Skills for Employment Investment Program (SEIP)

COMPETENCY-BASED LEARNING MATERIAL

(STUDENT GUIDE)

FOR

WEAVING TECHNOLOGY

(TEXTILE SECTOR)

Finance Division, Ministry of Finance
Government of the People's Republic of Bangladesh

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How to Use this Competency-based Learning Material

Welcome to the competency-based learning material for Weaving Technology for use in textile works. These modules contain training materials and learning activities for you to complete in order to become competent and qualified as a skilled worker.

There are six (6) modules that make up this course which comprises the skills, knowledge and attitudes required to become a skilled worker including:

1. Identify basics of weaving technology
2. Carry out preparation for weaving operation
3. Perform shedding operation
4. Perform picking operation
5. Perform beating operation
6. Identify weaving accessories and fabric faults

As a learner, you will be required to complete a series of activities in order to achieve each learning outcome of the module. These activities may be completed as part of structured classroom activities or simulated workplace demonstrations.

These activities will also require you to complete associated learning and practice activities in order to gain the skills and knowledge needed to achieve the learning outcomes. You should refer to **Learning Activity** pages of each module to know the sequence of learning tasks and the appropriate resources to use for each task.

This page will serve as the road map towards the achievement of competence. If you read the **Information Sheets,** these will give you an understanding of the work, and why things are done the way they are. Once you have finished reading the Information Sheets, you will then be required to complete the **Self-Check Quizzes**.

The self-check quizzes follow the Information Sheets in this learning guide. Completing the self-check quizzes will help you know how you are progressing. To check your knowledge after completion of the Self-Check Quizzes, you can review the **Answer Key** at the end of each module.

You are required to complete all activities as directed in the **Learning Activity and Information Sheet**. This is where you will apply your newly acquired knowledge while developing new skills. When working, high emphasis should be laid on safety requirements. You will be encouraged to raise relevant queries or ask the facilitator for assistance as required.

When you have completed all the tasks required in this learning guide, formal assessment will be scheduled to officially evaluate if you have achieved competency of the specified learning outcomes and are ready for the next task.

List of Icons

Icon Name	Icon
Module content	
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Module 1: Identify basics of weaving technology

MODULE CONTENT

Module Descriptor: This module covers the skills, knowledge and attitudes to identify the basics of weaving technology. It specifically includes defining weaving technology, identifying tools and equipment, and classifying raw materials. It also includes information sheets, job sheets, self-checking and answer keys.

Nominal Duration: 40 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee will be able to:

1.1 Define weaving technology

1.2 Identify tools and equipment

1.3 Classify raw materials

PERFORMANCE CRITERIA:

1. Weaving technology is accurately defined and illustrated.
2. Different types of weaves and materials are identified, compared and constructed.
3. Role and responsibilities of weaving loom operator are identified and explained.
4. Weaving floor layout is described.
5. Appropriate tools and equipment are identified as per job requirement.
6. Looms and other machinery are identified and labeled according to classification.
7. Raw materials required to perform weaving is identified and selected.
8. Different types of yarns are identified, classified and distinguished by key characteristics.
9. Different types of sizing materials for warp yarns are identified.

Learning Outcome 1.1 – Define Weaving Technology

Contents:

- Definition and illustration of weaving technology
- Different types of weaves and materials
- Weaves: plain, twill, satin
- Materials: yarn and fabric

Assessment criteria:

1. Weaving technology is defined and illustrated.
2. Different types of weaves and materials are identified, compared and contrasted.
3. Role and responsibilities of weaving loom operators are identified and explained.

Resources required:

Students/trainees must be provided with the following resources:

- Materials: warp and weft yarn, fabric

LEARNING ACTIVITY 1.1.1

Learning Activity	Resources/Special Instructions/References
Define and illustrate weaving technology	▪ Information Sheet: 1.1.1 ▪ Self-Check Quiz: 1.1.1 ▪ Answer Key: 1.1.1 ▪ https://en.wikipedia.org/wiki/Weaving ▪ http://web.itu.edu.tr/~berkalpo/Weaving_Lecture/Weaving_Chapter1a_06S.pdf

INFORMATION SHEET 1.1.1

Learning Objective: to define and illustrate weaving technology.

To define weaving technology following steps are important:

Winding: is the process to transfer yarn from ring bobbin to a suitable package in a long length. Cone cheese etc are the packages produced by winding.

Warping: is the process of transferring yarns from many small packages to large packages at a required length and number. Warpers beam is produced after warping.

Sizing: is the process of applying protective adhesive coating on the surface of the yarns to increase the strength and weave ability of the warp yarns.

Drafting: is the process of passing the warp yarns individually through the heald eyes of the heald frame.

Denting: is the process of passing the warp yarns group wise through the dent of the reed already passed through the heald eye of the heald frame.

Looming: is the process of setting the beam in the weaving machine.

Weaving: is the process of producing of woven fabric by interlacing warp and weft yarns in the weaving machine. Weaving machine or loom is required to perform weaving. Warp and weft yarns are used for weaving.

Individual Activity:

- *Define and illustrate weaving technology*

SELF-CHECK QUIZ 1.1.1

Write the correct answer for the following questions.

1. What is weaving?
2. Which machine is needed to perform weaving?
3. What materials are used for weaving?

LEARNING ACTIVITY 1.1.2

Learning Activity	Resources/Special Instructions/References
Different types of weaves and materials	▪ Information Sheet: 1.1.2 ▪ Self-Check Quiz: 1.1.2 ▪ Answer Key: 1.1.2 ▪ https://www.fibre2fashion.com/industry-article/3343/different-types-of-weaves

INFORMATION SHEET 1.1.2

Learning Objective: to identify different types of weaves and materials.

Materials:

To identify different types of weaves and materials, followings are required

- **Plain:** is the basic weave and simplest of all weaves having a repeat size of 2 x 2. Plain weave is obtained by raising all even-numbered warp ends at one pick and raising all the odd numbered ones at the other pick. It means threads interlacing in alternate order. The range of application of this weave is wide.

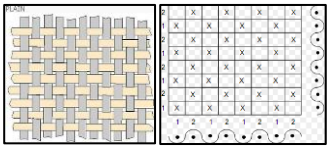


Figure: Plain weave

- **Twill:** is second basic weave. This weave is characterised by diagonal lines or twill lines on the face of the fabric. These twill lines are produced by letting all warp ends interlace in the same way but displacing the interlacing points of each end by one pick relative to that of the previous end. Twill lines are formed on both sides of the fabric.

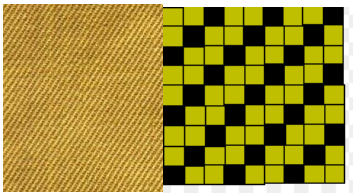


Figure: Twill weave

- **Satin:** is the third basic weave of the woven fabrics. Satin weaves produce a smooth, even and glossy fabric surface. This is due to the interlacing points being covered up by the floats of the neighbouring threads.

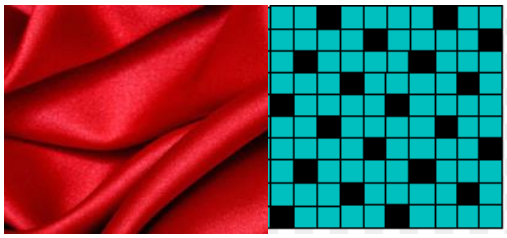


Figure: Slain weave

- **Warp and weft yarn:** are required to produce woven fabric.

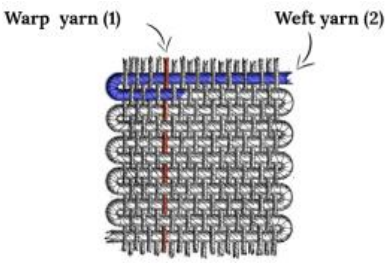


Figure: Warp and weft yarn

- **Fabric:** is the production of weaving machine produced by the interlacement of warp and weft yarn. A woven fabric is any fabric made by interlacing two or more threads at right angles to one another.

Figure: Fabric

SELF-CHECK QUIZ 1.1.2

Read the statement carefully and state whether it is ‘True’ or ‘False’.

1. There are three basic structures of woven fabric.
2. Only warp yarn is sufficient to produce woven fabric.
3. Diagonal line is produced in the satin weave.

Learning Outcome 1.2 – Identify Tools and Equipment

Contents:

- List of tools and equipment required for weaving
- Classification of looms
- Tools and equipment

Assessment criteria:

1. Necessary tools and equipment are checked for their usability.
2. Looms are classified and identified.

Resources required:

Students/trainees must be provided with the following resources:

- **Tools and equipment:** Pocket tape, adjustable wrench, files (flat, round ,half-round), hacksaw, hammer, pliers, screwdriver, trolley

LEARNING ACTIVITY 1.2.1

Learning Activity	Resources/Special Instructions/References
Tools and equipment required for weaving	▪ Information Sheet: 1.2.1 ▪ Self-Check Quiz: 1.2.1 ▪ Answer Key: 1.2.1 ▪ http://textilelearner.blogspot.com/2013/03/maintenance-tools-equipments-and-their.html

INFORMATION SHEET 1.2.1

Learning Objective: to identify tools and equipment required for weaving.

Tools and equipment : to perform weaving following tools and equipment are required

- **Pocket tape:** Pocket Measuring Tapes, also known as a "Short Tape" or "Pocket Tape" are handy measuring tapes to have around.

Figure: Pocket Tape

- **Adjustable wrench:** An adjustable wrench (US) or adjustable spanner (UK) is a wrench with a "jaw" of adjustable width. It can be used with different sizes of fastener head (nut or bolt).

Figure: Adjustable wrench

- **Hacksaw**: A hacksaw is a fine-toothed saw, originally and mainly made for cutting metal. The equivalent saw for cutting wood is usually called bow saw.

Figure: Hacksaw

- **Hammer:** A hammer is a tool that, usually featuring a head fixed to a handle (also called a haft or helve), delivers a blow to an object to break it apart, drive it into another (e.g. a nail or spike), or beat it into a desired shape.

Figure: Hammer

- **Pliers**: Pliers are a hand tool used to hold objects firmly.

Figure: Pliers

- **Screwdriver:** A screwdriver is a tool, manual or powered, for screwing and unscrewing (inserting and removing) screws.

Figure: Screwdriver

Individual Activity:

- *Identify and select appropriate tools and equipment to perform weaving*

SELF-CHECK QUIZ 1.2.1

Fill in the blanks with the correct answer:

1. _____ is used to hold the objects firmly.
2. _____ is used to insert and remove screws.
3. _____ is necessary to fasten nut or bolts.
4. _____ is also known as measuring tape.
5. _____ is used to cut the metals.

LEARNING ACTIVITY 1.2.2

Learning Activity	Resources/Special Instructions/References
Classification of loom	▪ Information Sheet: 1.2.2 ▪ Self-Check Quiz: 1.2.2 ▪ Answer Key: 1.2.2 ▪ http://fashion2apparel.blogspot.com/2017/07/classification-loom.html

INFORMATION SHEET 1.2.2

Learning Objective: to identify different types of loom used for weaving.

- **Hand loom:** Looms or weaving devices operated wholly or partly by hand or foot power is called hand loom.

Figure: Hand Loom

- **Semi-automatic loom:** This type of loom is basically the plain loom with additional attachments of automatic electronic/mechanical warp stop as well as weft stop motions along with positive let off motions.

Figure: Semi-automatic loom

- **Power Loom:** Power loom is a mechanized loom.

Figure: Power Loom

- **Shuttle loom:** is a loom where pick is inserted by the help of shuttle.

Figure: Shuttle Loom

- **Air Jet Loom:** An air-jet loom is a shuttleless loom that uses a jet of air to propel the weft yarn through the warp shed.

Figure: Air-jet Loom

- **Rapier Loom**: A rapier loom is a shuttleless weaving loom in which the weft yarn is carried through the shed of warp yarns to the other side of the loom by finger-like carriers called rapiers.

Figure: Rapier Loom

- **Projectile Loom**: Where picking action is accomplished by a series of small bullet projectiles which ultimately grip the weft yarn and carried it through the weaving shed and return empty.

Figure: Projectile Loom

- **Water jet Loom:** where picking action is performed by the help of water jet.

Figure: Projectile Loom

SELF-CHECK QUIZ 1.2.2

Write the correct answer of the questions below:

1. What is hand loom?
2. What is shuttle loom?
3. How pick is inserted in the air jet loom?
4. What is the meaning of shuttleless loom?

Learning Outcome 1.3 – Classify Raw Materials

Contents:

- Raw materials required for weaving
- Types of yarns
- Types of sizing materials

Assessment criteria:

1. Raw materials required for weaving is identified and selected.
2. Types of yarns are classified and identified.
3. Types of sizing materials for warp are identified.

Resources required:

Students/trainees must be provided with the following resources:

- Materials: Yarns and sizing materials

LEARNING ACTIVITY 1.3.1

Learning Activity	Resources/Special Instructions/References
Classify and identify types of yarns and sizing materials	▪ Information Sheet: 1.3.1 ▪ Self-Check Quiz: 1.3.1 ▪ Answer Key: 1.3.1 ▪ Job Sheet 1

INFORMATION SHEET 1.3.1

Learning Objective: to classify and identify types of yarns and sizing materials used for weaving.

- **Cotton:** A soft white fibrous substance which surrounds the seeds of the cotton plant and is made into textile fibre and thread for sewing and producing fabric. It is a natural cellulosic fibre.

Figure: Cotton

- **Polyester:** A synthetic resin in which the polymer units are linked by ester groups, used chiefly to make synthetic textile fibres is called polyester.

Figure: Polyester

- **Cotton/polyester :** It is a blend of cotton and polyester fibres. Blends may be 65 per cent polyester and 35 per cent cotton.
- **Nylon:** a tough, lightweight, elastic synthetic polymer with a protein-like chemical structure, able to be produced as filaments, sheets, or moulded objects are called nylon.

Figure: Nylon

- **Acrylic:** are fibres made from polymers of acrylic acid or acrylates.

Figure: Acrylic

- **Starch:** is an odourless, tasteless white substance occurring widely in plant tissue and obtained chiefly from maize, corn and potatoes.
- **Adhesive:** are a substance used for sticking objects or materials together.
- **Softener:** is used to soften the yarns after sizing.

SELF-CHECK QUIZ 1.3.1

Read the statement carefully and state whether it is ‘True’ or ‘False’.

1. Cotton is a natural cellulosic fibre.
2. Polyester yarn is a man-made fibre.
3. 65P/35C means 65 percent cotton.
4. Softener is used to increase the strength of the yarns.
5. Maize is a starch.

JOB SHEET 1			
Qualification:	Weaving technology		
Learning unit:	Identify the basics of weaving technology		
Learner name:			
Personal protective equipment (PPE):			
Materials:	Warp and weft yarn, sizing materials		
Tools and equipment:			
Performance criteria:	1. Weaving technology is accurately defined and illustrated. 2. Different types of weaves and materials are identified, compared and contrasted. 3. Role and responsibilities of weaving loom operate are identified and explained. 4. Weaving floor layout is described. 5. Appropriate tools and equipment are identified as per job requirement. 6. Looms and other machinery are identified and labelled according to classification. 7. Raw materials required to perform weaving is identified and selected. 8. Different types of yarns are identified, classified and distinguished by key characteristics. 9. Different types of sizing materials for warp yarns are identified.		
Measurement:			
Notes:			
Procedure:	1. Identify the steps of weaving technology 2. Identify the raw materials used for weaving 3. Identify the weaving machine used for weaving 4. Identify the tools and equipment used for weaving		
Learner signature:		**Date:**	
Assessor signature:		**Date:**	
Quality Assurer signature:		**Date:**	
Assessor remarks:			
Feedback:			

Important:

- *The quality of product depends on the quality of the raw materials.*
- *Identify appropriate materials used for weaving.*
- *Identify proper tools and equipment used for weaving.*

Individual Activity:

- *Open and read the link on steps of weaving and summarize key points (if facilities available)*
- *Define the basics of weaving technology following Job Sheet 1 (see above)*

ANSWER KEYS

ANSWER KEY 1.1.1

1. Weaving is a method of textile production in which two distinct sets of yarns or threads are interlaced at right angles to form a fabric or cloth. The longitudinal threads are called the warp and the lateral threads are the weft or filling.
2. Weaving machine or loom is used to perform weaving.
3. Warp and weft yarn are used for the production of weaving.

ANSWER KEY 1.1.2

1. True
2. False
3. False

ANSWER KEY 1.2.1

1. Pliers
2. Screw driver
3. Adjustable wrench
4. Pocket tape
5. Hacksaw

ANSWER KEY 1.2.2

1. A loom operated manually by the help of hand and legs.
2. A loom where shuttle is used to insert the pick during weaving.
3. By the help of air and nozzle, pick is inserted in the air jet loom.
4. A loom where shuttle is not used, or pick is inserted without shuttle. Pick is inserted by the help of rapier or air jet system.

ANSWER KEY 1.3.1

1. True
2. True
3. False
4. False
5. True

Module 2: Carry out preparation for weaving operation

MODULE CONTENT

Module Descriptor: This module covers the knowledge, skills and attitudes to carry out preparation for weaving operation which includes performing winding, warping and sizing tasks. It also includes information sheets, job sheets, self-checking and answer keys.

Nominal Duration: 48 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee will be able to:

2.1 Perform winding task

2.2 Perform warping task

2.3 Perform sizing task

PERFORMANCE CRITERIA:

1. Materials, tools and equipment is identified and selected according to job requirement.
2. Yarn from ring bobbins are correctly wound to form package
3. Lubricant is checked, and levels maintained as per manufacturer's guidelines.
4. Required number of yarns from a creel of single-end package is transferred to a beam.
5. Size material is prepared and applied on to the warp sheet
6. Hairiness and flexibility of yarn is checked and maintained.
7. Yarn tension is checked and adjusted as required.

Learning Outcome 2.1 – Perform Winding Task

Contents:

- List of materials required for winding
- Tools and equipment required for the task of winding
- Winding of yarn from ring bobbins to package

Assessment criteria:

1. Materials, tools and equipment are identified and selected according to job requirement.
2. Yarn from ring bobbins are correctly wound to form package.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): hand gloves, dust mask, ear plug and working clothes
- Tools and equipment: winding machine, pocket tape, wire, stripper, adjustable wrench, hammer, pliers and screwdrivers
- Materials : Cone, ring bobbin

LEARNING ACTIVITY 2.1.1

Learning Activity	Resources/Special Instructions/References
Identify tools and materials required for winding	▪ Information Sheet: 2.1.1 ▪ Self-Check Quiz: 2.1.1 ▪ Answer Key: 2.1.1

INFORMATION SHEET 2.1.1

Learning Objective: to identify tools and materials required for winding.

Personal protective equipment (PPE): To perform winding, following PPE is required :

Dust mask: Dust mask is necessary for dust protection in workplace.	
Working cloth/apron: Apron has been designed to protect the body from injury in the workplace.	
Hand gloves: These are used to protect the hands while working and safeguarding of hands.	
Ear plug: An ear plug is a device that protects the user's ears from the loud noises.	

Tools and Equipment:

To perform winding, following tools and equipment is required :

Winding machine: is a machine for transferring yarn from one package to another suitable package like cone, cheese, spool etc. Ring bobbin is used in winding.

Figure: Winding machine

Pocket tape: Pocket Measuring Tapes, also known as a "Short Tape" or "Pocket Tape" are handy measuring tapes to have around.

Figure: Pocket Tape

Wire stripper: A wire stripper is a small, hand-held device used to strip the electrical insulation from electric wires.

Figure: Wire stripper

Adjustable wrench: An adjustable wrench (US) or adjustable spanner (UK) is a wrench with a "jaw" of adjustable width. It can be used with different sizes of fastener head (nut or bolt).

Figure: Adjustable wrench

Hammer: A hammer is a tool that, usually featuring a head fixed to a handle (also called a haft or helve), delivers a blow to an object to break it apart, drive it into another (e.g. a nail or spike), or beat it into a desired shape.

Figure: Hammer

Pliers: Pliers are a hand tool used to hold objects firmly.

Figure: Pliers

Screwdrivers: A screwdriver is a tool, manual or powered, for screwing and unscrewing (inserting and removing) screws.

Figure: Screwdrivers

Materials:

To perform winding following materials are required:

Cone: is a package where long length of yarns are wound used for warp and weft yarns.

Ring bobbin: is a spindle with or without flanges, on which yarn is wound. Bobbins are used in spinning, weaving, knitting, sewing or lace making. Bobbin provides temporary or permanent storage for yarn and may be made of plastic, metal or wood.

SELF-CHECK QUIZ 2.1.1

Write the correct answer for the following questions.

1. Why dust musk is necessary during winding?
2. Write the name of materials used in winding?
3. Which machine is used to perform winding?

LEARNING ACTIVITY 2.1.2

Learning Activity	Resources/Special Instructions/References
Perform winding task	▪ Information Sheet: 2.1.2 ▪ Self-Check Quiz: 2.1.2 ▪ Answer Key: 2.1.2 ▪ https://www.skyeweavers.co.uk/story/cone-winding

INFORMATION SHEET 2.1.2

Learning Objective: to perform winding task.

To perform winding, following steps are followed:

1. Objects of winding: The object of winding is to transfer yarn from a small package to a suitable package and to remove yarn faults.

- **Winding machine:** is used to transfer yarn from ring bobbin to cone or any other suitable package. Cone winding machine is one of the types of winding machine. There are several types of winding machine also such as flanged bobbin winding m/c, cheese winding m/c and cop winding m/c etc

Figure: Winding Machine

There are different key features of cone winding m/c which are pointed out in the following:

1. In cone winding m/c, reciprocating cams which are attached with the traversing guide and attached with a shaft.
2. Cam controls the yarn with the yarn guide.
3. Cone are placed on the cone holder and kept on the contact of the drum.
4. A drum is in opposition of each cone.
5. A brake system is used to stop the machine instantly to avoid any accident.

The working procedure of a cone winding machine has described below:

1. Gets motion from the motor in one side of machine and cam shaft and drum shaft rotates by motor pulley.
2. Yarn supply gets from a bobbin and yarn go to the cone by yarn stop motion guide and yarn traversing guide.
3. Since cones are on holder and are contact with drum, cone rotates due to the friction of drum and holder and holder and finally become winding on yarn cone.

4. This type of winding is controlled with yarn guide.
5. Winding is stop with stop motion mechanism when yarn breakage.
6. When cone gets predetermined width, discrete from the drum and contact automatically and placed the new cone by taken out of the cone.

SELF-CHECK QUIZ 2.1.2

Write the correct answer for the following questions.

1. What is winding?
2. Write the name of some parts of winding machine.
3. What is the input and output of winding machine?
4. What is the function of brake system of winding machine?
5. What are the objects of winding?

Learning Outcome 2.2 – Perform Warping Task

Contents:

- Lubrication system
- Feeding of cone in the creel
- Transfer of yarn from creel to a beam

Assessment criteria:

1. Lubricant is checked and maintained in accordance with job requirements.
2. Cone is fed or placed in the creel.
3. Required number of yarns is transferred from creel to beam.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment PPE): gloves, dust mask, ear plug and working clothes
- Tools and equipment: warping machine, pocket tape, wire stripper, adjustable wrench, hammer, pliers and screwdrivers
- Materials: cone, lubricant

LEARNING ACTIVITY 2.2.1

Learning Activity	Resources/Special Instructions/References
Perform warping	▪ Information Sheet: 2.2.1 ▪ Self-Check Quiz: 2.2.1 ▪ Answer Key: 2.2.1 ▪ https://www.youtube.com/watch?v=V5e1YKkZFhc

INFORMATION SHEET 2.2.1

Learning Objective: to perform warping.

Personal Protective Equipment (PPE):

Gloves, dust mask, ear plug and working clothes.

- **Tools and equipment:** warping machine, pocket tape, wire stripper, adjustable wrench, hammer, pliers and screwdrivers.

  Warping: The parallel winding of warp ends from many winding packages (cone, cheese) on to a common package (warp beam) is called warping.

  Warping machine: is used to transfer yarns from many small packages or cone to a large common package called warpers beam. Cone or cheese packages are used as input and warpers beams are output of the warping machine.

Types of Warping:

- Sectional/indirect Warping
- High speed/ Beam/ Direct Warping.

  - **High speed warping:**

    High speed warping also called Beam warping/Direct warping. In high speed warping the yarn is wound parallel on the warping beam. All the yarns are wound at once and simple flanged beam is used. It is a very high-speed process and is used for making fabric of single colour.

    Features of High-Speed Warping

    - It is used to make grey fabrics in large quantities
    - It is used to produce weavers beam from single yarn
    - Large amount of yarn is required to produce a weavers beam
    - Simple flanged beam is used and drums are not required

  - **Sectional Warping:**

    In sectional warping equal length of yarn is first wound in small sections or sheets on a drum. Then from the drum it is transferred to the beam. By this process we directly get the weavers beam. This is a two-stage method and is used for making fancy fabrics.

    Working Procedure of Sectional Warping:

    1. Sectional warping is used for fancy pattern fabrics.
    2. In this case sections of the warp which may contain up to 1000 ends are first wound onto a drum tapered with a given cone angle.
    3. So, number of sections are combined on the drum and thus each layer of warp contains the same number of ends on the drum.
    4. Then the warp threads altogether are transferred onto a weavers beam by unwinding the drum.

    Features of Sectional Warping

    1. This is suitable for making checked, stripped or other fancy fabric.
    2. Sectional warping is used to produce a warp beam with a greater number of ends.

Figure: High speed warping

Figure: Sectional Warping

- **Materials:** Cone, lubricant
  - **Lubricant:**
  - Oil: is used in the cam box to reduce friction and for smooth running of the machine.
  - Grease: is used to clean the gears and pulley to reduce friction and for smooth running of the machine.

Figure: Lubricant

SELF-CHECK QUIZ 2.2.1

Write the correct answer for the following questions.

1. What is warping?
2. Mention the classification of warping.
3. What is the name of input and output package of warping machine?
4. Why sectional warping is used?
5. Mention the features of high-speed warping.

Learning Outcome 2.3 – Perform Sizing Task

Contents:

- Preparation of size materials
- Application of size materials on the warp sheet
- Hairiness and flexibility of yarn
- Yarn tension

Assessment criteria:

1. Sizing materials are prepared and applied on the warp sheet according to requirements.
2. Hairiness and flexibility of yarns are checked.
3. Yarn tension is checked and adjusted as required.

Resources required:

- Personal protective equipment (PPE): hand gloves, dust mask, safety shoes, goggles, working clothes
- Tools and equipment: Sizing machine, pocket tape, wire stripper, adjustable wrench, hammer, pliers and screwdrivers
- Materials: Warp yarns in the warpers beam, sizing materials

LEARNING ACTIVITY 2.3.1

Learning Activity	Resources/Special Instructions/References
Preparation of size materials	▪ Information Sheet: 2.3.1 ▪ Self-Check Quiz: 2.3.1 ▪ Answer Key: 2.3.1

INFORMATION SHEET 2.3.1

Learning Objective: to prepare size materials or size solutions for applying on the surface of the warp yarn.

Following size ingredients are required to prepare size materials or size solutions:

- **Starch:** is an odourless, tasteless white substance occurring widely in plant tissue and obtained chiefly from cereals and potatoes used to prepare size solutions. Maize, corn, potato, farina, carboxy methyl cellulose etc are used as starch. Starch is used to increase the strength and weaveability of the yarn.
- **Adhesives:** are a substance used for sticking objects or materials together.
- **Softening agent:** are used to make the yarns soft or flexible after sizing.

SELF-CHECK QUIZ 2.3.1

Write the correct answer of the questions below:

1. What are the functions of starch in sizing?
2. Write the name of some sizing ingredients.
3. Why softening agent is required in sizing?

LEARNING ACTIVITY 2.3.2

Learning Activity	Resources/Special Instructions/References
Perform sizing task	▪ Information Sheet: 2.3.2 ▪ Self-Check Quiz: 2.3.2 ▪ Answer Key: 2.3.2 ▪ Job Sheet 2 ▪ https://www.youtube.com/watch?v=QZkikKfH28I

INFORMATION SHEET 2.3.2

Learning Objective: to apply size material on the surface of the yarn.

To perform sizing task, following steps are following :

- **Sizing machine: i**s used to apply a protective adhesive coating on the surface of the yarn to increase the strength of the yarn and to improve the weaveability.

Size is a gelatinous film forming substance in solution or dispersion form, applied normally to warp yarns. Sizing is the process of applying the size material on yarn. A generic term for compounds that are applied to warp yarn to bind the fibre together and stiffen the yarn to provide abrasion resistance during weaving. Starch, gelatine, oil, wax, and manufactured polymers such as polyvinyl alcohol, polystyrene, polyacrylic acid, and polyacetates are employed.

Objects of sizing:

1. To improve the waeveability of the yarn
2. To improve the strength of the yarn
3. To increase smoothness of yarn
4. To increase yarn elasticity
5. To decrease hairiness

6. To decrease the generation of static electricity

Figure: Sizing Machine

In the sizing machine, following zones/units are important:

- Creeling zone/back beam unit
- Sizing zone/unit
- Drying zone/unit
- Leasing zone/unit
- Beaming zone/unit
  - **Creeling zone/back beam unit:** is used to feed the warpers beam in the creel or back beam unit of the sizing machine. Different types of beam arrangement are possible.
  - **Sizing zone/unit:** is used to apply the size materials on the yarns. In the sizing unit, size solutions are kept and always maintain a level for uniform sizing.
  - **Drying zone/unit:** is used to dry the sized warp yarns to avoid the joining of yarns. Multi cylinder drying system is commonly used. Drying temperature and speed is adjusted according to requirements.
  - **Leasing zone/unit:** is used to separate the layers of the yarns.
  - **Beaming zone/unit:** is used to collect the sized yarn on the weavers beam according to required length.

SELF-CHECK QUIZ 2.3.2

Write the correct answer of the questions below:

1. What are the units of sizing machine?
2. What is the function of the sizing zone?
3. Why is drying done after sizing?

JOB SHEET 2			
Qualification:	Weaving technology		
Learning unit:	Carry out preparation for weaving operation		
Learner name:			
Personal protective equipment (PPE):	Gloves, dust mask, safety shoes, goggles, apron.		
Materials:	Ring bobbin, cone, sizing ingredients		
Tools and equipment:	Winding machine, warping machine, sizing machine, pocket tape, wire stripper, adjustable wrench, hammer, pliers and screwdrivers.		
Performance criteria:	1. Materials, tools and equipment is identified and selected according to job requirement. 2. Yarn from ring bobbins are correctly wound to form packages. 3. Lubricant is checked and levels maintained as per manufacturer's guidelines 4. Required number of yarns from a creel of single-end package is transferred to a beam. 5. Size material is prepared and applied on to the warp sheet. 6. Hairiness and flexibility of yarn is checked and maintained. 7. Yarn tension is checked and adjusted as required.		
Measurement:	• Calculate the number of warp in the warping beam • Measurement to be taken for sizing ingredients		
Notes:	• Take the quantity of sizing ingredients as per job requirement • Mix the size ingredients gradually into the water • Continue stirring for proper mixing of sizing ingredients • Do not stop stirring until the end of the process. • Maintain size storing and applying temperature.		
Procedure:	1. Collect PPE, tools, equipment and materials 2. Check the usability of PPE, tools, equipment and materials 3. Feed ring bobbins or cones to the winding machine as required. 4. Operate the winding machine as per standard operating procedure. 5. Feed the cones to the creel section of the warping machine. 6. Operate the warping machine as per standard operating procedure. 7. Feed the warpers beam to the creel of sizing machine. 8. Prepare size solutions as required. 9. Operate the sizing machine as per standard operating procedure.		
Learner signature:		**Date:**	
Assessor signature:		**Date:**	
Quality Assurer signature:		**Date:**	

Assessor remarks:	
Feedback:	

<u>Important</u>:

- *The number of warp yarn in the beam depends on the creel capacity.*
- *The quality of the sizing depends on the sizing solutions.*

Individual Activity:

- *Watch the video shows on 'winding, 'warping' and 'sizing' and summarize key points (if facilities available)*
- *Perform winding, warping, prepare size solutions and perform sizing following Job Sheet 2 (see above)*

ANSWER KEYS

ANSWER KEY 2.1.1

1. During winding, there creates a lot of dust and micro fibres. So, dust musk is necessary to protect themselves.
2. Ring bobbins and cones are used as materials for winding.
3. Winding machine is used to perform winding.

ANSWER KEY 2.1.2

1. Winding is the process to transfer yarn from ring bobbin to a suitable package in a required length, like cone.
2. Cone holder, drum, cam, tensioner and yarn guide.
3. The name of input package is ring bobbin and output package is cone, cheese etc.
4. To stop the machine instantly to avoid any accident.
5. The object of winding is to transfer yarn from a small package to a suitable package and to remove yarn faults.

ANSWER KEY 2.2.1

1. Warping is a process in which a large number of warp yarns are transferred from many small packages to a large common package in required length.
2. Warping is two types. Sectional warping and high-speed warping.
3. The name of input package is cone or cheese and output package is warpers beam.
4. To produce stripe and check fabric, sectional warping is used.
5. The features of high-speed warping machine is as follows:
   - It is used to make common fabrics in large quantities
   - It is used to produce weavers beam from single yarn;
     - Large amount of yarn is required to produce a weavers beam
     - Simple flanged beam is used, and drums are not required

ANSWER KEY 2.3.1

1. The functions of starch in sizing is to increase the strength and weaveability of the yarn.
2. Starch, adhesive, softener and antifoaming agents.
3. To make the yarns soft or flexible , softening agent is used.

ANSWER KEY 2.3.1

1. Creeling zone, sizing zone, drying zone, leasing zone and beaming zone.
2. To apply size materials on the surface of the warp yarns.
3. Drying is important after sizing to avoid joining of neighbouring yarns together.

Module 3: Perform shedding operation

MODULE CONTENT

Module Descriptor: This module covers the knowledge, skills and attitudes to perform shedding operation which includes identifying dobby shedding, preparing for shedding and performing tappet and jacquard shedding. It also includes information sheets, job sheets, self-checking and answer keys.

Nominal Duration: 48 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee will be able to:

3.1 Identify dobby shedding

3.2 Prepare for shedding

3.3 Perform tappet shedding

3.4 Perform jacquard shedding

PERFORMANCE CRITERIA:

1. Shedding mechanism is identified and explained.
2. Main parts of shedding mechanism are correctly identified.
3. Types of dobby shedding are identified and described.
4. Work instructions are received and confirmed with supervisor.
5. Appropriate personal protective equipment is identified and selected.
6. Hand tools and equipment is selected as per job requirement.
7. Selected hand tools and equipment are used properly and safely.
8. Tappet shedding is performed as per standard operating procedure.
9. Shedding device is monitored and maintained during operation.
10. Report is prepared and submitted upon completion of shedding operation as per standard operating procedure.
11. Selected hand tools and equipment are used properly and safely.
12. Jacquard shedding is performed as per standard operating procedure.
13. Shedding device is monitored and maintained during operation.
14. Report is prepared and submitted upon completion of shedding operation as per standard operating procedure.

Learning Outcome 3.1 – Identify Dobby Shedding

Contents:

- Types of shedding mechanism
- Main parts of shedding mechanism
- Types of dobby shedding
- Design produced by dobby device

Assessment criteria:

1. Shedding mechanism is identified and selected.
2. Main parts of shedding mechanism are identified.
3. Types of dobby shedding are identified and described.
4. Designs produced by dobby devices are identified.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, dust mask, apron
- Tools and equipment: Loom with dobby shedding mechanism, sample cutter, yarn tension meter, tape tensioner, industrial weight scales
- Materials: Weavers beam with warp yarn

Activity

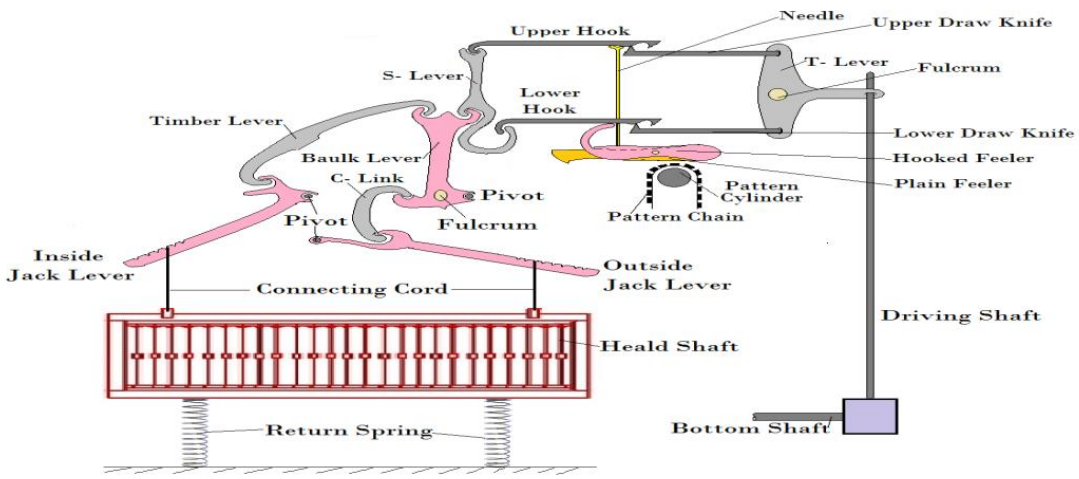
LEARNING ACTIVITY 3.1.1

Learning Activity	Resources/Special Instructions/References
Identifying dobby shedding mechanism	▪ Information Sheets: 3.1.1 ▪ Self-Check Quiz: 3.1.1 ▪ Answer Key: 3.1.1 ▪ https://www.youtube.com/watch?v=ijPP9wW2aP8

INFORMATION SHEET 3.1.1

Learning Objective: to identify dobby shedding mechanism for performing weaving.

- **Shedding mechanism :** Dobby is a shedding mechanism placed on the top of the loom in order to produce figured patterns by using large number of healds than the capacity of a tappet. Maximum 48 number of heald shaft can be used in the dobby loom.
- **Types of dobby shedding: 1.** Mechanical (i) Positive (ii) Negative **2.** Electronic dobby.
  - **Main parts of shedding mechanism :**
    - Bottom shaft
    - L-lever
    - Upright shaft
    - T-lever
    - Upper draw knife
    - Lower draw knife
    - Upper hook
    - Lower hook
    - S-lever
    - Bulk lever
    - Thumb lever
    - Jack lever
    - Heald shaft
      Returning spring
    - Motor
    - Crank shaft
    - Pattern cylinder
    - Pattern chain
  - **Working principle of dobby shedding :** Here a climax dobby is described to explain the dobby shedding mechanism. Climax dobby is a double lift double jack-lever negative dobby. Here two jack levers are operated by a single bulk lever. They are joined with the bulk lever by a timber lever and a link. The baulk lever is fulcrummed at a lower midpoint and is connected with S-lever. The S-lever controls two hooks, one upper hook and one lower hook. The hooks are controlled by feelers. One hook is controlled by hooked feeler and other by a connecting needle. The two hooks control two knives that are joined with a T-lever. The T-lever is fulcrummed and is controlled by an upright shaft and an L-lever. They get motion from motor and machine pulley. When the feeler comes in contact with a peg and when it is not in the contact it goes down.



Negative (Climax)/ Hook & Knife/ Double Jack Lever Dobby Shedding Mechanism

Working principle of electronic dobby:

Electronic rotary dobby converts the rotational movement to linear movement, which is required for lifting and lowering of healds. Rotary dobby can operate at high speed up to 1500 r.p.m. The cam shaft rotates by 180° and then stops momentarily and thus the motion is called as irregular rotary motion. The cam unit is mounted on the cam shaft but not fixed on it. The pawl, which is placed on the outside of the cam, connects it with the driver and then the cam rotates by 180° causing the movement to the heald shaft. The crank unit encloses the cam with ball bearings. Link (L_1) can rotate around its pivot by the action of the electromagnet through link L_2. If link L_1 rotates in an anticlockwise direction, then the pawl rotates in the clockwise direction and its bottom tip engages with the groove on drive. If link L_1 rotates in a clockwise direction, it presses the upper tip of the pawl and disengages it from drive. When the engagement happens, the jack rotates in an anticlockwise direction during the 180° rotation of the dobby shaft. The jack dwells at its foremost position during the 180° rotation of the dobby shaft, if the engagement does not occur. The dobby shaft stops after every 180° rotation, and the pattern selection mechanism engages or disengages the ratchet with the drive.

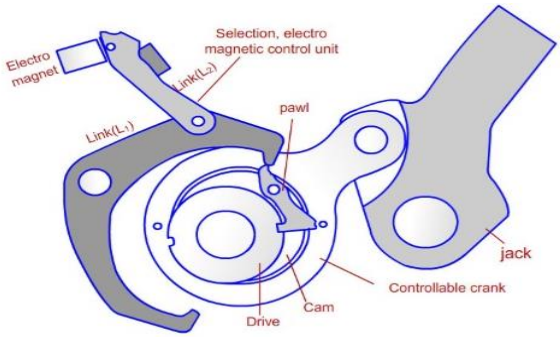


Figure: Electronic dobby

- **Design produced by dobby device:** any design can be produced by dobby mechanism with maximum 48 number of warp in the repeat size.

SELF-CHECK QUIZ 3.1.1

Write the correct answer of the following:

1. What is the maximum number of heald shafts used in the dobby loom?
2. Write the name of at least five parts of a dobby loom.
3. What are the types of dobby shedding?

Learning Outcome 3.2 - Prepare for Shedding

Contents:

- Names and uses of personal protective equipment (PPE)
- List of main tools and equipment required for shedding

Assessment criteria:

1. Personal protective equipment is identified and selected.
2. Tools and equipment are selected as per job requirement.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, dust mask, apron, ear plug
- Tools and equipment: weaving machine, sample cutter, yarn tension meter, tape tensioner, industrial weight scales
- Materials: warp beam

LEARNING ACTIVITY 3.2.1

Learning Activity	Resources/Special Instructions/References
Preparation for shedding	▪ Information Sheet: 3.2.1 ▪ Self-Check Quiz: 3.2.1 ▪ Answer Key: 3.2.1

INFORMATION SHEET 3.2.1

Learning Objective: to prepare for shedding to perform weaving.

- **Personal protective equipment (PPE)**: hand gloves, dust mask, ear plug, apron

Dust mask: Dust mask is necessary for dust protection in workplace.	
Working cloth/apron: Apron has been designed to protect the body from injury in the workplace.	
Hand gloves: These are used to protect the hands while working and safeguarding of hands.	
Ear plug: An ear plug is a device that protects the user's ears from the loud noises.	

Tools and equipment: Tappet loom, sample cutter, yarn tension meter, industrial weight scale:

Sample cutter : is used to cut the fabric in a required length.

Yarn tension meter : is used to measure the tension of the warp yarn to maintain uniform tension during weaving.

Industrial weight scale : is used to measure the fabric in gram per square meter.

Warp beam : is used as the package for warp yarn where number of yarns can be wound.

SELF-CHECK QUIZ 3.2.1

Write the correct answer of the question:

1. What is the function of a tension meter?
2. Write the name of the package used for warp yarn in the loom.
3. Why industrial weight scale is used?

Learning Outcome 3.3 – Perform Tappet Shedding

Contents:

- Uses of hand tools and equipment
- Types of tappet shedding.

Assessment criteria:

1. Hand tools and equipment are used properly.
2. Tappet shedding is performed as per standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, dust mask, apron, ear plug
- Tools and equipment: Tappet loom, sample cutter, yarn tension meter, industrial weight scale
- Materials: yarns

LEARNING ACTIVITY 3.3.1

Learning Activity	Resources/Special Instructions/References
Carry out tappet shedding	▪ Information Sheet: 3.3.1 ▪ Self-Check Quiz: 3.3.1 ▪ Answer Key: 3.3. ▪ https://www.youtube.com/watch?v=W5BRDDhR0dI

INFORMATION SHEET 3.3.1

Learning Objective: to carry out tappet shedding for weaving.

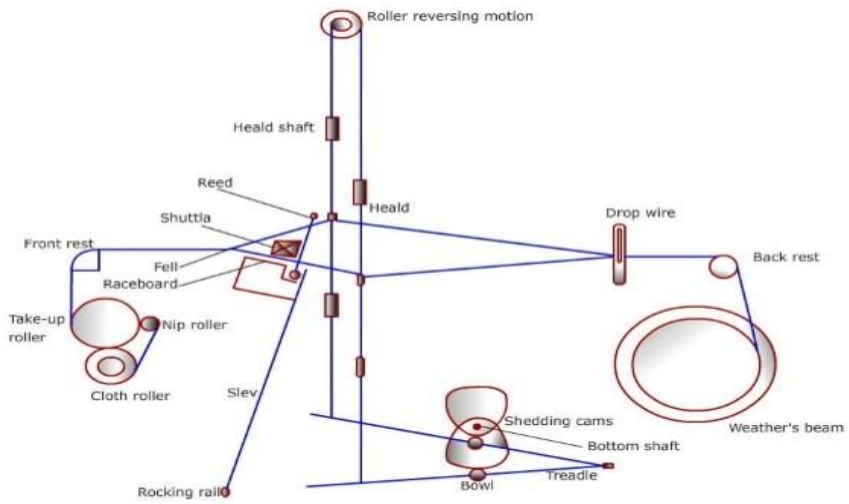
Tappet shedding:

Tappet shedding is the control of the movement of heald shafts in weaving simple constructions by means of cams or tappets. In positive cam shedding, the heddle (or heald) shafts are both raised and lowered by

the tappets. In negative cam shedding, the heald shafts are either raised or lowered by the mechanism but are returned by the action of an external device, usually springs. The maximum number of heald shafts controlled by tappet shedding is 10. Tappets are generally used for heald shedding.

Main parts:

1. Motor
2. Motor pulley
3. M/C pulley
4. Crank shaft
5. Crank shaft gear
6. Bottom shaft gear
7. Bottom shaft
8. Tappet
9. Connecting rod
10. Heald shaft
11. Top arm



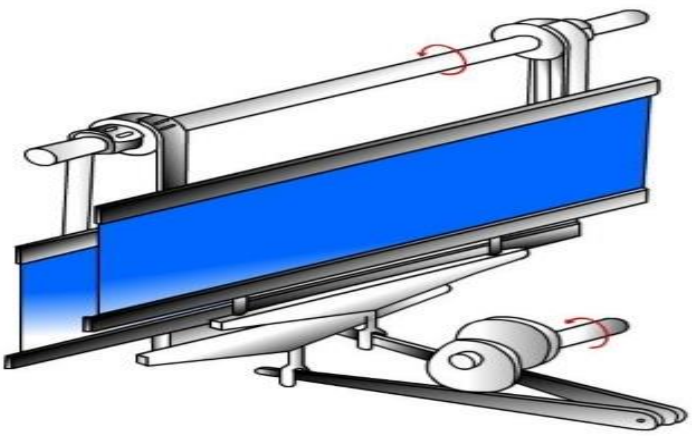


Figure: Tappet shedding

Driving of shedding tappet:

At first machine pulley gets drive by belt from motor pulley. Then machine pulley, which is directly joined with the crank shaft, gives motion to bottom shaft. This crank shaft gives motion to bottom shaft via gearing. Two tappets are joined with the bottom shaft. So, when bottom shaft moves then the tappets also rotate. When it gets contact with tradle bowl it lifts the tradle levers and the heald shafts are lifted by tradle levers via links. As this is a negative shedding tappet the heald shafts are lowered by their own weight.

SELF-CHECK QUIZ 3.3.1

Write the correct answer for the following:

1. Why tappet shedding mechanism is required?
2. Write down the name of some main parts of tappet shedding (at least 6).
3. Explain the driving mechanism of tappet shedding.

Learning Outcome 3.4 - Perform Jacquard Shedding

Contents:

- Uses of hand tools and equipment
- Types of jacquard shedding

Assessment criteria:

1. Hand tools and equipment are used properly
2. Jacquard shedding is performed as per standard operating procedure

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, dust mask, ear plug, apron
- Tools and equipment: Jacquard loom, sample cutter, yarn tension meter, industrial weight scale
- Materials: yarns

LEARNING ACTIVITY 3.4.1

Learning Activity	Resources/Special Instructions/References
Carry out jacquard shedding	▪ Information Sheet: 3.4.1 ▪ Self-Check Quiz: 3.4.1 ▪ Answer Key: 3.4.1 ▪ Job Sheet 3 ▪ https://www.youtube.com/watch?v=OlJns3fPItE

INFORMATION SHEET 3.4.1

Learning Objective: to perform jacquard shedding for the weaving.

Jacquard shedding:

In weaving if we want to make any design in our fabric we have to separate the warp yarn according to our weave plan. In tappet or dobby shedding we have some limitations in shedding for a critical design. But in jacquard shedding it can be done easily. Jacquard is a shedding device placed on the top of the loom to

produce large no of patterns by using a very large no of warp threads separately by means of harness cords, hooks and needles. The figuring capacity of a jacquard is 1800+. It means it can produce design with more than 1800 warp threads by controlling them individually, which is far beyond the capacity of a dobby or tappet loom.

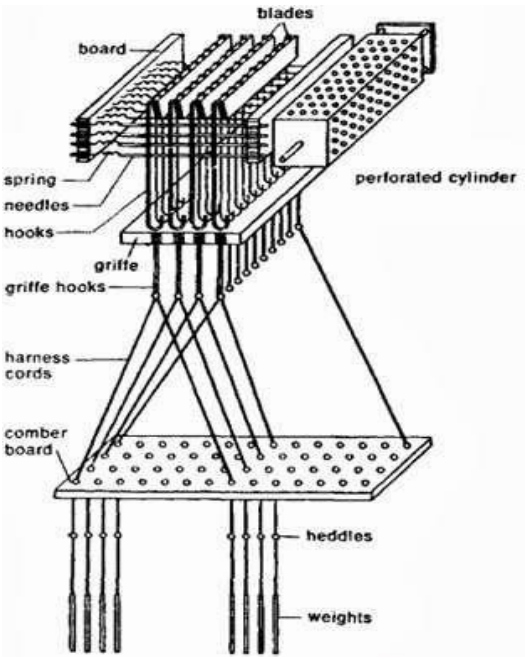


Fig: Jacquard shedding mechanism

Main parts:

1. Pattern chain
2. Motor
3. Pattern cylinder
4. Needle
5. Knife
6. Harness cord
7. Neck cord
8. Comber board
9. Top board
10. Hook
11. Grid bar
12. Dead weight
13. Spring board
14. Needle board

Jacquard shedding mechanism:

For shedding mechanism here punched card are used which is made according to design. One pattern card is used for one pick. With these pattern cards pattern chain is made which is placed on the pattern cylinder.

On each pick pattern cylinder rotates 1/4th of the full rotation in clockwise direction. At the same time it oscillates to and fro forming an arc.

With every 1/4th rotation, a new card comes in front of the cylinder in the hook side and for the two and fro movement the needles enter inside the holes of the punch card. This selection of entrance inside the punches of the needles is actually done according to design.

If a needle enters in the hole of the card the needle remains stationary in its position. So, the needle crank also remains stationary in its position. So, for the upward movement of the knife the hooks also go upward along with the warp threads to form the top line.

But if needle gets no perforation to enter, the hook is pushed to the right and as result the needle crank takes away the hook along with it. So, when the corresponding knife goes upward it cannot lift the hook with it. Thus, the warp ends of those hook remains fixed in its position and form the bottom line.

After certain time the knife releases two hooks which is lifted to form the top line and due to wrap tension and dead weight the heald eye comes down. Its downward movement is controlled by grid bar. Each needle has a spring push at its right and that spring pushes back the needle when the next card comes.

SELF-CHECK QUIZ 3.4.1

Write the correct answer for the following:

1. Why jacquard mechanism is required?
2. Write down the name of some parts (at least five) of jacquard mechanism.
3. Write down the working principle of jacquard mechanism.

JOB SHEET 3			
Qualification:	Weaving technology		
Learning unit:	Perform shedding operation		
Learner name:			
Personal protective equipment (PPE):	Gloves, dust mask, ear plug, apron, gum boot		
Materials:	Warp beam		
Tools and equipment:	Weaving machine, sample cutter, yarn tension meter, industrial weight scale		
Performance criteria:	1. Shedding mechanism is identified and explained. 2. Tools and equipment are selected and prepared in accordance with job requirement. 3. Types of dobby shedding are identified and described. 4. Shedding mechanism is identified and explained. 5. Work instructions are received and confirmed with supervisor. 6. Appropriate personal protective equipment is identified and selected. 7. Tappet shedding is performed as per standard operating procedure. 8. Dobby shedding is performed as per standard operating procedure. 9. Jacquard shedding is performed as per standard operating procedure. 10. Shedding device is monitored and maintained during operation.		
Measurement:	• Selection of weave structure and repeat size • Adjustment of EPI and PPI		
Notes:	• Maintain warp tension during weaving • Check the warp and weft breakage carefully		
Procedure:	1. Follow work instruction from supervisor 2. Collect PPE, tools, equipment and materials 3. Check the usability of PPE, tools and equipment 4. Set and check the warp beam creeled for weaving. 5. Check the drafting plan for required structure 6. Operate the weaving for shedding as standard procedure. 7. Maintain the shedding device during weaving.		
Learner signature:		**Date:**	
Assessor signature:		**Date:**	
Quality Assurer signature:		**Date:**	
Assessor remarks:			
Feedback:			

Individual Activity:

- *Watch the video shows on 'shedding mechanism and summarize key points (if facilities available)*
- *Perform shedding operation following Job Sheet 3 (see above)*

ANSWER KEYS

ANSWER KEY 3.1.1

1. In a dobby loom, there is maximum 48 number of heald shafts can be used.
2. S-lever, t-lever, Baulk lever, needle and hhk.
3. Mechanical and electronic dobby mechanisms are used.

ANSWER KEY 3.2.1

1. To measure the tension of warp yarn during weaving.
2. Warp beam.
3. Industrial weight scale is used to measure the weight of the fabric in gram per square meter.

ANSWER KEY 3.3.1

1. Tappets are generally used for heald shedding.
2. The name of the main parts are:

    - Motor
    - Motor pulley
    - M/C pulley
    - Crank shaft
    - Crank shaft gear
    - Bottom shaft gear
    - Bottom shaft
    - Tappet
    - Connecting rod
    - Heald shaft
    - Top arm

3. At first machine pulley gets drive by belt from motor pulley. Then machine pulley, which is directly joined with the crank shaft, gives motion to bottom shaft. This crank shaft gives motion to bottom shaft via gearing. Two tappets are joined with the bottom shaft. So, when bottom shaft moves then the tappets also rotate. When it gets contact with tradle bowl it lifts the tradle levers and the heald shafts are lifted by tradle levers via links. As this is a negative shedding tappet the heald shafts are lowered by their own weight.

ANSWER KEY 3.4.1

1. Jacquard is a shedding device placed on the top of the loom to produce large no of patterns by using a very large no of warp threads separately by means of harness cords, hooks and needles. The figuring capacity of a jacquard is 1800+. It means it can produce design with more than 1800 warp threads by controlling them individually.

2. The name of the main parts of jacquard shedding are:

    - Pattern chain
    - Motor
    - Pattern cylinder
    - Needle
    - Knife
    - Harness cord

- Neck cord
- Comber board
- Top board
- Hook
- Grid bar
- Dead weight
- Spring board
- Needle board

3. For shedding mechanism here punched card are used which is made according to design. One pattern card is used for one pick. With these pattern cards pattern chain is made which is placed on the pattern cylinder. On each pick pattern cylinder rotates 1/4th of the full rotation in clockwise direction. At the same time, it oscillates to and fro forming an arc.

   With every 1/4th rotation a new card comes front of the cylinder in the hook side and for the two and fro movement the needles enter inside the holes of the punch card. This selection of entrance inside the punches of the needles is actually done according to design.

   If a needle enters in the hole of the card the needle remains stationary in its position. So the needle crank also remains stationary in its position. So, for the upward movement of the knife the hooks also go upward along with the warp threads to form the top line.

   But if needle gets no perforation to enter, the hook is pushed to the right and as result the needle crank takes away the hook along with it. So, when the corresponding knife goes upward it cannot lift the hook with it. Thus, the warp ends of those hook remains fixed in its position and form the bottom line.

   After certain time the knife releases two hooks which is lifted to form the top line and due to wrap tension and dead weight the heald eye comes down. Its downward movement is controlled by grid bar. Each needle has a spring push at its right and that spring pushes back the needle when the next card comes.

Module 4: Perform picking operation

MODULE CONTENT

Module Descriptor: This module covers the knowledge, skills and attitudes to perform picking operation which includes identifying picking process, preparing for picking, performing conventional picking, air jet picking, rapier, projectile and water jet picking. It also includes information sheets, job sheets, self-checking and answer keys.

Nominal Duration: 40 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee will be able to:

4.1 Identify picking process

4.2 Prepare for picking

4.3 Perform conventional picking

4.4 Perform air jet picking

4.5 Perform rapier, projectile and water jet picking

PERFORMANCE CRITERIA:

1. Picking process is accurately defined
2. Different techniques for picking are identified and described.
3. Work instructions are received and confirmed with supervisor.
4. Appropriate personal protective equipment (PPE) is identified and selected.
5. Hand tools and equipment is selected as per job requirement.
6. Selected hand tools and equipment are used properly and safely.
7. Conventional picking is carried out as per standard operating procedure.
8. Conventional picking machine/ device is monitored and maintained during operation.
9. Selected hand tools and equipment are used properly and safely.
10. Air jet picking with yarn is carried out as per standard operating procedure to ensure quality.
11. Air jet picking machine/device is monitored and maintained during operation.
12. Selected hand tools and equipment are used properly and safely.
13. Rapier, projectile and water jet picking is carried out as per standard operating procedure.
14. Rapier, projectile and water jet picking machine/device is monitored and maintained during operation.

Learning Outcome 4.1 – Identify Picking Process

Contents:

- Definition of picking and picking process
- Different techniques for picking

Assessment criteria:

1. Picking and picking process is defined.
2. Different techniques of picking are identified and described.
3. Different picking system is carried out as per standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:.

- Personal protective equipment (PPE): safety cloth, hand gloves, dust mask,
- Tools and equipment: Weaving machine, sample cutter, yarn tension meter, industrial weight scale
- Materials: Yarns.

LEARNING ACTIVITY 4.1.1

Learning Activity	Resources/Special Instructions/References
Identifying picking and types of picking process	▪ Information Sheets: 4.1.1 ▪ Self-Check Quiz: 4.1.1 ▪ Answer Key: 4.1.1

INFORMATION SHEET 4.1.1

Learning Objective: to identify different types of picking process used in weaving.

- **Picking:** Picking means inserting a weft thread across the warp through during weaving.
- **Conventional picking :** Picking is the second primary motion in weaving. The action of inserting weft yarn through the warp yarns is called picking.

The functions of picking mechanism are:

1. To deliver the shuttle along the correct flight length.
2. To throw the shuttle at a predetermined speed.

Main parts:

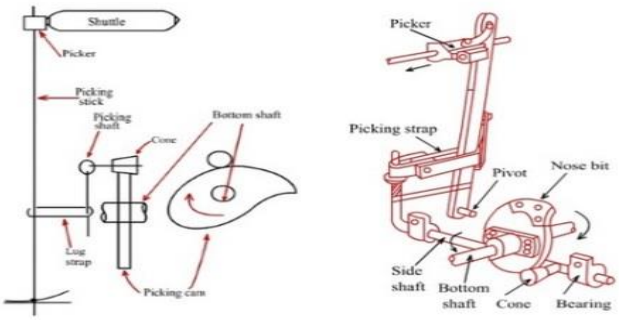


Fig: Under picking mechanism

1. Picking arm
2. Picker
3. Picking cam
4. Picking bowl
5. Race board 6.Shuttle
6. Bottom shaft
7. Treadle lever
8. Angular lever
9. Crank shaft

Features of under picking mechanism:

1. Picker arm is placed under the race board
2. Suitable for wider loom
3. Under picking works less smoothly
4. More direct action
5. Rough in action
6. More clean mechanism
7. Consumes more power
8. Used for heavy weight fabrics in silk and rayon looms

Under picking mechanism:

In under picking mechanism a race board is situated over picking arm. Under picking is controlled by picking cam which is fixed on the bottom shaft. At first the motion comes from motor and m/c pulley. Then the motion comes in to the bottom shaft and thus picking cam. When picking cam rotates and its nose portion comes in contact with treadle lever and pushes it then the treadle lever pushes the angular lever. The picking arm gets motion from angular lever which is connected with picking arm. A picker is placed in the picking arm which pushes the shuttle. When shuttle gets motion by picking arm then shuttle begins to move to and fro on the race board. Thus, picking is done. A spring is situated which causes the picking arm and picker to move back after the delivery of the pick. At the two end of bottom shaft, two picking tappets are fixed. By increasing nose length picking speed may be increased.

Over picking mechanism:

A picking cam attached to bottom shaft displaces the cone (picking cone) which is attached with the upright picking shaft. This causes rotation of the picking shaft. As a result, the picking stick, which is attached to the uppermost end of picking shaft, swing in a horizontal plane over the loom and transmits the motion to shuttle through picking strap and picker guided by a spindle. Picking strap is a leather or polymeric belt which is flexible. Here picker is constrained by the spindle to move in a straight line which otherwise would have

followed a path of arc. Obviously, this restriction of path is achieved at the expense of some energy. Moreover, pairs of picking cam and follower installed at either end of the loom have seldom ensured picking of equal strength (force). The cams responsible for impulsive rotation of the picking stick receive motion through bottom shaft. However, allied system of picking is having varying elastic behaviour (one of them is attached through a “stiff” short shaft while that at the further end through a long “flexible” one). All these warrants frequent adjustment of picking-strap or picking cam and nose settings. A system where a different cam and follower pairs are used for each end makes the matter work enduringly with standardized settings.

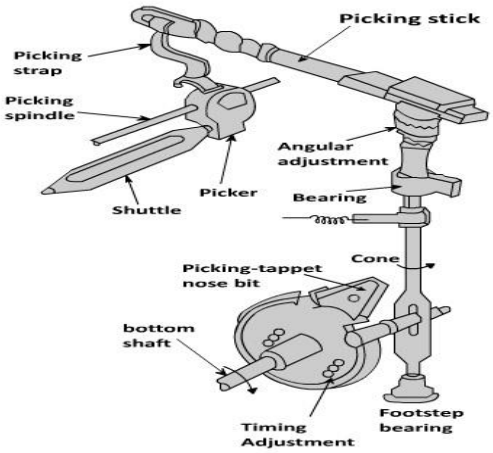


Figure: Over picking mechanism

- **Air jet picking:** An air-jet loom is a shuttleless loom that uses a jet of air to propel the weft yarn through the warp shed.
- **Rapier picking :** A rapier loom is a shuttleless weaving loom in which the filling yarn is carried through the shed of warp yarns to the other side of the loom by finger-like carriers called rapiers.
- **Projectile picking:** A projectile loom is a shuttleless weaving loom in which the filling yarn is carried through the shed of warp yarns to the other side of the loom by projectile.
- **Water jet picking:** A water jet loom is a shuttleless weaving loom in which the filling yarn is carried through the shed of warp yarns to the other side of the loom by the help of water jet.

SELF-CHECK QUIZ 4.1.1

Write the correct answer for the following:

1. What is picking?
2. How does under picking system works?
3. How weft yarn is inserted in a shuttle loom?

Learning Outcome 4.2 - Prepare for Picking

Same as for Learning Outcome 3.2 (“Prepare for Shedding”) pages 40 to 42.

Learning Outcome 4.3 – Perform Conventional Picking

Contents:

- Uses of hand tools and equipment
- Types of conventional picking:
  - Shuttle
  - Over picking system
  - Under picking system

Assessment criteria:

1. Hand tools and equipment are used properly
2. Conventional picking is carried out as per standard operating procedure
3. Picking device is maintained.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, dust mask, apron
- Tools and equipment: Shuttle loom, sample cutter, yarn tension meter, industrial weight scale
- Materials: warp and weft yarn

LEARNING ACTIVITY 4.3.1

Learning Activity	Resources/Special Instructions/References
Carry out conventional picking	▪ Information Sheet: 4.3.1 ▪ Self-Check Quiz: 4.3.1 ▪ Answer Key: 4.3.1 ▪ https://www.youtube.com/watch?v=auEd6gDgjvM

INFORMATION SHEET 4.3.1

Learning Objective: to carry out conventional picking.

Main parts:

- Picking arm
- Picking strap
- Picker
- Bottom shaft
- Picking spindle
- Shuttle
- Picking cam
- Vertical shaft
- Cone
- Bowl
- Angular
- Crank shaft

Features of Over Picking Mechanism:

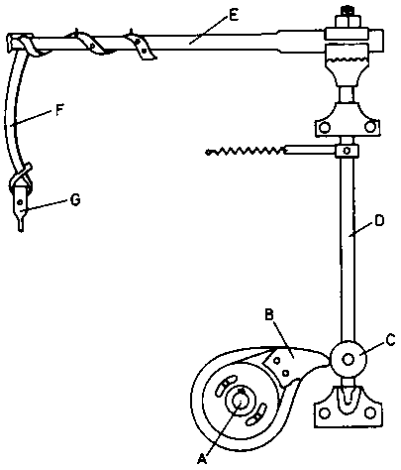
1. Picking arm is over shuttle.
2. Suitable for narrow loom.
3. Higher picks per minute.
4. Less power required.
5. Works more smoothly.
6. Shortening the picking strap and changing the shape of the cam can increase picking force.

Over picking mechanism is used on cotton and jute loom. It is robust and easy to adjust and maintain. The spindle is situated over the shuttle box and is essential to guide the shuttle along the correct path. It is normally set slightly up and slightly towards the front of the loom and its inner end.

The back end of the shuttle will thus receive a similar lift at the end of the stroke, so that its leading end will receive correct delivery down and into the shed. A flexible leather-picking strap is used to control the picker, which has tendency to stretched slowly in use, and vary with regard to its elastic property.

The cone over pick motion consists a vertical shaft placed either inside or outside the loom framing. The shaft serves as fulcrum of the picking arm, it is held against the loom frame. There is a spiral spring at the picking shaft, which causes the picking arm and picker to move back after the delivery of the pick.

At the two end of the bottom shaft, two picking cams are fixed. In revolving its nose, the tappet strikes the cone shaped ant frictional roller strut, positively rotates the shaft and causes the pick to move inward with sufficient velocity to drive the shuttle across the loom. The timing of the picker begins to move can be attend by turning the picking tappet on its boss.



SELF-CHECK QUIZ 4.3.1

Write the correct answer for the following:

1. Write the name of some parts (at least 5)of over picking system.
2. Why picking system is necessary?
3. Write down some features of over picking mechanism.

Learning Outcome 4.4 – Perform Air Jet Picking

Contents:

- Uses of hand tools and equipment
- Air jet picking system

Assessment criteria:

1. Hand tools and equipment are used properly and safely.
2. Air jet picking is carried out as per standard operating procedure.
3. Air jet picking device is maintained.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, mask, apron
- Tools and equipment: Air jet weaving machine, sample cutter, yarn tension meter, industrial weight scale
- Materials: Warp and weft yarns

LEARNING ACTIVITY 4.4

Learning Activity	Resources/Special Instructions/References
Carry out air jet picking	▪ Information Sheet: 4.4.1 ▪ Self-Check Quiz: 4.4.1 ▪ Answer Key: 4.4.1 ▪ https://www.youtube.com/watch?v=6p61-IGZo8c

INFORMATION SHEET 4.4.1

Learning Objective: to carry out air jet picking system during weaving.

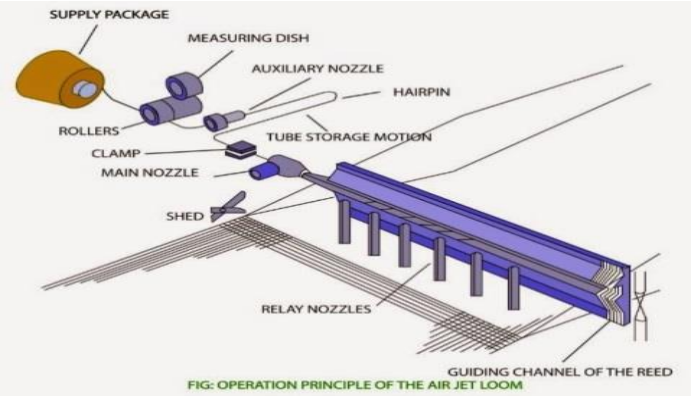


FIG: OPERATION PRINCIPLE OF THE AIR JET LOOM

Main Parts of Air Jet Loom for Weft Insertion:

1) Tensioner: Additive disk type tensioner is used for weft insertion which maintains proper tension in the weft yarn.

2) Weft break sensor: It is an electric sensor which detects any weft break in the region between weft package and accumulator and automatically stop the loom in case any weft break.

3) Accumulator: It is a device which fitted between weft package and main nozzle that unwinds a predetermined length of weft from the package and store it in the form of no. of coils on a cylindrical drum. This yarn then fed in to insertion device.

4) Stopper: It is an electronically controlled electromagnetic device integrated along with the accumulator. Its function in releasing the yarn at starts of insertion and stop it at the end of insertion.

5) Balloon breaker: It is fitted just after accumulator; its function is to separate the balloon formation. So as to reduce as ballooning tension as well as minimize the tension fluctuation. It is generally used for coarser yarn.

6) Fixed main nozzle: Its function is to form the air jet from compressed air with the required velocity and acceleration characteristics and project it in a proper direction in to air guide channel.

7) Relay nozzle or sub nozzle: Fitted in series along the sley. It creates an additional air flow in the direction of air jet. So as to compensate the loss of air velocity.

8) Profile reed: Here the reed is profiled. So as to form a guide channel which guide the air jet as well as weft during insertion.

9) Weft cutter: It is cam operated device fitted in the region between the moveable main nozzle and the reed at picking side. Its function is to grip and cut the weft after every pick at around beat-up.

10) Air guide channel: It is formed on the reed. Its function is guiding and confining the free expansion of the air jet in order to maintain the velocity over larger distance as possible.

11) Weft detector: It is an optical device fitted at the end of reed at the receiving side. Its function is to check the arrival of weft at the receiving side. In case of late arrival or miss pick, then it sense and automatically stopped the loom.

12) Stretch nozzle: Located just beside the weft detector. It supplements the effect of enhanced stretching action on the weft by the closely spaced relay nozzle at the end of insert ion. So as to prevent the chance of weft recoiling due to action of stopper.

13) Selvedge cutter: Located at the receiving side. It is an electronically operated mechanical device which cut the weft yarn extending between fabric and auxiliary selvedge. So as to separate the auxiliary selvedge which is passed out as a waste.

SELF-CHECK QUIZ 4.4.1

Write the correct answer for the following:

1. Write down the name of some parts of an air jet loom.
2. What is the function of an accumulator?
3. What is the function of a profile reed?

Learning Outcome 4.5 – Perform Rapier, Projectile and Water Jet Picking

Contents:

- Use of hand tools and equipment
- Picking system:
  - Rapier
  - Projectile
  - Water jet

Assessment criteria:

1. Hand tools and equipment are used properly and safely.
2. Picking is carried out as per standard operating procedure.
3. Picking device is maintained.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, dust mask, apron and ear plug
- Tools and equipment: Hand tools, picking system
- Materials: Yarn

LEARNING ACTIVITY 4.5

Learning Activity	Resources/Special Instructions/References
Performing rapier, projectile and water jet picking	▪ Information Sheet: 4.5.1 ▪ Self-Check Quiz: 4.5.1 ▪ Answer Key: 4.5.1

INFORMATION SHEET 4.5.1

Learning Objective: to perform rapier, projectile and water jet picking.

Rapier picking system: Rapier loom is a shuttle less weaving loom in which the filling yarn is carried through the shed of warp yarns to the other side of the loom by finger like carriers called rapiers. As in the projectile loom, a stationary package of yarn is used to supply the weft yarns in the rapier machine. One end of a rapier, a rod or steel tape, carries the weft yarn. The other end of the rapier is connected to the control system .The rapier moves across the width of the fabric, carrying the weft yarn across through the shed to the opposite side. The rapier is then retracted, leaving the new filling in place.

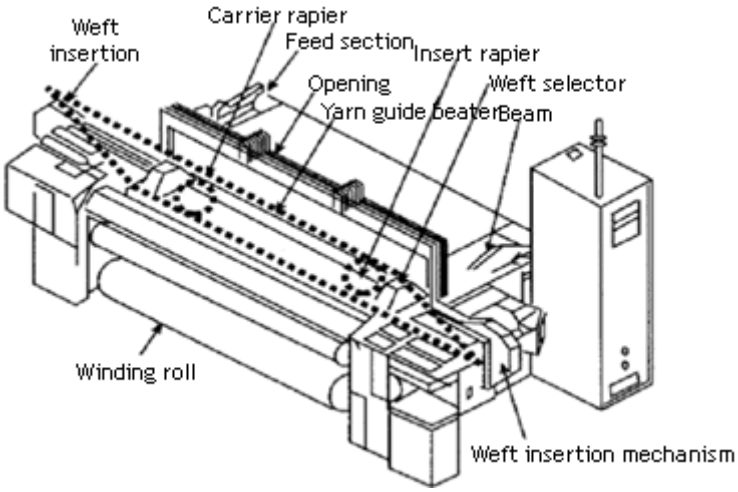


Figure: Rapier picking mechanism

Projectile picking system: Projectile weaving machine is a shuttle-less loom method for filling yarn insertion using a small metal device resembling a bullet in appearance with a clamp for gripping the yarn at one end, which is then propelled into and through the shed. In this weaving machine the weft insertion is carried out by small clamp projectiles, which number depends on the weaving width and which with their grippers take out the weft yarn from big cross-wound bobbins and insert it into the shed always in the same direction.

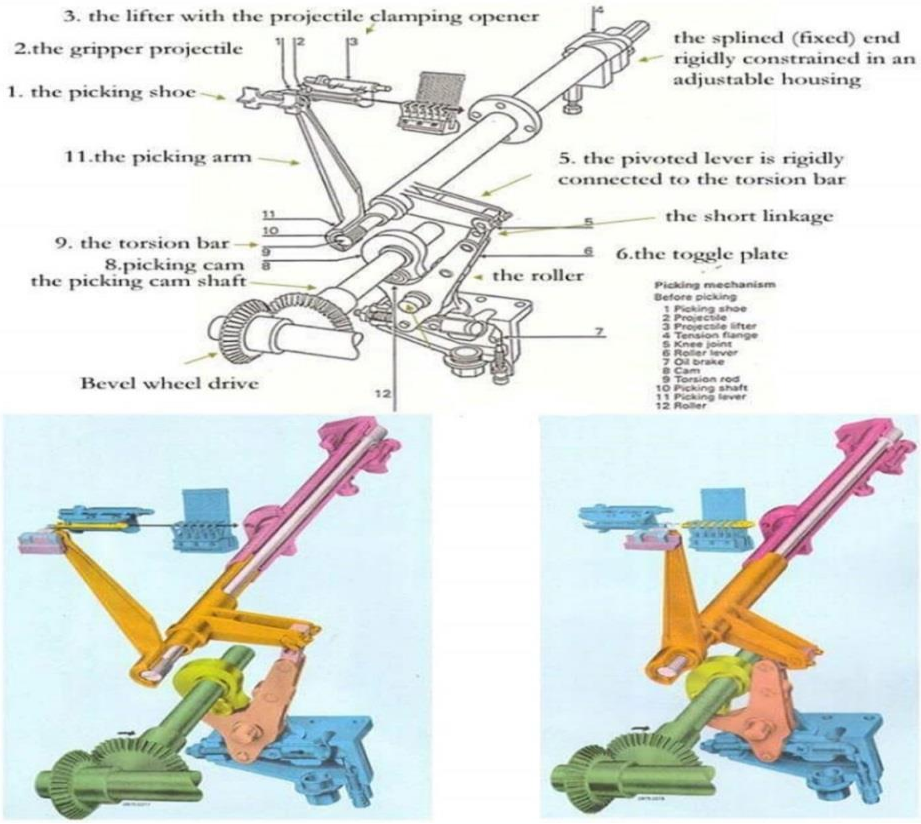


Figure: Projectile picking mechanism

JOB SHEET 4			
Qualification:	Weaving technology		
Learning unit:	Perform picking operation		
Learner name:			
Personal protective equipment (PPE):	Gloves, dust mask, ear plug, apron		
Materials:	Warp and weft yarn		
Tools and equipment:	Weaving machine		
Performance criteria:	1. Picking process is accurately defined. 2. Different techniques for picking are identified and described. 3. Work instructions are received and confirmed with supervisor. 4. Appropriate personal protective equipment is identified and selected. 5. Hand tools and equipment is selected as per job requirement. 6. Conventional picking is carried out as per standard operating procedure to ensure quality. 7. Air jet picking with yarn is carried out as per standard operating procedure to ensure quality. 8. Rapier, projectile, and water jet picking is carried out as per standard operating system. 9. Picking device is monitored and maintained during operation.		
Measurement:	• Carefully check the PPI • Adjustment of air pressure for different weft count • Selection of change wheel as required		
Notes:	• Check the weft package for continuous feeding • knot the weft yarn in case of breakage		
Procedure:	1. Collect work instruction from the supervisor. 2. Collect PPE, tools, equipment and weather coat paint. 3. Check the usability of PPE, tools, equipment. 4. Check the weft package set for weaving. 5. Check the drafting plan for required structure. 6. Operate the weaving for picking as standard procedure. 7. Maintain the picking device during weaving.		
Learner signature:		**Date:**	
Assessor signature:		**Date:**	
Quality Assurer signature:		**Date:**	
Assessor remarks:			

Feedback:	

Individual Activity:

- *Watch the video shows on 'Picking system' and summarize key points (if facilities available)*
- *Perform 'picking operation' following Job Sheet 4 (see above)*

SELF-CHECK QUIZ 4.5.1

Write the correct answer for the following:

1. Describe rapier picking system.
2. Describe projectile picking system.

ANSWER KEYS

ANSWER KEY 4.1.3

1. Picking means inserting a weft thread across the warp through during weaving.
2. In under picking mechanism a race board is situated over picking arm. Under picking is controlled by picking cam which is fixed on the bottom shaft. At first the motion comes from motor and m/c pulley.
3. Weft yarn is inserted by a shuttle with over or under picking system in a shuttle loom.

ANSWER KEY 4.2.1

1. Scaffolding is a temporary structure used to support a work crew and materials. In building construction, it is used to elevate and support workers and materials during the painting.
2. There are four types of scaffolding: supported, suspended, rolling and aerial platform are commonly used for construction works.
3. Steel, wood/timber and bamboo is mainly used for scaffolding.
4. Rolling scaffolding is most suitable for painting works inside the building.
5. The main components of scaffolding are standards, ledgers and transoms.

ANSWER KEY 4.3.1

1. Some parts of picking system
   - Picking arm
   - Picking strap
   - Picker
   - Bottom shaft
   - Picking spindle
   - Shuttle
2. Over picking system is necessary to insert weft yarn during weaving.
3. Features of over picking mechanism are:
   - Picking arm is over shuttle
   - Suitable for narrow loom
   - Higher picks per minute
   - Less power required
   - Works more smoothly
   - Shortening the picking strap and changing the shape of the cam can increase picking force

ANSWER KEY 4.4.1

1. Main Parts of Air Jet Loom for Weft Insertion: tensioner, weft break sensor, accumulator, stopper and balloon breaker
2. It is a device which fitted between weft package and main nozzle that unwinds a predetermined length of weft from the package and stores it in the form of no. of coils on a cylindrical drum. This yarn then fed in to insertion device.

3. Here the reed is profiled. So as to form a guide channel which guide the air jet as well as weft during insertion.

ANSWER KEY 4.5.1

1. Rapier loom is a shuttle less weaving loom in which the filling yarn is carried through the shed of warp yarns to the other side of the loom by finger like carriers called rapiers. As in the projectile loom, a stationary package of yarn is used to supply the weft yarns in the rapier machine. One end of a rapier, a rod or steel tape, carries the weft yarn. The other end of the rapier is connected to the control system .The rapier moves across the width of the fabric, carrying the weft yarn across through the shed to the opposite side. The rapier is then retracted, leaving the new filling in place.

2. Projectile weaving machine is a shuttle-less loom method for filling yarn insertion using a small metal device resembling a bullet in appearance with a clamp for gripping the yarn at one end, which is then propelled into and through the shed. In this weaving machine the weft insertion is carried out by small clamp projectiles, which number depends on the weaving width and which with their grippers take out the weft yarn from big cross-wound bobbins and insert it into the shed always in the same direction.

Module 5: Perform beating operation

MODULE CONTENT

Module Descriptor: This module covers the skills, knowledge and attitudes to perform beating operation, which includes the tasks of analysing different beating mechanisms, preparing for beating operation, performing cam and crank beat up, performing beating system with conventional loom and performing beating system with modern loom. It also includes information sheets, job sheets, self-checking and answer keys.

Nominal Duration: 48 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee will be able to:

5.1 Analyse different beating mechanisms

5.2 Prepare for beating operation

5.3 Perform cam and crank beat up

5.4 Perform beating with conventional loom

5.5 Perform beating system with modern loom

PERFORMANCE CRITERIA:

1. Different beating motions are identified, compared and distinguished.
2. Primary, secondary and tertiary mechanisms are identified and accurately defined.
3. Use of different motions in different types of looms are examined.
4. Work instructions are received and confirmed with supervisor.
5. Appropriate personal protective equipment (PPE) is identified and selected.
6. Hand tools and equipment is selected as per job requirement.
7. Selected hand tools and equipment are used properly and safely.
8. Cam and crank beat up is carried out as per standard operating procedure.
9. Mechanism is monitored and maintained during operation to ensure quality production.
10. Selected hand tools and equipment are used properly and safely.
11. Beating system using conventional loom is carried out as per standard operating procedure.
12. Mechanism is monitored and maintained during operation to ensure quality production.
13. Selected hand tools and equipment are used properly and safely.
14. Beating system using modern loom is carried out as per standard operating procedure.
15. Mechanism is monitored and maintained during operation to ensure quality production.

Learning Outcome 5.1 - Analyse Different Beating Mechanisms

Contents:

- Types of beating system
- Motions of loom:
  - Primary
  - Secondary
  - Tertiary
- Mechanism of motions:
  - Shedding
  - Picking
  - Beating
  - Take up
  - Let off
  - Warp stop
  - Warp protector
  - Weft replenishment
- Types of loom:
  - Air jet
  - Rapier
  - Water jet

Assessment criteria:

1. Beating system is identified.
2. Motions of loom ate identified.
3. Motion mechanisms are identified and defined.
4. Types of loom are identified.
5. Motions of looms are used.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, dust mask, apron and ear plug
- Tools and equipment: weaving machine, sample cutter, yarn tension meter, industrial weight scale
- Materials: warp and weft yarn

LEARNING ACTIVITY 5.1.1

Learning Activity	Resources/Special Instructions/References
Analyse different beating mechanism	▪ Information Sheet: 5.1.1 ▪ Self-Check Quiz: 5.1.1 ▪ Answer Key: 5.1.1

INFORMATION SHEET 5.1.1

Learning Objective: to analyse different beating mechanism.

Motions of loom:

- **Primary motion:** The fundamental or essential mechanisms of loom are called primary motion.

- **Types of primary motion**
  - **Shedding :** A process of rising and lowering of warp yarns by harnesses to make an opening for the filling yarn to pass through is called shedding.
  - **Picking:** The action of inserting weft yarn through the warp yarns is called picking.
  - **Beat-up:** The beating-up is the third primary motion of weaving which consists in driving the last pick of weft to the fell of the cloth.

- **Secondary motion:** These mechanisms are next in importance to the primary mechanisms. If weaving is to be continuous, these mechanisms are essential.

- **Types of secondary motion**
  - **Take-up motion:** The take-up motion withdraws the cloth from the weaving area at a constant rate so as to give the required pick-spacing (in picks/inch or picks/cm) and then winds it on to a cloth roller.
  - **Let-off motion:** The let-off motion delivers the warp to the weaving area at the required rate and at constant tension by unwinding it from the weaver's beam.

- **Tertiary motion:** To get high productivity and good quality of fabric, additional mechanisms, called tertiary mechanisms, are added to a loom.

- **Weft stop motion:** Weft stop-motion stops the loom in the event of a pick break.

- **Warp stop motion:** Warp stop-motion stops the loom in the event of an end break.

- **Warp protector mechanism:** To protect the warp yarn/reed/shuttle in case of trapping the shuttle in the shed is the function of warp protector motion.

Mechanisms of motions:

- Shedding
- Picking
- Beating
- Take up
- Let off
- Warp stop
- Warp protector
- Weft replenishment

Types of loom:

- Air jet
- Rapier
- Water jet

SELF-CHECK QUIZ 5.1.1

Write the correct answer of the questions below:

1. Write the name of primary motions.
2. What is beat-up?
3. What is take up?
4. Why weft-stop motion is necessary?

Learning Outcome 5.2 - Prepare for Beating Operation

Same as for Learning Outcome 3.2 (“Prepare for Shedding”) pages 40 to 42.

Learning Outcome 5.3 – Perform Cam and Crank Beat Up

Contents:

- Uses of hand tools and equipment
- Cam and crank beat up system
- Maintenance of beat up system

Assessment criteria:

1. Tools and equipment are properly used.
2. Cam and crank beating system are carried out as per standard operating system.
3. Beating system is maintained to ensure quality production.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): hand gloves, dust mask, apron and ear plug
- Tools and equipment: weaving machine, sample cutter, yarn tension meter, tape tensioner, industrial weight scale
- Materials: Warp and weft yarns

LEARNING ACTIVITY 5.3

Learning Activity	Resources/Special Instructions/References
Carry out cam and crank beat up	▪ Information Sheet: 5.3.1 ▪ Self-Check Quiz: 5.3.1 ▪ Answer Key: 5.3.1

INFORMATION SHEET 5.3.1

Learning Objective: To perform cam and crank beat up during weaving.

Cam beat up: The beating is performed by the cam beat up system.

Crank and crank arm beat up : The beating up is the third primary motion of weaving. It consists in driving the last pick of weft to the fell of the cloth. This is accomplished with the help of a reed fixed in the sley. The sley is given a sudden and quick movement direction to the fell of the cloth by the cranks in crank shaft.

SELF-CHECK QUIZ 5.3.1

Write the appropriate/correct answer of the following:

1. What is cam beat up?
2. What is crank beat up?

Learning Outcome 5.4 – Perform Beating System with Conventional Loom

Contents:

- Uses of hand tools and equipment
- Beating system of conventional loom
- Maintenance of beating system

Assessment criteria:

1. Tools and equipment are properly used.
2. Beating system using conventional loom is carried out as per standard operating procedure.
3. Beating mechanism is maintained to ensure quality production.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): safety cloth/apron, hand gloves, dust mask
- Tools and equipment: weaving machine, sample cutter, yarn tension meter, tape tensioner, industrial weight scale
- Materials: Warp and weft yarn

Activity

LEARNING ACTIVITY 5.4

Learning Activity	Resources/Special Instructions/References
Carry out beating system with conventional loom	▪ Information Sheet: 5.4.1 ▪ Self-Check Quiz: 5.4.1 ▪ Answer Key: 5.4.1 ▪ Job Sheet 5 ▪ https://www.cottonworks.com/topics/sourcing-manufacturing/weaving/the-art-of-weaving-basic-functions-of-the-weaving-loom/

INFORMATION SHEET 5.4.1

Learning Objective: to perform beating system with conventional loom.

Beating system:

The beating up is the third primary motion of weaving. It consists in driving the last pick of weft to the fell of the cloth. This is accomplished with the help of a reed fixed in the sley. The sley is given a sudden and quick movement direction to the fell of the cloth by the cranks in crank shaft.

Related Machine Parts:

- Crank shaft
- Crank shaft
- Crank bearing
- Crank pin
- Crank arm
- Sword pin
- Sley race
- Rocking shaft
- Race board
- Sley race
- Reed
- Reed cap

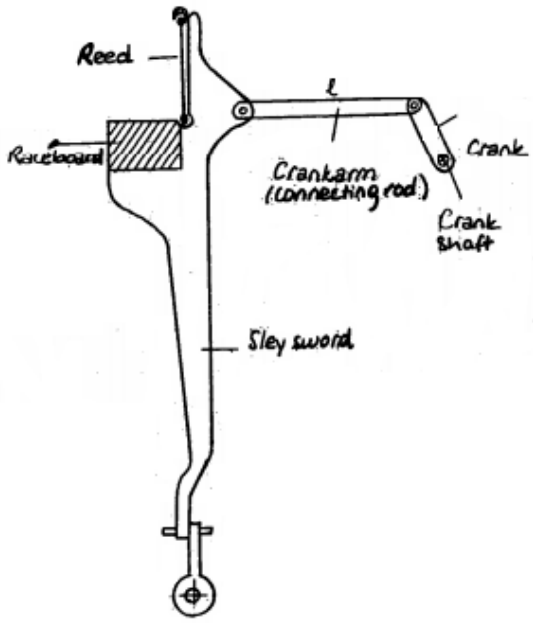


Figure: Crank and crank arm beat up

- **Construction of the mechanism:**

1. The beating up mechanism is connected with crank shaft. Here crank shaft is connected with machine pulley.
2. The crank shaft contains crank. Each crank connected with crank arm by crank pin and it contain bearing for smooth operation.
3. Crank arm and sley sword are attached with sword pin.
4. Position of the reed is top of the sley race.
5. Reed cap placed on the top of the reed.
6. The whole parts of the beating up mechanism are mounted on rocking shaft.

Working Principle:

1. Crank shaft achieved motion from machine pulley.
2. When crank shaft rotates due to the structure of the crank it moves forward and backward.
3. Each crank connected with crank arm which is connected with reed. So, when crank shaft rotates reed move forward and backward.

Maintenance of the beating system: oiling and greasing is done as per maintenance schedule.

JOB SHEET 5			
Qualification:	Weaving technology		
Learning unit:	Perform beating operation		
Learner name:			
Personal protective equipment (PPE):	Gloves, dust mask, apron and ear plug		
Materials:	Warp and weft yarn		
Tools and equipment:	Weaving machine		
Performance criteria:	1. Different beating motions are identified, compared and distinguished 2. Primary, secondary and tertiary mechanisms are identified and accurately defined. 3. Use of different motions in different types of looms is examined. 4. Work instructions are received and confirmed with supervisor 5. Appropriate personal protective equipment (PPE) is identified and selected. 6. Hand tools and equipment is selected as per job requirement 7. Cam and crank beat up is carried out as per standard operating procedure 8. Beating system using conventional loom is carried out as per standard operating procedure 9. Beating system using modern loom is carried out as per standard operating procedure. 10. Mechanism is monitored and maintained during operation to ensure quality production.		
Measurement:			
Notes:			
Procedure:	1. Collect PPE, tools, equipment and concrete paint 2. Check the usability of PPE, tools, equipment and concrete paint 3. Check the weft is inserted correctly. 4. Collect work instruction from the supervisor 5. Operate the weaving for beating as standard procedure. 6. Maintain the beating device during weaving.		
Learner signature:		**Date:**	
Assessor signature:		**Date:**	
Quality Assurer signature:		**Date:**	
Assessor remarks:			
Feedback:			

Individual Activity:

- *Watch the video shows on 'beating operation' and summarize key points (if facilities available)*
- *Perform 'beating operation' following Job Sheet 5 (see above)*

SELF-CHECK QUIZ 5.4.1

Write the correct answer for the following:

1. Write the name of some machine parts (at least 5) beating system.
2. Write down the working procedure of beating system.
3. Why beat up is necessary?

Learning Outcome 5.5 – Perform Beating System with Modern Loom

Contents:

- Uses of hand tools and equipment
- Beating system of modern loom
- Maintenance of beating system

Assessment criteria:

1. Tools and equipment are properly used.
2. Beating system using modern loom is carried out as per standard operating procedure
3. Beating mechanism is maintained to ensure quality production.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): safety cloth/apron, hand gloves, mask
- Tools and equipment: weaving machine, sample cutter, yarn tension meter, tape tensioner, industrial weight scale
- Materials: Warp and weft yarn

LEARNING ACTIVITY 5.5.1

Learning Activity	Resources/Special Instructions/References
Carry out beating system with modern loom	▪ Information Sheet: 5.5.1 ▪ Self-Check Quiz: 5.5.1 ▪ Answer Key: 5.5.1

INFORMATION SHEET 5.5.1

Learning Objective: to perform beating system with modern loom.

Beating system with modern loom:

- To achieve high loom speeds on shuttleless weaving machines:
  - The mass of the sley should be reduced to a minimum
  - The distance through which it reciprocates should be as low as possible
- In order to minimize the weight of the sley, heavy parts associated with picking are mounted on the loom except some means of guiding for the weft carrier through the shed.
- Since the device used to carry the weft through the shed will have a smaller cross-section than a shuttle, a smaller shed and hence a smaller sweep of the sley will be sufficient.
- The picking mechanism is mounted stationary on the machine frame, then the sley must dwell in its most backward position during the whole of the time occupied by weft insertion.
- Only a cam mechanism can precisely ensure the dwell position within the required range of 220° to 250°.

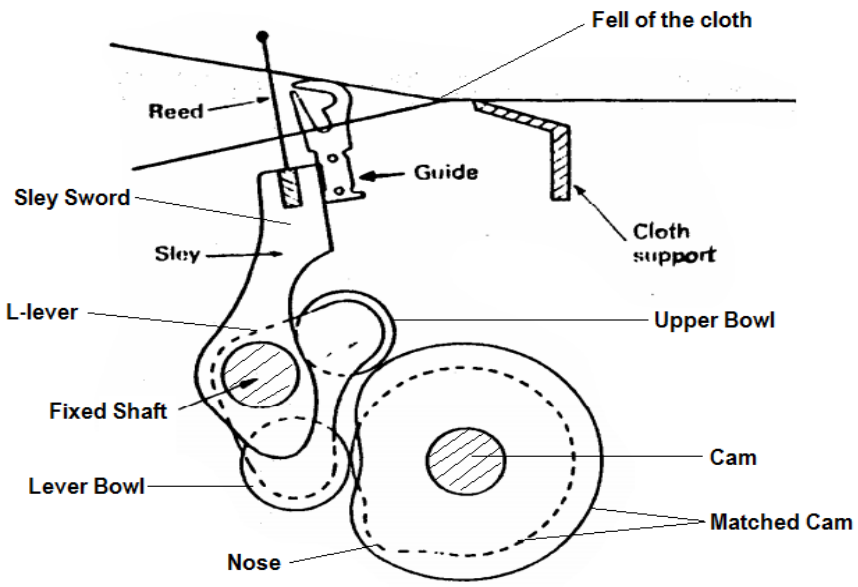


Fig: Cam Beat-up Mechanism

ANSWER KEYS

ANSWER KEY 5.1.1

1. Shedding, picking and beating
2. The beating-up is the third primary motion of weaving which consists in driving the last pick of weft to the fell of the cloth.
3. The take-up motion withdraws the cloth from the weaving area at a constant rate so as to give the required pick-spacing(in picks/inch or picks/cm) and then winds it on to a cloth roller.
4. Weft stop-motion stops the loom in the event of a pick break.

ANSWER KEY 5.3.1

1. The beat up is performed by the help of cam beat up system.
2. The beating up is the third primary motion of weaving. It consists in driving the last pick of weft to the fell of the cloth. This is accomplished with the help of a reed fixed in the sley. The sley is given a sudden and quick movement direction to the fell of the cloth by the cranks in crank shaft.

ANSWER KEY 5.4.1

1. Crank shaft, crank bearing, crank pin, crank arm, sword pin.
2. Working procedure:
   - Crank shaft achieved motion from machine pulley
   - When crank shaft rotates due to the structure of the crank it move forward and backward
   - Each crank connected with crank arm which is connected with reed (so when crank shaft rotates reed move forward and backward)
3. The beating up is the third primary motion of weaving. It consists in driving the last pick of weft to the fell of the cloth. This is accomplished with the help of a reed fixed in the sley. The sley is given a sudden and quick movement direction to the fell of the cloth by the cranks in crank shaft.

Module 6: Identify weaving accessories and fabric faults

MODULE CONTENT

Module Descriptor: This module covers the skills, knowledge and attitudes to identify weaving accessories and fabric faults, which includes the tasks of identifying weaving accessories, identifying fabric faults and testing the quality of the fabric. It also includes information sheets, job sheets, self-checking and answer keys.

Nominal Duration: 32 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee will be able to:

6.1 Identify weaving accessories

6.2 Identify fabric faults

6.3 Test the quality of the fabric

PERFORMANCE CRITERIA:

1. Weaving accessories are identified and selected as per job requirement.
2. Selected weaving accessories are implemented.
3. Fabric faults are identified and categorised according to severity levels and possible causes are determined.
4. Identified faults are reported to appropriate authority.
5. Fabric quality is identified and established.
6. Fibre and yarn properties are tested.
7. Test results are reported to appropriate authority.

Learning Outcome 6.1 - Identify Weaving Accessories

Contents:

1. Weaving accessories
   - Shuttle
   - Shuttle box
   - Picker
   - Beam (cloth, warp)
   - Front rest
   - Lease rod
   - Sley
   - Reed
   - Temple
   - Back rest
   - Dropper

Assessment criteria:

1. Weaving accessories are identified and selected as per job requirement.
2. Weaving accessories are used as required.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): gloves, mask, apron and ear plug
- Tools and equipment: Weaving machine

LEARNING ACTIVITY 6.1.1

Learning Activity	Resources/Special Instructions/References
Identifying weaving accessories	▪ Information Sheets: 6.1.1 ▪ Self-Check Quiz: 6.1.1 ▪ Answer Key: 6.1.1

INFORMATION SHEET 6.1.1

Learning Objective: to identify and select weaving accessories used in weaving machine.

Personal Protective Equipment (PPE): gloves, mask, apron

Weaving accessories :

Shuttle : is a tool designed to neatly and compactly store a holder that carries the thread of the weft yarn while weaving with a loom. Shuttles are thrown or passed back and forth through the shed, between the yarn threads of the warp in order to weave in the weft.

Figure: Shuttle

Shuttle box : It is the housing for the shuttle and is made of wood. It has a spindle and a picker. It may also accommodate the picker without spindle. The top and side of the box towards the sley race are open. The shuttle stays inside the box for the for the intermediate period between two successive picks.

Figure: Shuttle box

Picker: The devices used to cast a shuttle back and forth over a loom during the weaving operation. The picker is a piece made either of leather or synthetic material. It may be placed on a spindle or grooves in the shuttle box. It is used to drive the shuttle from one box to another. It also sustains the force of the shuttle while entering the box.

Figure: Picker

Beam (cloth, warp): This is also known as the weaver's beam. It is fixed at the back of the loom. The warp sheet is wound on to this beam. The length of warp in the beam may be more than a thousand metres.

It is also known as the cloth roller. The woven cloth is wound on to this roller. This roller is placed below the front rest. It is also known as the cloth roller. The woven cloth is wound on to this roller. This roller is placed below the front rest.

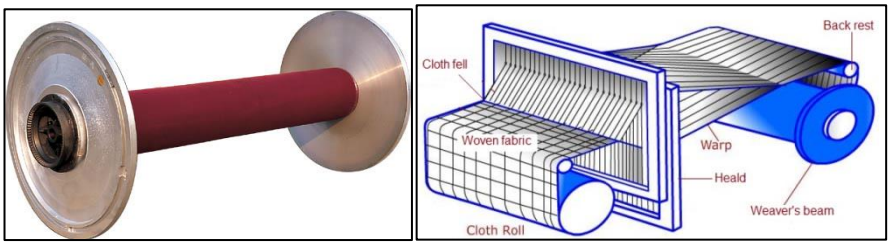


Figure: Beam

Front rest: It is also known as the breast beam. It is placed above the cloth roller at the front of the loom and acts as a guide for the cloth being wound on to the cloth roller. The front rest together with the back rest helps to keep the warp yarn and cloth in horizontal position and also maintain proper tension to facilitate weaving.

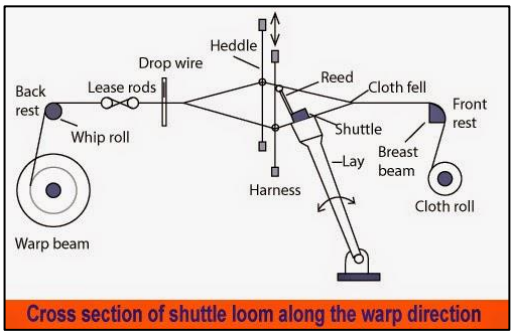


Figure: Front rest

Lease rod: An arrangement of warp to maintain the same relative position during handling. This is done generally by criss-crossing the yarns alternatively, keeping them in position by two rods called lease rod.

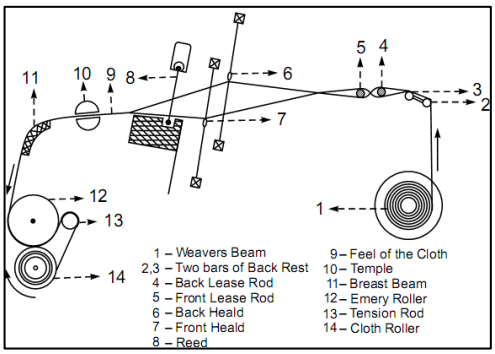


Figure: Lease rod

Sley : It is made of wood and consists of the sley race or race board, reed cap and metal swords carried at either ends. The sley mechanism swings to and fro. It is responsible for pushing the last pick of weft to the fell of the cloth by means of the beat-up motion. The sley moves faster when moving towards the fell of the cloth and moves slower when moving backwards. This unequal movement is known as ‘eccentricity of the sley’. It is needed in order to perform the beat up and also to give sufficient time for passage of shuttle to pass through the warp shed. The beat up of the lastly laid pick of weft is accomplished through a metal reed attached to the sley.

Reed : It is a metallic comb that is fixed to the sley with a reed cap. The reed is made of a number of wires and the gap between wires is known as dents. Each dent can accommodate one, two or more warp ends. The count of the reed is decided by the number of dents in two inches. The reed performs a number of functions which are enumerate as follows:

- It pushes the lastly laid pick of weft to the cloth fell
- It helps to maintain the position of the warp threads

- It acts as a guide to the shuttle which passes from one end of the loom to the other
- It determines the fineness of the cloth in conjunction with the healds
- It determines the openness or closeness of the fabric

Figure: Reed

Temple : A temple is an adjustable stretcher used on a loom to maintain the width and improve the edges of the woven fabric. During the process of weaving, fabrics can decrease in width (draw in) due to the interlacement of the weft material. Temples prevent this decrease by keeping fabrics at a fixed width, thus requiring more weft to enter the weave with each pass of the shuttle. Fabric produced without draw-in has a smoother selvage, weft can be packed in more evenly, and warp threads are less likely to break from excessive friction in the reed.

There are two main types of temples: metal and wood. Both types have a shaft, whose length can be adjusted, and sharp prongs at each end to attach to the fabric. Wooden temples tend to be lighter and have straight, fine teeth. The teeth on metal temples are angled and are wider at the base than the teeth on wooden temples. Metal temples are often recommended for rugs because the size and angle of the teeth are better for gripping the thick edges.

To use a temple, the length is first adjusted so that it matches the total width (or spread) of warp threads in the reed. The prongs are then inserted into the fabric, on each side, at the very edges of the cloth. The temple must be moved frequently to keep it close to the *fell* of the fabric, where the weaving is taking place

Figure: Temple

Back rest: is placed above the weaver's beam. It may be of the fixed or floating type. In the first case the back rest merely acts as a guide to the warp sheet coming from the weaver's beam. In the second case it acts both as a guide and as a sensor for sensing the warp tension.

Dropper:

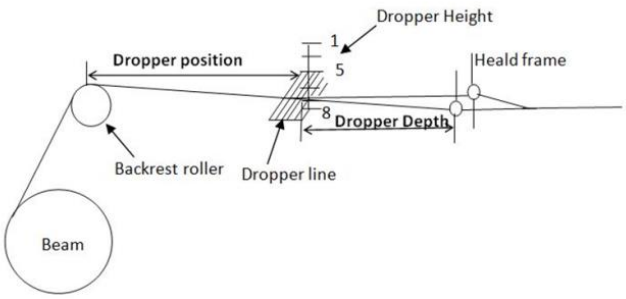


Figure: Back rest

SELF-CHECK QUIZ 6.1.1

Write the correct answer of the following:

1. What is the function of a shuttle?
2. Why temple is used in loom?
3. Why front rest is needed in weaving machine?
4. What functions are performed by a reed?

Learning Outcome 6.2 - Identify Fabric Faults

Contents:

- Types of fabric faults
- Causes of fabric faults

Assessment criteria:

1. Fabric faults are identified and categorised according to standard system.
2. Causes of fabric faults are determined.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): hand gloves, dust mask, safety shoes, goggles, apron
- Tools and equipment: fabric inspection table
- Materials: Fabric

LEARNING ACTIVITY 6.2.1

Learning Activity	Resources/Special Instructions/References
Identify fabric faults	▪ Information Sheet: 6.2.1 ▪ Self-Check Quiz: 6.2.1 ▪ Answer Key: 6.2.1 ▪ https://www.youtube.com/watch?v=iNPsPyTTNl4

INFORMATION SHEET 6.2.1

Learning Objective: to identify causes and remedies of fabric faults.

- **Broken ends:** A defect in the woven fabric caused by a warp yarn that was broken during weaving or finishing**.**

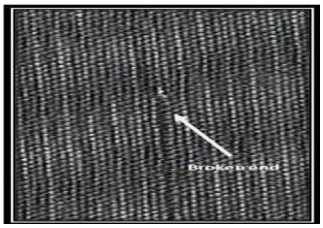


Figure: Broken Ends

- **Broken picks:** A filling yarn that is broken during weaving in the fabric.

Causes

- Weft break or weft exhaustion on ordinary looms
- Weft break or improper size of bunch on auto-pirns
- Improper functioning of weft fork
- Weft change effected through weft fork mechanism on automatic looms

Remedies

- Check the shuttle for loose fitting of pirn or roughness of surfaces as these causes more weft breaks
- Check also the shuttle boxes for settings and surface condition to prevent cutting of weft
- Check the shuttle and shuttle boxes
- Ensure proper size of bunch on auto-pirns
- Maintain the weft-fork mechanism in good working condition
- Resort to pirn change by weft feeler mechanism
- Resort also to pick finding before restarting the loom

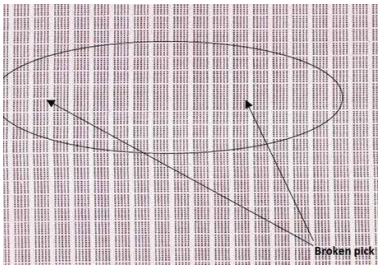


Figure: Broken Picks

- **Floats :** Defect in a woven fabric where warp and weft threads do not interlace as desired.

Causes

- Broken end getting entangled with the adjacent warp ends. The breaks between reed and healds are more prone to form floats, especially when the warp loses its elasticity due to over stretching or over-backing during sizing.
- Knots with long tail ends leading to entanglement of ends
- Fluff with long tail ends leading to entanglement of ends
- Fluff or foreign matter trapped in the shed
- Broken heald unable to lift or lower the thread
- Lighter type of warp-stop motion pins used on the loom

Remedies

- Attend to broken ends without delay on looms equipped with warp stop motion; ensure proper functioning of the same

- Avoid long tail ends in knots in weaving preparatory and weaving
- Ensure cleanliness of loom
- Take maximum possible care while blowing the looms
- Use screens to avoid fluff flying to adjacent looms
- Inspect the healds for wear before putting on a new beam
- Ensure proper selection of drop pins

- **Irregular pick density :**

Hole: A fabric imperfection in which one or several yarns are sufficiently damaged to create an opening. A defective portion in the fabric marked by distortion or cutting of warp and weft.

Causes

- Mechanical faults in loom
- Weavers tapping the fabric with the shuttle tip or pirn on the front rest when inserting a new pirn
- Carelessness of the weaver in removing gout
- Holes form during the finishing processes due to the presence of foreign matter

Remedies

- Rectify the mechanical faults.
- Make the weaver quality conscious.
- Take precautions in weaving to avoid incidence of woven foreign matter.

- **Miss pick:** this kind of defects is produced in woven fabric when operator starts a stopped machine without picking the broken weft from the shade.

- **Double Pick:** This defect is caused by the presence of two picks in the same shed in a plane weave fabric. It is produced in woven fabric when the cutter don't work properly.

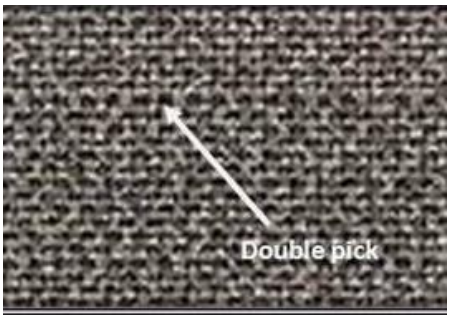


Figure: Double Pick

- **Start and stop mark:** Narrow band of different weave density, across the width of a woven fabric, caused by improper warp tension adjustment after a loom stop. A well-trained weaver can reduce this type of defects.

- **Oil spot :** Fabric may be got oil mark by the oil, grease, mobile etc. from the machine during fabric manufacturing.

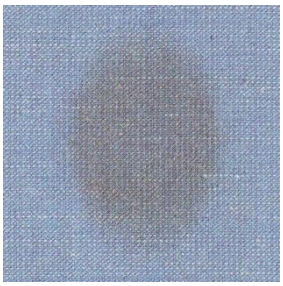


Figure: Oil Spot

Remedies

1. Proper maintaining of machine.
2. Keeping the machine clean.

SELF-CHECK QUIZ 6.2.1

Write the correct answer of the following:

1. Write the name of at least five fabric faults.
2. What is floating?
3. Mention the causes and remedies for broken picks?
4. What do you mean by miss pick?
5. Why do broken ends occur?

Learning Outcome 6.3 - Test the Quality of the Fabric

Contents:

- Fabric quality
- Yarn property

Assessment criteria:

1. Fabric quality is checked and identified.
2. Yarn properties are tested as required.

Resources required:

Students/trainees must be provided with the following resources:

- Personal protective equipment (PPE): hand gloves, mask, apron
- Tools and equipment: fabric inspection table
- Materials: Yarns and fabric

LEARNING ACTIVITY 6.3

Learning Activity	Resources/Special Instructions/References
Identify fabric quality	▪ Information Sheet: 6.3.1 ▪ Self-Check Quiz: 6.3.1 ▪ Answer Key: 6.3.1 ▪ Job Sheet 6

INFORMATION SHEET 6.3.1

Learning Objective: to identify quality of the fabric.

- **Fabric quality:** Grey fabric is checked according to standard.
  - **Four-point system:** Four-Point system is a standardized Test Methods for fabric Visually Inspecting and Grading.

Figure: Four-point system

To use this system someone, have to know following things:

1. Fabric inspection method or preparation
2. Vast idea on nature of fabric defects (how an error looks and its appearance)
3. Criteria of giving penalty points based on defects and defect length
4. Calculation method of total penalty points for total defects found in a fabric roll or than
5. A Check sheet or format for recording data.

Defect Classification:

Whenever errors are recognized during fabric inspection under 4 points system and defect must be assigned a number of points depending on the severity or length.

Inches (˝)	**(mm)**	**Points**
From **0 > 3″** length/width	Up to 75mm	1 point
From **3.1″ > 6″** length/width	75mm > 150mm	2 points
From **6.1″ > 9″** length/width	150mm > 230mm	3 points
More than **9″** length/width	More than 230mm	4 points

Upon the number and the size of the imperfections in the given yard, a maximum of 4 points can be given to one linear yard. Hole point may be evaluated by size.

Holes and openings (the largest dimension)	
1“ or less	2
Over 1“	4

- **Ten-point system:** The 10-point method is a point per fault system, which gives a measurable guide to quality grading per roll.

Warp Defects

Ser	**Size of defects**	**Penalty**

1	Up to 1 inch	1 Point
2	1 to 5 inches	3 Points
3	5 to 10 inches	5 Points
4	10 to 36 inches	10 Points

Filling/Weft Defects

Ser	Size of defects	Penalty
1	Up to 1 inch	1 Point
2	1 to 5 inches	3 Points
3	5 inches to half the width	5 Points
4	Half to Full width	10 Points

A maximum 10 Points is charged for one linear yard of fabric.

Working Procedures

- Under the 10 Points system, a piece is graded as “First”, if the total penalty points do not exceed the total yardage of the piece.
- In case of a fabric wider than 50 inches; “First” quality is considered if the total defect points do not exceed the total yardage of the fabric.
- A piece is graded as “Second” if the total penalty points exceed the total yardage of the piece.

JOB SHEET 6			
Qualification:	Weaving technology		
Learning unit:	Identify weaving accessories and fabric faults		
Learner name:			
Personal protective equipment (PPE):	Gloves, dust mask, apron		
Materials:	Fabric		
Tools and equipment:	Fabric inspection table, nipper, cutter		
Performance criteria:	1. Weaving accessories are identified and selected as per job requirement. 2. Selected weaving accessories are implemented. 3. Fabric faults are identified and categorized according to severity levels and possible causes are determined. 4. Identified faults are reported to appropriate authority. 5. Fabric quality is identified and established. 6. Fibre and yarn properties are tested. 7. Test results are reported to appropriate authority.		
Measurement:	• Measurement to be taken following standard fabric inspection system • Carefully take the measurement and calculate the fabric faults		
Notes:	• Follow standard system to measure the fabric faults. • Correctly count the number of fabric faults		
Procedure:	1. Follow an inspection system referred by the authority. 2. Collect PPE, tools, equipment and paint with other materials for spray 3. Check the usability of PPE, tools and equipment . 4. Collect fabrics for inspection. 5. Count and tabulate the number of faults found in the fabric. 6. Calculate the fabric faults according to requirement.		
Learner signature:		**Date:**	
Assessor signature:		**Date:**	
Quality Assurer signature:		**Date:**	
Assessor remarks:			
Feedback:			

Keep in mind:

- *Follow the authors instruction to measure the fabric faults.*
- *Always follow standard inspection procedure.*

Individual Activity:

- *Watch the video shows on 'fabric inspection system' and summarize key points (if facilities available)*
- *Perform fabric inspection following Job Sheet 6 (see above)*

SELF-CHECK QUIZ 6.3.1

Write the appropriate/correct answer of the following:

1. What is four-point system?
2. How can you measure the fabric faults by four-point system?
3. How warp defects can be measured by ten-point system?

ANSWER KEYS

ANSWER KEY 6.1.1

1. A shuttle is a tool designed to neatly and compactly store a holder that carries the thread of the weft yarn while weaving with a loom. Shuttles are thrown or passed back and forth through the shed, between the yarn threads of the warp in order to weave in the weft.
2. A temple is an adjustable stretcher used on a loom to maintain the width and improve the edges of the woven fabric. During the process of weaving, fabrics can decrease in width (draw in) due to the interlacement of the weft material. Temples prevent this decrease by keeping fabrics at a fixed width.
3. It is also known as the breast beam. It is placed above the cloth roller at the front of the loom and acts as a guide for the cloth being wound on to the cloth roller. The front rest together with the back rest helps to keep the warp yarn and cloth in horizontal position and also maintain proper tension to facilitate weaving.
4. Functions of reed are as follows :
   - It pushes the lastly laid pick of weft to the cloth fell
   - It helps to maintain the position of the warp threads
   - It acts as a guide to the shuttle which passes from one end of the loom to the other
   - It determines the openness or closeness of the fabric
   - It determines the fineness of the cloth in conjunction with the healds

ANSWER KEY 6.2.1

1. Broken ends, broken picks, miss picks, floats and hole.
2. Float is a woven fabric fault where warp and weft threads do not interlace as desired.
3. Causes :
   - Weft break or weft exhaustion on ordinary looms
   - Weft break or improper size of bunch on auto-pirns
   - Improper functioning of weft fork
   - Weft change effected through weft fork mechanism on automatic looms

   Remedies :
   - Check the shuttle for loose fitting of pirn or roughness of surfaces as these causes more weft breaks
   - Check also the shuttle boxes for settings and surface condition to prevent cutting of weft
   - Check the shuttle and shuttle boxes
   - Maintain the weft-fork mechanism in good working condition
4. This kind of defect is produced in woven fabric when operator starts a stopped machine without picking the broken weft from the shade.
5. A defect in the woven fabric caused by a warp yarn that was broken during weaving or finishing.

ANSWER KEY 6.3.1

1. Four-Point System is a standardized test method for fabric visually inspecting and grading.
2.

Inches (˝)	**(mm)**	**Points**
From **0 > 3″** length/width	Up to 75mm	1 point
From **3.1″ > 6″** length/width	75mm > 150mm	2 points
From **6.1″ > 9″** length/width	150mm > 230mm	3 points
More than **9″** length/width	More than 230mm	4 points

3. Warp Defects

Ser	**Size of defects**	**Penalty**
1	Up to 1 inch	1 Point
2	1 to 5 inches	3 Points
3	5 to 10 inches	5 Points
4	10 to 36 inches	10 Points