ in\ roll\ X\ 36\ X\ 100}{Fabric\ length\ (yd.)\ X\ Fabric\ width\ (inch)}$$

Defect Characteristics	Penalty Points
Up to 3 inches	1
3 inches to 6 inches	2
6 inches to 9 inches	3
Greater than 9 inches	4

4 Fabric Relaxation

Fabric relaxation is an essential operation prior to spreading and cutting the fabric for garment manufacturing. Without sufficient fabric relaxation, especially in knitted fabric and those containing spandex/ elastane, it is not possible to obtain the dimensional stability of the final products. Fabric relaxation is characterized by the shrinkage of the fabric. Fabric relaxation can be done by different methods, namely, bale relaxation, compressive relaxation, heat set relaxation and sponging relaxation.

Figure 46: Fabric Relaxation Machine

5 Fatigue

The term fatigue refers to an overall feeling of tiredness or lack of energy. Since operations in the apparel-manufacturing unit are characterised by repetitive actions and prolonged task performance, fatigue is a common phenomenon. It has a major impact on product quality and results in productivity losses. When people become fatigued, they usually have trouble in maintaining task performance at an adequate level. Rest breaks during the working day prevent the accumulation of excessive fatigue.

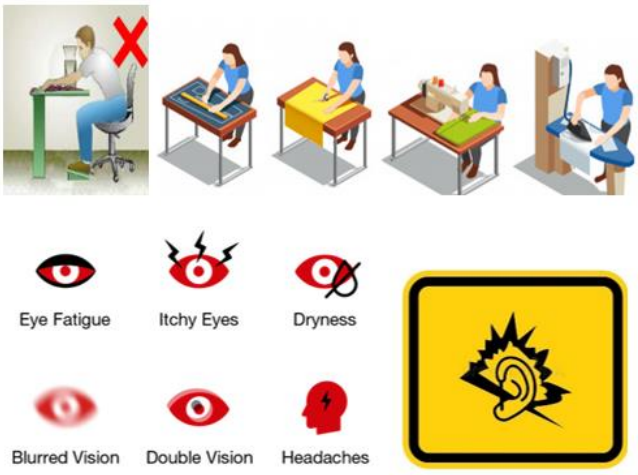
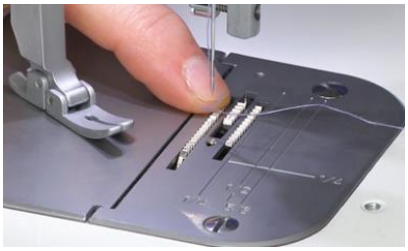


Figure 47: Fatigue in workers could be posture and work-induced fatigue, visual fatigue, and fatigue and irritation due to noise

6 Feed System

Feed system is the mechanism by which a fabric moves on the feeding zone of the sewing machine by involving the presser foot, throat plate, feed dog, and needle. The simplest and common sewing machine feed system is the drop feed. The other feed types are needle feed, unison feed, differential feed, variable top and bottom feed, variable top and bottom differential feed, needle feed and alternating top feed, and X-feed. The terms feed system, feed types, and feed mechanisms are used interchangeably in the apparel industry.



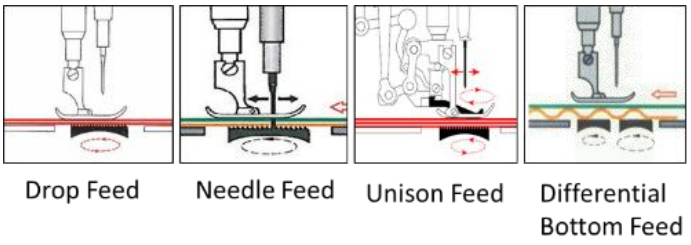


Figure 48: Types of Feed

7 FIFO

FIFO is the abbreviation for first-in, first-out. It is a method of inventory valuation used in the fabric/ raw material and finished goods warehouse. It means that the first unit bought in the inventory is the first to be sold or issued. Apart from that, following FIFO procedure for every cut in the cutting section also helps to manage WIP by keeping cycle times low through cut flow control.

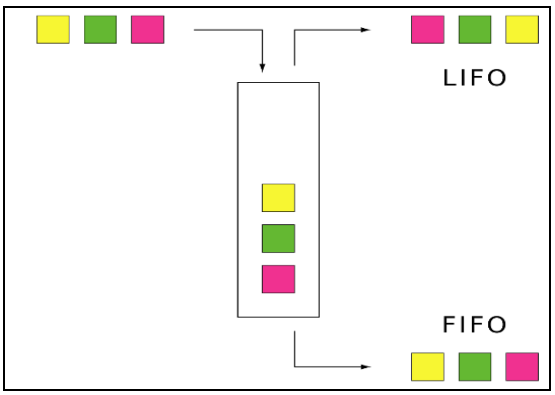


Figure 49: FIFO Flow

8 Final Inspection

It is the inspection procedure carried out of finished garments before packing. The garments inspection is for their performance requirements, overall appearance, and sizing and fit. The final inspection should mandatorily be of superior quality.

Figure 50: Final inspection station

9 Final Statistical Audit

The quality team conducts final statistical audit once the garments are packed in the cartons. The auditor randomly selects sample cartons for inspection – only from boxes that are complete. Samples from the finished seal boxes are randomly obtained as well. The final statistical audits usually follow AQL 4.0. The auditor carries out the inspection in a routine fashion to avoid overlooking of any operation. The approved pre-production sample, and approved top of production sample is reviewed and the consistency with the inspection sample is checked.

Parameters checked and marked in final audit report:

- Garment presentation
- Colour shade
- Measurements
- Fit and balance
- Workmanship and visual defects

10 Finished Goods Warehouse

The activities associated with the finished goods (FG) warehouse/ department is the last in the apparel-manufacturing unit's VSM process. The garments in the warehouse are packed in cartons/ boxes and are waiting to be shipped on specific dates listed on the sales order or as and when called for by the customer. The FG warehouse usually is a restricted area and has limited accessibility to only related employees. It works to ensure on time delivery of shipment and takes care of all the shipment related documentation. The records maintained in an FG warehouse are sectionalised as 'shipped garments', 'on call or waiting garments' and 'stock sell garments'.

Figure 51: Storage of finished goods in hanger form or in cartons

11 First Time Through

First time through (FTT) is one of the key performance indicators (KPI) of production efficiency and quality. It is expressed as percentage. It reflects the number of units produced without defects or additional improvements against the total number of produced items. In the pre-production training process, the operator-training target is 100% FTT. FTT is also recorded when the production starts as daily FTT, weekly end line FTT rate, and weekly plant (manufacturing unit) FTT. The technical supervisor closely monitors the operators with a low FTT.

Equation:

$$FTT = \frac{Total\ Pieces\ Produced - Defective\ Pieces}{Total\ Pieces\ Produced} X100$$

12 Flat Sketch

A flat sketch is the technical representation of a garment illustrating the design requirements to the manufacturer. It is neatly sketched with basic solid lines such that visual guidelines can be clearly followed. Typically, a solid line on a flat sketch represents a seam line and a dashed line represents stitching.

Since a flat sketch forms an essential part of the tech-pack, some of the key points to consider while making it are:

- Include all details and do not omit any parts of the sketch.
- Include views of both front and back.
- If needed, add sketches to show small parts or inside of the garment.
- Keep the sketch simple.

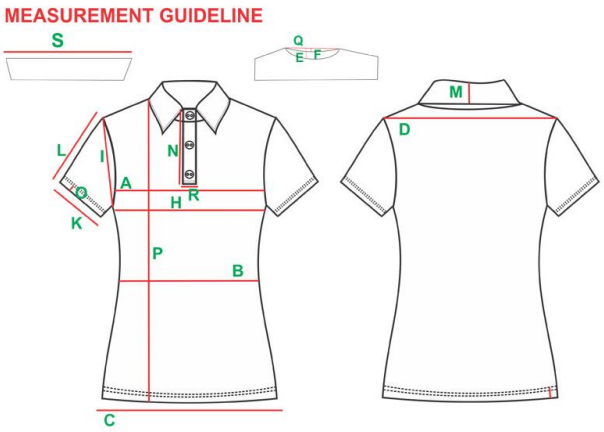


Figure 52: Flat sketch of a polo t-shirt

13 Floater/ Jumper

A floater or a jumper is an operator who can generally perform all operations but at much lower efficiency than the dedicated operators. Their allocation is done to balance the line under unforeseen circumstances such as operator absenteeism, operators performing below standard, sickness, or any other emergencies.

Categorisation of jumpers may be as:

- Depending on the number of operations known
- Depending on the number of machines known to use

14 FOB

FOB stands for 'Free on Board'. It indicates that the buyer is liable for goods once shipped by the seller (apparel manufacturer). The buyer is at risk and takes ownership of any damage that may occur during shipping. FOB is suitable for maritime and inland waterway transport. Since, in export the garments transportation is by sea under normal circumstances, pricing of garments is mostly quoted on FOB.

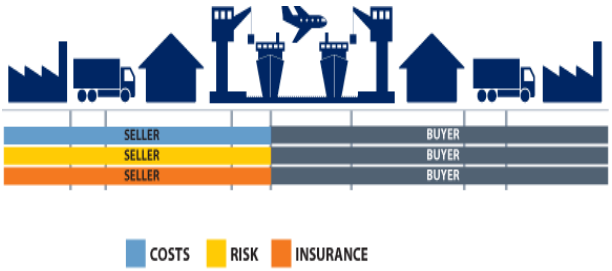


Figure 53: Ownership in FOB

15 Fusing

Fusing is a process for attaching interlinings by bonding it to the outer fabric by means of a thermoplastic resin. It takes place by application of a suitable temperature and pressure for a certain time. The methods of fusing are reverse, sandwich, double, block. The equipment used can be a specialised fusing press, hand irons, or steam presses.

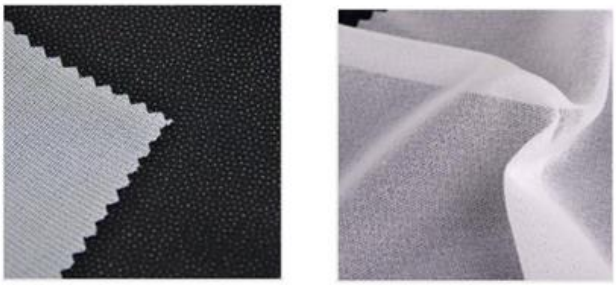
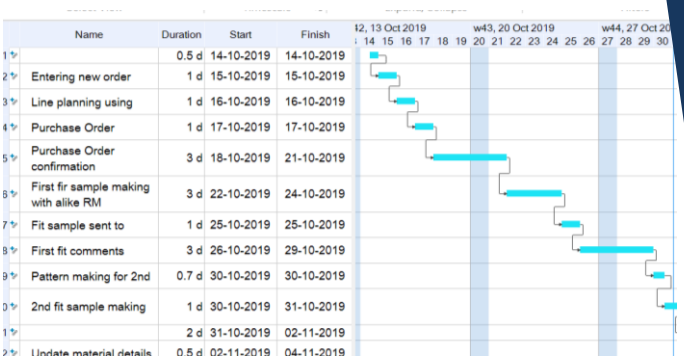


Figure 54: Fusing material

1 Gantt Chart

Gantt chart is a visual view of tasks scheduled over time. It is widely used in planning, scheduling, and project management. A product development (PD) calendar can be developed using a Gantt chart format. It is also used to plan and control the sequence of operations, to show machine loading, thereby identifying idle time, and to plan operators' deployment on various machines, or materials procurement and delivery needs. These charts are advantageous are they offer management an easily readable and visual demonstration of a work plan and the position regarding implementation at a certain date.



	Name	Duration	Start	Finish
1		0.5 d	14-10-2019	14-10-2019
2	Entering new order	1 d	15-10-2019	15-10-2019
3	Line planning using	1 d	16-10-2019	16-10-2019
4	Purchase Order	1 d	17-10-2019	17-10-2019
5	Purchase Order confirmation	3 d	18-10-2019	21-10-2019
6	First fir sample making with alike RM	3 d	22-10-2019	24-10-2019
7	Fit sample sent to	1 d	25-10-2019	25-10-2019
8	First fit comments	3 d	26-10-2019	29-10-2019
9	Pattern making for 2nd	0.7 d	30-10-2019	30-10-2019
0	2nd fit sample making	1 d	30-10-2019	31-10-2019
1		2 d	31-10-2019	02-11-2019
2	Update material details	0.5 d	02-11-2019	04-11-2019

Figure 55: Gantt chart of some activities in an apparel manufacturing unit

2 Garment Accessories

Accessories of a garment are its components other than the main fabric. These could be an essential part of the construction of the garment, act as trimmings/fastenings, or enhance the aesthetics of the garment. Garment accessories categorised as:

- Basic accessories (essential part):

Buttons, Zippers, Linings, Interlinings, Velcro, Elastic, Rivets, Labels, Thread

- Decorative accessories (aesthetics):

Bias tape, Elastic tape, Buttonhole tape, Seaming tape, Ribbed tape, Cords, Lace, Embroidery, Piping, Ribbons, Fringes, Tassels

- Finishing accessories (packaging):

Hang tag, Price tag, Polybag, Paper, Carton, and Tape

Figure 56: Garment accessories - hook, piping, label, button, zipper

3 Garment Defects

A garment defect is a shortcoming that is beyond the defined specifications or construction requirements. A defect might be related to specifications (variation of measurement), raw material quality (fabric and trims used in the garment), shade variation, stitching defects, construction defects or performance defects.

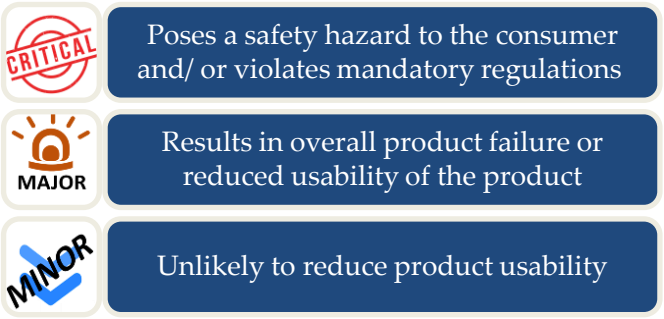


Figure 57: Classification of defects

4 Garment Dyeing

Garment dyeing is the process of colouration of sewn or knitted garments cut and sewed from grey/ pre-treated fabric. Garment dyeing may be beneficial as it reduces the lead-time and can give quick response to the market demand. It also reduces wastage of dyed fabric. Paddle machines and rotary drums are most commonly used machines for garment dyeing.

Usually, hosiery, socks, sportswear, shirts, T-shirts, trousers, bathrobes, bath mats, throw rugs are dyed in garment form.

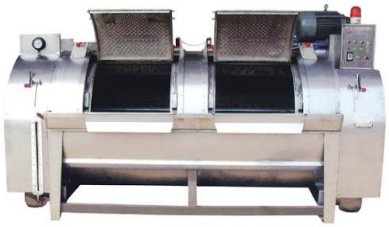


Figure 58: Garment dyeing machine

5 GRN

Goods Receipt Note (GRN) is a unique number allotted to the received goods to record the delivery of items from suppliers. It represents the confirmation of receipt of goods to issue payment, after physical verification of goods in terms of quantity, quality, and pricing with respect to the raised PO. On approval, GRN stickers are printed and pasted on the goods.

Figure 59: GRN sticker

1 Hemming

A hem is the finished edge of a garment, sewn so that the fabric has a clean end and prevents unravelling of thread. The operation is known as hemming. Hemming is done by folding the edge and then stitching. This action is usually assisted by a hemming folder. The main types of hems are double fold hem, narrow rolled hem, bias tape hem, blind hem, zig zag or overlocked hem. For a perfectly flat hemmed, for example in a pair of cuffed pants, a hemming tape is used.

Hemming operation is usually carried out for:

- Sleeves and bottom edge of a t-shirt
- Pocket mouth
- Bottom edge of pants, skirts, etc.

Figure 60: Bottom hem of trouser

2 Human Resource Management

Human resource management (HRM) is the organizational function that manages activities related to people. The strategic approach to the effective management of people include employing people, training them, compensating them, developing policies relating to them, and developing strategies to retain them. HRM plays a very important role in the apparel industry as it is a labour-intensive industry, and they contribute largely to the productivity improvement and development. The HRM team proactively participates in addressing the quality and productivity issues in various departments.

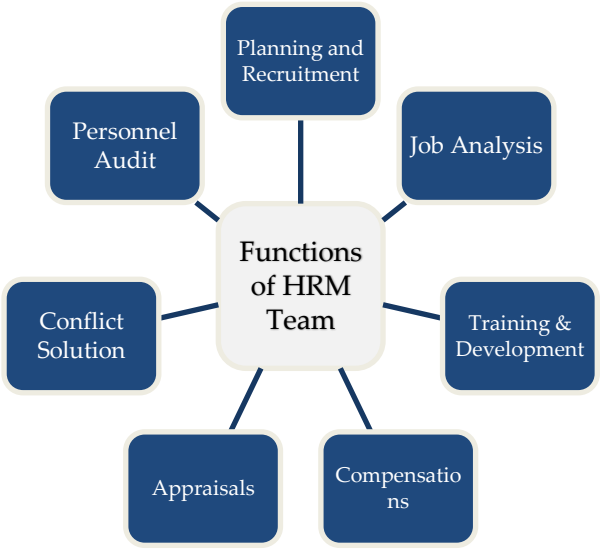


Figure 61: Functions of the HRM team

1 Incentive Plan

Incentives are payments or concessions given to the workforce to motivate them to increase their output. A well-designed and fair incentive plan is a driving force for operators to work more consistently by getting rid of ineffective time, and the gaps between their productive movements. The most common form is a straight piecework system, where the operator's pay is based entirely on what the operator produces.

An example of an incentive system and incentive earning calculation shown in this article.

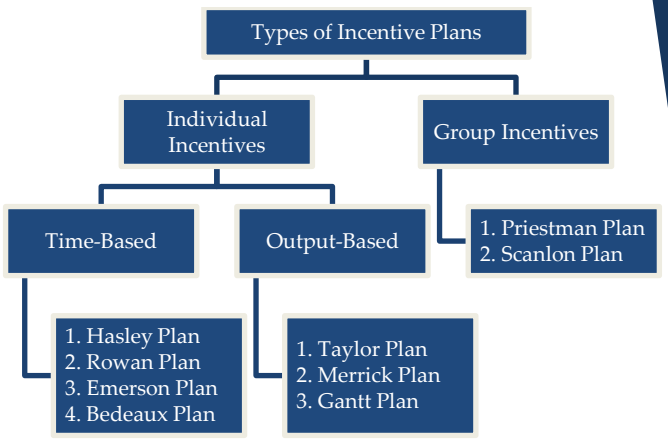


Figure 62: Types of incentive plans

2 Inline Inspection

Inline inspection is the process of checking the pieces (semi-stitched garment) after operators carry out the respective operation. A quality inspector moves in the line and inspects a pre-determined number of pieces from the finished work of operators at random. It can be carried out by different ways such as inspection at checkpoints in the line, roving quality checking, implementing traffic light system, inspection by buyer QA representative. The purpose is to identify any problems at the source and developing and implementing corrective action plans based on inspection findings.

Simple Method - 1: Measuring Quality Performance in Defective Percentage

Line/Section No.	T-4	Checker Name	Ajay	Total units Checked	266
Style No.	#29845	Date	1/31/2014	Total Defetive units	20
				% Defective	7.52

Hours	Total Pieces Checked	Total Pieces Accepted	Total Defective Pieces found	Remarks
Hour - I	20	19	1	
Hour - II	32	30	2	
Hour - III	25	21	4	
Hour - IV	30	28	2	
Hour - V	25	24	1	
Hour - VI	22	18	4	
Hour - VII	26	24	2	
Hour - VIII	30	29	1	
OT Hours	56	53	3	
Toal	266	246	20	

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Figure 63: Inline inspection report format

3 Intrinsic Balance

Line balancing by allocation of operators to operations by finding the closest match between operator performance required and operator performance available is intrinsic balance. Unlike dynamic balancing, here, the operator allocated is not necessarily the best one for that operation, thus operator utilisation is lesser. However, it is a convenient balancing technique, as the supervisor does not need to do much re-allocation.

Advantages of intrinsic balance:

- Better workforce management
- Easier WIP management
- Lower warm-up losses
- Less material and operator movement

4 Inventory

Inventory includes all the stock held by the manufacturing unit, ranging from raw materials to the finished garments. Inventory is the units' assets that are intended for sale, are in the process of being produced for sale, or are to be used in producing goods. Stock is replenished in an optimum quantity for an uninterrupted operation, optimised sourcing cost, and minimised risk of stock- out.

Figure 64: Fabric inventory in raw-material warehouse

5 Inventory Carrying Cost

Inventory Carrying Cost is the cost a company incurs over a certain period, to hold and store its inventory. Slow moving items increase ICC, while just-in-time items have a low ICC. A merchandiser needs to optimise order quantity to fulfil demand while keeping the cost low. It is expressed as the percentage of the total value of inventory.

Equation:

$$ICC = \frac{Inventory\ Holding\ Sum}{Total\ Value\ of\ Inventory}\ X\ 100$$

Inventory Holding Sum = Addition of the components of ICC – cost of capital, storage and warehouse space, obsolescence and shrinkage, insurance, material handling, and taxes.

J

1 Just-in-Time

Just-in-Time (JIT) is a "pull" concept or a management philosophy to control the inventory. The raw materials orders from suppliers are directly aligned with production schedules i.e. only when it is needed, and in the desired quantities. The stock is replenished in very short cycles as small and frequent orders to ensure that an acceptable inventor fill rate and a low inventory level is maintained. The JIT manufacturing is referred to as lean manufacturing and the JIT delivery concept accommodates fast fashion.

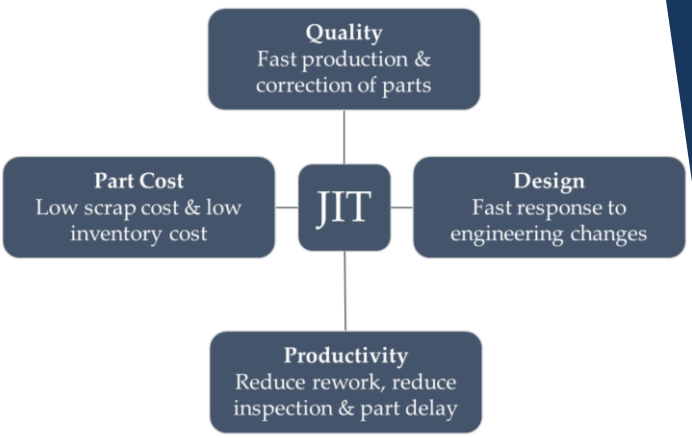


Figure 65: JIT Principles

2 Jig

A jig or a stitching jig is a type of a work aid where accurate stitching lines are required. It is commonly used for attaching labels, stitching collars, cuffs, pockets. A jig consists of an upper plate and a lower plate. The fabric is held between these two plates. The inside surface of the plates is covered with a strip of non-slip material like emery sheet, to have a firm grip of the fabric. As the jig moves along the X-Y direction, relative to the guide on the stitching machine, stitch line is formed where there is a slot on the jig. Sewing automats like pattern sewer, back pocket attaching machine, top stitching of fly in trouser, etc.

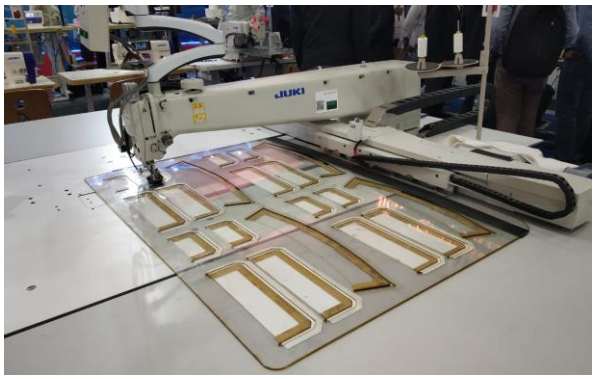


Figure 66: Sewing jig for shirt sleeve and cuff manufacturing

1 Kanban

Kanban is a visual job order card used to achieve JIT. It is a method of regulating the flow of goods both within the factory and with outside suppliers and customers. The card indicates when more goods are needed and at what time for replenishment, and thus eliminates waste from inventory and overproduction, minimising line downtime.

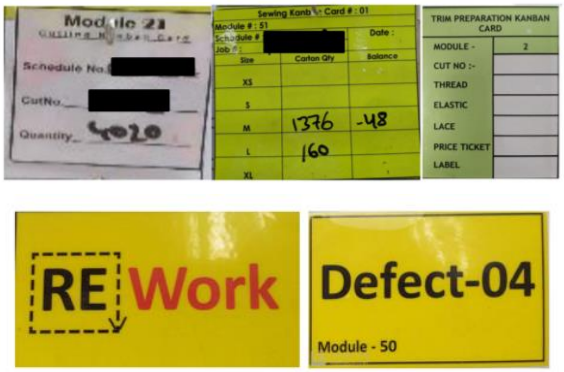


Figure 67: Kanban cards

2 Knitted Fabric

Textile structure resulting from inter-looping of yarns or inter-meshing of loops is a knitted fabric. Knitted fabrics are subdivided into warp and weft knitted fabrics. Knitted fabrics usually possess high elasticity due to their loop structure, high degree of wrinkle resistance, good drape, a high degree of comfort, and a porous nature.

Figure 68: Knitted fabric

3 KPI

KPI stands for Key Performance Indicators. KPIs are a set of data that reflect the performance of the department, while help in assessing the efficiency, capability, and effectiveness of various manufacturing aspects. KPI is usually measured for:

- (a) Whole factory
- (b) Material quality control (MQC)
- (c) Cutting
- (d) Sewing
- (e) Final inspection and shipment

(a)	Efficiency, Capacity utilisation, Quality, Style change-over time, Cut/ order to ship ratio, On time delivery rate, Right first time, Downtime Percentage, Turnover rate
(b)	Supplier Evaluation, Material Inspection, Material Downtime, Inventory
(c)	Recordable incident, Quality audit failures, Plan pcs vs. actual cutting pcs, rejections, Absenteeism
(d)	Recordable incident, First time through, Daily plan vs. actual pcs, Absenteeism
(e)	Returns/ Claims, On-Time Delivery, Quality Delivered

Figure 69: Examples of KPI in different departments

1 Lab Dip

Lab dip is a specimen of dyed fabric or yarns prepared for colour approval. Lap dip is an important and essential process in fabric development for both apparel and fabric manufacturing business. Prior to bulk fabric dyeing lab dip approval is taken from the buyer. Apparel brands evaluate fabric colour and shade visually using a light box and/or digitally using the spectrophotometer.

Figure 70: Lab dip approval card

2 Labour Cost per Minute

Labour cost per minute is a significant parameter to determine the garment cost. It is the cost of direct labour of the processes in unit time. In garment factories the most common method for calculating cost is working minute cost. Read more about labour cost per minute.

Equation:

$$Labour\ Cost\ per\ Minute = \frac{Total\ Wages\ of\ Labour\ X\ Garment\ SAM}{Total\ Available\ Working\ Minutes\ X\ No.of\ Labour}$$

3 Lay Planning

Lay planning is another term for 'cut order planning'. Apparel manufacturers make use of computer aided design (CAD) to facilitate the process. The lay plan needs to be optimised in an economical way to minimise fabric wastage. Read more about the need of a cut planning and roll planning software.

Date: Lay Slip/ Lay Order
Colour: Marker Way: Consumption: Lot No.: Ply Length:

	Estimate					Actual					
Sr. No.	Roll width (cm)	Roll length (m)	No. of plies	Total pcs.	End bit length (m)	Roll width (cm)	Roll length (m)	No. of plies	Total pcs.	End bit length (m)	Shortage/ Excess
1											
2											
3											
4											
5											
Total											
Prepared by: Checked by: Approved by:											

Figure 71: Lay slip format

4 Laying

Laying is the process of superposing layers of fabric on a table prior to cutting. Each layer of the fabric is laid in an unrestrained state, up to the length of the marker. The lay height is maintained depending on the cutting machine to be used and the fabric thickness. Laying can be done either to form a straight lay or a stepped lay. The direction of fabric laying from right to left, or right to right, or in a zigzag manner.

Figure 72: Manual laying of fabric

5 Lead Time

Lead-time is the period between the confirmation of an order to the manufacturer and the dispatch of the order to the buyer. The period comprises waiting time prior to or after actual manufacturing and throughput time.

The different lead-time referred to in an apparel-manufacturing unit are – customer lead time or delivery lead time (time between order confirmation and order fulfilment), material lead time (time order placement with a supplier and receiving in-house), production lead time (time taken for manufacturing the garment).

Lead time calculation method is shown in this article.

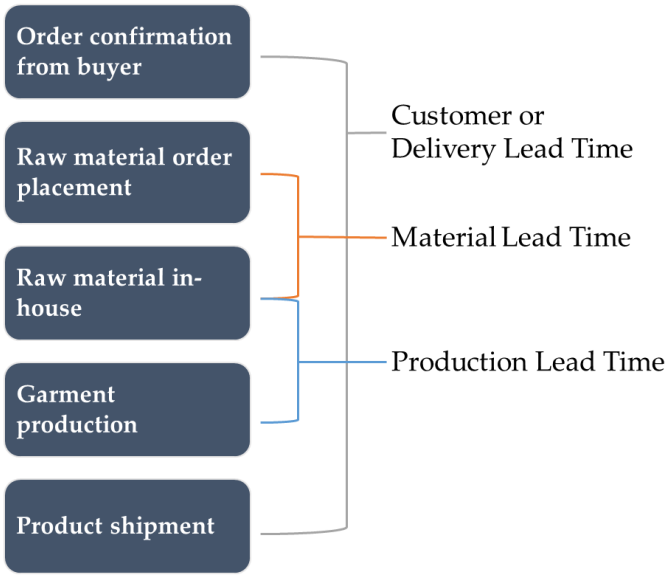


Figure 73: Types of lead time

6 Lean Manufacturing

Lean manufacturing is a way of manufacturing with the goals to reduce waste in human effort and inventory, reaching the market on time, and managing manufacturing stocks that are highly responsive to customer demand while producing quality products in the most efficient and in economical manner without waste. The types of wastes are waste from overproduction, waste of waiting time, transportation waste, inventory waste, processing waste, waste of motion, and waste from product defects. Some of the tools used for lean manufacturing are 5S, Kanban, Kaizen, Jidoka, Poka-Yoke, Andon, Just-in-time, Gemba. Learn more about Lean.

Figure 74: Principles of Lean

7 Learning Curve

A learning curve is the representation of an operator's performance growth against the time required or number of repetitions to achieve the regular target efficiency. When an operator learns a new operation for a new style, one cannot achieve the required speed of production, thus lowering the output. In the initial days of production of the new style, the target output is thus deliberately kept low and gradually increased based on operators learning curve. The adoption of accelerated training methods may considerably shorten the time/ no. of repetitions needed for achieving the target.

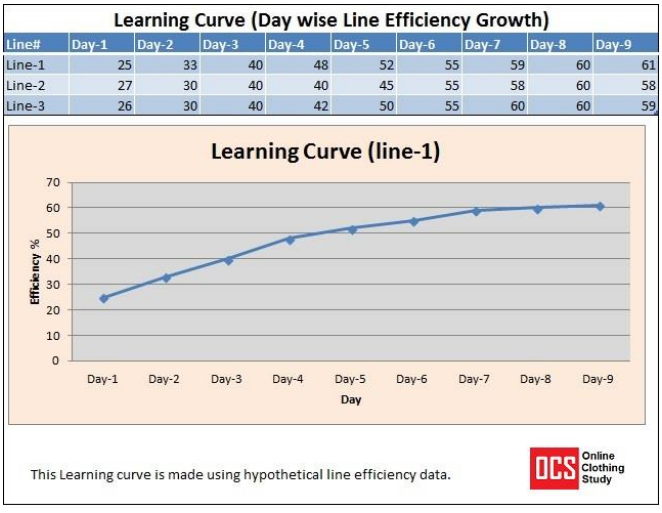


Figure 75: Learning curve

8 Line (Production Line)

A line is defined as a group of operators under the control of one production supervisor. In the sewing line, a number of sewing machines (including different types of sewing machines and non-sewing equipment) are placed in a line according to the process sequence requirement. Sewing lines have different arrangement of the workstations. Garment bundles are loaded at one end of the line and moved from one workstation to another, and finally stitched garments come out from the line. There are multiple sewing lines in an apparel manufacturing unit.

Figure 76: Sewing lines in a factory

See the different types of sewing line layout.

9 Line Balancing

Line balancing is the technique of maintaining the same level of inventory at each operation at any point of time to meet the production target and to produce garments of acceptable quality. The work-study officer does line balancing by doing the product analysis, process analysis, and capacity analysis, and then allocating the available operators to the operations. The line balancing needs to be done such that target is fulfilled, priorities of operations are met, operators and machines are properly utilised, and the idle tie for operators is minimised. A well-balanced line has a smooth workflow, no bottlenecks are created, and the operators are able to work at peak performance throughout the day.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Line balancing format						T/ 8h	No Pers					
2							1963	35					
3					Hours	06.00 - 08.00		08.00 - 10.00		10.30 - 12.30		12.30 - 14.30	
4					Target	491	491	491	982	491	1472	491	1963
5	Operation	T/ 8h	Plan/ 8h	Eff plan	OPERATOR	Plan	Real	Plan	Real	Plan	Real	Plan	Real
6	Operation 1	906	900	100%	Person 1	225		450		675		900	
7			850	93%	Person 2	213		425		638		850	
8			213	81%	Person 3	53		107		160		213	
9				0%		-		-		-		-	
10				0%		-		-		-		-	
11				0%		-		-		-		-	
12				0%		-		-		-		-	
13				0%		-		-		-		-	
14			1963		Total	491	0	982	0	1472	0	1963	0
15	Operation 2	1091	625	81%	Person 3	156		313		469		625	
16			880	81%	Person 4	220		440		660		880	
17			458	90%	Person 5	115		229		344		458	
18				0%		-		-		-		-	
19				0%		-		-		-		-	
20				0%		-		-		-		-	
21				0%		-		-		-		-	
22				0%		-		-		-		-	
23			1963		Total	491	0	982	0	1472	0	1963	0
24	Operation		246	90%	Person 5	62		123		185		246	

Figure 77: Line balancing format

Read more:

1. Traditional line balancing method
2. Line balancing using skill matrix

10 Line Efficiency

Line efficiency is the efficiency measurement for the sewing line. It is also termed as line utilisation. Line efficiency is calculated based on the line output. It is expressed as percentage. Read more…

$$Line\ Efficiency = \frac{Total\ Minutes\ Produced}{Total\ Attended\ Minutes}\ X100$$

Where,

$Total\ min.produced = Line\ Output\ X\ SAM$

$Total\ min.attended = No.of\ Operators\ X\ Working\ hrs.X\ 60$

11 Line Planning

Line planning is scheduling and allocating of orders to production lines according to product requirements and due dates of production completion. Based on available time and production capacity of a line, a planner may have to plan for multiple lines for an order. A planner decides on which date a style to be loaded and how many lines to consider so that the style meets the production completion date. An assessment needs to be done whether a style can be loaded on to a particular line.

Based on the timeline, the planner needs to decide whether to allocate one line or more than one line to the order. Read more…

Line No.	Product	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May
1	Dress			Order#AA1							Order#PQR2				
2	Blouse	Order#AA5													
3	T-Shirt	Order#AA7							Order#PQR4						
4	Skirt								Order#PQR8						
5	Trouser		Order#AA8												

Figure 78: Line loading planning

12 Loading Production

Loading production refers to allocating the quantity of work to the sewing lines to manufacture the garments. The production planner carefully plans which garment style and the quantity to be loaded in the production line.

Figure 79: Line Loading WIP

1 Machine Breakdown

Machine breakdown is the situation where in a machinery stops working or needs to be stopped due to an internal malfunction or a broken part(s), requiring its repair or replacement. Machine breakdown can cause delays in the production system.

Machine Service Plane						
Machine Type	Jan	Feb	Mar	Apr	May	Jun
SNLS	20	20	20	20	20	20
Zig Zag	45	45	45	45	45	45
Overlock	60	60	60	60	60	60
Flatlock	70	70	70	70	70	70

Figure 80: Machine service plan to reduce machine breakdown

2 Machine Maintenance

Machinery maintenance involves regular servicing of equipment, routine checks, repair work, and replacement of worn or non-functional parts. The role of maintenance is to reduce the equipment downtime, breakdowns and to increase the productivity and quality.

Apart from machine maintenance, the maintenance department in a manufacturing unit also looks after the electrical and civil maintenance.

Planned	Preventive maintenance, Routine/Scheduled maintenance, Predictive maintenance, Condition monitoring maintenance, Design-out maintenance, Reliability centred maintenance
Un-planned	Emergency/reactive or break down maintenance

Figure 81: Types of maintenance

3 Marker

A marker is an illustration of accurate and precise planning of patterns for a particular style of garment and the sizes to be cut from a single spread on a marker paper. Markers are generally defined by two parameters, namely, the relation to the relative symmetry of the garment, and mode. Once markers of each style are finalized, the yield of fabric needed for production can be calculated and accordingly order the fabric.

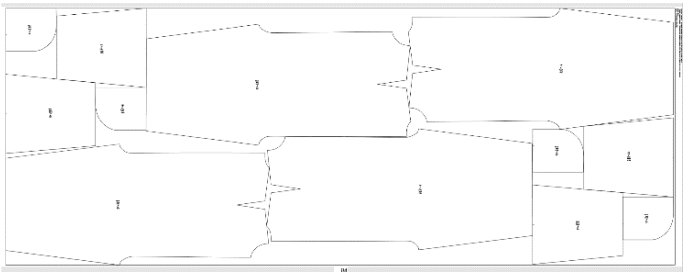


Figure 82: Marker (on paper)

4 Marker Efficiency

Marker efficiency is the percentage of the fabric area used by the marker of the total fabric area. It depends on how closely the patterns are arranged in the marker. An efficiency around 80%–85% is considered good and varies based on the pattern shapes, constraints on pattern placements and fabric nature. It is generally determined for each marker plan.

Equation:

$$Marker\ Efficiency = \frac{Area\ of\ Marker\ Used\ for\ Garment\ Pattern}{Total\ Area\ of\ Marker}\ X\ 100$$

5 Marker Planning

Marker planning is a creative, intuitive, and conceptualising process to place the garment patterns in a paper to meet the technical requirements as well to minimise wastage of fabric. The main purpose is to produce a shortest marker by considering all the practical and technical constraints such as fabric characteristics, design requirement in the finished garment, cutting quality, and production planning. Marker planning methods are – manual marker planning and computerised marker planning. In a computerised marker planning, the planner inputs the details of fabric width, the pattern pieces to be utilised, and product sizes to be included in the marker and the constraints to be considered including any matching of checks. Then the system generates a marker plan automatically or interactively.

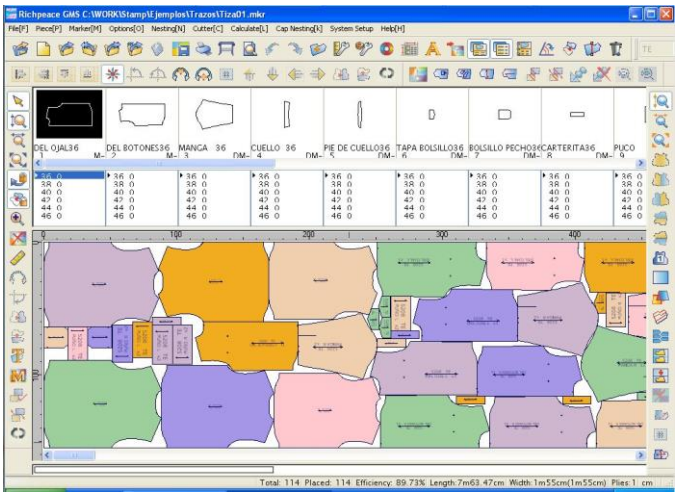


Figure 83: Marker planning with software

6 Marker Types

The types of markers are decided based on garment quantity, size and colour ratio, time available to lay and cut, fabric type, budget.

- Continuous marker

Comprise patterns of all garment sizes for a particular garment style.

- Sectioned marker

Comprise all of the patterns of a particular garment size and style.

- Half marker

Half of one size and half of the other size

- Step marker

Marker starts with the smallest order quantity size then progresses to the size ordered in the biggest quantity.

- Marker for folded lay

Usually for knit fabric

- One-way marker

All pattern pieces are laid in one direction

The most common types of markers used in apparel manufacturing are continuous markers and sectioned markers

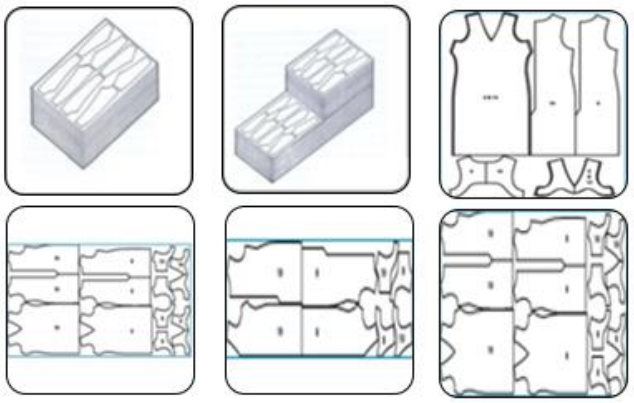


Figure 84: Types of marker - continuous, sectioned, half, step, marker for folded lay, one-way marker

7 Material Handling System

The means used for transporting work (fabrics, cuttings, bundles, finished garments and general items) from one place to another, storing materials and protecting material from damage, are material handling system. Appropriate material handling system across the factory departments reduces material transportation time, waiting time at work and delays. There are different type materials handling systems based on process requirement like trolleys, fabric bags, racks, centre table, bins, overhead hangers, etc.

Figure 85: Material handling system - racks, centre line table, hanger stands, overhead hangers

8 Measurement

Measurement denotes the size of the garment between defined points in a garment. The measurement is the key factor for a proper fit of the garment. Measurement details and the point of measurement of garment are included in the tech-pack. For example, a polo t-shirt is measured at front length (A), full chest (B), across shoulder (C), sleeve length (D), armhole (E), collar length (F), placket length (G), and sleeve opening (H).

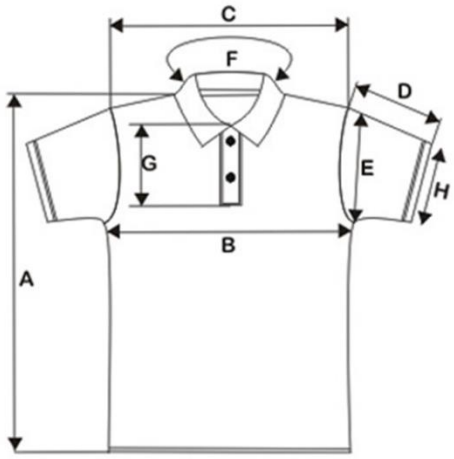


Figure 86: Measurements points of a polo t-shirt

9 Merchandise Management

Merchandise management is the process by which a merchandiser attempts to offer the right quantity of the right merchandise in the right place at the right time and meet the company's financial goals. The supply is matched with the demand by looking after performance objectives for sales, inventory, and other finance-related processes. There are several merchandise planning software solutions commercially available.

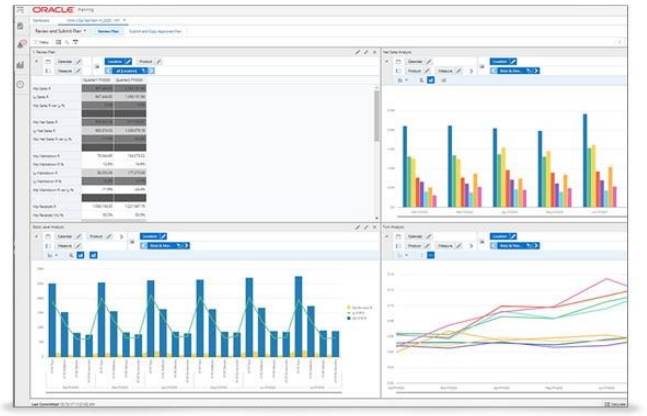


Figure 87: Merchandise planning software provide insights through infographics

10 Merchandiser

A merchandiser is personnel with planning capability, decision-making skills, and strong communication skills. Merchandising department works as a mediator in between factory and buyers. The merchandiser works on all activities from product conceptualisation and development to the final dispatch of the product.

Figure 88: Types of merchandiser in apparel-manufacturing unit and their role

11 Method Study

Method Study is the systematic recording and assessing the way of doing a task to measure the improvement potential, and thus reduce the work content of a job or operation. Method study involves a number of tools and techniques such as – process chart, multiple activity chart, flow diagram, two-handed process chart, micro motion study and SIMO chart.

The steps to carry out method study are:

- Record every detail about the job
- Examine all the details
- Consider alternatives for improvement and develop the most suitable
- Define the jobs
- Install new method
- Maintain the new method

12 Modular System

A modular production system works on the principle of pull-type system. In this system, a work team generally has a group of operators having corresponding skills who are devoted to achieve the set of performance goals. The operators work on standing or sitting stations and rotate to different machines as they work, becoming familiar with multiple steps in producing the garment. Productivity is high in this production system since the operator handles the garment only once for several operations, instead of handling it for every operation.

Read about the different types of apparel production systems in this article.

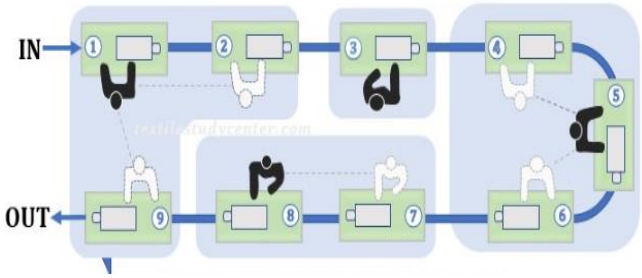


Figure 89: Modular production system

13 MOQ

MOQ-'Minimum Order Quantity', represents the minimum quantity of raw materials that the raw material suppliers could supply to the apparel manufacturer. It plays an important role in sourcing of fabrics and other accessories as it determines the cost-effectiveness of the order. If the ordered quantity of fabric is less than the determined MOQ, then the supplier could claim higher price as compared to regular charges.

High MOQ	Low MOQ
High investment	Low investment
High holding cost	Low holding cost
Less frequent ordering	Products need frequent reviews
Lower ordering and administration cost	Higher ordering and administration cost
Higher risk of obsolescence	Lower risk of obsolescence
Lower risk of stockouts	Increased risk of stockouts

Figure 90: Results of High MOQ or Low MOQ

14 Motion Study

Motion study – defined by Gilbreth, the real founder of motion study as "the science of eliminating wastefulness resulting from ill-directed and in efficient motions". The aim of motion study is to find the scheme of least wastage of labour. The work study officer carefully studies the movement of the operator's body and hand, to enhance work performance, and reduce ergonomic stresses. Standard target time is determined by time and motion study.

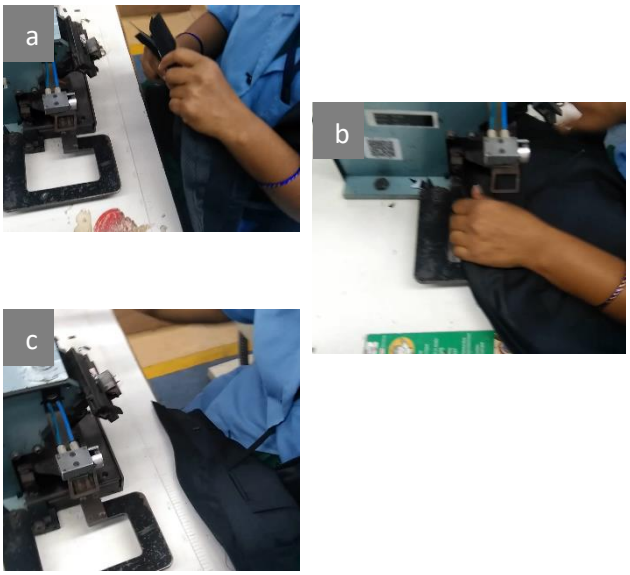


Figure 91: (a) Pickup, (b) Position, and (c) Dispose motions

15

Multiple Activity Charts

Multiple activity charts (MAC) are the process charts using a time scale. It is also termed as 'man-machine' chart. In the apparel manufacturing unit, a number of workers work in a group or an individual operator handles two or more machine. These charts represent the inter-relation of the workers activities on a common time scale. The activities have to be properly coordinated to optimise work distribution and minimise idle time. An analysis of the MAC ultimately assists in developing an improved method to accomplish a task and to have an effective labour lost control.

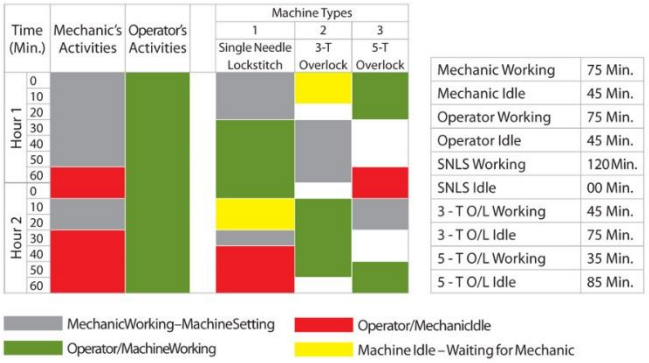


Figure 92: Example of a Multiple Activity Chart

1 Needle

Needle is the central feature of the sewing machine that penetrates in the fabric to create a passage for the sewing thread to pass. It carries the needle thread through the material and form a loop which can be picked up by the hook or looper mechanism. The parts of a needle are butt, shank, shoulder, blade, groves, eye, point, tip.

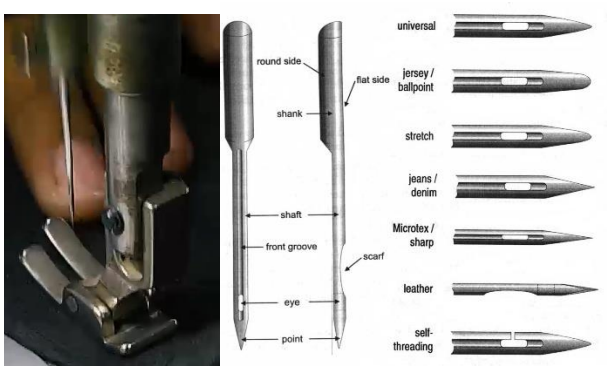


Figure 93: Sewing needle and its type

2 Non-Productive Time

Non-productive time is the time spent by an operator in doing activities other than producing a garment. Non-productive time reflects how much standard time is lost due to various reasons such as defect corrections, rework, over production, absence of operator, line setting, machine breakdown, improper balancing, raw material unavailability, change of feeding plan, workers' fatigue, etc. Of these, the major 4 identified are waiting for work, cut components not available, rework, and line setting. A supervisor monitors NPT and the lost time in man minutes is recorded in a format. Read [the reason why garment factories should measure NPT time](#).

NPT Report

Date: _____ Line No.: _____
Style No.: _____ SMV: _____
Operation: _____ Operator: _____

Bobbin Changing	Thread Break	Bundle Handling	Record	Machine	Instruction	Personal &	Waiting for Work	Own Repairs	Talking	Others

Percentage of Non Productive Time =
(calculated w.r.t. productive time)

Figure 94: NPT Report Format

1 Off-Standard and On-Standard Time

Standard time is the time allowed to an operator to carry out the specified task under the specified condition and defined level of performance.

Off-standard time: The time to which SMVs are not allocated. It is calculated as a percentage of operator attended time (utilisation) and reported in different categories such as machine breakdown, waiting for work, rework, re-training, unmeasured work.

Figure 95: Example of off-standard time (No-work)

On-standard time: The time spent by an operator in productive tasks (producing a garment). It is the difference between attended time and off-standard time, where attended time is the total time the operator is supposed to spend in working in the factory. This parameter is used in calculating operator performance. Tasks contributing to on-standard time accounts for the incentive payment to the operators.

Figure 96: Example of On-standard time

2 On-Time-In-Full (OTIF)

OTIF – abbreviation for 'On-time, In-Full'. OTIF is a KPI to measure the extent to which shipments are delivered to their destination according to both the quantity and schedule specified on the order by the buyer. It is expressed as percentage. An extension of OTIF is on-time, in-full and error-free.

Equation:

$$OTIF = \frac{(Cases\ matching\ the\ criteria)}{(Total\ number\ of\ cases)}$$

Criteria:

$$On\ time = (Delivery\ time) - (Confirmed\ delivery\ time)$$

$$In\ Full = (Delivered\ amount) - (Confirmed\ amount)$$

3 Open Marker

Open marker is a marker type where in the pattern pieces are full (i.e. not halved). This type of marker is prepared for asymmetric garments. Better spreading and cutting quality may be obtained by keeping the garment panels close to each other along the marker length. Under this marker type, the fabric is spread in all face up mode in open condition.

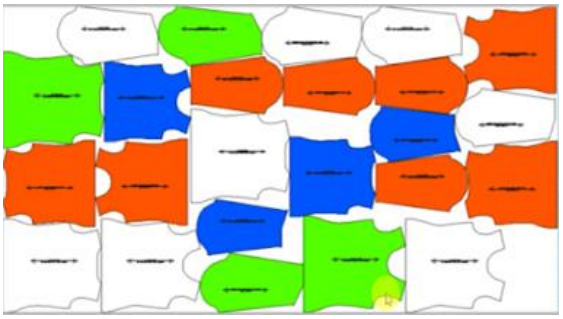


Figure 97: Open Marker

4 Operation

Tasks or activities involved in producing a garment are called operations. Operations could be sewing and non-sewing operations, or machining and non-machining. To produce a garment, number of such operations are involved, and each are connected to the preceding and succeeding operation. The work process contains separate operations depending on equipment available, equipment utilisation, workers skills, and time available, such that quality and efficiency are ensured. Each separate sewing operation is characterised by a start and stop action (with or without back tack and except for a burst in a single operation).

Figure 98: Operations performed for a simple t-shirt

5 Operation Breakdown

An operation breakdown is a sequential list of all operations involved in assembling a garment, component, or style. It represents the planned steps in sewing and the responsibilities of different operators to carry out specific tasks. With the details obtained from an operation breakdown, one could understand the following:

- Estimate the difficulties in doing a critical operation
- Plan a layout and allocate operators conveniently
- Calculate SMV to set target
- Machine, additional guides, folder, and attachment requirements.

SL. No.	OPERATION	SAM	MACHINE TYPE
Cutting Room Operations			
1	Fuse Placket	0.13	Fusing M/c
2	Hem Front Placket	0.55	SNLS
3	Bottom Hem	0.64	Flat lock w/ trimmer
4	Size label to main label	0.22	SNLS w/ UBT
5	Main label to yoke	0.28	SNLS w/ UBT
Stitching Operations			
1	Attach placket to front	0.83	SNLS
	Cut placket		Manual
2	Front placket edge stitch	0.51	SNLS
3	Sew Box at placket	0.68	SNLS w/ CP
4	Yoke attach to back	0.46	DNLS
5	Shoulder overlock	0.56	5T O/L
6	Topstitch Shoulder	0.34	SNLS
7	Tack piping at collar ends		
	Attach piping to collar	0.77	SNLS
8	Turn Placket ends inside out		
	Finish Piping	1.00	SNLS
9	Cuff O/L	0.45	5T O/L
10	Cuff Topstitch	0.59	SNLS
11	Sleeve attach	0.89	5T O/L
12	Sleeve topstitch	0.60	SNLS
13	Slits Making	1.40	SNLS
14	Side seam O/L & bottom placket O/L	0.86	4T O/L
15	Tack at sleeve ends	0.30	SNLS
	Finishing Operations		
20	Button Hole	0.29	B/H m/c
21	Button attaching	0.30	Buttoning M/c
22	Thread trimming	0.35	Manual
23	Garment inspection	1.45	Manual
24	Ironing the garment		Manual
25	Packing	0.43	Manual
	Total SAM	**12.65**	

Figure 99: Operation breakdown

6 Operation Bulletin

An operation bulletin is a summary document that includes the operation breakdown and more details. These are – total number of components in the garment, job code, machinery, work-aids, calculated number vs actual number of machines, work content of each operation, daily working hours, target output per day or per hour, SMV (Sewing and Non-sewing), SMV@100% efficiency, SMV @target efficiency, pieces per machine, remarks. An OB helps to set a production line with the correct number of machines and manpower. It is prepared by Industrial Engineering department. To prepare and OB, the industrial engineer has to study the product and operations carefully.

Operation Bulletin - Boxer (shorts)

Parameters		Sample Sketch (Boxer shorts)
Style	Boxer (back pocket)	
Target output	400	
Target Efficiency (Start up)	65%	
No. of Workplaces	19	
Minutes per Day	480	
Absenteeism	10%	
Operators - Sewing	16	
Total SAM	13.56	
Pieces/Op / day	25	

S.No.	Operation	Estimated Time	Machine type	No. of operators	No. of machines (Calculated)	Hourly Target @65%
1	Hem Pocket opening	0.30	SNLS	0.43	0.38	130.00
2	Pocket shape press with template	0.60	IRON	0.85	0.00	65.00
3	panel	1.00	SNLS	1.42	1.28	39.00
	Front					
4	Attach right placket facing	0.62	SNLS	0.88	0.79	62.90
5	placket	1.52	SNLS	2.17	1.95	25.66
	Assembly					
6	Front rise join	0.20	4THOL	0.28	0.26	195.00
7	Back rise join	0.35	4THOL	0.50	0.45	111.43
8	Top Stitch front and back rise	0.80	DNLS	1.14	1.03	48.75
9	Side seam	0.60	4THOL	0.85	0.77	65.00
10	Top Stitch side seam	0.91	DNLS	1.30	1.17	42.86
11	Make slit @ side seam bottom	1.00	SNLS	1.42	1.28	39.00
12	topstitch	1.20	SNLS	1.71	1.54	32.50
13	Join placket @ waistband	0.36	SNLS	0.51	0.46	108.33
14	Measure and cut elastic	0.40	MANUAL	0.57	0.00	97.50
15	Attach elastic at Waistband	0.60	4THOL	0.85	0.77	65.00
16	Waistband finish	1.00	DNCS	1.42	1.28	39.00
17	Bottom Hem	0.75	SNLS	1.07	0.96	52.00
18	Attach label (size/main)	0.50	SNLS	0.71	0.64	78.00
19	Bar tacking @slit top, pocket opening	0.45	Bartack	0.64	0.58	86.67
20	Button Hole	0.20	BH	0.28	0.26	195.00
21	Button attach	0.20	BS	0.28	0.26	195.00
	Total SAM	**13.56**		**19.32**	**16.10**	

Machine	SAM	No. of	Actual
SNLS	7.25	10.33	10
4THOL	1.75	2.49	2
DNLS	1.71	2.44	2
DNCS	1.00	1.42	1

Figure 100: Operation bulletin (sample)

7 Operator

An operator is an individual who is performing the specified tasks on the machine. Operator in the apparel-manufacturing unit is generally referred to the sewing machine operator (SMO). SMO for the backbone of the apparel-manufacturing unit and their role is very critical to the industry. They are also called a 'Stitcher or Machinist'. The primary responsibility of an SMO is to stitch/ sew fabric to produce apparels. It is expected of an SMO to have a strong hand-eye-leg coordination and eyesight that is perfect both in near, distance, colour, peripheral vision, ability to change focus and depth perception.

A sewing operator is also known as tailor and Seamstress. Read about the difference between a tailor and an operator.

Figure 101: A sewing operator

8 Operator Performance

Operator performance is the measure of both skills and attitude of the operator. Operator performance plays a vital role in incentives calculation. It is calculated for individual operators and averaged for a line to evaluate the line leader/ supervisor. To monitor the operator performance, the following can be calculated – single cycle efficiency, on-standard efficiency, global efficiency.

Equation:

$$Single\ cycle\ efficiency = \frac{Target\ single\ cycle\ time\ in\ minutes}{Average\ observed\ single\ cycle\ time\ in\ minutes}$$

$$Onstandard\ efficiency = \frac{Operation\ production\ X\ SAM\ of\ operation}{Working\ time\ in\ minutes - Off\ standard\ time\ in\ minutes}$$

$$Global\ efficiency = \frac{Operator\ production\ X\ SAM\ of\ operation}{Working\ time\ in\ minutes}$$

9 Operator Training

Operator training is a structured way used to build operator sewing skills, teach machine handling and material handling and to impart basic knowledge about the sewing machine and quality of stitch. Manufacturers follow different operator training modules such as methods explained in Juki's "Sewing factory operator's training handbook", fast-track training method, etc. Training can take two separate identities, the giving of skills and knowledge to new recruits and the upgrading of the abilities of the existing workers.

For example, training a new operator includes:

- Demonstration of machine basics – threading needle, bobbin change, safety
- Hand, eye, leg coordination exercises
- Basic sewing exercises
- Specific skills training related to specific operation
- Training of the specific operation
- On the job training (training in the unit's sewing lines)

Read more about operator training topic.

10 Operator Grading

Operator grading refers to categorising operators based on their skills, expertise, and experience. This categorisation aids in processes such as operator allocation, deciding wages, and to some extent motivation. Generally, operators are graded as unskilled, semi-skilled, skilled and highly skilled operators. Sometimes they are graded as A, B, or C. For operator grading, the steps followed are:

- Grading operations based on criticality, skill requirement, machine, and garment area
- Creating operator grading criteria based on grade and number of operations that can be performed
- Study the operator's skill for the respective operations.

Grade	Criteria
A+	• Almost all A grade operations • 5-6 B operations • Almost all C grade operations • Eff. - 56
A	• Min 6-8 A grade operation • 5-6 B grade operations • Almost all C grade operations • Eff.- 52
B	• Min 2 A grade operations • Min 4 B grade operations • Almost all C grade operations • Eff. - 50
C	• MIN 5 B grade operations • Almost all C grade operations • Eff. - 45
D	• Trainees • Any B or C grade operations

Figure 102: Example of operator grading and grading criteria

11 Operator Rating

Operator rating is a tool for comparing the performance of operator against a set standard performance. The rating value of the operator is expressed as percentage. It is also termed as performance rating. The use of performance rating enables time study to determine a more accurate time for the job. It is the adjustment of the Observed Time value, based on the Time Study practitioner's subjective assessment of the operator's performance. Some of the rating systems are namely Speed or pace or performance rating, Skill and effort rating (by Charles E. Bedaux), Levelling rating system (by Lowry, Maynard and Stegemerten), Objective rating (by Dr. Marvin E. Mundel), Synthetic rating (using PMTS), Portnoff rating system.

Characteristics of a 100% operator:

- Fluid motions without hesitation
- No false starts or duplications
- Consistent, coordinated, effective rhythm
- No wasted actions or work
- Focused attention on the task

$$Basic\ time = Cycle\ time\ X\ Performance\ rating$$

Q&A on operator rating.

12 Overtime

The amount of time beyond the normal working hours of the factory that an operator has to spend in its job is termed as overtime. Operators need to do an overtime in their job under situations when there is a lot of pending orders, accumulated WIP, rework, poor planning, lack of factory policies. Factory policies usually cap the overtime that an operator can do. Unnecessary overtime must be avoided. Overtime adds to excess cost of the factory.

Equation:

$$Overtime\% = \frac{Total\ overtime\ minutes}{Total\ working\ minutes}\ X\ 100$$

1 Packing List

A packing list is a document belonging to the finishing/ shipment department. It is one of the mandatory documents for export of goods. The shipper or forwarding agent uses the packing list to determine the total shipment weight, volume and item wise list of the materials shipped to ascertain shipment of the right cargo. The customs broker or forwarder generally requires the packing list of a consignment in order to book the shipping space and to obtain the S/O and / or to prepare the shipping note.

ABC Apparel Packing List									
Buyer: Add: Contact: Shipper: Add: Contact: P.O. No.: Style No.: Description:						Date: Ship Qty.: Excess/ Short: Ctn. Qty.: Ctn. Size: Net weight: Gross weight:			
Type of Shipment: Vessel No.: Port of landing: Port of discharge: Special Instructions:									
Colour	Size								
	XS	S	M	L	XL	Pcs. Per Ctn.	Total Ctn.	Total Qty.	Grand Total
_____ Factory In charge									

Figure 103: Sample format of a packing list

2 Pareto Chart

A Pareto chart is a bar diagram that is used to map the frequency of occurrence of defects/ problems. The graph is created with the parameters (defects) on the x-axis and the frequency of occurrence on the y-axis. The bars are arranged as the longest ones on the left and the shortest to the right, thus depicting which defect is more significant. Application of Pareto chart helps solving those problems on priority basis.

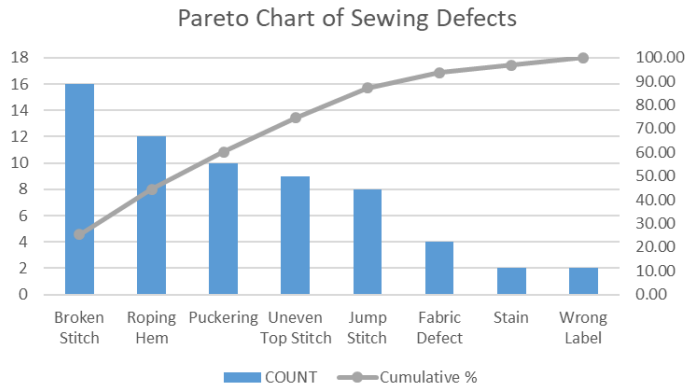


Figure 104: Pareto chart

3 Pattern

A pattern is a template of the garment on paper, made with accuracy and precision, based on the body measurements or standard measurement chart. It is a guide for cutting garment(s). Patterns are the bridge between design and production.

Few examples of pattern making software are TUKAcad, Lectra, Optitex, Gerber Accumark, Richpeace, Etelestia, FashionCAD.

4 Pattern Grading

Pattern grading is a drafting process of enlarging or decreasing the pattern dimensions from the master pattern (base size or sample size pattern) to obtain sizes as per the specification sheet, without altering the style sense of the original model. Pattern grading can be done manually or by using computerized pattern making software. The computerised pattern grading process could improve the capacity to make several garment pattern sets in a given period of time. Once the fit is approved, the patterns are produced in a range of different sizes according to a set of grade rules derived from a size chart.

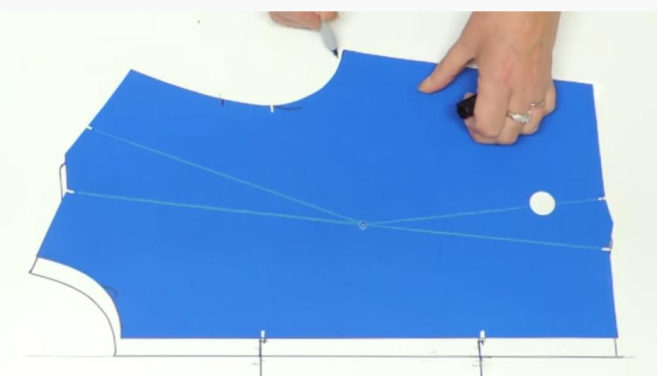


Figure 105: Pattern grading

5 Product Development Calendar

Product Development is the process of setting up collections for the season by carrying out market trend research, conceptualizing and developing a line of products using the technical design process, making proto-samples of the styles with standards, identify sourcing requirements and suppliers involved, costing, and plan the manufacturing. The PD Calendar is a chart that represents these activities in a planned and scheduled manner, roles and responsibilities of the individuals initiating and achieving each task to accomplish them on time.

The PD calendar aids in coordinating, monitoring, controlling, disciplining individuals for efficient task completion. The timeline and activities in the PD calendar may vary from company to company depending on factors such as the product type, the company's business practice.

6 Piece Rate

Piece rate is a wage determination system. Piece rate pay occurs when workers are paid by the unit performed i.e. the total number of whole garments manufactured. The piece-rate amount can be justified by using capacity study and operation cycle time. Piece-rate could be individual (for individual operators to produce a single piece of clothing, disregarding quality) or group piece-rate (for team collectively producing a single piece of clothing that meets quality standards and is saleable). Read more -

- Piece rate calculation method using garment SAM
- How to justify operator piece rate?

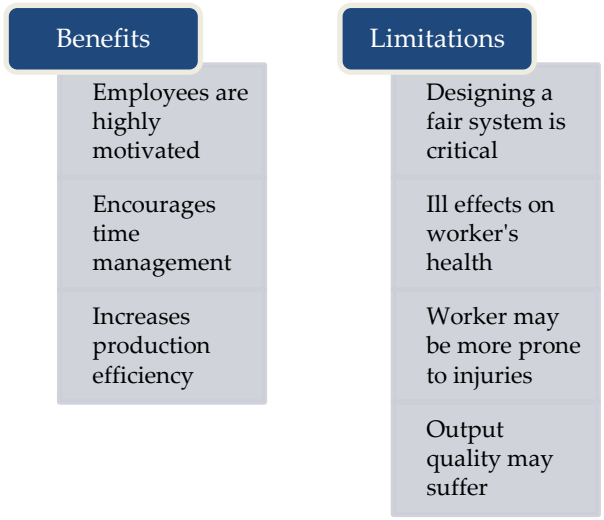


Figure 106: Benefits and limitations of piece-rate system

7 Pilot Run

Pilot refers to manufacturing a set number of pieces of all sizes of the garment style to observe the bulk production metrics the garment. It is carried out after the pre-production (PP) sample is approved, following the comments mentioned in PP sample approval report. Pieces produced in the pilot are carefully monitored for quality, and if any challenge that may arise in the bulk production. Pilot run should be done in the production line, and not in the sampling line.

Checkpoints after pilot run:

- Pattern and fit accuracy
- Review overall specifications of pilot run sample with approved sample
- Risk analysis of critical operation
- Check final wash appearance, shade, and hand feel where applicable

8 Pitch Time

Pitch time is the theoretical operation time that an operator should take in a planned balanced line. It is used for theoretically allocating work force and machine. The IE/ work study officer club operations for a single operator or split among more operators to match every operation timing with the pitch time. A better balancing efficiency results if the deviation between operation time and pitch time is low.

It is a ratio of total SAM of garment and number of operations to be set for the style.

Equation:

$$Basic\ Pitch\ time = \frac{SAM\ value\ of\ a\ garment}{No.\ of\ operator\ required\ to\ meet\ the\ target}$$

9 Pitch Diagram

A graphical presentation of individual operation's time (SAM) and pitch time on a same chart is called pitch diagram. The standard minutes for each operation are plotted on the graph with operation names on the X-axis and the time on the Y-axis. This diagram aids in balancing an assembly line.

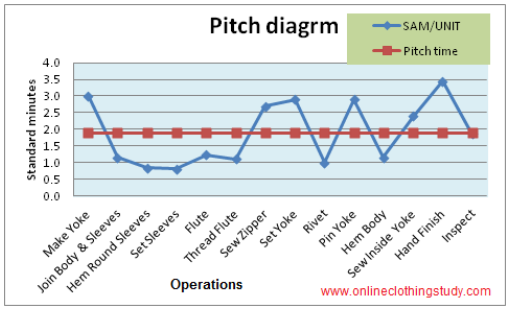


Figure 107: Pitch diagram

10 Plant Layout

Plant layout refers to the placement of the facilities, departments, workstations, and equipment in the plant area, and directs the flow of materials. The spatial arrangement and configuration have a significant impact upon the manufacturing cost, WIP, lead-time, quality, etc. The layout should be such that manufacturing cost is minimised, material flow is continuous without overlap, material handling and work transfer is minimised, and future expansion plans may be feasible.

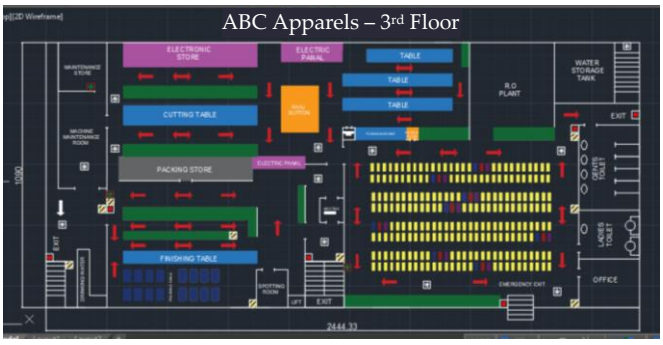


Figure 108: Example of a plant layout

11 PLM

PLM stands for product lifecycle management. Product lifecycle management software plays an important role in the process automation and digitisation of apparel designing, merchandising, development and sourcing, manufacturing, and linking internal and external teams and partners.

The automation in PLM software helps designers to lessen the time required for creating new designs and products. CentricSoftware, Lectra Fashion PLM 4.0, FDM4, BlueCherry by CGS, and many more provide the PLM software for the fashion industry.

The diverse functions that can be done through PLM are:

- Product data management (PDM)
- Computer-aided design (CAD)
- Computer-aided manufacturing (CAM)
- 3D computer-aided engineering (CAE) and simulation
- Predictive engineering analytics
- Mechatronic system simulation (1D CAE)
- Finite element analysis (FEA)
- Modal testing and analysis
- Digital manufacturing
- Manufacturing operations management (MOM)

12 Plotting

Plotting refers to printing a natural-size patterns and markers made in any CAD system. Productivity in cutting section increases compared to conventional marker planning system primarily due to the elimination of manually drawing around the patterns, which is replaced by the plotter.

Figure 109: Plotters (Image Credit: Tukatech)

13 Ply Alignment

Ply is a single layer of fabric that is spread. It relates to accuracy with which fabric edges, both length and width are aligned during spreading. Careful attention should be given to ply alignment to avoid any defects in cutting (cut components may be incomplete if plies are not aligned properly). Ply alignment also affects fabric wastage.

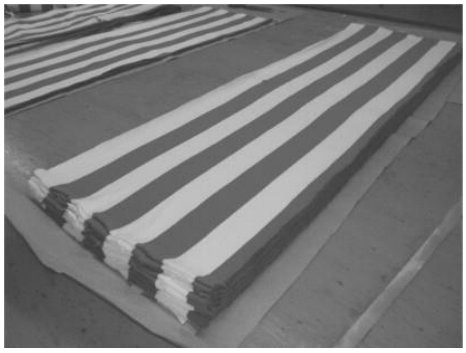


Figure 110: Example of Fabric ply alignment during fabric layering

14 PPM

PPM stands for Pre-Production Meeting. The meeting discussion is held by referring to the final buyer approved preproduction (PP) sample, prior to starting bulk production. The PP sample is made with actual fabric, trims and accessories of the style. The meeting is attended by members from the following departments: sourcing, fabric inspection, technical, embellishment, cutting, work study, machines, and production executive. In the PPM, cutting requirements, planning details, production requirements, critical quality requirements are thoroughly discussed. Read more about PPM.

Purpose of PPM is to:

- Discuss construction details of approved style
- Identify possible problem prior to production and offer solutions
- Ensure that production team understand and agree on style specification and relevant standards
- Discuss any difficulty incurred during sample making
- Confirm availability of all materials like fabric, trims and accessories
- Designate the tasks involved in preproduction and production processes to respective personnel

15 Pressing

Pressing is the process of finishing garments after the fabric is sewed. It involves application of heat, pressure and moisture to shape or crease garments or garment components into the geometric forms proposed by the designer. The main objective of pressing is to enhance the look and durability of the garment dimensions.

Pressing equipment are classified as:

Solid Pressure- Pressing irons, Buck presses, Mangle presses, Block presses, Form presses, pleating presses, Creasing machines

Moisture Pressure Equipment- Wetting tanks, Sponging machines, Steam guns and jets, Steam chambers, Autoclaves

Heat Energy Equipment- Thermoelectric machines, Hot plates, casting equipment, Dry heat ovens

Figure 111: Garment pressing

16 Process Flow Chart

A process flow chart is a visual representation of the manufacturing process that take place from order receiving to dispatching shipment of the finished garments. Elements that may be included in a flowchart are a sequence of actions, materials/ services entering or leaving the process, decisions, people involved, time involved at each step, and/or process measurements. It helps in easy analysis to improve the process through elimination/ simplification of operations, reduction in material handling or people movement, reduction in delay or waiting time, better material storage management. Read more…

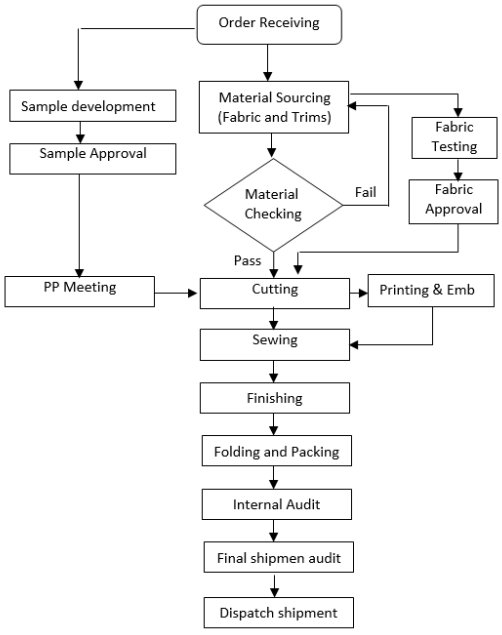


Figure 112: Example of a process flow chart (apparel production)

17 Production

Production is the act or process of producing/ manufacturing desired end products from components or raw materials. Apparel production (from raw materials – fabric and trims) is an organized and sequential process of activities consisting of fabric spreading, marking, cutting, sewing, trimming, checking, finishing, pressing, and packing. Apparel production system is an integration of materials handling, production processes, personnel and equipment that directs workflow and generates finished products.

Figure 113: Production (line output)

18 Production Planning and Control

Production planning and control (PPC) is one of the vital processes, which involves planning and scheduling of orders. The accuracy in planning corresponds to on-time order shipment through optimised allocation based on man and machine availability and their better utilisation. There are three stages in PPC – planning, action, and control. Planning refers to the estimating, routing, scheduling, and loading of orders. Action refers to the execution of the production process. Control refers to the dispatching, expediting, inspection, evaluation, and taking necessary corrective actions.

Thus, the roles of PPC Department are - Task Scheduling, Material Resource Planning, Loading Production, Process Selection and Planning, Facility Location, Estimation Quantity and Costs of Production, Capacity planning, line planning, Follow-up, and Execution.

Read more articles on production planning in apparel manufacturing.

19 Production Start Date

Production Start Date (PSD) is the date on which the fabric is cut into the garment components for loading in the sewing line. It is also called planned cut date (PCD). Adhering to the planned date is very crucial in order to complete the production on time.

Figure 114: Production start

20 Production Systems

Apparel production system is the integrated framework within which all processes take place that converts the raw materials into apparels. In the apparel industry, four types of production systems commonly used: bundle system, progressive bundle system (PBS), unit production system (UPS), and modular system. The attributes of a production system can be human labour, machines, or tool. The type of production system followed in the manufacturing unit should meet the two basic objectives - to meet the specification of the final product and to be cost-effective in nature.

Figure 115: Production floor

21 Productivity

Productivity refers to the amount of output obtained (production) per unit of input of resources. It is an efficiency measurement parameter to assess the extent to which a certain output can be extracted from a given input. In the apparel-manufacturing unit, productivity measures usually assessed are:

Equation:

$$Labour\ productivity = \frac{Production\ in\ standard\ hours}{Actual\ man\ hours}$$

$$Labour\ productivity = \frac{Total\ cost\ /\ sale\ value\ of\ output}{Number\ of\ workers}$$

$$Machine\ productivity = \frac{Output\ in\ standard\ hours}{Actual\ machine\ hours}$$

$$Material\ productivity = \frac{Material\ cost}{Number\ of\ units\ produced}$$

22

Purchase Order

A Purchase order (PO) is a commercial document representing the confirmation of the order from the buyer to the supplier. The PO could be from the garment buyers end as well from the apparel-manufacturer – who is the buyer of raw materials from various suppliers.

For example, a garments buyers PO mentions vendor information, factory information, customer details, terms of payment, currency, billing and shipping details, packing instructions, commercial invoice description, article number, SKU, product description, factory unit cost, order quantity, customer PO no., shipping mode, purchase order total.

Another example, the PO of trims and accessories should clearly mention the specifications of trims like colour, shade, and measurement (width and length) with tolerance limit, and where applicable the appropriate standard to which the product should conform.

Fields included in a PO:

- Buyer details (in letter head)
- Date
- Manufacturer details
- PO Number
- Item – Description – Colour – Quantity – Unit Price – Total Price
- Total price
- Delivery/ Shipment
- Currency
- Payment terms
- Authorised signatures

1 Quality Assurance

Quality assurance can be defined as "part of quality management focused on providing confidence that quality requirements will be fulfilled." The main purpose of quality assurance is to verify that quality control is being maintained. It includes all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfil requirements for quality. It serves those who are not directly responsible for conducting operations but who have a need to know such as plant, functional, or senior management; corporate staffs; regulatory bodies; customers; and the general public.

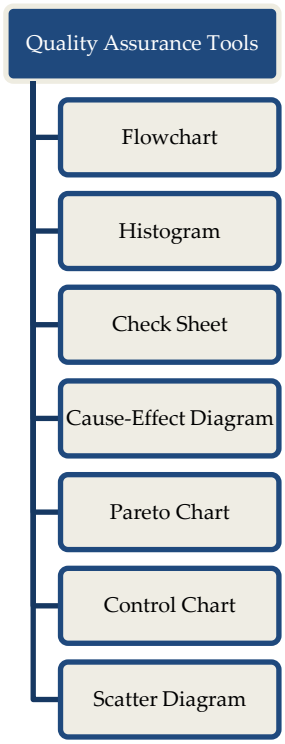


Figure 116: 7 Tools of quality control

2 Quality Control

Quality control refers to the process of maintaining given standards of the product such that they meet the intended requirements and achieve customer satisfaction. The primary purpose of quality control is to maintain control by evaluating the performance during operations, comparing it to the goal, and acting on the difference. A quality control checklist is used in the production floor to assess the product quality by being unbiased.

Quality control in the apparel-manufacturing unit involves the following:

- Pre-production quality control/ material quality control (fabric, trims and accessories)
- Quality control during production (defects during spreading, cutting, sewing, pressing and finishing)
- Final inspection (test for performance requirements, overall appearance, and sizing and fit)

1 Roll Allocation

Roll allocation is the process of allocating fabric rolls for spreading to process an order, in such a way that the end-bits and wastage are minimised, thus ensuring higher yield from the fabric. Fabric rolls may have varying yardage which may lead to difference in fabric loss during spreading. Fabric rolls are allocated with the objective to minimise cost and handle roll length variation, fabric defects, fabric shade, shrinkage, width variation, and spreading costs. Roll allocation can be manual or automated.

Automated roll allocation software allocates fabric rolls based on real-time data by analysing, creating, and re-adjusting the allocation to ensure substantial fabric saving.

Figure 117: Fabric rolls before cutting

2 Real-time Data Monitoring

Real-time data monitoring (RTDM) refers to capturing real time information - which is the right information at the right time for strategic decision making at many levels of the factory. The real-time data monitoring systems use RFID (Radio Frequency Identification) or Barcode technology for real-time information capturing. Information tracked via RFID readers (terminals) from the shop floor is processed through software and provides various real-time reports that help managing production. Through RTDM, example of some of the parameters usually monitored are shift efficiency, output, lost time, defective pieces.

Some of the real-time production tracking systems are listed in this blog post.

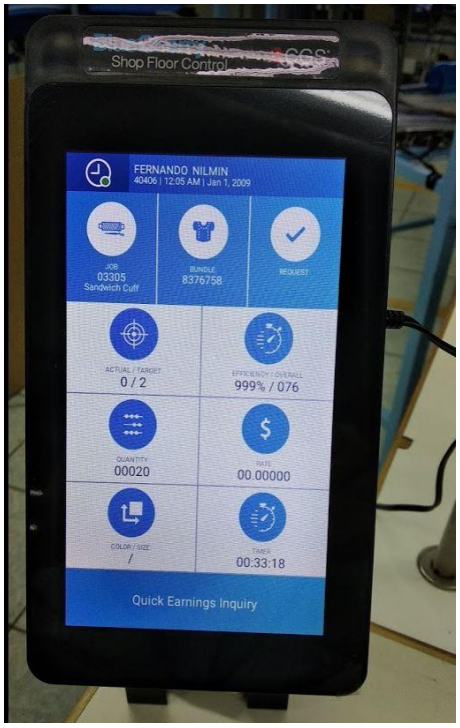


Figure 118: Real-time production tracking device (BlueCherry)

3 Resource Planning

Resource planning is the process of allocating tasks to both human (workforce) and nonhuman (material, machines) resources. Its aim is to maximize resource efficiency, while simultaneously giving an overview of resources' availability and capacity. Enterprise Resource Planning (ERP) is a method of effective planning of all the resources in an organization. Material resource planning is the planning and creation of material requirement sheet as per the garment sample and the specification sheet provided by the buyer. The consumption of raw materials (and their costs are estimated. Human resource planning involves calculating the work content, deciding the target, and calculating the workforce required to meet the target.

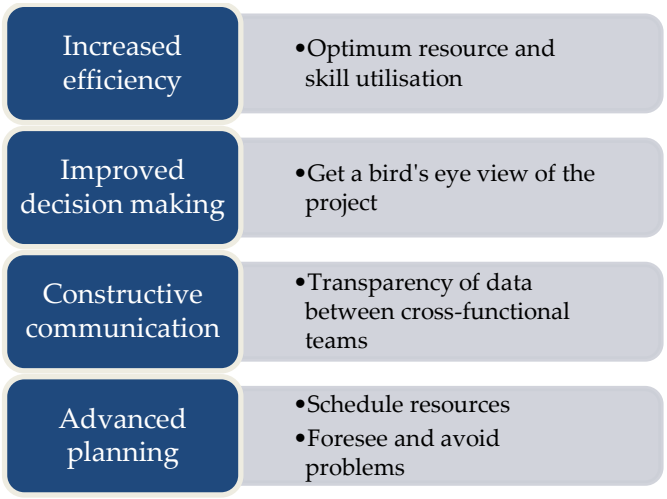


Figure 119: Benefits of effective resource planning

4 Retraining

Retraining is the process of giving the operators additional training to teach them new skills or improve on their existing skills in order to improve the quality and quantity of work. The trainees for reference can use video recording or defining the improved method in an operative instruction sheet until operators are fully conversant with the new method. Video recordings are particularly valuable when retraining. Operators may be quite unaware of the way they are carrying out an operation, and a film in slow motion will enable them to see their exact movements and, once these are understood, they can start to learn the new method.

Figure 120: Training of SMO under close supervision of a trainer

5 Rejection

In the apparel-manufacturing sector, the 'rejection' term is used in couple of areas. It can be the rejection of submitted garment samples by the apparel buyer, it can be rejection of shipment after the final quality audit.

Another most common term is 'garment rejection'. At the final garment inspection stage, factory rejects garments that are beyond repair even by changing parts or due to severe defects in garments and trims/accessories attached to the garment. Factories keep record of garment rejection rate after shipment dispatch.

Read more about calculating garment rejection rate and controlling garment rejection in a garment factory.

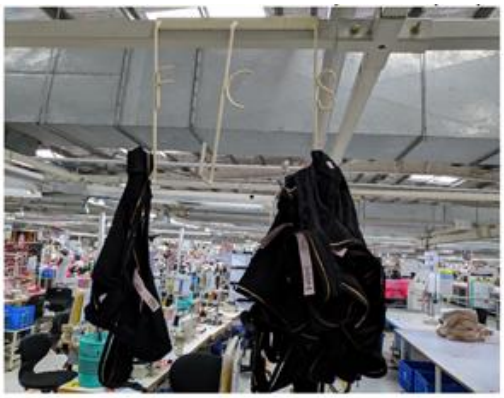


Figure 121: Rejected garments sorted as per cause of rejection (fabric, cutting, or stitching)

6 Rework

Incorrect processing (sewing) of garments leads to rework. It is the activity of working on a finished operation/ garment for a second (or more) time due to producing a piece that does not meet the set specifications or requirements. Rework in the sewing line hampers the smooth process flow and leads to a low production rate, increased cost, and inferior product quality. Sewing rework is usually done after ripping the already sewn stitch and then re-working on it. Minimization of reworks is essential for quality and productivity improvement.

Figure 122: Seam ripping for rework

1 SAH

Standard allowed hour (SAH) is the time in hours required by a normal operator to complete one operation using a specified method. The concept of standard hours allowed is usually based on a reasonable estimate of hours required to produce a product (sometimes called an attainable standard). It is also referred to as standard hours earned.

The total planned SAH, till date achieved planned SAH, balance SAH are monitored on the production control board. Time represented in SAH form makes it easy to compare produced hours against available hours in a day (efficiency).

Equation:

$$SAH = \frac{SAM\ of\ operation\ X\ Garments\ produced}{60}$$

2 SAH Hit Rate

SAH hit rate represents the number of days the sewing line achieves the Planned SAH out of total days the line's SAH achievement was observed. It is a measure of the amount of work done by the operators. Since daily planned efficiency is the presentation of the learning curve of a line (depending on the product category), SAH hit rate term can be also be termed as Planned Efficiency Hit Rate or Learning Curve efficiency hit rate.

Equation:

$$SAH\ hit\ rate\ of\ a\ line$$

$$= \frac{No.\ of\ days\ the\ planned\ SAH\ is\ achieved}{No.\ of\ days\ performance\ observed\ for\ a\ line} X100$$

3 SAM

SAM stands for standard allowed minutes, is the allocated time (including allowances) in minutes for a task. It is assigned to specific operations after doing time study or using PMTS (Pre-determined Motion Time System). SAM is used to assess the operator's performance, calculate operator and associated cost ratios, determine incentive amount, and most importantly for line balancing. Sometimes, SMV – standard minute value, is also used alternatively. However, some organisations consider SAM as allowances added to SMV.

SAM plays an important role in production management on the shop floor.

Learn how to calculate SAM of garment.

Know about the SAM of few apparel products.

4 Samples (Garment Samples)

Samples are a representation of the garment made as per the specifications provided by the buyer to foresee the finished product appearance, fit, production capability when produced in bulk by the manufacturer. There are various types of samples at different stages that need to be approved for proceeding with the production process. Samples also aid to determine the fabric consumption, thread consumption, and the requirement for various accessories. The different kind of samples are: Proto, Fit, Size set, Salesman, Photo shoot, Development, Pre-production, Top of production, Counter, Shipment, Showroom, GPT (tests), Gold seal/sealed, Red tag, Digital Garment.

The manufacturer carries our improvement based on the approval and comments provided after assessing the samples at their respective stages.

Read more about different types of garment samples.

5 Seam

A series of stitches that joins two or more plies of material. The edges of fabric, leather, or other material is joined by sewing (machine) in a variety of stitches, sometimes incorporating "bias binding," "cording," "piping," or other decorative trimming. The choice of seam type is determined by aesthetic standards, strength, durability, comfort in wear, convenience in assembly in relation to the machinery available, and cost. The 8 classes of seam are: superimposed seam, lapped seam, bound seam, decorative stitching, edge neatening, addition of separate items to the edge of garment part, one piece of material need be involved in constructing the seam.

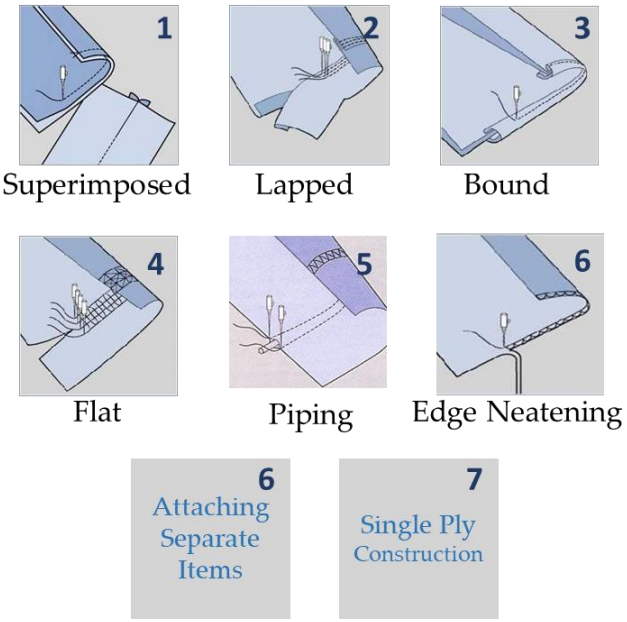


Figure 123: Seam types

6 Seam Pucker

Pucker is a wrinkled appearance along a seam in an otherwise smooth fabric. It is a corrugated sewing line whose finished sewed length is equal to or more than its original cut length. Seam pucker does not press out and negatively affects the aesthetics of the garment. Seam pucker may be caused due to differential fabric dimensional instability, extension or shrinkage in the sewing thread; structural jamming caused by the presser foot, feed dog or tensioning devices, mismatched patterns. Seam puckering is not to be confused with gathering – which is an intentional process for aesthetic purpose.

Figure 124: Seam puckering

7 Seam Strength

Seam strength is the load required for breaking seam and it results from the breakage of either textile material or sewing thread or sometimes both simultaneously. When a seam joins two pieces of woven fabric, and an increasing force is applied to the assembly at right angles to the seam line, rupture ultimately occurs at or near the seam line and at a load usually less than that required to break the unsewn fabric. Seam strength depends on the fabric quality, thread strength and stitch density along with the stitch and seam selection and sewing conditions.

Figure 125: Seam strength tester

8 Sewing

The process of making stitches or seam is called sewing. It is the craft of fastening or attaching objects using stitches made with a needle and thread. In the factories, sewing is the term used to describe the process of mass-producing a wide range of garment (or other goods) by created by joining different components together along the course of a structured process. The parameters involved in sewing are stitch, seam, and a sewing method.

Figure 126: Sewing a garment using industrial machine

9 Sewing Automats

Sewing automats are sophisticated and specialised sewing machines that carry out many complex functions in addition to sewing. These machines perform automatic sewing when the fabric is positioned and the machine is started, cut thread after sewing; dispose the sewn product for next operation. Automats are equipped with electric, electronic, and pneumatic control and sophisticated conveyor and clamp technology.

Examples are patch pocket setting, run stitching collars, long seam joining, making jetted pockets, serging trousers and sequential buttonholing. The operator needs to load the machine and may remove the garment part after sewing, but the machine controls the rest of the handling and all the sewing.

The use of such machines provides the opportunity to considerably improve machine productivity.

Figure 127: Automatic sewing workstation

Check this article for sewing automations in jeans pocket attachment.

10 Sewing Exercise

Sewing exercises are given to new operators or for training operators to build their hard skills. Sewing exercises for hard skill development includes machine speed-control exercise, fabric exercise, stitching using attachments, and operation exercises. These exercises may be basic or to Operation specific skills using a series of purpose, designed fabric exercises. Example of some of the basic sewing exercise are- straight sewing, straight sewing with matching notches, straight sewing with back tack, right angle corner sewing, curve sewing. Learn more about exercises (slideshare.com)

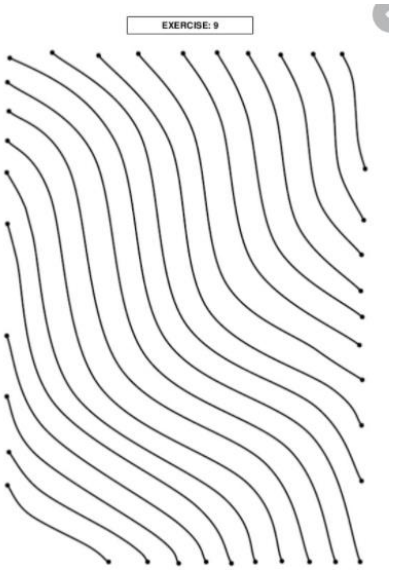


Figure 128: Sewing exercise for curved line stitching (Source: Juki operator training manual)

11 Sewing Machine

Sewing machines are commonly used equipment for sewing garment components. Industrial sewing machines differentiate themselves from domestic sewing machines by varieties of bed and feed type, computerised functions, the possibility of integrating the work aids, and are designed for more heavy-duty workload and working for longer hours.

Examples of Sewing Machines:

- Single/multi-needle industrial lockstitch sewing machine with or without trimmer
- Blind stitch machine
- Chain stitching machine
- Flatlock machine (cylinder bed, flatbed)
- Overlock machine (3 threads/4 threads and 5 threads)
- Single/double needle chain stitch machine
- Zigzag flatbed sewing machine
- Button attaching machine, Buttonhole machine
- Label/elastic inserting machine
- Bar tacking machine
- Hemstitch machine

Figure 129: Sewing machine parts

12 Sewing Thread

Sewing threads are one of the consumables in the sewing process, which passes through the fabric with the aid of a needle to form stitches. Sewing thread commonly used are 3-ply (occasionally 2 or 4 ply) yarns, specially engineered and designed to pass through a sewing machine rapidly. Three S twisted single yarns are Z twisted to form a three-ply sewing thread. The basic function of a thread is to deliver aesthetics and performance in stitches and seams.

Figure 130: Sewing thread spool

Sewing threads can be classified based on substrate or material of fibre, based on construction, and based on finish. For example, sewing thread made of poly-cotton, core spun, with anti-static finish.

13 Shade Sorting

Shade is the colour term for hues with difference in its depth (darkness or lightness). Fabric rolls from mills may have a difference in shade due to various processing reasons. Generally, fabric spread for one lot of garments, requires more than one fabric roll to produce the required order quantity. This roll-to-roll shade variation may cause a garment to exhibit a shade variation between its different panels when assembled from components cut from these different fabric rolls. Thus, the fabric inspection department sorts the fabrics (into A, B, C, …) as per the shade and groups the similar roles. Fabric from rolls different groups in a spread are separated by means of interleaving paper, which aids in easy identification and separation of the plies for bundling.

Fabric shrinkage and width are other parameters for fabric grouping.

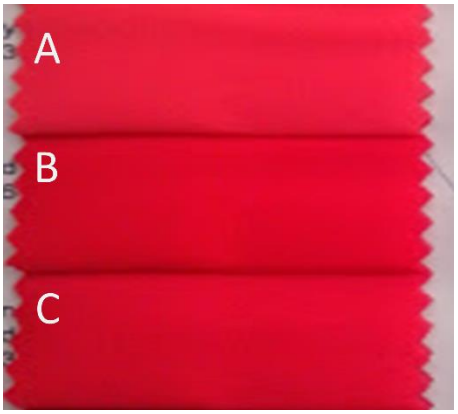


Figure 131: Sorting fabric shades

14 Shade Variation

Shade variation is one kind of fabric flaws. Fabrics with shade variation are the fabrics of same colour but having different depth of colours called shade. Slight shade variation between fabric rolls is accepted but the shade variation between parts in the same garment is not an acceptable quality garment. To avoid shade variation in garment, shade sorting is done prior to bulk fabric cutting and fabric layering is done carefully following the fabric roll shade band.

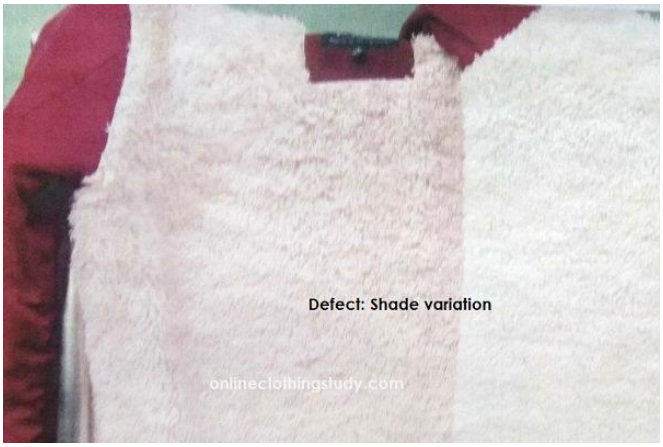


Figure 132: Shade variation in a garment

15 Short Shipment

Shipment quantity lesser than the purchase order quantity asked by the buyer results in a short shipment. Usually, buyers allow apparel manufacturers to dispatch short shipments with 2-3% shortage, but they are a loss to the manufacturer.

The reasons for short shipment could be due to wrong cutting in size ratio, wrong quality production, wrong cutting in shade variation, incorrect marks in garment, wrong measurement, wrong target, or weak security.

Formula used to calculate short shipment percentage –

Equation:

$$Short\ Shipment\ \% = \frac{(Ordered\ Quantity - Shipped\ Quantity)}{Ordered\ Quantity}\ X\ 100$$

Garment manufacturers can be penalized by the buyer for short shipment.

16 Shrinkage

Shrinkage means the length of the fabric gets shorten after wash or any other wet processing. Shrinkage is a common issue found in the textile fabrics, and is more concerning in knitted fabric and those containing elastic yarns. If there is a high shrinkage in a fabric and shrinkage has not been controlled before fabric cutting, garment specifications (measurement) will not match.

Prior to cutting fabric for bulk production, factories normally check fabric shrinkage percentage in washing. The shrinkage percentage needed to add to the production pattern. Otherwise, you would not get garment of correct fit and measurement could not match the specification sheet.

Figure 133: Fabric relaxation to even out tension in roll, giving uniform shrinkage

Read more on this topic:

- Fabric shrinkage calculation method
- Average shrinkage percentage of different fabrics

15 Size Chart

A size chart is defined as a 'table of data showing measurements either of the body or of the clothing attached with a size label'. It includes the basic dimensions and proportions of garments specified by a firm. The key body measurements mentioned define a range of garment sizes within a fashion line, and this is crucial to ensure fit consistency across the size increments. The general components of a garment size chart are header – indicating the type of garment, size label, and the individual point of measurement.

MEN'S SIZES (TOP WEAR)

CONVERSION					STANDARD MEASUREMENTS			
India Size	India Size	US Size	UK Size	EU Size		Collar	Chest	Sleeve
S	36	S	34-36	87	Inch	14-14.5	34-36	22-23
					Cm	36-38	86-91	56-58.5
M	38	M	36-38	91-97	Inch	15-15.5	38-40	23-24
					Cm	38-40	96-102	58.5-61
L	40	L	40	102	Inch	16-16.5	42-44	24-25
					Cm	40-42	107-112	61-63.5
XL	42	XL	42-44	107-112	Inch	17-17.5	46-48	25-26
					Cm	43-44.5	117-122	63.5-66
XXL	44	XXL	46-48	117-122	Inch	18-18.5	50-52	26-27
					Cm	45.5-47	127-132	66-68.5

Figure 134: Sample measurement chart

16 Skill Matrix

Skill Matrix is a chart or a database where operator's past performances on various operations are recorded in a systematic way for the future reference. The operator performance recorded here is as efficiency percentage. Skill matrix is also called as skill inventory of the operators. This matrix is very useful while allocating operators and balancing a line. Industrial engineers/line supervisors need minimum time to find and select most efficient operators for an operation from the pull of operators., and operators can be selected according to work content. It also aids when operation clubbing is required (for less work content works), skill matrix gives the information what all operation to be given to an operator. In case of an operator being absent, the supervisor can easily identify the most suitable replacement.

Emp. Code	Emp. Name	Operation	Mark Neck Trim & Run stitch	Join Shoulder	Insert Neck trim	Serge Edge	Bind Shoulders
		M/c	SNLS	4TOL	SNLS	4TOL	DNLS
9810	Radha		81	76		75	
9811	Seema		65	93	71		
9812	Roma					80	75
9815	Leela				76		65
9818	Kamal				74		
9820	Anil		76				

Figure 135: Operator skill matrix

⊕	Cannot perform operation
◒	Can do but require supervision
◒	Can perform without supervision but not meeting standard time
◕	Can perform without supervision and meeting standard time
●	Can perform without supervision, meeting standard time and teach others

Figure 136: Skill matrix labels

17 Skilled Operator

Skilled operators are those operators in the manufacturing unit, who show 'expected performance' at various types of work. The IE/ supervisors maintain a list of the same, which provides both a talent list for section/team staffing and a means of planning the growth of the skills of the workforce. In case of operator absenteeism, the role of a skilled operator plays a vital role in covering up for production loss (if any).

A multi-skilled operator may perform different operations of the same category with similarity of execution, given the same movements and same finger dexterity. The other categorisation of operators is unskilled/raw-skilled, and semi-skilled operators.

Wage	•Skilled operators are paid a higher salary than semi-skilled and low-skilled operators
Production	•Skilled operator can produce more garments
Quality	•Low quality garments are less likely from a skilled operator

Figure 137: Characteristics of skilled operators

Through a systematic training process, a low skilled operator can be upgraded as skilled operator.

18 SKU

SKU is the short for 'Stock Keeping Unit'. It is an alphanumeric code assigned to inventory that allows the manufacturer and buyer to track their stock/ product in inventory, and measure product sales. Another term associated with SKU is the SKU planning frequency. This relates to how frequently a firm plans production as a reaction to changes in forecast or in order demand. The frequency can be monthly, biweekly, weekly, or daily.

Figure 138: SKU (highlighted)

19 Sourcing

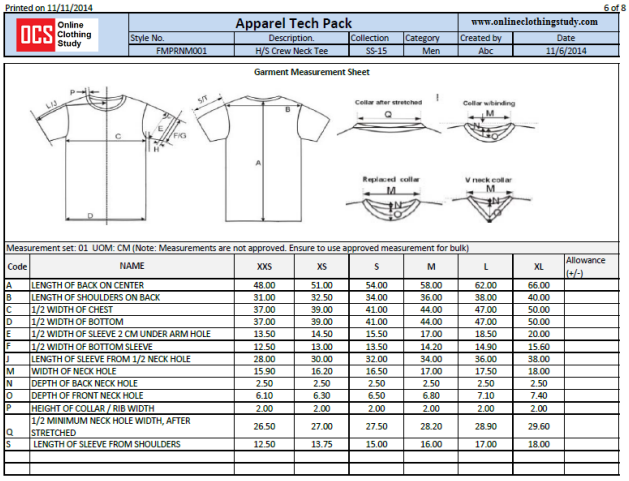
Sourcing in the apparel-manufacturing unit refers to the activities engaged in deciding from where and how the raw materials – fabrics, trims and accessories need to be procured. The sourcing team coordinates with the front-end merchandiser and suppliers to make raw material available in time before the PSD.

The responsibilities of the sourcing in charge are:

- Development of appropriate suppliers based on quality, price, MOQ, etc.
- Price negotiations with the supplier
- Dealing with supplier for quality related issues
- Raw material inventory management
- Dealing all documentation works like PO raising, making suppliers' payments, follow-up with the transporter and getting material in-house
- Developing fabric, trim reference library.

20 Spec Sheet

A document that contains a sketch of the garment design and garment construction details is called specification sheet or spec sheet or simply garment spec. A designer makes the spec sheet to communicate design detailing and how the garment to be constructed. A spec sheet includes measurements of point of measures (POM) of the apparel product/design. These details (specs) should be stated with minimum words. The numbers of units of measurements with plus-or-minus tolerance limits with reference to the aesthetic features that control quality standard need to be clearly mentioned in a spec sheet. Sometimes spec sheet may be corrected after sample development and checking the sample fitting on live model or on the dress-form.



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Apparel Tech Pack — www.onlineclothingstudy.com

Style No.	Description.	Collection	Category	Created by	Date
FMPRNM001	H/S Crew Neck Tee	SS-15	Men	Abc	11/6/2014

Garment Measurement Sheet

Measurement set: 01. UOM: CM (Note: Measurements are not approved. Ensure to use approved measurement for bulk)

Code	NAME	XXS	XS	S	M	L	XL	Allowance (+/-)
A	LENGTH OF BACK ON CENTER	48.00	51.00	54.00	58.00	62.00	66.00	
B	LENGTH OF SHOULDERS ON BACK	31.00	32.50	34.00	36.00	38.00	40.00	
C	1/2 WIDTH OF CHEST	37.00	39.00	41.00	44.00	47.00	50.00	
D	1/2 WIDTH OF BOTTOM	37.00	39.00	41.00	44.00	47.00	50.00	
E	1/2 WIDTH OF SLEEVE 2 CM UNDER ARM HOLE	13.50	14.50	15.50	17.00	18.50	20.00	
F	1/2 WIDTH OF BOTTOM SLEEVE	12.50	13.00	13.50	14.20	14.90	15.60	
J	LENGTH OF SLEEVE FROM 1/2 NECK HOLE	28.00	30.00	32.00	34.00	36.00	38.00	
M	WIDTH OF NECK HOLE	15.90	16.20	16.50	17.00	17.50	18.00	
N	DEPTH OF BACK NECK HOLE	2.50	2.50	2.50	2.50	2.50	2.50	
O	DEPTH OF FRONT NECK HOLE	6.10	6.30	6.50	6.80	7.10	7.40	
P	HEIGHT OF COLLAR / RIB WIDTH	2.00	2.00	2.00	2.00	2.00	2.00	
Q	1/2 MINIMUM NECK HOLE WIDTH, AFTER STRETCHED	26.50	27.00	27.50	28.20	28.90	29.60	
S	LENGTH OF SLEEVE FROM SHOULDERS	12.50	13.75	15.00	16.00	17.00	18.00	

Figure 139: Spec sheet from a tech-pack

Read more on this topic.

- The method of preparing spec sheet by your own.
- Difference between a techpack and a sec sheet.

21 Splicing

Splicing is the process of cutting fabric width wise and overlapping a certain length of the fabric in between the cut ends of a lay. Splicing may be required when fabric runs out from the roll and the next roll is to be continued, or to eliminate fabric defects during spreading. The length of overlapping is decided by referencing the splice mark. Splice marks represent the area which is adequate to allow a complete garment panel rather than sections only to be cut. These marks are placed along the control selvedge or on the edge of cutting table before spreading using reference of the marker.

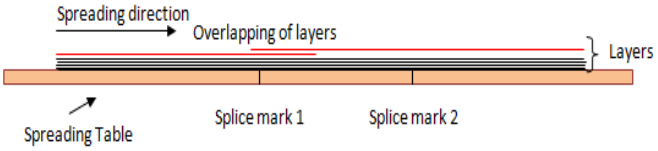


Figure 140: Fabric splicing

22 Spotting

Spotting is the process in garment finishing for removing unwanted dirt or spots or stains that may have appeared on a garment due to manufacturing process by use of certain chemical solutions. The process includes brushing the stains with the chemicals or uses a spray gun with solvent chemicals. The sources of the dirt, spots, and stains could be oil stains from sewing machine oil or cutting machine oil, watermark from washing, grease/ dust from material handling, dirt/ food oil from irresponsibility of workers, etc. Chemical solutions/ formulations such as PyratexLV, StreePRO, StreeTAN, Adco rust and stain remover are used. While spotting, the operator needs to take precautions such as wearing facemask, gloves while handling the chemicals.

Figure 141: Spotting equipment

23 Spreading

Spreading refers to the process of superposing layers of fabric as a preparation for cutting. The superposing plies of materials on a table is done in such a manner that it permits these plies to be cut simultaneously into garment components for sewing. Predetermined lengths of fabric and number of plies are spread on a spreading table. The spreading modes are related to fabric nap direction and fabric face direction. These are Nap-one-way (N/O/W), nap-either-way (N/E/W), nap-up-and-down (N/U/D), and face-to-face (F/F), face-one-way (F/O/W). While spreading, the objectives followed are - shade-sort fabric rolls, take care of ply direction and lay stability, align plies properly, maintain correct ply tension, eliminate fabric faults, smoothen fabric and avoid skewing or bowing.

Figure 142: Fabric spreading using auto spreader

24 Standard Performance

Standard performance or normal performance is the rate of output, which skilled workers will naturally achieve without over-exertion as an average over the working day or shift; if they know and adhere to the standardised method and that, they are motivated to do their work. This performance is denoted as 100 on the standard rating and performance scales. Standard performance is set as a benchmark to effectively rate people and for comparisons.

Characteristics of a 100% performance or normal operator:

- Smooth motions without hesitation
- No false starts or duplications
- Consistent, coordinated, effective rhythm
- No wasted actions or work
- Focused attention on the task

25 Standard Operating Procedure

Standard Operating Procedure (SOP) is the documentation of the step-by-step procedure to carry out the routine tasks by the various personnel in the workforce. It can also be considered as a checklist for the user to refer to, to perform their task in a way to obtain desired result and maintain consistency. The benefits of following an SOP are: consistency in output, right quality first time, better concentration on work by referring to steps on their own, reduced process delays as wait for instruction is eliminated, minimised miscommunication, and work place safety is maintained. Some tasks where garment manufacturers set up SOP are for trainability test, fabric inspection, cutting, daily factory shutdown, production, etc.

Task-4: Approval of Bulk fabric

Title: Bulk fabric approval process
Version: Original
Prepared on: 12/10/2015
Approved by: Anil Kumar
Responsibility: Merchandisers

Standard Operating Procedure

1. Receive fabric swatch card (3 sets) from fabric store on receiving of bulk fabric. (prior to PP meeting)
2. Merchandiser need to provide approvals to each fabric for Fabric quality, Shrinkage and spirality and Fabric Shade band
3. In case bulk fabric approval to be taken from buyer/buying house, merchant should do sample submission and follow up for the approval
4. One swatch card to be given to Store, One for production file and one for merchandiser
5. For rejected or Hold Fabric, decision to be taken by Merchant

Figure 143: SOP for Bulk fabric approval

Read a sample standard operating procedure for merchandising department.

26 Standard Time

Standard time is the more commonly referred term in work-study books and by manufacturers instead of SAM or SMV. Standard time is the time allowed to an operator to carry out the specified task under the specified condition and defined level of performance. Work measurement, or 'Predetermined time standard' codes can be utilised to establish 'standard time'.

The basic constituents of standard time are 'Observed Time (Time Study) + Rating Allowance + PF&D (Personal Fatigue and Delay) Allowances' Or 'Synthetic Time (PTMS) + PF&D (Personal Fatigue and Delay) Allowances'.

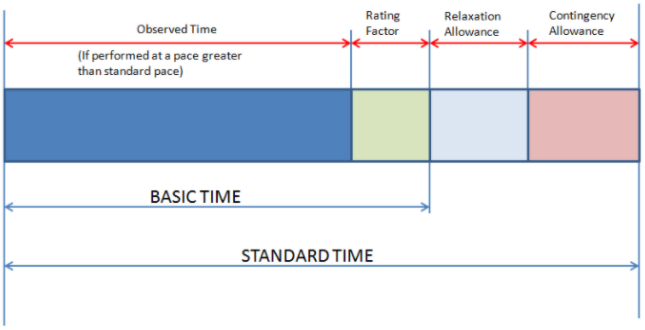


Figure 144: Standard time elements

27 Standard Worksheet

A standard worksheet is usually made for operators in the inspection department, spreading and cutting department, sewing department, and finishing department. This sheet contains work step description similar to an SOP, but contains additional details such as standard time for each work step description and the total time, pictures of how the work needs to be done, responsible person, safety measures, etc.

Date: __

Style desc.: Operation:		Takt time: Cycle time:			RPM:
Step	Work desc.	Time Elements			Picture
		Manual	Automatic	Total	
1					
2					
3					
Allowances: Total					
Possible safety hazards and protective measures:					

Figure 145: Example of a standard worksheet format

28 Start-up Loss

The drop in production when a new style is fed to a line is termed as start-up loss. The start-up loss could be categorised as set-up loss (time taken for machine setting), production loss (time taken for operator to adjust). It is also termed as changeover loss or shift-in/ shift-out loss. An IE is responsible to ensure that the start-up loss is minimised by doing the possible preparations in advance. Lean manufacturing tool - Single Minute Exchange of Die (SMED) is used for reducing start-up loss.

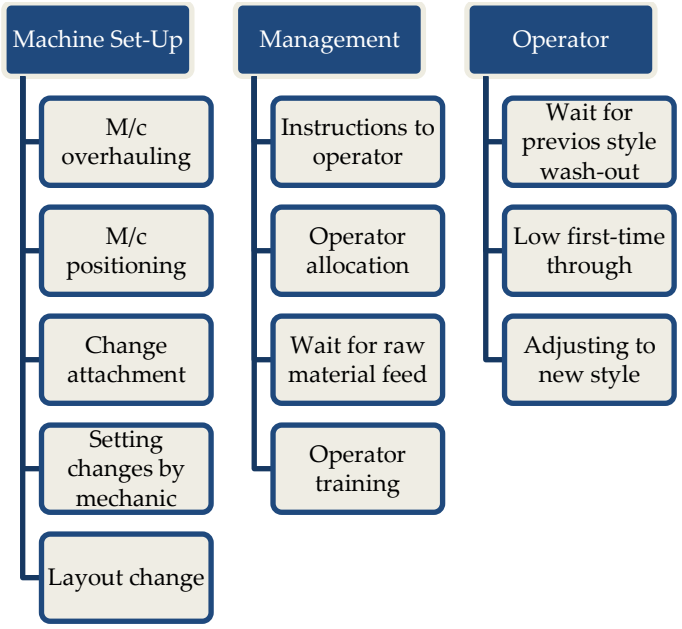


Figure 146: Some reasons for start-up loss

29 Statistical Process Control

Statistical Process Control (SPC) is a tool of quality control that includes data collection; statistical analysis using control charts; and application of corrective action for controlling various processes in the manufacturing cycle. Control charts are a visual tool to communicate whether a process is being performed under control or is out of control. For SPC, a sample is drawn from the output of critical operations at a fixed time interval and is evaluated against given specifications.

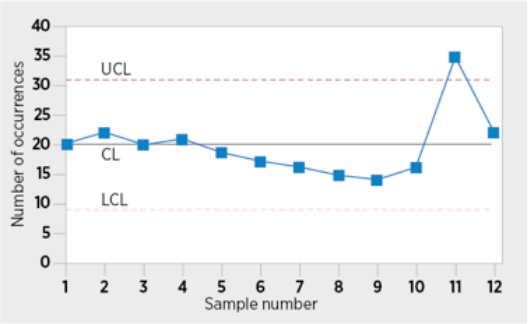


Figure 147: Control chart

If the values go beyond the control limits on the chart, a corrective action is initiated, if there is trend of the task tending towards out of control, the corrective action is warranted.

30 Statistical Quality Control

Statistical Quality Control (SQC) is a means of sample inspection employed for quality control that is designed to yield results freed from biases and not requiring inspecting 100% pieces produced. SQC comprises the set of statistical tools used by quality control professionals that are broadly categorised as descriptive statistics (mean, standard deviation, range and distribution of data), SPC, acceptance sampling (random inspection of a sample of goods). SQC monitors process outputs (dependent variables).

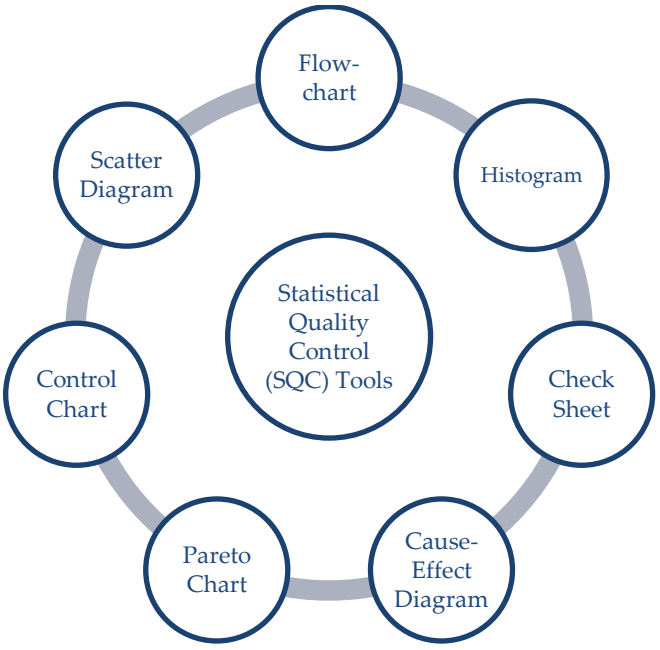


Figure 148: 7 tools of quality control

31 Stitch

A stitch is a loop structure of threads formed when one or more needle threads move through the fabric and inter-loop with a group of looping threads on the underside of the garment. Stitches are categorised under six stitch classes:

- Class 100: Chain stitch
- Class 200: Hand stitch
- Class 300: Lock stitch
- Class 400: Multi-thread chain stitch
- Class 500: Over-edge chain stitch
- Class 600: Covering chain stitch

The stitch could be formed by interloping (created by passing the loop of one thread through the loop of another sewing thread), intra-looping (created by passing the loop of one thread through the loop of the same thread), or interlacing (one thread passes over another thread).

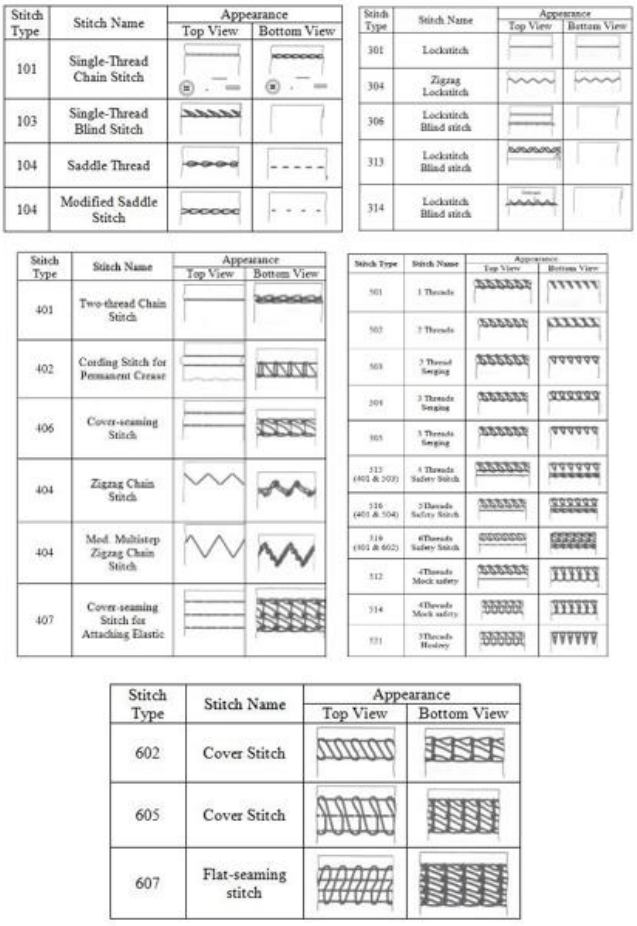


Figure 149: Stitch classes and stitch appearance

32 Stitches per Inch

Stitches per inch (SPI) or stitch count is the total number stitches in one-inch length of the sewn portion of the garment. SPI has a direct influence on the seam strength, the stitch appearance, and the seam elasticity on stretch fabrics. To measure SPI, count the number of lengths of thread found within one inch. Read the SPI calculation method.

Figure 150: A tool used for measuring machine SPI

33 Strike-Off

Strike-off term referred to a fabric swatch prepared for print approval for print design (artwork) and colours. Print strike-off is send to buyer for approval of print artwork prior to the bulk printing on the garment panel or on the fabric. Print artwork design, colour and shade, size of artwork, print sharpness are usually checked for approving the strike-off.

Strike-Off Approval Form	
Date:	Print ref #:
Supplier:	Fabric ref #:
Region:	Technique:
Category:	Season:
Light Source:	Approved: Rejected: Comments:
Sample: 	

Figure 151: Strike-Off submission/ approval format

33 Style

Style is the characteristic or distinctive appearance of a garment. Manufacturer when making or selecting the specific types of apparel for seasonal collections uses the term 'style'. Each garment style is developed for a particular buyer. Different styles have specific pattern parts, make use of different fabrics, may have value added processes like embroidery, printing, washes and have a different way of packaging.

Styles are referred to by a style number that is unique to the specific style.

A 'style' is also called as 'Model' in European countries.

34 Style Changeover

Style changeover refers to the feeding of a new style in a production line after the completion of the ongoing style. Style changeovers have become frequent with the concept of fast fashion – a higher number of styles, but smaller order quantity.

Changeover time is measured from the last good part of the current part run to the first good part of the next part run. Method of style changeover time.

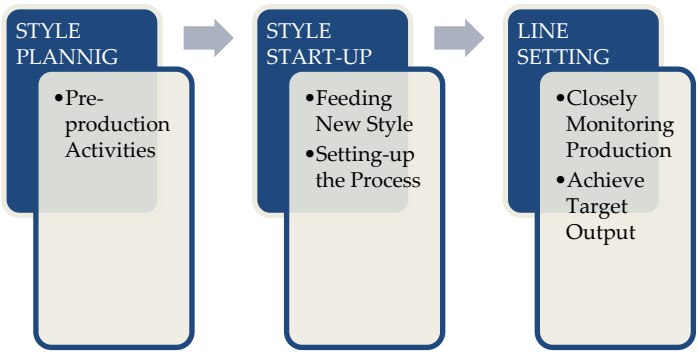


Figure 152: Phases of Style Changeover

1 Takt Time

Takt time is the pulse of the production system i.e. the pace of production needed to meet the customer demand. It depends on monthly production demand, if the demand increases the Takt time decreases, if the demand decreases the Takt time increases. It links production activity to actual customer demand and ensures all the production activity will be synchronized from first process to final assembly process. It also indicates to what extent the supplier is able to deliver the required amount of gears to the customer.

Equation:

$$Takt\ time = \frac{Net\ available\ working\ time\ per\ day}{Total\ daily\ customer\ request\ or\ demand}$$

Or

$$Takt\ time = \frac{Time\ available\ for\ production}{Target\ or\ required\ no.of\ pieces}$$

Where,

$$Time\ available\ for\ production = (No.of\ operators\ X\ Time\ contracted)$$

2 Tech Pack

Tech-pack is a document obtained from the buyer containing all required details for execution of the order/ manufacturing a garment. It covers all the details and technical information of a particular product style such as product style design, measurement details of garment, tolerances, type of fabric and construction, style code of a product, surface ornamentation details if any etc. It provides necessary information required for various departments. For example, tech-pack provides details required for marker planning, marker consumption etc. by the cutting department, and details such as construction details, measurements etc. for the sewing department.

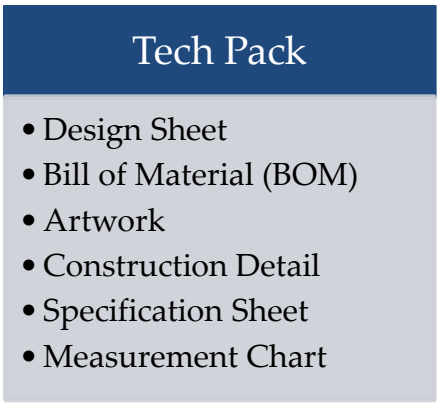


Figure 153: Constituents of a Tech Pack

3 Throughput Time

Throughput time is the amount of time the product takes to pass through the manufacturing phase, thereby being converted from raw materials into finished goods. It includes the actual processing time and the time a style waits to be processed ahead of each operation. Throughput time may be given from when the fabric is cut to when the garment is shipped, or a lines throughput is considered as the time required "from loading first bundle to the line to get first garment out from the line".

Figure 154: Improving throughput time helps manufacturers to meet customer deadlines

4 Ticketing

Ticketing is the process of marking/ sticking tickets on patterns that are cut from the fabric lay. Number stickers or colour coded stickers are pasted on the cut components corresponding to the number of the fabric ply from which the component was cut. The components with the same sequence number/ colour code will be sewed to make one garment. It is an essential preparatory activity for sewing and bundling. This numbering helps to eliminate any confusion of the components and prevent the joining of components with different colour shades. Ticketing is done manually, using a special hand-held numbering device (a sticker gun) with small labels. If a bar code system is used to monitor the production process, the bar codes are fixed on the bundle tags. It is also called as ply numbering.

Figure 155: Ticketing or ply numbering

5 Time and Action Calendar

Time and Action Calendar (TNA) is a project management tool used by production merchandisers that lists the order's key tasks or processes, and their respective planned date of action against each of them. For execution of the order on time, TNA helps in scheduling the daily tasks of the merchandiser and for monitoring whether they are on track or delayed. The TNA includes the following details: buyer, order no., style no., expected delivery, order quantity, ex-factory date, product description, lead time. The heads that are tabulated are: process, planned start date, planned end date, planned duration, actual start date, actual end date, actual duration, responsibility, and remarks. Read more…

Lilly Clothing Company

Time & Action Calender								Season:	
	Buyer	Monica		Order Qty.	2000		Ex-factory date (on PO)		
	Style #	404		Merchant	Aman		Ex-factory date(as per plan)		8-Jan
	Style Description	Dress		Recvd Date	20-Nov		Lead Time (days)		48
	Key Processes	Planned Start	Planned End	Duration (days)	Actual start	Actual End	Duration (days)	Responsibility	Remakrs
1	Order receipt (Buyer PO)	20-Nov						Merchant	
2	Consumption calculation	21-Nov						Pattern master	
3	BOM generation	23-Nov						Merchant	
4	PO issue for Fabric, trims	24-Nov						Store Mngr. (Fabric/Trim)	
5	Size set submission	25-Nov						Merchant	
6	Size set Comments	28-Nov						Merchant	
7	PP meeting	1-Dec						Merchant	
8	Production planning updates and circulation	11-Dec						Production Manager	
9	Fabric inhouse	24-Nov	8-Dec	15				Store Mngr. (Fabric/Trim)	
10	Trims Inhouse	24-Nov	3-Dec	10				Store Mngr. (Fabric/Trim)	
11	Pattern Grading	2-Dec	3-Dec	2				Pattern master	
12	Khaka making	2-Dec							
13	Cutting	11-Dec	12-Dec	3				Cutting incharge	
14	Beading/Sequence	16-Dec	19-Dec	4				Production Manager	
15	Embroidery	20-Dec	23-Dec	4				Production Manager	
16	Re-cutting/shaping	23-Dec	28-Dec	4	Online Clothing Study			Cutting incharge	
17	Fabrication/stitching	28-Dec	30-Dec	5				Production Manager	
18	Finishing	31-Dec	3-Jan	4				Finishing Incharge	
19	Packing	2-Jan	6-Jan	5				Finishing Incharge	
20	Inspection	7-Jan						QC	
21	Dispatch	8-Jan						Finishing Incharge	

Figure 156: TNA format (sample)

6 Time Study

Time study is a work measurement technique for recording the times and rates of working for the elements within specific conditions, and for analysing the data so as to determine the time necessary for carrying out a job at a defined level of performance. Time obtained from time study is called cycle time. Time study method is used further for calculation of SAM.

Style No. -			Machine -				Image		
Operation -			Attachment -						
Fabric -			UBT (Y/N) -						
	Operation Element Breakdown						Foreign Elements		
	Pick up & stitch 1st line		Stitch 2nd line		Check & Dispose		Waiting				
Operation Cycle	T	R	T	R	T	R	T	R	T	R	Description
1											
2											
3											
4											
5											

Figure 157: Time Study Format

7 Tolerance

Tolerance is the variation allowed from a specified value. It includes an upper limit as well as a lower limit. Setting tolerances levels is crucial for quality control operation. Too slack tolerance standard may allow excessively inferior merchandise to pass through, whereas standards that are too rigid and may result in acceptable merchandise being unnecessarily rejected. A tolerance is provided for each measurement, allowing production flexibility and fit quality control during production. Tolerances are set for fabric inspection parameters, trims inspection, measurement after sewing, shipment quantity.

GRADED MEASUREMENT SHEET

POINTS OF MEASUREMENTS	38	39	40	42	44	46		TOL
GENERAL								
CHEST (1" BELOW ARMHOLE)	20 1/2	21	21 1/2	22 1/2	24	25 1/2		1/4
WAIST (9 1/2" FROM ARMHOLE)	19	19 1/2	20	21 3/4	23 1/2	25 1/4		1/4
BOTTOM SWEEP STRAIGHT	20 1/8	20 5/8	21 1/8	22 1/8	23 5/8	25 1/8		1/4
FRONT NECK DROP (FROM HPS)								1/8
POCKET LENGTH								0
POCKET WIDTH								0
POCKET FROM SHOULDER SEAM	7 1/2	7 5/8	7 3/4	8	8 1/4	8 1/2		0
POCKET POSITION FROM CF	2	2	2	2	2 1/4	2 1/4		0
SHOULDER FORWARD	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4		0
ARMHOLE CURVE (HALF)								1/4
BICEPS (1" BELOW ARMHOLE)	8 1/8	8 3/8	8 5/8	9	9 1/2	10 1/8		1/8
SLEEVE LENGTH FROM SHOULDER	25	25 1/4	25 1/2	26	26 1/2	27		1/4
SLEEVE PLACKET LENGTH	6 1/2	6 1/2	6 1/2	7 1/4	7 1/4	7 1/4		0
SLEEVE PLACKET WIDTH								0
CUFF WIDTH FULL	9 1/4	9 1/2	9 3/4	10 1/4	10 3/4	11 1/4		1/8
CUFF CLOSED WIDTH - 1/2	4	4 1/8	4 1/4	4 1/2	4 3/4	5		0
CUFF HEIGHT	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2		0

Figure 158: Measurement grading with tolerances

8 TPM

Total Productive Maintenance (TPM) is a maintenance philosophy incorporating skills of all employees and focussing on improving the overall effectiveness of the facility with total participation of the workforce. It uses a combination of equipment selection, predictive maintenance, preventive maintenance, and equipment reengineering to prevent unexpected breakdowns. TPM's motto is "zero error, zero work-related accident, and zero loss". With the implementation of TPM, the factory expects to achieve the following: no breakdowns, no small stops or slow running, no defects, no accidents.

The eight pillars of TPM are:

- 5S (Sort, Systematic, Shine the workplace, Standardization, Sustain);
- JISHU HOZEN (Autonomous Maintenance);
- KOBETSU KAIZEN (Focused Improvement);
- Planned Maintenance;
- Quality Maintenance;
- Office TPM;
- Education and Training;
- Safety, Health and Environment.

9 Traffic Light System

Traffic Light System (TLS) is a quality inspection tool to reduce defect generation at the source in the garment sewing line. The quality supervisor carries out random inspection to measure the operator's performance level in quality. A visual communication system is used to depict the performance – usually, red for poor; yellow for improvement; green for good. This colour system also motivates the operators to produce acceptable quality products.

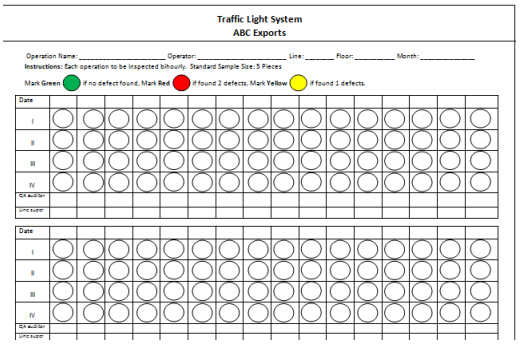


Figure 159: Format for Traffic light system data capturing

10 Trim Card

A trim card has all approved garment trims and accessories on a sheet/card attached. In the production floor, supervisors follow the trim card as a guide for identifying the right trims. A copy of the trim card duly approved by the buyers for each style sent to the vendors forms a reference for them.

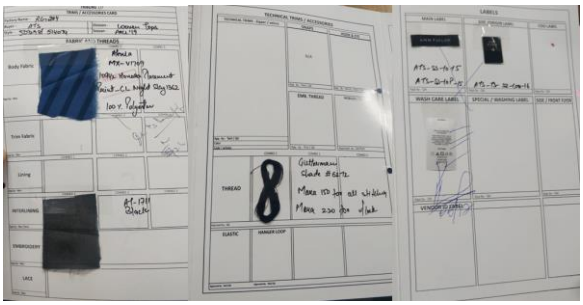


Figure 160: Trim card

11 Trims

Trims comprise all materials other than fabric utilised in the garment such as sewing threads, zippers, buttons, elastics, labels, etc. All the trims should be in house before commencing the bulk production. To maintain the right quality of trims as per buyer requirements, wherever possible, the trims are purchased along with certificates stating that the products conform to the required specifications.

Figure 161: Common trims for garments

1 Unit Production System

In a Unit Production System (UPS), the material flow is one single piece at a time and not in bundles. The operation starts at a staging area in the sewing section, the garment components automatically transport with the help of a hanging carrier from one workstation to other according to a pre-determined sequence. Garment components are loaded in a planned way from the staging area; hence, minimum material handling is required to deliver garment panels accurately in the order and manner that they will be sewn. This considerably reduces the WIP and manufacturing throughput time as compared to other bundle system of production.

Figure 162: Example of a Unit production system

2 Utilisation of Operator

Operator utilisation is the measure of how well the operators working time is on-standard time and the off-standard time is kept to a minimum. It is the time spent on productive tasks out of total attended time. This performance measure is usually done for a line to assess the supervisor's capability of managing the line.

Equation:

$$Utilisation = \frac{On\ standard\ time}{Attended\ time} X\ 100$$

1 Value Stream Mapping

VSM- Value stream mapping is one of the important tools of lean production. This tool is used to map the current state, analyse it, and design a future state for a series of events involving flow of material and information as a product makes its way through the value stream. The ultimate goal of VSM is to identify all types of waste in the value stream and to take steps to try and eliminate these. A visual representation with the use of symbols of every process in material and information flow is carefully drawn. Read more…

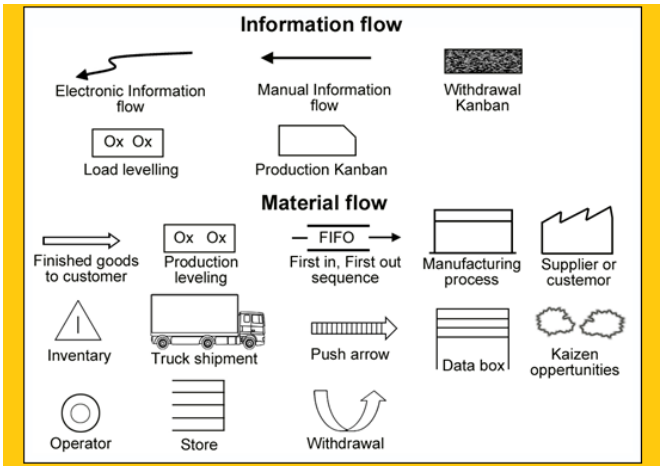


Figure 163: VSM diagram

2 Vendor

In the apparel supply chain, apparel buyers and buying houses call their garment suppliers as vendor. Vendors are referred to the suppliers. For garment manufacturers, fabric mills and trim suppliers are their vendors.

The term 'vendor' is commonly used in vendor management, vendor selection criteria, buyer-vendor relationship.

In accounting, vendors are termed as 'Party'.

Vendor Selection/ Evaluation Criteria

- AQL level followed
- Average order to ship ratio
- Certifications
- Compliance
- CSR activities
- Financial stability
- Good practices followed
- Machine details
- Operator skill-set and training given
- Order fulfillment cycle-time
- Payment terms
- Product quality
- Safety practices
- Technology or innovation

Figure 164: Buyer decides the criteria required for vendor selection/ evaluation

1 Waiting Time

Waiting time is a type of loss time on the production floor. When there is no work for operators, or the operators need to wait for the bundle, is called as waiting time. Waiting time of unfinished garments is the idle time of a work bundle when it waits for the next operation. Waiting time arises due to various reasons such as machine breakdown, misuse of automation, unbalanced workload, unplanned maintenance, long process setup times, upstream quality problems, un-level scheduling, poor communication, no feeding. Waiting time is also referred to as standing time.

The waiting time per operator can be calculated by capturing operator's bundle work time (bundle stop time minus bundle start time) and total time attended by an operator.

Equation:

$$Waiting\ time = (Total\ attended\ time) - (Bundle\ work\ time)$$

2 Warp and Weft

Warp and weft are the technical names of the yarns in a fabric. Woven fabrics are made of two sets of yarns - warp yarns and weft yarns. The yarn lies parallel to the fabric edge (selvage) is called the warp and the yarn lies perpendicular to the fabric edges is called weft yarns. During fabric formation, first warp yarns are drawn from a warper beam and the loom shed is formed. The weft yarns are interlaced by passing it through warp yarns shed from one edge to another one by one.

Check the comparison Warp Vs Weft.

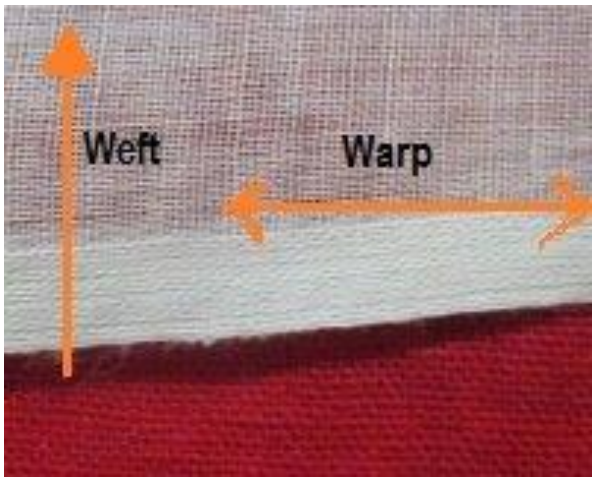


Figure 165: Warp and weft in fabric

3 Weave & Woven Fabric

Weaving is a process of making fabrics thorugh interlacement of two sets of yarns - warp and weft yarns. The fabric thus formed is called woven fabric. The interlacement of warp and weft can be done in many different patterns – which are called as **weave patterns**. The common weave pattern are plain weave, matt weave, twill weave, satin weave, baseket weave, jacquard patterns etc.

Read the different types of weaves in woven fabrics with images.

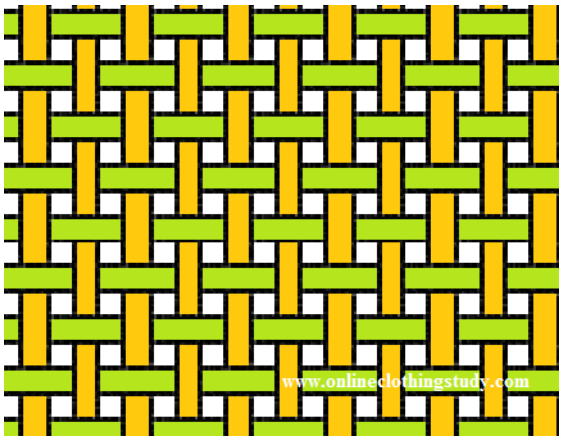


Figure 166: Plain weave (1 up 1 down)

4 WIP

Work in progress (WIP) refers to the pieces of semi-finished items which are transported from one workstation to the other, waiting to be worked upon for its completion. It can be measured as the time the product is under work in progress stage as well. A reasonable level of WIP should be maintained. Higher levels of WIP add to production costs, and lead to longer lead times. A very low WIP will not give the supervisor sufficient time to react to a breakdown. WIP can be managed by production planning, trims control, production build-up, line balancing, cut-flow control.

Style Wise WIP Report

Style No.	Total Cutting Quantity	Total dispatch to Sewing section	Cutting WIP	Total loading to Sewing lines	Total output	Sewing floor WIP
ABC	3000	2500	500	2500	1500	1000
ABD	4000	2000	2000	2000	1500	500
ABE	2000	1000	1000	1000	800	200
Total	9000	5500	3500	5500	3800	1700

Figure 167: WIP Report (Sample)

Read more about WIP report making and WIP report template in this article.

5 Work Aids

Work aids are additional tools/ devices provided to the workstation or machines to relieve the operator of some of the handling associated with sewing operations. They may be built into machines, added to them afterwards, attached alongside or made use of in resourceful ways as required. Work aids improve productivity, improve, or maintain quality standards, reduce operator training time, and minimise fatigue for the operator. Examples of commonly used work aids include tools for guiding or folding materials, for trimming threads and other components from garments, and for stacking the work after sewing.

Figure 168: Elastic band puller (attachment)

Figure 169: Piping and binding attachment

6 Work Content

Work content, as per ILO is the amount of work "contained in" a given product or a process measured in "work-hours" or "machine hours". The basic work content is the irreducible minimum time theoretically required to produce one unit of output. The work content of a garment could increase due to design complexities, improper utilisation of materials, inefficient methods of manufacture or operation. According to the work content of a style, daily production target can be estimated, operator requirements can be calculated, and can aid to balance the line.

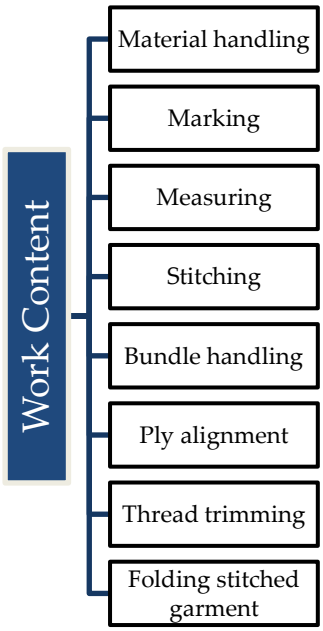


Figure 170: Elements of work content in garment sewing

7 Work Cycle

A work cycle is the sequence of elements, which are required to perform a job or yield a unit of production, which may be repeated or occasional.

The elements of a work cycle are:

- Repetitive elements- occurs in every work cycle of an operation
- Occasional elements- may occur at regular or irregular intervals
- Constant elements- basic time remains constant whenever it is performed
- Variable elements- basic time varies in relation to some characteristics of a product, equipment, or process
- Manual elements- performed by a worker
- Machine elements- performed automatically by any machine
- Governing elements- occupies a longer time than any other element which is being performed concurrently
- Foreign elements- observed but does not form a part of the operation(s) being studied

8 Work Study

Work-study is the systematic examination of the methods of carrying on activities, analysing them, and proposing improvements and setting standards. It aims at examining the way an activity is being carried out, simplifying or modifying the method of operation to reduce unnecessary or excess work, or the wasteful use of resources, and setting up a time standard for performing that activity. Through work-study, it is a function of the work-study officer to provide management with information to help the efficient and productive running of the factory.

For the apparel production students and industrial engineers, work-study is necessary study topic. A very popular book on work Study "Introduction to Work Study by ILO". The Cover page of this book is shown here.

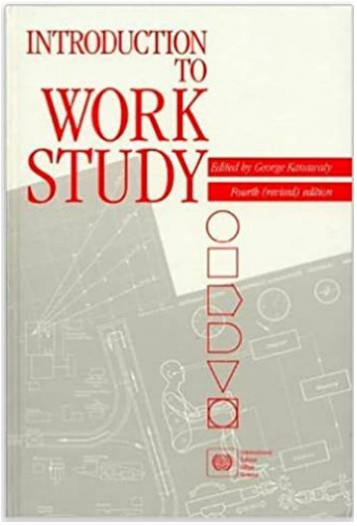


Figure 171: Book cover page 'Introduction to Work Study'

9 Workstation

Workstations are the set-up for carrying out operations/ tasks in the production of a garment. A sewing line generally contains sewing workstation, inline inspection table, end-line quality checking workstation, and finishing and packing workstation.

Elements of standard workstations are –

- Sewing workstation:

Sewing machine, Standard work sheet, Machine service card/ tag, thread holder, thread trimmer, dustpan and duster, dustbin, Vacuum, Cycle time and SAM card, Technical specification sheet

- Quality checking workstation:

Inline defect analysis report, Measurement sheet with allowances and directions for measurement, Standard worksheet, Trim card, Style and technical comments sheet, Sample garment, Defect sticker, Quality audit report, Good garment bin, defective garment bin, reject garment bin.

- Packing workstation:

Packing trim card, Master trim card sample, Garment sample, Standard work sheet, Price ticket attaching gun, Tape board (to remove loose threads), Carton, Hourly production review report

10 Workstation Layout

Workstation layout refers to the arrangement of the elements on and around a workstation in the sewing line. The design of the workstation layout varies widely from one operation to another depending on the quantity of work, number of components, and type of machine to handle during operation. Some of the characteristics of a good workstation are:

- All components should be placed within the reach of the operator
- Work should be presented in a correct way for easy unbundling and quick pick up
- Operators must have enough space on the table to handle the garment parts
- Enough space in between two machines for operator movement.
- Use jig and folders where required
- Define a space for every element on the workstation
- Provide height adjustable chair

Figure 172: Sewing workstation

1 Yamazumi Chart

Yamazumi chart is a bar chart that shows the average cycle time (on Y-axis) for each operation (on X-axis) performed by the operators in an assembly line. It is a visual tool used within lean manufacturing to aid visualizing the various work elements within a process. The representation of the chart is in the form of stacked up coloured bars, each denoting a specific value. For example, time spent in non-value added activities (NVA), necessary non-value added activities (NNVA), and value added activities (VA) during an operation can be recorded in different colours, for better analysis, motivation, as a competition booster among teams for improvement.

The chart may also represent for comparison of the cycle times to the required customer output or TAKT time.

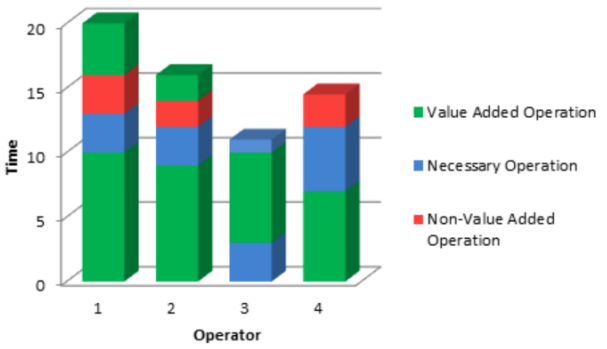


Figure 173: An example of Yamazumi Chart

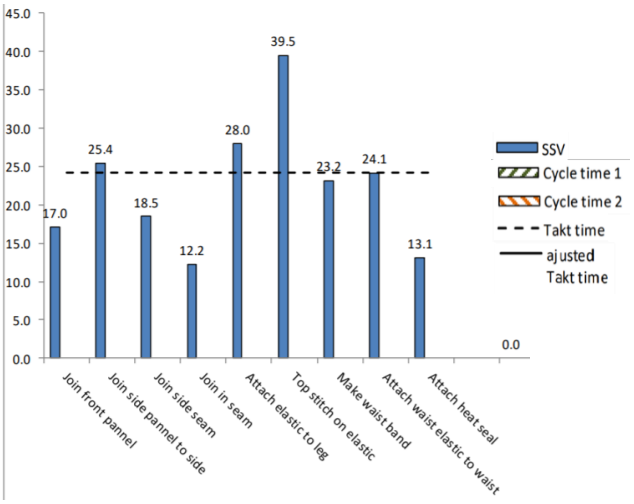


Figure 174: Yamazumi for comparison of SSV/ cycle time with Takt time

2 Yardage

A unit of measure for cloth. Yardage is the equivalent of the standard yard. The width of the fabric is measured and labelled in inches and the length of fabric roll is labelled in yard or meters. Some part of the world still prefer measurement in yardage rather than the metric system.

- 1 Yard = 0.91 meter
- 1 Yard = 36 inches = 3 feet.

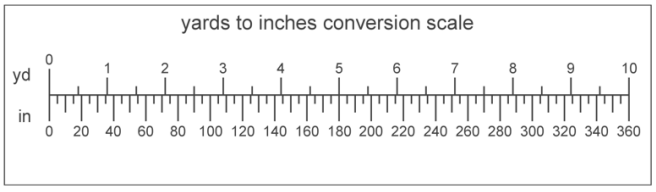


Figure 175: Yard to inches conversion scale

1 Zero Defects

Zero defect is a manufacturing strategy, where in the quality performance standard is to produce zero defective pieces by doing it right first time. The zero-defect approach is beneficial to achieve waste reductions and increase profits by eliminating cost of poor quality. The strategy suggests that the manufacturer change their perspective and realise the high cost of quality issues, monitor causes of defects, and proactively take improvement measures.

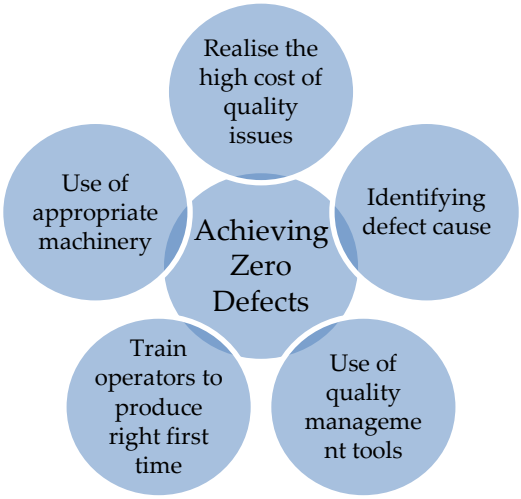


Figure 176: Implementing zero defect strategy

2 Zones in Garment

A garment is divided into zones to evaluate visual defects during quality audit. A garment can have three zones - A, B, and C. The number of zones is dependent on the product and its end use. In most of the cases apparel buyers, provide garment figures with marking zones in their quality manual along with a list of defects that fall under major or minor categories. A defect that is minor if it falls in zone B may be major if it is in zone A.

Zone A – the visual area of the garment is considered as a major area and of critical importance.

Zone B - the visual area of the garment is considered as a minor area of importance and is not critical.

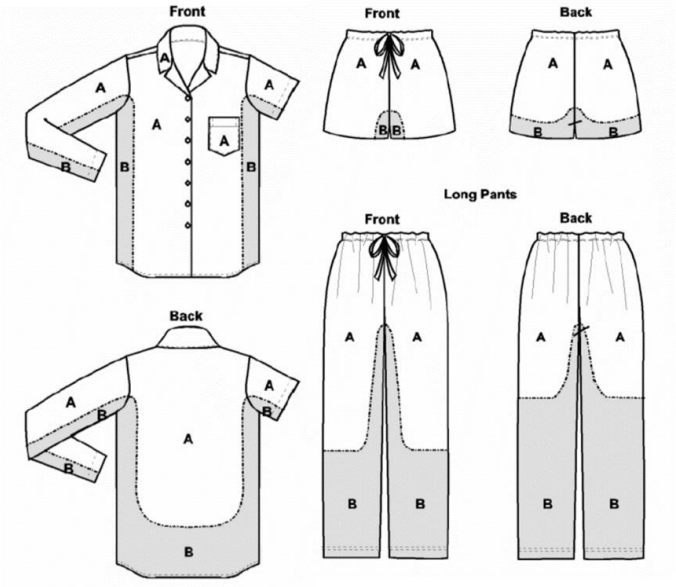
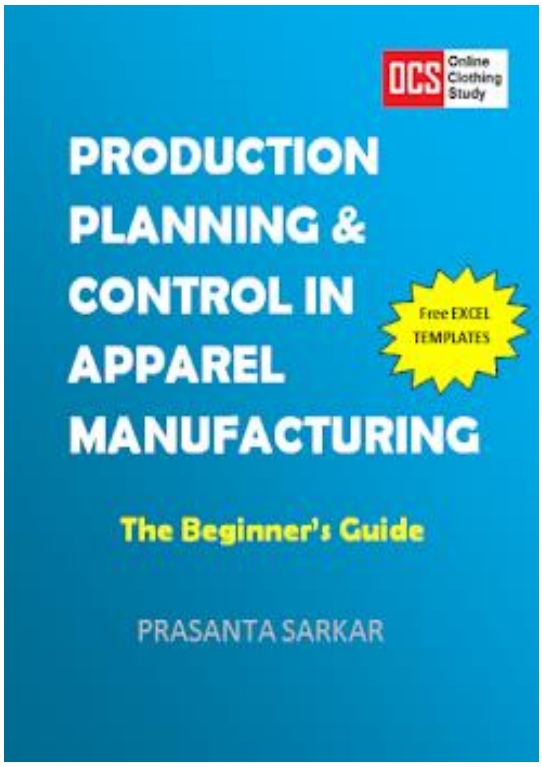


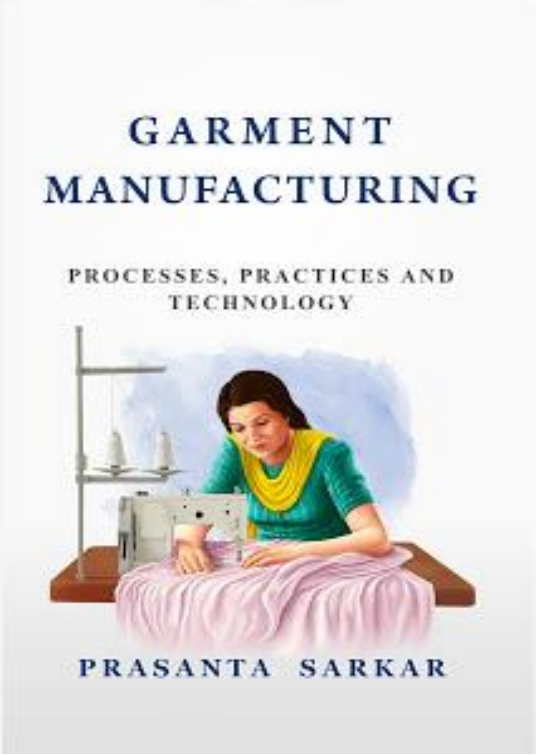
Figure 177: Zone in a shirt, shorts, and long pants

Further Reading

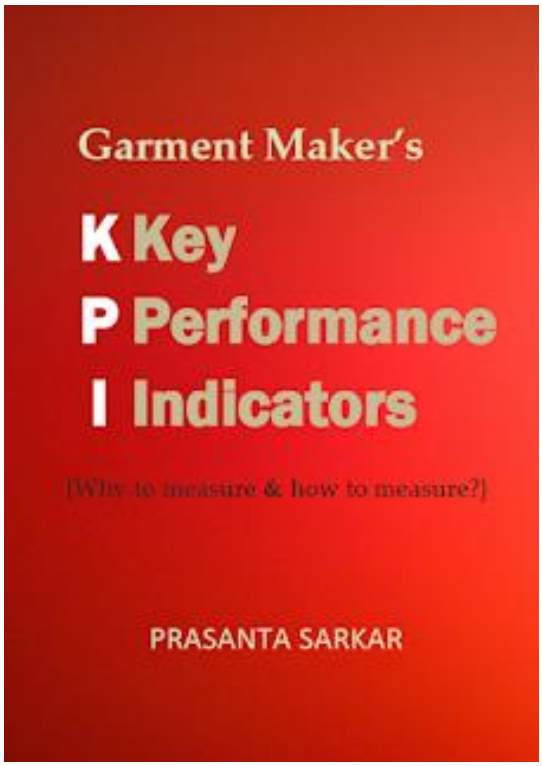
Here are some more books published by OCS. Do check them out!



Buying Details



Buying Details



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