Manual

on

Low Cost Technological Solutions

for

Health Hazards

and

Environmental Impacts

of

Textile Production.

Manual on Low Cost Technological Solutions for Textile Production and Environmental Impacts in Textile Production

Acknowledgements

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Executive Summary

Occupational health and safety (OHS), as a discipline, is concerned with providing safe working conditions so that the health of the people engaged in that work or occupation is protected. The goal of all occupational health and safety programs is to minimise disease, injury, and death. It is also believed that if the safety of the work-place is assured, then the surrounding environment is also rendered pollution- or damage-free and family members who are settled in the neighbourhood, and nearby communities and other members of the public, who may be impacted, are also protected.

Earlier, when manufacturing processes were relatively simpler, it was easier to study these impacts in isolation at the work-place itself. But globalisation of the market economy and the rapid industrial growth of the last few decades have so interlinked the development and management of new technologies that occupational health and safety has become a more complicated subject. Even the handicraft sector of India, that is labour intensive and mostly home based, has become integrated into the global market, although it remains highly unorganised and a largely neglected part of the developing economy.

At the request of AIACA, Hazards Centre conducted a baseline study in 2009-2010 on the environmental and occupational health impacts in six different cottage industry clusters in India: i) Hand Block Printing in Bagru, Rajasthan; ii) Blue Pottery in Jaipur, Rajasthan; iii) Leather in Ajmer and Jaipur, Rajasthan; iv) *Ikat* Weaving in Pochampally, Andhra Pradesh; v) Dhokra in Orissa; and vi) Bell Metal in Orissa. We believe this baseline study is one of the few of its kind in India and helps to understand the implicit linkage between safe work, healthy environment, workers' health, and reducing the hazards at source.

As a sequel to the above study, Hand Block Printing in Bagru, Rajasthan and *Ikat* Weaving in Pochampally, Andhra Pradesh were selected for a detailed review of the process of textile handicraft production, its associated hazards, and low-cost technical solutions, resulting in the prevention of hazards and the safety of artisans at the work-place. The outcomes were presented before artisans of both the clusters and their feedback obtained. The results have been compiled in the form of this manual which enumerates the different hazards, their related health concerns, laws and rules for their prevention, and innovative methods to control them at the source.

Hopefully, this document will help to initiate an understanding about the occupational health and safety issues prevailing in this unorganised sector and their links to environmental impacts and their mitigation, among policy makers, academicians, health specialists, labour organisations, government agencies, and the affected workers themselves.

1 - Introduction

The word 'textile' originates from 'texere', which means 'to weave', referring to a flexible material comprising of a network of natural or artificial fibres, known as yarn. Cottage means a 'small house' or 'hut', and the term 'cottage industry' was evolved from it, meaning 'a business or manufacturing activity carried on in a person's home'. Combining the two we get the 'textile industry', one of the largest employers of labour throughout the world. But there have been various stages of its historical evolution from a domestic enterprise to the iconic status it currently holds.

There is a significant presence of the Indian textile industry, both within India as well as in the international arena. It contributes 20% of industrial production, 9% of excise collection, 18% of employment in the industrial sector, nearly 20% to the country's total export earning, and 4% to the Gross Domestic Product[1]. From growing its own raw material (cotton, jute, silk, and wool) to providing value added products to consumers (fabrics and garments), the textile industry covers a wide range of economic activities, including employment generation in both the organised and unorganised sectors.

India has been well known for her textile goods since very ancient times, where the culture of silk was introduced in 400 AD, but spinning of cotton dates back to 3000 BC. Before the advent of the East India Company, India only had cottage industry, but the modern textile industry took birth in India in the early 19th century when the first textile mill in the country was established at Fort Gloster near Calcutta in 1818[2]. With the further advent of industrialisation, cottage industries witnessed a sharp decline, although the government took steps to revive them in the early years after Independence.

Cottage industries play an important role in the Indian textile industry and are responsible for preserving the rich cultural heritage of India. A large proportion of the rural population of India is supported by them. This industry not only maintains a distinct identity of its own but also provides a unique platform to display its hand-crafted speciality, even in the face of tough competition in international markets. It is only because of cottage industries that indigenous goods can fairly compete with foreign goods as they preserve the imprint of an unique Indian culture.

At the same time, the occupational health and safety of the artisans involved with these industries has become a matter of indirect concern because of greater consumer awareness and the consequent demands of the international market for products free from toxic materials. It is the artisans who enter the work-place every day, where toxic materials are used, and they additionally encounter hazards of heat, stress, cold, noise, dust, vibrations, and awkward working postures. They are the closest to hazardous processes and materials, yet they are the ones who are systematically overlooked in the debate on sustainability.

1-http://www.legalpundits.com/Content_folder/THETEXTILEINDUSTRYREPORT290710.pdf
2-http://www.fibre2fashion.com/industry-article/pdffiles/indian-textile-industry.pdf?PDFPTOKEN=4bea06f0e72d34d4a8d0ab212c8815144d2deb1e|1323256633#PDFP

The exposure of the workers is occasionally assessed through long working hours and low wages, but the issues of occupational health and safety are generally ignored. There are several laws and regulations that provide for compensation, treatment cost, paid leave, and so on, but they are generally applied only in the organised sector. The statistics published by the Ministry of Labour do not include information on the health and safety of the unorganised sector workers; primarily because research institutions do not either have the money or the inclination to explore this impoverished arena.

A detailed study concerning occupational health and safety in this sector has long been marked by its absence. The present study hopes to begin filling in some of the gaps by both working closely with associations who are working for the welfare of artisans as well as developing low-cost methods and techniques to collect data that would otherwise require large funding and institutional support. It also points to issues and concerns that may be of great importance for future research and action.

2 - Objectives of the Study

The main objectives of the study are as follows:

Detailed documentation of hazards involved in the production process of two cottage industry (textile) clusters:

- Block printing in Bagru, Rajasthan
- *Ikat* weaving in Pochampally, Andhra Pradesh

Preparation of a manual on low cost technical solutions for minimising hazards in textile production activities.

3 - Methodology

- Survey of each step required in the production process and listing out the materials and equipments used by the artisans.
- Documenting the possible health impacts while handling of materials and equipment in each process.
- Listing of affordable safety measures for improvement in handling equipments and Chemicals to reduce health hazards of the textile artisans.
- Trial run of the safety measures in the textile units for assessing their comfortable handling / use by the artisans.
- Preparation of a safety manual for safe working in the textile cottage industry

4 - Block Printing in Bagru, Rajasthan

The beautiful art of Block Printing employs wooden blocks to print designs and patterns on the fabric by hand. The uniqueness lies in the fact that the design has to be created before the printing begins and it is carved onto the block by hand. The colours used are normally vegetable dyes though now mineral and non-toxic chemical dyes are also used. The carved block is dipped into the required colour, and then it is used to print designs on the fabric.

The traditional process of hand block printing on textiles, with rich natural colours, has been known for many centuries, beginning perhaps around 450 years back. Excavations of dyed and printed fabric have traced the origin of block printing to 17th century in Gujarat. From Gujarat, the art of block printing spread to Rajasthan. Here, colourful prints of birds, animals, human figures, gods and goddesses are popular. The important centres for this form of hand printing are Jaipur, Bagru, Sanganer, Pali and Barmer. Today, block printing is practiced in numerous centres all over India.

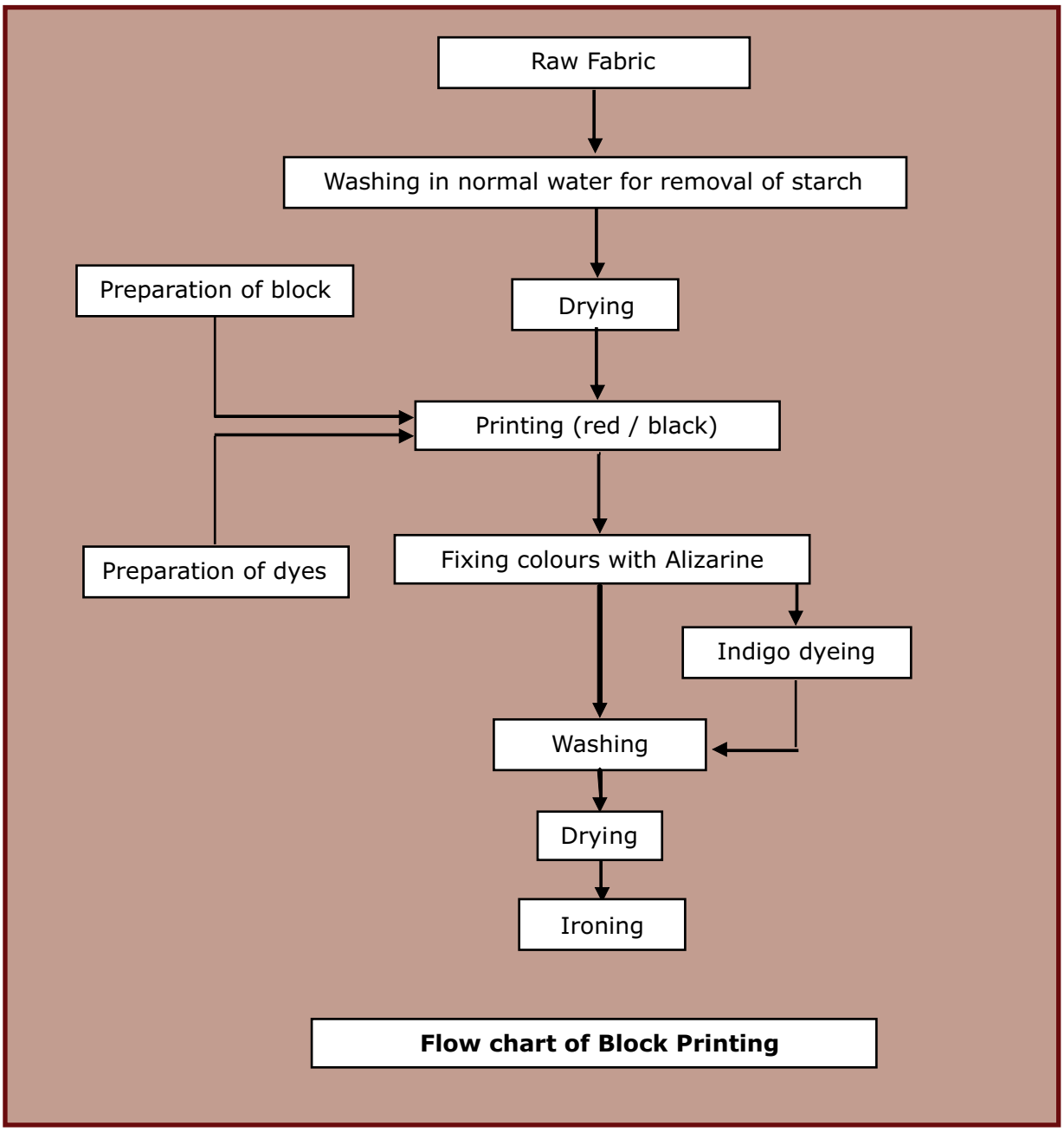
Bagru has a community of Chhipas who printed the fabrics by hand and came from Sawai Madhopur, Alwar, Jhunjhunu, and Sikar districts of Rajasthan[1]. Earlier there were about 3000 households who were engaged in the craft and used only vegetable dyes. However, now production has been diversifying from screen printing to digital printing according to market demands; with mechanisation requiring less manpower, faster production, and the use of chemical dyes. Thus, hand block printing has declined in Bagru (only 600-800 households remain now) while screen printing has spread to more urban neighbourhoods in Sanganer and Jaipur.

4.1 Process description

Prior to printing the fabric is washed several times for the removal of starch, thus making it softer and more absorbent for dyeing and printing. The washing is carried out either manually or mechanically (with the help of a machine). This process of washing is also known as bleaching when mild caustic soda and hydrogen peroxide are used. After that, the fabric is dried properly in the sun and printing is carried out. For the printing process various types of dyes are used, namely:

- Vegetable dyes, along with which mordant is used to make the colour permanently adhere to the cotton fabric.
- Rapid dyes are used for negative type designs. They are mixed with water and boiled with caustic soda and gum paste. For these dyes, true colours only appear after the fabric has been printed and washed with mild sulphuric acid solution.
- Discharge dyes are used when printing has to be done on a dark background. When exposed to heat they concurrently bleach the colour from the dyed background of the fabric and print the desired colour in its place.

1-http://www.msmefoundation.org/folder/Article/58.pdf



4.1 Process flow-chart

The preparation of dyes is similar in various printing processes like Block Printing, where wooden blocks are used for printing; Screen Printing, where screens are used; and Daabu (or resist) Printing, where a paste of mud, gum, and sawdust is used. Dabu and Block printing processes are mainly practiced in Bagru. These two methods of printing may be described thus:

- **Direct printing:** In this process the master printer develops the main pattern using an outline block with a single colour. He is then followed by a series of assistant printers who use filler blocks with different colours to produce the final pattern.
- **Resist printing:** Daabu or resist printing involves the application of a mixed mud paste onto the fabric with the filler or outline blocks. Since this paste does not dry immediately, it may be sprinkled over with sawdust which acts as an absorbent.

After drying, when the fabric is immersed in a dyeing vat, the colour is not taken up by the fabric where the paste has been applied. Although women have traditionally done the Daabu printing, men are also now involved in the craft.

After the printing process, the fabric is dried by hanging out in the sun. The colours are then matured and fixed by dipping the fabric in a heated copper vessel (tamra) containing alizarine mixed with sakura flowers for about 4-5 hours.

Sometimes, particularly for resist printing, the fabric may be imparted a blue background colour. For this purpose, 2m deep sunken vats (math) are used and filled with indigo, lime, molasses, and water. The cloth may be dipped several times for a deeper shade of blue, or for daabu (resist) printing it will be first dyed a light blue and then, after the daabu print is in place, it may be re-dyed to acquire a deeper hue.

Once the printing and dyeing are complete, the cloth is again hand-washed and sun-dried, finally ironed to heat-treat the colours, and the fabric is then ready for the market.

5 - *Ikat* Weaving in Pochampally, Andhra Pradesh

Pochampally is a small town in Nalgonda district of Andhra Pradesh, a handloom cluster that has been known for its very unique *Ikat* design for centuries. It is also known as a centre for handloom silk *sarees* which has developed over the past 60 years. Pochampally textiles were famous right from 1900 when artisans with their creative skills started manufacturing tie-and-dye *rumals* (handkerchiefs) and scarves which achieved renown as Asia *rumals*, *sobiyani rumals*, *jananilu*, etc. At that time, these scarves were popular not only in and around Hyderabad but were also exported to Pakistan, Afghanistan and other Arab countries, where they were mostly used as *keffiyeh / shemagh / ghutra* (a traditional head dress typically worn by Arab men).

During the end of the Nawab's rule (1948), the handloom business of Pochampally was in distress because of the collapse of the Hyderabadi business elites. But in the first five-year plan of the country (1951), handlooms were given priority after agriculture and weavers started working under a co-operative society in Koyalagudem which is located about 20 kilometres away from Pochampally. The difficulty in bringing raw materials and delivering finished products to and from Koyalagudem persuaded the weavers to open a branch at Pochampally in 1952, which later on became an autonomous society in 1960 known as the "Pochampally Handloom Weavers' Co-Operative Society Limited".

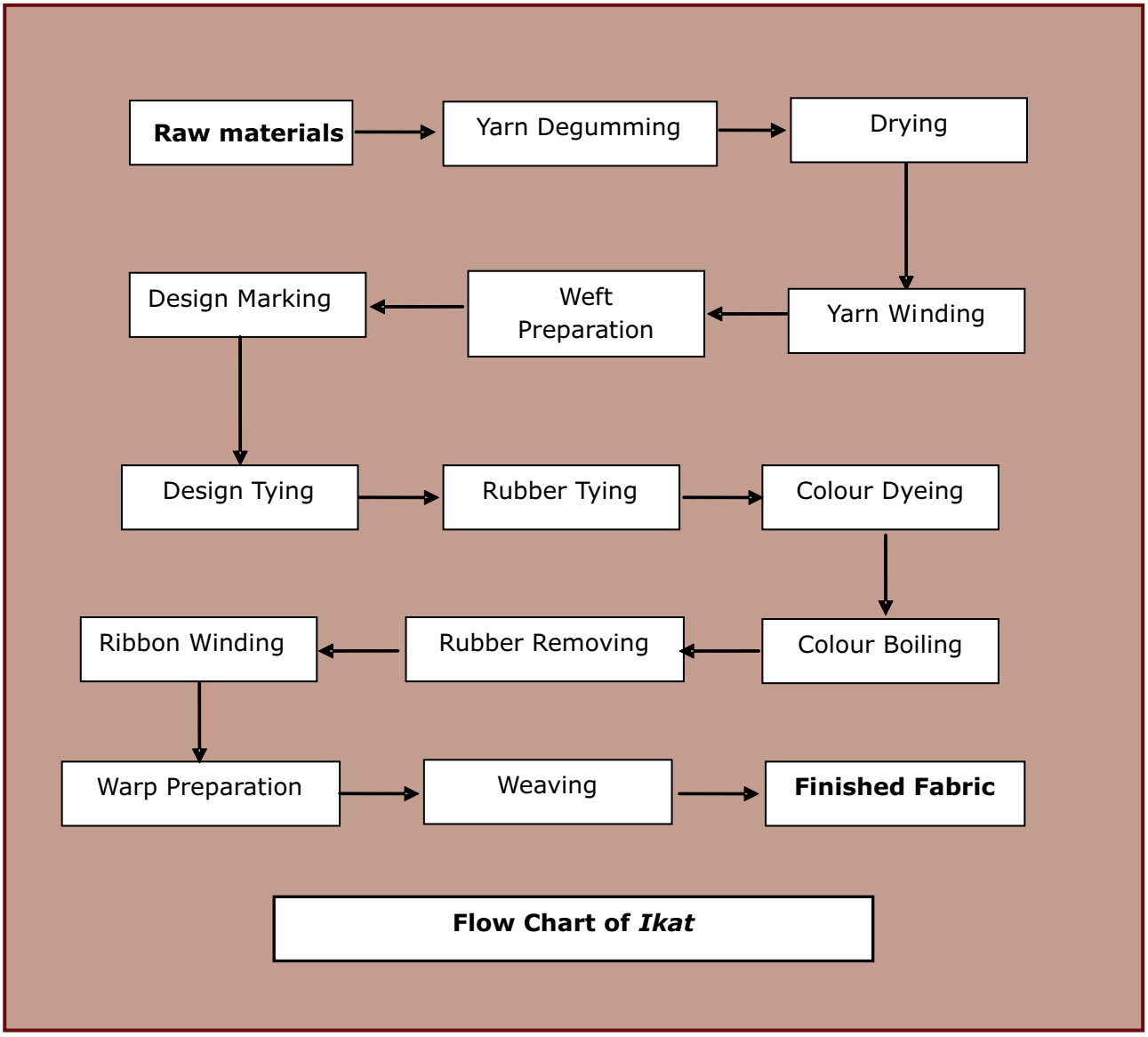
After that, artisans began their efforts to weave tie-and-dye *sarees* which gained popularity and slowly Pochampally developed as a centre of handloom silk in the entire country. Currently, there are about 5,000 weavers who are basically Hindus of the Padmasali or Devang communities who have been residents in the area for long and have adopted the local dialect and social norms[1]. They produce *Ikat* textiles with geometrical designs but have recently started experimenting with all-Indian styles. In principle, *Ikat* or resist dyeing, involves the sequence of tying (or wrapping) and dyeing exposed sections of bundled yarn to a pre-determined colour scheme prior to weaving. The patterns formed on the yarn are then configured into the woven fabric.

The designs in various colours may be formed on the fabric either by warp threads or weft threads (single *Ikat*) or by both (double *Ikat*). In single *Ikat*, the tie-and-dye warp or weft threads are positioned accurately on the woven fabric through a predetermined sequence of weaving. In case of double *Ikat*, not only are the warp and weft threads individually positioned but the relative position of each is also accurately ensured to give the final design. In these textiles, the forms are deliberately feathered so that their edges appear hazy and fragile by the use of very fine count yarn, tied-and-dyed in very small sets. Increasing the number of colours for bringing out the figures increases the number of tying-and-dyeing operations.

1-http://textilescommittee.nic.in/pochampally-GI.pdf

5.1 Process description

A single yarn is made from a group of filament or staple fibres twisted together. About 15 different types of fibres are used to make yarn. The process of making this craft starts with removing fats and oils (gums) from the yarn which is called yarn degumming. The artisans of Pochampally follow the water degumming process in which a water bath is heated to a temperature of about 70-90°C by burning fire-wood, and subsequently the yarns are dipped and washed in the bath with the help of a bamboo. After degumming, the yarn is hung on a bamboo pole for complete drying under a shelter as sun-drying can affect the colour of the yarn. The skein of the yarn is then tightly fixed in a wooden wheel from which it is wound on to a piece of PVC pipe which is attached to a rim. Thus by rotating the rim with a hand pedal, the yarns are wound from the skein of yarn.



5.1 Process flow-chart

From the winding ball, the yarns are then horizontally coiled into a bunch of yarns called weft preparation. On the weft threads, design is marked with pen or pencil and after marking, wefts threads are tied with the help of threads in the marked portions. Rubber tubes of bicycle are also used for tying which are wrapped onto the portion of weft threads where dyeing is not required. The weft threads are then dipped in the dye bath where Naphthol or Vat dyeing is done, according to the requirement of yarn that is to be dyed. The number of tying-and-dyeing operations increases with the number of colours to be used for a particular design. After tying-and-dyeing, the wax is removed by boiling and this gives a multi-coloured and motif piece of art fabric. Then the rubbers are removed from the wefts, the threads are straightened, and the process is repeated with a different colour of dye.

The yarns are then wound on a bobbin by using the spinning wheel. Simultaneously, warp preparation is carried out where the yarn is transferred from single packages to an even sheet representing hundreds of ends and then wound onto a warp beam. Finally weaving is done with the help of a loom. This process requires the setting up of the loom and installation of the warp on the loom. The warp is passed through the heddle, separated into two sets of warp, and the weft is then passed manually through these sets with the use of a shuttle. As a result, a final woven piece of fabric is produced. This could be used as a ready-made garment or a final print raw material that may be used by tailors to make customized products.

6 - Description of Hazards

The workplace hazards (both for Block printing and *Ikat*) as observed and analysed during the course of the study are as follows:

6.1 Chemical Hazards

Human beings live in a physico-chemical environment. They have also developed complex chemical processes over millions of years which enable them to exploit this environment. Chemicals are not hazardous by themselves but become hazardous when they are in the wrong place in the wrong amount or when they are produced synthetically and humans have never encountered them before. Chemical hazards are present when a worker is exposed to any chemical preparation in the workplace in any form (solid, liquid or gas) above a particular concentration. Some are safer than others, but to some workers who are more sensitive to chemicals, even commonly used concentrations can cause illness, skin irritation, or breathing problems.

Chemical hazards basically fall into five main categories[1]:

- **Chemicals are poisonous or toxic:** This means that chemicals are absorbed by the body through skin, gut or lungs and they exert a short term effect (such as unconsciousness) or a long term effect (such as liver disease or cancer after 20 years). The study of toxic effects and how the body reacts to different chemicals is called Toxicology.
- **Chemicals are corrosive:** Some of the chemicals may corrode the skin or lungs. Burns are usually caused by acids such as sulphuric acid or by caustic soda and this burning sensation can be correlated with the burning of fire. Contact of the eye with such corrosive liquids can cause blindness for lifetime.
- **Chemicals are irritants:** There are hundreds of chemicals used in industry which irritate the skin and lungs, causing dermatitis (inflammation of the skin) and bronchitis (inflammation of the respiratory tract).
- **Chemicals are sensitizers:** Chemicals can exert long-term skin effects (contact dermatitis) and lung effects (asthma) by a process of sensitisation. Sensitisation is an allergic reaction of the body to the chemicals.
- **Chemicals are explosive or flammable:** Some of the chemicals like petroleum can cause major explosions. Other chemicals can burn, causing devastation with their flames and heat or, more indirectly, through the toxic fumes they emit when on fire.

6.1.1 Route of entry into the Body

In order to cause damage, toxic materials must first enter the body. Entry occurs primarily in three ways: ingestion, absorption and inhalation.

1-Mathews John "Health and Safety at Work", Australian Trade Union Safety Representative Handbook, Pluto Press Australia Limited, 1985, Chapter 9

Ingestion	Absorption	Inhalation
– Eating, smoking or drinking while working – Touching soiled hands to the mouth – Biting nails – Accidental swallowing – Dusts trapped by mucous and transported back to the throat from where they enter the stomach	– Skin has a barrier of wax, oils and dead cells on the surface which are destroyed by the chemicals to pave their entry – Cuts, abrasions, burns, rashes, etc. on the skin allow chemicals to penetrate into the blood and be transported throughout the body – Eyes may also absorb chemical substances, either from splashes or from vapours	– Breathing leads to the entry of the chemical through the nose and sinuses to the lungs – Some are absorbed by lungs and then transported via blood to other organs – Other substances are deeply inhaled and remain in the lungs for a lifetime which finally leads to chronic diseases

Table 1: Route of entry in human body

6.1.2 Chemical Hazards in Block Printing

In earlier times, vegetables dyes were used for block printing processes. But now-a-days, different chemical dyes and pigments are in use. Several factors are accountable for the replacement of vegetable dyes with chemicals, such as:

- Cost of the chemicals is low in comparison to vegetable dyes.
- More time is required to extract the dyes from nature whereas chemicals are easily accessible.
- Durability of the finished products of chemical dyes is better than the vegetable dyes.
- Moreover, the cost of the products is more in case of vegetable dyes and hence the markets automatically tend towards the low-cost products which are, of course, made of chemical dyes.

Picture 1- Chemical Dyes

In the study area Bagru, most of the artisans still prefer to use vegetable dyes although they are being impacted adversely by the market demand. Hence, the artisans are forced to leave the traditional craft and shift to daily wage work either under a contractor or in other printing units.

Some of the artisans are also given the impression that due to the minimal use of chemicals in the small units as compared to the amounts being used in the large scale industries, their effects should also be negligible – and this is a matter of concern from the perspective of ignorance of long-term effects (chronic problems).

New chemicals are being introduced into the workplace at an increasing pace while vast numbers of chemicals are already in use posing significant long term threats. Chemical hazards are omnipresent. The working spaces in the block printing units are confined and gases and vapours can steadily build up to cause severe health hazards. Fumes from acids can cause blindness with terrifying burns; flammable liquids can leak in undetected areas and catch fire or explode. Sometimes chemicals can be used and handled for years without any obvious problem and suddenly the workers are seized by cancer or chronic liver or kidney diseases.

No.	Name	Hazard Identification
1.	Sulphuric acid[2]	– Very hazardous, corrosive, irritant and penetrative in nature. – In case of skin contact, it causes skin inflammation characterised by itching, burning, scaling, reddening and blistering. – Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract characterised by coughing, choking and shortness of breath. – It is carcinogenic and toxic to kidneys, lungs, heart, eyes, teeth, cardiovascular system and upper respiratory tract. – Severe over-exposure can result in death.
2.	Alizarin[3]	– Very hazardous in case of ingestion. – Causes eye and skin irritation. – Inhalation of dust may cause respiratory tract irritation. – It is toxic to lungs and mucous membranes. – Repeated or prolonged exposure to the substance can produce damage in target organs.
3.	Lime[4]	– Severe irritation of mucous and skin, removes natural skin oils. – Severe irritation, intense watering, possible lesions in eyes if exposed for prolonged periods. – Irritation in respiratory tract, cough and sneezing, if inhaled in the form of dust. Excessive inhalation leads to silicosis, pneumoconiosis and pulmonary fibrosis. – If ingested, it causes pain, vomiting blood, diarrhoea and drop in blood pressure. – Repeated and prolonged contact causes redness, peeling of the skin, and fissures.
4.	Adhesive[5]	– Long exposure may cause skin irritation. – Breathing high concentration of vapour may have effect on central nervous system with vomiting, headache and dizziness. – Long and frequent exposure may cause anaemia, hepatic disorders and effects on nervous system. – May be harmful if swallowed. Vapour may be irritating to eyes and respiratory system.

Table 2: Chemicals used in Block Printing process with their Hazard Identification

2-http://cartwright.chem.ox.ac.uk/hsci/chemicals/sulfuric_acid.html
3-http://www.sciencelab.com/msds.php?msdsId=9922824
4-http://www.lhoist.us/pdf/Lime-SparBlend042908.pdf
5-http://www.c-sgroup.com/files/tech-center/acrovyn/msds/pdf/ex-85m003002_10.pdf

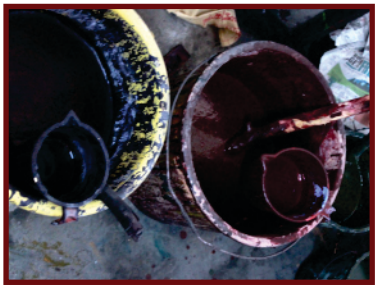
5.	Alum[6]	– May cause irritation to eyes, skin and mucous membranes. – Ingestion may cause gastric problems, irritation, and vomiting. – Astringent property may cause tightening of the skin.
6.	Dyestuff[7]	– Causes skin irritation, skin rash, scaling and bleeding, often on the hands and forearms. – Itchy or stinging noses; sneezing and blocked nose; and sore and watery eyes.
7.	Caustic soda[8]	– Eye contact can cause severe damage including burns and blindness. – Exposure to vapour, mist or liquid can produce burns of the respiratory tract and severe lung damage. – Contact with skin may cause burns and tissue destruction. Prolonged or repeated contact causes high degree of tissue destruction. – Ingestion causes severe burns and complete tissue perforation of mucous membranes of mouth, throat, and stomach.
8.	Hydrogen peroxide[9]	– Very hazardous in case of skin and eye contact – Exposure may damage mucous membranes of eyes, mouth, and respiratory tract – Prolonged exposure causes skin burns and ulcerations

Table 2: Chemicals used in Block Printing process with their Hazard Identification (contd.)

6.1.3 Issues of concern in Block Printing

- **Washing:** Washing is one of the important procedures in both block printing and screen printing processes. Washing is done twice in this process: first, the fabric is washed for the removal of starch; and the second washing is done after printing for the removal of excess colour. The washing method is very tedious and takes more time than printing. Artisans have to wash the cloth 2-3 times for both removal of starch and excess colour. The removal of excess colour is a matter of concern from the point of health hazards of artisans as they have to immerse half of their body in a water tank and beat the cloth several times and the same procedure is followed in 3-4 tanks for complete removal of excess colour. The chemicals bleached during the process of washing can create toxicity for artisans who have been engaged in the same work pattern for number of years and among most of the artisans, colourisation and pigmentation in different parts of the body is a common problem in the study area. The removal of excess colour is an issue of concern both from the point of health hazards of artisans as well as the discharge of wash water into the environment, and may be addressed by reducing excess application of colour, reducing water requirement, and redesigning the washing tank.

Picture 2: Washing of fabric after printing



Picture 3: Mixing of chemical dyes

6-http://www.jmloveridge.com/cosh/Alum%20%28Potash%29.pdf
7-http://www.atul.co.in/colors/msds/sulphurdyes.pdf
8-http://www.mvc.com.ph/pdf/MSDS-NaOH.pdf
9-http://www.sciencelab.com/msds.php?msdsId=9924299

- **Mixing of chemicals and dyes:** In the block printing process, it is seen that artisans mix the chemicals in a small bucket with the help of a wooden stick. Fumes will always be produced when two different chemicals are mixed irrespective of their quantities and when it is done in close proximity; health of the artisans is definitely affected. However, the pattern of toxicity is dependent on the amount of chemicals and acids used for mixing and the work environment. If high amount of chemicals are mixed in a closed environment then automatically the artisans will suffer from asphyxiation. On the other hand, if the amount of chemicals used is less, then the vapour or fumes will rise less and remain undetected, but if the worker follows the same procedure in close proximity for longer period of time then automatically the worker will be seized with chronic toxicity through inhalation and diseases like cancer may appear. In either case, inadequate ventilation is a matter of concern for block printing units. The vapours could be mitigated by better mixing equipment and proper ventilation. Storage and clear labelling of hazardous chemicals along with regular health checks of the workers will help to control releases beyond the exposure limits.

- **Printing:** In the block printing process, a wet cloth is carried in a tray in which one side of the wooden block is dipped and it is placed on the fabric and hit by the other hand for printing and this process continues for the whole day. After an interval, the cloth is wetted again by pouring dyes on it. The tray is placed on a movable table at a height equivalent to height of the table on which the fabric is kept for printing. Thus, a continuous odour can be smelt during printing which is undesirable for the artisans in a closed room. The printing process is mostly done in the summer for better fixing of the dyes onto the cloth but, according to the artisans, they cannot use the fan as the dyes get dried quickly due to air circulation. Moreover, there is no exhaust system for proper ventilation in the studied areas. Poor lighting adds to eye strain for the workers and can be addressed by design of the roof for better natural illumination. Back pain from repetitive work can be reduced through regular rest breaks and more ergonomic table design; and injuries to the hand, fingers, arms, wrists may be prevented by adoption of protective gear.

Picture 4: Block printing

Thus, there are significant hazards that can be predicted from the use of chemicals in a closed environment which can also create chronic toxicity for the artisans.

6.1.4 Chemical Hazards in *Ikat* Weaving

No.	Chemical and Dust	Hazard Identification
1	Cotton dust[10]	– The first symptoms are difficulty in breathing or perhaps tightness across the chest. – Prolonged exposure causes chronic obstructive lung diseases like bronchitis, asthma, emphysema, and byssinosis.
2	Naphthol dye[11]	– Causes irritation to eyes and respiratory system. – Skin problems like contact dermatitis. – Evidence of causing cancer.
3	Acetic acid[12]	– Exposure to vapour irritates the membranes of nose, throat, lungs, and eyes. – Severe irritation in respiratory tract leads to coughing, choking, or shortness of breath. – Liquid or vapour may cause severe eye damage, irritation, burning, and watering of the eyes. – Skin contact may produce burns, itching, scaling, reddening, and occasionally blistering. – Repeated or prolonged contact with spray mist may produce chronic eye irritation, severe skin irritation and respiratory tract irritation leading to frequent attacks of bronchial infection.
4	Hydrochloric acid[13]	– Can cause tissue damage by liquid or spray mist. – Skin contact may produce burns, itching, scaling, reddening, and blistering. – Inhalation of the spray mist may produce severe irritation of respiratory tract, characterised by coughing, choking, shortness of breath, and swelling in the lungs. – Inflammation of the eye is characterised by redness, watering, and itching. – Repeated or prolonged exposure to dilute solutions may result in skin disease and discolouration of the teeth. – Severe over-exposure can result in death.
5	Hydrogen peroxide[14]	– Skin contact causes irritation, blister, and whitening of skin. – Inhaling mist or vapour irritates the mucous membrane of the respiratory system. – Ingestion causes internal damage, gastric distension, nausea, vomiting, and internal bleeding. – Eye contact may cause eye irritation, burning sensation or watering, even blindness.

Table 3: Materials in *Ikat* Weaving Process with their Hazard Identification (cont.)

10-http://www.garryson.com/Library/MSDS_AbrasiveCottonFibreProducts.pdf, http://www.cdc.gov/niosh/75-118.html
11-http://www.pburch.net/dyeing/naphtholdyes.shtml
12-http://www.sciencelab.com/msds.php?msdsId=9922769
13-http://www.ee.iitb.ac.in/~nanoe/msds/Hydrochloric_acid-9924285.pdf,
http://www.sciencelab.com/msds.php?msdsId=9924285
14-http://www.sciencelab.com/msds.php?msdsId=9924299

6	Wetting agents[15]	– Inhaling mist causes irritation in the respiratory tract. Over-exposure may lead to coughing, shortness of breath, dizziness, and intoxication. – Ingestion leads to moderate irritation in mouth, throat, gullet, and stomach; nausea, vomiting, and diarrhoea. – Skin contact causes redness, itching, and pain. – Eye contact leads to discomfort and irritation. – Repeated or prolonged contact leads to progressive skin disease, aggravates asthma, and liver and kidney damage.

Table 3: Materials in *Ikat* Weaving Process with their Hazard Identification (cont.)

6.1.5 Issues of concern in *Ikat* weaving

- **Colour preparation:** In Pochampally, chemicals are used in the process of *Ikat* weaving. Once the design is prepared, artisans use different colours according to the design pattern. The colours are prepared in a small pan by mixing different chemicals. For cotton cloth; naphthol base, caustic soda, alum, hydrochloric acid, and sodium nitrate are used which is known as *Naphthol Dyeing*. Whereas for silk cloth, a mixture of synthetic powder, soda-ash, acetic acid, and water is used, known as *Vat Dyeing*. While mixing different chemicals for dye preparation, artisans use their hands without any protection, in close proximity but in open area. Though the amount of chemicals used is low and it is done in an open area, the particular artisan in the same activity for a longer duration may be seized with chronic toxicity. Mitigation is possible through design of better mixing equipment and substituting the hazardous chemicals. Storage and labelling of hazardous chemicals, along with regular health checks, help to keep damage under control.

Picture 5: Mixing of dyeing powder

- **Dyeing:** In most of the places in Pochampally, single artisans use a small pan for dyeing but if a bunch of yarn is to be prepared, 2-3 artisans are required for the dyeing purpose. A big tub containing dyes is used and the bunch of yarn is dipped in it several times. Though the gases and fumes cannot be observed visually in the dyeing process but the stringent odour in the surrounding environment indicates the possible release of fine particles from dyes into the air which is obviously harmful for the artisans through inhalation as they work in close proximity. Moreover, artisans engaged in the dyeing process have reported having coloured nails, hands, and feet causing skin irritation. Though the symptoms from the exposure have been observed, most of the artisans have a notion that the traditional ways of craft processing are not at all harmful to their health and also the use of protective gear creates obstruction in their work and may slow down their efficiency. The stringent odour in the atmosphere indicates vapours from the dyes that are harmful for the artisans, and improvement would require the use of natural vegetable dyes and provision of better ventilation. Health checks of workers also act as early warning indicators of higher emissions.

Picture 6: Dyeing

15-http://www.ofite.com/msds/280-00.pdf

- **Colour boiling:** After tying-and-dyeing, the wax is removed by boiling and this gives a multi-coloured and motif piece of art fabric. During this process, hot vapours are released and it may also cause respiratory problems in the long run with longer working hours. Though the process is carried out in open area yet production of vapour from the dyeing products and proximity to the artisans is sufficient for causing damage in the respiration system over longer periods. Forced ventilation would significantly reduce exposure. The impact of heat from the vat can be reduced by better insulation and shorter exposures.

Picture 7: Removal of wax

- **Tie-and-Dye:** According to the design, the portion of fabric which is not required for dyeing is tightly tied so that the portion remains uncolured. For tying purpose, artisans mainly use strips of old bicycle tubes as it gives proper firmness and does not affect the fabric. After dyeing in boiled colouring solution and drying the untied portion of the fabric, the strips are removed. Artisans have been following this process from ancestral times. The main concern arises from the leaching of rubber strips as they are of synthetic rubber which contains toxic chemicals such as butadiene and styrene. Because of the continous use of old strips of rubber, these toxic chemicals will undeniably enter into the food chain and there is possibility of biomagnification. This may be avoided by using substitutes for the rubber. Injuries to the back, ankles, and fingers may be prevented by the use of appropriate protective gear.

Picture 8: Rubber tying

- **Weaving:** After tie-and-dye, the most important part for *Ikat* printing is weaving. In general, for completion of a *saree*, weaving is done for 4-5 days at a pace of 6-8 hours daily. The *Ikat* fabric is either made of cotton or silk. The release of fine particles from cotton is greater as compared to silk and most of the artisans have reported having breathing problems. Hence, they might be affected by byssinosis, a lung disease caused by cotton dust due to long term exposure among the artisans. The release of fine particles from cotton is greater as compared to silk and the lungs of the artisans are significantly affected, as is their body because of bad work postures. Hence, development of the loom around better ergonomic design can provide better safety.

Picture 9: Weaving loom

6.2 Physical Hazards

The hazards that can occur due to unsafe conditions in any workplace are termed as Physical Hazards. The main factors for the unsafe conditions are lack of knowledge (not always recognised as a hazard), neglecting any improvement due to high costs, or simply delay in making the required changes. Some examples are[1]:

Noise: Noise may be defined as unwanted sound. Sound is an energy which is propagated through a medium (air, water) as a succession of small and rapid variations in pressure.

1-Mathews John "Health and Safety at Work", Australian Trade Union Safety Representative Handbook, Pluto Press Australia Limited, 1985, Chapter 6&7

The quality of sound is dependent on two characteristics of these fluctuations. One is their frequency and other is their intensity. Frequency refers to the number of times these fluctuations occur in a given time period and it is usually given as cycles per second which is called as Hertz (Hz). The human ear can respond to frequencies in the range of 20 to 20,000 Hz. Intensity refers to the size of the pressure fluctuations reaching the ear and is measured by the energy content of the noise. Technically, it is the energy input per unit area and per unit time, measured in terms of watts per square meter.

Health effects: The health effects of noise are a multitude of bodily and mental reactions. Continuous low level noise results in a general stress reaction which has ramifications including heart disease, cancer, and birth defects. A noisy environment also reduces concentration thus raising the risk of accidents.

- Exposure to excessive noise for a short period of time can cause temporary hearing loss.
- Over a longer time period of exposure to noise of high intensity, permanent noise-induced hearing loss or deafness can be caused.
- Noise not only damages hearing sensitivity but can also give rise to tinnitus, a disturbing ringing sound in the ear. This usually persists and is especially worrisome at night when it can prevent an individual from going to sleep.
- Very loud noise from explosions can cause special form of damage termed as acoustic trauma.

Vibration: Vibration is the rapid to and fro movement of an object. The damage that vibration may do to the human body depends on three main factors. These are:

- The length of time for which a worker is exposed (i.e. exposure duration) – the longer the duration of exposure, more is the damage done.
- The rate at which the surface vibrates is called frequency and it is measured in vibrations per second or Hertz (Hz). The human body is affected differently by various frequencies. In industry, frequencies from 1 Hz to 5,000 or 10,000 Hz are common.
- The amplitude of the vibration. The vibrations of an object can be measured in terms of displacement, velocity, and acceleration, each of which is simply related to the other.

Noise is a special form of vibration hazard where the vibration (and hence the energy) is transmitted through air (and other media) and sensed by the ear.

Health effects: It is convenient to split the effects of vibration on the human body into two areas which can also overlap:

- **Whole body vibration:** This occurs when a worker's whole body is shaken up and down (vertically), side to side (transversely) or front to back (horizontally). This type of vibration occurs near moving machinery.
- **Hand-arm vibration:** This occurs, as the name suggests, to the hands and arms, when using equipment or tools that vibrate.

Heat: An excess or deficit of heat is termed as thermal stress. Environmental factors that determine the level of heat stress include:

- Air temperature
- Relative humidity
- Air movement
- Radiant temperature of the surroundings

Health effects: Working with heat induces heat stress when more heat is being absorbed into the body than can be dissipated. The short term effects of heat stress are:

- Reduces concentration and thus promotes accidents
- Aggravates effects of other workplace hazards
- Induces heat illness

The long-term effects of heat stress include:

- Heat rash (prickly heat)
- Chronic heat exhaustion
- Birth deformities and other reproductive problems

Light: Light occurs in many forms from very short waves of ultraviolet light, through visible light, to infrared or heat radiation.

Region	Wavelength Range nanometres (nm)	Effects
Ultraviolet (UV)	100 to 380-400	Severe eye damage, cancer
Visible (light)	380-400 to 760-780	Eye strain, if either too much or too little light is present during work
Infrared (IR)	760-780 to 1,000,000	Burns the skin and forms cataracts in the eyes from the heat produced in the body

Table 4: Regions of the optical radiation spectrum

Natural light from the sun contains a wide spectrum of visible, ultraviolet, and infrared rays. Artificial light contains a more limited array of light waves. It is well known that ultraviolet rays from the sun can damage the skin and eyes, and even cause skin cancer.

Artificial light also contains a wide spectrum of light. Incandescent bulbs, computer monitors, and most of the small bulb-sized fluorescent lights usually do not produce ultraviolet light in amounts sufficient to be resulting in any risk. *Large fluorescent lights, halide and mercury vapour lights, however, can produce ultraviolet radiation sufficient to be harmful.* Fixtures containing these types of bulbs should have glass or plastic radiation shields.

The manufacturer's directions should be followed for the specific types of bulbs being used. Eye strain can be caused if the work area has either too much or too little light or if the lighting produces a glare on the object being crafted. This eye strain can lead to fatigue and accidents. The best workplace lighting usually is diffuse overhead lighting for general illumination combined with a smaller direct light on the task at hand. Light from computer monitors is associated with eye strain. Crafters who also use computers for long hours should get regular eye examinations and take frequent work breaks.

Two common sources of Ultraviolet (UV) Radiation are sunlight and welding. Skin cancer can occur in welders and people exposed to too much sunlight. Ultraviolet light from welding is also known to cause eye damage, even leading to blindness. Simply walking past someone who is doing arc welding can result in a painful flash burn which feels as if sand has been put in the eye. It may take several days for a flash burn to heal. In rare cases, permanent damage has been caused by flash burns. The precise type of shade or lens must be chosen for each type of welding.

6.2.1 Issues of concern in Block Printing

- **Noise:** Starch removal process is very tedious; and in various units of block printing, machinery is in use. This technique requires less time and less manpower for the process of starch removal and subsequently increases the efficiency but the main negative aspect is the generation of high noise. This is generally due to the improper maintenance of the machinery that can cause health effects, mainly leading to hearing problems in the artisans working with it.

Picture 10: Wax removal

- **Height:** After printing and washing, the fabric is sun-dried and for this purpose the artisans manually make bamboo roofs (as shown in the picture). The height of the roof varies from 15 to 20 feet and artisans have to climb up repeatedly for hanging the material on it. On doing so, the probability of falling from the roof is high, causing possible accidental damage to the artisans.

Picture 11: Working at a height

- **Light:** Improper light is one of the major problems in most of the units. The block printers have to focus constantly on the fabric for proper printing. Though in some of the units, provision of proper artificial light is seen but in some of the homes in Bagru, the artisans have to work in natural light due to inadequate supply of electricity. Hence, artisans undergo more strain on their eyes and problems like watering, burning sensation, etc. are commonly reported.

Picture 12: Poor lighting

- **Improper ventilation:** Improper ventilation is seen in most of the block printing units where a number of chemicals are used. Powders of different chemicals are mixed with different solvents for the preparation of different colours and dyes before the printing. During the study, it was observed that the mixing of chemicals is done in a closed room without any precautions. The artisans cannot use fans as the dyes dry rapidly due to air circulation and hence, these might cause a severe problem to the health of the artisans in the longer duration.

6.2.2 Issues of Concern in *Ikat* Weaving

- **Heat:** In the process of degumming, artisans boil the fabric at a very high temperature for the removal of starch and grease. In doing so, artisans have to whisk and stir the fabric continuously and it takes about 1-2 hours for completion. From the study done in Pochampally, it has been seen that most of the artisans preferred to be engaged with tie-and-dye and weaving, and the degumming process is usually outsourced to other artisans who are specially engaged in this process. Hence, artisans employed with the degumming process have to do so in bulk for the whole day and, while doing it, they are exposed to high temperatures. Moreover, in large scale production units, heat becomes a matter of greater concern.

Picture 13: High temperatures

- **Light:** There are three major work processes in *Ikat* weaving which require proper light facility, that is in marking, tying, and weaving. These processes require more time and attention, mainly in terms of detailing, but because of inadequate power supply and poor lighting, artisans suffer from many eye problems regardless of their span of work.

6.3 Ergonomic Hazards

Any physical factor within the workplace that harms the musculo-skeletal system (muscles, joints, bones, and related structure) of workers is termed as ergonomic hazards. They are hardest to spot since the strain on the body or the harm these hazards pose is not immediately noticed. Short-term exposure may result in "sore muscles" the next day or in the days following exposure, but long term exposure can result in serious long-term injuries. Ergonomic hazards impact employers, workers, and their families. Poor workplace design, awkward body mechanics or postures, repetitive movements and other ergonomic hazards induce or contribute to a staggering number of cumulative trauma disorders (CTD) that affect hands, wrists, elbows, arms, shoulders, the lower back, and the cervical spine area. Structures involved include tendons, muscles, bones, nerves, and blood vessels.

Picture 14: Strain on shoulder

One can plan strategies for abatement by learning to recognise the hazards that contribute to CTD. OSHA (Occupational Safety and Health Administration) in the USA has published the Economic Program Management Guidelines that are of significant value. According to the guidelines, a complete ergonomic assessment has to be developed, followed by a well written ergonomic plan. Ergonomic abatement will decrease the costs associated with CTD and ultimately impact the economic "bottom line".

In general the ergonomic hazards depend on[1]:

- Tools and equipments
- Work Stations
- The work-process
- The workplace as a whole

Ergonomic hazards include[1]:

- Improperly adjusted workstations and chairs
- Frequent lifting
- Poor posture
- Awkward movements, especially if they are repetitive
- Repeating the same movements over and over
- Having to use too much force, especially if it has to be done frequently

6.3.1 Issues of Concern for Block and Screen Printing

- **Shoulder (highly repetitive):** The processes involve working with the hand above the head or the elbow above the shoulder. The practice is seen among the screen and block printing artisans when they lift the screen and for hanging the cloth for drying. These are repetitive processes that cause shoulder pain among the artisans.

- **Back (highly repetitive):** The work involves working with the back bent forward at an angle of more than 30° (without support or the ability to vary posture). According to the breadth of the fabric, artisans for block printing have to bend forward frequently for printing. Moreover, as most of the artisans are on contractual basis, their daily wages are dependent on the metres of cloth printed by them. Hence, they work as much as they can print and it varies from 6 -9 hours daily.

Picture 15: Strain on back

- **Fingers, arms, wrists (highly repetitive):** The pinching of the wooden block with two fingers (thumb and index finger) and other fingers for proper adjustment of the block is in practice for block printing process. According to the design of the print, the shape and size of the blocks change. Weight of the block varies from 200-1000grams. Thus, this repetitive pinching and printing work causes harmful effects on the body of artisans and they suffer from pain in arms, wrists and hands.

Picture 16: Strain on fingers

- **Whole body (high body force):** Work that requires more force leads to whole body ache to the artisans. Artisans have to carry the fabric from place to place, like from printing place to washing tanks, washing tanks to drying yard, and drying yard to ironing machine.

1-http://employment.alberta.ca/documents/WHS/WHS-PUB-BCL002.pdf

They generally pull a trolley for transporting the fabrics from place to place. Along with exerting force for loading and un-loading, an artisan has to exert great force for pulling the trolley. There are other factors like uneven pathways which makes them more vulnerable to the problems.

Picture 17: Strain on the whole body

- **Hand (highly repetitive):** Along with the frequent lifting of the block, the artisans have to press the block on the fabric for printing the design. While one hand is used for placing the block in an appropriate position, the other hand is used for hitting the block for pressing the design in the fabric. Consequently, the risk factor is greater for artisans who do this repetitive work – corn is a common problem on the palm of the artisans which is caused due to the hitting procedure on the block.

Picture 18: Strain on fingers

6.3.2 Issues of Concern in *Ikat* Weaving

- **In tie-and-dye:** At each step of tie-and-dye, there is the possibility of different ergonomic problems due to difficult postures and prolonged working hours. In various processes like design marking, design tying, rubber tying, yarn winding, bobbin winding, and weft preparation, artisans have to sit on the ground without any back support for long duration and hence, back and knee are two main parts of the body which suffer the maximum pain. Sometimes it leads to muscle spasm as has been reported by the artisans. Likewise, artisans have to bend their neck also for the same duration as compared to back and knee. The hands, on the other hand, are engaged with repetitive work which also leads to fatigue in the muscles. Moreover, while working on the floor, artisans crawl from one end of the yarn to the other, leading to cracks in the feet and callus in the ankles.

Picture 19: Prolonged Sitting

- **Weaving:** There are two types of loom used for weaving purposes in Pochampally: pit loom and free loom. Pit loom is one of the traditional ways of weaving in Pochampally and weavers associated with it have reported back ache problems. Routine work for more than 6 hours daily in weaving leads to fatigue in different muscles of the body.

Picture 20: Prolonged Sitting

- Sitting posture, bending their back leads to back pain.
- Continuous and rigorous movements of arms in up and down directions during shuttle movements in weaving result in severe pain in forearms and elbows.

- For smoother movements of the pedals to push the heddle frame in up and down direction, weavers generally sit in such a way that maximum pressure (weight) of the body is exerted on the waist and abdomen and sometimes it causes abdomen and knee fatigue.
- Furthermore, frequent movement towards left and right for adjustment of the heddle frame causes ache in the shoulder.

6.4 Other Health Problems

There are also other health effects with relation to the occupation in the craft sectors. Other than chemical, physical, and ergonomic hazards, the craftspersons are exposed to many problems, only some of which are immediately visible.

- **Cuts and Wounds:** This type of hazard is more significant with the tie-and-dye workers (*Ikat*), where the weavers have to tie the bundle of yarn prior to dyeing. The continuous friction with the thread and rubber while securely tying results in cuts in the fingers. Manual tightening gives proper firmness and there is no real alternative for the tying process. Furthermore, the craftperson also find no suitable remedial measures as gloves and other protection hinder their efficiency and the same traditional methods are followed without any prevention or protection in their activities.

Picture 21: Cuts on Fingers

- **Effects due to Habits:** In textile craft, the artisans have to handle many chemicals and are exposed to many types of vapours and fumes. Besides this, the habits of artisans increase the probability of adverse health impacts upon them. In both the study areas, artisans are addicted either to smoking or drinking and the prolonged nature and fatigue of the work pattern is one of main causes of this addiction.

Picture 22: Habits: Bidi butts

7 - Summary findings

The environmental and occupational hazards were identified during the course of the study and specific recommendations were made to mitigate the same as well as take various safety precautions required by usage as well as law.

Issues in Block Printing

- **Washing:** The removal of excess colour is an issue of concern both from the point of health hazards of artisans as well as the discharge of wash water into the environment, and may be addressed by reducing excess application of colour, reducing water requirement, and redesigning the washing tank. The noise of the motor can be kept below the limits through better maintenance.
- **Mixing of chemicals and dyes:** The mixing of chemicals often produces vapours that affect the health of the artisans over long periods of time and could be mitigated by use of non-toxic materials, better mixing equipment, and proper ventilation. Storage and clear labelling of hazardous chemicals along with regular health checks of the workers will help to control releases beyond the exposure limits.
- **Printing:** The printing process requires higher temperatures for better fixing of the dyes onto the cloth but the artisans cannot use fans as air circulation dries the dyes faster than required. An exhaust system for proper ventilation could remedy this hazard. Poor lighting adds to eye strain for the workers and can be addressed by design of the roof for better natural illumination. Back pain from repetitive work can be reduced through regular rest breaks and more ergonomic table design; and injuries to the hand, fingers, arms, wrists may be prevented by adoption of protective gear.

Ikat weaving

- **Colour preparation:** Several toxic chemicals are used for Naphthol dyeing of cotton cloth, and Vat dyeing of silk cloth, and these affect workers, particularly during the mixing process. Mitigation is possible through design of better mixing equipment and substituting the hazardous chemicals. Storage and labelling of hazardous chemicals, along with regular health checks, help to keep damage under control.
- **Dyeing:** The stringent odour in the atmosphere indicates vapours from the dyes that are harmful for the artisans, and improvement would require the use of natural vegetable dyes and provision of better ventilation. Health checks of workers also act as early warning indicators of higher emissions.
- **Colour boiling:** Hot vapours are released in this process that may be responsible for respiratory distress in the long run with longer working hours. Though the process is often carried out in the open yet forced ventilation would significantly reduce exposure. The impact of heat from the vat can be reduced by better insulation and shorter exposures.

- **Tie-and-Dye:** The leaching of toxins from the rubber strips during the boiling process is a strong possibility and may be avoided by using substitutes for the rubber. Injuries to the back, ankles, and fingers may be prevented by the use of appropriate protective gear.
- **Weaving:** The release of fine particles from cotton is greater as compared to silk and the lungs of the artisans are significantly affected, as is their body because of bad work postures. Hence, development of the loom around better ergonomic design can provide better safety.

8 - Safety Laws and Legislation in India

8.1 General guidelines

There are various laws that have been passed with respect to the safety and other provisions for workers in India. The Factory Law is applicable in workplaces that have more than 10 workers with power and more than 20 workers without power in any manufacturing unit. But the artisans of India have never had any statutory health and safety protection. Laws and regulations are all means of control, that is, they are regulatory or statutory instruments that provide a set of limits or minimum standards of protection for workers' health and safety. With respect to the safety of artisans, the legislations should be broad and enabling in character. In other words, it should not be specific to a certain category; rather it should lay down the duties which can enable specific hazards to be dealt with efficiently.

Regulations, on the other hand, are drawn up under powers conferred by legislation. They are normally more detailed than the legislation and apply to a specific industry or hazard. Legislations and regulations together make up the law which must be complied with. Thus, it becomes a mandatory requirement for the employer to regulate work conditions such that the workers are not subjected to any type of unsafe environment, and breaches can also be prosecuted and penalised if the provisions are inadequate for the safety of the employees.

8.2 Safety laws

There are certain laws that are relevant to the issues of workplace hazards and safety, but the main provisions with respect to health, safety, welfare, etc., that are to be maintained by the contractor or employer or occupier emerge from a thorough understanding of "The Factories Act, 1948". In addition to this, textile manufacturing needs to also comply with all applicable Indian legislations and statutory requirements as listed below for better health and safety management at production units above the stipulated size.

1. Workmen's Compensation Act, 1923
2. Employees' State Insurance Act, 1948
3. Employer's Liability Act, 1938
4. Trade Union Act, 1926
5. Industrial Disputes Act, 1947
6. Contract Labour (Regulation and Abolition) Act, 1970
7. Inter-state Migrant Workmen (Regulation of Employment and Condition of Service) Act, 1979
8. Bonded Labour System (Abolition) Act, 1976
9. Child Labour (Prohibition and Regulation) Act, 1986
10. Children (Pledging of Labour) Act, 1933
11. Minimum Wages Act, 1948

12. Payment of Wages Act, 1936
13. Equal Remuneration Act, 1976
14. Payment of Gratuity Act, 1972
15. Payment of Bonus Act, 1965
16. Employees' Provident Fund and Miscellaneous Provisions Act, 1952
17. Maternity Benefit Act, 1961
18. Public Liability and Insurance Act, 1991

8.2.1 Worker Protection Rules

The worker protection rule that is now part of the regulations in almost every country in the developed world is known as "the right to know" or "hazard communication." These rules give workers the right to know what chemicals are in the products they use on the job, the hazards of those chemicals, and how to protect themselves. The rules usually require employers to provide this information in the form of proper labelling and Material Safety Data Sheets (MSDSs).

8.2.2 MSDSs and Labels

The MSDSs are forms provided by the manufacturers of chemicals and other toxic materials. MSDSs should provide data on a product's hazards and the precautions required for its safe use. Most countries' laws require employers to have MSDSs readily available and to provide each worker with training to enable them to understand the terminology of the MSDSs. Labels must provide safety warnings and advice for users, although the requirements for proper labelling also vary greatly from country to country. And since different languages are spoken in various countries, many manufacturers add symbols on the MSDSs and labels that will identify the product's hazards. One commonly used set of symbols are those of the European Union.

8.2.3 Compliance Today

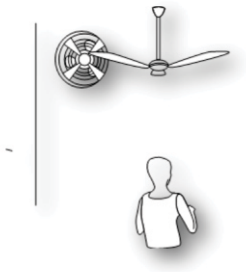
One problem is that many workers do not know their rights and many employers either do not know they are supposed to have MSDSs and train their workers, or they have decided not to comply with these laws. Usually employers are not called to account for breaking these laws until someone is hurt or there is a complaint about conditions. However, complying with these regulations is good for both workers and employers. A knowledgeable worker is one who will follow safety rules because he/she understands the consequences of chemical exposure. It also means, years later, workers will not develop diseases that can be traced back to the hazardous conditions at the work place.

9 - Occupational Hygiene

Occupational hygiene is the discipline that measures and evaluates hazards, and develops procedures for their control.

9.1 Control Measures of Chemical Hazards[1]

- **Through substitution:** It is a concrete step in which toxic chemicals which are more hazardous in nature can be substituted by use of non-toxic chemicals. In textile sector the chemical dyes and pigments can be replaced with natural or vegetable dyes.
- **Through dilution:** In some methods where the use of a toxic chemical is important, (like washing with acid gives more durability to the finished design), the dilution factor can minimize the risk to the workers associated with the use of these chemicals.
- **Through insulation:** Insulation means isolating a substance which is hazardous from the artisans, e.g. mixing of volatile chemicals in an enclosed container.
- **Through ventilation:** Ventilation is a means of removing contaminated air and replacing it with fresh or re-circulated air. It is used to remove dusts, fibres, chemical fumes, and heat. A number of technical issues arise in the design of a ventilation system, like the location and strength of the exhaust system, the extent of contamination, etc. and a competent ventilation engineer or occupational hygienist is needed for this task.



- **Through wet method:** Water sprays are used to suppress dust and fumes produced from the mixing of chemicals. Wet methods are simple and inexpensive, but there are pitfalls that should be considered:

  Contaminated water has to be properly disposed off after use.

  Slippery conditions produced by water sprays must be taken care of.

There are many **general precautions** which should be taken in all craft shops with respect to the storage of chemicals:

- **Store minimum quantities:** Do not stock more than a year's supply of chemicals. Amount of chemicals that can be used up in 3 months are recommended. Do not purchase larger quantity than needed – it will increase the potential hazards, take up valuable space, and could result in a costly disposal problem.
- **Use unbreakable containers:** Such as plastics whenever possible.
- **Do not use hand while mixing of chemicals:** Use of mixing equipment wherever possible.

1-Mathews John "Health and Safety at Work", Australian Trade Union Safety Representative Handbook, Pluto Press Australia Limited, 1985, Chapter 9

- **Chemicals in the storage area:** Store as few chemicals in the work area as possible, and it should be usually one day's supply. Chemicals should be put back into the storeroom at the end of the workday; storage area must be separate from processing / handling area. Store the reactive chemicals separately and check MSDS of each chemical. Keep all the containers closed.

- **Access:** Unauthorised access to the storage area must be prevented.

- **Proper placement:** Containers of chemicals should not be crowded in one place. Access to one container should not require the movement of other containers. Store chemicals below the eye level but racks should be used for storage (avoid storing on the floor) and containers should not be stacked one on top of another.

- **Proper labelling:** Every bottle, box, or gas cylinder and chemical must be properly labelled, with information on its content; all appropriate supplier information, the date received and the expiry date if applicable. Labels should be waterproof, easily legible, and periodically checked to ensure that the labels are not falling off.

Class	Hazards	Colour Code
Class – I	Explosives	Orange
Class – II GASES	Non-flammable, non poisonous, non-corrosive	Green
	Poisonous	White
	Flammable	Red
	Oxidizing	Yellow
Class – III	Flammable liquids	Red
Class – IV	Flammable solids	Red/white
	Spontaneous combustible	Red/white
	Substances that emit flammable gas in contact with water	Blue
Class – V	Oxidizing substances, organic peroxide	Yellow
Class – VI	Poisonous and infectious substance	White
Class – VII	Radioactive materials	Yellow/white
Class – VIII	Corrosive	Black/white

Table 5: Different colour codes used for identification[2]

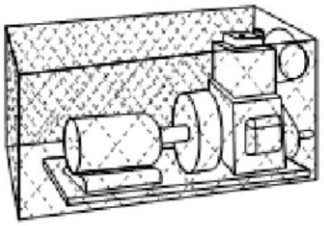
9.2 Control Measures for Physical Hazards

Noise: Noise survey should be done to assess the noise level and focus attention on the areas that are contributing most to the problem. The options available for reducing the noise levels at the worker's ear are threefold:

2-http://www.fsi.illinois.edu/awareness/hazmat/classroom/ch4les10.html

- **Control at source:** Controlling at source means reducing the noise output of the machines and should be the first line of defence.
- **Control of noise path:** Controlling the noise path means placing shields and baffles between the noise source and operator.
- **Enclosure of operator:** Finally, only when all else fails, there is enclosure of the operator, either in a sound-proof booth or with ear protection through ear plugs and ear muffs.

Vibration: Most machines vibrate due to careless or irresponsible design, or to the fact that it is required to run at faster and faster rates. Common sources of vibration are machine tools (e.g. grinding), pumps, generator, forging hammer, and fans. The vibrating machinery can interact with other hazards, producing a compound effect, for e.g., noise and vibration which often go together are worse at damaging hearing than noise on its own. The most common way of reducing vibrations emitted from established machines is to insulate the machine from the surrounding surface. This may be done in several ways:



- By mounting on a heavy base.
- By using insulating mountings.
- By using above and sinking the machine into a pit.

Moreover, a wide range of vibration isolation equipment is available from a number of suppliers.

Heat and cold: The range of thermal control for humans has been found to be 19°C to 30°C. Control of heat and cold should aim to lower and raise working temperature to within this range. Measures that are available include:

- Insulation
- Ventilation
- Isolation
- Shielding the source from the operator
- Job modification and job rotation
- Protective clothing

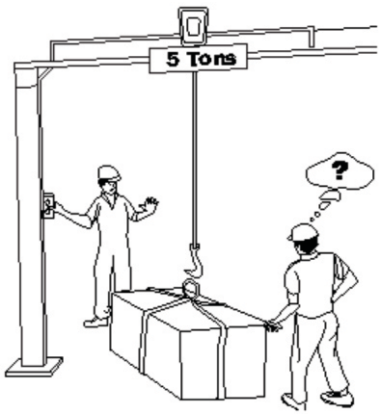
For indoor workers, the most desirable working environment is one which is air conditioned and temperature controlled. In case of unfeasibility of air conditioning, other methods that can be used are:

- Insulation or shielding of sources of heat, e.g. engines, oven, etc.
- Roof and wall insulation of working area to protect from the heat of the sun.
- Insulation or shielding of sources of heat, e.g. engines, oven, etc.

Outdoor control measures for heat and cold are not a matter of concern for artisans who are home-based workers.

Illumination and ventilation: Proper design of the craft shop is required for enhancing the quality of illumination and ventilation for the artisans.

9.3 Control measures for Ergonomic Hazards

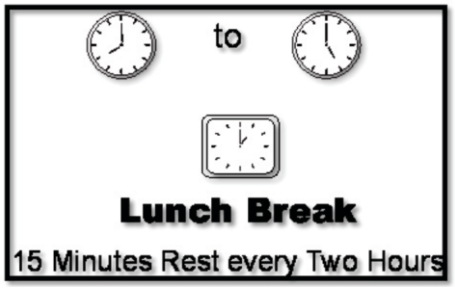


Engineering controls are the most preferred method for controlling ergonomic risk factors because they are more permanent and effective. Engineering controls include modifying, redesigning or replacing of:

- Work stations and work areas
- Materials/objects/containers design and handling
- Hand tools used
- Equipment

Proper investigation and competent personnel from designing / engineering are required for the application of engineering controls. However, for prevention of ergonomic hazards, artisans must pay careful attention to their bodies for signs of fatigue, pain, changes in endurance, weakness, and the like. In other words, listen to your body while it is still whispering rather than waiting until pain shouts for attention. Certain good work habits can help to resolve early symptoms. Some of these are[3]:

- Keep good posture: Appropriate posture is necessary while working for prolonged duration. Proper design can reduce or eliminate awkward posture associated with extended reaches, bending or twisting when handling materials, tools or other objects.
- Take frequent rest and bathroom breaks: Sufficient and frequent breaks in between work should be in practice that can reduce the fatigue. During breaks, movement of muscles in different directions can help artisans to deal with fatigue.



- Job rotation and enlargement: This involves rotating workers through different jobs or enlarging jobs to rest the different muscle groups of the body, reduce repetition, and reduce mental demands.
- Warm up muscles before work; move and stretch muscles during breaks.
- Ease back into heavy work schedules rather than expecting to work at full capacity immediately after holidays or periods away from work.
- Increase the number of employees: This method certainly helps to reduce the exposure limit of posture problems to a specific individual and distribute the work load among others.

3-http://employment.alberta.ca/documents/WHS/WHS-PUB-BCL002.pdf

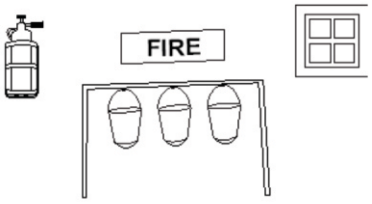
- Training in safe working postures and techniques is important, along with monitoring, to make sure that proper work practices are being followed.

9.4 General Precautions

Housekeeping: Housekeeping means not only cleanliness but also orderly arrangement of operation tools, equipments, storage facilities, and supplies. The term housekeeping signifies "a place for everything and everything in its place".

General provisions that can maintain adequate housekeeping are:

- Daily removal of dirt and refuse
- Keep tools in boxes, racks, or trays when not in use
- Do not let materials such as scrap lumber, metal, and debris accumulate which might cause a tripping hazard
- Weekly washing of floor. Keep the aisle clear for safe passage of people and material
- Sharp objects like nails, pieces of wood with protruding nails, and others should not be left on floors and walkways; store them where they cannot be stepped on



- Effective drainage of floor
- Regular painting of walls, partitions, and ceilings
- Keep exits clear; keep fire extinguishers readily accessible and free of obstruction
- Store flammable and combustible materials in proper containers and in flammable liquid storage cabinets
- Make effective arrangements for treatment of wastes and effluents to render them harmless and for their final disposal

Water Spills and Leaks: Do not allow spills of water or other liquids to remain on floors, making them slippery.

Clean up spills around sinks, dye pots, and potters wheels. When water cannot be removed immediately, special mats or slatted flooring should be installed so that people will not slip. Failure to address water in the workplace can also result in the growth of moulds and bacteria, some of which cause disease. Clean and disinfect areas where mould is seen or bacterial odours are noted. If mould is a regular problem, a dehumidifier can be installed. Mould will not grow and becomes dormant when humidity is low. Even opening windows or turning on ventilation systems can reduce mould growth. If there is severe water damage, such as from a flood or major plumbing leak, discard carpet, wall board, or other porous materials that have been soaking wet for more than 48 hours to prevent mould and bacterial growth.

10 - Personal Hygiene

One of the simplest and most neglected methods of avoiding exposure to toxic substances is to practice good hygiene in the workplace. Studies show that tiny amounts of toxic substances left on the skin, or brought home on clothing can affect even the workers' families. Some basic hygiene rules include the following:

- *Do not eat, drink or smoke* at the workplace, shop floors, or in other environments where there are toxic materials. Dust settles on food, vapours can be absorbed by food, and soiled hands can transfer toxic substances to food and cigarettes. Smoking is especially hazardous because some substances inhaled through a cigarette can be converted by the heat to more hazardous forms.
- *Wear work clothes* and, if possible, change clothes and leave the work clothing in the shop. Wash work clothes frequently and separately from other clothing. If the workplace is dusty, wear some hair covering. And for safety as well as hygiene, tie back long hair, do not wear loose clothing, scarves or ties, or jewellery.
- *Wash hands carefully* after work, before eating, using the bathroom, and applying make-up.

10.1 Protective Clothing and Equipments

For some managers, and even some workers, health and safety begins and ends with use by workers of protective clothing and equipment. But every piece of protective clothing and equipment that workers have to use is a burden which reduces the efficiency of work and production. Hence, use of personal protective equipments (PPEs) should always be seen as a last resort, to be employed only when all other methods have been tried and found not to work. In a properly controlled working environment, a worker should not need any PPE at all.

Table 6 gives a listing of various hazards to different parts of the body and the PPEs required for protecting them. As may be seen, if the worker were to wear all these PPEs, he / she would barely be able to move, far less work!

Organs of human body	Sensitive to	Types of PPEs
Eye	Bright light, particles, dust, fumes	Goggles, spectacles, shields, dust screen, wire mesh, lenses
Ears	Noise and sound	Ear muffs and ear plugs
Face	Particles, chemicals, liquids, fumes, gases etc.	Face shield, helmets
Nose, lungs, respiratory system	Chemical fumes, dust, poisonous gases	Respirators, gas mask, airline helmet, hoods, chemical cartridge, mechanical filter

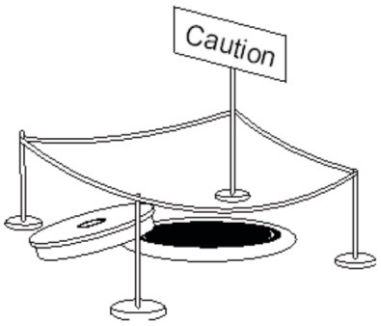
Table 6: The various PPEs[1]

1-http://www.asminternational.org/content/TSS/pics/safety/safety1.pdf, http://www.statonco.com/SafetyManual.pdf, http://agsci.oregonstate.edu/sites/default/files/FST_manual/02-04.pdf

Head, neck and torso	Falling objects, accidental hitting	Head safeguards, hard hats, protective caps
Arms, hands, fingers	Accidental hitting, insertion in moving parts	Finger coats or stalls, gloves, band cuff
Legs and feet	Sensitive to falling objects and chemicals	Shoes, chaps, guards, safety shoes
Body	Electric shock, heat and cold	Aprons and protective costumes
Skin	Heat and cold	Aprons
Safety against fall		Safety belts

Table 6: The various PPEs[1] (contd.)

10.2 Administrative Controls



Hazards can be reduced and controlled, not only by modifying the process (engineering control) or protecting the worker (PPE) but by modifying the job procedures. This again is a way of managing work and it does not involve any expense at all. This can be done by:

- Job rotation (reducing time of operation)
- Limited entry locations (reducing area of exposure)
- Permit to work systems (total procedural control)
- Job exclusion of groups of vulnerable workers

Job rotation: Job rotation is a method of reducing risk by reducing an individual worker's exposure time to hazards.

It is used by agreement, e.g. for stress related work (weaving, washing) and work in noisy areas. Although job rotation practices reduce the exposure level, but there are a number of drawbacks from the workers' point of view, including the following:

- The hazard still exists.
- The time of exposure might still be sufficient to cause damage.
- Job rotation might be used to 'burn out' workers, that is, to expose them to the allowed limit and then move them on.
- The responsibility for control is passed to the workers.
- Control of job rotation can add another element of discipline to work. Therefore, the call for job rotation can only be as a backup to other forms of control.

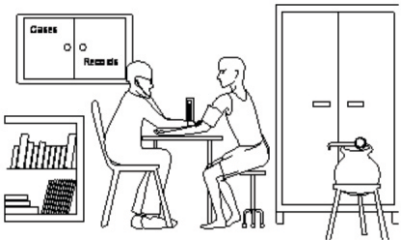
Limited entry areas: This is an alternative to job rotation, in that it does not reduce the time, but the place of workers' exposure to hazards is restricted. Limited entry areas are characterised by signs saying 'danger', 'entry by authorised employees only'.

Permit to work system: A permit to work is essentially a legal document which sets out work to be done, the hazards

involved, and precautions to be taken. It predetermines a safe procedure and is a record that all foreseeable hazards have been considered in advance and precautions taken. It is generally applicable in a large production unit. Some of the areas where permit to work systems might operate include:

- Repair and maintenance of machinery
- Work on high voltage electric equipment
- Work in confined space in a chemical plant

Medical check-up: Regular check-up from a physician is an important factor for early recognition of occupational disease and prevention of it. Two most useful tests are regular lung function test for artisans exposed to dusts and blood or urine test for those artisans using metal containing materials.



11 - Innovative Methods to Control Hazards

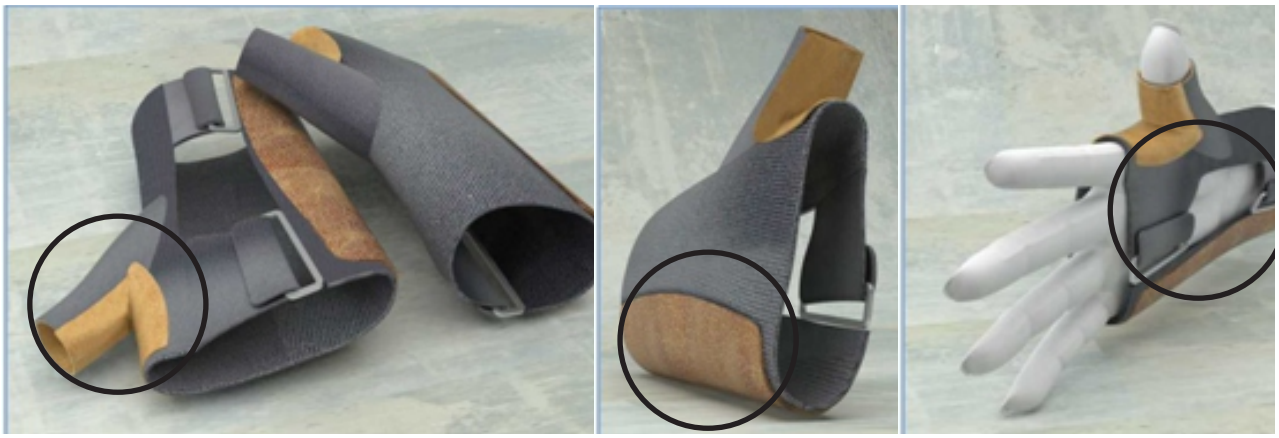
Control of hazards through engineering methods is most reliable but artisans can not apply it on their own as it may be expensive. Moreover, they are also not in favour of great changes in their traditional practices. Thus, little initiative has been taken to improve the practices to deal with the existing health problems among artisans, although some artisans have evolved some basic protective measures on their own.

11.1 Safety gears

Some of the examples of the concerns and the innovative methods that can deal with the problems are as follows:

Cuts | Callus | Wrist pain | Hardening

Concerns for Block Printers



Suede protector for cuts | Hard edge support | Palm protection

Protection: Hand gear and Gloves

How does it help?

- Suede between thumb and palm prevents cuts
- Firm edge supports the wrist while carrying loads
- The palm is protected from calluses by the glove

- The firm edge also cushions the hand while hitting the block
- Cut-away glove ensures free movement of the fingers
- Cotton layer inside the gloves acts as sweat absorbent

How to use?

Suggestions from artisans:

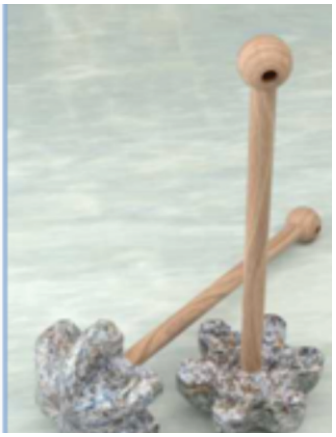
- The firm edge should have a soft inner lining to ensure that no pain is caused to the worker, while repeatedly using the glove to hit the block. Currently, the hard outer layer of the edge causes the impact to be concentrated at a point on the base of the hand, thus leading to pain.
- The surface of the edge should be rougher to prevent slippage.
- The gloves should not cover the thumb as this causes inconvenience, and reduces the free movement of the hand.
- There should be a cushion between the thumb and the forefinger which supports the block.

Mixing Spills Decolouration Acid-dye

Concerns for Block Printers and *Ikat* Weavers

Disc mixer with adjustable handle

Hand mixer with collar and finger placers



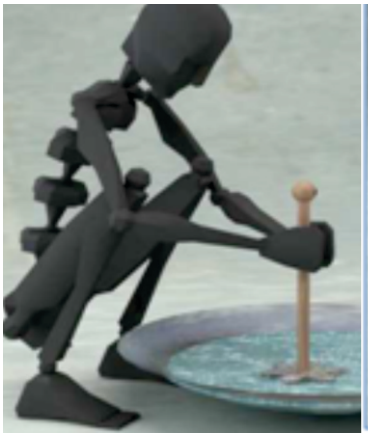
Stick mixer

Prevention and Protection: Mixers

How to Use?

Long handle for standing

Short handle for sitting



Stirrer Mixing

Protective Collar

Hand protected Collar

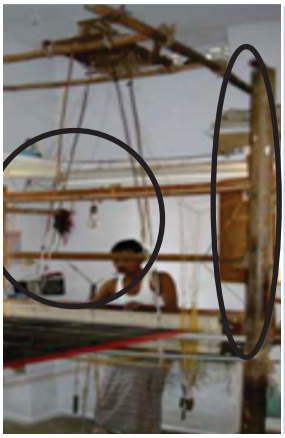
How does it help?

- Disc mixer prevents direct contact of the hand with the chemicals

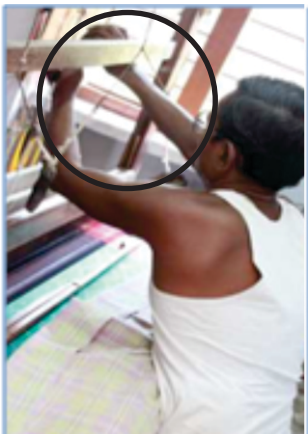
- It provides for faster mixing in both sitting and standing positions
- The length of the handle can be adjusted for sitting or standing
- The disc can be replaced with one of suitable size for the mixing vessel
- The hand mixer has finger placers for better hold
- The collar on the hand mixer prevents contact of the hand with the chemical
- The rotating stick mixer gives a better grip with both hands
- A transparent cover can be placed above the mixing vessel to prevent fumes and vapours escaping into the air

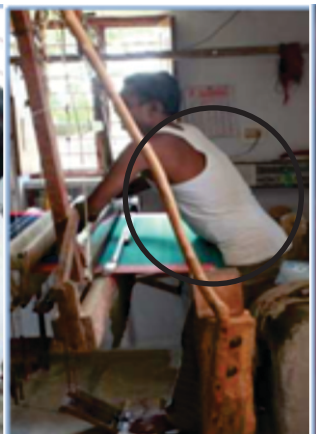
Suggestions from artisans:

- The disc mixer should be strong, lightweight and not react with the dyes
- The joint between the disc and the handle should not break under shear



Top joint & high loom



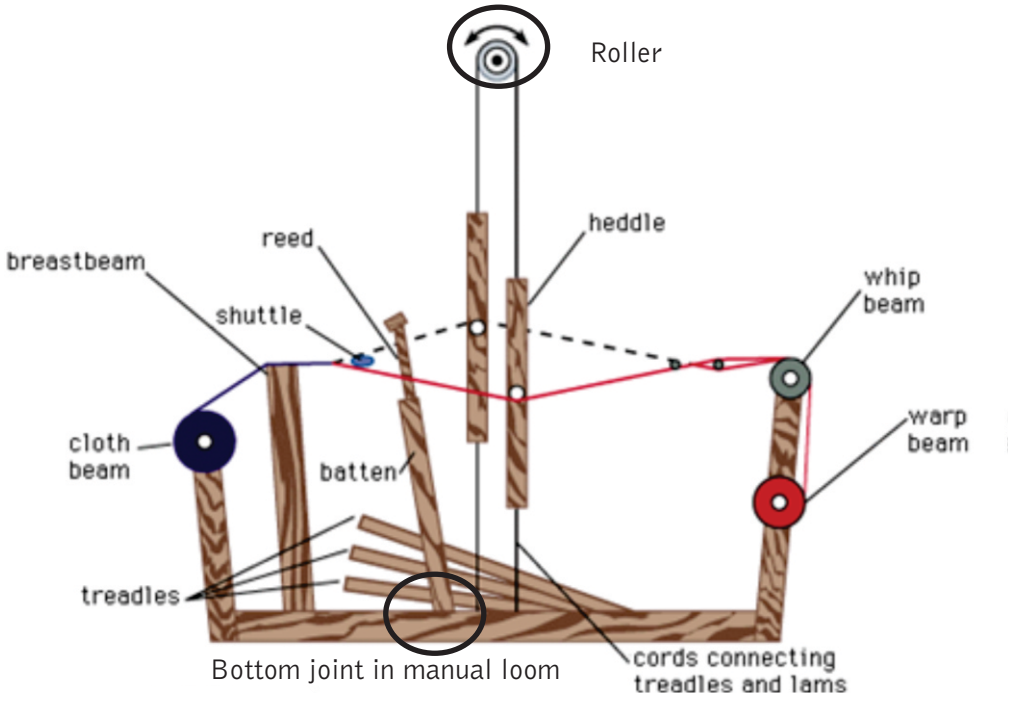


Top joint makes for bad posture & prevents easy access to heddles

Concerns in Weaving

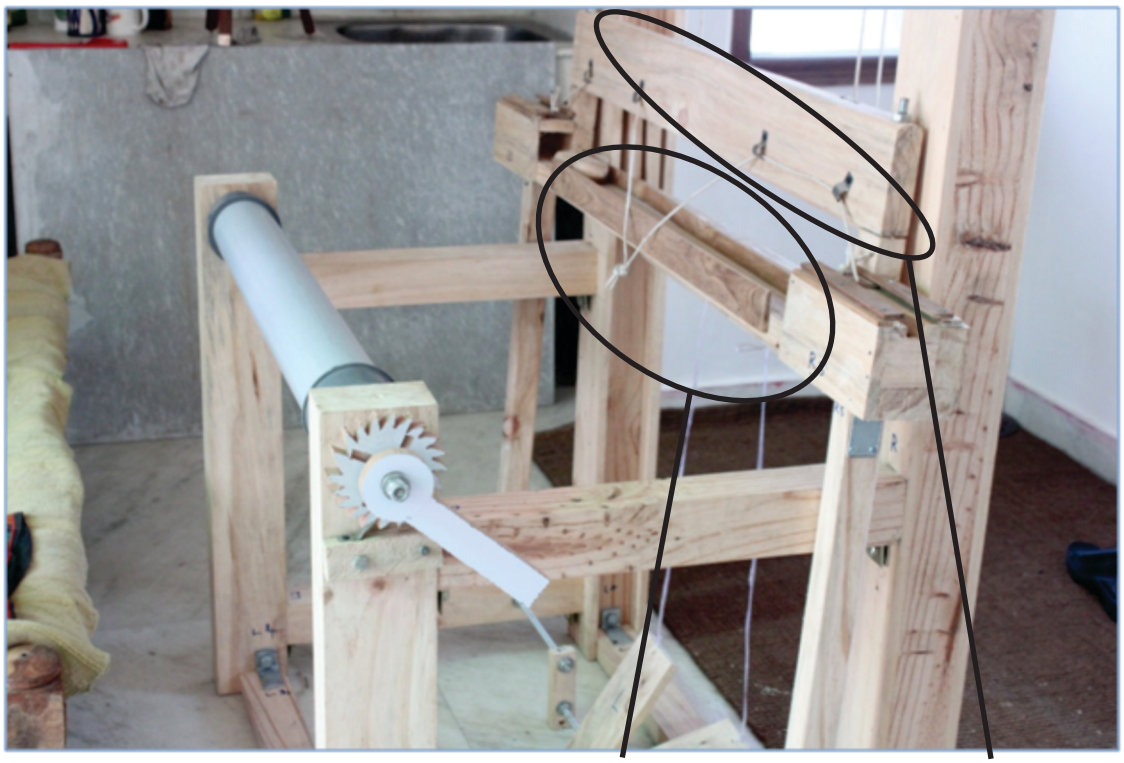
Stick used as an anti-rolling device, length depends upon height of loom

Protection and Prevention: Modification in the Loom



Bottom joint in manual loom

Manual loom



Shuttle box to carry shuttle Broader frame at top for good hold

Manual loom

The bottom joint concept has been taken from the manual loom but the batten and reed frame are modified by broadening the top of the reed frame to provide a good hold and adding on a shuttle box for the shuttle to ride in.

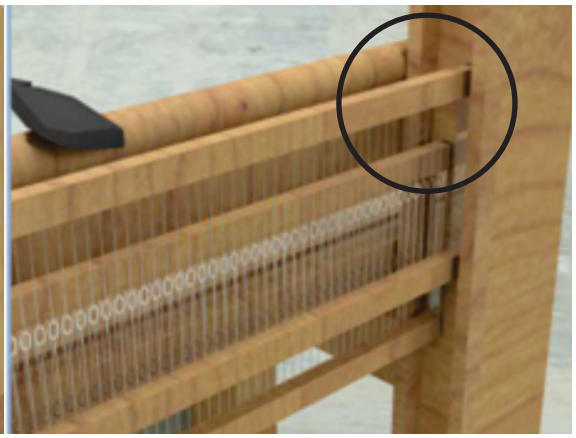
Bottom joint

Lower height

Better hold & access

Good posture

Ratchet lock



C-section holds heddle frames

How does it help?

- In the top joint loom the batten and reed frame come in the way of access to the broken threads in the heddle frames behind the reed frame
- The weaver has to reach out awkwardly from his seat to access the heddles
- The bottom joint for the batten lowers the height of the loom
- The broader bar at the top of the reed frame provides for better hold
- It also allows for easy access behind the reed frame
- This improved reach and an appropriate slope of the seat helps in better posture
- The breast beam does not prevent the artisan from reaching out to the heddles
- The addition of a shuttle box on the reed frame permits easy shuttle movement
- The hand movement for the shuttle changes from up and down to to-and-fro
- The C-Section keeps the heddle frames in place and reduces cotton dust
- Ratchet locking system helps in better treadle movement and tensioning of the cloth

Suggestions from artisans:

- The bottom joint is more useful for cotton weaving as compared to silk
- The heddle frames should be lighter and the distance between them greater
- The height of the reed frame should be the same as that of the roller
- The reed frame could be in the fashion of a sliding door because the swing of the frame on the bottom joint may affect the weaving and there is a risk of breaking threads
- The distance to the treadles is too much preventing application of sufficient power
- The lams should be indirectly connected with the treadles as otherwise there is the possibility of the heddles shifting and errors creeping into the weave
- The shuttle box should be of polished teak for smooth movement of the shuttle

Rubbing of ankle on the floor causes callus formation

Concerns in *Ikat* Weaving

Hard cap | Rubber sole | Adjustable straps

Protection: Ankle guard

How does it help?

- The hard cap protects the ankle when it is dragged along the floor
- It can either be just a cap that can be strapped on or part of an anklet
- A rubber sole could prevent the foot from being exposed to other hazards
- Different sizes of feet can be accommodated through adjustable straps

Suggestions from artisans:

- The artisans said that the footwear is useful for them provided it is affordable
- They were not much in favour of a rubber sole as they felt that would add to the discomfort on hot days
- The strap-on cap was also preferred over the anklet

Rinsed cloth and heavy drums have to be transported along uneven paths

Concerns in transportation

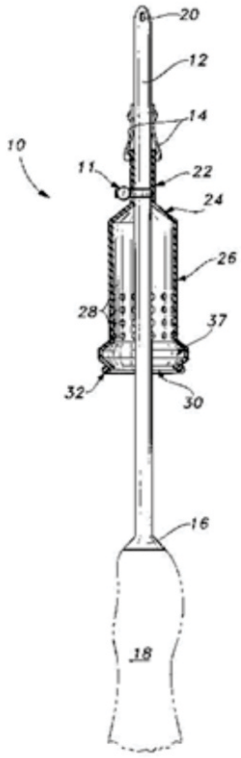
Prevention: Concrete tiled pathways

How does it help?

- The effort in pulling heavy loads is reduced substantially
- There is less possibility of heavy loads toppling off the trolley and causing injury
- Proper drainage ensures that harmful wash waters do not come into contact with skin

Manual wringing of wet fabric requires a lot of effort

Concerns in manual wringing of yarn



Protection: Mechanical wringers

How does it help?

- The perforated wringer (26) is mounted on a hollow tube (16) that is capped on to the yarn (18) and when twisted by the handles (14) it wrings the yarn
- When passed through rollers the yarn is wrung dry, but the rollers have to be soft enough not to damage the yarn
- Both reduce the effort required to wring the cloth

Dust and cotton fibres accumulate in the pit where the weaver sits

Concerns of dust/fibre accumulation in Pit Loom

Protection: Dust removal

How does it help?

- The dust pan can be easily lowered into the pit
- The rubber piece helps to sweep up the fibres and dust with a broom
- The slot provided in the pan helps to collect the dust and fibres into the pan
- Regular maintenance will keep the area dust free and protect the worker

11.2 Guidelines for Reduction of Hazards

No	Hazard	Substitution
1	Cotton dust	Redesigning heddle frame for smooth passage of the yarn
2	Naphthol dye	Use traditional non-toxic vegetable or fibre-reactive dyes
3	Caustic soda	Use measured quantities so that the excess is known
4	Sulphuric acid	Use exact quantity that will neutralise the caustic soda
5	Acetic acid	Use exact quantity that will neutralise the soda ash
6	Hydrochloric acid	Use exact quantity that will neutralise the caustic soda
7	Hydrogen peroxide	Procure non-starched cloth directly from the mills
8	Alizarin	Non-polluting if used in required quantities
9	Lime	Non-polluting if used in required quantities
10	Alum	Non-polluting if used in required quantities

Concern: Chemical hazards

How does it help?

- The toxic chemical is substituted so the hazard is eliminated
- Exact quantities of chemicals are used so that they react with each other and leave behind no toxic residues
- This reduces the hazard to which the artisan is exposed
- It also decreases the polluting releases to the environment

Suggestions from artisans/owners:

- However, discussions with both owner-entrepreneurs and artisans indicate that the cost of substitution does not favour eco-friendly measures being adopted

Guidelines of Rajasthan State Pollution Control Board[1]

1. The recovery and re-use of chemicals are to be explored in the following areas:
   - The re-use of dye solutions from the dye bath;
   - The recovery of caustic after the mercerizing process;

1-210.212.96.131/rpcb/Guidelines/textile_guidelines_final.pdf

- The recovery of size in cotton processing (in practice this is limited to integrated operations which apply and remove size)

2. In conventional dyeing, usually only the dye and a few specialty chemicals are totally consumed during the process. Most of the chemicals remain in the dye bath and are discarded with it. The feasibility of dye bath re-use depends on dye, colour, shade and whether dyeing is carried out in a batch or a continuous process. In some cases, dye baths can be re-used at least 5 - 10 times (in other cases up to 25 times) until the build-up of impurities limits further re-use.

3. List of harmful Dyes, Pigments and other Chemicals and their Alternatives

a) Usage of Alternative Dyes

Safer Alternatives for Banned Disperse Dyes			
Banned	CI Number	Alternative	CI Number
Disperse Yellow 7	23660	Disperse Yellow 15	
Disperse Yellow 23	22130	Disperse Orange 102	29156
Disperse Blue 12	3900	Disperse Red 81	28160
Disperse Orange 50	22145	Disperse Red 120	25275
Disperse Yellow 24	29185	Disperse Yellow 23	29160
Disperse Yellow 46	23050	Disperse Yellow 31	29100
Disperse Yellow 62	29175	Disperse Yellow 4	29165
Disperse Yellow 1	22570	Disperse Violet 66	29120
Disperse Yellow 2	22311	Disperse Yellow 112	29166
Disperse Yellow 29	22580	Disperse Yellow 51	27720
Safer Alternatives for Banned Acid Dyes			
Acid Orange 45	22195	Acid Orange	1914690
Acid Red 4	14710	Acid Red 157	17990
Acid Red 5	14905	Acid Red 191	14730
Acid Red 26	16150	Acid Red	24785
Acid Red 115	27200	Acid Red 37	17045

Acid Red 49	42640	Acid Violet 72	42665
Acid Red 12	18075	Acid Violet 13	16640
Acid Black 94	30336	Acid Black 24	26370
Safer Alternatives for Banned Direct Dyes			
Direct Yellow 48	23660	Direct Yellow 15	
Direct Orange 8	22130	Direct Orange 102	29156
Direct Red 2	23900	Direct Red 81	28160
Direct Red 10	22145	Direct Red 120	25275
Direct Red 24	29185	Direct Red 23	9160
Direct Red 46	23050	Direct Red 31	29100
Direct Red 62	29175	Direct Red 4	29165
Direct Violet 1	22570	Direct Violet 66	29120
Direct Brown 2	22311	Direct Brown 112	29166
Direct Black 29	22580	Direct Black 51	22720

Source: Environmental Quick Scan Textiles, complied for CBI and SIDA by Consultancy and Research for Environmental Management, Published by CBI, SIDA, VIVO, 1996

b) Use of Alternative Pigments in Printing

Suspected Pigment	CI Number	Alternative	CI Number
Pigment Orange 50	20170	Pigment Orange 38	12367
Pigment Yellow 12	21090	Pigment Yellow 147	60645
Pigment Yellow 63	21091	Pigment Yellow 148	59020
Pigment Yellow 126	21101	Pigment Yellow 5	11660
Pigment Red 39	21080	Pigment Red 87	73310
Pigment Yellow 176	21103	Pigment Yellow 101	48052
Pigment Yellow 114	21092	Pigment Yellow 10	12710

Source: Environmental Quick Scan Textiles, complied for CBI and SIDA by Consultancy and Research for Environmental Management, Published by CBI, SIDA, VIVO, 1996

c) Chemical Substitution

Process	Chemical	Substitute
Sizing	Starch based wrap sizes by PVA	Acrylates or partial substitution
Desizing Scouring	Acid	Hydrogen Peroxide & enzymes
Aqueous Scouring	Alkylphenol Ethoxylates TSP, NaOH	Fatty alcohol ethoxylates Sodium Carbonate
Detergent Souring	Alkyl benzene sulphonates	Fatty alkyl sulphates Polyglycolether
Light Scouring	NTA, EDTA	Zeolites (sodium aluminium Silicate)
Bleaching	Reductive sulphur bleaches	Peroxide bleaches
	Chlorine compounds	Peroxide Bleaches
Dyeing	Benzidine based dyestuffs and other amine releasing dyes	Mineral/pigment dyes single class dyes like indigsol, pigments, reactives
	Dichromate used for oxidation in vat and sulphur dyes	Peroxide, air oxygen, metal free agents
	Acetic acid in the dyeing bath	Formic acid
	Dispersants for dyes and chemicals	Water based system
	Copper sulphate used to treat direct dyes	Polymeric compounds
	Dye powder in automatic injection	Liquid dyes
	Sodium hydrosulphite	Stabilized sodium hydrosulphite
	Aldehyde and toxic metallic salts used as auxiliaries	High molecular weight polymeric auxiliaries
	Sodium sulphide	Glucose based reducing agents

Printing	Kerosene or white spirit	Water based systems
Finishing	Formaldehyde	Poly carboxylic acid
	Alkyl phenol	Fatty alcoholethyoxylates
Anti-wrinkle finishing	Dimethylol dihydroxyethylene urea	(Poly carboxylic acids mainly 1,2,3,4 butane tetra carboxylic acid) Glyoxales
Flame retardant finishing	Asbestos, Halogenated compounds like, bromated diphenylethers (PBDEs) and heavy metal containing compounds	Inorganic salts and phosphonates
Preservation finishing	Biocides such as chlorinated phenols (PCP), metallic salts (As, Zn, Cu or Hg), DDE, DDT, Benzothiazole	UV Treatment, mechanical or enzymatic finishing

Source: Textile Sector Part A
(http://www.eeaa.gov.eg.seam/Manuals/TextilesectorReport/content.htm)

4. Water Conservation Measures: Following water conservation methods can be adopted in textile units depending on the processes being used and size of the unit:

- Installing water meters to monitor water use
- Using automatic shut-off nozzles and marking hand-operated valves in such a way that open, close and directed-flow positions are easily identified
- Using high-pressure, low volume-cleaning systems, such as CIP (clean in place) for washing equipment
- Installing liquid level controls with automatic pump stops where overflow is not likely to occur
- Recycling cooling water through cooling towers
- Minimizing spills on the floor minimizes floor washing in the dye house
- Repairing leaks in the water pipe network
- Handling solid waste dry
- Recycling steam condensate whenever possible
- Using technologies which do not require large quantities of water, such as low dye bath ratio, high pressure steam washing and plasma cleaning of fabrics

5. Process Water Re-Use Options in Textile industry: Significant savings can be made in textile processing industries by recovering and re-using of water at processes itself. Few areas where these options can be examined by the units are out lined hereunder:

- Recycling of final wash water after H_2O_2 (hydrogen peroxide) bleaching as a wash water for second scouring step or for earlier bleaching steps
- Reusing bleaching wash water to start another bleaching batch
- Re-use of hot bleach water for starting optical brightening batch
- Re-use of optical brightening wash water to start another batch of optical brightening batch
- Final wash water of cone scouring and bleaching can be used as wash water for scouring and bleaching
- Cold rinse water used after scouring step for sulphur black dying can be used for the reduction step
- Re-use of hydrosulphite wash water for another batch of hydrosulphite batch
- Re- use of clarified print wash-water in washing and blankets and screens of the print machine

11.3 Specifications and Costs of prototype safety equipment (all prices for Delhi in November 2011):

Dye Mixer

Dimensions:

Perforated disc of 10'' diameter
Mixer handle, 25mm diameter, 44'' in length, made of two pieces, each 22'' long, with a threaded joint at one end.

Materials and costs:

Iron: Rs 875/-, that would reduce to Rs 550/- for bulk production

Iron is relatively cheap and robust but will be corroded by both acids and bases.

Aluminium: Rs 905/-

Costs will vary on a per day basis (Rs 115 per kg in Nov 2011). Light weight but may be attacked by chemicals and dyes. Fabrication on a bulk scale will require a Die, which may cost up to Rs 45,000; cannot be welded if broken.

Stainless Steel:

1. Magnetic SS: (Weak, non-durable but cheaper) Rs 2200/-
2. Pure SS: (Long lasting, but expensive) Rs 2500/-

Costs will vary on a per day basis (Rs 135 per foot in Nov 2011). Stainless Steel is heavy but extremely durable and non-corrosive, as it does not react with acids and dyes. If it breaks it can be welded; can also be made by local vendors.

Plastic (HDPE): Rs 850/-

Plastic is relatively cheap but is structurally weak and will be corroded by both acids and bases.

Copper: Rs 2500/-

Light weight but may be attacked by chemicals and dyes.

Bottom Joint Loom

Dimensions:

6' wide x 6.5' long x 5' high: the size is actually determined by the Reed frame which is manufactured by a single agency in Mumbai who has distributors all over the country

Materials and costs:

Hardwood is required for the construction of the Reed frame (Beater), Shuttle box, C-section support columns, and the Heddle frames

1. Burma teak: Rs 2600 to Rs 3200 per sq.ft.
2. Nagpur teak: Rs 2100 to Rs 2700 per sq.ft.
3. Sheesham: Rs 1575 to Rs 2200 per sq.ft.
4. Babool: Rs 1200 to Rs 1500 per sq.ft.

Total cost of the loom will vary from Rs 16,000 to Rs 22,000 per loom.

Hand Safety Gear

Dimensions:

Medium size available in the local market

Materials and costs:

Mesh / Polyester wash-proof leather half gloves cost between Rs 130 to Rs 240 per pair

Shin Guards of HDPE with ribs and foam inner padding, for making the hard edge, cost Rs 180 to Rs 375 per pair

Velcro strips for straps cost Rs 30 to Rs 42 per metre

Total cost for a Medium size Glove, including materials and labour) would be about Rs 700 per piece

Foot Safety Gear

Dimensions:

Foot size of 9 (Indian Standard)

Materials and costs:

Velcro strips for straps: Rs 30 to Rs 42 per metre

Shin Guards (HDPE with ribs and foam inner padding) for making the ankle cap cost Rs 180 to Rs 375 per pair

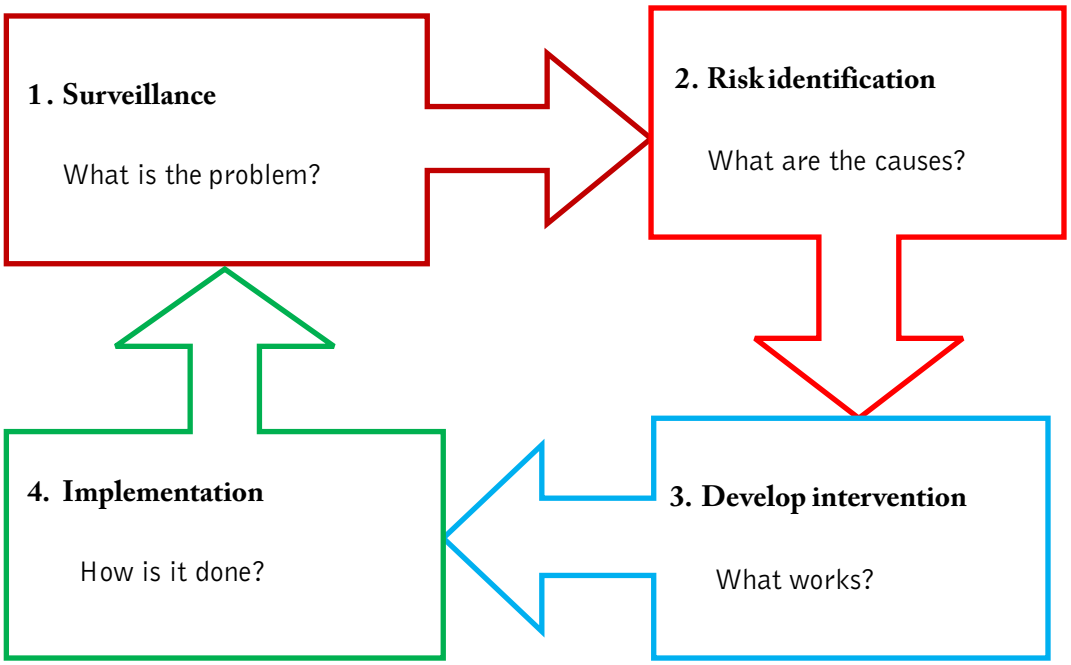
Total cost for a Size 9 Ankle Guard would vary between Rs 400 to Rs 500 per piece

For bulk orders costs should generally come down by more than 25-30%, depending upon the vendor selected and the number of pieces that could be extracted out of the raw material, thus cutting down on wastage. There are no existing commercial vendors for such supplies and local entrepreneurs would have to be sought out at each location to make these items. But this would be contingent on first extensive testing of each safety gear to assess its feasibility and modifications for improved usage.

12 - Investigation, Reporting and Analysis of risk

In most industries, it is somewhat easy to identify the risk in the workplace as there are various methods to evaluate the process and its magnitude of impact on the health of the workers. For example, the record of the accident rate in a particular job indicates the magnitude of the hazard in the work. But in home-based industries, the causes of the problems are hidden and somewhat chronic and indirectly related to health due to the traditional work pattern. In such industries, the accidents may be small or negligible but the severity rate due to long term exposure of work pattern may be more. In other words, accidents are low but the diseases are more. For example, the general condition of artisans is much better than other industrial workers with respect to cuts, wounds, and major accidents which lead to death, but chronic effects due to chemical exposure and ergonomic problems may be significantly high, particularly because of the changes in production processes in response to market demands.

There are 4 steps in approaching the problem for investigation



These four steps may be described as:

1. The first step is to determine the magnitude, scope, and characteristics of the problem. Defining the problem goes beyond simply counting cases, it includes delineating deaths, injuries and disease, and risk taking behaviour. This step includes obtaining information on the socio-economic characteristics of the person involved, the time and place of the incident, the circumstances under which it occurred, and the severity and cost of the injuries.

2. The second step is to identify the factors that increase the risk of injury or disability, and to determine which factors are potentially modifiable. Whereas the first step looks at "who, when, where, what and how", the second step looks at "why". It may also be used to define populations at high-risk for violence or accidental injuries and to suggest specific interventions.

3. The third step is to assess what measures can be taken to prevent the problem by using the information about causes and risk factors to design, pilot test, and evaluate interventions.

4. The fourth step is the implementation of interventions that have been proven or are highly likely to be effective on a broad scale. In both instances, it is important that data be collected to evaluate the programme's effectiveness.

Thus, in the present study, on which this Manual is based, the first three steps have been almost completed, but "evaluation" in the third step and Implementation in the fourth step are yet to be accomplished.

12.1 Health Check-up Kit

However, for home-based industries, this method may not be sufficient for the assessment of the root cause which is responsible for the deterioration of the health of an artisan. For understanding this, in addition to the above four steps, the development of a small kit for surveillance of the present heath status of the workforce is important. One more significant point is that the artisan him/herself should be able to carry out the risk assessment of his/her health problems through the kit.

Some additional tests for evaluating occupational health problems are:

- The BMI (Body Mass Index) test, for the general health of an artisan
- The PFT (Pulmonary Function Test), to measure the effective function of the lungs
- The HGM (Hand Grip Meter) test, to assess the muscle tone
- The eye test, through the Snellen Chart
- The recording of observations of damage
- The recording of occupational history and symptoms

12.2 Looking at the entire system

Traditionally, analysis of risk has examined the user, technology, and environment separately. Furthermore, there is a tendency by researchers and practitioners to look for one or a few factors when, in actual fact, they should be analysing a multiplicity of factors. The essence of using a systems approach is to consider, not only the underlying factors, but also the role of different agencies and actors in prevention efforts. For example, if designing of a new tool is reduced to one "cause" only, it is obvious that the design becomes easier but components of the entire system - human, infrastructure, and traditional methods - are considered as independent. Thus measures addressing each problem can be implemented separately, which makes things easier, however the linkages between the different problems as part of an overall process are not considered. Furthermore, how one set of measures developed in one unit or cluster may be applied to another (for example, by changes in the work pattern) are entirely ignored.

12.3 Data collection and analysis principle

Data collected from primary or secondary sources needs to be analysed to answer such questions as:

- What are the most common causes and types of health effects in different age groups?
- What are the characteristics of persons who are most likely to be affected?
- What are the circumstances under which effects are most likely to occur?
- What policies and programmes can reduce the likelihood and severity of health problems in a community?

Analysing data, producing regular outputs, and disseminating information on occupational health and safety are all vital activities. It is necessary to share and disseminate data and evidence on causes and remedial measures of the problems to artisans, other researchers, policy makers, victims, and the community at the local and national levels. Though writing reports is central to this activity, this should not be an end in itself. The design of databases should therefore take account of the principal needs of their users, providing quality data without overburdening those collecting the data.

Index	Description	Use and limitations
Number of affected population	Absolute figure indicates the number of people affected, whether chronic or acute, and the need for treatment.	Useful for the planning of adequate medical services at the local level.
Rate of severity due to traditional work pattern	Absolute figure indicates the number of people who suffer more and are more prone to a particular hazard.	Gives a partial estimate of the magnitude of the safety problem. Useful for planning of best practices that can reduce the rate or use of alternative methods.
Severity rate due to machine or tool	Shows the ratio of occupational health problems with respect to the use of tools and machinery.	Useful for comparing the hazards with alternative tools through proper design without compromising the efficiency.
Affected among 100 workers	A means of personal safety or the average probability of an individual being affected in a particular cluster.	Shows the impact of work pattern as a health burden on human population at a particular cluster. Used for comparing the relative seriousness of the problem at different clusters.

Table 7: Indicators of occupational health problems in home based industries

13 - Detailed Recommendations

1. The Manual developed through this study, containing safety guidelines, protective measures, and legal provisions, should be made widely available in local languages to employers, artisans, and workers in the industry.

2. A systematic schedule of training workshops in the local language with groups working with artisans and craftspersons has to be designed and pursued so as to both make them aware of the environmental and occupational hazards and to elicit their willing cooperation in future activities.

3. The safety gear designed during this study should be tested widely through repeated trial runs over reasonable time periods in different clusters and the suggestions made by workers incorporated for better user-friendly designs.

4. Subsequent innovations by the workers themselves should be recorded and studied for their impact on safety so as to modify and adopt them in the safety Manual.

5. Monitoring protocols for regular health check-ups and regulating safety measures have to be developed and conducted by associations interested in the welfare of the industry.

6. Trained occupational hygienists should be recruited to assist in investigating, reporting, and analysing risks, and suggesting remedial measures for specific problems in the work place.

7. The substitution of hazardous substances and chemicals by eco-friendly ones is often made impossible by the higher costs involved and a detailed study of the economics of concealed subsidies and externalities would be valuable for the entire industry.

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Annexure: Questionnaire for Occupational Health Survey

1. Place:

2. Craft: 3. Date:

4. Name:

5. Age: 6. Sex:

7. Years working in craft: 7A. Employed/Self-employed

8. Main tasks of work:

9. Inspection (mention parts of the body):

Callus	Cuts	Burns	Spots	Tremors	Skin

10. Reported Symptoms/Illness:

(a) Eyes	
(b) Ears	
(c) Aches	
(d) Lungs	
(e) Other	

11. Habits (tick):

Paan	Smoking	Tobacco	Alcohol	Ghutka	Ganja	Bhang

12. Tests:

(a) Height	(b) Weight	(c) Eyesight	(d) Hand grip	(e) Peak flow (avg. of 3 readings)
			Left Right	

13. Comment on safety equipment, precautions, condition of work, ventilation and light:

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14. Case History:

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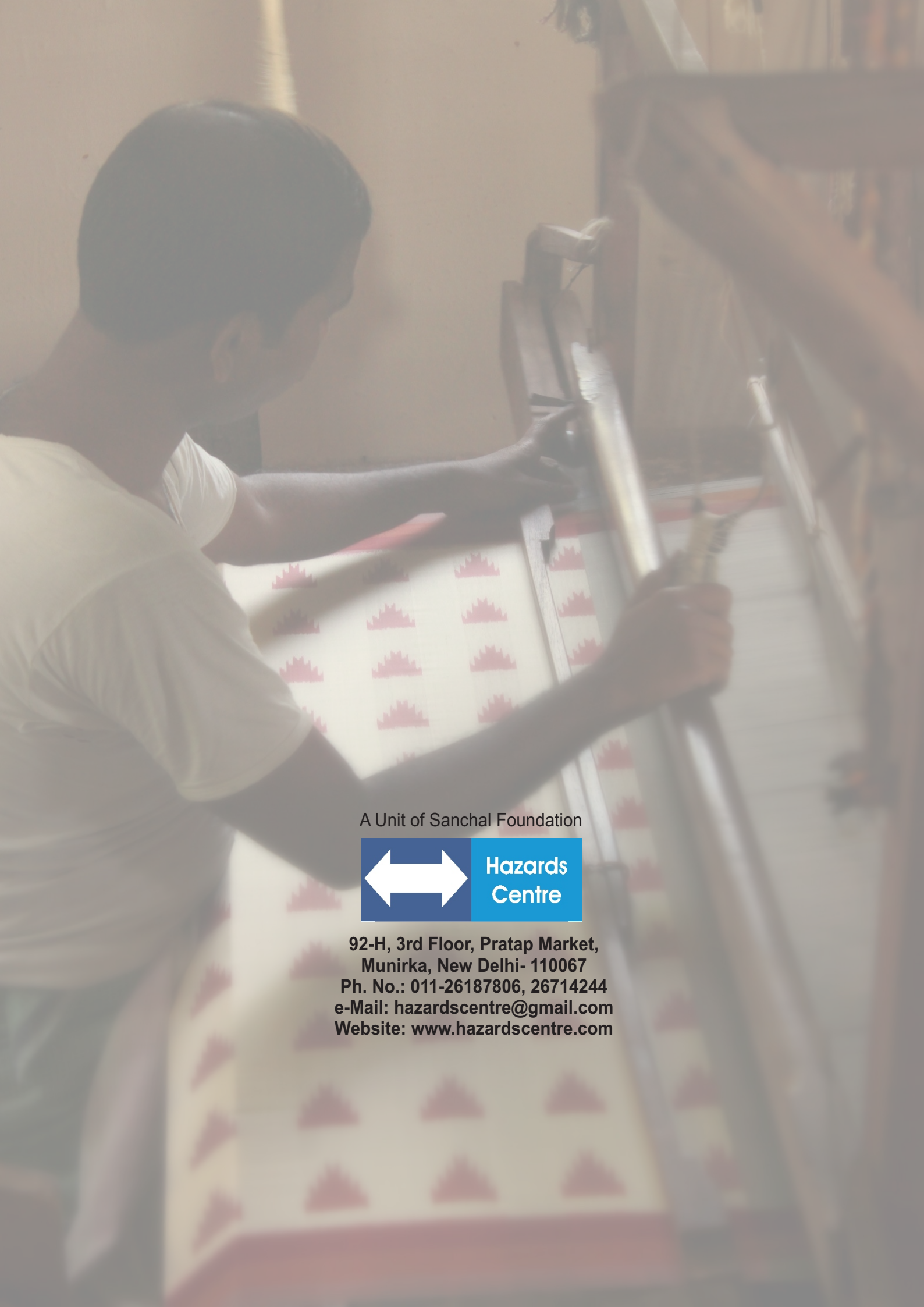

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