HIGH FABRIC UTILIZATION

# THROUGH

CUTTING ROOM MANAGEMENT

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DECLARATION

I hereby certify that this work incorporated in this dissertation was solely carried out by me under the supervision of Mr. Nihal Wanigatunge, and this dissertation or any material incorporated in it, has not been submitted for any other academic qualification at any institution.

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(Candidate)

To the best of my knowledge the above statement is correct.

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Nihal Wanigatunge.
(Supervisor)

ABSTRACT

"High Fabric Utilization Through Cutting Room Management"

One of the growing trends of customer service is to reduce the total operational cost that has to bear when supplying services or goods. As a customer service trade, the garment industry which is a high caliber expanding and fast growing fashionable Industry, is also looking for the reduction of production cost. Hence the fabric plays a vital role in the garment trade; it represents a high percentage of the garment cost. Therefore through getting high fabric utilization will provide a better customer service. The Cutting Room is the place that consumes the fabric to make a value addition as cut panels. Therefore a proper planning and carrying out of cutting room operation is a must to reduce the fabric consumption. Collecting data while working in a cutting room is the method used by me to find the best and effective cutting operational methods. The results benefit to the Cutting Managers and related people to get a decision in advance. Therefore this dissertation can be used as a Management tool in garment industry.

ACKNOWLEDGEMENT

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CHAPTER 1

1. INTRODUCTION

Basic human needs of a civilized man are Food, Water, Shelter and Clothes. The Cloth requirement is the only element, which is not required by other living things. It seems that cloth is one of the symbols of the intelligence and civilization, where it gives a beauty and a security from hot, cold, and dirtiness too.

History of clothes goes back to where the human's civilization started. The Bible says that Adam and Eva started to wear clothes once they had eaten the prohibited fruit. That proves the statement, which says the cloth requirement started with the beginning of civilization. After they have civilized, when struggling to live in this fast moving world, the human needs became larger and larger, and very complicated. The spare time they had to prepare their clothes became smaller and smaller. Therefore people intended to wear ready-made garments. Eventually the tailors and the garment factories came into the scene. Thereby the garment trade became a fast growing fashionable industry, where a huge number of employees are employed and that much of huge material cost is spent.

Out of the total material cost, the fabric cost normally takes the value between 50% and 95% and it represents 20% to 70% of the total producing cost. A considerable percentage of this huge material cost mainly represents the type and the amount of fabric used. As,

Fabric cost = Fabric price per meter X   Fabric use

By reducing either the
- Fabric price or
- Fabric use.

The cost of fabric can be lowered.

The person who can reduce the fabric usage in professional manner is the Cutting Room Manager. Reducing the price of fabric is not something that he could do, but reducing fabric use is one of his main duties.

Therefore the cutting room management should be well experienced in high fabric utilization and should have a vast knowledge in various aspects in cutting room management. Hence, the author wishes to discuss in deeply on the "High Fabric Utilization Through Cutting Room Management".

The author is experiencing in a technically sound cutting room and thereby can get an advantage of computerized systems. Also the author's one of the main duties is to reduce the fabric wastage. The author has been selected this topic in the aim of identifying the most economical cut order plan and improve the methods used for high fabric utilization. Also this effort support to reduce the cost of a garment and a vast value addition in to the cutting departmental operations.

CHAPTER 2

2. OBJECTIVES AND METHODOLOGY

2.1 Objectives

The objective of this dissertation is to find out how the fabric behaves against the patterns and designs with it's uncertainty and how the cutting room operations are carried out with the avoidable and unavoidable barriers and with insufficient resources, in terms of meeting dead lines and avoiding all types of wastages, in the aim of high fabric utilization. As to support the objective some questions and some topics are listed below.

- Why customer requirements are important in the cutting room?
- Why supplier specifications are important in the cutting room?
- How does the fabric GSM help the cutting room?
- What is the importance of fabric width?
- Dealing with inconsistent and narrow widths
- Is the fabric weight important for cutting room?
- Is it necessary to know the fabric length of a roll?
- The effect of the fabric colour and quality for cutting room operations
- Importance of fabric shrinkage
- The importance of Chemical and physical properties
- The importance of fabric types and structure in cutting room
- Does the fabric fault make a significant damage to the cutting room?
- How to go ahead with fabrics with high fault rate?
- Calculation of the amount of fabric waste by fabric fault
- The role of shortage at cutting room
- The role of the pattern engineering for "higher fabric utilization"
- Does the marker making play a vital role in fabric saving?
- What are the advantages and disadvantages of cost marker methods?
- The type of external reasons, which will disturb the cutting room process
- Way of reducing fabric and overall cost through pattern and marker making process
- How to deal with excess and shortage fabrics at lay planning?
- What is the best ratio marker?
- How to select the fabric for marker making and cutting operations?
- How to achieve higher fabric utilization through spreading?
- The main cutting errors and how to overcome them
- The methods that can be used to store cut panels securely before stitching
- Method to utilize the existing resources by overcoming the day to-day problems
- The avoidable wastages

The above objective questionnaires were formed to achieve the object, by looking at the whole process in the cutting room. Aiming the objective questionnaires, by doing experiments without harming the cutting operations, has carried out the evaluations.

Moving towards the topic, high fabric utilization through cutting room management, the author likes to discuss on following points to study on how it support the high fabric utilization.

- Customer requirements,
- Supplier specification,
- Chemical & physical properties of fabric,
- Fabric types and structures,
- Fabric faults,
- Pattern engineering,
- Marker types,
- Cost methods,
- External process,
- Internal process,
- Resource utilization,
- Reducing wastage,

All the above points have direct or indirect impact on fabric utilization. That knowledge will help us to reduce the total cost in Cutting Room.

2.2 Methodology

The facts and data used in this dissertation are derived from multiple case studies conducted in the Cutting Room at Hiradaramani Mercury (Pvt) Ltd., at Katunayake.

To prepare this dissertation, the author had to carry out lot of experimental work while working in a cutting room to collect some data from inbound and out sourcing entities.

An extra support has been taken from the other cutting departments of the Hirdaramani group such as Hirdaramani factories at Seethawake, Maharagama, and the fabric suppliers such as M/s Ocean Lanka (Pvt) Ltd., Biyagama and Hayleys MGT Knitting mills at Horana.

Deeply studied the requirements of customers through e-mails and went through some of the Buyer's manuals and also the audit reports on Product safety.

Lot of pattern drawings were done to collect data, and lot of experimental amendments such as changing number of plies, ply lengths, method of spreading and cutting, were done without disturbing the day today processes at cutting room, also the author experiencing on day today operations, identified the difficulties of some processes.

Past records on garments' cutting processes were studied, and got known the instructions given by buyers and the feedback received from them.

Also used the knowledge gained from relevant seminars conducted by external entities.

Further dealt with suppliers to study fabric details and made factory visits to collect more details from other factories.

The author had to dealt with high range of various GSM's, widths, etc. therefore had to keep close connections with Merchandisers, Laboratory personals etc.

While working the author could get experience on fabric shortages, spreading errors, cutting errors, storing errors and other damages. It has been given a clear idea on theoretical and practical differences especially on shrinkage percentage.

The author did experimental reduction of fabric by fault and waste management. There were lot of opportunities to make pattern amendments resulting both good and bad feed back.

The author did the time study work by him self for certain activities. As well as he had to work lot with out side entities to over come process delays. The author had to interfere with other departments greatly to solve day today errors that would occur and to take decisions on fabric selecting, marker preparing, cut order planning, spreading, cutting and storing.

The data analysis includes bench marking with internal and external data.

CHAPTER 3

3. FACTORS AFFECTING FABRIC UTILIZATION

3.1 Customer Requirements

The customer in the garment trade is the end user, who wears the designed and manufactured garment. Therefore, thorough identification of the target customer and their needs will able to provide a demand end product.

The Cutting Room Management must know some of the special customer requirements that start from the cutting operations. First of all it is necessary to identify who is our customer. Normally the end user is the consumer. However in Sri Lankan Export garment trade, routine from the designer to end user flows as in the diagram below (figure3.1). Still the Sri Lankan garment factories are too far from the end user, and are producing garments as per intermediate buyer's requirements. *References 5 & 8.*
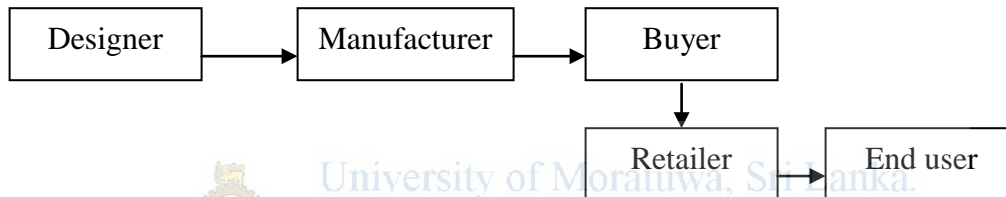
Figure 3.1 – Flow chart from Designer to End-user.

The end user used to buy a piece of garment, by looking at the labels, which are well known brands. Some brands are well established throughout the world. The Sri Lankan manufacturers also produce garments under some of the worldwide popular brands, under the supervision of immediate buyers.

Some of the popular brands in Sri Lankan manufacturers are, (source Board of Investment – Sri Lanka)

>Marks & Spencer (M & S)
>Bhs
>Levis
>Nike
>GAP
>Victoria Secretes (V& S)
>Triumph
>Liz Claiborne
>TOMMY-HILFIGURE
>Abercrombie & Fitch
>NEXT
>JONES NEW YORK

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The Designer designs to fulfill the end user's satisfaction and the requirements. But these requirements may or may not have a direct impact on fabric consumption. Sometimes the cutting room Manager could do adjustments (with out any harm) to the design and / or pattern to get better fabric utilization. Any way the end user's choice depends on various factors. Some of those are as follows.

3.1.1 Design and Pattern

This is the aesthetic factor, which attracts the customer with the very first vision. This totally depends on the designer's talents. Design and pattern should not be disturbed at any process in the cutting room. So there is no much opportunities to do any changes to pattern or design at cutting room, but there might have minor opportunities. Identifying the limited number of opportunities should be done very carefully. *Reference- 5.*

3.1.2 Season

The season mainly refers in European countries and North America, as they have to face huge climatic changes in their countries. As Sri Lanka exports mainly to USA & Europe, Sri Lankan factories also have to work according to these seasons. Basically there are four seasons namely, Winter, Spring, summer and Autumn.

The **Winter** season falls from December to March, which is very cold. People expect to avoid from the cold and snow by the apparel they wear. They go for Fleecy or Thicker garments during these days.

The **Spring** season falls from March to June, which is somewhat hot. In this season people needs some type of lightweight comfortable garments, to avoid the perspiration and the hotter climate

The **Summer** season falls from June to September, which is the hottest season, and thereby people look for very light and soft garments for these days to avoid high perspiration and minimize the energy loss from the body. Mostly they prefer high cotton content fabrics so that cotton absorbs sweat and cools the body surface.

The **Autumn** season falls from September to December, which is cooler, and the people again goes for thicker garments to stop the body heat loses.

Due to these seasonal changes, the end user wishes to get some protection from the climate. These seasonal changes come along with the festivals, like Christmas, New Year etc.

The wearer wishes
- To keep the body heat at normal (to get warm).
- To avoid from getting wet from the rain hail and snow.
- To avoid perspiration.
- To avoid from the direct sunlight UV rays.
- To minimize the energy loss from the body.

By considering these factors the Designer designs garments, by selecting the correct fabric for the correct season. As there are fabrics with different characteristics, which suits to each and every seasonal change, selecting a marker, number of plies, etc must be done according to the fabric types. Consequently the cutting room processes must be planned according to the seasonal changes and thereby higher fabric utilization can be achieved.

3.1.3 Customs

People of different countries, different religions, races, etc do have different types of customs, which affects their dress as well. Thereby their costumes and dresses should be designed accordingly.

For example some Muslim Ladies do wear a fully covered totally black dress to obey their religious regulations.

Every nation does have a national dress. In Sri Lanka it is a white shirt and a white sarong for men and saree for women.

Some people use to wear European full suit to show their living standard. Mostly this can be seen in third world countries although it is the national dress in European countries. Likewise when a garment is designed their customs too have to be considered along with maximum fabric utilization. The cutting room authority has some freedom to do changes to get a better fabric usage, without making any noticeable change to the out look of the garment and the custom of the relevant group of people.

3.1.4 Occasion

People like to choose their garments according to the occasion they wish to attend. For example,

- Everybody dresses well for parties.
- Light Night dresses at nights
- Casual wears for evenings.
- Smart wears at offices
- Uniforms at Schools, Offices, etc.
- Sports wear at sporty events.

Unnoticeable minor amendments to the pattern can be done for nightdresses rather than from party dresses without leading for rejection by the consumer.

3.1.5 Special Purpose

People do change their normal dress according to the special purposes. For example,

- Baby wears and maternity clothes.
- Rain coats, Fire coats, technical clothes, etc.

Extra attention on selecting fabric and designing should be aimed on fire coats, technical cloths etc. In such cases, availability to save fabric is limited. Thereby the authorization should try to maximum reduction of fabric wastage other than trying to save more material.

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3.2 Supplier Specifications

Normally fabric suppliers give only the important specifications, which are very important to cutting room management. *References- 6, 7, 8, 10 & 11.*

3.2.1 GSM
This measures mass per unite area; normally it measures grams per square meter and some times ounces per square yard. This is an important factor, which determines the fabric amount, cost, quality and the ply height of a lay.

3.2.2 Width
The fabric width has a high influence to the Marker efficiency. Normally fabrics come within the range of 90cm to 198cm width.

3.2.3 Weight
This is not a significant factor. However some fabric supplier deals with weight of a fabric roll where the length can be calculated by using the value of GSM and width. Weight of a roll must be controllable as per the cutting room perspective.

3.2.4 Length
Long lengths are efficient but it is limited by the weight and the production capabilities of the fabric supplier. Lengthy the fabric higher will be the fabric utilization.

3.2.5 Colour
This is one of the aesthetic factors. To identify a colour some suppliers use MSC (Marks and Spencer Colour code) code numbers, and some are Pantone colours, which are recognized worldwide. There can be colour variations in batch to batch, roll to roll and among the roll as well. Colour variation / shading likewise will lead to huge losses.

3.2.6 Quality / Finishers
The quality of a fabric defines the chemical and physical condition of fabrics such as characteristic of hand feel (texture) or appearance or both. This can be varied from supplier to supplier. This quality factor has a direct impact on the processes in cutting room especially when spreading, cutting etc.
Some of the commercially available fabrics with different types of qualities are,
> Flannelette, Fleece and Fur, etc.
> Tom, Aberdeen, Picasso and jenny, etc.
> Certain specific numbers are given by the supplier.

3.2.7 Shrinkage
The shrinkage percentage length-wise and width-wise is another essential specification of a fabric; it is an important factor for Marker preparation.

Fibre compositions, Structures, Ends and Picks per inch, Colour fastening factors, Flammability, Chemical & Physical reactions, are also some other specifications.

The above mentioned specifications have become very important factors in the cutting room at certain processes such as lay planning, fabric spreading, cutting etc. Therefore thorough knowledge on such will lead to high fabric utilization and finaly to the reduction of the fabric cost.

Figure 3.2 shows some fabric labels.
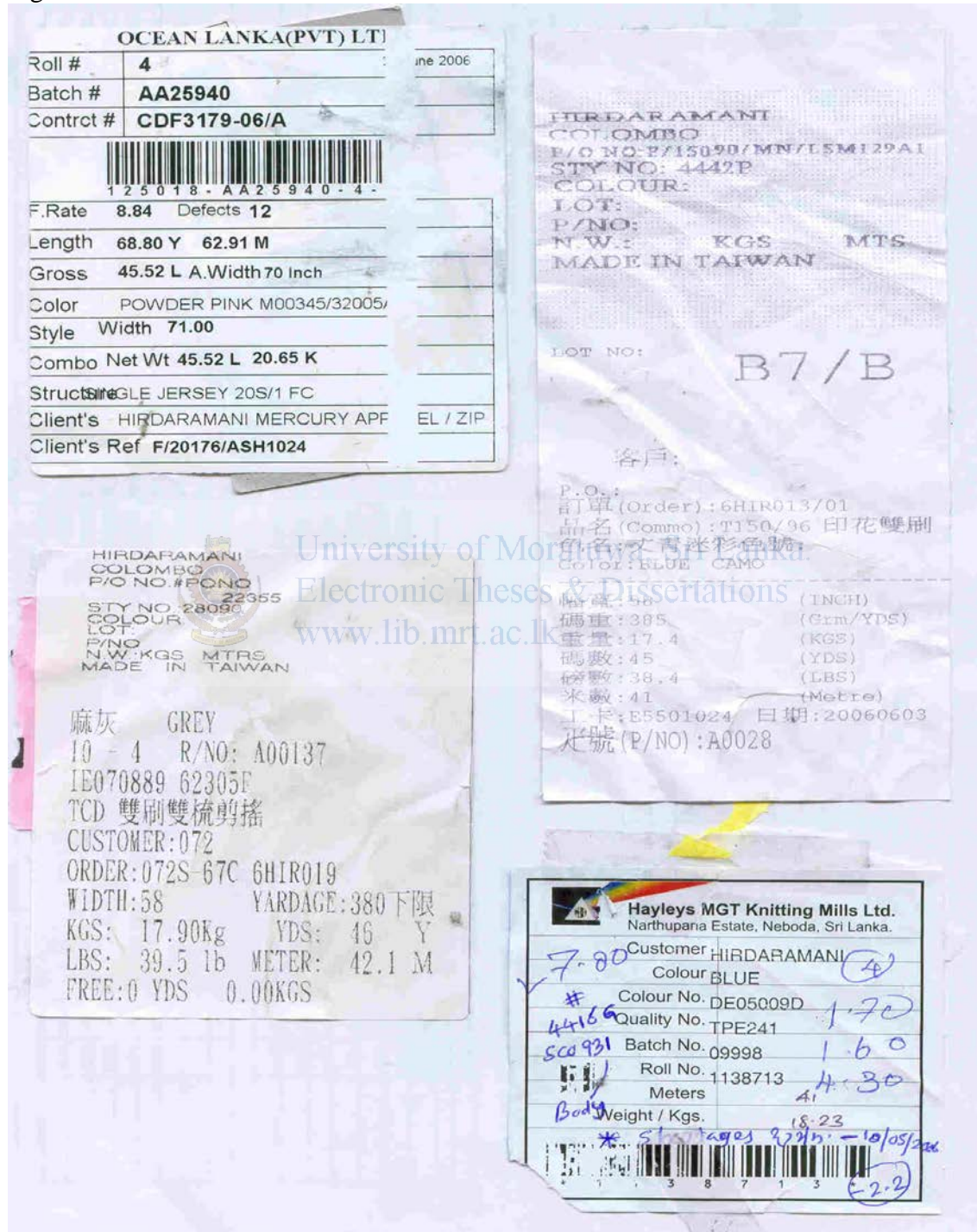
Figure 3.2 – Some fabric labels.

3.3 Chemical & Physical properties of fabrics

This is also a very deep area to study. Many factors related to fibres are important in terms of identifying the Chemical and Physical properties of the material to be used in a textile product. To enhance the quality of texture or other characteristics from a material it needs to add some finishers to the fibre content. These factors have direct influence to the fabric cost, quality, appearance, performance and the production aspects. Many of these facts may be specified by the fabric supplier and sometimes may not be provided eventually to the buyer (garment producer) unless specifically requested. The cutting room management when processing the cutting operations must know some of the properties given below. *References-6, 7 & 9.*

3.3.1 Fibre Content

The generic fibre types present and their percentage distribution in the product at the point of sale is required by such federal laws on the Textile Fibre product identification Act and the Wool product labeling Act. In addition fibre content helps to determine characteristics that are important in handling of materials, selecting a spreading or cutting method, temperatures concerned in pressing and finishing steps and product manufacturing and finishing steps. Fibre content is also critical in terms of many Chemical and Physical characteristics of the product those which are important to the customer.

The chemical and physical properties are important, especially in terms of Comfort aspects, Safety aspects, Health aspects, Physical aspects and General aspects. Some chemicals can be harmful to the customer's skin or make an influence to the life- time of the garment and some do provide a comfort to the customer.

3.3.2 Comfort Aspects

Comfort is complex combination of physical, physiological and psychological factors. Environmental factors and conditions can influence comfort significantly. Comfort describes how materials interact with the body and addresses how the body's functional environmental can be expanded. The relationship between comfort and materials includes how a material moves with or restricts body movement, retains or conducts body or environmental heat, absorbs or repels moisture, feels next to the skin, allows or restricts access of still or moving air to the skin, confirms to a three dimensional shape and conducts static electricity. Any step taken by the cutting Manager should not be affected to these aspects. Discussed below are some aspects of comfort,

3.3.2.1   Heat retention / conduction

One of the aspects of comfort is the way materials effect on the heat transfer, whether it retains or conducts body or environment heat. But when it is in fabric form it may shows difficultness to spread, cut or any other processes in cutting room. This must be handled very carefully and requires a special attention.

3.3.2.2   Moisture absorbency

Moisture absorption is not only absorbing water content in the air but also the ability to retain water. Sometimes this may be helpful in cutting operations, such as cutting, spreading, etc, as this property sometimes makes some sort of attraction between plies.

3.3.2.3 Water repellency

If the material refuses the water to absorb or transfer through or wetting, it says that material is water repellent. For examples, Raincoats and umbrellas are made of water repellant fabrics. This is an important characteristic for protective clothing, outerwear, portable shelters, and other applications in which a textile product is intended to protect an object from wetting. Most such materials are made from materials that, posses this desirable property by a combination of their physical structure and finish. This type of fabrics may slips out from the adjacent ply, thereby need an extra care.

3.3.2.4 Water resistance / proof / vapour transmission

In water resistance fabrics, water is not transferred / penetrates through and such water proof materials are usually coated with composite materials that have closed pores or very tiny interstices that are resistant to water regardless of its pressure. Also the vapour transmission property is very important especially for outerwear. In this type of materials water vapor / sweat is transferred from inside to the outer environment. Such properties may affect at spreading and cutting because of the chemicals that are applied sometimes.

3.3.2.5 Air permeability

This is also an important character for comfort outerwear, tents, blankets and other protective textile products and industrial products such as parachutes, hot air balloons, air bags, sails, etc. This type of materials may make some difficulties when cut with an automatic cutter.

3.3.3 Safety Aspects

Safety addresses the physical risks to which the user of the textile product is exposed. Main items on safety aspects are Flammability, Thermal protection, Chemical resistance, Impact resistance, Electrostatic property etc. When processing this type of fabric in cutting room, the existing properties of the fabric should have to be survived.

3.3.3.1 Flammability

Flammability is one of the main safety aspects especially on night wear and children wear and it refers to the time taken to remove the cloth before spread a fire. There are some standard times depends on the garment and the buyer / brand.

3.3.3.2 Thermal protection / Chemical resistance / Impact resistance

These properties are required by some technical cloths etc, which must be protected the wearer from heat, chemicals and shocks. These types of properties must be improved while processing such garments.

3.3.3.3 Electrostatic property

Electrostatic property is a measure of the capacity of a non- conducting material to acquire and hold an electric charge through friction or other means. Knowledge of this behavior allows us to determine materials, which are likely to develop problems of this nature and to take steps to minimize the problem in terms of productivity especially in spreading one ply over the other ply.

3.3.4 Health Aspects

The main health aspects occurred by materials are Allergens and Irritants, Formaldehyde, UV rays, Biological organisms, etc. Normally the health aspects are not changed due to cutting methods, but there can be some special instances.

Reactions with acids
Reactions with alkali
Reactions with oxyding agent
Reactions with reducing agent
Wash ability
Dry clean ability
Chlorine effect
Fire resistant (flammability)-16 secs etc
Biological organisms
Toxicity
Formaldehyde resin, hydril

3.3.5 General Aspects

3.3.5.1   Aesthetic
This refers the appearance of the material. The cutting management has to cut the material without harming the aesthetic factors.

3.3.5.2   Picks and Ends per unit area
Picks and ends per unit area are the general term that describes the number of components in the fabric per unit measure. Probably, the most common measure of this is number of yarns in the weft direction in one unit of measure (picks per inch / cm) and the number of yarns in the warp direction in one unit of measure (ends per inch / cm). This is also an essential factor when lay planning, because this says the hardness of the fabric.

3.3.5.3   Fabric mass per unit – GSM / Area density
This was discussed earlier.

GSM   =   Weight of the fabric (kg)
                Length (m) **X** width (m) of the fabric

3.3.5.4   Thickness
The thickness of a material affects comfort in terms of heat transfer, flexibility bulk and drape. The material thickness is very important in laying, cutting, storing, handling, etc. for example, a high thick material takes a large space to store than a thinner material.

3.3.5.5   Elasticity
When subjected to a force, the property of a material, which gets longer than the normal dimension and returns back to its original dimension is called the property of elasticity. These types of fabrics must be handled very carefully when spreading and cutting.

### 3.3.5.6	Plasticity

A material, which become longer than its original size even after releasing the force applied is called the property of plasticity and also called growth of a material. These types of fabrics must be handled very carefully when spreading, cutting, bundling and storing etc. Especially the dimension of a material can be changed after certain processes, such as

> After relaxing
> After cutting
> After stitching
> After washing
> After drying
> After dry clean
> After pressing

These factors must be considered and need to be added to the pattern dimensions before the cutting operation.

### 3.3.5.7	Tearing strength and Tensile strength

These are durability factors that describe the breaking force and Elongation. High values are required for hard and heavy-duty apparels. When cutting such materials the cutting room management has to decide the ply depth to cut.

### 3.3.5.8	Abrasion resistant

Abrasion resistance is also one of the durability factors, and is the ability of a textile material to resist erosion as a result of rubbing against a surface or other material. When spreading and cutting a low abrasion resistance fabric, there should be an extra care hence a fabric can lead to wastages.

### 3.3.5.9	Shrinkage

Shrinkage is one of the most undesirable factors that cause major concern of the Cutting room Management. This must be taken in to consideration when marker drawing, spreading and cutting. Some of the shrinkage types are listed below.

> Shrinkage lengthwise
> Shrinkage widthwise
> Shrinkage at printing
> Shrinkage at embroidery

If the garment is designed to do printing and or embroidering, the shrinkage allowance must be added to the pattern. Thereby it may leads to low fabric utilization.

### 3.3.5.10	Pile retention

Pile retention refers the degree to which cut pile yarns and others are held secure and intact to wear and resist pile loss as a result of pile pull-out. While processing such materials the cutting room management has to take necessary actions to avoid these.

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3.4 Fabric types and Structures

There are several types of fabrication methods. The technology is different from fabric to fabric. Fabric is classified according to the fibre composition and types of fibres are classified as Natural and Synthetic (man made).

In Sri Lanka the garment sector mainly uses fabrics consist with Cotton, Viscose, Polyester, Nylon and Linen etc. There are lots of other fibre types, which are not used in Sri Lanka largely (eg. wool) and some are rarely used. In future, this can be changed according to the trend and technology.

Mainly there are four types of fabric structure types.

Woven fabric
Knit fabric
Non woven fabric
Quilted or bonded

3.4.1 Woven Fabric

Woven fabric is constructed by interlacing width wise yarn (weft) with length-wise yarns (warp). Figure 3.3 shows a structure of woven fabric. *Reference – 1.*
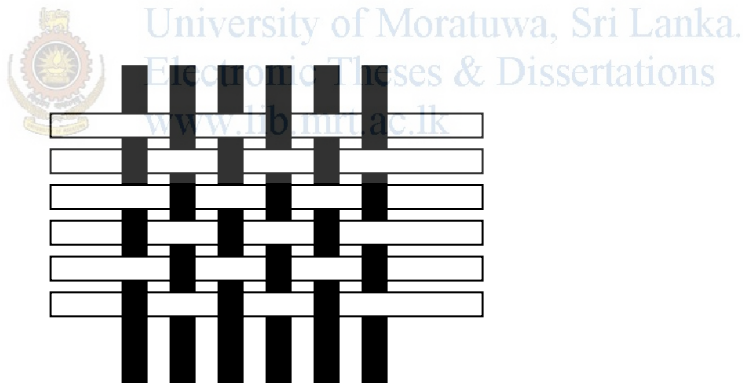
Figure 3.3 – Structure of Woven fabric.

Different types of weaving creates different types of woven fabrics such as Twill types, Satin & Sateen, Coloured Stripes, Coloured Check, Crinkled (Crepe), Puckered (Seasucker), Pebble effected (Georgette), Mockleno, Pique fabric, Bedford weaves, Double clothe fabric, Backed cloth fabric, Pile fabric (Valvet, Velveteen), Corduroy, etc.

Apparels made by woven fabric are Gents, Ladies & Children's Shirts, Jackets, Coats, Pants / Trousers / Jeans / Shorts, Ladies Blouses, Frocks, Dungarees, Pinafore, Some Linings, Pocket bags of apparels, etc. Normally woven fabrics are easy to handle when spreading, cutting etc, thereby woven fabrics do not create much problems.

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3.4.2 Knitted Fabric

Mainly, there are four types of knitted fabric

Single Jersey knitted fabric
Ribs (Double Jersey)
Interlock (Double Jersey)
Purl

3.4.2.1   Single Jersey

Knitted fabrics are formed by loops as in the figure 3.4. A yarn forms loops by going through a loop formed by an earlier step. *Reference- 2 & 3.*
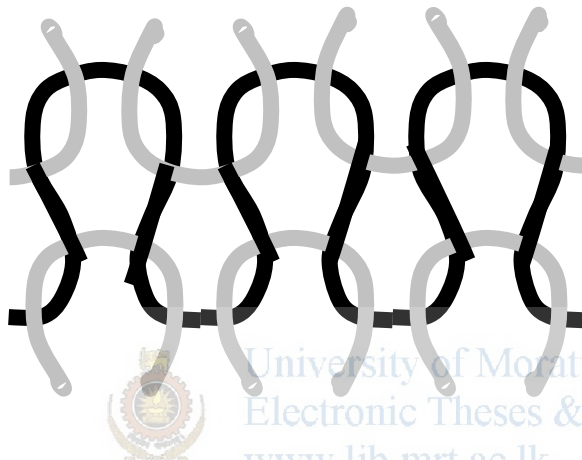
Figure 3.4 – Structure of Single Jersey Knitted fabric – face side view.

Single Jersey has a clear technical face side and a technical reverse side, where a "V" can be seen on face side and curves on reverse side. Such fabrics curl in to face side at lengths and curl in to reverse side at width ends.

Single jersey fabrics are used for T -shirts, Jackets, under wears, etc. Single jersey fabrics are also creating fewer problems at cutting room operations, but not so easy as woven fabrics.

3.4.2.2   Ribs

Ribs are formed as if two single jerseys kept together face to face with interchanging loops between the two layers. Both sides the appearance is same and it is look like the technical face side of a single jersey. When stretched a Rib a reverse side appearance of a single jersey can be seen among the wales. There are several types of ribs such as 1 X 1, 2 X 2, 4 X 4, 1 X 2, 1 X 3,……etc. Ribs are used for apparels where high extensibility requires, such as Jerseys cuffs, waistbands, and neckbands of apparel. Ribs show much difficulty at spreading and cutting, thereby it must be planned with an extra care. *Reference- 2 & 3.*

3.4.2.3   Interlock

Interlock is also another Double Jersey and used where less extensibility is required. Only the face side appearance is seeing, but not the reverse side appearance in both sides. The spreading and cutting is not as difficult as ribs. *Reference- 2 & 3.*

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3.4.2.4   Purl
According to literature, both sides of the fabric look like a reverse side of a single jersey. *Reference- 2 & 3.*

The author has introduced here only on weft knitted (Circular knitted) fabric where used for T shirts, Pants, Joggers, Jackets, Gowns, Under wears, Specially Children's wears, Sports wears, etc.

3.4.3 Non Woven Fabric
There are some non -woven fabrics but the usage of such fabrics is still negligible, (other than interlining) just as contrast parts, lining parts, etc. Most of non- woven fabrics are made out of synthetic fibres, hence it decreases the ply height of a layer.
For Example, Interlining, Mesh, Nets, felts, forms, etc. *Reference- 4.*

3.4.4 Bonded and Quilted Fabric
Pasting or sewing two types of fabrics form these types of fabrics. Normally these types of fabrics are thicker than others, thereby, it is rare to find lengthy fabrics, which causes to significantly higher wastage. *Reference- 4.*

Moreover the above discussed fabrics; there are some other fabric types and structures in literature. Examples, braids, laces, etc.
In future, there will be many other fabric types, those that can be identified and constructed using new technologies.

3.5 Fabric Faults

Fabric faults are defects in the fabric those, which are not required by the fabric consumer or the apparel producer, as it reduces the fabric usage significantly. There are two types of defects
1. Patent defects – which can be identified by an inspection.
2. Latent defects – which are hidden problems those that can be identified only after testing

Again these can be divided in to three types, critical defects, major defects and minor defects, which are classified again according to defect type, size, placement and the garments to be produced. *Reference- 6, 10, 11 & 12.*

3.5.1 Holes
One of the main problems coming with material is hole, which can be varied around 0.5mm and upward. Sometimes holes less than 0.5mm holes, pinholes are also considerable and it depends on the apparel, and the placement of the hole on the panel. All other fabric pieces with holes must be rejected, thereby fabric utilization becomes lower.

3.5.2 Missed yarns
Missed yarns can be seen in the material, which can be occurred at weaving or knitting. In knitting it is called a tuck. All missed yarn panels are rejected, hence lower the fabric usage.

3.5.3 Contamination / Foreign yarn
There are some foreign yarns in materials, which are attached to the material at weaving or knitting. This fault also reduces the fabric usage.

3.5.4 Slubs
This is an abnormal density of yarn that can be added at weaving or knitting, which would be highly highlighted in a garment and definite fabric wastage.

3.5.5 Skewness
Skewness is that the crosswise yarns (weft) form an angle other than 90° as it moves across the fabric (figure 3.5). This is highly highlighted in check, stripe and printed materials. If this occurs in a check material, then it fails. However in some cases this faulty fabric has to be accepted with some agreed compensation from the supplier.
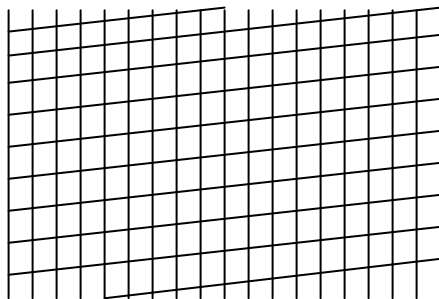
Figure 3.5 – An example for Skew-ness.

3.5.6 Bowing

Bowing is that the crosswise (weft) yarns form one or more arcs as it moves across the fabric (figure 3.6 and figure 3.7). This is also a critical problem in check and stripe materials. This fault has also to be accepted in sometimes, and such fabric should be cut bravely.
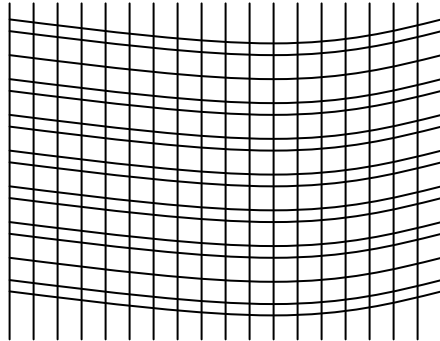
Figure 3.6 – An example for bowing.
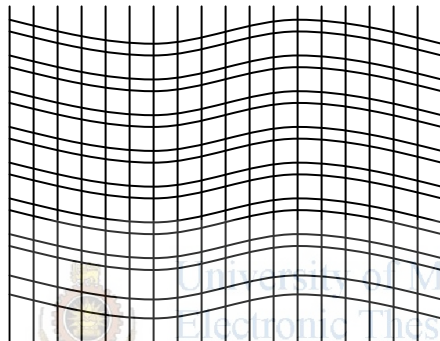
Figure 3.7 – An example for Bowing in both sides.

3.5.7 Brush effect

This is also a critical problem in napped fabric (fleece, velvet etc.). The direction of nap way is changed across and along the material. The brush effect makes colour shading and way out the garment. This would be a critical damage when marker drawing.

3.5.8 Barre

Barre is the optical result of physical or dye difference in the yarn, geometric difference in fabric, structure or any consisting of the differences. This problem is often seen as a subtle stripe or shade variation in material. This also makes marker makers a problem.
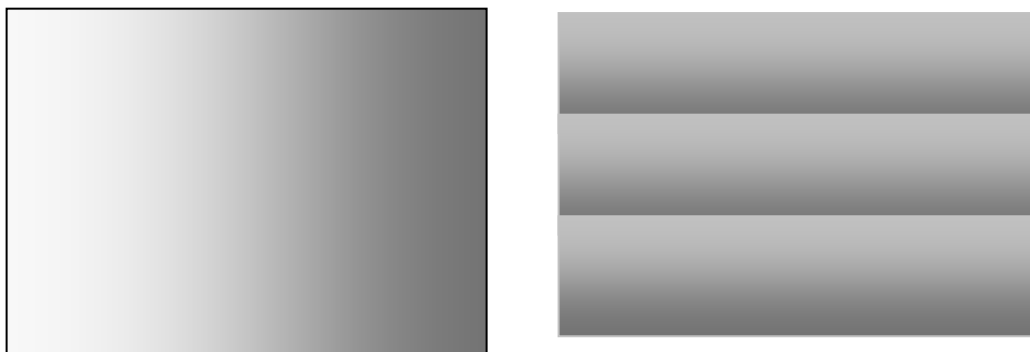
Figure 3.8 – Two examples for barre.

3.5.9 Shrinkage – non -constant shrinkage

All the fabrics show shrinkage to a certain extent. The shrinkage percentage in both ways must be considered when marker making. However cutting room management is in a trouble when the material shows non – constant shrinkage or if the said shrinkage does not occur after cutting / after stitching / after washing. If it does not shrink after cutting, then the cut panels have to be trimmed. If the material were over shrunk, then it would be a huge problem.

3.5.10 Growing

Growing is the other side of the shrinkage; the fabric grows if it subjected to a force. This is also a headache when materials in panel form, where it has to re-cut / trim the panels. The biggest problem of this defect is that panels become out of shape.

3.5.11 Colour shading / variation

The variation of the colour across and along a fabric sheet is another severe problem. Some times the colour shading exists among batches, rolls, even at distinct places in a roll. This defect would be negligible for sometimes.

3.5.12 Print defects

Print defects are also another problem where they have to be removed before stitching. Mainly this defect comes as lower or higher intensity of prints in some places, some non required patches, non-registration, misprints etc.

3.5.13 Un even repeats

The un-even repeat will be a significant damage if it has to match the repeats according to the buyer / design. The cutting room management has to follow a special spreading and cutting method to avoid this defect.

3.5.14 Embroidery defects

Some fabrics are received with already embroidered in roll form. A wrong or miss embroidering in such material is also a defect. It has to remove the fabric or the whole panel form in these materials to avoid this defect.

3.5.15 Un even width (inconstant width)

Another most common and major defect is width variation in a same roll. These rolls have to lay separately or lay short length markers. The markers must be drawn to the smallest width and thereby fabric fallout will be higher.

3.5.16 Crease line visible

Some tubular knitted fabrics have a visible crease line along the fabric. Sometimes, this is can be recovered by pressing and steaming. Some times it is difficult and cost consuming. In some cases the crease lines are in the middle but in some cases it spreads throughout the width.
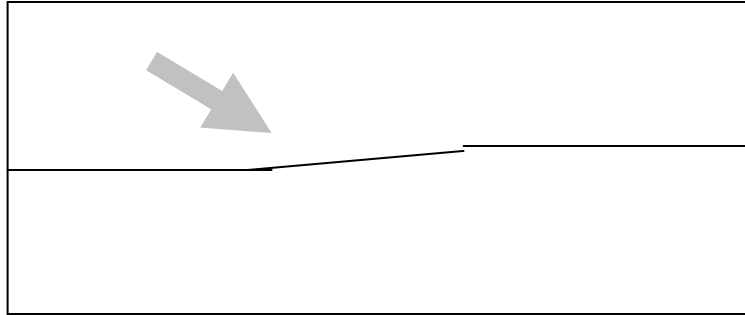
Figure 3.9 – A crease line in a fabric.

3.5.17 Shortage

A shortage means that roll doesn't have the stated length on the tag.

This is mostly common on knit fabric than woven fabric. Some times the inspection machines may show the length is correct, but the fabric at spreading stage there shows a shortage. Also the fabric supplier doesn't agree to check the shortage at spreading stage. This should discuss in deeply.

3.5.18 Stains

Some fabrics have some stain marks due to unsuitable storing or transporting. Some times these stains can be removed by using solvents. Or that has to replace the panels. Any how it also consumes extra fabric and or time.

The aim of the cutting room management should be to make the cut panels defect free and higher fabric utilization even though the fabric behaves as above.

3.6 Pattern Engineering

Pattern engineering is a technique, which can gain high fabric utilization and easy cutting methods. This can also be used to avoid the fabric faults in garments. *Reference- 14 &15.*

3.6.1 Corners rounding

This is one of the types of pattern engineering. If it found any difficulty (overlapping) to place a pattern part among others, which can get a significant saving on fabric, then one option is rounding corners. For an example,
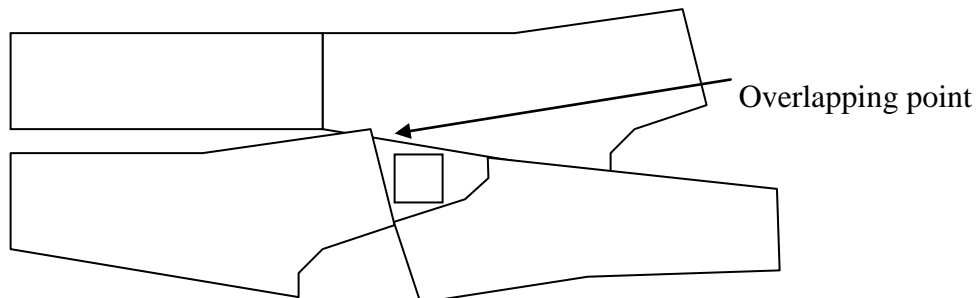
Figure 3.10 – An overlapping point in a Marker.

This corner (see figure 3.10) can be made round and get higher fabric utilization. However this must be done very carefully, without having a shape out of the pattern.

3.6.2 Reducing sewing allowance

Each panel has a sewing allowance of 5mm to 11mm. This allowance will be wasted at stitching. If it is manageable with a lesser sewing allowance than the normal allowance then it can be reduced by 1 mm or 2mm. But reducing sewing allowance in some areas would be harmful, thereby optimizing sewing allowance is one best solution.
For an example, a front panel of a ladies T shirt shown in figure 3.11.
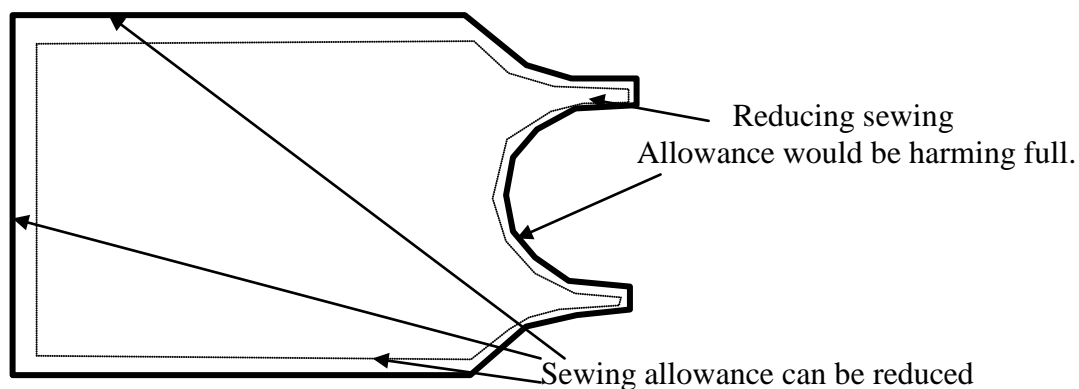
Figure 3.11 – Sewing allowance of a marker.

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3.6.3 Turning hidden parts – non-much visible parts

Normally all parts must be aligned with the grain lines in the fabric(way), if it is not specially required. Some times the customer requires a bias pattern or a width direction pattern. Commonly all parts are drawn in to the grain direction. In terms of higher fabric utilization, some panels especially, hidden parts, which are not much visible at the out look can be turned slightly as in the figure 3.12.
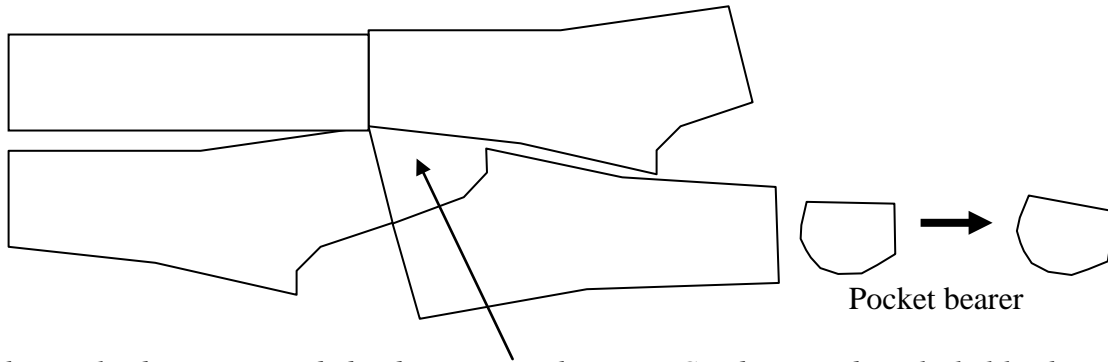
Pocket bearer

This pocket bearer is needed to be put in to this area. Can be turned it a little like this
Figure 3.12 – How to turn a part.

3.6.4 Adjusting dimensions

Adjusting dimensions must be done without noticeable change to fit and style. There is a tolerance given by buyer to the fit of each style. That can reduce the dimensions by taking the tolerance advantage. For an example, if it says a leg panel's length must be 90.0 cm with a tolerance of +/- 0.5cm, then the length can be reduced up to 89.5 cm in the aim of getting advantage of higher fabric utilization.

3.6.5 Parts separation & Merging

Sometimes there is a chance to divide some parts in to two or three. In the same manner it can merge two-three parts together. By both these ways the marker efficiency can be improved. A left side panel of a children's pant can be divided as in figure 3.13 and vise-versa.
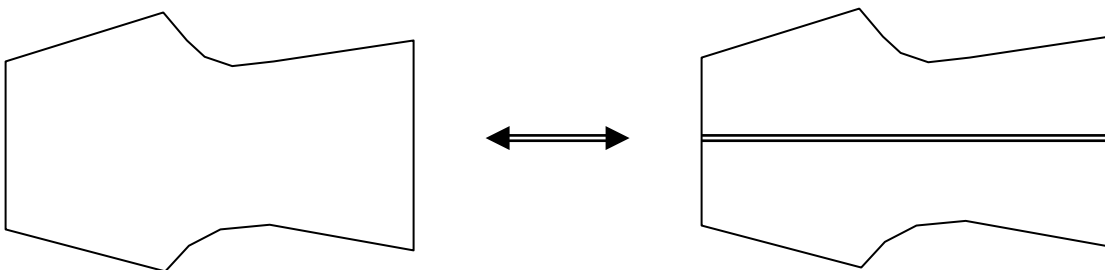
Figure 3.13 – Panel Separation and Merging.

3.6.6 Removing buffer

Normally a buffer space is introduced among panels, just 1mm. This buffer uses to avoid cut damages that can be occurred to adjacent panels while cutting around a cut mark or a notch or a critical cut. This can be removed by changing the cutting method by using expert cutters.

3.7 Marker Types

There are several Marker types, where a few of those are cost effective. Several marker types can be drawn for a particular style and some of those give higher fabric utilization, but most optimum marker gives the best results in terms of all other factors. When considering cost reduction, that should not stick only on to fabric, but also the other resources as well. Thereby an optimum marker must be decided. *Reference- 13.*

3.7.1 Half garment markers
This draws only a half of a garment. This marker can be applied only for garments, which have symmetric panels in left and right, and need to lay fabric face- to face, These are especially good for tubular form fabric. Also for those, which are slipping out against face side with the back side, due to surface structure or electrostatic effect. Mostly velvet fabric slips like this.
Figure 3.14 shows an example for a layer slipped and moved away from the bottom layer.
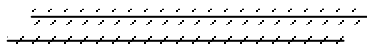
Figure 3.14 – An example of slipping of layers.

3.7.2 Full garment markers
This kind of a marker includes all parts of a garment, usually used for open width fabrics. Varieties of this type of markers are used widely in the garment sector. This can be divided in to two, as single size marker and multi size marker.

3.7.2.1   Single size markers
This marker contains markers for only one size of a garment. Normally these types of markers can be used for remnants fabric pieces.

3.7.2.2   Multi size markers
This contains two or more sizes of garment in one marker. These types of markers are commonly used in garment sector. This type of markers, gain high marker efficiency than the single size markers. There are three types of multi size markers, namely Sectional marker, Interlocking marker and Mixed multi size marker.

3.7.2.3   Sectional marker
This marker is made at least two distinct rectangular sections. Each section contains all the parts for a single size. These markers can be divided in to two or more single size markers in rectangular shape.

3.7.2.4   Interlocking marker
There is no demark-able straight line among the pattern sizes in the interlocking marker, but can be separated size wise.

3.7.2.5   Mixed multi size marker

This marker contains two or more sizes. The pattern pieces of one or more different garment sizes are marked together. This is the marker type that usually gives the best marker utilization. This is also called "Ratio marker".

There are several ways to make markers in this way, which depends on the marker maker, and there may be several options that give maximum benefit in term of fabric utilization, spreading and cutting methods etc.

All the above marker types can be divided again in to two categories, One-Way marker and two way (both ways) marker.

3.7.3 One-way marker

Whole the parts of all sizes are drawn in to one direction.

3.7.4 Two-way marker – Normal mixed marker

This is called as normal marker as well, and this is the common marker in the garment sector when the fabric does not show defects such as shade variations, non-unique brush level and barre effect etc.

3.8 Costing Methods

At the point of order acceptance, the cost of a garment must be calculated. As explained earlier a higher percentage of cost is represented by the fabric. The cutting room management must give the amount of fabric that is going to be utilized. Mean time the cutting room Manager must consider how to lower the cost, not only fabric but also cutting departmental cost.

There are lot of methods can be used to calculate the fabric cost. But some of the information may not be received at the stage of order acceptance, those are,

- Actual sample – to get a complete view.
- Fabric type – to get an idea on marker type, spreading and cutting method.
- Fabric width – to do the exact forecast.
- Fabrics shrink percentage – to fix the shrinkage allowances.
- Order ratio – to get an idea on base size.

The cutting room management must be strong enough to prepare the cost marker up to certain accuracy even in the absence of the above information. The cutting room management could calculate the cost portion which absorbs by fabric of a garment, by using the following methods. Anyhow minimizing the fabric representation is one of the key functions of the cutting room management. *Reference- 16.*

3.8.1 Single marker
In this method a single size is drawn in to a marker. Here the fabric width must be received from the supplier even though the delivering width would be different.

3.8.2 Double marker / Average marker
If the width of the fabric is enough to place two marker sets, then it can get the advantage to find a marker length for two garments hence for a one garment. It gives higher accuracy than a single marker.

3.8.3 Single marker from the ratio given
If the order quantity with the size break down is available then it can take the average size for the base size and draw a single marker, which would be very close to the actual marker.

3.8.4 Ratio marker
If the order quantity with size break down is available, then it is more suitable to draw ratio marker (actual marker) for the costing purpose also.

3.9 External Processes

The cutting room management has to deal with all the other departments in terms of having a smooth run altogether. Especially, flow of information in time to both sides would be a great benefit.
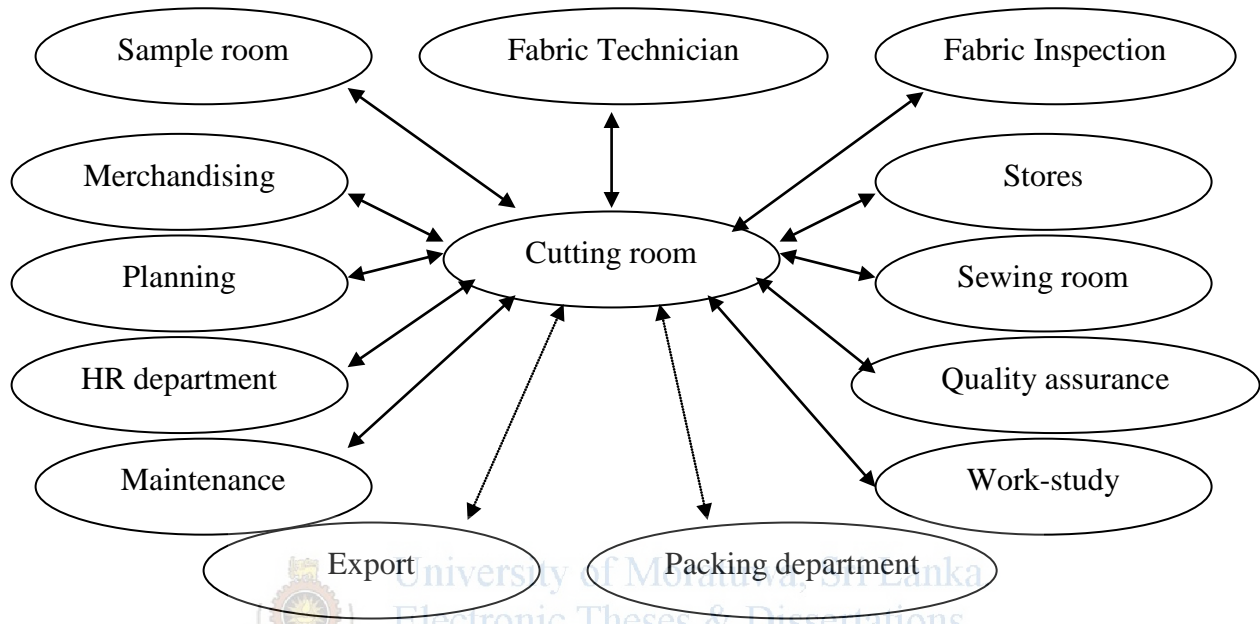
Figure 3.15 – Inter-department connections.

Sample room, Fabric technician room, Fabric inspection room. Merchandising, Stores, Planning, Work-study, Quality assurance, HR department are sourcing departments to the cutting room. Likewise cutting room is a sourcing department to Sewing room, Quality assurance, etc.

When dealing with day today work in the cutting room, it has to face a lot of incidents, lack of information, may be due to failure of another department's or buyers failure. These external failures may affect the cutting room operations, subsequently, to the sewing room. The cutting room management must try to avoid any failure to reflect to the sewing room.

Figure 3.16 – The Cutting room process should be.

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3.10 Internal process

Sketch
Size chart
Order details
Fabric details

Pattern for costing

Marker making for costing

Costing

Order acceptance

Pattern making

Lay planning

If any amendments

Marker making

Fabric receiving

SPC check

Trial cut

Spreading

Ok.

Proceed Cutting

Bundling

Embroidery / print

If embroidery / print to be done

Numbering

Quality inspection

Cut storing

Panel sorting

Failed

Issue to sewing

Fusing if necessary

Figure 3.17 – Internal process flow chart.

3.10.1 Pattern and Marker making for Costing

This is the stage where the cutting room management starts its work for an order. As explained earlier he may or may not be equipped with all details that require to prepare cost marker. This should not be different from the actual marker, but there would be some differences. Most suitable cost marker is the ratio marker, which prepared with the actual ratio. *Reference- 16.*

3.10.2 Pattern and Marker making for Production

After confirming the order and after the fabric receipts the cutting room management has to prepare the patterns and markers for production.

3.10.3 Lay planning

Lay planning is another task that have direct relationship with fabric utilization. Once the patterns are ready the cutting room management must calculate the possible cut quantity from the received fabric.

3.10.4 Fabric receiving

According to the lay plan the fabric should be selected from the stores for spreading. This fabric should have same characteristic for a single layer (set of plies).

3.10.5 Fabric spreading

Spreading can be done by manual or automatic machine. There are lots of advantages when spreading, by an automatic machine.

3.10.6 Cutting

There are several ways of cutting by using manual and automatic machines and this is one of the main operations at cutting and must be carried out very carefully with experts.

3.10.7 Bundling & Storing

A proper bundling and storing method must be adhered at cutting room, which an easy identification and traceability exists.

3.10.8 Numbering

This is one of the trace-ability methods, which a cutting room management follows. In some factories the numbering process is out of the cutting room. However it is safer if it is under the cutting room.

3.10.9 Trial cut and SPC report

At the beginning of an order general practice is to cut a trial cut and get a Statistical Process Control report to precede the cutting process. According to the SPC report that needs to do the correction to the pattern for next layers.

3.10.10 Panel Inspection

A panel inspection for all styles is a best practice, but it is difficult to carryout with existing carder. However, carrying out a panel inspection for the first cut out-put, will reflect the fabric fault percentage.

3.10.11 Fusing

Fusing is a pre-stitching process. Therefore it is better to do under the cutting room management's supervision.

3.10.12 Issuing

The converted fabrics in to cut panels must be issued in a controlled manner, which is the final operation in the cutting room.

3.11 Resource Utilization

According to the management theory, there are 5M's where, these must be controlled in the cutting room environment also.

As far as concerned by everywhere, the most valuable resource is Man power also gives a high value in the cutting room by any means.

The other most valuable resource is machinery in the cutting room, where it uses a high tech machineries.

The cutting room is the place that develops the most valuable material used in a garment.

The value of methods cannot be evaluated, but gives a degree of service to any process.

The other most valuable factor is time, that cannot be evaluated in any mean.

3.12 Reducing Wastage

The waste is a potential resource. The wastages can be due to internal or external problems. Reducing wastage is one of the main tasks of cutting room Management, because the out put of the cutting room are cut and dust (marker fall out). Technically, The marker fall out can be reduced by using pattern engineering, marker making, lay planning, spreading, cutting, bundling, storing etc. Therefore an efficient cut order plan is required. (Reference – e-library)

Further wastes can be classified as
- Waste by over production.
- Waste by waiting time.
- Waste in transportation.
- Waste of excess inventories.
- Waste in manufacturing process.
- Useless human movements.
- Waste of defective units.

3.12.1 Eliminate fabric wastage.

As discussed in the introduction, the fabric cost represents 50% to 95% of total cost of manufacturing a garment. By eliminating wastage can be reduced the cost significantly.
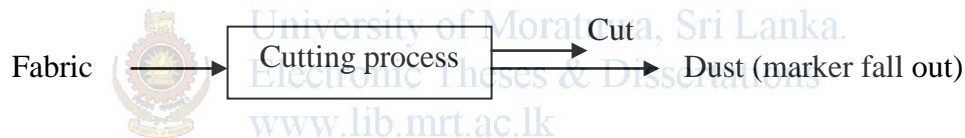
Figure 3.18 – Cutting process.

3.12.2 Eliminate other material wastage.

Not only fabric, but other materials also make a significant cost to total cost. Especially consumable items such as marker paper, kraft paper, polythene, etc are very expensive.

3.12.3 Eliminate man -power and time wastage

A proper plan is needed to avoid idling time of all type of man -power, which is a combined output of mental and physical knowledge.

Make the best use of machinery and spaces available and selecting best methods.
At a cutting room it has more sophisticated and valuable machineries than the other departments. Thereby these machineries must be used more productively.

CHAPTER 4
4. DATA ANALYSIS

4.1 Why customer requirements are important in the cutting room?

Somebody can argue that, there is no point of talking about customer requirements in the cutting room, because that the designer has already thought of the customer requirements and designed accordingly. However in some special cases the cutting room management must have an idea on this, at cutting operations.

Example 1
Buyers request certain test reports in various aspects in the process of garment cutting and making. The buyer, M & S has introduced a system called MSQR (Marks and Spencer Quality Requirements) to test the bond strength in fuse line, and the effects after label washing and durability washing, two times per day for each style. If the fusing process is carried out in the cutting room, then the cutting room management should have a sound knowledge on the buyers' requirements.

Example 2
The cutting room management should also have a sound knowledge on patterns and designs, which are required by the customer, when doing pattern engineering by means of reducing the fabric usage.
Some times piping wastes lot of fabric, when cutting it in width direction or bias direction. If the cutting room management is having an idea about the pattern and it is identified that the piping can be turned to length direction then it is possible to make a significant saving on fabric.
Or lesser width fabrics can be selected and used.
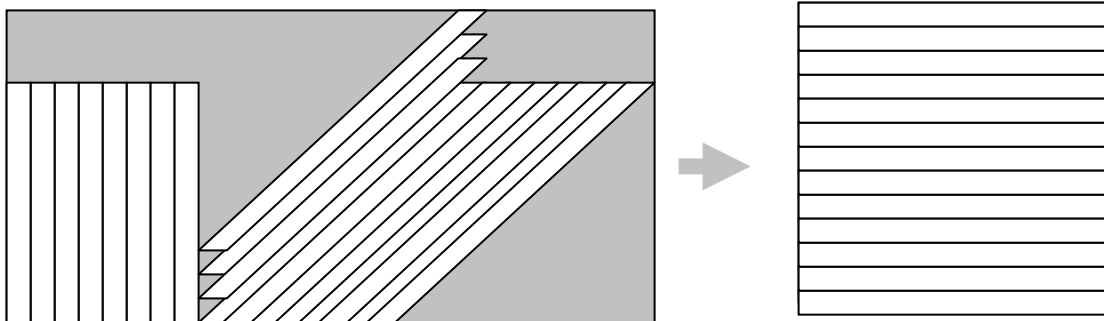
Figure 4.1 – Marker of piping.

The shaded area in the figure 4.1 is a waste, which can be eliminated if the piping is cut in its length direction.
The buyer M & S requests neck stretch of a t shirt's neck up to a certain extent (Example: 29 cm for 4/5 years) in children garments, therefore, the piping that is going to attach to the neck must be in width direction for such garments. For such purposes (piping) less width fabric is better.

Example 3

The cutting room management has to plan the cutting operations, not only to day to- day work but also to next week, next month and next season as well. When planning, knowledge on the seasonal changes is also a must. A best example for this is that fleece fabric styles prepared for colder seasons and when spreading such fabric, the lay depth becomes less with a small quantity of plies. Thereby the cut out put becomes less, and therefore requires a higher workmanship. Accordingly the cutting schedule has to be arranged with the other resources.

Example 4

It requires to lay nap (pile) down way, when spreading and cutting fleece fabric, as the nap down way will help to slip water, which might fell on to the apparel when wearing. If it is not required, the patterns can be drawn as both way markers and both way patterns.

Example 5

If the garment is a children-wear, then a special attention must be paid at all the processes of garment making. An embroidery work on a front panel must be backed by a fusible interlining to avoid rough surface that contact child's skin.
The environment in the cutting room must be metal free. Therefore an extra care is required when sharpening blades, spreading by using pins, and all kinds of metal using.

Example 6

Most of the times the buyer requests to match stripes or checks, so it should be considered when spreading fabric.

Example 7

Some buyers request to adhere some compliance regulations, health safety regulations and product safety regulations. Most of the European buyers request the ISO9000 standards, and the USA buyers request ISO9000 standards, WRAP (World Responsibility for Apparel Product) certificate and Social Accountability 8000 standards. When cutting for such buyers the cutting room management must be adhered to those rules and regulations.
Some such regulations requested by buyers are, compliance regulations and Health and Safety regulations.

Some Compliance regulations are,
- Maximum overtime hours that can be done by an operator, per one day is two hours.
- A Minimum wage limit.
- No under 17 years of age workers.
- The existence of ability to unite workers.
- No harassment on workers.
- Wastes must not pollute the environment.
- Availability of one off day for each week.

Some Health safety regulations are
- Dust free environment.
- A first aid facility must be available.

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- An insurance scheme for all workers.
- Availability of safety guard equipments.
- Availability of trained people for an emergency.

Some Product safety regulations are
- Metal free apparels.
- Delayed-flammability apparels
- No hazard chemicals to be used in production.
- Durability strength in apparels.
- No easy removable items in children garments.

The customer requirements are different from one buyer to the other. Therefore the knowledge on customer requirement, on the product, as well as on to the process is essential for planning, spreading, cutting, fusing processes and also in human resource management in the cutting room. The customer might reject the sourcing, due to the failure to fulfill their requirements. In that sense the achieved high fabric utilization is useless.

4.2 Why supplier specifications are important in the cutting room?

Before starting operations at cutting room, fabric specifications of a fabric roll should be studied, which are to be dealt with marker making, spreading, cutting, etc. The cut order plan must be planned accordingly. The supplier specifications help to,

- Identify and to segregate the fabric,
- Identify the nature of the fabric,
- Find the shrinkage level,
- Find the fabric amount received,
- Check the fault rate and to re-act on that,

The cutting room management has to take some special actions on some special fabrics. The segregation is useful to prepare lay plans, pattern making, marker making and forecasting the total cut quantity in advance.

Example 1
Fabrics composite with Lycra or synthetic material must be cut with an extra care, - cannot use high speed cutting machine, the RPM of the cutter (automatic) must be reduced and the ply height must be lesser. If not the adjacent plies would be fused and all the cuts would be waste or must be subjected to trim where an additional cost and wastage are incurred.

Example 2
There is a limitation of ply height that can be cut according to the fabric type and the machine to be used.

For Shirt materials	100 to 350 plies
For Denim materials	40 to 180 plies
For Knitted fabric	80 to 300 plies.
For Fleece fabric	40 to 100 plies
For Bonded / quilted fabric	20 to 80 plies

With the knowledge on the highest number of plies that can be laid according to the GSM would give a cost effective benefit.

Example 3
The width is an essential factor to know prior to spreading, to get higher fabric utilization. Always the cutting room management tries to use separate markers for individual widths by segregating widths of fabrics received.

Example 4
Fabrics wider than 180 cm, and heavier fabrics are easy and better to lay using a spreading machine rather than doing it manual.

Example 5
The length of a fabric roll must be known in advance to calculate the number of plies that can be laid, number of quantity that can be cut, the length of the balance fabric piece, etc.

Example 6
The quality of a fabric must be known to take necessary actions when at spreading, cutting, bundling, numbering and fusing. A same marker cannot be used and cannot be cut together by spreading different types of fabric together, that is because of differential shrinkage.

Example 7
The shrinkage percentage is very important to make patterns, and lay the fabrics, which are having equal shrinkage percentages together. There need to draw separate markers for each fabric with different shrinkage levels.

The knowledge of supplier specifications will help to make the operations easier at cutting room and it is also a traceability method at error correction. Lack of knowledge of the supplier specifications would be a huge loss, and may be repairable with an extra cost, with a lesser yield.

4.3   How does the fabric GSM help the cutting room?

The GSM is necessary to calculate the ply height and to find out the fabric shortages. Higher the GSM value, higher will be the fabric density. Therefore the number of plies for a lay would be limited. If the GSM is higher, then the fabric is harder, and an extra effort is needed to cut that, therefore when lay planning the cutting room management must consider the GSM.

Example 1
To cut a certain denim fabric, which has a weight of 12.5 Oz per square yard, it is easy to cut 70 odd plies by manually and 40 odd plies by an automatic cutter in a normal speed.

Example 2
A material, which is having a GSM of 74, can be laid up to 200 odd plies for automatic cutter and 350 odd (or higher) plies for manual cutter.

The table 4.1 shows some of the fabric types and highest ply height laid for cutting by Hirdaramani Mercury (Pvt) Ltd, from January 2006 to June 2006.

Table 4.1 – Fabric types and highest number of plies can be laid.

Fabric type	GSM	Max No of plies can be laid	
		For automatic	For manual
65% Cotton + 35% Polyester woven	92 gm^{-2}	200	300
65% Cotton + 35% Polyester woven	98 gm^{-2}	180	250
70% Cotton + 30% Polyester woven	114 gm^{-2}	160	250
100% Cotton woven	125 gm^{-2}	150	230
100% Cotton woven	130 gm^{-2}	150	230
100% Cotton knitted	144 gm^{-2}	150	230
100% Cotton knitted	163 gm^{-2}	140	200
100% Cotton woven	180 gm^{-2}	120	180
100% Polyester Fleece knitted	205 gm^{-2}	100	150
100% Polyester Fleece knitted	220 gm^{-2}	100	150
100% Polyester Fleece knitted	258 gm^{-2}	90	140
100% Cotton Denim (in Oz) woven	262 gm^{-2}	80	120
100% Cotton bonded fabric	280 gm^{-2}	60	110

Number of plies can be laid

GSM
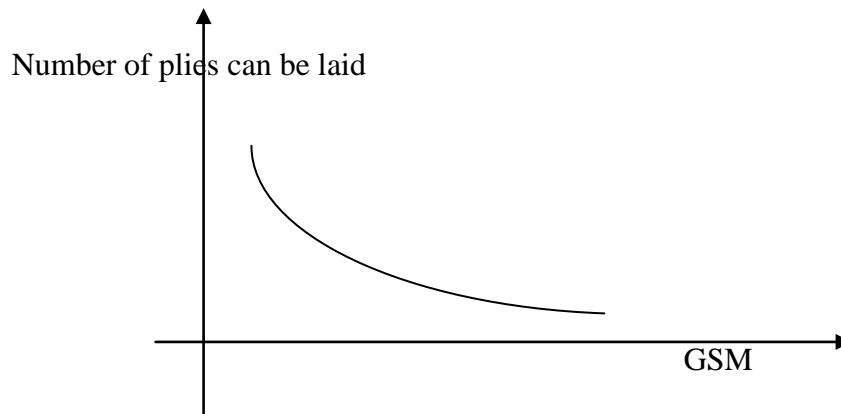
Graph 4.1 – GSM vs. Number of plies per lay.

The GSM refers the mass per unit area of the fabric and it determines the lay depth. Higher GSM's reduce the cutting efficiency – cut output per hour. Also higher GSM's require more power to cut, so the machines (knives) wear and tear is high. The administrative cost is high. That means the overall cost excluding fabric cost for high GSM fabrics is high, as it requires higher workmanship, higher machinery cost, and more time, etc. Therefore the cutting room management must have a thorough knowledge on GSM when preparing the cut order plan. Also the GSM can be used for calculate the shortages; will be discussed in chapter 4.15.

4.4   What is the importance of fabric width?

The width makes a high influence on the Marker efficiency, therefore it is an important factor for marker preparation and spreading. Just 1cm variation to the required width would be a big loss. Therefore a constant width is very important.
Normally knitted fabrics are wider than woven fabric. In the survey, the author found the widest width for woven fabric is 160cm and for knitted fabric 196 cm. However these do not imply, as those are the widest.

When drawing markers, there can be an optimum one width or more widths for each marker that gains the highest efficiency. The variation from this optimum width makes a loss in fabric utilization.
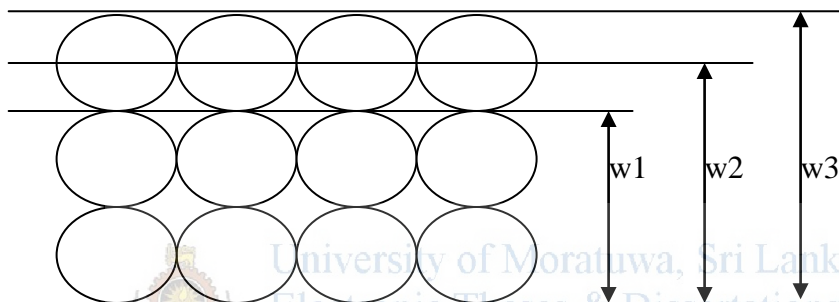
Figure 4.2 – Marker of circular panels of scarves.

In the figure 4.2 the widths w1 and w3 are cost effective, but w2 gives high wastage.

Some of the Marker efficiency and the Marker length variation for different widths for given ratio markers are as follows:

Example 1
The Garment   T – shirts (children's wear, under 18momths)
Style   T78/ 3254
Fabric   100% cotton knitted fabric

The Ratio is,

0-3m	3-6m	6-9m	9-12m	12-18m
2	5	7	4	2

Total sets   20 sets

Figures in table 4.2 are taken from Cutting department - Hirdaramani Mercury (Pvt) Ltd Katunayake.

Table 4.2 – Values for style number T78/3254.

Width	Marker Length (m)	Marker efficiency	Fabric unit price US$	Fabric value for a marker length US$
144 cm	3.59	86.5	2.05	7.3595
146 cm	3.49	85.2	2.05	7.1545
148 cm	3.48	86.2	2.05	7.1340
150 cm	3.45	**86.6**	2.05	7.0725
152 cm	3.39	86.1	2.05	6.9495
154 cm	3.34	85.9	2.05	6.8470
156 cm	3.31	86.3	2.05	**6.7855**
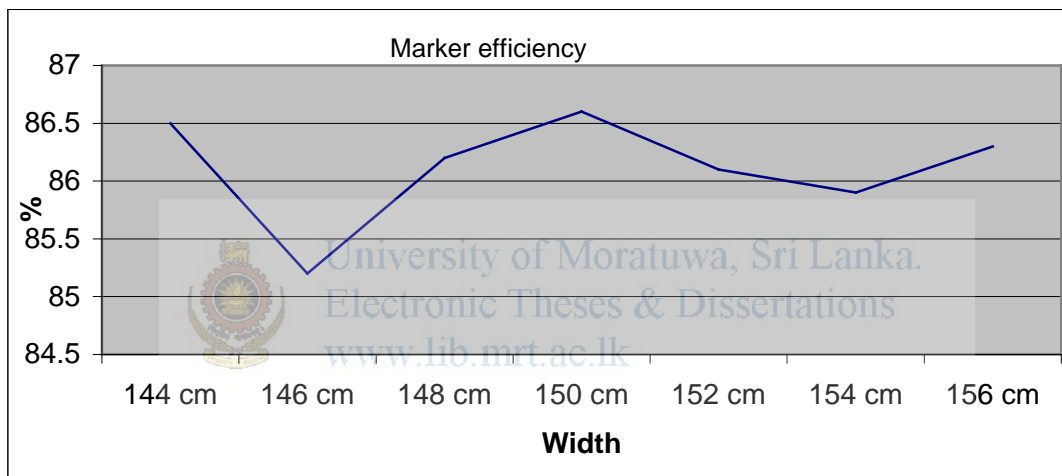
Graph 4.2 – Marker Efficiency vs. Width for style number T78/3254.

By looking at the table 4.2 the highest marker efficiency is shown by 150 cm width, and the best price is given by 156 cm – "the economical width". Therefore this example doesn't show a significant advantage of marker efficiency along with the cost because a same fabric unit price has been given. If fabric is selected by considering the best marker efficiency, the fabric cost will be US$ 7.0725 for 20 garments (for 150cm width). Here the material wastage becomes less. If fabric is selected by considering the best price, then the fabric cost will be US$ 6.7855 (for 156cm width). However the marker fallout would be 0.03% higher than the 150cm width fabric.

If it is identified in early stages, considering on marker efficiency or price can do then purchasing of fabric. Anyhow this decision must be taken by considering the other factors as well.

Example 2

The garment   T – shirts (adult children's wear)
Style   T87 / 4629
Fabric   100% Cotton knitted fabric

The Ratio is, 5-6Y	6-7Y	7-8Y	9-10Y	11-12Y
1	1	2	2	4

Total sets   10 sets.

Figures in table 4.3 are taken from Cutting department - Hirdaramani Mercury (Pvt) Ltd Seethawake.

Table 4.3 – Values for style number T87/4629.

Width	Marker Length (m)	Marker efficiency	Fabric unit price US$	Fabric value for a marker length US$
165 cm	7.82	86.3	2.49	19.4718
166 cm	7.91	87.8	2.49	19.6959
170 cm	7.68	87.5	2.51	19.2768
171 cm	7.72	**88.4**	2.51	19.3772
173 cm	7.44	86.1	2.51	18.6744
175 cm	7.28	85.3	2.55	18.5640
180 cm	7.25	87.3	2.55	**18.4875**

Graph 4.3 – Marker Efficiency vs. Width for style number T87/4629.

Here the most benefited width is 171 cm, but by considering the value of fabric here fabric price is varying with the width of the fabric, unlike the first example (table 4.3). Therefore the best width is 180 cm, if considered on price, but marker fall out is higher.

Example 3

| The garment | Pant (adult children's wear) |
| The garment | Pant (adult children's wear) |

The garment   Pant (adult children's wear)
Style   T87 / 4600
Fabric   100% Cotton woven fabric

The Ratio is,

5-6Y	6-7Y	7-8Y	9-10Y	11-12Y
1	2	3	3	1

Total sets   10 sets.

Figures in table 4.4 are taken from Cutting department - Hirdaramani Mercury (Pvt) Ltd Seethawake,

Table 4.4 – Values for style number T87/4600.

Width	Marker Length (m)	Marker efficiency	Fabric unit price US$	Fabric value for a length US$
146 cm	8.22	87.11	3.40	27.948
148 cm	8.11	87.10	3.40	27.574
150 cm	8.01	87.00	3.40	27.234
152 cm	7.91	86.90	3.40	26.894
154 cm	7.79	87.14	3.40	26.486
156 cm	7.69	87.10	3.40	**26.146**
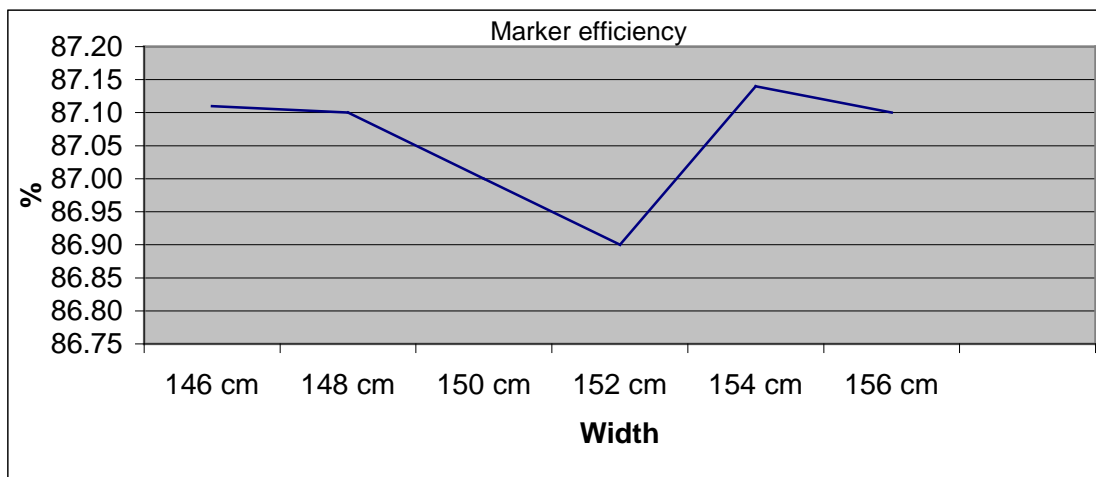
Graph 4.4 – Marker efficiency vs. Width for style number T87/4600.

The highest marker efficiency is given by 154 cm width, but the most economical width is 156 cm.

Example 4
The garment   Pant (children's wear – under 18 months)
Style   T87 / 2058
Fabric   100% Cotton knitted fabric

The Ratio is,

0-3m	3-6m	6-9m	9-12m	12-18m
2	4	6	4	2

Total sets   18 sets.

Figures in table 4.5 are taken from Cutting department - Hirdaramani Mercury (Pvt) Ltd Katunayake.

Table 4.5 – Values for style number T87/2058.

Width	Marker Length (m)	Marker efficiency	Fabric unit price US$	Fabric value for a length US$
170 cm	6.02	87.70	2.51	15.1102
174 cm	5.82	88.10	2.51	14.6082
176 cm	5.54	**92.50**	2.51	**13.9054**
178 cm	5.68	90.30	2.51	14.2568
180 cm	5.66	90.60	2.51	14.2066
182 cm	5.59	**92.50**	2.51	14.0309
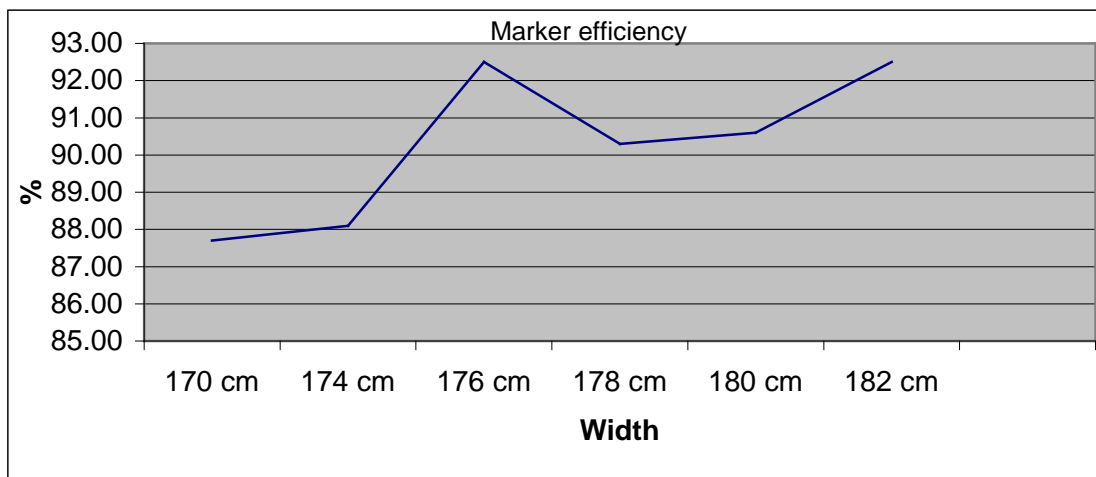
Graph 4.5 – Marker Efficiency vs. Width for style number T87/2058.

The highest marker efficiency is given by 176 cm and 182 cm widths, and the most economical width is also 176 cm.

Example 5

The garment	Dungaree (children's wear – under 18 months)
Style	T78 / 3262
Fabric	100% Cotton Denim fabric

The Ratio is,

0-3m	3-6m	6-9m	9-12m	12-18m
1	2	4	3	2
Total sets	12 sets.			

Figures in table 4.6 are taken from Cutting department - Hirdaramani Mercury (Pvt) Ltd Katunayake.

Table 4.6 – Values for style number T78/3262.

Width	Marker Length (m)	Marker efficiency	Fabric unit price US$	Fabric value for a length US$
144 cm	7.24	85.10	3.05	22.082
148 cm	7.07	84.79	3.05	21.564
150 cm	6.94	**85.23**	3.05	21.167
152 cm	6.88	84.84	3.05	20.984
154 cm	6.82	84.47	3.05	20.801
156 cm	6.76	84.13	3.05	**20.618**
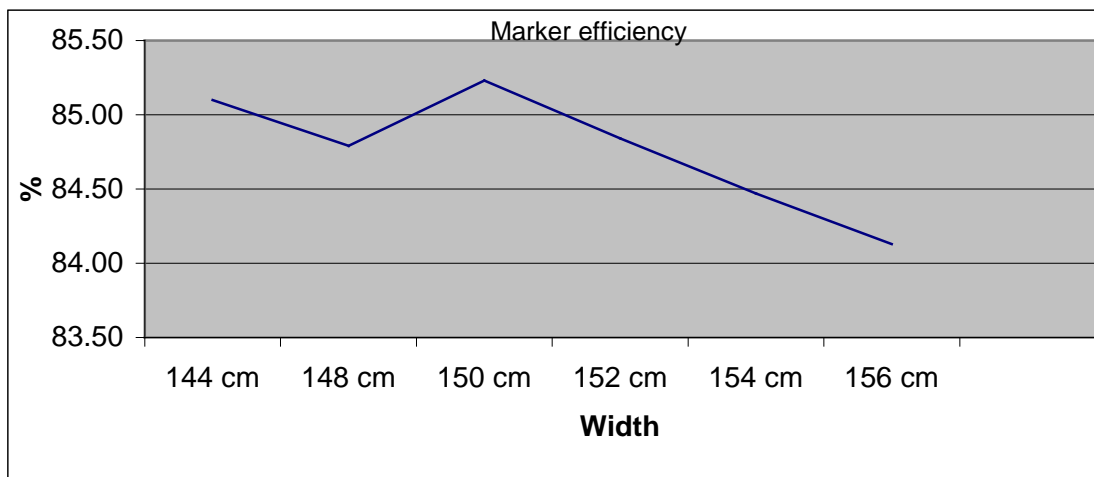
Graph 4.6 – Marker Efficiency vs. Width for style number T78/3262.

The highest marker efficiency is given by 150 cm width, and the most economical width is 156 cm.

According to the five examples above (Tables 4.2, 4.3, 4.4, 4.5 and 4.6), there's an optimum width (or two) for each style that gains the maximum marker efficiency and less wastage of fabric amount. However it may or may not be the economical width in terms of money. Hence the width of a fabric determines the marker efficiency and the fabric cost in the garment industry. Therefore the fabric width is a significant characteristic at marker making.

As discussed earlier, if this situation is identified in early stages, then purchasing can be done for a selected width, with considering the other factors as well. It will be the most economical fabric width for a particular order.

4.5 Dealing with inconsistent and narrow widths

One of the biggest problems is that the fabric suppliers fail to supply the required width and the dispatched batch consists with two or more width types. The most critical problem is the inconsistent width with in a roll.

The following steps can be advisable, which have been taken by the cutting room management in recent past history at Hiradaramani Mercury (Pvt) Ltd.

1) Can use the minimum width of the width inconsistent roll or return it back to the supplier.
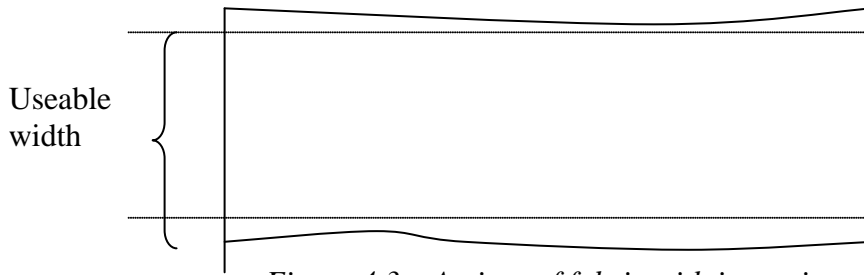
Figure 4.3 – A piece of fabric with inconsistent width.

The inconsistent width wastes a lot. Normally this occurs in knitted fabrics, which formed in tubular system.

2) Segregate all fabric rolls width-wise and prepare the lay plans and marker plans accordingly.

After segregating widthwise, markers can be drawn for the widths with a higher amount of fabric available.

Example 1

Received width	Quantity (m)	Marker can be drawn to the width
140 cm	309 m	140 cm
141 cm	1459 m	141 cm
142 cm	105 m	
144 cm	2059 m	144 cm
145 cm	557 m	
146 cm	860 m	146 cm
148 cm	175 m	
150 cm	3065 m	150 cm
152 cm	2066 m	150 cm

By drawing one marker for close two or more widths will provide some advantages.

Advantages
- Number of markers to be drawn is less.
- Layers with less number of plies can be avoided
- Workmanship of spreading, cutting, bundling, etc are less.

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Disadvantages
- Some amount of fabric will lose as waste.
- Total cut quantity is less.

The table 4.7 shows some examples, how the received width varies from the ordered width and the shortages occurred due to that.

Table 4.7 – Variation between ordered and received widths and shortages occurred.

Ordered width (cm)	Consu-mption m/Dz.	Order qty Dz.	Ordered amount (m)	Received width (cm)	Received amount (m)	Cons. for recd width	Short-age (Dz)	Qty cut by engineered pattern
148	5.61	500	2805.0	146	1510.5	5.69	7.86	501.83 Dz
				144	1306.1	5.77		
152	4.78	750	3585.0	150	1201.3	4.84	22.89	741 Dz
				148	1008.9	4.91		
				144	1380.4	5.05		
160	8.20	700	5740.0	156	5751.0	8.41	16.19	700.5 Dz
172	3.91	1100	4301.0	170	1506.8	3.96	27.81	1088 Dz
				166	2800.7	4.05		
175	4.67	350	1634.5	170	1640.3	4.81	8.79	352 Dz
175	2.51	600	1506.0	172	403.7	2.55	12.29	599 Dz
				170	1110.1	2.58		
180	8.09	800	6472.0	175	6480.9	8.32	21.15	791 Dz
180	6.33	750	4747.5	176	4751.6	6.47	16.03	747 Dz

The table 4.7 also shows the cut shortage due to width variation of some of styles planned to cut in Hirdaramani Mercury (Pvt) Ltd.

If it shows shortages because of narrow width fabric supplying, the shortage must be recovered any how, basically using pattern engineering methods.

An example is shown in chapter 5 (see page 137).

When shortage occur like above, then followings are advisable to do,

- Can recover the short fabric at free of charge from the supplier. The recovering must be done, by avoiding the following losses as much as possible.

  If the fabric recovering is delayed, it may not have enough time to produce the short quantity.

  Recovering fabric may not be same as the earlier batch.

  Has to lay and cut small quantities from the recovered fabric.

- Debit the FOB cost of short quantity to the fabric supplier.

  The garment buyer and the fabric supplier won't be happy, no any gain at all.

- Do pattern engineering and achieve the order quantity using available fabric.

Normally it is hard to get the required width from the suppliers. Within the period of January 2006 to June 2006 there were 98 fabric supplies with width variations, at Hiradaramani Mercury (Pvt) Ltd.

Table 4.8 – The behavior of fabric supplies of width variation.

Wider width than the ordered width	19 batches	
Narrow width than the ordered width	79 batches.	
Debited for narrow width	23 batches	29 %
Pattern engineered (with 12 debited also)	27 batches	34 %
Fabric recovered out of 79	41 batches	*52 %*
On time recovered	26 batches	*64 %*
Delayed but shipment recovered	9 batches	
Delayed and Air freighted	4 batches	
Rejected by the buyer –short shipped	2 batches	
To recover the narrow width,		
Number of lays laid less than 20 plies	22 times.	
Number of lays laid less 20 - 30 plies	17 times	
Number of lays laid more than 30 plies	2 times.	

The above figures show that the cutting room had to spend lot more resources and an extra effort to recover the shortages due to width variations. However, all the efforts and the extra cost spent will be useless because of delays and rejections by the buyer.

When recovering, that exists
- Labour cost wastage.
- Time wastage.
- Additional airfreight cost.
- Production idling cost etc.

When debiting, nothing can be received (neither loss nor profit).

When pattern engineering that could gain
- Some debited value.

- Profits on low fabric utilization.
- Less marker fall-out.
- Customer satisfaction.
- Supplier satisfaction.
- Knowledge and experience on pattern engineering.

It is clear that the fabric recoveries for the shortages due to narrow and inconsistent width, or debiting the supplier do not often get best results. However achieving the order quantity by pattern engineering or by any means gets more benefits. Also this says the fabric width plays a vital roll in fabric utilization.

4.6 Is the fabric weight important for cutting room?

Nobody can say that this factor is not so important. Mostly the fabric supplier deals with weight of fabric and converts it into length by using GSM and width.

The fabric length (m)   = Weight (Kg) / (width (m) X GSM)

In other aspects the workers have to handle the fabric roll manually (still in factories in Sri Lank). Only one worker could handle up to 30 - 50 Kg., which is controllable. If a roll weighs more than 50 kg, then it needs two or more workers or hard machineries to handle it. This creates an unnecessary cost.

For up to 30 Kg.	Can be handled by one worker easily.
For 30 – 50 Kg.	Can be handled by one worker – but difficult
For 50 – 80 Kg.	Need two workers.
For 80 – 120 Kg.	Need three or four workers or any lifter.

There is a maximum weight that a spreading machine can lift.
Example: 250 Kg for a Gerber spreading machine.
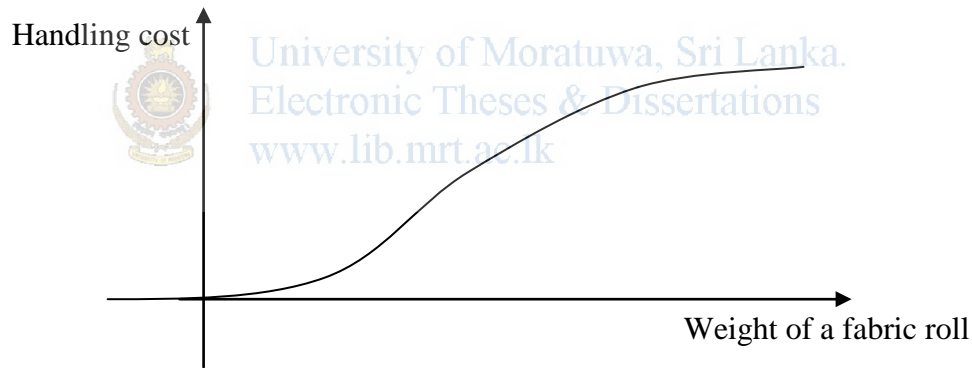
Graph 4.7 – Handling cost vs. Weight of a fabric roll.

It says more the fabric weight, more will be the cutting cost. Thereby the longer length advantage vanishes if cost of handling is high. Also one of the easy methods to find the fabric amount in a roll is by weighing it. Therefore the weight of a roll is also an important factor to the cutting room.

4.7   Is it necessary to know the fabric length of a roll?

Yes. It is necessary to know the length of a roll before start cutting processes, at lay planning. It is necessary to,

- Find the amount of fabric available.
- Find the number of plies that can be laid by a roll.
- Find the remnant piece or balance would be.
- Find the shortages would be.

The figures in the table 4.9 are calculated by using the fabric length stated on the label where pasted on the rolls received from M/s Ocean Lanka Ltd. to Hiradaramani Mercury Apparel (Pvt) Ltd.

Table 4.9 – Lengths of fabric rolls and the number of plies can be laid.

Roll No.	Roll length (m)	Lay length (m)	No of plies can be laid	Balance (m)
12	62.91	4.07	15	1.86
14	61.03	4.07	14	4.05
17	59.27	4.07	14	2.29
19	63.02	4.07	15	1.97
21	60.07	4.07	14	3.09
22	29.33	4.07	7	0.84
23	38.65	5.39	7	0.92
24	60.45	5.39	11	1.16
27	62.33	5.39	11	3.04
29	59.45	5.39	11	0.16
31	50.25	6.27	8	0.09
32	49.38	6.27	7	5.49
33	20.37	6.27	3	1.56
34	48.65	6.27	7	4.76
37	61.89	6.27	9	5.46
41	56.34	6.27	8	6.18
49	58.94	2.98	19	2.32
51	59.47	2.98	19	2.85
52	61.05	2.98	20	1.45
Total	**1145.98**			**50.49**

Reading the fabric amount in a roll helps to a perfect cut order plan, by avoiding large remnant pieces. If fabric rolls can be ordered to an exact length, then the fabric balance becomes zero. However it is not practical. Because, suppliers cannot supply in that way (exact length), there might be shortages, excess and fabric defects.

4.8   The effect of the fabric colour and quality for cutting operations

It is necessary to care on colour and quality at spreading, cutting, storing, numbering and panel replacing. Some colours are very close in appearance; one of the identifiable methods is that MSC number or Pantone number. Some suppliers name the colour, by using common names. For examples,
Red – Maroon, Bright red,
Pink – Powder pink, Pale pink, Rose pink, Pink sorbet, Sugar pink,
Purple – Lavender, Plum,
Yellow – Golden yellow, Tangerine,
Green – Apple green, Forest green, Olive Green, Lime Green,
Blue – Indigo, Navy, Sea blue, Bright blue, Aqua blue, Teal, Turquoise,

The colour name and the colour number is useful to
- Identify the correct roll to be laid.
- Avoid different shade mixing.
- Avoid different quality type mixing.
- Avoid the colour bleeding / bleaching from a dark colour to lighter when spreading, cutting & storing.

To avoid the above,
Should keep the swatches until the order finishes.
Spreading should be done separately or separated by a tissue or any other type of fabric.
Cutting should be done separately.
Storing must be done separately.
Numbering must be carried out.

4.9 Importance of fabric shrinkage

Most of the fabrics are shrunk after cutting. Normal average is 2% – 4% for both ways. Some times the shrinkage percentage changes drastically after cutting, printing, embroidering, fusing, washing etc. It is unable to repair a shrunk garment back to the normal size or shape (pattern).

Pieces of a flight clothes have tested after cutting, and the results were as follows.

The original pattern size	30.0cm X 23.0cm		
24 hours after cutting	29.2cm X 22.5cm	shrunk %	2.7% x 2.2%
2 hours after fusing	27.8cm X 21.7cm	shrunk %	7.3% x 5.7%
After embroidering	28.5cm X 21.9cm	shrunk %	5.0% x 4.8%
After printing	27.2cm X 21.5cm	shrunk %	9.3% x 6.5%
After washing	27.5cm X 21.7cm	shrunk %	8.3% x 5.7%

When at pattern making, the shrinkage percentage must be identified and need to be added to the pattern length- wise and width wise.
If the said shrinkage does not occur either after cutting, after stitching or after washing, etc, will also a problem to the cutting room management, if it has not shrunk after cutting or under shrunk then, the cutting Management has to trim cut panels. If the material has over shrunk, then it would be a huge problem.

There are few types of shrinkages.
1. Constant shrinkage within the total badge.
2. Shrinkage percentage differs roll to roll.
3. Different shrinkages within the roll.

The first shrinkage type is easy to handle, as only one pattern is enough for whole batch.
For the second one there it needs to draw two or more patterns.
In the third case it will be a disaster, because that cannot be identified at the testing stages, as if only one piece from a roll end is tested.

If the required shrunk is not exists, the only option is trimming. If it is over shrunk, then sizes must be down graded, by trimming the over shrunk panels to a smaller size, can be overcome this problem, to a certain extent.
Here the smallest size would be a waste, but that can be used to replace some other part panels instead of a defect panels.
As in figure 4.4, sleeve of any size sometimes can be cut from the smallest front panels of a T-shirt.
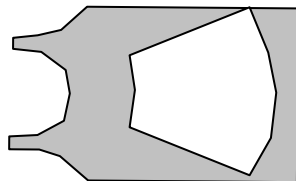
Figure 4.4 – How to utilize a smallest waste panel.

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Thereby even there is shrinkage constant or non constant, there are ways to overcome it rather than send back to the supplier or raising debit notes.

Meanwhile, some fabric shows growing effect, and it reduces the GSM. In this case an additional care must be taken when spreading, cutting, bundling and handling.

> When spreading, it should not give a tension at all.
> When cutting, it should not be pressed or tensioned.
> When bundling, it should not be tighten.
> When handling, numbering or fusing or stitching there need to have an extra care.

By trimming the grown panels before sending to the sewing room, can be over come this.

4.10 The importance of Chemical and physical properties

It is necessary to get an idea of how the fabric behaves at spreading and cutting, and accordingly a method has to be implemented. Some of the general aspects of chemical and physical properties can be subjected to change at cutting operations. Therefore the cutting room management has to take steps to avoid those.

- It is necessary to know the fibre content in the fabric when planning the cutting schedule, because some artificial fibres melt at somewhat high temperature. Not only fibres some finishes in the fabrics also destroy at heat or pressure. Such fabrics cannot be cut by high -speed machines which are a cooling system is not available, as it fuses with each other plies or destroy the quality of finishes, which are concerned by the end user. For example some Lycra fabrics and Nylon fabrics need to be cut by speed variable cutting machines, and have to lay in low number of plies.

- It is very important to know chemical and physical properties, and its behavior after cutting, when pattern making and pattern engineering. The elasticity property may only in lengthwise or width wise or both, accordingly that has to prepare patterns lengthwise or widthwise or bias. It can be identified by the fibre composition.
  For an example a neck piping must have some extensibility, so it should cut along where the elasticity property exists.

- It is a common method to draw all panels along the length way of the fabric to get the drape ability of the garment. However in some cases the pattern pieces are drawn along the width direction or some other direction, as the cutting room management must think on the aspects of the comfort of the finished garments.
  Some parts can make uncomfortable to the wearer because of over shrunk or less shrunk. The cutting room management must think on these when preparing patterns.

- Some fabric and cut bundles must be stored with an extra care, to avoid crease marks and damages that can be occurred when at tightening and pressure rising. Example velour, brushed, fleecy and fur fabrics. When bundling, an extra care must be taken for such materials and also for colour bleeding fabrics. These should not tighten and have to store separately.

- Some velvet or fleece type fabrics cannot be laid in large number of plies, because it is difficult to cut and there is a possibility to occur crease marks.

- Some fabrics have elasticity or plasticity properties, which must be laid and cut without harming the pattern dimensions. The fabric having the property of elasticity can form out of shape panels due to tension that can be occurred at cutting. Also fabrics having the property of plasticity can form an out of shape after cutting due to tension occurs at handling. These types of fabrics need an extra care.

- Knitted fabric must be relaxed for a certain period of time (example 24 hours) before spreading, as it must be allowed to shrink. Likewise some fabrics must be stricken before lay.

- Some fabrics frayed highly after cutting, an extra care is needed for such fabrics when bundling and storing.

- The aesthetic factor is very important when at spreading and cutting. For an example, if a pattern requires a stripe, which draws from one arm -hole to other, or requires bias stripe lines (see figure 4.5). Then it should lay and cut by considering the design of the fabric.
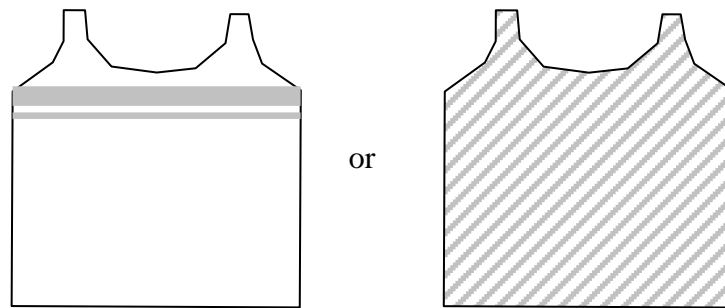
Figure 4.5 – Panels with stripes.

- Some fabrics repel the numbering stickers; thereby it is difficult to number them using stickers. Like these cases, it is necessary to find a high gum sticker or any other system to number such as writing by a pencil or printing. Likewise, some fabrics may require a low gum sticker as they retain the gum mark on the fabric.

- The fabric density / GSM is necessary to determine the ply height and lay length. Accordingly the cutting system.

Knowledge of the chemical and physical properties may help to make decisions at planning and operations in the cutting room. The absence or the lack of this knowledge would be lead to a considerable loss in the process.

4.11 The importance of fabric types and structure in cutting operations

As mentioned in the fabric classification (chapter 3.4) in the factors affecting fabric utilization, Woven, knitted, non-woven and bonded fabrics are largely used in apparel sector. These can again be divided in to sub categories as plain (white and coloured), printed, stripes, checks etc. Some special methods must be used for the above types of fabric when spreading, cutting, etc.

4.11.1   Woven fabric
- Normally a plain -woven fabric is easy to lay and cut. There are no special requirements, other than their chemical and physical properties.
- There is a tendency to fray off yarns from the panel's ends, therefore there must be careful enough when cutting, storing, numbering, fusing etc.
- The fabric faults are also lesser than the others. Bowing and skew ness are the main fabric faults in woven fabrics. If it is striped or check or having fabric faults, special operational requirements have to be followed which will be discussed in latter.
- When pattern engineering, an additional care must be needed for woven fabrics to get best results. For an example, turning slightly a pattern piece would be highly reflects at the finished garments, and when reducing seam allowance would be harmful if it frays off. To avoid such fray off, these fabrics can be fused with interling.
- The woven fabrics do not necessary to relax before spreading.
- Normally it is difficult to identify the face side of the fabric. Therefore suppliers are requested to wind the roll as the face side facing into the core direction.
- At the spreading stage the end allowance can be reduced in a woven fabric, by using well-experienced layers, which is a good option to reduce the fabric utilization.
- Woven fabrics can be laid up to 350-450 plies according to the GSM, therefore the cutting time, marker making time, and other resource usages can be lowered. The panels becoming out of shape is less in woven fabric.

Therefore the efforts to be used for woven fabrics are less and not so complicated in general.

4.11.2   Knitted fabric
- There are lots of problems coming with knitted fabrics. Mainly this is difficult to lay when comparing with the woven, since it's selvedges are curling and have wider widths.
- It should not have any kind of tension or looseness at all when spreading and cutting.
- Normally the knitted fabric must be relaxed before spreading.
- Normally a higher number of defects can be found in knitted fabric than woven fabric.
- The maximum ply height would be 300 according to the GSM and the knit type.
- Marker making gives higher marker efficiency in knitted fabric than in woven fabric, because knitted fabrics are wider than the woven.

In general, the cutting room management must put an extra care on knitted fabric at all operations in the cutting room.

4.11.3   Non-woven, Quilted and bonded fabrics

Interlining, Mesh, Nets, etc are non- woven fabrics. Mostly these have low content of cotton but some synthetic fibres and some glue types especially in interlining are highly melting at heat. Therefore, these cannot cut by spreading higher number of plies and by an automatic cutter, which is subjected to higher pressure with a little heat at cutting.

Normally, two layers of two kinds of fabrics form quilted fabrics and bonded fabrics, by stitching (quilting) or pasting (bonding) together. These fabrics are thicker than others, but the hardness is dependable. Due to the thickness of the fabrics, the spreading ply height would be lesser.

It is very useful to identify the fabric type and its behavior during all the cutting operations from pattern making to cut issuing, to utilize the existing resources in maximum.

4.12 Does the fabric fault make a significant damage to the cutting room?

Fabric fault is the main threat to the cutting room. Some of the fabric faults can be identified at the pre-stages of cutting, like fabric inspection, at the suppliers end etc. Some can be identified at spreading and cutting stages. Some cannot be identified until the garment finishes, and some are needed to do a testing to identify such defect (latent defects). If the garment is rejected at the final point then the total effort to make high fabric utilization is useless.

Some of the patent defect types can be recovered by an additional operation with a little additional cost. Those faults are, Holes, Missed yarns, Contamination, slubs, print defects, embroidery defects, shortage, stain marks, etc.

However some are very difficult to recover and need a somewhat high cost. Those faults are, Brush effect, negligible Skew-ness, bowing, Barre, colour shading within the range, uneven repeat, un-even width, crease-line, etc.

Some are cannot be recovered at all, those are Skew-ness and bowing more than 3%, non - constant shrinkage, colour shading out of the range, total print / embroidery defects, etc.

However the cutting room management needs to know the gravity of the existing fault rate. It needs a fabric inspection and a grading system before spreading and cutting. There are various systems to inspect and grade fabric. Usually fabrics are inspected according to an agreed system by two parties, the supplier and the purchaser (garment producer). In cutting room perspective all the systems are unfair for the smooth operation at cutting room and an additional operational cost is required. Thereby it is necessary to have an idea on world recognized fabric inspection systems.

4.12.1 Four points system

The four points system is published in 1962, and revised in 1971. It refers the number and size of defects in fabric by length or width. There are 54 visible defects described in this system as a standard.
Less than 40 defects per 100 square yards are defined as first quality. More than 40 defects per 100 square yards are defined as second quality. Based on the price line and the type of garment produced, the manufacturer can be changed the acceptance criteria accordingly.
The points scoring system of the four points system is as follows.

A length of a defect up to 3"	scores 1 point.
A length of a defect 3" – 6"	scores 2 points
A length of a defect 6" – 9"	scores 3 points
A length of a defect over 9"	scores 4 points

Holes or opening (largest dimension – length or width)

<div align="center">scores 4 points</div>

4.12.2　　Graniteville 78

The Graniteville system was originally introduced in 1975. It was revised in 1978. This refers to the number and length of defects by area. This covers 186 defect types, and there are definitions for major and minor defects. The quality pass rate must be negotiated with supplier and buyer.

One point	for each 9" or part	- Major
½ point	for each 9" or part	- Minor

The assignable maximum penalty points can be determined by dividing the fabric width in inches by 9.

For an example; the maximum penalty points can be assigned to a 48" width fabric as
　　48/9 = 5.33 or 6.

Same as the assignable maximum penalty points for a single square yd. is 4.

4.12.3　　Ten points system

For this system points allocated are as table 4.10.

Table 4.10 – Points system – Ten points.

Length of defect (warp)	Points allocated
Up to 1"	1
1" to 5"	3
5" to 10"	5
10" to 36"	10
Length of defect (filling)	
Up to 1"	1
1" to 5"	3
5" to 10"	5
Larger than half of the width	10

Maximum number of points that can be allocated for a linear yard is 10, no matter how bad or frequent the defects are.

As per this system the first quality fabrics are defined as if the number of defect points are less than the number of yards of fabric inspected. In case of a fabric wider than 50 inches, the fabric is considered first quality if the total defect points do not exceed the number of yards of fabric during 10% inspection.

4.12.4　　M & S system

A different system should be followed by the Marks and Spencer, apparel producers, and it has two separate systems for knit fabric and woven fabric.

4.12.4.1　　For knit fabric

They call it "one in nine", which means one fault in nine meters as the pass rate. More than one fault in 9m is considered as a high fault rate fabric and may be rejected or accepted with other conditions such as panel inspection by the fabric supplier and replace the rejection at free of charge and to pay the re-cutting charge, or pay the total FOB cost when rejecting

garments at the finished garment inspection, or any other compensation is agreed and given by the supplier to cover the losses. However more than one fault in less than 4m is reject. Here also only one point is assigned to all defects within a meter

4.12.4.2   For woven fabric
Here considers the total area of the fabric. Reject margins are;

Average per batch	15 points / 100m^2
Maximum per roll	26 points / 100m^2

Only 50% of the fabric supplied should not have more than one point fault.

4.12.4.3   Garment rejection due to fabric faults
100% defect free fabrics are hard to find, and the cost of such are higher. Most fabrics are in the passable grade according to any fabric grading system, such as Four points system, Graniteville, Ten points system, M & S system or any other. However it may be failed at the garment stage.

For an example, a knitted fabric is marginally passed according to the M & S system, that is found one fault in 9 m, and the fabric consumption is for that style is 9 m per dozen garments. It means that there is one defect within 9m, and 12 garments can be cut from 9m. Therefore, a high probability to reject one panel, accordingly one garment out of 12 garments would be rejected. Consider that the panel replacement cannot be done or not done.

The rejection probability of garments 1/12   = 8.33 %.

If the panel replacement can be done, and there is "N" number of panels in a garment, then the rejection percentage would be   = 100 / 12N   = 8.33/ N
(assume all the panels of same size)

The number of panels of a single colour garment is varying.

For a T Shirt	Minimum 4	Front, Back, 2 sleeves,
For a Pijama pant	Minimum 3	Left side, Right side, W/band
For a Blanket	Minimum 1	

This changes for multi coloured garments. For an example a T- shirt with two colours, one colour in front and back, and another for sleeves.

That can make an equation to find the rejection percentage,

Consider,

Fabric fault rate is	1 / F (one in "F" meters).
Consumption rate / gmt is	"C" meters per garment.
Number of panels per garment	"N"

Therefore the rejection percentage would be   = 100 C / F N
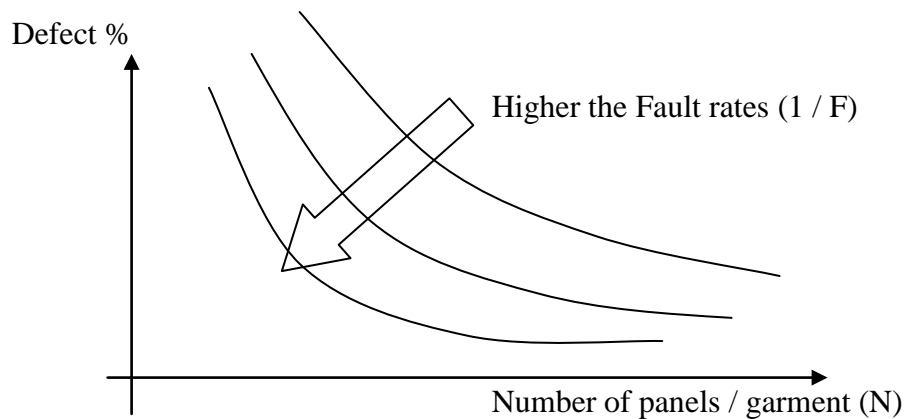
Defect %

Graph 4.8 – Defects percentage vs. Number of panels per garment.

Even though, a zero defect production is looking for, a defect target must be planned, that can be achieved with the external problems. Normally the expecting defects percentage is less than 2%.

Then
$$2 \quad > \quad 100C / FN$$
$$C / N \quad < \quad F / 50 \quad < \quad 9 / 50 \text{ (for M \&S)}$$
$$< \quad 0.18 \text{ meters.}$$

This says if the average panel consumption for a garment (C/N) is less than 0.18 m/panel, then the M & S system is workable for garment manufacturers.
Therefore this implies that the M & S rule is unfair for some large garments, mostly knitted garments.

Similarly in woven fabrics the garment rejection percentage would be

$$= F W C / 100 N$$

Where W = width of the fabric
C = consumption per garment
N = Number of panels per garment.
F = Number of defects in $100 m^2$.

Therefore the maximum area of a panel, which can pass easily through the M & S system is,
$$C / N \quad < \quad 200 / F W \quad < \quad 13.33 / W \text{ (for M \& S)}$$

Where passable F for M & S is 15 faults per 100 m^2.

Disadvantages of M & S system
Does not consider the width of knitted fabric.
No matter how big the defect is.
The pass rate is not sufficient for high fabric consuming garments
Above is only on M & S system. Following are some disadvantages of other systems.

Disadvantages of four points systems

No any special definitions for major / critical defects.
Disregarded up to 1" from selvedge.
A maximum allowable penalty for a yard is 4.
Specially defined for knit fabric

By the way the fabric faults make a barrier for the high fabric utilization. Not only on fabric, an additional manpower and time is required to avoid and replace the fabric faults. Totally fabric faults make big losses to the cutting room, even though it passed at any inspection criteria.

4.13 How to go ahead with fabrics with high fault rate?

Rejecting a fabric roll due to high fabric fault rate should not be the only and wise option. Sometimes the faults can be overcome very easily. Before that the cutting room management must have some knowledge on fault rates, which could be found at once by an inspection. To find the fabric faults an inspection must be carried out. Normally every apparel producer used to do an inspection may be 10% or 100% on first batch or random inspection or 10% of each batch. Depending on the inspection results the apparel producers take steps according to the negotiation made with the fabric supplier. The steps can be taken as follows.

- 100% inspection in fabric form by the apparel producer.
- Inspection of another portion of fabric by the fabric producer even after delivering the consignment.
- Another 10% inspection in presence of the supplier at the apparel-producing factory.
- 100% inspection by the supplier.
- Replacing a new consignment, if no other option is available.

By the above methods defects are marked, which should be removed and replaced by good panels at cutting before stitching. Following systems can do for remove defects.

- 100% defects removing at the spreading process.
- 100% cut panel inspection and replacing in cut form at cutting room.
- 100% inspection and replace at stitching process.
- 100% inspection in garment form.

The above steps must be taken with care by means of reducing wastage and cost effectively. Therefore, the cutting room management has to be considered on following points.

- Fabric price – when rejecting or accepting.
- Fabric lead-time to replace – when rejecting the consignment.
- Line idling cost – if no cuts available until a new consignment.
- Shipment delaying cost – if air freighted
- Fabric inspection cost – if the garment manufacturer has to do it.
- Panel inspection cost – if cutting room has to do it.
- Panel replacement cost – if cutting room has to do it.
- Garment rejection cost – if no other options other than final inspection.
- Cost of pattern engineering or additional marker preparation.
- Cost of additional effort at spreading and cutting stages, may be small layers having one or two garment sets.
- Cost of fabric waste.
- Other additional costs.

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Cost of defect removing
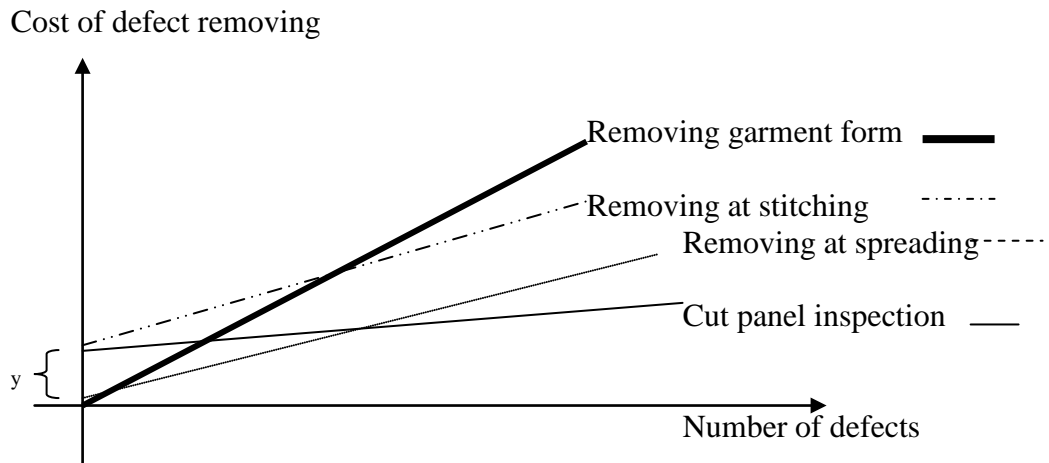
Where y is the cost of inspection that has to bear in zero defect situation

Graph 4.9 – Cost of defects removing vs. Number of defects.

Anyway the cutting room management has to deal with fabric faults, in terms of lowering overall cost. Following are some defect types.

4.13.1   Holes / slubs / stain marks / missed yarn

Holes, (also considerable pin holes less than 0.5mm) slubs, stain marks (that cannot be removed by washing), missed yarn are the most existing defects in fabrics. The definition major or minor says upon the size of the defect and defect placement on the panel / garment, etc. The smaller defects in size can be ignored if that cannot be seen clearly in the garment. Some times these minor defects can be ignored, if the hole or slub or stain mark or missed yarn is in a hidden area or under part / lining or can be covered it by a stitching or by attaching (in a seam allowance) or by embroidering or by printing (especially stain marks) then the defect would be negligible. Such defects do not need to be replaced.

For an example, following defects shown in figure 4.6 would be acceptable.
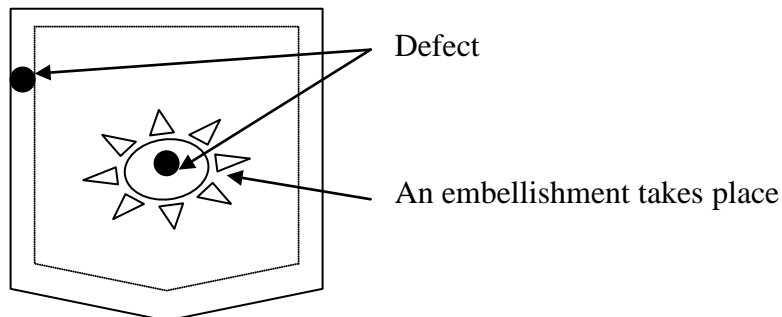
Figure 4.6 – Acceptable defects in a panel.

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Sometimes, a smaller part can be cut from a defect panel as shown in figure 4.7.

Defect   smaller panel
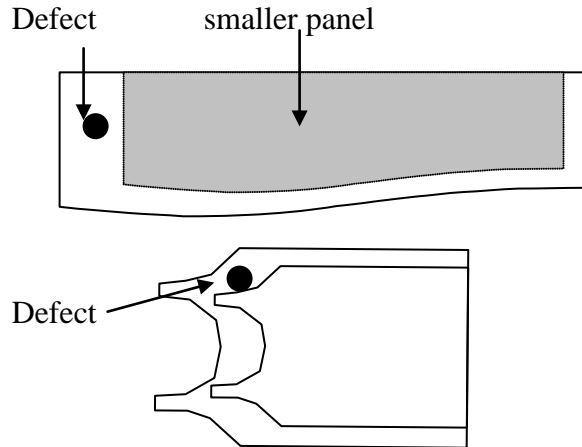
Figure 4.7 – Getting smaller parts from defect panels.

4.13.2   Foreign yarn / Stain marks

Foreign yarn can be removed by picking it up very carefully. Some stain marks also can be removed by washing. It is better to remove foreign yarns and stain marks rather than replacing a panel, and it is easy.

4.13.3   Colour shading / Brush effect

The colour shading or brush effect some times exists among batches, rolls, even in distinct places in a roll.
To over come these defects can be prepared shaded markers or small cut layers may be one or two garments per layer.
If the colour shading or brush effect exists with in a roll as shown in figure 4.8 (place to place shading), the best marker type is sectional marker, one-way marker.
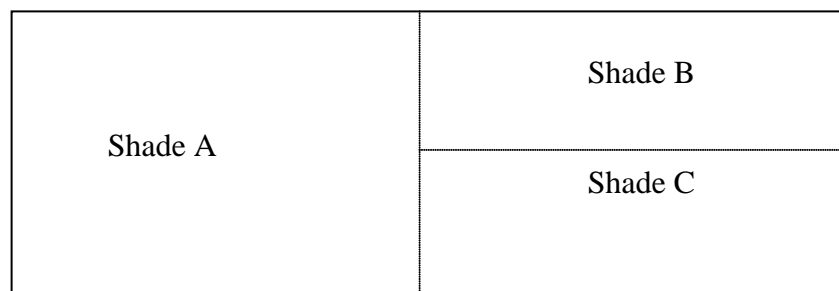
Figure 4.8 – A fabric piece with shade variations.

Panel replacement for other defects in shade -varied fabrics, is very difficult, but it could be done very carefully by matching the colour.

4.13.4   Un even repeats

Un-even repeats will make a significant damage if the garment needs to match the repeats according to the buyer / design. The sleeve pairs shown in figure 4.9 are not balanced.
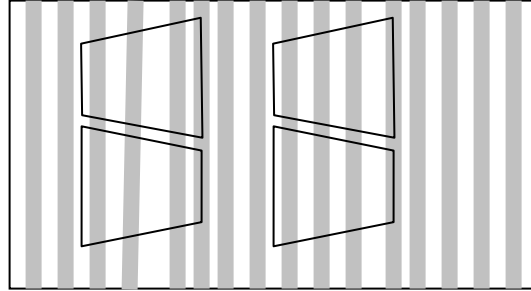
Figure 4.9 – A fabric piece with uneven repeats.

When spreading this type of fabric, it is advisable to remove the defect area and lay them separately by balancing the panels or go for panel replacement with an excessive care.

4.13.5   Crease lines

Some tubular knitted fabrics have visible crease lines along the fabric. Sometimes, this is can be recovered by pressing and steaming. Some times it is difficult and cost consuming.
In these cases a special marker (sectional) has to be used, which have a low efficiency. Here the sectional marker avoids the crease line. The marker is divided in to two or more, and can be drawn separately as shown in figure 4.10. Here, the fabric fall out is significantly high.
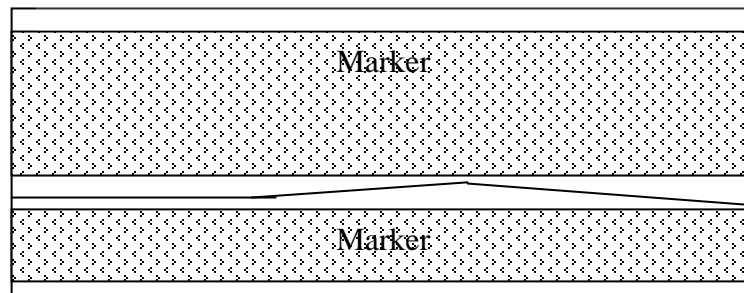
Figure 4.10 – A fabric piece with crease lines.

If the crease line is non- constant, that it is not parallel to the edge or placed in variable places (middle / left / right), then the wastage becomes very high.

In this way it is clear that the fabrics, which have high fault rate can also be used. However it would not achieve a better fabric utilization, but it reduces the fabric wastages in other way, and shows a capability of a better cutting room management.

4.14 Calculation of the amount of fabric waste by fabric fault

The fabric requirement for panel replacement can be calculated even after doing 100% panel inspection and removing defected panels. This can only be carried out at the end of the process, which would not have enough time to do recoveries. Thereby the best way of doing this is to calculating the defects in advance. It is not easy to forecast an accurate figure regarding to loss quantity of fabric.

4.14.1 Method I

After doing all panels inspection by the fabric supplier or garment producer, then can be calculated the loss in two ways.

4.14.1.1 Considering the weight

Let's take the weight of the defect panels is $= D$ kg.
The GSM of the relevant fabric is $= G$ kgm^{-2}
The width of the relevant fabric is $= W$ m

Thereby the lost length due to fabric defects is $= D / (G \times W)$
This is excluding the fabric fallout.
The marker efficiency is $= E$ %

Therefore the actual fabric lost should be $\dfrac{D \times 100}{G \times W \times E}$ meters

4.14.1.2 Counting the number of defect panels

The total number of defect panels $= N$
Number of panels for a garment $= n$
The fabric consumption / garment $= C$ m/pc

Therefore loss of fabric due to defects $N \times C / n$ meters

If the fabric has shade variation, when replacing, either that can match the shade with the defect panel or remove all panels of the garment, which belongs to the defect panel. The above two methods can be done only at the end of the process and fabric replacement would be delayed and would be useless. Therefore it is no point to ask fabric for replacement at the last moment other than if the fabric supplied excessive at the initial deliveries, and the fabric supplier has to agree to pay for the loss quantity of garments by considering,

Fabric loss due to defects,
Cost of garment quantity of order short,
Cost of excess trims and other material due to order short,
Panel inspection cost if done by garment manufacturer,

Advantages
- Exact amount of defects can be calculated.
- Can be asked additional (without estimating) fabric for replacement in advance.

Disadvantages
- Not enough time to recover the, fabric if additional fabric is not received in advance.
- Loss of goodwill due to short shipments.
- Has to collect the defects up to end of the process.
- No much support for colour shading problem.
- The actual picture would not display.

4.14.2   Method II

The second method is calculating after doing a panel inspection of pilot (first) cut. The first cut may be 300 garments or 600 garments or any quantity considerably lesser amount than the total order. By considering this sample inspection, the total extra fabric requirement can be forecasted by using one of the above two methods.

Amount of fabric length required to replace the defects of pilot cut quantity of N is "L" m. Consider the total order quantity is P.

Then the Total replacement should be $= P \times L / N$ meters.

Advantages
- Can recover the fabric loss in advance.
- Can lay and cut the recovered fabric with the bulk.

Disadvantages
- This method is just a way of forecasting.
- If the latter batches having higher fault rates than the first batches, it would be a problem.

4.14.3   Method III

Another forecasting method is to calculate defects based on the fault rate identified at the fabric inspection.

Lets consider the fault rate per meter of fabric is $= R$ Nos/m
The fabric consumption for a garment is $= C$ m/pc
Number of panels for a garment is $= n$
The total fabric received is $= F$ m.

The defect quantity in a "garment consumption" $= R \times C$
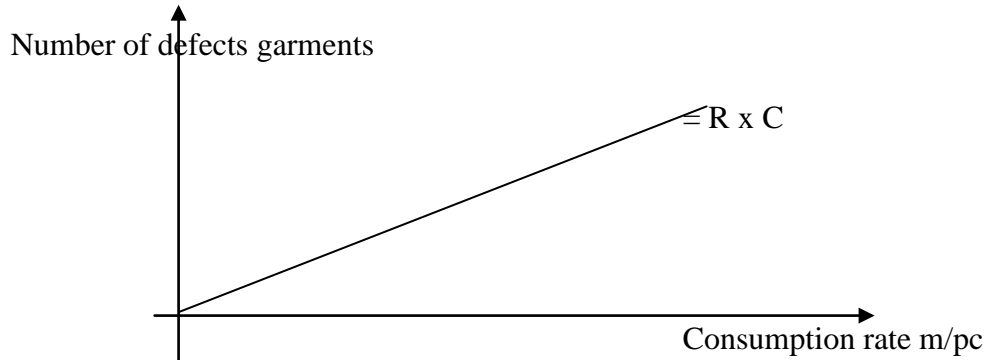
Graph 4.10 – Defect garments vs. Consumption.

When the consumption increases number of defect garments also increases.

The total number of defects would be	$= F \times R$ defects.

This number of defects would be appeared in panels that should be removed later.
The average number of garments would be represented (and rejected).

	$= F \times R / n$
Amount of fabric required to replace the above quantity	$= C \times F \times R / n$

Actually one or more defects may fall in to one panel and one defect may fall in to one or more panels. When forecasting, this can be ignored. Also some defects may be fall in to the wastage (marker fall out), where the occurrence of that possibility is = 1 – Marker efficiency.

The possibility of a defect fall in a panel is = Marker efficiency

$$= E \%$$

The fabric requirement would be	$= C \times F \times R \times E / 100 \times n.$

When re-cutting, it has to be carried out by manually. That may need 1.5 times of fabric than the normal cutting.

Therefore the actual requirement would be	$= 1.5 \times C \times F \times R \times E / 100 \times n.$

If the garment has to be washed then the fabric defects may be higher as some of these defects can be identified after washing only. Those can be calculated after washing the whole lot of garments or sample and to be recovered as above.

The fabric loss can be replaced as above. However the labour cost, for additional spreading, cutting, re-cutting, sewing (especially in wash garments) etc must be recovered. This should be agreed with the supplier to recover.

4.14.4 Method IV

Defects can be calculated by considering the final inspection in garment form, with an agreement of supplier. This method is totally a waste, since at that time a lot of value addition had done. However, if there is no any other option than this, then can follow this method and can recover the FOB cost of the garment.

4.15   The role of shortage at cutting room?

Shortage means that a roll doesn't have the stated length, which, may or may not display on the inspection machines because of some tension that can be applied. Therefore it is difficult to measure a shortage by using an inspection machine.

The best way of calculating shortage for knit fabric is to get weights of all individual rolls at the receiving time and compare with the packing list, which comes from the supplier. Subsequently, the GSM of all rolls must be calculated and compared with the GSM stated in the packing list, and also check the shrinkage percentage with the stated. If any one of those is not tallied with the packing list then there should be a shortage or excess.

The cutting room management has to agree with the supplier to recover the fabric shortages. For the recoveries to be made more than a certain percentage of shortage must be negotiated with supplier at the contract.

For an example, normally, only 4% or higher shortages would be recovered by the supplier.

Following (table 4.11) are some figures of shortage calculation of style 4416, an order, which was cut and completed at Hirdaramani Mercury (Pvt) ltd katunayake in May, 2006.

Fabric supplier   Hayleys MGT Knitting Mills (Pvt) Ltd.
Fabric   100% Polyester fleece fabric.
Colour   Blue,   Colour number DE05009D
Batch No.   09998
Quality No.   TPE241

Table 4.11 – Shortage calculation for style number 4416.

Roll no.	Stated				Length (m) at layering	Width (cm)	Weight (kg)	GSM g/m2	Length short / excess %	Weight short / excess %
	Length (m)	Width (cm)	Weight (kg)	GSM g/m2						
-8713	41.0	148	18.23	300	38.8	148	18.13	310	-5.4%	-0.5%
-8714	39.2	148	17.43	300	39.2	148	17.43	300	0.0%	0.0%
-8715	46.0	148	20.45	300	44	148	20.45	307	-4.3%	0.0%
-8718	41.7	148	18.54	300	39.5	148	18.45	310	-5.3%	-0.5%
-8719	41.8	148	18.59	300	41.8	148	18.59	300	0.0%	0.0%
-8720	42.0	149	18.81	300	40	149	18.75	308	-4.8%	-0.3%
-8721	43.1	148	19.17	300	40.8	148	18.67	310	-5.3%	-2.6%
-8725	44.0	148	19.56	300	44	148	19.56	300	0.0%	0.0%
-8726	41.6	147	18.37	300	40.3	147	18.37	305	-3.1%	0.0%
-8727	40.2	148	17.87	300	40.5	148	17.87	300	0.7%	0.0%
-8729	39.4	148	17.52	300	38.2	148	17.22	304	-3.0%	-1.7%
-8730	36.3	149	16.25	300	35.5	149	16.25	304	-2.2%	0.0%
-8733	43.5	147	19.21	300	43.8	147	19.21	300	0.7%	0.0%
-8734	42.7	148	18.99	300	40.5	148	18.49	308	-5.2%	-2.6%
-8735	40.5	148	18.01	300	40.5	148	18.01	300	0.0%	0.0%
-8736	38.1	149	17.06	300	37.2	149	17.06	302	-2.4%	0.0%
-8738	45.6	146	20.00	300	45.6	146	20.00	300	0.0%	0.0%
-8740	44.1	147	19.48	300	42.8	147	19.48	305	-2.9%	0.0%
-8741	43.2	148	19.21	300	43.2	148	19.21	300	0.0%	0.0%
-8742	40.5	148	18.01	300	40.3	148	18.01	301	-0.5%	0.0%
-8744	39.6	148	17.61	300	39.6	148	17.61	300	0.0%	0.0%
-8749	36.8	148	16.36	300	37	148	16.36	300	0.5%	0.0%
-8750	44.0	147	19.43	300	43.1	147	19.43	301	-2.0%	0.0%
-8751	46.1	146	20.22	300	45.8	146	20.22	301	-0.7%	0.0%
-8752	43.6	148	19.39	300	42.2	148	19.39	304	-3.2%	0.0%
-8755	41.5	148	18.45	300	41.7	148	18.45	300	0.5%	0.0%
-8761	39.9	148	17.74	300	37.8	148	17.74	307	-5.3%	0.0%
-8766	40.2	148	17.87	300	40.2	148	17.87	300	0.0%	0.0%
-8767	41.3	148	18.35	300	39.1	148	18.35	308	-5.3%	0.0%

Sometimes a length shortage exists, even the weight is correct, so it implies that the stated GSM is not available, and / or stated shrinkage is not exists.

Also sometimes a weight shortage exists, even the length is correct, so it implies that the stated GSM is not available, and / or stated shrinkage is not exists.

The above figures say that the actual amount of fabric shortage does not define the length shortage and also not the weight shortages.

So, if the fabric amount is not available according to the label, then it spoils the cut order plan, which planned in early stages to achieve higher fabric utilization.

4.16 The role of the pattern engineering for "higher fabric utilization"

There are several ways to do pattern engineering in the mean of getting high fabric utilization through high marker efficiency. Some of the pattern engineering types are

Corners rounding
Reducing sewing allowances
Turning hidden parts
Adjusting dimensions
Parts Separation or merging
Removing buffer.

4.16.1   Rounding corners
In this survey the author found following details in table 4.12, by rounding corners.

Table 4.12 – Values taken by rounding corners.

Item	Width of material	Normal marker		Engineered marker		No of sizes/ marker
		Length	Efficiency	Length	Efficiency	
T Shirt	178 cm	6.05 m	87.98%	6.04 m	**87.97%**	20
T Shirt	174 cm	5.61 m	84.35%	5.55 m	85.31%	16
T Shirt	168 cm	4.31 m	86.75%	4.23 m	88.35%	14
T Shirt	180 cm	4.47 m	86.36%	4.39 m	87.91%	12
T Shirt	172 cm	3.99 m	88.01%	3.95 m	88.80%	10
T Shirt	166 cm	5.76 m	80.21%	5.60 m	82.37%	16
T Shirt	178 cm	4.78 m	87.87%	4.77 m	88.01%	15
T Shirt	172 cm	5.06 m	86.25%	5.04 m	86.55%	13
H/Top	166 cm	6.02 m	81.25%	5.99 m	81.57%	14
L/s Top	178 cm	5.76 m	79.67%	5.70 m	79.76%	12
Shirt	155 cm	5.32 m	81.03%	5.23 m	81.99%	9
Shirt	152 cm	6.78 m	80.00%	6.68 m	81.09%	14
Shirt	150 cm	6.02 m	83.04%	5.92 m	84.31%	13
Shirt	148 cm	5.97 m	82.21%	5.91 m	83.00%	11
Shirt	144 cm	5.43 m	80.97%	5.35 m	82.03%	10
Shirt	146 cm	4.34 m	82.35%	4.25 m	84.01%	8
Shirt	148 cm	6.51 m	83.02%	6.36 m	85.00%	12
Shirt	150 cm	3.26 m	81.56%	3.24 m	81.99%	6

Shirt	151 cm	5.97 m	84.00%	5.86 m	85.50%	11
Shirt	152 cm	5.43 m	83.27%	5.32 m	84.96%	10
Skirt	163 cm	4.62 m	77.61%	4.56 m	77.90%	16
Skirt	162 cm	8.20 m	76.98%	8.08 m	78.06%	18
Skirt	161 cm	9.98 m	78.65%	9.92 m	79.09%	20
Skirt	164 cm	8.79 m	77.25%	8.59 m	79.01%	15
Skirt	160 cm	7.62 m	77.03%	7.43 m	78.94%	16
Short	160 cm	5.67 m	85.03%	5.61 m	85.50%	20
Pant	158 cm	5.35 m	82.98%	5.30 m	83.10%	12
Jogger	178 cm	5.79 m	80.01%	5.72 m	80.25%	16
Jogger	178 cm	9.27 m	83.02%	9.05 m	84.96%	12
Jogger	180 cm	7.82 m	82.94%	7.69 m	84.35%	10
Jean	178 cm	6.45 m	81.99%	6.32 m	83.64%	8
Pant	178 cm	5.98 m	84.00%	5.92 m	84.77%	8
Pant	176 cm	8.25 m	86.35%	8.13 m	87.56%	11
Pant	178 cm	7.9 m	84.78%	7.88 m	84.98%	10
Pant	176 cm	7.45 m	81.25%	7.27 m	83.22%	10
Pant	178 cm	8.92 m	78.95%	8.91 m	**78.94%**	20

The rounding corners done as follows.

      T shirts   - Corners of vent, pocket, sleeve hem, buggy, etc.
      Shirts   - Corners of placket, cuff, sleeve, collar, pocket, etc.
      Skirts   - Corners of waistband, pocket, bottom hem, etc.
      Pants/ Joggers- Corners of waistband, bottom hem, pocket facing, etc.
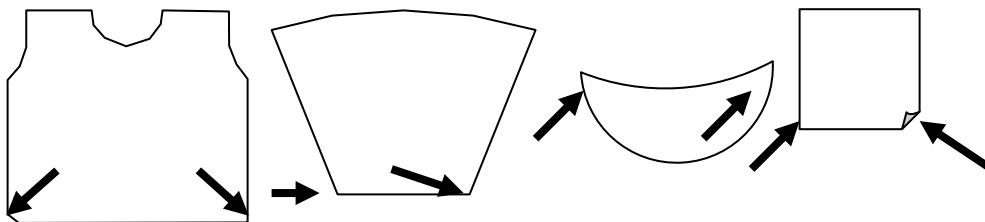
Figure 4.11 – some panels that can round the corners.

The above table 4.12 shows
- All marker lengths have become less.

- Marker efficiency normally became higher however it has become low in some cases.
- Same number of sets per marker.
- Fabric consumption per garment has become less.

Even though the fabric utilization is higher, the marker efficiency has become less in some styles. If we look at the first line and the last line of the table 4.12, it shows a drop in marker efficiency but shows a lower length. Therefore, in this method sometimes the marker efficiency doesn't show a correct picture.

Let's consider

W - width of the a marker
L1 - Original length of the marker
L2 - Changed Marker length.
E1 - Efficiency of original marker.
E2 - Efficiency of changed marker.
A1 - Total area of the original marker
A2 - Total area of the pattern engineered marker.
X1 - Area of the pattern pieces of the original marker
X2 - Area of the pattern pieces of the engineered marker.

Always	L1	>	L2
Since W is same	WL1	>	WL2
That is	A1	>	A2
And	X1	>	X2 very close.
So	X1 / A1	> = <	X2 / A2
That is	E1	> or = or <	E2

The marker efficiency doesn't show the correct picture at pattern engineering, even though the length of the marker is short.
The rounding corners, is carried out mainly in terms of improving the fabric utilization.

However, very often X1 is very close to X2, therefore it is possible to consider X1 = ~X2, by considering the A1 & A2.

Then   E1   <   E2

4.16.2   Reducing sewing allowance

Before reducing the sewing allowance the cutting room management Should know about the stitch type. For an example reducing seam allowance for four-thread over-lock seam is cannot be done. A front panel of a ladies T shirt

Following exercises has been carried out for the styles in table 4.13 by reducing the sewing allowances,

Table 4.13 – Values taken by reducing sewing allowances.

Item	Width of material	Normal marker		Engineered marker		No of sizes/ marker
		Length	Efficiency	Length	Efficiency	
T Shirt	180 cm	3.75 m	89.82%	3.61 m	89.57%	15
T Shirt	179 cm	4.65 m	87.64%	4.50 m	**87.84%**	15
Shirt	164 cm	2.80 m	86.65%	2.65 m	**86.98%**	8
Shirt	158 cm	3.90 m	87.50%	3.75 m	87.36%	10
Skirt	165 cm	3.84 m	91.20%	3.81 m	90.99%	16
Pinafore	145 cm	4.20 m	78.92%	4.15 m	**79.07%**	12
Trouser	148 cm	5.41 m	82.36%	5.27 m	82.28%	12
Short	148 cm	4.25 m	84.78%	4.12 m	84.70%	20
Dungaree	148 cm	3.50 m	79.79%	3.46 m	**79.91%**	10
Pram suit	178 cm	2.40 m	81.54%	2.39 m	81.47%	16

A higher percentage can be achieved by reducing all types of hem width. Here also the marker efficiency doesn't play a required role, but the Marker lengths are decreased considerably. Therefore the fabric utilization became higher.

Again consider,

Always		$L1$	$>$	$L2$
Since W is same		$WL1$	$>$	$WL2$
That is		$A1$	$>$	$A2$
And		$X1$	$>$	$X2$

So $\quad\quad\quad X1 / A1 \quad\quad > = < \quad\quad X2 / A2$

That is $\quad\quad\quad E1 \quad > \text{ or } = \text{ or } < \quad E2$

Where,

W - width of the a marker
L1 - Original length of the marker
L2 - Changed Marker length.
E1 - Efficiency of original marker.
E2 - Efficiency of changed marker.
A1 - Total area of the original marker
A2 - Total area of the pattern engineered marker.
X1 - Area of the pattern pieces of the original marker
X2 - Area of the pattern pieces of the engineered marker.

4.16.3 Turning of hidden parts

Normally pattern pieces must be placed in a certain direction, namely along the grain line. It creates the drape ability, avoids the spirallity and many other properties. Thus, this criteria waste more fabric. Some pattern pieces can be turned slightly against the grain line, without creating a noticeable change to the garment. Then some fabrics can be saved. Some parts that can be turned are,

Small parts such as coin pockets, appliqués,
Hidden parts such as some under arm parts (if available),
Inner parts such as pocket bags, inner waistbands, etc

Following exercises have been carried out for styles given in table 4.14 by turning some parts.

Table 4.14 – Values taken by turning of hidden parts.

Item	Width of material	Normal marker		Engineered marker		No of sizes/ marker
		Length	Efficiency	Length	Efficiency	
Short	160 cm	6.00 m	88.12%	5.91 m	89.46%	20
Short	149 cm	6.44 m	86.24%	6.35 m	87.50%	20
Trouser	154 cm	7.85 m	89.36%	7.75 m	90.57%	14
Trouser	158 cm	6.84 m	87.52%	6.77 m	88.37%	12
Skirt	145 cm	5.91 m	80.20%	5.81 m	81.57%	20
Skirt	148 cm	5.92 m	78.90%	5.80 m	80.47%	16
Pinafore	148 cm	6.57 m	80.63%	6.48 m	81.72%	12
Pinafore	145 cm	8.58 m	81.73%	8.50 m	82.47%	14
Dungaree	148 cm	5.35 m	76.27%	5.31 m	76.86%	8
Dungaree	158 cm	4.81 m	80.25%	4.76 m	81.10%	10

Always this brings higher marker efficiency, while the pattern area is same for both markers.

4.16.4 Adjusting dimensions

Adjusting dimensions must do without any noticeable change to fit and style. There is a certain tolerance given by the buyer to the fit for each style. Taking that advantage the dimensions can be reduced. When adjusting dimension of one panel, it is necessary to do two more other panels also.

Mostly the dimensions can adjust for pocket bags, buggies, etc very easily.

Table 4.15 – Values taken by adjusting dimensions.

Item	Width of material	Normal marker		Engineered marker		No of sizes/ marker
		Length	Efficiency	Length	Efficiency	
Short	160 cm	6.14 m	87.22%	5.91 m	89.46%	20
Trouser	154 cm	6.85 m	88.36%	6.74 m	91.15%	14
Skirt	145 cm	5.91 m	80.20%	5.78 m	82.18%	20
Pinafore	148 cm	6.57 m	80.63%	6.50 m	82.11%	12
Dungaree	148 cm	5.35 m	76.27%	5.32 m	76.61%	8

4.16.5   Parts separation & Merging

Sometimes, there is a chance to divide some parts in to two or three. In the same way two or three parts can merge together. By both these ways that can be improved the marker efficiency.

Table 4.16 – Values taken by parts separation and merging.

Item	Width of material	Normal marker		Engineered marker		No of sizes/ marker
		Length	Efficiency	Length	Efficiency	
Merging						
Short	160 cm	6.00 m	88.12%	5.94 m	89.00%	20
Short	149 cm	6.44 m	86.24%	6.38 m	87.04%	20
Skirt	145 cm	5.91 m	80.20%	5.87 m	80.73%	20
Separation						
Skirt	148 cm	5.92 m	78.90%	5.83 m	80.00%	16
Pinafore	148 cm	6.57 m	80.63%	6.49 m	81.61%	12
Pinafore	145 cm	8.58 m	81.73%	8.55 m	82.02%	14
Dungaree	148 cm	5.35 m	76.27%	5.27 m	77.40%	8
Dungaree	158 cm	4.81 m	80.25%	4.70 m	82.07%	10

4.16.6   Removing buffer

By removing the buffer, the author got following results in the table 4.16. At a cut mark or a turning point – the cutters require a buffer space especially, when using an automatic cutter, as for knife clearance. This can be removed by changing the cutting machine to manual.

At a curved cut – This buffer is also can be removed by using a manual cutter or controlling the automatic machine, using mirror cut or using a lesser speed.
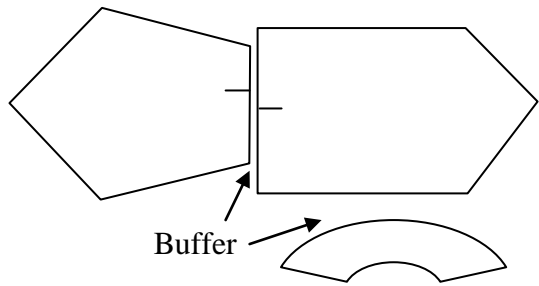
Figure 4.12 – Buffer allowance.

The results of some exercises carried out at Hirdaramani Mercury (Pvt) Ltd., Katunayake, are given in table 4.17. The subjected patterns are Children's and adult's garments where some are body fabric some are contrast.

Table 4.17 – Values taken by removing buffer.

Item	Width of material	Normal marker		Engineered marker		No of sizes/ marker
		Length	Efficiency	Length	Efficiency	
T shirt	184 cm	2.87m	91.25%	2.85m	91.89%	10
T shirt	182 cm	3.99m	89.27%	3.96m	89.85%	16
Pant	182 cm	8.09m	85.65%	7.98m	86.83%	12
T shirt	180 cm	2.89m	93.11%	2.88m	93.43%	12
Shirt	180 cm	6.55m	88.78%	6.49m	89.60%	10
Skirt	180 cm	4.27m	84.81%	4.25m	85.21%	9
Pant	178 cm	8.15m	82.46%	8.00m	84.01%	11
T shirt	178 cm	2.98m	91.00%	2.95m	91.93%	8
Shirt	175 cm	4.95m	89.56%	4.91m	90.29%	12
Skirt	174 cm	5.67m	85.45%	5.6m	86.52%	10
T shirt	172 cm	2.12m	92.45%	2.1m	93.33%	8
T shirt	172 cm	2.33m	93.41%	2.31m	94.22%	8
Pant	172 cm	8.46m	79.54%	8.39m	80.20%	11
Pant	172 cm	9.25m	82.41%	9.11m	83.68%	12
T shirt	170 cm	3.87m	88.56%	3.85m	89.02%	10
Shirt	170 cm	6.12m	82.46%	6.03m	83.69%	12
Pant	168 cm	8.61m	80.61%	8.55m	81.18%	11
Pant	166 cm	6.16m	78.20%	6.13m	78.58%	9
Shirt	164 cm	6.14m	81.25%	6.10m	81.78%	12
Pant	160 cm	7.16m	80.64%	7.11m	81.21%	13

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4.16.7   The short- comings of pattern engineering process

- Pattern makers have to re draw the patterns.
- Marker makers have to re-draw the markers.
- Need an extra effort for cut planning and cutting.
- There is a tendency to non- attaching places at stitching, when rounding corners or reducing sewing allowances.
- The stitched garments can be deviated from the required shape of the pattern.
- The stitched garments can be deviated from the required measurements.
- Stitching must be done very carefully.
- An extra effort and a cost would be incurred at stitching
- Cutters must be professional enough to cut the rounded corners, to achieve the required task.
- The after wash shrinkage effect must be considered.

Anyway the pattern engineering helps greatly to increase the fabric utilization.

4.17   Does the marker making play a vital role in fabric saving?

As in the introduction there are several types of marker making methods. However all the types do not give a gain but each type has special features that can get a maximum gain in terms of overcoming fabric faults and other difficulties.

4.17.1   Half garment markers

The table 4.18 contains half garment markers for children Raglan T – shirts, which are range of 3 years to 8 years of a style done at Hirdaramani Mercury Apparel (Pvt) Ltd. Katunayake. Here the lay time is calculated only for just lay and cut the end by an end cut machine. Here the preparation time, fabric receiving time from the rack etc are not calculated.

Table 4.18 – Values for half garment marker.

No of sizes in the marker	Half width (usable) (cm)	Marker length (m)	Marker Efficiency %	Time taken to lay 10 plies
3	71 cm	1.05 m	60.1 %	9 seconds.
4	73 cm	1.36 m	63.0 %	10 seconds.
7	74 cm	2.23 m	65.6 %	16 seconds.
5	70 cm	1.67 m	64.2 %	13 seconds.
6	68 cm	2.04 m	66.1 %	15 seconds.
7	68 cm	2.32 m	65.1 %	18 seconds.
8	67 cm	2.68 m	65.2 %	19 seconds.
6	70 cm	1.99 m	66.7 %	15 seconds.
5	71 cm	1.66 m	63.3 %	13 seconds.

Advantages
- Ideal for fabrics having slipping surface.
- Good for tubular fabric, rather than slitting.
- Good for fabrics which have a crease line in the middle.
- Good for patterns where the parts have mirror effect or in symmetric pairs.

Disadvantages
- Low efficiency and high fabric requirement.
- Difficult to lay long lengths.
- An extra time is required to lay than a normal marker.
- Spreading and cutting must be carried-out by professionals.
- Can be used only for styles, which have symmetric pattern pieces, that are every panel should have a mirror panel. The garments, which are not in this manner are cannot be

laid in this way. For an example, a gent's pant has a fly "J", these types of patterns cannot be cut using a half garment marker.

Similarly patterns of some skirts, shorts, shirts (due to front placket and single pocket) etc cannot be drawn.

4.17.2   Full garment markers - Single size markers

This marker contains markers for only one size of a garment. Especially these markers can be used to cut the remnants pieces by means of meeting the order quantity exactly.

Example
The marker lengths of single size markers are as follows,

Table 4.19 – Some single size markers.

Size	S	M	L	XL
No of sets	2	3	2	2
Marker length	0.80 m	1.25 m	1.01 m	1.05 m
Lay length	0.84 m	1.29 m	1.05 m	1.09 m
Marker Efficiency	71.6 %	73.2 %	69.6 %	71.7 %
Fabric wastage as end allowance %	5.0 %	3.2 %	4.0 %	3.8 %
Time taken to spread 10 plies	8 seconds	9 seconds	8 seconds	9 seconds

Advantages
- Lay planning is easy as the size wise order quantity can be managed very easily.
- Fabric spreading is very easy as this requires a small lay length.
- The remnants (balance fabric pieces at the end of rolls after laying longer length markers) can be used effectively.
- Can use for fabrics with high shrinkage properties.
- It is possible to use for styles, those have matched parts with stripes and checks, with skew-ness or bowing.
- Can use for high fault rate fabrics, as the defects can be removed while spreading.
- Need only small space to lay.
- No need to lay by professionals.

Disadvantages
- Marker efficiency is significantly low.
- Material requirement is high.
- Spreading time is significantly high.
- End allowance wastage is high relative to the lay length.

4.17.3   Full garment markers - Multi size markers

This contains two or more sizes in one marker. There are three types of multi size marker, namely sectional marker, interlocking marker and mixed multi size marker.

Table 4.20 – Figures of a same size set drawn Sectional, Interlock and Mixed markers.

Marker type	Sectional	Interlocking	Mixed
No of sets	6	6	6
Marker length	3.36 m	3.26 m	3.12 m
Lay length	3.40 m	3.30 m	3.16 m
Marker Efficiency	76.1 %	78.4 %	81.9
Marker making time	40 minutes	51 minutes	69 minutes

4.17.3.1   Sectional marker
A sectional marker has separate sections for each size, as figure 4.13.
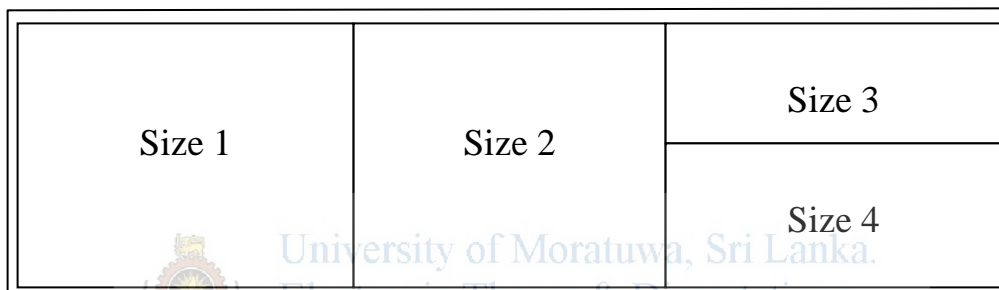
Figure 4.13 – Sectional marker.

Advantages
- It is possible to use for shade variation (length wise and width wise) fabrics.
- Lay planning is easy.
- It is possible to use for step layers, to meet the ratio requirement of the customer.
- It is possible to use for stripes and check fabrics or printed fabrics. As some times those fabrics require smaller length markers.
- It is possible to use for fabric remnants.
- The fabric faults can be avoided.
- When spreading and cutting can be used any size first and the others can be kept for latter cutting.
- Changes of size combination can be done at marker making.
- Joints can be introduced easily at fabric spreading and no need to over lap - splices.

Disadvantages
- Marker efficiency is low than normal markers.
- Fabric wastage is high.
- Marker making time is somewhat high.
- Need professional layers to lay.

4.17.3.2   Interlocking marker

This is also a sectional marker, but there are no straight lines to separate sizes.

Advantages

- Marker efficiency is somewhat higher than a sectional marker.
- Fabric utilization is somewhat high.
- It is possible to separate size wise, and cut any required size in first.
- Ideal for fabrics having shade variations – shaded markers.
- It is possible to use joints even in shade variation fabric.

Disadvantages

- Lower marker efficiency than the mixed markers.
- No better solution for fabric faults.
- Need professional layers and cutters to lay and cut.
- Difficult to use for stripe or check or printed fabrics.
- Markers are having long lengths.
- Splice marking is not so easy when using joints.

4.17.3.3   Mixed multi size marker

There are several ways to make this kind of markers depending on the marker maker, and there may be several options that give maximum benefit in terms of fabric utilization, spreading and cutting methods etc.

Advantages

- Higher marker efficiency.
- Higher fabric utilization
- Easy to cut a large number of sizes with large quantities.
- It is possible to use joints.

Disadvantages

- Difficult to mark splices.
- Spreading is average in difficulties; long lengths have to be layered.
- Large remnant pieces can be occurred.
- Professionals must do spreading, cutting and bundling.
- No better solution for fabric faults.
- Difficult to lay stripe, check or printed fabrics.

All the above markers can be drawn as One way marker or Two way (both ways) marker, where one way marker is useful for brush effect, fleecy, velvet fabrics to avoid the brush differences, colour shading, barre, etc.

4.17.4   One-way marker

All the parts are aligned to one direction in this marker.

Advantages
- It is possible to use for shade varied, fabrics.
- Ideal for fleece or fur fabric (brush effect)
- Ideal for some printed or check or stripe materials as per design.

Disadvantages
- Marker efficiency is low when considering a normal marker.
- Fabric requirement is higher than normal marker.
- Difficult to use joints.
- Difficult to do cut order plan.
- Long spreading lengths.
- No better solution for some fabric faults.

4.17.5 Two-way marker – Normal mixed marker

Here all the panels of a single size are aligned to one direction and the other sizes are aligned to the opposite or same.

Advantages
- High marker efficiency can be achieved.
- High fabric utilization can be gained.
- The output of the cut plan would be high.
- It is possible to use joints.

Disadvantages
- Need professionals to lay, cut and bundle.
- It is impossible to use for shade-varied fabrics.
- Difficult to mark splices to use joints.
- Large remnant pieces can be occurred.
- Cannot cut the urgent sizes first.
- Difficult to do cut order plan.
- Difficult to match stripe, check or printed fabric.
- No better solution for fabric faults.
- Markers are longer lengths.

In this way the appropriate marker type can be selected by considering the following facts.

Maximum utilization of fabric.
Over come the fabric faults.
Available space.
Available manpower.
Available time.
Available other resources.

4.18   What are the advantages and disadvantages of cost marker methods?

4.18.1   Cost with a single marker
An example for a denim skirt – children's garment – dept. T74 is shown in figure 4.14.
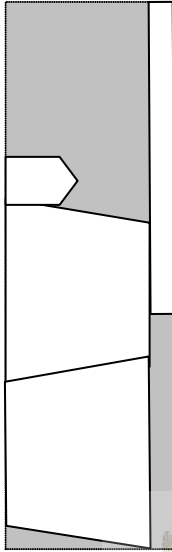
Figure 4.14 – A single normal marker.

The Marker in the figure 4.14 is a normal marker and its length is 0.40 m per garment giving the marker efficiency of 58.7% with the width of 150 cm.

Now can go ahead, with the existing information and past records.
Actual area taken by the skirt 0.40w X 58.7%   = 0.2348w m^2.
Where w is the width of the fabric. (w = 150 cm)

By looking at the past records, the average marker efficiency of a department T74 children wear – denim skirt is 88% for the width = 150cm.
By keeping 1% for the unexpected circumstances, then the marker length can be taken as,
                     = 0.2348w / w 87%   (where w= 150 cm)
The marker length   = 0.27 m / gmt.

This may be unfair if the fabric would have shaded or brush effect. In that case the marker has to draw one garment one way.
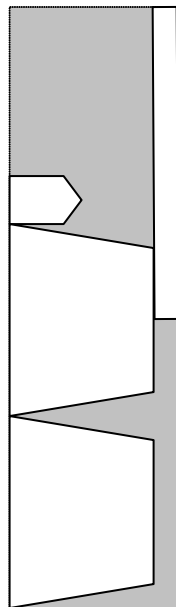
Figure 4.15 – A single one-way marker.

As the marker length is 0.40 m, and the marker efficiency is 58.7%. To over come this problem that can draw two sizes.

By looking at past records that can be seen shaded marker efficiency for a department T74 skirt is 85 % (one way marker).

Therefore the marker length would be $\quad$ = 0.40w X 58.7% / w 85%

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ = 0.28 m./ gmt.

Where w= 150 cm.

When ordering fabric, just add 2% to 7% extra, by considering the supplier evaluation (defect rates, shrinkage level, shortage etc).

If there is no idea on the fabric shade effect, then it is better to go with 0.28m / gmt.

In this case, can negotiate the price of the fabric with the supplier based on the above two markers.

If the order quantity is "a"

Then the fabric requirement as per normal marker $\quad$ = 0.27a

If the unit price fabric is "$" then fabric cost $\qquad$ = 0.27a$

If the fabric would have shaded effect than the fabric requirement would be $\qquad$ = 0.28a.

Need to negotiate with the supplier to buy "0.28a" much of fabric to the value of "0.27a$"

Then the unit price of the shaded effect fabric $\qquad$ = 0.27a$ / 0.28a $\qquad$ = 27$ / 28.

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Advantages

- Easy to draw a marker.
- Time consuming is low.
- Easy calculations.

Disadvantages

- It is difficult to guess the base size (average size) that must be justified for the cost for all other sizes.
- Always gives a low efficiency.
- Must keep past records to compare and for calculations.
- A high risk is existing.

4.18.2 Cost with a Double marker / Average marker

If the width of the fabric is enough to place two marker sets then it is better to find a marker length for one garment by drawing two sets. It gives higher accuracy than the single marker.

4.18.3 Cost with a Single marker from the ratio given

If it is known the order quantity with size break down then can take the average size for the base size to prepare the cost marker.

Example 1

Size	S	M	L	XL	XXL
Quantity	1000	3500	4500	6000	2000

The total qty = 17,000
The base size = L (since L is the medium of the array)

Example 2

Size	S	M	L	XL	XXL
Quantity	500	1500	2500	6000	2000

The total qty = 12,500
The base size = XL (since XL is the medium of the array)

Example 3

Size	4	5	6	7	8	9	10	11	12
Quantity	100	120	240	360	360	360	240	120	100

The total qty = 2,000
The base size = 8 (since 8 is the medium of the array)

Example 4

Size	4	5	6	7	8	9	10	11	12
Quantity	100	150	250	350	400	450	450	200	100

The total qty = 2,500
The base size = 8 or 9 (since 8 & 9 are the medium of the array)

4.18.4   Cost with a Ratio marker
The above calculation can be done for a single size marker. However it is more suitable to draw ratio marker by using actual size break down for the costing purpose also.

Advantages
- More accurate than single or double marker.
- High marker efficiency.
- Low risk at costing.

Disadvantages
- Time consuming to draw a marker.
- If the buyer has changed the ratio while in the progress, it would be a problem.

For the Season Autumn'06 phase-I, Hirdaramani Mercury Apparel (Pvt) Ltd., prepares following cost markers and achieved actual markers as in table 4.21. (Considered only shell fabric, and also ignored pattern changed styles)

Table 4.21 – Comparison of cost and actual ratio markers.

Style #	Item	Cost marker		Actual ratio marker		Deviation %
		Width cm	Consumption m/dz.	Width cm	Consumption m/dz.	
Single markers						
0706	Top	175	4.25	175	3.97	+6.51
1719	Pant	150	8.39	150	7.76	+7.55
1928	Short	145	5.02	145	4.57	+8.96
2060	Top	166	3.10	166	2.76	+10.94
2135	Top	147	4.47	147	4.12	+7.79
2139	Blue Top	180	2.87	180	2.65	+7.73
2139	Red Top	180	2.89	180	2.67	+7.76
2630	Top	178	3.13	178	2.82	+9.98
2951	Gown	150	14.10	150	12.88	+8.68
3255	Pant	149	4.21	149	3.91	+7.20
3255	Pram suit	182	1.86	182	1.72	+7.64
6405	Top	151	4.94	151	4.17	+15.59
6409	Dungaree	158	6.22	158	5.81	+6.62

	Cost width > delivered width					
4107	Top	178	3.56	171	3.74	-5.02
4108	Top	178	2.37	170	2.79	-17.59
	Cost width < delivered width					
2058	Top	180	3.84	186	3.30	+14.03
2142	Top	179	2.63	185	2.22	+15.78
2143	Top	147	4.44	154	3.56	+19.86
6072	Jogger	173	8.14	174	7.26	+10.84
6303	Jogger	144	8.14	148	6.96	+14.44
6308	Jogger	144	8.14	148	6.94	+14.72
6511	Top	180	3.74	185	3.64	+2.70
Double markers						
0294	Top	170	4.00	170	4.06	-1.44
0299	Top	172	4.32	172	4.18	+3.26
0546	Shirt	179	6.85	179	6.61	+3.55
0558	Shirt	182	6.09	182	6.18	-1.56
0706	Top	175	4.25	175	4.00	+5.80
1004	Top	169	4.32	169	4.26	+1.46
2266	Pant	150	12.30	150	11.73	+4.63
2628	Pant	150	7.08	150	6.84	+3.41
2628	Top	170	3.61	170	3.45	+4.30
2629	Pant	144	8.57	144	8.17	+4.72
2631	Top	129	7.47	129	7.14	+4.39
2633	Pant	145	9.46	145	9.15	+3.26
2633	Top	150	6.30	150	5.89	+6.57
4600	Pinafore	180	5.04	180	4.92	+2.37
4628	Pant	171	9.87	171	9.88	-0.12

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4629	Pant	171	9.87	171	9.58	+2.96
5026	Pinafore	147	4.97	147	4.66	+6.15
5027	Skirt	149	2.95	149	2.85	+3.48
5027	Top	170	2.14	170	2.10	+1.75
8013	Dungaree	150	9.43	150	8.94	+5.17
Cost width > delivered width						
2007	Top	178	2.12	171	2.14	-0.89
2046	Top	178	2.64	174	2.59	+1.75
2053	Skirt	178	2.71	170	2.73	-0.81
2055	Top	178	2.22	170	2.26	-1.74
2628	Pant	150	5.64	145	5.78	-2.53
Cost width < delivered width						
1004	Top	169	4.32	180	3.55	+17.76
1557	Pant	168	5.76	180	4.48	+22.23
2250	Top	178	2.32	180	2.25	+2.86
2631	Jean	147	8.20	154	7.15	+12.76
2780	Top	150	2.53	151	2.34	+7.33
3259	Jacket	144	4.18	147	3.90	+6.79
3263	Shirt	144	4.71	147	4.15	+11.86
4019	Hooded	104	6.80	110	6.19	+8.90
4287	Top	162	3.75	169	3.30	+12.00
4415	Shirt	162	5.36	166	5.26	+1.84
4513	Shirt	173	5.14	172	4.96	+3.54
4515	Top	170	4.96	180	4.42	+10.89
6072	Pant	173	8.14	174	8.07	+0.89
8013	Top	158	2.58	160	2.27	+12.19
8806	Jean	148	8.74	150	8.28	+5.23

Ratio markers						
0703	Top	169	4.70	169	4.64	+1.25
1321	Dungaree	182	6.94	182	6.93	+0.16
2004	Top	171	2.20	171	2.19	+0.45
2045	Pink Top	158	2.33	158	2.32	+0.61
2045	Red Top	158	2.42	158	2.39	+1.08
2054	Pant	129	5.15	129	5.11	+0.80
2056	Top	180	2.22	180	2.20	+0.83
2140	Top	147	3.37	147	3.37	+0.07
2141	Skirt	149	4.36	149	4.33	+0.77
2630	Pant	150	7.23	150	7.18	+0.75
2830	Blue Top	178	5.93	178	5.91	+0.34
2830	Pink Top	178	4.05	178	4.02	+0.73
3257	Pant	144	4.14	144	4.13	+0.35
3259	Top	171	2.33	171	2.33	+0.06
3262	Top	170	2.32	170	2.29	+1.45
3263	Vest	185	1.52	185	1.53	-0.86
4138	Pram suit	180	2.46	180	2.44	+1.00
5023	Top	173	2.60	173	2.56	+1.65
5026	Top	166	2.85	166	2.83	+0.58
Cost width > delivered width						
2780	Pant	147	5.56	142	5.71	-2.58
4106	Top	178	3.99	171	4.18	-4.63
Cost width < delivered width						
0548	Dungaree	180	7.84	182	7.76	+1.08
0704	Shirt	152	4.75	171	4.14	+12.78
0907	Top	170	3.49	175	3.38	+3.09

1003	Pant	170	5.88	175	5.55	+5.61
2050	Pram suit	162	2.71	170	2.69	+0.85
2053	Pram suit	168	2.71	184	2.08	+23.18
2056	Short	178	2.05	180	2.02	+1.57
2130	Top	148	3.75	152	3.49	+7.05
2136	Red Top	162	2.76	181	2.55	+7.64
2136	Wht Top	162	2.76	184	2.44	+11.54
2780	Pant	150	2.67	155	2.54	+4.68
3257	Short	145	2.68	152	2.50	+6.56
3262	Jean	144	7.24	152	6.88	+4.98
3294	Jacket	145	10.08	150	9.50	+5.76
3294	Jean	145	5.65	154	5.35	+5.27
4105	Gillette	148	3.69	166	3.21	+12.89
4196	Top	170	7.80	178	7.16	+8.19
4401	Top	170	3.94	192	3.46	+12.16
4403	Top	185	4.82	188	4.75	+1.35
5025	Short	148	3.88	152	3.55	+8.38
6062	Jean	157	8.54	160	8.52	+0.27
7162	Jogger	170	8.55	181	7.49	+12.39

The above figures in the table 4.21 show that,
- Cost ratio marker is more close to the actual marker.
- Cost width of 53 styles out of 106 is changed with the received fabric width.

The above cost marker is used to calculate the cost through bill of materials and to order the fabric, which is done by merchandisers. However providing a low consumption is one of the major responsibilities of a cutting room management. The past records and the experiences are essential to prepare effective cost markers.

Past records must include,

Item type,

Fabric behavior - type, Fabric width, Shrinkage, Fault rate,

Supplier evaluation, etc, Spreading and Cutting method used,

4.19   The type of external reasons, which will disturb the cutting process

There are lots of external reasons, which disturb the smooth process of cutting room. Some of those are listed below, where cutting room management has to be dealt with.

4.19.1   Sample is not ready
The sample must be ready at the beginning of cutting. It is highly useful to prepare pattern, marker, and to identify the fabric type and colour etc. Especially in pattern engineering, it is necessary to see the sample.
Even the sample is not available the cutting room management must have an ability to go ahead with other information received like sketches, fabric swatches, etc. However this may creates an additional cost, and some times losses.

4.19.2   Sample approval is pending
If the sample is pending, there is no right to cut fabric. This delay may cause tighten the situation in cutting room process. This may cause an excess cost at the tight periods like over time, etc. The cutting room management must be in alert on the sample approval.

4.19.3   Buyer is looking for an amendment
This is another barrier for cutting room processes. If an amendment takes place, the cutting room management has to do a lot. He has to,
Increase the marker efficiency by pattern engineering or any other means,
Put the fullest effort to cut the total order from the received fabric,
Avoid the shipment delays.

4.19.4   Order detail is not given
If the order detail is not given by the relevant personal, the cutting room manager must have an ability to collect those as soon as possible. Some of the missing details are Order quantity, the ratio break -down, fabric / interlining to be used, allocated fabric amount, etc. Here also an indirect cost takes place.

4.19.5   Fabric is not available / Fabric received is rejected
This is another loss to the cutting processes. The delayed fabric supplying creates a high tight situation in all aspects in the cutting room. This makes idle time at cutting and leads to losses.

4.19.6   The width of the fabric received is different
This makes to re-draw the markers and may lead to pattern engineering.
Thereby an additional cost will incur.

4.19.7   Received fabric length is short / excess
If the length of the fabric is short, then the order would not be completed. It creates unnecessary paper and manual work and the buyer will not be satisfied.
If the fabric is in excess, then the balance of fabric takes place and it will be an additional cost to the stores, especially if the buyer doesn't agree to purchase the additional quantity.

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4.19.8 Fabric inspection has not been carried out
It is a high risk to cut the non-inspected fabrics, which would be a great loss.

4.19.9 Fabric test report is not given
The cutting room management must know the test status of the fabric before starting the cutting process.

4.19.10 High fault rate fabrics / inconsistent fabric
This is a highly effective problem that a cutting room management has to face, which incurred with a high unnecessary cost, as most of the time fabric is accepted even it has a high fault rate.

4.19.11 Higher target required by the sewing room
Some fabrics such as stripes and trimmings have to undergo a special operation in the cutting process. Therefore it is difficult to supply a higher requirement with in a short period to the sewing room.
However the cutting room management must have the ability to analyze the work and make necessary allocations for the workforce.

4.19.12 Maintenance not carried out
This would be a serious problem, as high cost machineries are available in the cutting room, therefore all machineries must go through a routine maintenance process to get a smooth run.

4.19.13 Man- power requirement not given
The carder has been decided by the HR department, and the cutting room management has to analyze the work load and allocate the required work force to the section.

4.19.14 Complains that may come from other departments
- Cut delays. - Sufficient cut quantity is not available in cutting room at right time.
- Size out. – Panel size variations to the original pattern.
- Fabric faults. – Fabric defects in panels.
- Colour shading. – One or more panels have colour variations.
- Numbering mistakes.
- Fusing mistakes.

The cutting room management must have an ability to give solutions, which may gain profits instead of losses.

4.20 Way of reducing fabric and overall cost through Pattern and Marker making processes

There are several operations in the cutting room and in each step there are some type of cost saving method especially fabric savings.

After confirming the order and at the fabric is received the cutting room management has to prepare the patterns and markers for production, which is a great challenge. The challenges to be faced are,

>   The required fabric width is not received.
>   Fabrics have several widths.
>   Fabric faults.
>   Not receipt the required amount of fabric.
>   Actual shrinkage varies with the pre-planned shrinkage.

The summery of the all the above stories are that if the receipt fabric does not match with the planned. An order short or an excess of fabric may occur. The order short supplying leads to customer un-satisfaction, and the fabric balances creates unnecessary problems. However the cutting room management has a task to avoid any short come that can be occurred. At this stage the cutting room management can take some steps as follows.

Rounding corners,
Reducing sewing allowances,
Turning some hidden parts,
Adjusting dimensions,
Parts separating,
Parts merging,
Removing buffer,
Drawing marker types 4 to 6 times to get a best marker,
Fabric segregating,
Fabric inspection,

Before carryout the above exercises to get the maximum utilization of fabric, it is essential to consider the possible losses that can be saved against the possible extra cost incurred. Some of the significant additional cost factors are labour cost, extra machine running cost, time cost, and other administration costs. The value of losses that can be recovered must be greater than the total cost that has to be spent with the additional cost. Then it gains a profit. Otherwise any exercises carryout to get a higher cut quantity is useless.

Profits can be gained > Spent cost + Additional cost need to spend

Table 4.22 – Additional cost that has to spend.

Advantages	Spent costs	Additional costs
Additional Garments cut	Fabric cost	Labour cost
		Pattern engineering
		Marker making
		Spreading
		Cutting
		Bundling
		Machine cost
		Electricity
		Compressed air
		Maintenance
		Additional time
		Delaying cost
		Delaying of other styles.
		Other administrational cost
		Cost can be occurred from others
		Damage cost
		Repair cost
		Airfreight cost
		Rejection cost.
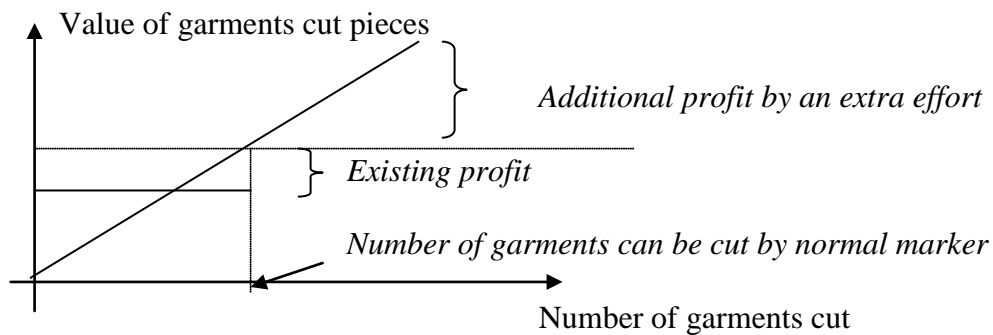
Graph 4.11 – Value of garment cut pieces vs. Number of garments cut.
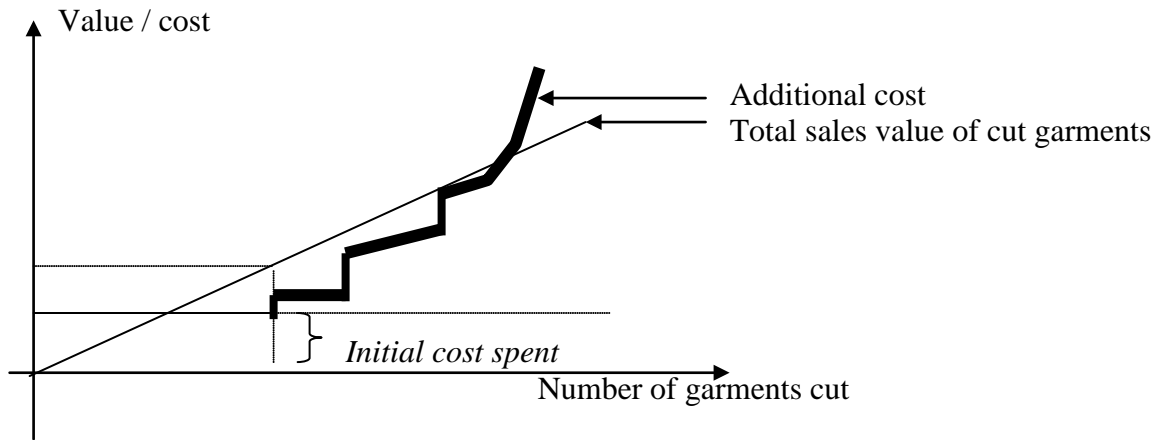
Graph 4.12 – Value / Cost vs. Number of garments cut.

Trying to achieve an extra quantity than the possible quantity cut is cost consuming. Some times cost exceeds the profit that can be occurred by cut garments, and occur high damages, rejections at the production stage. Therefore the aim should be to get high profit, but not with higher cost, by pattern engineering and marker making.

4.21   How to deal with excess and shortage fabrics at lay planning?

Lay planning is another task that has direct relationship with fabric utilization.
Once the patterns are ready the cutting room management must calculate the possible cut quantity from the received fabric.

- If a fabric shortage occurred due to a short supply by the fabric producer, then it is necessary to get the balance fabric from the supplier.
- Carryout pattern engineering and try to reduce the fabric consumption stated earlier.

If the fabric is in excess then it must be checked, what additional percentage of quantity can be cut. Then it should be informed to the buyer through merchandisers.

Table 4.23 – Quantity calculation before cut

Style.	Order qty Dzs.	Fabric received	Production Marker cons m/Dz	Can cut Dz.	Excess %
0311	500	2434.5 m	4.51	539.8	+ 07 %
3257	417	1291.0 m	2.50	516.4	+ 23 %
4510	342	2437.8 m	6.65	366.5	+ 07 %
2135	292	1275.0 m	4.12	309.4	+ 06 %
2141	208	1029.3 m	4.33	237.7	+ 14 %
2060	562	1861.4 m	2.76	674.4	+ 20 %

Normally shipments can be done up to a certain extra percentage (eg: +5 %), but more than that must be negotiated. Some examples for negotiating are,

- All garments can be sold at the same price negotiated.
- Can be negotiated with a discounted price for the extra, or reduced price to all.
- Can be sold the extra garments to some other buyer / stock lot.
- The balance fabric could be returned to the supplier, or can be sold to some other manufacturer, or possible to negotiate with supplier on the fabric price for the excess receipts.

However balance fabric at stores is a cost – which must be avoided.

It is better to consider the additional profit that can be gained, when at the price negotiating.
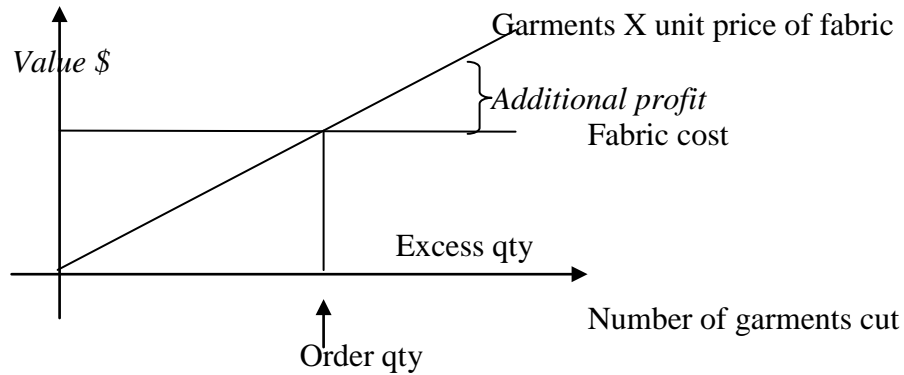
Graph 4.13 – Additional profit

Example 1

Style number	0311
Order quantity	6000 singles.
Cost marker rate	4.77 m/Dz.
Fabric price	US $ 2.10 /m
Fabric cost / gmt	US $ 0.83475
Required fabric	2,385 m.
Fabric received	2,434.5 m
Fabric value	US $ 5,112.45
Production marker rate	4.51 m/Dz
Can cut garments	6,477 singles +7% extra
Forecast production	6,347 singles (allowing –2% for sewing damages)

If it is possible to ship the forecasted production (6,347 singles) at the rate of initial cost, the fabric representation gains   US $ 0.83475 X 6,347.

The total earnings by fabric is	US $ 5,298.15
Extra amount	US $ 185.70.

Or
It is possible to ship,

First 6,000 at the fabric representation cost of	US $0.83475	
		US $ 5008.50
The balance (347 singles) at a discounted rate (75% - US $ 0.626)		
		US $ 217.22
Total gain		US $ 5225.72
Extra gain		US $ 113.27

It is also possible to sell all garments (6,347 singles) at a discounted price.
Then the fabric representation cost can be between

US$ 5,112.45/6347 & US$ 0.84
= US $ 0.81 – 0.84.

Only the fabric value is considered to get the above gained profit, and this can be changed according to the other trims and the Cut + Make + Pack cost involved in a garment. Table 4.24 shows how many could be saved and the profits could be increased.

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Table 4.24 – Savings and Additional profits.

Style no.	3257	4510	2135	2141	2060
Order qty singles	5004	4104	3504	2496	6744
Initial marker rate m/Dz.	3.05	7.10	4.31	4.91	3.30
Fabric price US$/m	1.95	2.45	2.05	1.95	2.55
Fabric cost US$/Dozen	5.9475	17.395	8.8355	9.5745	8.415
Required fabric m	1271.9	2428.2	1258.6	1021.3	1854.6
Received fabric m	1291.0	2437.8	1275.0	1029.3	1861.4
Fabric value US$	2517.45	5972.61	2613.75	2007.14	4746.57
Prod marker rate m/Dz.	2.50	6.65	4.12	4.33	2.76
No of garments can cut	6196	4399	3713	2852	8093
Excess %	+23	+07	+05	+14	+20
Planned to Shipp quantity	6010	4311	3638	2766	7770
If the whole quantity can shipped at the rate of cost prepared					
Value gain by fabric US$	2978.70	6249.15	2678.62	2206.92	5448.71
Profit on fabric US$	461.25	276.54	64.87	199.78	702.14

Such gained excess by the extra cut (other than the fabric cost) is a bonus for apparel producers.

This bonus amount can be kept as it is or can be reduced it, depending on the advantages that can be gained.

Possible advantages
- Buyer's satisfaction.
- Better Customer – Buyer relationship.
- Profit at manufacturer's end.
- Profit at Buyers end.
- Competitive advantages.

By considering the above, the cutting management can take a decision to cut all fabric or part. The lay plan can be prepared accordingly.

4.22   What is the best ratio marker?

There are several ways and ratio combinations to prepare markers. Only one or more of those would give a high marker efficiency and high fabric utilization.

Example 1 - Style 0974
- Normal T-shirt of children wear
- Single Jersey – quality Aberdeen – supplier Ocean Lanka.
- Plan to lay and cut by an automatic spreading machine and an automatic cutting machine.
- Maximum number of sizes can be put in to a marker is 20.
- Maximum ply height is 100 plies.
- Shipment requirement 1st – 1500, 2nd –1500, 3rd – 3000.

Only two types of marker combinations are considered for this example, but there are more combinations may or may not be better than these.

Table 4.25 – Comparison of set of ratio marker A and B for style 0974.

Size	4	5	6	7	8	9	10	11	12	13	Total
Quantity	180	240	420	660	900	1020	1260	900	240	180	6000
Ratio %	3	4	7	11	15	17	21	15	4	3	100
Ratio Marker combination A											
A1 x100	1	2	4	5	-	-	-	5	2	1	20
A2 x100	-	-	-	1	5	5	5	4	-	-	20
A3 x100	-	-	-	-	4	5	7	-	-	-	16
A4 x20	4	2	1	3	-	1	3	-	2	4	20
Must use 4 markers, first 3 (A1, A2 and A3) with 100 plies and the 4th marker with 20 plies.											
Ratio Marker combination B											
B1x60x3	1	-	1	1	5	3	3	5	-	1	20
B2x60x4	-	1	1	2	-	2	3	-	1	-	10
Must use 3 times of B1 marker and 4 times of B2 markers. This can be reduced by considering the maximum number of plies that can be laid. Thereby that needs to use only B1 x 2 with 90 plies and B2 x 3 with 80 plies.											

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Comparison

	Marker A	**Marker B**
Number of marker types	4	2
Number of lays	4	7
Spread length (with end allowance)	A1 = 7.02 m	B1 = 7.08 m
	A2 = 7.05 m	B2 = 3.48 m
	A3 = 5.64 m	
	A4 = 7.05 m	
Total length to be laid	26.76 m	24.60 m
Total plies to be laid	320 plies	420 plies
Total Fabric to be laid	2112.0 m	2109.6 m
Fabric cost US$ 1.96 / m	$ 4,139.52	$ 4,134.82

Total marker making time 9 minutes per marker (professional)

	Marker A	**Marker B**
	0.6 Hours	0.3 hours
Cost of marker making	Rs. 0.6x	Rs. 0.3x

(Where Rs. x is the cost of marker making for an hour)

	Marker A	**Marker B**
Total spread time Hr. (professional)	3.05 hr.	3.41 hr.
Spread cost	Rs. 3.05y	Rs. 3.41y

(Where Rs. y is the cost of spreading for an hour)

	Marker A	**Marker B**
Number of sizes cut	76	70
Cutting time	1.05 hr.	0.97 hr.
Cutting cost	Rs. 1.05z	Rs, 0.97z

(Where Rs. z is the cost of cutting for an hour)

Considered only direct materials and direct costs.

Total considered direct cost so far

For Marker A = US$ 4,139.52 + Rs. (0.6x + 3.05y + 1.05z)

For Marker B = US$ 4,134.82 + Rs. (0.3x + 3.41y + 0.97z)

All costs are low in marker B other than the spread cost. By comparing with the other labour costs, layers do not get higher wages in Sri Lanka than the other professions in garment sector.

Advantages of Marker B than Marker A
- Lesser number of markers has to be drawn.
- Total spread length is less.

- Lesser amount of fabric required.
- Lesser number of size sets has to be cut.
- Lesser number of bundles to store, number or any type of other handling.
- Less cut stock can be maintained.

If the ratio percentage has to maintain for each and every partial shipments, then the cutting process also must be followed the ratio. To fulfill the ratio of the 1st shipment, it is necessary to cut 1,500 singles with the required ratio breakdown.

Therefore A1 and A2 must be cut in combination A, then the cut quantity will be 4000 singles and B1 and B2 must be cut in combination B, then the cut quantity would be 2,600. Therefore the balance cut quantity will be after the 1st shipment 2,500 in combination A and 1,100 in combination B.

Same as, to fulfill the 2nd shipment it is necessary to cut only B1 and two times of B2, then total cut quantity will be 3,400 singles, then the stock balance will be 400 singles only. In marker A, it is necessary to cut A1, A2 and A3 also to full fill the ratio, then the cut quantity will be 5,100 singles, so the balance cut at the end of 2nd shipment is 2100 singles in combination A.

Disadvantages
- Higher number of layers to lay.
- Higher number of plies to lay.
- Remnants cannot be used successfully as in A.

Example 2 - Style 2254
- Normal T-shirt of children wear
- Single Jersey – Jenny – supplier Ocean Lanka.
- Plan to lay and cut by an automatic spread machine and an automatic cutting machine.
- Maximum number of sizes can be put in to a marker is 20.
- Maximum ply height is 80 plies.
- Shipment requirement 1st – 1200, 2nd –2400, 3rd – 3000.
- Total order quantity 6600 singles.
- However the fabric was available to cut +5% extra and buyer had agreed to buy this in the original ratio, in each delivery. Possible shipped quantity is 6,930 singles.
- +2% allowed to sewing damages, so cut quantity calculated as 7,100 singles.
- Here the marker is considered only for the main fabric.

The author wishes to compare only selected two types of marker sets, though there are many other different marker types.

Table 4.26 – Comparison of set of ratio marker A and B for style 2254.

Size	4	5	6	7	8	9	10	11	12	13	Total
Quantity	139	347	416	832	1109	1109	1386	1178	208	208	6930
Ratio %	2	5	6	12	16	16	20	17	3	3	100
Ratio Marker combination A											
A1x80x1	1	4	5	-	-	-	-	6	2	2	20
A2x80x2	-	-	-	4	4	4	4	4	-	-	20
A3x80x1	-	-	-	2	5	5	8	-	-	-	20
A4x30x1	2	1	1	1	2	3	4	2	2	2	20
Must use 4 markers, and need to cut five times, as A1 x80 plies, A2 x80 plies, A2 x80 plies, A3 x80 plies and A4 x30 plies.											
Ratio Marker combination B											
B1x71x2	1	2	3	-	-	-	6	6	1	1	20
B2x71x3	-	-	-	4	5	5	2	1	-	-	17
B3x71x1	-	1	-	-	1	1	2	2	1	1	9
Must use 3 markers only, and need to cut 6 times, as B1 x71 plies, B1 x71 plies, B2 x71 plies, B2 x71 plies, B2 x71 plies and B3 x71 plies											

Comparison

	Marker A	Marker B
Number of marker types	4	3
Number of layers	5	6
Spread length (with end allowance)	A1 = 6.12 m	B1 = 6.18 m
	A2 = 6.25 m	B2 = 5.28 m
	A3 = 6.34 m	B3 = 2.63 m
	A4 = 6.05 m	
Total length to be laid	31.01m	30.83m
Total plies to be laid	350 plies	426 plies
Total Fabric to be laid	2178.3 m	2188.93 m
Fabric cost US$ 2.15 / m	$ 4,683.35	$ 4,706.20
Qty can be cut singles	7000 pcs	7100 pcs

Total marker making time 9 minutes per marker (professional)

	0.6 Hours	0.45 hours
Cost of marker making	Rs. 0.6x	Rs. 0.45x

(Where Rs. x is the cost of marker making for an hour)

	Marker A	Marker B
Total spread time Hr.(professional)	3.33 hr.	3.66 hr.
Spread cost	Rs. 3.33y	Rs. 3.66y

(Where Rs. y is the cost of spreading for an hour)

	Marker A	Marker B
Number of sizes cut	100	100
Cutting time	1.45 hr.	1.45 hr.
Cutting cost	Rs. 1.45z	Rs, 1.45z

(Where Rs. z is the cost of cutting for an hour)

Considered only direct materials and direct costs.

Total considered direct cost so far

For Marker A = US$ 4,683.35 + Rs. (0.60x + 3.33y + 1.45z)

For Marker B = US$ 4,706.20 + Rs. (0.45x + 3.66y + 1.45z)

All costs are low in marker A other than the marker making cost. By comparing with other labour costs, Marker makers are getting higher wages.

Advantages of Marker A than Marker B
- Lesser amount of fabric required.
- Lesser number of layers.
- Lesser number of plies to lay.
- Remnants can be used successfully.

Disadvantages
- Number of markers is higher.
- Total spread length is higher
- Lesser number of cuts than B

Example 3 - Style 8013
- Dungaree of children wear
- Denim – supplier Aravind mills.
- Plan to lay and cut by an automatic spreading machine and an automatic cutting machine.
- Maximum number of sizes can be put in to a marker is 12.
- Maximum ply height is 60 plies.
- Shipment requirement 1st – 2000, 2nd –2000, 3rd – 2000.
- Total order quantity 6000 singles.
- However the fabric was available to cut +5% extra and buyer had agreed to buy this in the original ratio, in each delivery. Possible shipped quantity is 6,300 singles.
- +4% allowed to sewing and washing damages, so cut quantity calculated as 6,550 singles.
- Here the marker is considered only for main fabric.

The author wishes to compare only selected two types of marker sets, though there are many other different marker types.

Table 4.27 – Comparison of set of ratio marker A and B for style 8013.

Size	3/6	6/9	9/12	12/18	18/24	24/36	36/48	48/60	Total
Quantity	315	504	1134	1260	1386	945	441	315	6300
Ratio %	5	8	18	20	22	15	7	5	100
Ratio Marker combination A									
A1x60x5	1	1	3	1	1	3	1	1	12
A2x60x3	-	1	1	5	5	-	-	-	12
A3x60x1	-	-	1	1	3	1	2	-	8
A4x15x1	1	2	-	-	-	-	2	1	6
Ratio Marker combination B									
B1x63x5	1	1	2	2	2	2	1	1	12
B2x63x3	-	1	2	3	4	1	-	-	11
B3x63x2	-	-	1	1	-	1	1	-	4

This says that, to achieve the target combination A must be laid five times from marker A1, three times from A2, once from A3 and A4, and the combination B must be laid five times

from B1, three times from B2 and two times from B3. It is not so affected if that has laid 3 plies extra.

Comparison

	Marker A	Marker B
Number of marker types	4	3
Number of layers	10	10
Spread length (with end allowance)	A1 = 8.92 m	B1 = 8.94 m
	A2 = 8.95 m	B2 = 8.18 m
	A3 = 5.94 m	B3 = 3.03 m
	A4 = 4.50 m	
Total length to be laid	81.89m	75.30m
Total plies to be laid	555 plies	630 plies
Total Fabric to be laid	4710.9 m	4743.9 m
Fabric cost US$ 2.55 / m	$ 12,012.80	$ 12,096.95
Qty can be cut	6330 pcs	6363 pcs

total marker making time is 9 minutes per marker (professional)

	Marker A	Marker B
	0.6 Hours	0.45 hours
Cost of marker making	Rs. 0.6x	Rs. 0.45x

(Where Rs. x is the cost of marker making for an hour)

	Marker A	Marker B
Total spread time Hr.(professional)	6.68 hr.	6.85 hr.
Spread cost	Rs. 6.68y	Rs. 6.85y

(Where Rs. y is the cost of spreading for an hour)

	Marker A	Marker B
Number of sizes cut	110	101
Cutting time	1.75 hr.	1.60 hr.
Cutting cost	Rs. 1.75z	Rs, 1.60z

(Where Rs. z is the cost of cutting for an hour)
Considered only direct materials and direct costs.

Total considered direct cost so far
For Marker A = US$ 12,012.80 + Rs. (0.60x + 6.68y + 1.75z)
For Marker B = US$ 12,096.95 + Rs. (0.45x + 6.85y + 1.60z)

Advantages of Marker A than Marker B
- Lesser amount of fabric is required.
- Lesser number of plies to lay.
- Remnants can be used successfully.

Disadvantages
- Number of markers is higher.
- Total length to be laid is higher.
- Lesser number of cut quantity than B

From the above three examples that can say, that a lesser number of marker sets always give better results. There may be several marker sets can be drawn for any order. But

the best marker selection is a huge task. Normally the cutting room authority looks to achieve less number of marker sets, less lay lengths, high amount of cut panels, less number of fabric plies and less remnant pieces. But most of these factors are affected by some other conditions which related to the order, such as shipments with ratio break down, time availability etc.

4.23 How to select the fabric for marker making and cutting operations?

The fabric must be selected from stores, according to the lay plan for spreading. Better to use fabrics with same characteristics for one layer (set of plies). Then all cuts' behavior will be same.

The classification must be done as in the figure 4.16.

Received fabrics to stores

Fabrics from supplier "A"   fabrics from supplier "B"

Batch X   Batch Y   Batch Z

Shade-A   Shade-B   Shade-C

Width w1   Width w2   Width w3

Shrinkage x%   shrinkage y%

Lay 1 (cut number. 1)
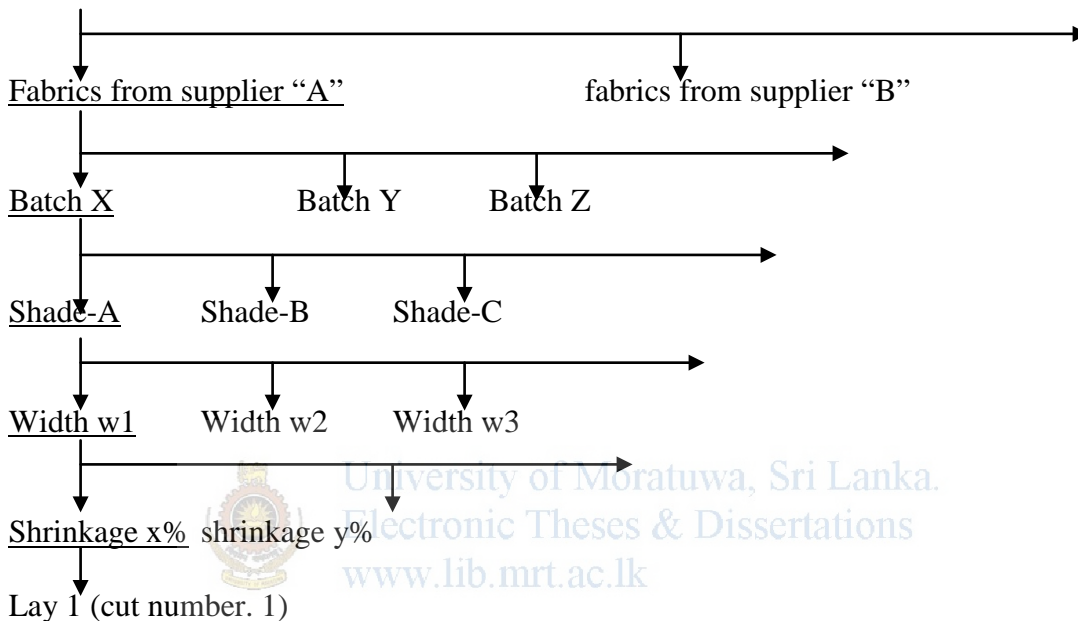
Figure 4.16 – Fabric classification.

There may not have enough fabric from same shrinkage percentage, same width, same shade and same batch.
If the shrinkage percentage difference is too high, separate spreading is advisable.
If there is a width variation, then can select fabric rolls up to 2cm tolerance for one layer and the marker can be drawn to the smallest width.

An Example;
If the available widths are, 141cm, 142cm, 144cm, 145cm, 146cm, then can prepare markers only for the widths of 141cm, 144cm rather than preparing markers for each separate width. However, preparing separate markers for each width need to be done if those widths contain sufficient quantity to lay.
Further to the above example, if the fabric received as follows,

188 m from	141 cm width
75 m from	142 cm width
154 m from	144 cm width
80 m from	145 cm width
171 m from	146 cm width

The markers can be drawn for 141 cm, 144 cm and 146 cm widths.
However, if the marker length were less than 2.0 m then drawing separate markers for each width would gain advantages.

The width segregation must be done by considering the marker length, fabric amount, fabric cost etc. Also this decision must be taken by comparing the following costs against the fabric saving which could be gained by using one marker for two or three widths as stated above.

- Cost of re-drawing a separate marker.
- Cost of spread for separate markers width wise.
- Cost of cutting separate markers.
- Cost of bundling separate layers.
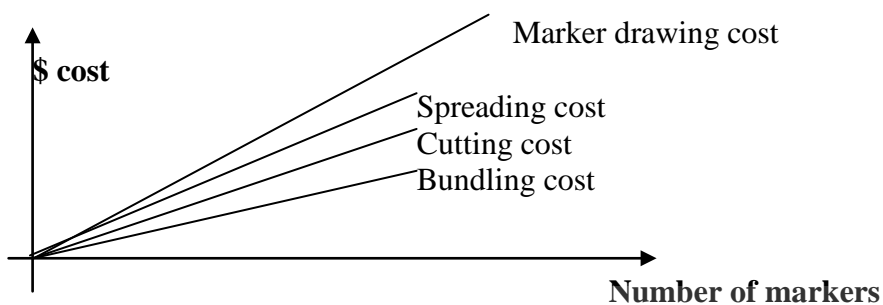
Graph 4.14 – Cost vs. Number of markers.

When considering the above facts, laying a separate lay for each separate width is profitable for high valued fabrics.

If there is a shade variation among the rolls or among the batches then the plies must be separated by a paper (interleaving or tissue) or a different type / colour of fabric.

4.24   How to achieve higher fabric utilization through spreading?

Spreading can be done manually or by automatic machine. There are many advantages when spreading by an automatic machine. One of the main advantages is that the end allowance can be reduced.

Advantages of an automatic spreader
- Quick and easy – time saving.
- Accuracy is higher.
- No need to count number of plies for a lay.
- Just 2cm end allowance is enough for woven fabric and 3cm end allowance for knitted fabric.
- One person is enough to lay woven fabric.
- Very easy to lay face to face. (optional).

Disadvantages of an automatic spreader
- Need to check the machine error for each layer (set of plies).
- Need to check the lay length by manually.
- Spreading stripes or check fabric is difficult.
- Spreading bow or skew fabric is a problem.
- To service the machine need professionals.

When spreading, it would mostly have some balance length of fabric at the end. These are (remnants) smaller than the length of the lay. These small pieces must use anyhow to get higher fabric utilization.

By using the remnants,   can replace damaged panels
                              can lay small lay lengths
                              can use for contrast or appliqué parts, etc.

4.24.1   Replacing of damaged panels

The remnants also can be used to replace the damaged panels. When doing panel inspection there may have lot of defected panels that have to be replaced. Replace can be done considering the shade and the way of the fabric. To identify the shades, a label of the roll or the lot number must be attached to remnants.

4.24.2   Joints

Joints can be used to avoid the remnants. However some are reluctant to use joints as fabrics almost have colour shadings. If there is no colour shading at all, then it is possible to use joints with any type of marker. If a fabric has colour shading effect, then it is possible to use joints with sectional markers or interlocking markers.

For a normal marker if there is no colour shading

Splice marks

Figure 4.17 – Joints in a normal marker.

For a sectional marker

Size A   Size B

Figure 4.18 – Joints in a sectional marker.

For an interlock marker

Size A   Size B

Splice marks

Figure 4.19 – Joints in an interlock marker.

When marking splices, it is necessary to take precautions because it should not create additional panels. However sometimes that can be occurred. To avoid this it is possible to introduce a separation paper or some different type of fabric piece. In this method the fabric balance will be zero at the end.

4.24.3   Short length layers

The remnant pieces can be used for small layers, which are smaller than the remnant piece. Even if the fabric has shade variation among the rolls, that can lay for single markers or for any other short markers,

Sometimes there is no chance to use some small remnants, because the remnants are not long enough. For an example; Gents Trousers – single marker length may around 1m, and Dressing Gown – single marker length may around 1.5m.

These problems must be identified at the early stages at least a ply before the last ply, so the remnant can be used more productively.

Example 1

Marker length	6.03 m
Lay length of a woven fabric	6.05 m
Stated fabric length in a particular roll	55.5 m
Plies can be laid	9 plies
Balance would be (remnant)	1.05 m
The smallest single marker lay length	1.18 m

If that have laid only 8 plies then the remnant would be $\quad = 7.10$ m
Then can lay 6 plies from this remnant piece for single marker. $\quad = 1.18 \times 6 = 7.08$ m

Or Let's consider another lay length.
Lay length of a 3 garments marker $\quad$ 4.38 m
The remnant piece after spreading 7 plies $\quad = 55.5 – 6.05 \times 7 \quad = 13.15$ m.
Then can lay 3 plies from this remnant for the 3 garments marker.

At the beginning, the cutting room management can predict the length of the remnant as shown below.
Length of the remnant = MOD (length of the roll / lay length).

Example 2
Style 0424. $\qquad$ Order qty $\quad$ 1200 pieces.
Lay lengths to be laid
    1. 6.33 m 148 cm width 16 sets.
    2. 4.81 m 148 cm width 12 sets.
    3. 3.05 m 148 cm width 9 sets.

The single lay lengths,
    1. 0.41 m 148cm width.
    2. 0.43 m 148cm width.
    3. 0.47 m 148cm width.

Table 4.28 – List of all 148cm width fabric received for style number 0424.

Roll No.	Roll length	Number of plies planned to lay from					
		6.33m	4.81m	3.05m	0.41m	0.43m	0.47m
100029	44.5	6		2	1		
100032	38.9	6				2	
100033	37.8	5	1			3	
100035	41.2		7	2			3
100039	40.0		8				3
100040	42.3	6		1	3		
100041	44.1	6	1			3	
100049	45.0		9		4		

100052	44.3	6	1				3
100053	37.8	1		10			2
100054	36.9			11	8		
100055	39.0		8				1
Total	**491.8m**	36	35	26	16	8	12
Total garments		**576**	**420**	**234**	**16**	**8**	**12**

Here it can cut 1266 pieces only

Disadvantages
- Need to calculate the amount of fabric earlier.
- Additional spread time.
- Small layers to cut.
- Additional cutting time.
- Additional bundling time.
- Pre- calculation would be incorrect, if fabric shortage or defects found.

Advantages
- It is possible to use all fabrics- maximum utilization.
- It is possible to cut higher number of pieces.

4.24.4 Reducing end allowances
Theoretically, 4cm must be added for end allowance. However using automatic spreader or end cutters can reduce this up to 2cm by according to the fabric type.
The best way is to reduce up to 2cm for woven types and 3cm for knitted types.

Example 3
A same marker is laid manually and by automatic machine, gave following results.

Table 4.29 – The results of spreading Manual vs. Auto.

	Manual	Auto
Fabric	Denim	Denim
Marker length	4.11 m	4.11 m
Lay length	4.15 m	4.13 m
No of plies	77 Nos.	77 Nos.
Fabric used	319.55 m	318.01 m

Savings by reducing end allowance   1.54 m.

4.24.5   Stripes and Check spreading

Normally customers request to match the lines in stripe fabrics and check fabrics as follows,

- Side seam must be matched.
- Front panels must be matched.
- Sleeves must be balanced.
- Pocket must be matched.
- Bottom hem must be parallel with lines.
- Yoke must be balanced and matched.

Normally layers used to use pins to lay stripes and check fabrics, to get the lines aligned. Generally, the pinning is done in equal lengths.

However it is rather productive if the marker can be seen first, and decide the pining positions at the places where matching is difficult and required.
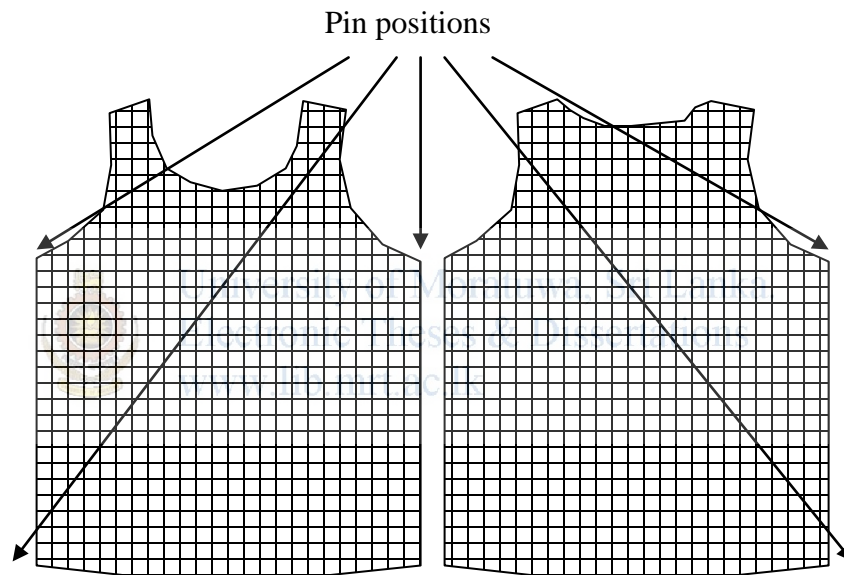
Pin positions

Figure 4.20 – Pinning positions.

Also can lay pairs (two by two) face to face.

4.24.6   Spreading two by two

When spreading stripe or check fabric, can lay them by pairs (two by two). Here, every two plies are aligned with each other's check or stripe design. The main advantage can be taken by this method is that can cut some parts (which have pairs) with a same picture (stripe or check) from adjacent two plies. That is, right sleeve can be taken from the first ply while the left sleeve from the second ply for one garment. Likewise the left sleeve from the first ply and the right sleeve from the second can be stitched together for another garment. This can be done only for non-shaded fabric among rolls.

4.24.7   Spreading face to face

In face to -face method, can lay the style only if the left and right panels have their mirror images.
For example: pair of sleeves, pair of front panels (left and right), pair of leg panels, pair of pockets, etc.
By this method can be over come the inequality shape of left and right panels as well.

4.24.8   Skew ness and bow and possible solutions

The major problem in a cutting room is fabric defect. If a hole or a slub or a foreign yarn is found in a fabric, then it can be replaced. However if the fabric is having bowing or skew ness, this would be a big problem. The best way can do is to reject the fabric and get a new consignment in time. However fabric would not be in housed at the required time and the new consignment also may reflect the same defect.

If the fabric is slightly skew, then can turn the panels as per the skewness, as shown in the figure 4.21.

Figure 4.21 – A pattern placing method for skew fabric.

The pin placement and also the cut edge must be turned slightly, so the marker takes the shape of trapezium and must be drawn accordingly.
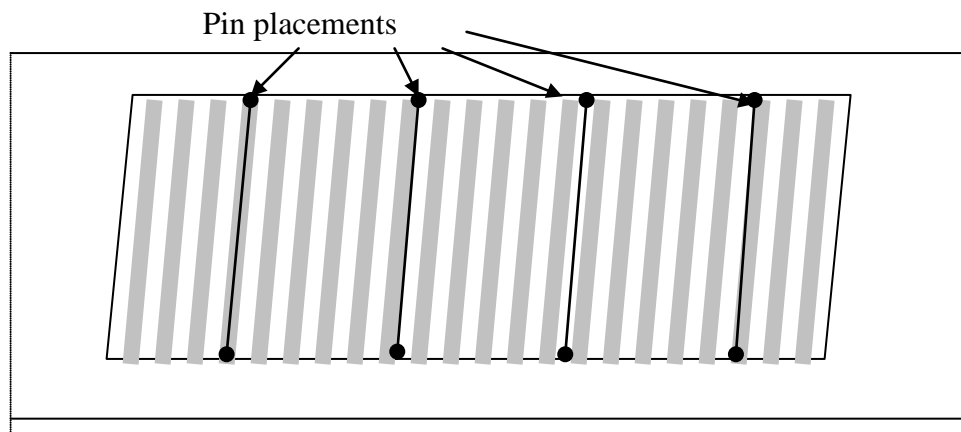
Figure 4.22 – Pinning position of a skew layer.

This system is not suitable for skew check fabric, because skew ness makes a deviation from the right angle between width vise and length vise lines. For an example a normal shirt's placket and the bottom hem should be perpendicular, and the placket must be parallel to the warp lines and the bottom hem must be parallel to the weft lines. If a shirt panel is cut from the skew check fabric it looks as shown in figure 4.23.
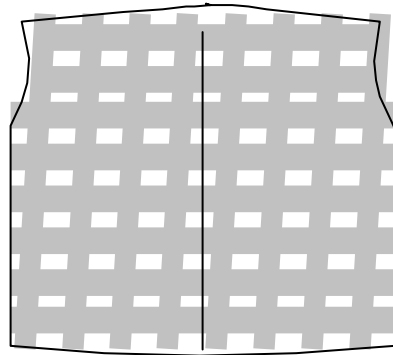
Figure 4.23 – Shirt panels cut by a skewed check fabric.

Due to this effect the skew check fabric cannot be used for some garments, such as shirts, blouses, etc. However this skewness may not be a problem for some apparel especially if the check is small.

Bow is the other problem that can be overcome some times and some times not. Following figure 4.24 shows some example shapes.
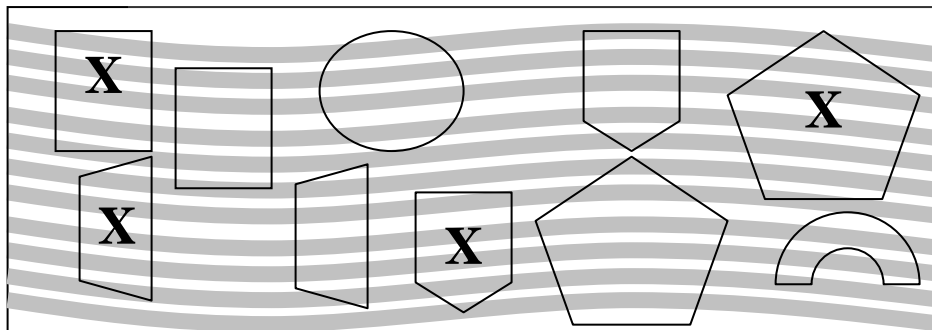
Figure 4.24 – Bowing effect.

The "X" marked panels cannot be used, as they are in incorrect placements with the fabric design, while the others are OK for stitching. However, the problem is this bowing pattern does not same throughout the fabric roll. This type of fabrics can be used only for the styles that do not require matching lines, for hidden panels, for cut one ply by one, for appliqués, and for damaged panel replacement, etc.

4.25 The main cutting errors and how to over come them?

There are several ways of cutting, between manual and automatic.
Machines used in manual cutting are straight knife machine, band knife machine, circular knife machine, bias cutting / slitting machine, die cutting machine, end cutting machine, and also pair of scissors.
In automatic methods, machines with computerized systems such as Gerber, Lectra etc and also laser-cutting machine are used.

Cutting errors and methods to overcome:
- Non-symmetric cutting. The following is an example, which has different shoulders widths.

To overcome this problem, it needs to cut from both ends towards to center.
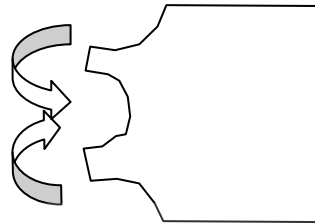
Figure 4.25 – A mirror cutting.

- Cut is not a fine cut. This is may be due to non-sharpness of the cutting blade or quality of the fabric or inexperience of the cutter.

To overcome this problem, a band knife must be used to do final cutting. Especially, some small parts and curved parts must be cut by a band knife machine. If the cutting knife blade is not sharp enough, it should be sharpen.

- Out of shape panels – This can happen due to high ply height and or vacuum out of control in automatic machine.

To over come this, the ply height can be reduced or it is possible to use the band knife for cutting. It is also possible to use the pair method as indicated earlier, to avoid inequality of sizes of left and right panels.

4.26   The methods that can be used to store the cut panels securely before stitching

4.26.1   Bundling & Storing

After cutting, all parts which belong to the same size must be bundled and packed together in bags or containers and must be stored in a place which can be find easily. When storing, the rack number and the quantity must be noted in a separated book or a paper.

4.26.2   Numbering

There is a general procedure to number all parts of a garment in terms of identifying the size, avoiding shade mixing, and as a counting method. However some parts are not necessary to be numbered and numbering the top panel and the bottom panel is enough to identify the size. Examples for such are contrast parts, lining, under parts, etc.

Here, care must be taken to avoid the sticker mark on a panel. To avoid this the sticker must be placed on the reverse side or at a corner that cuts off at stitching or must be used the appropriate (low level of adhesive) sticker. Also the numbering placement must be identified, as it should not be a barrier for stitching.
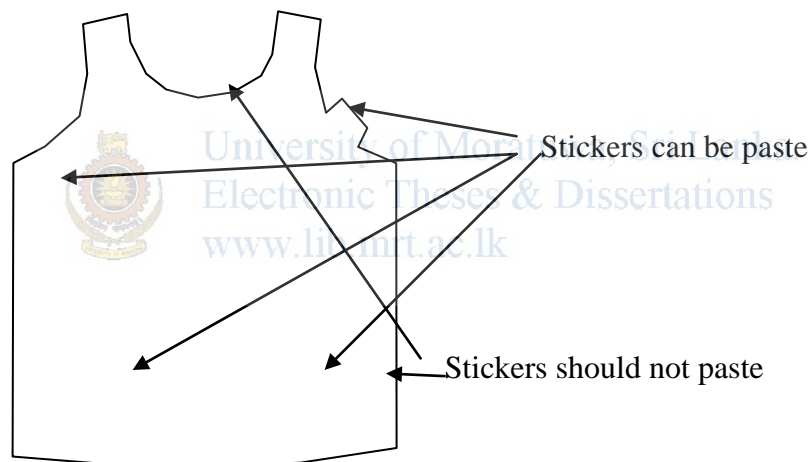
Figure 4.26 – Numbering sticker placement.

4.26.3   Panel Inspection

In general, can depend on the fabric inspection report and it is not necessary to do panel inspection for all styles, even a sample quantity.

However, it is possible to carryout a panel inspection at the first cut, and has to take a decision whether to carryout 100% panel inspection or 100% inspection in garment form and select the best method. The damage panel replacement can be done at the time of panel inspection.

4.26.4   Fusing

Fusing is also a part of the cutting room process. Fusing is carried out by means of getting stabilize, reinforce, create shape, add body, and for safety. Fusing is done by using a fusible interlining attaching a garment panel by reaching a temperature (around $140^0 – 180^0$ C), pressure (around $4 – 5$ N) and the time (around 12 seconds) specified by the interlining

supplier. Fusing should be carried out by avoiding the marks of the numbering sticker on the panel. This could be done by removing and re-pasting the stickers on the interlining, or keeping away the sticker from the above heat, and pressure. There are some special conditions apply on the fuse line, which depend on the buyer.

For an example the bond strength should be 13 – 14 N.

4.26.5   Issuing

Issuing for stitching is the last operation in the cutting room, which should be controlled according to the line target, shipment schedule, and ratio requirement.

For an example, if a production line's target is 650 pieces per 8 hours day and the week-end shipment is 3600 pieces for first week and another 3600pcs for 2nd week, the ratio break down might be S-600, M- 1200, L-1200, XL-600, then the cuts can be prepared to issue as follows.

Always it is normal to issue +5% extra for stitching.

Table 4.30 – A method of cut issues.

	Small	Medium	Large	X large
Monday	630	20	-	-
Tuesday	-	650	-	-
Wednesday	-	590	60	-
Thursday	-	-	650	-
Friday	-	-	550	100
Saturday	-	-		650
Monday	-	-	140	510
Tuesday	-	-	650	-
Wednesday	-	180	470	-
Thursday	-	650	-	-
Friday	220	430	-	-
Saturday	410	-	-	-

If the production line is planned to work extra hours, then the issues also must be prepared accordingly.

4.27 Method to utilize the existing resources by over coming the day-to-day problems

4.27.1 Man

The main resource persons in the Cutting room are Pattern makers, Marker makers, Layers, Cutters, Bundlers, Panel checkers, Fusing operators and other administrational staff etc.

Mainly Pattern makers, Marker makers, Layers and Cutters are professionals are paid high wages in Sri Lanka and are very valuable and important to the cutting room operations.

When preparing the day-today cutting plan with the support of the work-study the cutting room management must have an idea to avoid the idling time of the above professionals.

Every layer must be trained to lay manually and also to use the automatic spreading machine. Each Cutter must also be trained to cut manually and to use the automatic machines. Developing multi skilled operatives will be an advantage and only the Sri Lankan garment factory cutting rooms can do this perfectly. This may help to cover absenteeism and turn over, and also balance the operations in the cutting room at a time where there's not having enough capacity to work and to none violate the compliance rules, such as maximum overtime up to 2 hours, rules on night shift, etc.
For an example, if there is a high requirement to cut piping by a slitting machine, and the piping Cutter can work only up to another 2 hours other than the normal day -time, then can allocate a straight knife Cutter as a piping cutter for the additional work requirement.

All human resources should have a daily target to achieve and entitled to a reward scheme on their achievements. There are also some motivational methods, opportunities to develop their skills, and the knowledge on their career path development.

Even the human resource is highly valuable; it is not an easy task to control them. A well – experienced and a thorough knowledge must be needed to control their behaviors.

4.27.2 Machinery

When comparing other departments in the garment sector in Sri Lanka the most valuable and computerized machineries are lying in the cutting room. Among these, CAD / CAM machineries, automatic cutter, automatic spreader, Band knife, Slitting machine, Fusing machines, pattern and marker preparation computers, etc. are in first place.
To avoid any machine break -downs those must be maintained regularly. All these machines must be aligned with all safety criteria to avoid any violation of compliance.

4.27.3 Material

The most valuable material used in the garment sector is fabric, and it develops and makes a value addition in the cutting room with the help of other resources.

Interlining, marker papers, kraft papers, polythene, numbering stickers, stationeries, etc are some other material mostly used in cutting room.

4.27.4 Methods

The methods used in the cutting room are different from style to-style, fabric to- fabric, and machine to -machine, etc.

The Gerber system, Lectra system are some of the common systems that used in the cutting room for pattern making, marker making, spreading, cutting, etc.

4.27.5 Minutes

This is a very important factor that cannot be evaluated in any mean.

Only the cutting people can make the lead -time of the garment producing process shorten and effective.

For an example: to cut a huge quantity in advance or at the right quantity, right size, in right time.

The cutting room management can cut and issue a late delivery of fabric to the production with in a day, but the production people cannot sew the total order in that speed, it takes the standard minute.

Therefore the cutting room management has a great opportunity to mix, control and get the maximum utilization of all available resources.

4.28   The avoidable wastages

The waste is a potential resource. As a unit the cutting room has greater effect on excessive manufacturing costs than any other department concerned with the actual production of garments.

Wastes can be classified as

4.28.1   Waste by over production
If the cutting room cut more than the quantity requirement with an allowance for sewing damage, it would be a great loss. The effort and resources used to lay, cut, bundle, number, fuse and may print or embellishment are all in -vain. If the excess quantity were stitched, then the garment would be wasted. If the excess quantity were not cut, the fabric would be wasted.

> **Example 1**
> | | |
> |---|---|
> | Order quantity | 12,000 pcs. |
> | Negotiated quantity can be shipped | 12,600 pcs. |
> | Quantity cut with available fabric | 13,000 pcs. |
> | Quantity damaged at stitching | 85 pcs |
> | Wastage by over production | 315 pcs. |

Even that has achieved higher fabric utilization at cutting; the total result is not in expected level.

4.28.2   Waste by waiting time
If the cutting room management has to delay the work due to the fabric receipts, pattern receipts, lab report receipts or until machine repairs, then the whole process would be delayed. This may leads to an airfreight shipments or cancellation of shipment. The effort and resources would be useless. This delay may also affect to the others as well. At this point it's useless to talk on high fabric utilization

4.28.3   Waste in transportation
If fabrics or cuts get damaged while transportation from stores to cutting room or cutting room to sewing room, then fabrics or cuts along with the value addition would be a waste. Even here, the maximized fabric utilization is useless.

4.28.4   Waste of excess inventories
Keeping a stock of excess fabric or excess cuts would be a loss. It blocks the others and is being destroyed.

4.28.5   Waste in manufacturing process
The end allowances and remnants, which are fabric damages, are wastes. Also damages occurred at stitching stages and packing stages are also wastes. Not only these, but also high consumption of electricity, machineries, etc. are wastes too. Therefore the final rupee term advantage is not gained.

4.28.6   Unnecessary human movements

Idling time of workers, using more workers than the required amount, using incorrect methods and doing non-assigned works are also wastages.

Examples 2
Cutting two parallel lines instead of a common line
If it is possible to cut 100 plies, but the cut layers are 60 and 40 for a same marker, then cutting of the same marker in two times is a waste.
Some times the cutting room management has to do sudden changes in the operational plan, in such cases the steps taken for the pre-planned process are all wastes.

4.28.7   Waste of defective units

Panels with fabric faults, panels with incorrect cutting, incorrect markers, incorrect bundling, incorrect fusing, and incorrect numbering are defective units. Panels with incorrect numbering and bundling do mislead the sewing operations too.

4.28.8   Eliminate fabric waste

Following steps can be used to reduce the wastages on fabric.

- Purchasing only the required length and width of fabric, where the width and the length can be accurately determined at the early stages of the order, and especially need to consider the required width (economical width) as it is determined according to the highest marker efficiency gained. If the fabric is in excess, then it must be tried to cut all and ship or use the balance to some other style or return the excess fabric back to the supplier.

- Reduce the marker fall out – This is carried out to get higher marker efficiency. To get a higher marker efficiency, it is possible to follow,
    - Pattern engineering such as,
        - Splitting panels,
        - Rounding corners,
        - Reducing seam allowances and hem width,
        - Adjusting pattern dimensions without noticeable change to fit and style,
        - Adjusting grain lines for hidden parts, etc.
    - Mixed size, long length markers and optimum number of sets to get economic cut quantities.
    - Improving spread methods, such as,
        - Two or three markers lay together, by joining or stepping.
        - Reducing end allowances, by using automatic spreader or end cutters.
        - Using skilled spreaders.
    - Improving and selecting cutting methods.
        - When cutting by an automatic machine, it needs to add some buffer space for knife clearance at a notch or cut mark. To remove this buffer it is necessary to cut by manually.

- For some hard fabric like denim or thicker fabric like fleece, the automatic cutter requires a lower number of plies, around 40 to 60 plies, but in manual that can cut 70 to 90 plies, with out much effort.
        - Using skilled cutters.

- An efficient and suitable way of removing fabric defects is to do it at spreading or at the panel inspection stage. For an example, it is possible to cut a small part from a large defected panel avoiding the defect as shown in figure 4.27.

Figure 4.27 – A method of avoid defects.

To reduce the fabric wastages must be aimed to
- Use very long length fabric rolls.
- Use very large width fabric rolls.
- Reducing width variation.
- Marker making for actual width of the fabric.
- Striving towards to zero defects fabric.
- Protective fabric packaging and storing.
- Minimum shade variations.

4.28.9 Eliminate other material waste
Eliminating the unnecessary usage would stop a certain amount of wastage.
Eliminate material wastages can be done by reducing the usage or by using a cheaper material.
For an example towel papers (toilet papers) can be used instead of using interleaving papers to separate the plies among the shade varied fabric rolls.
Re-using the materials can reduce the wastages. For an example used polythene bags can be used again to pack the cuts instead of getting new bags.

However the management has to be very careful to do the cost reduce by using cheap materials, because some items can be purchased at low prices which are not suitable for the product and also must affect the smooth running of the machines. This type of mistakes makes a big losses to the company.
For an example, to obtain computer printouts, typing papers can be used as well, but it damages the printer and wastes lot of papers and time.
Another example, when using some low cost numbering stickers, the efficiency of a numbering operator will be reduced.

4.28.10   Eliminate manpower and time waste

To eliminate the idling time the following has to be maintained.
- o Proper day to day plan,
- o Exact number of workforce,
- o Better supervision,
- o Use skilled, target oriented and multi expertise people,
- o Reduce unnecessary overtime work,
- o Eliminate double work and unnecessary work.

When reducing man- power it should not affect the cutting production and also the sewing requirements, where that has to maintain a smooth flow of work to the sewing room.
One of the major opportunities that have is the ability of controlling man- power is to reduce the wastage of other departments that would be occurred due to some sourcing lapses. For an example, if the fabric is received in late evening and it should have to stitch from next morning or almost delayed, that can plan overtime or a night shift to carryout the cutting operations, having a multi skilled workforce is an advantage to rotate the workers or increase workforce for a required task. For an example if it needs to number the panels to higher target and is urgent, then some panel checkers or bundlers can be allocated temporarily stopping their work, which is identified that is not so urgent, for that moment.

4.28.11   Make the best use of machinery and spaces available and select the best methods

For some examples,
- o The band knife cutter is best to use if a fine cut is needed.
- o A long straight knife (12") is best to cut deeper ply heights.
- o The automatic spreader should not be used for stripes and check fabric, if the garment requires matching stripes and checks.
- o Pins or laser lights can be used to lay stripes and checks.
- o Some piping and appliqués must be fused; it can be fused after cutting or can be cut after fusing, where it depends on the style and the ability.
- o The cutting room arrangement must be implemented in an easy to access method, means everything must be readily available at a nearest place. Thereby the arrangement must be as follows which would again reduce the unnecessary human movements, and avoid any damages that can be occurred at transport, etc,

    Fabric storage (with labeled style, width, etc.)
    Spreading table, Cutting table,
    Bundling table, Cuts storing rack,
    Numbering table, Panel checking table,
    Cuts issuing counter,

To reduce wastages using new techniques, steps must be taken to give training to the staff and introduce incentives and rewards as motivational factors.

CHAPTER 5

5. APPLICATION

To identify the most economical lay plan, the author selected an order received from Marks and Spencer to Hirdaramani Mercury (Pvt) Ltd., Katunayake, for the style number T86-2913D.

5.1 The effect of customer requirements

The customer (M & S) requirements are shown in table 5.1 and 5.2 and the sketch in figure 5.1.

Table 5.1 – Order quantity requirement in colour vise and size vise.

Size	S	M	L	XL	XXL	Total
Ratio	10 %	15 %	30 %	25 %	20 %	100 %
Grey mix	360	540	1,080	900	720	3,600
Red mix	540	810	1,620	1,350	1,080	5,400
Green mix	720	1,080	2,160	1,800	1,440	7,200
Total	**1,620**	**2,430**	**4,860**	**4,050**	**3,240**	**16,200**

Table 5.2 – Shipment requirement in colour vise.

	Grey mix	Red mix	Green mix	Total / week
1st week	3,600	1,800		**5,400**
2nd week		3,600	1,800	**5,400**
3rd week			5,400	**5,400**
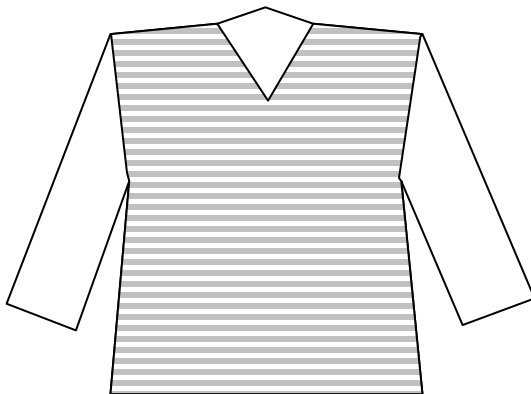
Figure 5.1 – A sketch for fleece stripe top (night wear).

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The fabric that had to used was 100% polyester with stripes in grey and white, red and white, & green and white. The GSM should be 380gm[-2].

5.2 Preparing the cost marker and fabric ordering

As per the sketch there are one front panel, one back panel, and two sleeves. The cost marker can be drawn considering all the customer requirements and the limitations stated below;

Maximum number of plies is 40.
Maximum lay length possible 5.0 m.
All markers are in one way – nap down direction.
Maximum number of marker sets 16.
Maximum width available at supplier 160 cm.
Maximum shrinkage would be -1.3%.
Maximum available length 45 m per roll.

Maximum 16 sets can be drawn in to one marker. So it is cost effective to draw two markers. As there are lots of combinations, drawing 10 sets in one marker would be easy and cost effective.
Accordingly following markers were drawn. (Table 5.3)

Table 5.3 – Possible markers and marker lengths for style T86-2913D.

	S	M	L	XL	XXL	Marker length	Marker length (m)	Consumption m/garment
M1	2	3	5			10	3.68	
M2	0	0	1	5	4	10	4.02	0.385
M3	2	3	4	1		10	3.70	
M4	0	0	2	4	4	10	4.00	0.385
M5	2	3	4		1	10	3.71	
M6	0	0	2	5	3	10	3.99	0.385
M7	2	3	3	2		10	3.72	
M8	0	0	3	3	4	10	3.98	0.385
M9	2	3	3	1	1	10	3.63	
M10	0	0	3	4	3	10	3.97	0.38
M11	2	3	3	0	2	10	3.59	
M12	0	0	3	5	2	10	3.96	0.3775
M13	2	3	2	3		10	3.74	
M14	0	0	4	2	4	10	3.96	0.385
M15	2	3	2	2	1	10	3.75	
M16	0	0	4	3	3	10	3.95	0.385
M17	2	3	2	1	2	10	3.56	
M18	0	0	4	4	2	10	3.94	0.375
M19	2	3	2	0	3	10	3.62	
M20	0	0	4	5	1	10	3.93	0.3775
M21	2	3	1	4	0	10	3.66	
M22	0	0	5	1	4	10	3.94	0.38

M23	2	3	1	3	1	10	3.67	
M24	0	0	5	2	3	10	3.93	0.38
M25	2	3	1	2	2	10	3.58	
M26	0	0	5	3	2	10	3.92	0.375
M27	2	3	1	1	3	10	3.59	
M28	0	0	5	4	1	10	3.91	0.375
M29	2	3	1	0	4	10	3.60	
M30	0	0	5	5	0	10	3.90	0.375
M31	2	3	0	5	0	10	3.68	
M32	0	0	6	0	4	10	3.92	0.38
M33	2	3	0	4	1	10	3.59	
M34	0	0	6	1	3	10	3.91	0.375
M35	2	3	0	3	2	10	3.60	
M36	0	0	6	2	2	10	3.90	0.375
M37	2	3	0	2	3	10	3.61	
M38	0	0	6	3	1	10	3.89	0.375
M39	2	3	0	1	4	10	3.62	
M40	0	0	6	4	0	10	3.88	0.375
M41	2	2	6			10	3.70	
M42	0	1	0	5	4	10	3.90	0.38
M43	2	2	5	1		10	3.72	
M44	0	1	1	4	4	10	3.88	0.38
M45	2	2	5	0	1	10	3.63	
M46	0	1	1	5	3	10	3.87	0.375
M47	2	2	4	2		10	3.64	
M48	0	1	2	3	4	10	3.86	0.375
M49	2	2	4	1	1	10	3.60	
M50	0	1	2	4	3	10	3.80	0.37
M51	2	2	4	0	2	10	3.61	
M52	0	1	2	5	2	10	3.84	0.3725
M53	2	2	3	3		10	3.76	
M54	0	1	3	2	4	10	3.84	0.38
M55	2	2	3	2	1	10	3.57	
M56	0	1	3	3	3	10	3.73	0.365
M57	2	2	3	1	2	10	3.58	
M58	0	1	3	4	2	10	3.72	0.365
M59	2	2	3	0	3	10	3.59	
M60	0	1	3	5	1	10	3.76	0.3675
M61	2	2	2	4		10	3.63	
M62	0	1	4	1	4	10	3.77	0.37
M63	2	2	2	3	1	10	3.59	
M64	0	1	4	2	3	10	3.71	0.365
M65	**2**	**2**	**2**	**2**	**2**	10	**3.10**	
M66	**0**	**1**	**4**	**3**	**2**	10	**3.30**	**0.32**
M67	2	2	2	1	3	10	3.51	
M68	0	1	4	4	1	10	3.69	0.36
M69	2	2	2	0	4	10	3.52	0.36

M70	0	1	4	5	0	**10**	3.68	
M71	2	2	1	5		**10**	3.60	
M72	0	1	5	0	4	**10**	3.70	0.365
M73	2	2	1	5		**10**	3.70	
M74	0	1	5	0	4	**10**	3.80	0.375
M75	2	2	1	4	1	**10**	3.61	
M76	0	1	5	1	3	**10**	3.79	0.37
M77	2	2	1	3	2	**10**	3.52	
M78	0	1	5	2	2	**10**	3.78	0.365
M79	2	2	1	2	1	**8**	2.71	
M80	0	1	5	3	3	**12**	4.59	0.365
M81	2	2	1	1	4	**10**	3.54	
M82	0	1	5	4	0	**10**	3.76	0.365
M83	2	2	0	5	1	**10**	3.43	
M84	0	1	6	0	3	**10**	3.57	0.35
M85	2	2	0	4	2	**10**	3.44	
M86	0	1	6	1	2	**10**	3.56	0.35
M87	2	2	0	3	3	**10**	3.35	
M88	0	1	6	2	1	**10**	3.55	0.345
M89	2	2	0	2	4	**10**	3.46	
M90	0	1	6	3	0	**10**	3.54	0.35
M91	2	1	6	1		**10**	3.54	
M92	0	2	0	4	4	**10**	3.76	0.365
M93	2	1	6	1	1	**10**	3.65	
M94	0	2	0	5	3	**10**	3.85	0.375
M95	2	1	5	2		**10**	3.66	
M96	0	2	1	3	4	**10**	3.84	0.375
M97	2	1	5	1	1	**10**	3.57	
M98	0	2	1	4	3	**10**	3.73	0.365
M99	2	1	5	0	2	**10**	3.58	
M100	0	2	1	5	2	**10**	3.72	0.365
M101	2	1	4	3		**10**	3.58	
M102	0	2	2	2	4	**10**	3.62	0.36
M103	2	1	4	2	1	**10**	3.49	
M104	0	2	2	3	3	**10**	3.61	0.355
M105	2	1	4	1	2	**10**	3.50	
M106	0	2	2	4	2	**10**	3.70	0.36
M107	2	1	4	0	3	**10**	3.51	
M108	0	2	2	5	1	**10**	3.69	0.36
M109	2	1	3	4		**10**	3.50	
M110	0	2	3	1	4	**10**	3.70	0.36
M111	2	1	3	3	1	**10**	3.51	
M112	0	2	3	2	3	**10**	3.69	0.36
M113	2	1	3	2	2	**10**	3.42	
M114	0	2	3	3	2	**10**	3.68	0.355
M115	2	1	3	1	3	**10**	3.63	
M116	0	2	3	4	1	**10**	3.67	0.365

M117	2	1	3	0	4	10	3.64	
M118	0	2	3	5	0	10	3.86	0.375
M119	2	1	2	5		10	3.82	
M120	0	2	4	0	4	10	3.88	0.385
M121	2	1	2	4	1	10	3.53	
M122	0	2	4	1	3	10	3.67	0.36
M123	2	1	2	3	2	10	3.34	
M124	0	2	4	2	2	10	3.66	0.35
M125	2	1	2	2	3	10	3.35	
M126	0	2	4	3	1	10	3.65	0.35
M127	2	1	2	1	4	10	3.66	
M128	0	2	4	4	0	10	3.64	0.365
M129	2	1	1	5	1	10	3.65	
M130	0	2	5	0	3	10	3.65	0.365
M131	2	1	1	4	2	10	3.66	
M132	0	2	5	1	2	10	3.64	0.365
M133	2	1	1	3	3	10	3.37	
M134	0	2	5	2	1	10	3.63	0.35
M135	2	1	1	2	4	10	3.38	
M136	0	2	5	3	0	10	3.62	0.35
M137	2	1	0	5	2	10	3.68	
M138	0	2	6	0	2	10	3.52	0.36
M139	2	1	0	4	3	10	3.69	
M140	0	2	6	1	1	10	3.61	0.365
M141	2	1	0	3	4	10	3.60	
M142	0	2	6	2	0	10	3.50	0.355
M143	2	0	6	2		10	3.78	
M144	0	3	0	3	4	10	3.72	0.375
M145	2	0	6	1	1	10	3.39	
M146	0	3	0	4	3	10	3.71	0.355
M147	2	0	6	0	2	10	3.30	
M148	0	3	0	5	2	10	3.70	0.35
M149	2	0	5	3		10	3.70	
M150	0	3	1	2	4	10	3.60	0.365
M151	2	0	5	2	1	10	3.31	
M152	0	3	1	3	3	10	3.69	0.35
M153	2	0	5	1	2	10	3.62	
M154	0	3	1	4	2	10	3.78	0.37
M155	2	0	5	0	3	10	3.53	
M156	0	3	1	5	1	10	3.37	0.345
M157	2	0	4	4		10	3.32	
M158	0	3	2	1	4	10	3.68	0.35
M159	2	0	4	3	1	10	3.33	
M160	0	3	2	2	3	10	3.67	0.35
M161	2	0	4	2	2	10	3.54	
M162	0	3	2	3	2	10	3.66	0.36
M163	2	0	4	1	3	10	3.25	0.345

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M164	0	3	2	4	1	10	3.65	
M165	2	0	4	0	4	10	3.36	
M166	0	3	2	5	0	10	3.44	0.34
M167	2	0	3	5		10	3.64	
M168	0	3	3	0	4	10	3.56	0.36
M169	2	0	3	4	1	10	3.35	
M170	0	3	3	1	3	10	3.45	0.34
M171	2	0	3	3	2	10	3.36	
M172	0	3	3	2	2	10	3.64	0.35
M173	2	0	3	2	3	10	3.27	
M174	0	3	3	3	1	10	3.63	0.345
M175	2	0	3	1	4	10	3.38	
M176	0	3	3	4	0	10	3.62	0.35
M177	2	0	2	5	1	10	3.37	
M178	0	3	4	0	3	10	3.73	0.355
M179	2	0	2	4	2	10	3.38	
M180	0	3	4	1	2	10	3.62	0.35
M181	2	0	2	3	3	10	3.39	
M182	0	3	4	2	1	10	3.51	0.345
M183	2	0	2	2	4	10	3.50	
M184	0	3	4	3	0	10	3.60	0.355
M185	1	3	6	0	0	10	3.51	
M186	1	0	5	4	4	10	3.99	0.375
M187	1	3	5	1		10	3.73	
M188	1	0	1	4	4	10	3.87	0.38
M189	1	3	5	0	1	10	3.64	
M190	1	0	1	5	3	10	3.66	0.365
M191	1	3	4	2		10	3.75	
M192	1	0	2	3	4	10	3.65	0.37
M193	1	3	4	1	1	10	3.46	
M194	1	0	2	4	3	10	3.64	0.355
M195	1	3	4	0	2	10	3.47	
M196	1	0	2	5	2	10	3.63	0.355
M197	1	3	3	3		10	3.67	
M198	1	0	3	2	4	10	3.63	0.365
M199	1	3	3	2	1	10	3.28	
M200	1	0	3	3	3	10	3.42	0.335
M201	1	3	3	1	2	10	3.59	
M202	1	0	3	4	2	10	3.41	0.35
M203	1	3	3	0	3	10	3.30	
M204	1	0	3	5	1	10	3.70	0.35
M205	1	3	2	4		10	3.79	
M206	1	0	4	1	4	10	3.71	0.375
M207	1	3	2	3	1	10	3.40	
M208	1	0	4	2	3	10	3.70	0.355
M209	1	3	2	2	2	10	3.31	
M210	1	0	4	3	2	10	3.69	0.35

M211	1	3	2	1	3	**10**	3.32	
M212	1	0	4	4	1	**10**	3.38	0.335
M213	1	3	2	0	4	**10**	3.33	
M214	1	0	4	5	0	**10**	3.37	0.335
M215	1	3	1	5		**10**	3.61	
M216	1	0	5	0	4	**10**	3.69	0.365
M217	1	3	1	4	1	**10**	3.32	
M218	1	0	5	1	3	**10**	3.38	0.335
M219	1	3	1	3	2	**10**	3.33	
M220	1	0	5	2	2	**10**	3.37	0.335
M221	1	3	1	2	3	**10**	3.34	
M222	1	0	5	3	1	**10**	3.66	0.35
M223	1	3	1	1	4	**10**	3.35	
M224	1	0	5	4	0	**10**	3.65	0.35
M225	1	3	0	5	1	**10**	3.34	
M226	1	0	6	0	3	**10**	3.46	0.34
M227	1	3	0	4	2	**10**	3.35	
M228	1	0	6	1	2	**10**	3.45	0.34
M229	1	3	0	3	3	**10**	3.36	
M230	1	0	6	2	1	**10**	3.64	0.35
M231	1	3	0	2	4	**10**	3.37	
M232	1	0	6	3	0	**10**	3.43	0.34
M233	1	2	6	1	0	**10**	3.45	
M234	1	0	4	4	4	**10**	3.45	0.345
M235	1	2	6	0	1	**10**	3.26	
M236	1	1	0	5	3	**10**	3.74	0.35
M237	1	2	5	2		**10**	3.57	
M238	1	1	1	3	4	**10**	3.53	0.355
M239	1	2	5	1	1	**10**	3.28	
M240	1	1	1	4	3	**10**	3.42	0.335
M241	1	2	5	0	2	**10**	3.29	
M242	1	1	1	5	2	**10**	3.51	0.34
M243	1	2	4	3	0	**10**	3.39	
M244	1	1	2	2	4	**10**	3.51	0.345
M245	1	2	4	2	1	**10**	3.40	
M246	1	1	2	3	3	**10**	3.50	0.345
M247	1	2	4	1	2	**10**	3.41	
M248	1	1	2	4	2	**10**	3.49	0.345
M249	1	2	4	0	3	**10**	3.42	
M250	1	1	2	5	1	**10**	3.48	0.345
M251	1	2	3	4	0	**10**	3.41	
M252	1	1	3	1	4	**10**	3.49	0.345
M253	1	2	3	3	1	**10**	3.42	
M254	1	1	3	2	3	**10**	3.48	0.345
M255	1	2	3	2	2	**10**	3.33	
M256	1	1	3	3	2	**10**	3.37	0.335
M257	1	2	3	1	3	**10**	3.34	0.34

M258	1	1	3	4	1	**10**	3.46	
M259	1	2	3	0	4	**10**	3.35	
M260	1	1	3	5	0	**10**	3.35	0.335
M261	1	2	2	5	0	**10**	3.43	
M262	1	1	4	0	4	**10**	3.47	0.345
M263	1	2	2	4	1	**10**	3.34	
M264	1	1	4	1	3	**10**	3.46	0.34
M265	1	2	2	3	2	**10**	3.25	
M266	1	1	4	2	2	**10**	3.45	0.335
M267	1	2	2	2	3	**10**	3.36	
M268	1	1	4	3	1	**10**	3.34	0.335
M269	1	2	2	1	4	**10**	3.37	
M270	1	1	4	4	0	**10**	3.53	0.345
M271	1	2	1	5	1	**10**	3.46	
M272	1	1	5	0	3	**10**	3.34	0.34
M273	1	2	1	4	2	**10**	3.37	
M274	1	1	5	1	2	**10**	3.43	0.34
M275	1	2	1	3	3	**10**	3.48	
M276	1	1	5	2	1	**10**	3.32	0.34
M277	1	2	1	2	4	**10**	3.39	
M278	1	1	5	3	0	**10**	3.31	0.335
M279	1	2	0	5	2	**10**	3.29	
M280	1	1	6	0	2	**10**	3.21	0.325
M281	1	2	0	4	3	**10**	3.40	
M282	1	1	6	1	1	**10**	3.20	0.33
M283	**1**	**2**	**0**	**3**	**4**	**10**	**3.21**	
M284	**1**	**1**	**6**	**2**	**0**	**10**	**3.19**	**0.32**

According to the markers drawn only two sets have given best utilization. The marker sets M65+M66 and M283+M284 give the best consumption as 0.32 m per garment (table 5.4). All the markers are drawn to the width 160 cm and with the end allowance included.

Table 5.4 – The best marker sets for style T86-2913D.

M65	**2**	**2**	**2**	**2**	**2**	**10**	**3.10**	
M66	**0**	**1**	**4**	**3**	**2**	**10**	**3.30**	
M283	**1**	**2**	**0**	**3**	**4**	**10**	**3.21**	
M284	**1**	**1**	**6**	**2**	**0**	**10**	**3.19**	**0.32**

According to the selected marker sets' consumption and the order quantity the fabric requirement is as follows.

    Width 160 cm.
    Length - Grey   1,152 m.
             - Red   1,728 m.
             - Green   2,304 m.

5.3 Economical lay plan on received fabric

The received fabric can be segregated as per width and shrinkage as shown in table 5.5.

Table 5.5 – Inspection list of the fabric received for style T86-2913D.

Colour	No of rolls	Length	Width	Shrinkage %	Total faults
Grey	10	406.1m	160cm	1.1%	26
Grey	11	412.3m	160cm	1.2%	29
Grey	10	337.6m	160cm	0.9%	17
Grey Total	**31**	**1,156.0m**			**72**
Red	9	381.0m	160cm	1.0%	9
Red	10	403.5m	160cm	1.1%	21
Red	7	278.4m	162cm	1.1%	23
Red	9	343.2m	162cm	1.2%	10
Red	8	305.2m	162cm	1.1%	11
Red Total	**43**	**1,711.3m**			**74**
Green	8	315.5m	160	1.1%	9
Green	8	341.0m	160	1.2%	3
Green	8	348.7m	162	0.9%	12
Green	7	266.5m	162	1.1%	11
Green	10	406.1m	162	1.2%	23
Green	6	242.5m	163	1.2%	14
Green	10	344.9m	164	1.2%	24
Green Total	**57**	**2,265.2m**			**96**

As per the amount of received fabric it seems that the fabric received would not be enough for the order.

Deciding the cut quantity

- To overcome the defects in the stitching stage, an additional 3% to the order quantity has to be cut.
- There are all together 242 fabric faults, thereby 242 odd garments would be rejected according to the inspection list. It is time wastage if the fabric faults were removed at the spreading stage. Therefore it would be cost effective if it is removed by panel form.
- Remnant pieces would not be small as per planned, therefore planned to use joints.

Therefore the planned cut quantity for each colour must be

		No of garments	Required amount of fabric
Grey	= 3600+3% + 72	= 3780 garments.	= 1,209.6 m.
Red	= 5400+3% + 74	= 5636 garments.	= 1,803.6 m.
Green	= 7200+3% + 96	= 7512 garments.	= 2,403.9 m.

The shortage quantity of fabric (shown below) must be saved by any means, therefore an effective pattern engineering shall be carried out.

Grey - 54 m.
Red   - 93 m
Green - 139 m.

As there are wider fabric than 160cm for certain fabric of red and green those would be advantages. There are some possibilities to reduce the sewing allowance from the bottom hem as the shrinkage specified by supplier (1.3%) is not included in the received fabric (maximum 1.2%).

The selected best 14 markers, which gives best consumptions are in table 5.3, are drawn reducing the sewing allowance by 5mm from the bottom hem. Those are shown in table 5.6.

Table 5.6 – Patten engineered marker sets for production of style T86-2913D.

	S	M	L	XL	XXL		Marker length	Consumption
							(m)	m/garment
M65	2	2	2	2	2	10	3.00	
M66	0	1	4	3	2	10	3.10	0.305
M199	1	3	3	2	1	10	3.13	
M200	1	0	3	3	3	10	3.37	0.325
M211	1	3	2	1	3	10	3.07	
M212	1	0	4	4	1	10	3.23	0.315
M213	1	3	2	0	4	10	3.28	
M214	1	0	4	5	0	10	3.22	0.325
M217	1	3	1	4	1	10	3.27	
M218	1	0	5	1	3	10	3.23	0.325

M219	1	3	1	3	2	**10**	3.08	
M220	1	0	5	2	2	**10**	3.32	0.32
M255	1	2	3	2	2	**10**	3.18	
M256	1	1	3	3	2	**10**	3.32	0.325
M259	1	2	3	0	4	**10**	3.30	
M260	1	1	3	5	0	**10**	3.30	0.33
M265	1	2	2	3	2	**10**	3.10	
M266	1	1	4	2	2	**10**	3.30	0.32
M267	1	2	2	2	3	**10**	3.21	
M268	1	1	4	3	1	**10**	3.29	0.325
M277	1	2	1	2	4	**10**	3.24	
M278	1	1	5	3	0	**10**	3.16	0.32
M279	1	2	0	5	2	**10**	3.14	
M280	1	1	6	0	2	**10**	3.16	0.315
M281	1	2	0	4	3	**10**	3.25	
M282	1	1	6	1	1	**10**	3.05	0.315
M283	1	2	0	3	4	**10**	3.16	
M284	1	1	6	2	0	**10**	3.04	0.31

According to the table 5.6 the best out put comes from M65 + M66 marker combination. The best consumption is 0.305 m/ garment for the width of 160cm.

Table 5.7 –The best markers for all available widths.

	S	M	L	XL	XXL		Marker length	Consumption
Width 160cm							(m)	m/garment
M65	2	2	2	2	2	10	3.00	
M66	0	1	4	3	2	10	3.10	0.305
Width 162cm								
M283	1	2	0	3	4	10	3.00	
M284	1	1	6	2	0	10	3.00	0.300
Width 164cm								
M65	2	2	2	2	2	10	2.85	
M66	0	1	4	3	2	10	2.95	0.290

Since there are few amount of fabric received from width 163cm, those can be merged with 162cm. The spreading plan that should be followed is shown in the table 5.8.

Table 5.8 – Lay plan for style T86-2913D.

Cut No	No of plies	No of layers	S	M	L	XL	XXL	Total sets	Total	Fabric required (m)
Grey 3,600 pcs (3,780 pcs) - width 160cm										
1-4	40	4	2	2	2	2	2	**10**	**1600**	480
5-8	40	4	0	1	4	3	2	**10**	**1600**	496
9	29	1	2	2	2	2	2	**10**	**290**	87
10	29	1	0	1	4	3	2	**10**	**290**	89.9
Total			378	567	1134	945	756		3780	1152.9
Red 5,400 pcs (5,636 pcs) - width 160cm -2,560 pcs only										
11-13	40	3	2	2	2	2	2	**10**	**1200**	360
14-16	40	3	0	1	4	3	2	**10**	**1200**	372
17	8	1	2	2	2	2	2	**10**	**80**	24
18	8	1	0	1	4	3	2	**10**	**80**	24.8
Total			256	384	768	640	512		2560	780.8
Red 5,400 pcs (5,636 pcs) - width 162cm -3,076 pcs only										
19-21	40	3	1	2	0	3	4	**10**	**1200**	360
22-24	40	3	1	1	6	2	0	**10**	**1200**	360
25	34	1	1	2	0	3	4	**10**	**340**	102
26	34	1	1	1	6	2	0	**10**	**340**	102
Total			308	462	924	770	616		3080	924
Total red			**564**	**846**	**1692**	**1410**	**1128**		**5640**	
Green 7,200 pcs (7,512 pcs) - width 160cm -2,136 pcs only										
27-28	40	2	2	2	2	2	2	**10**	**800**	240
29-30	40	2	0	1	4	3	2	**10**	**800**	248
31	27	1	2	2	2	2	2	**10**	**270**	81
32	27	1	0	1	4	3	2	**10**	**270**	83.7
Total			214	321	642	535	428		2140	652.7
Green 7,200 pcs (7,512 pcs) - width 162cm -4,212 pcs only										
33-37	40	5	1	2	0	3	4	**10**	**2000**	600
38-42	40	5	1	1	6	2	0	**10**	**2000**	600
43	10	1	1	2	0	3	4	**10**	**100**	30
44	10	1	1	1	6	2	0	**10**	**100**	30
Total			420	630	1260	1050	840		4200	1260
Green 7,200 pcs (7,512 pcs) - width 164cm -1,164 pcs only										
45	40	1	1	2	0	3	4	**10**	**400**	114
46	40	1	1	1	6	2	0	**10**	**400**	118
47	19	1	1	2	0	3	4	**10**	**190**	54.15
48	19	1	1	1	6	2	0	**10**	**190**	56.05
Total			118	177	354	295	236		1180	342.2
Total green			**752**	**1128**	**2256**	**1880**	**1504**		**7520**	

According to the table 5.8 there are 48 layers. But when spreading following layers those that can be merged together, lesser number of layers has to cut, by keeping the maximum ply height for 40.

Cut no. 17 (8 plies-red) + cut no. 31 (27 plies-green)
Cut no. 18 (8 plies-red) + cut no. 32 (27 plies-green)

Even though there will be 131 remnant pieces left. To avoid this it can be laid with splices.

Other economical plans.
- Planned to lay 2 operators.
- Planned to lay manual as this fabric is a stripe material.
- Planned to cut manual.
- Planned to panel inspection with removing defects and necessary trimming work.

Other points
- There are no much fabric faults.
- There are no inconsistent widths
- There is no colour shading.
- There is no colour bleeding – can spread one colour over the other.

Advantages
- Could achieve the order quantity with lesser amount of fabric. A higher yield is achieved.
- Could recover the fabric's defects.
- Easy to spread because of short lay lengths.
- Easy to cut.
- Easy to remove defects and replacement.
- Reduced cutting time by one layer.
- Used all fabric.

Disadvantages
- Finding the best marker is time consuming.
- When removing fabric defects, total panel sets have to be removed.

This is the best economical plan for style T86 – 2913D identified.

5.4 A strategic sequence to follow to get economical lay plan

- Check order details and customer requirements.
- Check the supplier specifications and the fabric physical and chemical properties.
- Choose and prepare the best cost marker.
- Order fabric with considering shrinkage and other fabric faults.
- Plan to have better deal with fabric fault
- Inspect the fabric received and segregate according to width, shrinkage, shades, etc.
- Calculate the possible cut quantity by fabric receipts.
- Calculate the remnant pieces and length of those.
- If it is going to cut short, then try to do possible pattern engineering to achieve the required cut quantity.
- Choose and prepare marker for production with considering minimize the wastages.
- Prepare the suitable lay planning and prepare a plan to utilize fabric remnants.
- Spread the fabric effectively with or without joints.
- Progress cutting with high quality by choosing the best method.
- Bundle and number the cut panels.
- Carry out panel inspection and replace the damages.
- Progress issuing with a better control.
- Reconcile the order with advantages and disadvantages received.

CHAPTER 6

6. CONCLUSION

When considering the high fabric utilization through cutting room management, the proper and good management of the cutting room which is a definite requirement, should be dealt with its' external and internal processes. To have a proper management system at cutting room, the manager should have an idea of their buyers and their basic requirements not only the pattern but also trend flows / seasonal changes, to stay as a sustainable sourcing entity. Otherwise the required proper plan cannot be worked out. If the plan and organizing is out, no high fabric utilization would be achieved any more. Also a thorough knowledge on pattern and design would give better results on fabric savings as shown in the example 2 and 4 in chapter 4.1.

Basically, the fabric utilization addresses as follows,

Fabric utilization (FU)   =   <u>Fabric re-shipped</u> X 100% $\rightarrow$ (1)
                                Fabric received

Fabric re-shipped (FRS) α   Cutting room management (CRM)

Where this CRM (cutting room management) is an index which varies between 0 to 100, assuming 100 is a perfect management.

    FRS   = k_1 x CRM / 100 $\rightarrow$ (2)

Where k_1 is a variable depends on other factors which related to fabric utilization.

Fabric plays the main role when utilizing it highly. Therefore the supplier specification on fabric greatly help the cutting room to plan day today operations. For an example the necessary supplier specification on fabric, gives an idea how to prepare the cut order plan effectively. Supplier specification specifies the nature of the fabric, amount dispatched by supplier, fault rate, shrinkage percentage, GSM etc. which are useful to segregate the fabric received. This segregation helps to achieve high fabric utilization. (see chapter 4.23). Especially, supplier specification helps to forecast possible cut quantity, possible defects, possible remnant sizes and to avoid wastages.

The GSM is one of the key information in supplier specification. But the GSM does not make a significant barrier for high fabric utilization. The effect of GSM

is clearly showed by the author in chapter 4.3, how it helps to achieve high fabric utilization. It is also showed that the GSM sometimes reacts as a barrier to high fabric utilization. If the GSM is higher, then the number of plies can be laid is lesser. Thereby the cut out put per hour or per day becomes lower. It creates problems (heavy work load) in cutting room operations, which then will be an indirect barrier to achieve high fabric utilization. Thereby the cutting room capacity has to be expanded if there are much orders with high GSM.

The length of a roll plays a vital role in high fabric utilization. A great advantage is gained, if fabric is ordered in to exact lengths, which gives remnants as zero or plan according to the lay length by minimizing the remnants. Table 4.28 shows how to minimize the remnants. The length and the weight of a fabric roll will also create an additional cost. Shortages and large remnant pieces are also barriers to achieve high fabric utilization.

Width of a fabric roll also plays a vital role in marker efficiencies, ultimately the high fabric utilization. Thereby an optimum width must be identified and ordered to get high fabric utilization at the fabric ordering / purchasing stage. In the tables 4.2, 4.3, 4.4, 4.5 and 4.6, show an optimum width an economical width. If this situation is identified earlier, then the optimum fabric width can be decided to order fabric by concerning the other factors as well.

Even though fabric is ordered for a specific width , the received width may differ, and these may have several widths. Therefore the cutting process must be carried out by segregating widths in to fare quantities as shown in example 1 in chapter 4.5, without drawing markers for each and every width.

Another main barrier to gain high fabric utilization is the inconsistent width. The chapter 4.4 shows how to react with inconsistent width. However it creates an additional cost and a waste.

The shrinkage also plays a vita role in high fabric utilization. It is a must to test the shrinkage percentage in each and every fabric roll. It is better to test in three places if the shrinkage varies within the roll. Patterns must be drawn based on those results. If there are several types of shrinkage percentages, the best method using in the industry is to segregate fabric rolls with a smaller tolerance.

The biggest support in high fabric utilization is given by the marker making process. The marker makers should be capable enough to select the appropriate and best marker for a particular pattern and particular type of fabric. Also they must do the costing and fabric ordering accurately as much as possible. It is they who decide the fabric width, that must be purchased which is then sent for cutting. Some examples are shown in chapter 4.17 and 4.18. Higher the marker

efficiency, lower will be the fabric fall out. The high marker efficiency is one of the main routes where high fabric utilization can be gained. Tightening the cost markers might be a difficult target to achieve, however maximize fabric utilization must be the end result.

Fabric re-shipped (FRS) α   **Marker efficiency (ME)**

Where
Marker Efficiency (ME) α   **Width of the fabric roll (W)**
Marker Efficiency (ME) α   **Shrinkage percentage of fabric roll (S)**
Marker Efficiency (ME) α   **Efficiency of marker maker (EM)**

Therefore,
Marker Efficiency (ME) = k_2**W x** k_3**S x EM**   → (3)

Where k_2 is a variable (per 1 cm) depends on the fabric width and other factors, k_3 is a variable depends on the fabric shrinkage.

$$FRS \quad = \quad k_4 \text{ x } (k_2 W \text{ x } k_3 S \text{ x EM}) \quad\quad → (4)$$

Where k_4 is a variable depends on the fabric type.

Another highly concerned key point in high fabric utilization is the **fabric faults**. An additional manpower and time are required to avoid and replace the fabric defects. Totally fabric faults make big losses to the cutting room, even though it passed through any inspection criteria. This dissertation shows that how a high fault rate fabric can be used to get high fabric utilization with an additional cost. There are several possible ways to get used all defect panels, some ways are shown in figures 4.6 and 4.7. However better dealing with high fault rate fabric shows the better cutting room management.

Fabric re-shipped (FRS) α   **Fabric fault rate (FF)**

$$FRS \quad = \quad k_5 \text{ x FF} \quad\quad\quad → (5)$$

Where k_5 is a variable depends on fabric type and the pattern.

Finding the best method to overcome fabric faults including shrinkage, shortage, narrow width, etc and achieving the required target can be done by pattern engineering. However the pattern engineering helps greatly to increase the fabric utilization, by avoiding lot of barriers as stated above. Any way, to achieve the high fabric utilization through better pattern engineering is also a difficult task to work with other limited resources such as available space, available

manpower, available time and other available resources. Some of the results are shown in tables 4.12, 4.13, 4.14, 4.15, 4.16 and 4.17 in chapter 4.16.

According to the tables 4.12 and 4.13 some of engineered markers, especially, corners rounding, reducing seam allowance, etc show lower efficiencies than the original efficiencies. It can be happened if the off area by panels is greater than the reduced area of marker. It proves by the equation derived in chapter 4.16.

But certain decisions taken in pattern engineering when achieving high fabric utilization may sometimes become a loss, because that the pattern goes out of size or will delay the whole process due to the delay of marker making. Such errors may lead to RTM (return back to manufacturer) or a shipment cancellation or a short shipment or a delay shipment or an additional costs like air freight cost or a ratio out shipments or a high rejection at work-in-progress or even loss of goodwill. Therefore the best method must be evaluated to follow rather than trying to get high fabric utilization at all the time.

Normally the behavior of fabric does not support the higher marker efficiency, as fabric has lot of uncertainties. To overcome these fabric faults and unexpected features the spreading and cutting methods must be improved properly using new techniques. While considering fabric and its' features, they are varied from fabric to fabric, batch to batch, roll to roll. Therefore the styles are varying drastically. Thereby the pattern making methods, marker making methods, spreading methods, cutting methods etc are varying from style to style and fabric to fabric.

The spreading and cutting methods also influence significantly to high fabric utilization. Even though it is cut with higher fabric utilization, the wastages in work-in-progress at the sewing room or at finishing leads to a loss, thereby the effort taken to achieve the high fabric utilization in the cutting room may become useless. Effective bundling, numbering, fusing and panel inspection lead to avoid the above losses at the value addition process.

Achieving high fabric utilization is a profit to a garment sector. Even though, higher fabric utilization is achieved, the end result might be a loss. This can be happened because of useless, unplanned and uncontrolled resource utilization. For example, if high amount of other resources were spent other than fabric to get high fabric utilization it might be a loss. Therefore even the fabric plays a big roll in the process of value addition; it may be in vein if an error occurred at any step in the cutting room.

The customer requirements on product, ethical and environmental rues and regulations should not be violated by any means, because that is the main bond of

customer service. The customer requirements differ from customer to customer, country to country, style to style, fabric to fabric, etc. Sometimes the customer requirements do not help in high fabric utilization. However it is useless to achieve high fabric utilization without attending properly to customer requirements.

Also this dissertation shows that the cutting room management has a great opportunity to mix, control and get the maximum utilization of all available resources. The possible advantages that can be gained are buyer's satisfaction, better Customer – Buyer relationship, profit at manufacturer's end, profit at Buyers end, competitive advantages, etc.

Fabric utilization (FU) = $\underline{\text{Fabric re-shipped}}$ X 100% $\rightarrow$ (1)
Fabric received

FRS = k_1 x CRM / 100 $\rightarrow$ (2)
ME = k_2W x k_3S x EM $\rightarrow$ (3)
FRS = k_4 x (k_2W x k_3S x EM) $\rightarrow$ (4)
FRS = k_5 x FF $\rightarrow$ (5)

So the Fabric re-shipped can be derived as, (from equations (2), (3), (4) and (5))

FRS = k_5 x FF x k_4 x (k_2W x k_3S x EM) x k_1 x CRM / 100

    = k_1 x k_2 x k_3 x k_4x k_5 x FF x W x S x EM x CRM / 100

    = k x FF x W x S x EM x CRM / 100

    Where k = k_1 x k_2 x k_3 x k_4x k_5

From the equation (1)

Fabric utilization (FU) = $\underline{\text{k x FF x W x S x EM x CRM}}$ %
Fabric received

Thereby, CRM is the most deciding factor for high fabric utilization, as others are common for most of the factories.

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