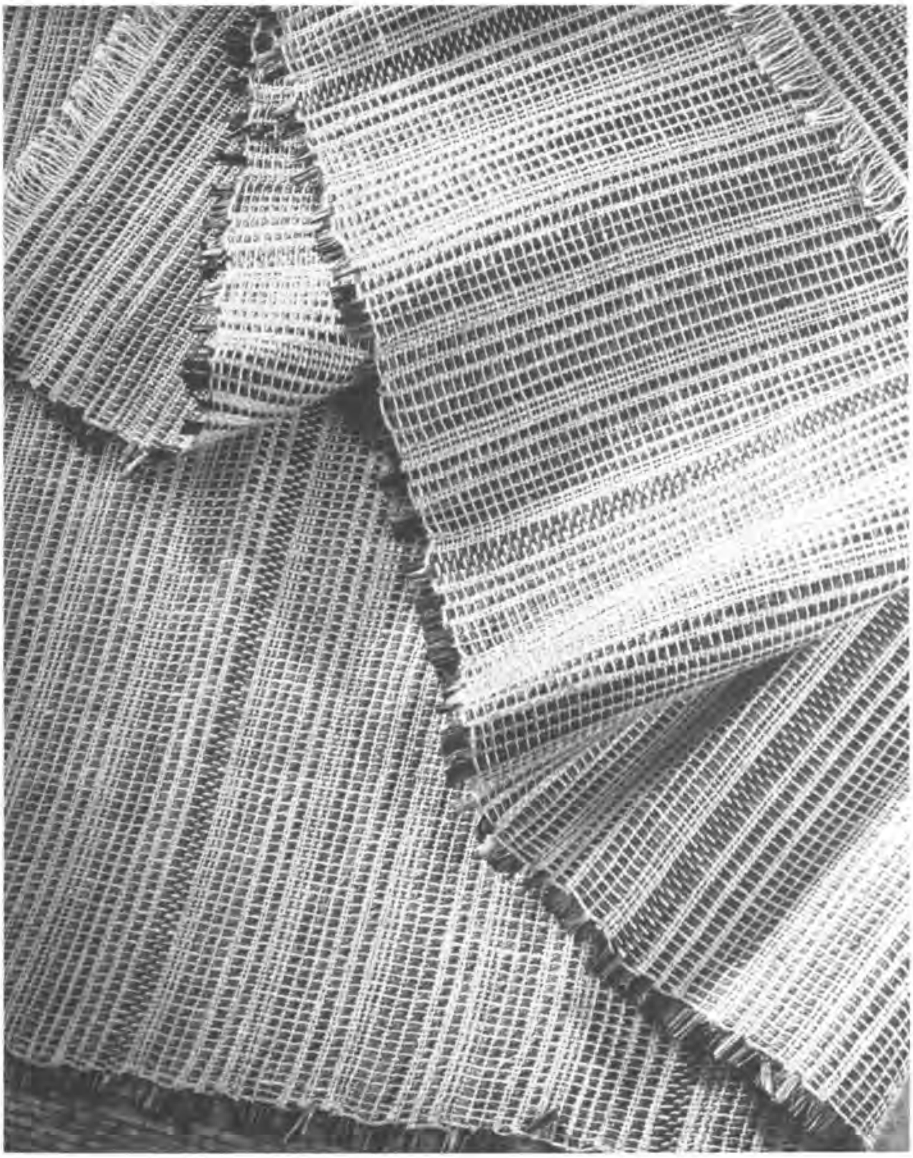
# CONTEMPORARY HANDWEAVING



# CONTEMPORARY

RUTH OVERMAN
LULA SMITH

# HANDWEAVING

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THE ILLUSTRATION on the title page is a tablecloth of black raffia and natural linen on a natural linen warp, woven by Ed Rossbach. Variation in the arrangement of the filler elements plus an unusual use of materials add drama to the plain weave.

# FOREWORD

*This is a book about creative weaving — understanding and appreciating the accomplishments and procedures of the past as foundations for individual achievement today. It is addressed especially to those individuals who wish to learn the basic techniques of weaving so they may, if they like, proceed alone and develop the craft in their own fashion.*

*The 4-harness loom, with which this book is concerned, is an extremely versatile instrument; it is capable of producing almost every type of fabric. If used as a creative agent, it offers an unlimited opportunity for exploration. The weaver will realize this when he becomes familiar with the countless materials available to him and the innumerable ways in which they can be arranged and combined in fabric.*

*The mechanism of a 4-harness loom is relatively simple, this simplicity making it adaptable to many ways of doing things. To take advantage of this, the weaver should devote some time to a study of the various parts of the loom, their operation, purpose, and function in relation to the weaving process. Pattern modifications then open up broad new horizons of special effects.*

*There are numerous ways of performing certain manual operations, such as winding the warp and putting it on the loom. The methods given here are those used by the authors in their own work and in teaching.*

*In the majority of cases, procedures are presented in a step-by-step progression and accompanied by illustrations showing actual work in various stages.*

*It has been advisable, in a professional approach, to use somewhat detailed explanations in certain sections of the book. Cross-indexed text references and definitions in the Glossary fully explain the terms used.*

*Emphasis has been placed on the fundamental weaves, particularly the plain weave and the twills. These are the strong, stable constructions which lend themselves to many modifications; these structures are used to develop decorative patterns, many of which are seen in historic textiles.*

*In comparison with artisans of the past, the weaver today has access to an amazing variety of yarn elements. With this diversity of materials, the need for pattern emphasis is not as compelling as it once was. If the creative artist will limit himself to a few yarns, making a selection from contrasting types, he will find that he can exploit these in basic structures and achieve surprising vitality in his textures.*

*As proved by the illustrations, many of the textiles of contemporary weavers owe their effectiveness to a simple and direct design approach. Modern printed fabrics also give evidence of this same discipline. We hope, however, the reader will pursue his quest in his own way; his fabrics then will bear the stamp of his own personality.*

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# CONTEMPORARY HANDWEAVING

# CHAPTER 1

# OUR WEAVING HERITAGE

A MARKED REVIVAL IN THE ARTS AND CRAFTS has occurred since the 1920's. Handweaving has shared in this movement to such an extent that today we find weavers in many parts of the world who are producing fabrics of aesthetic quality. A few work professionally with architects, decorators, and designers, but most weavers follow the craft for their own pleasure as an avocation.

Whatever our accomplishments today, they are but a very small link in the long evolution of handweaving—a craft that dates back to the beginnings of Man.

## ► DEVELOPMENT OF FUNDAMENTAL WEAVES

The fundamental aspects of handweaving have remained unchanged. Our looms are essentially the same as those used a thousand years ago, and many of our fabrics are woven in structures that antedate that period. The fundamental weaves—plain, twill, and satin—were developed before the Christian era.

Just how early Man became a weaver is a matter of speculation. Originally, he used pelts and hides for garments and blankets. The concept of a web—a woven structure—was probably intuitive and could be ascribed to chance. Since food has always been a primary concern in all ages, it is not unlikely that primitive Man first realized the possibilities of the web from interlacing twigs and grasses, in making weirs and nets that would assist in catching fish and game. By twining, knotting, and braiding, Man created such utilities as mats and baskets many years before making cloth.

The earliest cloth fragments found by archeologists have been estimated by some authorities as being more than ten thousand years old. Such fragments, made of linen, have been found in Switzerland, in the area inhabited by the Neolithic Lake Dwellers.

The making of cloth was contingent upon two factors: finding suitable fibers, and devising a process that would twist these fibers into a strand. The blue-flowering flax plant, native to Europe and Africa, grew abundantly, and the stem of this yielded thin, tough fibers, flexible, and of sufficient length to permit them to be twisted into yarn.

The tool that was originally made for this operation was the *spindle.* It consisted of a narrow piece of wood, 6 to 15 inches in length, smooth and tapered on both ends. Between the center and one end was attached a disc made of clay, wood, or bone called a *whorl* and as the operator rotated the spindle between his fingers the disc would impart momentum, as in a child's top.

Loosely twisted fibers were first attached to a notch at the top of the spindle; it was then rotated and, by twisting, the fibers were drawn out into a strand. Repetition of this performance would reduce the size of the strand and form it into a compact yarn. In spinning very fine yarns, the spindle might rest in a bowl of water. By frequently dipping the fingers in the water, the moisture promoted adhesion when the fibers were being twisted. Such methods have been delineated on many ancient pottery vessels.

It was by this method the yarns for the famous Dacca muslins of India were spun, more than two thousand years ago. These cotton fabrics were like cobwebs—transparently thin and made from incredibly small yarns. Using a spindle the size of a darning needle, fibers were drawn out into minute strands that often yielded two hundred miles of yarn to the pound. So adept were the weavers of that period that they used these yarns as warp elements as well as for filler.

### ► KINDS OF LOOMS

The first requisite to weaving is to keep warp yarns under tension—so they will lie, in order, on one plane.

The first looms were vertical. Weavers suspended the warp from a horizontal pole or bar and, at the bottom, they used a weight for tension. The means for holding down the warp varied, and it is significant that different peoples in widely separated parts of the world used the same method, depending on the fiber that was used in the warp.

Such scattered peoples as the Swiss Lake Dwellers, the early Egyptians, the Scandinavians, and the Haida Indians of Alaska, all wove chiefly with linen and, to achieve their warp tension, they tied stones or weights to individual warp yarns.

In India, Central America, and Peru—where cotton was used more often than other fibers—a pair of poles or bars was used. Early Chinese are said to have used this method for silk which, like cotton, adjusts itself more readily in warp than does linen.

An adaptation of these vertical looms was devised by the pre-Inca Peruvians. They developed a method that enabled the weaver to regu-


Fig. 1.1—A Huichol Indian of El Cuapinole, Nayarit, Mexico, the side view showing tension placed upon the backstrap. (Photograph by Donald Cordry, owned by the Cooper Union Museum. Courtesy "Handweaver and Craftsman.")

Fig. 1.2—Backstrap loom being used by a Zapotecan woman of Yalalag, Oaxaca, Mexico. (Photograph by Donald Cordry, owned by the Cooper Union Museum. Courtesy "Handweaver and Craftsman.") Tension is maintained by the stance and pull of the body against the loom frame. Length of warp can be increased by wrapping around the upper loom bar, while width is limited by the reach of the arms.

late and maintain warp tension at will. Two bars were used, and at the end of each bar a heavy cord was lashed to form a loop. One loop went about a tree, the other about the waist of the weaver. By leaning back against the loop, or waist strap, the weaver pulled up the warp; a shift of weight, forward or back, adjusted the tension as he liked. This type of loom is used today by natives in Central America; it is seen occasionally in Mexico and among the Indians in southwestern United States.

For centuries the act of weaving was accomplished solely with the fingers, by lifting each warp yarn separately. In order to lift a group of warp yarns at one time, thereby forming what we call the *shed*, some sort of heddle and rod arrangement had to be developed. An example of an early version is shown in Figure 1.3. The reader will appreciate the obvious disadvantage of this heddle rod: one hand constantly must be em-

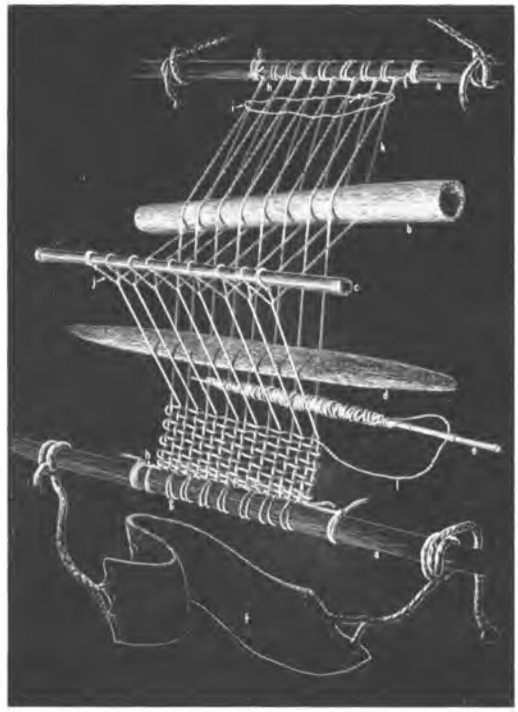

Fig. 1.3—Diagram of a primitive backstrap loom: (a) loom bars; (b) shed rod; (c) heddle rod; (d) batten or sword; (e) bobbin; (f) backstrap; (g) warp lashing; (h) heading string; (i) lease cord; (j) leash cord; (k) warp; (l) weft. (From "Andean Culture History," by W. C. Bennett and J. B. Bird. Courtesy of the American Museum of Natural History.) Warp is attached to the warp bars. When heddle rod (c) is pulled forward, a shed is formed for the weft. This is beaten into position by the batten or sword, then the alternate warp yarns are lifted to form a shed. The bobbin is returned and the batten again beats the weft into place. The warp is held taut by fastening the cord attached to the upper loom bar to some stationary object while the backstrap goes around the weaver's waist or hips. This loom was known in Egypt prior to 2000 B.C. According to Junius Bird it apparently was not known to Peruvian weavers before 1200 B.C. It is used at the present time in Mexico, Central America, and South America.

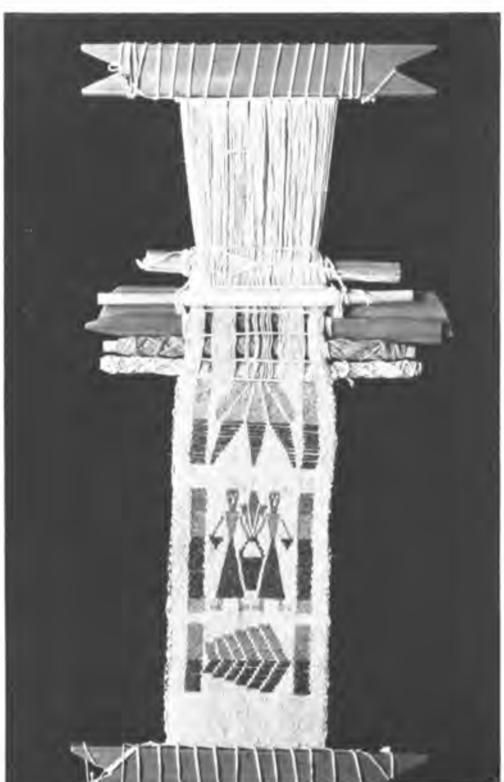

Fig. 1.4—Loom from Lima, Peru, referred to as the rod-and-heald type, a modern loom similar in operation to the backstrap loom. (From the Florence Dibell Bartlett Collection. Courtesy of the Art Institute of Chicago.)

ployed to hold the rod up and away from the remaining warp yarns in order to pass the filler yarn.

To free both hands, so the weaver could use a shuttle, required the discovery and application of two important mechanical devices—the

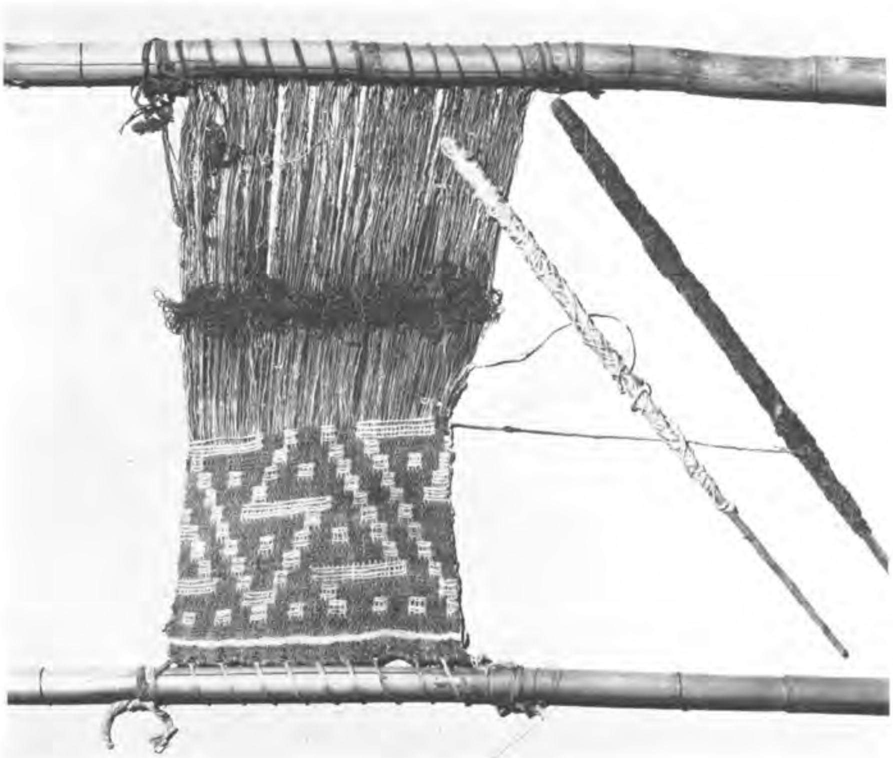

Fig. 1.5—Peruvian loom with double cloth in process of weaving. (American Museum of Natural History. Courtesy "Handweaver and Craftsman.") Note fineness and closeness of warp and pattern.

pulley and the lever. A loom that incorporated these, with a horizontal warp, first appeared in early Egyptian excavations. Some authorities, however, believe the Chinese used a similar loom as early as 1298 B.C.

It was thirteen hundred years later that China developed the draw loom—a notable development. In this loom the individual warp yarns were attached to cords, which were passed through holes in a board called the *comber board;* the cords then were grouped according to the pattern to be woven. Control cords were lifted by a boy stationed at the top of the loom. With a draw-boy, the weaver was free to concentrate his attention on the shuttle.

The draw loom did two things: it increased textile production tre-

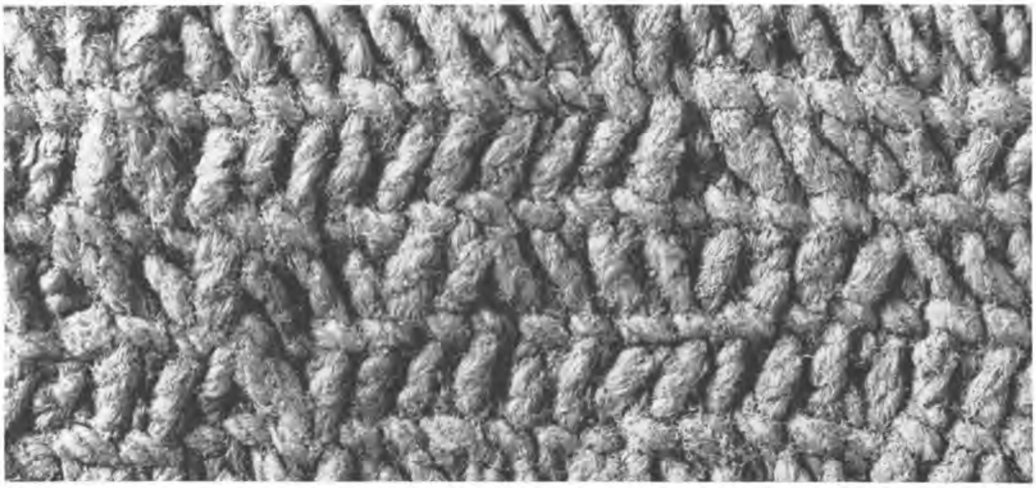

Fig. 1.6—Twined fabric in which pattern is produced by reversing direction of transposed warp; a complex pattern used between 2500 and 1200 B.C. (American Museum of Natural History. Courtesy "Handweaver and Craftsman.")

Fig. 1.7—Fragment of a woven textile of about 1500 B.C., using 2-ply warp yarns and single wefts. (American Museum of Natural History. Courtesy "Handweaver and Craftsman.") Illustrations 1.6 and 1.7 are from recent excavations in the Chicama Valley in northern Peru, under the direction of Junius Bird, Associate Curator of Archaeology of the American Museum of Natural History. These findings have brought to light a collection of textiles dating from approximately 2500 B.C. Made of cotton fiber combined with some bast fiber, the methods of construction varied. Unusual weaves as well as unusual uses of yarns occur showing a high degree of skill. Using a single element construction, or one yarn, fabrics were made by a figure-8 looping. Also common was netting, made by knotting or tying a single yarn. Twining and weaving, using a warp and weft yarn, were employed to fabricate cloth, twining being used much more generally. Mr. Bird believes that all of these fabrics were made with the fingers only, as a means of interlacing the weft and warp.

mendously; and, since individual warp yarns could be controlled by this system, the possibilities of pattern were greatly enlarged. This resulted in a period of intricate and elaborate decoration, one that continued through the nineteenth century.

The draw loom was used in Europe until 1787. At that time Cartwright invented the power loom, and, at the turn of the century, the Jacquard attachment appeared. This device made it possible to attain selective warp control through the medium of perforated cards—a principle once employed with music rolls on the old player piano and used today with sorting systems. These inventions marked the beginning of machine production and were the forerunner of equipment used in modern textile mills.

## ► TYPES OF FABRIC

The type of fabrics created in this vast interim was influenced by the customs and cultures of the various peoples. Examples of many historic textiles are seen in museums today, and the weaver can study these with profit. They not only exemplify the proficiency of the weavers but reflect the religious, political, and economic conditions of their period.

In the early Egyptian period, wool was used very little because of religious reasons. Since it came from animals it was considered unclean and was not allowed in the temples. As early as 4000 B.C. flax fiber was used. Constant preoccupation with linen made the Egyptians skillful in weaving fabrics of unusual fineness and excellent quality. The textiles that have been preserved in tombs, used as mummy wrappings and to cover pottery and relics, were all woven in plain weave with no evidence of decoration.

Although cotton was native to the region, it was seldom used. It has been suggested that the difficulty of separating cotton fibers from the seed may have accounted for the almost insignificant use of this fiber. Cotton did not become important in Egypt until the Christian era when it was used by the *Copts,* as the early Egyptian Christians were called.

Examples of Coptic textiles consist, in most cases, of articles of clothing found in tombs along the edge of the desert. The various designs were usually woven of wool carried out in a brocading technique, and on a linen or cotton warp. These textiles alternately show influences of classic Christian or Mohammedan art, reflecting the political situa-

Fig. 1.8—Fragment of a Coptic tapestry, third or fourth century. (Courtesy of the Detroit Institute of Arts.) These textile fragments, woven of wools in blue, red, pink, and natural, have been found in tombs along the edge of the desert and, in most cases, are articles of clothing. Sometimes the designs were woven into the main part of the fabric, sometimes they were in bands or medallions used to decorate the tunic or other garment. At various times the designs show Classic, Christian, and Mohammedan influences.

tion of the time. Wool was used by the Copts to carry out the motifs, chiefly, it is said, because wool could be dyed so easily.

Silk was known in China as early as 3000 B.C.; some authorities say earlier. To produce the silk filament used in fine fabrics, the worm feeds upon the leaves of the white mulberry tree, which is native to China. The importance of silk culture as a national industry was fully appreciated, and for years was a carefully guarded secret. Beautiful silk fabrics that were woven in China were in demand in neighboring countries as early as 700 B.C.

Although the people of Korea and Japan soon learned the secret, it was not until the fifth and sixth centuries after Christ that silk culture

Fig. 1.9—A Hispano-Moresque, eleventh to twelfth century fabric. (Fabric owned by the Cooper Union Museum. Courtesy "Handweaver and Craftsman.") Weave is a compound twill. This motif was called the "Hippocamp" and was popular in early Persian and Byzantine art, having been brought to the West by the Arabs.

was introduced into Europe through the efforts of Justinian, Emperor of Rome. In his desire to have the most magnificent court in Europe, he dispatched two monks to China to learn silk culture. The story relates that when they returned they brought back the eggs of the silkworm and seed from the white mulberry tree concealed in the heads of their bamboo canes.

Following the invasion of the western Mediterranean by the Mohammedans, and during the early development of the city states of Italy, the production of textiles grew at an amazing pace. The weavers then had at their disposal all four of the major textile fibers—wool, silk, cotton, and linen—plus a rich heritage of design compounded of Oriental, Byzantine, classic Greek and Roman, and Mohammedan.

By the time of the Renaissance, Italy had a well-developed silk industry. It was producing silks, velvets, and brocades—fabrics that were in great demand by the churches and wealthy ruling classes. The desire for these textiles spread elsewhere, especially in France and England. By the time Louis XIV ruled France, the French had a virtual

Fig. 1.10—"Velvet Brocade Dalmatic," Italian textile of the fifteenth century. (Courtesy of the Detroit Institute of Arts.)

monopoly on silk production in Europe. Silk continued to be a favorite fabric until the late seventeenth and early eighteenth centuries.

Cotton, although our most important textile fiber today, had not been used by the ancient weavers of the East, except in India. From

Fig. 1.11—Italian, sixteenth century, border of red silk over drawn thread. (Courtesy of the Detroit Institute of Arts.)

records and literature historians have assigned the first cotton culture to southern India where it reached an advanced stage of development by 800 B.C. In Europe, the weaving of cotton did not become important until after the Mohammedan conquests of the eighth and ninth centuries. They not only introduced cotton cultivation but brought many skilled weavers from the East. The demand for cotton fabrics was greatly increased by the beautiful printed cottons from India which were included in the cargoes of the Spanish and Portuguese explorers. These fabrics were soon reproduced by the weavers of England and France. The vogue for printed cottons replaced the use of silks in the late eighteenth and early nineteenth centuries.

Although wool does not have the historical glamour that is associated with silk or linen, its development is equally interesting. The empires of Chaldea, Babylonia, and Assyria used wool at an early date. It is believed that wool was the chief fiber used there in making clothing. No examples exist of the weaving of these peoples, but they left extensive records engraved on clay tablets that would substantiate this belief. Excavations of the palace sites of their kings in Ninevah, Babylonia, and Ur of Chaldea have brought to light numerous accounts of their magnificent wool fabrics; the records also indicate they had an extensive commerce in textiles, carried on with neighboring countries.

Wool was used throughout Europe from prehistoric times. Caesar gives a vivid account of the plaid and striped materials worn by the Gauls. After the Arab conquest in the eighth century, Spain became widely known for her fine wools.

Sheep were introduced into North America by the Spanish. By the middle of the eighteenth century the Navajos and other Indians of the West were weaving their blankets and rugs from wool. Natural colored fibers and available vegetable dyes were used, but the Indians had no dye that would give them the bright red they admired in the Spanish materials. It was by raveling the woolen garments containing this color that they secured the red wool seen in the famous Bayeta blankets, so highly prized by the modern collector.

Prior to this time the American Indians wove with cotton. It is known that cotton has been cultivated since prehistoric times throughout the Southwest, and in Central and South America. Although little remains in Central America to prove its claim to early cotton culture, authorities believe the Mayas of that area reached a high state of culture and advancement in textile art as long ago as the sixth and seventh centuries B.C. The pueblos of the Southwest have yielded remnants of cotton cloth, seeds, and the tools for spinning and weaving that date back many years before the Spanish conquests.

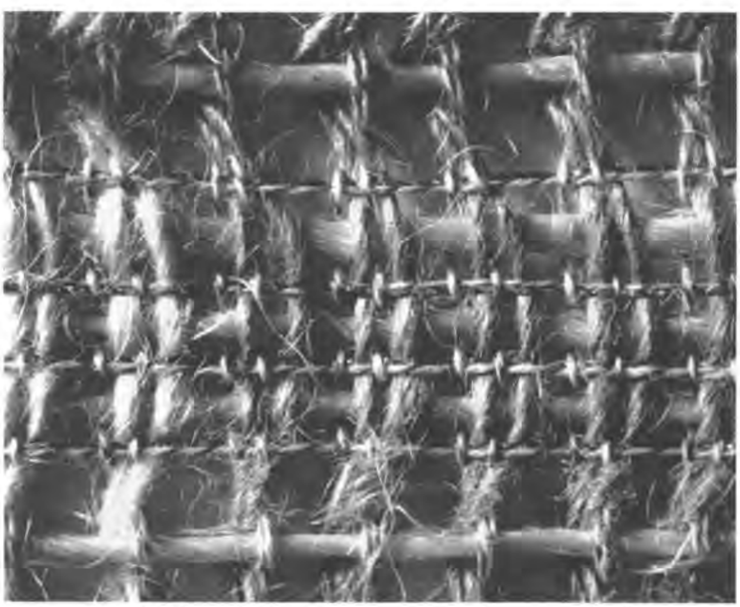

Fig. 1.12—Gauze weave, by Anni Albers. (Courtesy "Arts and Architecture.") Modern example of a very old technique, common among the early Peruvians. In gauze weave, warp yarns are used in pairs, twisted around each other between each weft shot. This twisting is accomplished by using an extra set of heddles, called "doups." Gauze is a common weave used for sheer fabrics because its structure prevents slippage. Marquisette is a gauze weave in common use. This illustration combines a gauze with a plain weave.

## ► TEXTILES IN THE NEW WORLD

Of all the countries in the New World, Peru presents the most interesting background in the textile arts. Although the tools were the simplest, the weaves represent a wide variety, including gauze, tapestry, embroidery or a type of brocade, and the pile weave. Both cotton and wool were used. Cotton grew along the coast; in the mountains, the llama and alpaca furnished wool. Skill in spinning and weaving is evident from the textiles that have been discovered. According to the late Philip Ainsworth Means, an authority on Peruvian culture, the fineness of the cotton yarns was surpassed only by the Dacca cotton of India. In his discussion of Peruvian woolens, he says:

> More usually the best woolen threads of ancient Peru ranged from 180 to 200 weft threads to the inch for one ply threads; and from 130 to 190 for two ply. The finest modern woolen threads made from vicuna wool give a weft count of between 70 and 90.[1]

Although the Peruvians had no written history, the Spanish invaders, fortunately, left a vivid description of the country as they found it. The vast treasures of fabrics, tools, and relics found in their burial grounds tell their own story.

Excavations in the Chicama Valley in northern Peru have brought to light a collection of textiles dating from approximately 2500 B.C. to 1200 B.C. Many of the fabrics were made of cotton in combination with a bast fiber. They were constructed by twining and netting methods as well as by weaving.

Early weavers employed the various types of construction in different ways. The plain, twill, and satin weaves each have certain characteristics that suggest their use. Where small, fine yarns were available to the weaver, as in Egyptian linen and the Dacca cottons of India, the quality of sheerness was emphasized by use of the plain weave. The satin weave, which originated in China somewhere around 1000 A.D., was a favorite with silk weavers of that country; this weave brings out the high gloss of the silk fiber as no other structure can. In damasks we generally see a combination of weaves which tend to point up the pattern by a contrast in texture.

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[1] Philip Ainsworth Means, *Ancient Civilizations of the Andes*, Charles Scribner's Sons, 1931, p. 461.

## ► COLOR USAGE

Effectiveness in structure is often achieved with color, and dyed yarns have played a conspicuous role in textiles of all civilizations. There are certain exceptions, as in one period in Peru when weavers utilized the natural colors of fibers, with their cotton graduating in shade from white, through gray tones, to several shades of tan and light brown. Hair fibers from the llama and alpaca also varied from white to gray, to different shades of tan and brown. The natural urge for color, however, manifested itself in primitive peoples who first used stains from berries and the secretion from plants for dyes.

Dyeing involves the use of mordants, such as alum, or salt, to fix the coloring matter. The natural pigments used for dyeing were derived from plant, insect, and marine life. Yellow and orange tones came from saffron, an herbacious plant; from resin of the sandarac tree; from Syrian orpiment, a mineral formation; and from many other sources. Carmine and scarlet were obtained from cochineal, a scale insect; blue-green, from the henna shrub; and blue-purple, from the glands of the murex, a shellfish. The roots of the madder plant gave a pigment similar to alizarin, used today in painters' pigments. Today practically all of our pigments are of synthetic origin and have a greater degree of permanency than the natural type.

Throughout history Man has always given symbolic qualities to colors, either from subconscious association or common assent. Churches at one time delegated to certain hues such qualities as penitence, charity, innocence, love, hope, or piety. Purple for centuries was associated with reverence and dignity, and was the prerogative of the clergy and royalty. The Phoenicians obtained this pigment from shellfish in the Mediterranean, and enjoyed a monopoly on Tyrian purple. With the fall of Constantinople, in the middle of the fifteenth century, purple was displaced by the scarlet dye obtained from cochineal, and this color is used today in certain church vestments.

## ► INFLUENCE OF MACHINE AGE

The nineteenth century brought the machine age to fabric production and other industries. With invention of the power loom in 1787 and the Jacquard loom in 1801, handweaving became a forgotten craft in all but a few isolated areas. The transition from hand-loom to power-loom weaving resulted in a greatly increased output of yard goods, and this in turn was reflected in lower priced fabrics. Efforts to supply an ever-increasing demand brought confusion and deterioration; the old standards of quality and design were sacrificed for quantity production.

In the late nineteenth century William Morris and a group of English writers and artists lodged a protest against commercialism on the grounds of its pretentious decoration and lack of sincerity. This marked the beginning of the Arts and Crafts movement in England, a movement that was dedicated to the restoration of traditional standards.

### ► STANDARDS OF QUALITY RESTORED

After World War I the industrial art schools in Germany assumed a more liberal attitude toward technology. They recognized the economic importance of the machine—with its ability to produce rapidly and accurately—and the school at Weimar, called the Bauhaus, attempted to effect a reconciliation between art and industry by first breaking down the separation that existed between the so-called "fine arts" and "applied arts."

New materials and new processes were being discovered and the Bauhaus group sought to correlate an art approach to product development. The basis for improved design was governed by three vital factors: the nature of the raw material, the method of construction, and the particular end use or function of the product. A close integration of these three factors makes an expressive design, one that is obviously related to its purpose. Examples of this intimate relationship between material and construction for a specific function are seen in plant organisms and other forms in Nature.

This school of thought has had a marked influence on architecture, furniture, and other household accessories. The products are characterized by a refined simplicity where the only decoration may be the material itself.

The role of handweaving in today's society is avocational. It makes up for some of the deficiencies of a highly organized industrial system—an age of specialization where the individual is confined to, and responsible for, but one small phase of a total activity. The need for release from the frustrations and emotional strains of contemporary life, as well as an outlet for the urge for creativity, is found in handweaving.

The individual here controls all elements of creating and producing, from the beginning to the final realization. This makes for cultural development and the textile becomes a personal accomplishment, expressing the personality of the weaver, and reflecting his own ideas of usefulness.

Today the individual weaver need not rely entirely on his own resources. This interest in a new and realistic approach to design in the crafts, especially in weaving, is being fostered by various agencies and in schools, where it is included as an integral part of the curriculum in the art or applied art area.

# CHAPTER 2

# TOOLS AND ACCESSORIES

Looms used by the hand weaver vary in many respects. One of the important differences is the number of harnesses the loom has. There may be only two or as many as thirty or more. With each additional harness the pattern possibilities of the loom are increased decidedly.

## ► CHARACTERISTICS OF DIFFERENT LOOMS

Effective textiles may be created within the limitations imposed by a 2-harness loom. The addition of 2 more harnesses, however, enlarges the structural possibilities immeasurably. This especially applies to materials that can be made solely with the "thrown" shuttle. Recognition of this fact has made the 4-harness loom one of the most popular with weavers today.

Two types of hand looms in common use are the *counterbalanced* and the *jack type*. In the counterbalanced loom the harnesses operate in pairs—depress a treadle and one harness will be pulled downward while its companion rises in a counter action. With the jack type, each harness may be operated separately as an independent unit.

Since the counterbalanced loom employs a reciprocating action, it is a comparatively easy loom to treadle. The jack type, however, has an advantage with unbalanced weaves, those in which it is necessary to have 3 of the 4 harnesses tied to a single treadle, a combination needed for some lace weaves.

## ► CHOOSING A LOOM

These and other factors make the selection of a loom a perplexing problem for the beginner. Experienced weavers often hold widely divergent views on the merits of looms, especially on the particular aspects of these two looms. Some looms are better adapted to certain types of weaving than others, and no one loom will be found to meet the exacting requirements of all. In schools or groups using more than one make or type, the beginner will have opportunity to see these in operation. This is information of a practical sort that will be helpful if he wishes to make an independent decision.

Important considerations with any loom are:

*Quality of construction.* It should be made of seasoned, kiln-dried hardwood to prevent warping and should be sturdy enough to withstand the impact of the constant beating during the weaving process.

*Tie-ups.* The cords, chains, or wires that connect the treadles to the lams should be of a type easily connected or disconnected; once connected they should be stable and should not stretch nor tangle.

*Treadling ease.* Whether the treadles are attached to the front or back of the loom is unimportant as long as they have sufficient leverage to permit easy operation.

*Beater.* This should be adjustable to accommodate different heights and lengths of reeds. A heavy beater is preferable to a light one, and is a necessity in rug weaving. Some weavers weight their beaters to give them extra force.

## ► PARTS OF A LOOM

It should be understood that these qualities are relative, and looms must be judged comparatively. Regardless of the selection, all floor looms have certain parts in common. These parts are illustrated in Figure 2.1 and include:

*Frame.* This supports two revolving members called the *warp beam* and the *cloth beam*. On the warp beam, located at the back of the loom, the warp is wound preparatory to weaving. The cloth beam at the front receives the fabric as weaving progresses. The diameter of the warp beam is important as a factor in maintaining warp tension. The larger the beam, the better, since it prevents excessive piling-up of warp yarns.

*Harness.* Technically speaking this includes the heddle frames, the lams, and the treadles—the mechanism which creates the shed. Most weavers, however, understand harness to mean the frame with attached heddles. The harness is suspended by means of cords or chains midway

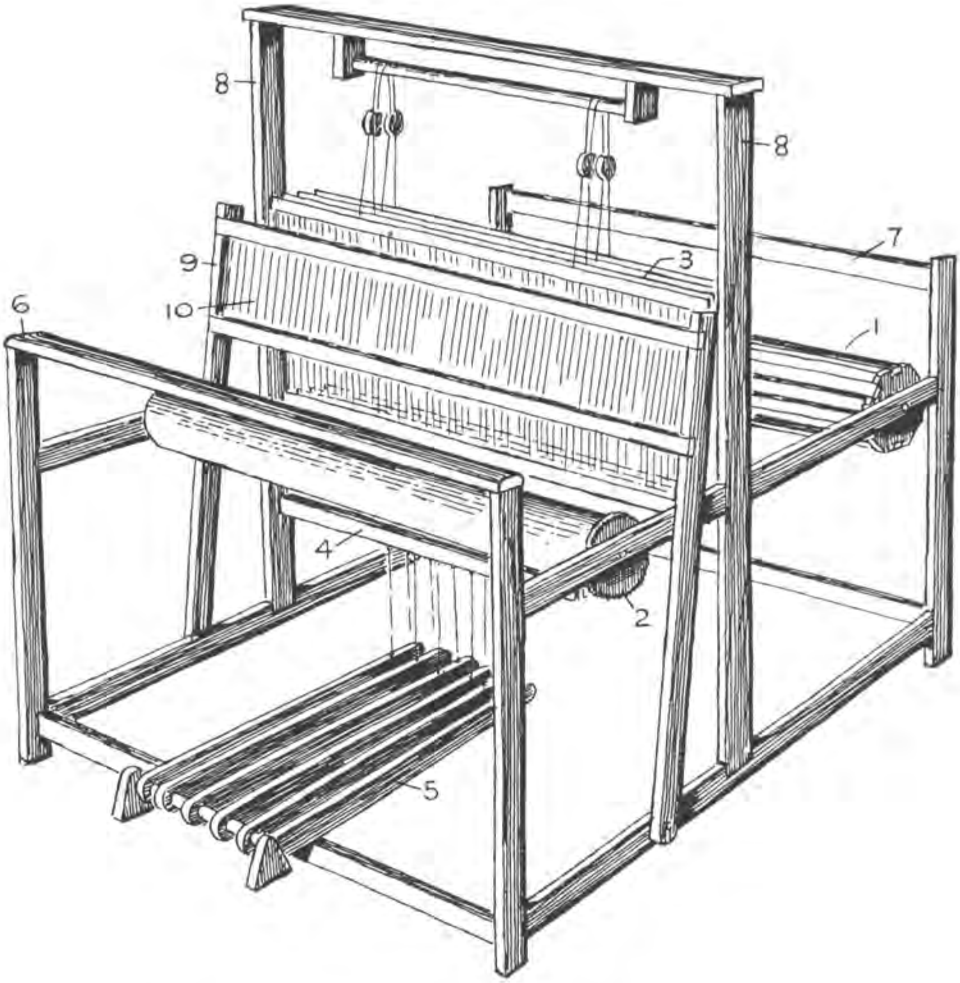
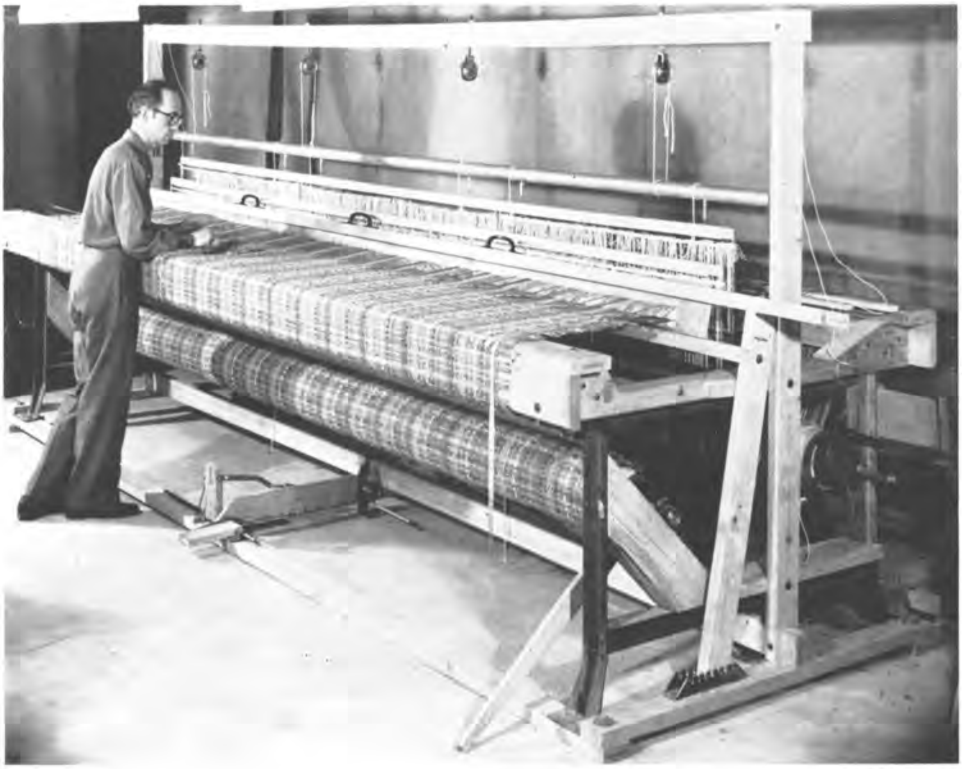



Fig. 2.1—Floor loom showing the important parts common to all looms. The first essential is a means of holding the warp yarns taut. This was accomplished by attaching the warp to the two bars in the primitive loom; by the warp beam (1) and the cloth beam (2) in the floor loom illustrated here. After being wound onto the warp beam (1) the warp passes up and over the back beam (7), then through the heddles and reed to the front of the loom. As weaving progresses, it is guided over the breast beam (6) and wound onto the cloth beam (2). Both the warp beam and cloth beam are equipped with ratchets for controlling the movement of the beams. The second essential is a method of separating the warp into sheds forming an opening for the passage of the shuttle. This mechanism includes the harnesses (3), the lams (4), and the treadles (5). The third important part of the loom is the beater or batten, shown here as the frame (9) which holds the reed (10) in place. The framework which supports the harnesses is shown in the side supports (8), connected by a beam across the top.

between the front and back of the loom. Individually, a harness may consist of either a frame or of two sticks, one placed directly above the other. They support the heddles, making it possible to elevate or depress selected sections of the warp in sequence, to achieve a given pattern structure. Harnesses are generally controlled by lams and these in turn are actuated by the treadles.

*Heddles*, illustrated in Figure 2.3, are suspended between the 2 harness sticks, with warp yarn threaded through the center eye. They may be made of stout cord, of wire, or of steel or aluminum strips. Wire heddles usually have larger eyes than flat heddles and, therefore, are more desirable if nubby yarns are used in the warp. When a variety of sizes and types of novelty yarns are combined, cord heddles are preferred. They have an advantage of large eyes that permit the yarns to pass easily and, being flexible, they cause less wear, abrasion, and breakage. Many weavers find them easier to thread.

Fig. 2.2—Loom with a 15-foot weaving width built to weave screens, wall dividers, and rugs. (Courtesy Sam Tushingham Studio.)



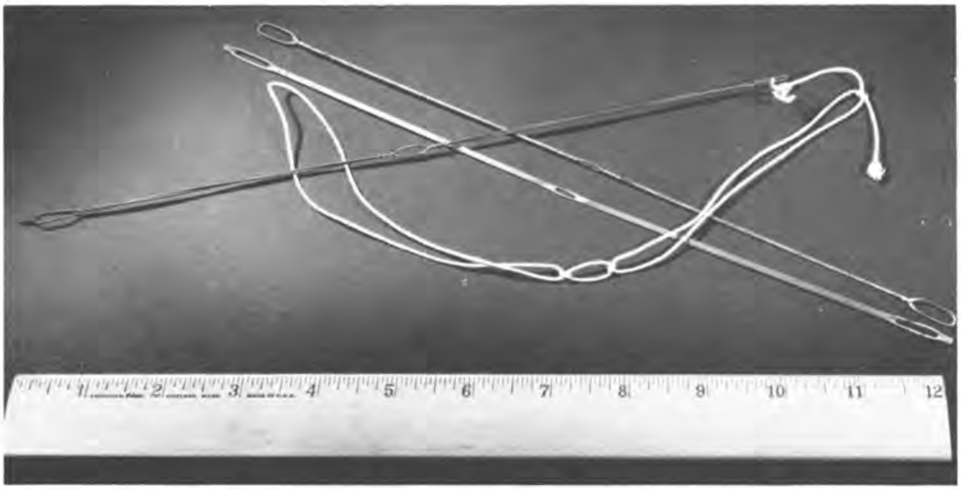



Fig. 2.3—Heddles of cord, twisted wire, flat steel, and aluminum. Not only do heddles vary in length but the size of the center eye or opening may vary. A larger opening is more desirable, and the wire heddles accommodate more variety of yarn sizes than do the flat metal ones.

*Lams* are the wooden arms found under, and parallel to, the heddle frames. They are attached to the loom framework on the left and are the connecting link between the harnesses and the treadles.* Lams make it possible to connect more than one harness to a treadle. Without them it would be necessary for the weaver to use both feet simultaneously to raise or lower two or more harnesses at the same time.

*Treadles* are the foot-controlled mechanisms that raise and lower the harnesses, creating the shed and controlling the warp yarns to effect the fabric structure the weaver desires.

A *beater*, or *batten*, is attached to the loom either at the base from which it pivots, or from an overhead framework where it is suspended to swing as a pendulum. This latter is termed an *overhead beater;* the former, a *floor beater*. The relative merits of these two systems is a subject of considerable controversy among certain groups of weavers. Either system, if well designed, will function satisfactorily. Preference generally results from long experience with one type or the other.

* They are attached to the harnesses by cords or wires at the exact center of the lower bar of the harness frame. Lam 1 is attached to Harness 1; Lam 2 to Harness 2, continuing in this order. Harnesses and lams may be numbered from front to back, or back to front, whichever the weaver chooses.

A *reed* is held in place by the beater, at the level of the warp. A reed consists of a metal frame that has a series of thin metal strips held parallel to each other, and equally spaced, throughout the length of the frame. Openings within this comblike device are called *dents.* Warp yarns are threaded through the dents to keep them in order, uniformly distributed throughout the width of the warp, and in proper position for weaving. When the weaver pulls the beater forward, the reed pushes the filling yarn into place, thus making the web, or cloth. Reeds are manufactured in many dent sizes. *Dent size* is determined by the number of openings per inch and may run from 4 to 40 or more. Contemporary weavers frequently use a range that extends from 6 to 15 openings per inch. Occasions may arise where it is desirable to thread more than one yarn to a dent, or thread in an irregular order, or even skip dents to achieve certain design effects. Reeds with fewer dents per inch permit greater latitude in the size of yarns used and in the arrangement of the warp ends. With a reed having many dents per inch the openings are proportionately smaller, therefore restricting its use to fine yarns.

### ► EQUIPMENT FOR MAKING A WARP

The usual equipment needed for preparing the warp includes:

Swift
Spool rack
Warping reel
Paddle

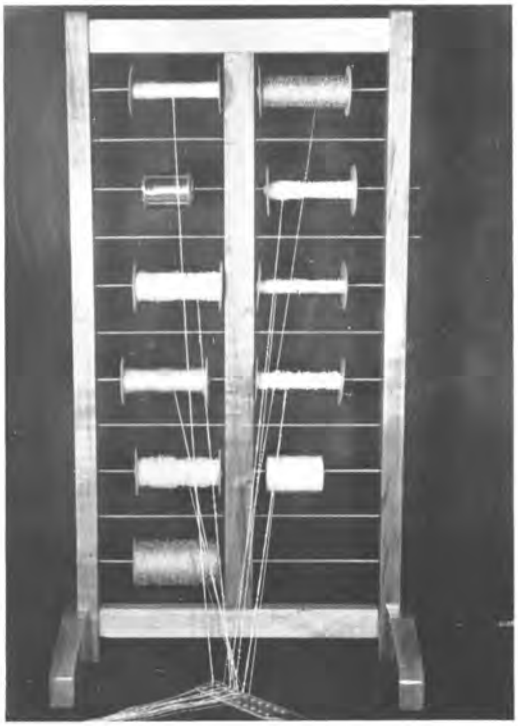
Weaving yarns are packaged in many forms: they may be in skeins or on cones, tubes, or spools, as in Figure 2.4, or other type of put-up. Yarn on cones, tubes, or spools generally presents no difficulties; it can be wound directly onto the warp reel, and a fairly constant tension can be maintained. Skein yarn, however, must be transferred to spools. The only exception would be when but one or two yarns are used in the warp and these both are in skein form; then they may be wound from the swift directly to the reel.

A *spool rack,* Figure 2.5, is a frame for holding the spools of yarn. It is an essential in keeping the yarns from tangling, and in retaining even tension. The metal rods on the rack shown are removable.

Two types of swifts are illustrated in Figure 2.6, the *umbrella* and the *floor swift.* Both incorporate adjustable features, to accommodate

Fig. 2.4—Yarns packaged on tubes, spools, cones, and in skeins. Note skein of chenille in background and white loop mohair at front. Linen tow yarn gives a dull texture to the tall spool, while the smooth white cone at left front is a mercerized cotton.

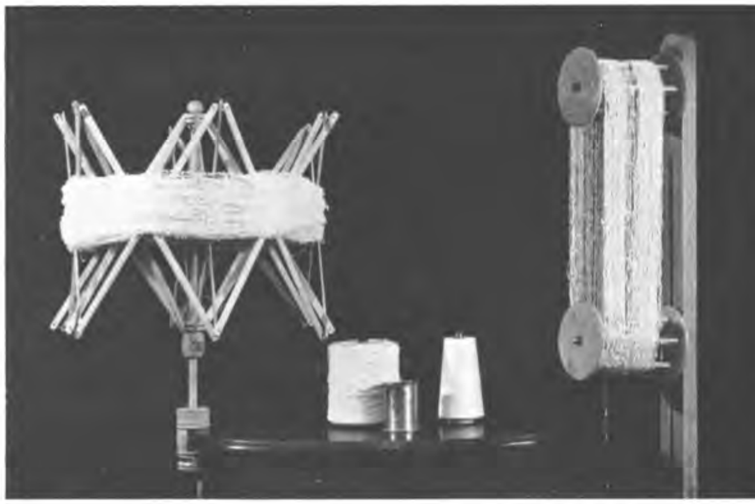
Fig. 2.5—Spool rack with spools of yarn in place and the paddle used in winding warps of four or more yarns.



various diameters of skeins, and they enable the weaver to keep the yarn taut so it may be unwound conveniently.

The preparation of a warp requires a *reel* or a *frame*. The reel shown in Figure 5.4 has a revolving section that consists of four uprights spaced 27 inches apart; one revolution would give 3 yards of warp. The pegs at the top and bottom are for starting the warp and making the cross. The pegs for making the cross may be either at the top or the bottom of the reel. The choice lies with the weaver. The cross is a separation of the warp yarns in an orderly sequence and is made by winding the yarns alternately over and under the pegs in the form of a figure eight. The separation of warp yarns is held in place on the loom by the lease sticks. This is to insure the proper arrangement of the warp as it is wound onto the warp beam and to facilitate the correct threading of the heddles. Three pegs are necessary if a warp is to be wound with a paddle, otherwise two are sufficient.

Fig. 2.6—Swifts, used for winding yarns from skeins. These can be the umbrella type like the one attached to the table, or the floor type at the right. In the floor swift the upper cylinder is stationary while the lower one is adjustable up or down. In the umbrella type the diagonal sticks are pushed up and out to fit a longer skein.



A typical *paddle* is shown in Figure 2.7. This is made of wood, metal, or plastic. It is used when more than five different yarns are employed as a warp unit and it is desired to wind them all at once. Otherwise it would be necessary to cut and tie the yarns to keep them in their proper sequence for threading. Many weavers use the paddle for winding fewer than five yarns.

A *stationary frame*, usually attached to the wall, is sometimes used for winding warps. The warp yarns are wound back and forth about a series of pegs, uniformly spaced to give an exact yardage. At the top of the frame are two additional pegs for making the cross.

### ► INSTALLING THE WARP ON THE LOOM

The following accessories are needed for this operation:

Spreader
Pair of lease sticks
Warp beam sticks
Reed hook

Fig. 2.7—The paddle used when winding warps of four or more yarns. Numbered holes show the order of threading the warp ends.

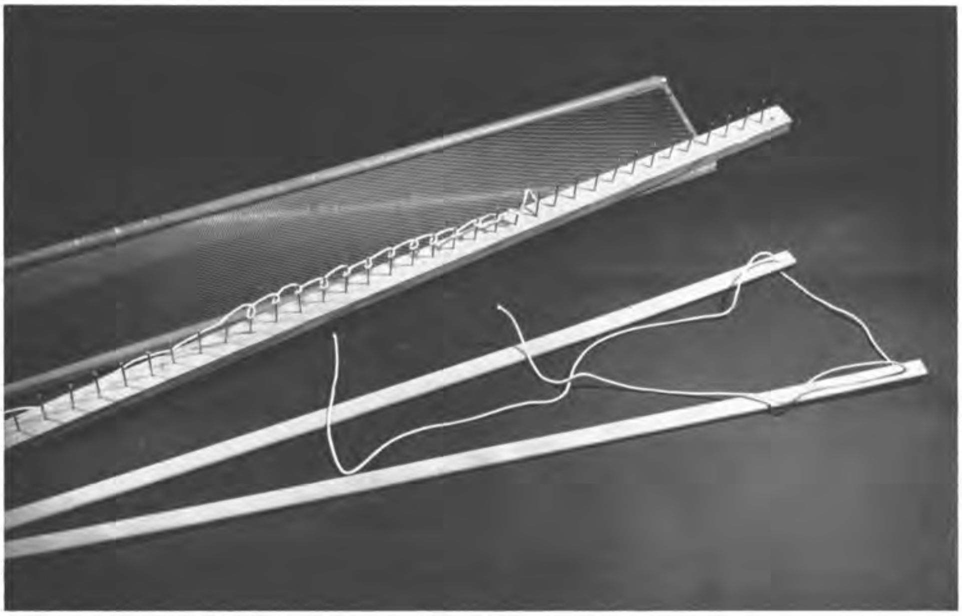


Fig. 2.8—A reed, a spreader, and a pair of lease sticks. A cord is laced around the nails to hold the warp in place. A stick or bar tied back of the nails could be used.

Before winding the warp onto the warp beam, the weaver must make some provision to see that the warp is spread out evenly to its full width. The *spreader* is usually used for this purpose. Like many loom accessories, it is a simple appliance and easy to make. Use a piece of 1″ × 3″ softwood, slightly longer than the width of the loom; drive No. 10 finishing nails one inch apart into the wide side of the wood, extending the entire length of the spreader. Prior to winding the warp on the beam, the spreader is placed in front of the loom uprights that support the harnesses. It rests on two sticks which have been placed inside and against the uprights and which extend from the breast beam to the back beam. These, together with the spreader, are tied securely to the uprights before making the warp distribution. The warp is then distributed within the 1-inch intervals of the spreader according to the number of ends per inch.

Resting on the same horizontal sticks that support the spreader are the *lease sticks.* Their purpose is to maintain the cross made at the time of winding the warp. After insertion in these openings on either side of the cross the lease sticks should be kept in place until the warp has been threaded through the heddles and reed, and the warp has been checked for mistakes, then they may be removed.

Another group of sticks is placed between the layers of warp as the warp is wound onto the warp beam. These *warp beam sticks* are flat strips of wood, approximately 1/4 inch thick and 1 to 1 1/2 inches wide, cut the length of the warp beam and sanded smooth on all edges. In cutting these for length, make allowance for ratchet and pawl clearance; otherwise they will interfere in turning the warp beam. These sticks are inserted as the warp is wound on the beam. They prevent the warp yarns from piling up, and also help to maintain warp tension. With long warps, especially those having textured yarns, they should be used quite freely.

The *reed hook* is a flat metal hook, similar to a crochet hook that is used to pull the yarn through the reed.

## ► WEAVING ACCESSORIES

Once the warp is on the loom, the weaver needs certain accessories to do the actual weaving:

- Shuttles
- Bobbins
- Bobbin winder
- Tape measure, scissors, and other sewing accessories

Fig. 2.9—A few of the many types and sizes of shuttles. At the extreme right, rollers in the bottom of the shuttle eliminate friction. The flat stick accommodates wefts too bulky or wiry to be wound in the usual manner. The shuttle in the center foreground uses a wooden bobbin. With the others, paper quills or spool-like bobbins of wood or plastic are used.

The type of *shuttle* selected by the weaver is determined largely by the material to be woven. Shuttles, which carry the filler yarn, are made in many sizes and shapes, as seen in Figure 2.9. Some, like tapestry shuttles, may be only 2 inches long; others, such as flat rug shuttles, may be more than 20 inches in length. Boat-type shuttles vary in length from 7 to 15 inches and have either an open or closed bottom. In some shuttles the yarn comes from an opening in the side, in others from the end. For fine filler yarns a small boat shuttle is often best. Heavy yarns call for a proportionately larger shuttle that has a large bobbin opening and an open bottom to take the maximum amount of yarn.

Rollers are sometimes recessed in the bottom of the shuttle to eliminate friction. Many weavers weight their shuttles to increase their speed as they pass through the shed. Sooner or later weavers develop individual preferences on such matters and frequently adapt shuttles to their own uses, or may design and make their own.

*Bobbins* usually are made of plastic, wood, or cardboard, though some weavers use soda straws or wrapping paper as bobbins. If paper is used, it is cut in an oval shape with the length slightly shorter than the shuttle opening. This paper form, or quill, is wrapped about the winder shaft near the end, then forced back on the tapered shaft until it is tight. While the weaver holds the paper tightly, the end of the filler yarn is inserted under the edge of the paper, the shaft turned a few times, and the winding proceeds.

*Bobbin winders* may be of the hand type or electric. An electric winder, shown in Figure 2.10, that combines two shafts—one for wind-

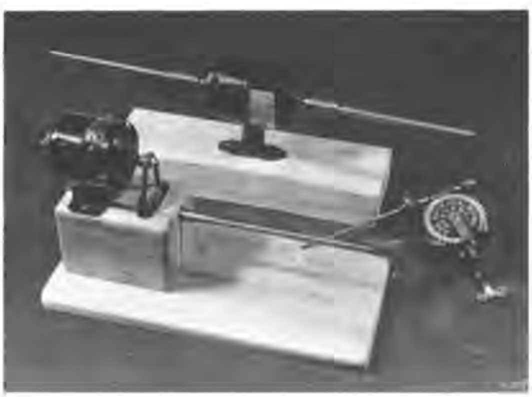


Fig. 2.10—Bobbin winders. For extensive work the weaver will find an electric winder a necessity. The one shown above has two metal shafts or mandrels, a large one at the right for winding spools and a small one at the left for bobbins. The lower winder has a tapering mandrel which serves both purposes. A Swedish hand winder is shown at right.

ing bobbins and the other for winding spools—is a decided asset to anyone doing a large amount of weaving. The electric winder has the advantage of allowing the weaver to use both hands in guiding the yarn. With the hand winder one hand must be used to turn the winder.

While the list of tools given here may be expanded, the beginner will find these essential and adequate. Many of them can be made by the weaver himself; further, he can incorporate his own ideas and make any improvements that might interest him.

It is well for the hand weaver to realize that the loom as we know it today has been developed over a long period of time by those using it and knowing its requirements. Many excellent looms are available. A good loom, one that works easily and efficiently, is absolutely necessary to produce a worthwhile fabric, and no hand weaver should be satisfied with less.

# CHAPTER 3

# FABRIC MATERIALS

The tangible element in textiles is yarn.* Yarn is made from fibers, slender thread-like filaments that are derived from leaves and stems of plants, from animals, minerals, and chemicals. These materials have diversified properties and characteristics: they may differ not only in appearance but also in such properties as strength, durability, and elasticity; in response to heat and moisture; and in lightness, warmth, and coolness. These factors are important to the hand weaver since they have a bearing on the use of a yarn and its suitability for certain fabrics, and may often dictate its use as a warp or a weft element.

The weaver is often confronted with a situation where he has to compromise between a yarn that is aesthetically agreeable but, because of the nature of the fiber and the yarn construction, it may be less suited to the structural needs of a fabric than a less promising yarn. Any evaluation in such cases must be based on knowledge of the fibers and, particularly, from an examination of their behavior in the weaver's preliminary design samples.

## ► SOURCES OF FIBERS

A list of the more commonly used textile fibers includes:

1. Natural fibers
   a. Vegetable origin
      (1) Cotton — a seed-hair fiber almost 100 per cent cellulose
      (2) Linen, hemp, jute, and ramie — bast fibers, from the stems of plants

* Thread, which is designed and made solely for sewing purposes, is rarely used for weaving; the hard cable construction is unsuitable for most textiles.

(3) Sisal and silk grass — from the leaves of plants
(4) Coir — from the outer shell of the coconut
b. Animal origin — wool, silk, and the hair fibers
c. Mineral origin — Fiberglas, metals, and asbestos

2. Man-made fibers
a. Vegetable origin
(1) Viscose rayon and cuprammonium (Bemberg) — derived from regenerated cellulose
(2) Acetate — from unregenerated cellulose
(3) Vicara — from the protein of corn
b. Mineral origin
Acrilan, dacron, dynel, nylon, orlon, and saran — with others whose uses are not so well defined. This group of fibers, including acetate, is referred to as thermoplastics because of their sensitivity to heat. Static electricity is another property common to this group of fibers.

## ► NATURAL FIBERS

Until the twentieth century, cloth was woven predominantly from four fibers: cotton, linen, wool, and silk. Today, the first three in this group are probably used more often by the hand weaver than all other fibers combined.

Of the vegetable fibers, *cotton* is still the most important economically. At the present time it exceeds all fibers in the total quantities produced. While the United States is the largest producer, the plant has a wide distribution and is cultivated in many parts of the world. Egypt, India, Turkey, Brazil, Russia, Peru, and China—all produce a sizable volume.

The cotton fiber is obtained from seed pods, or the bolls, of the plant. It is an exceptionally fine filament and possesses a slight natural twist—a feature that is most conducive to spinning. There are four or five species of the cotton plant and many varieties. In this country the most important is *American Upland.* This is grown throughout the Cotton Belt, from the Carolinas to Texas, and comprises the major portion of our production, supplying us with our commodity fabrics. For quality cloth and fine materials, *Sea Island* and *Pima* are often used.

Pima is a soft, silky fiber that was developed from the Egyptian species transplanted to this country more than 100 years ago. (The name Pima is taken from the county, Pima, in Arizona, where the plant was first grown.) For strength and firmness Pima is rivaled only by Sea Island, a variety grown in Georgia, the islands off the coast of South Carolina, and in sections of Florida.

The nature of cotton—its general stability under conditions of heat, tension, and rough handling—makes it a valuable yarn for the hand weaver. Since cotton yarns can be spun with a variety of textures—soft or hard, dull or shiny, and in intermediate degrees—their usefulness extends over a wide range of textiles.

By means of mercerization, cotton yarns can be given extra-smooth surface qualities and rich luster. In this process the yarn is immersed in a caustic soda solution and held under tension; the fiber swells, the natural twist of the fiber is reduced, and a bright, smooth yarn is produced. Long-fiber cotton is usually used for mercerizing; after being combed and spun into yarn, the projecting ends of the fibers are usually singed by passing through a gas flame. Yarns so processed are termed "gassed."

In altering its structure, mercerizing increases the strength of the yarn. It also gives it a greater affinity for dye, and clear bright colors are attainable by vat dyeing. Mercerized cotton yarns that conform to fixed standards of quality are often sold under proprietary names, such as "Durene." The names "Pearl" or "Perle" carry similar connotation, but refer more specifically to a soft twist type of mercerized cotton.

Many fibers of commercial value are obtained from the leaves and stems of plants. Stem fibers are usually finer in size and more pliable than leaf fibers, and certain yarns from stem fibers, such as linen and ramie, are of particular interest to hand weavers.

*Linen* is made from fibers found in the stem of the flax plant. Flax, which has been cultivated for centuries, is grown for two purposes: for fiber production and for seed, from which we get linseed oil. Plants grown for fibers may yield strands as long as 30 inches. While small in diameter, they possess marked strength and, when spun into yarn, give a smooth finish and sheen that is quite beautiful in its natural state.

The fiber is not an easy one to dye, but because of demand by hand weavers, yarn manufacturers now offer an extensive range of color in linen. The cool, smooth, lintless properties of linen are found in no other fiber. These qualities added to its exceptional durability recommend the use of linen in many types of fabric, and we find it a favorite with hand weavers today as it was, indeed, two thousand years ago.

In processing flax, the long fibers are made into a strong, smooth, lustrous yarn called "line" linen. However, a percentage of the fibers will be reduced to short, broken lengths. These are spun into a type of linen that is known as *tow*. Cheaper grades of fiber are spun into a yarn that has a relatively coarse, uneven surface, with no appreciable luster. From the hand weaver's point of view, however, they are very usable, for they have a peculiar homespun quality that combines well with other yarns. Weavers sometimes dye the natural-colored tow themselves to get soft, muted tones that will complement another filler yarn.

A yarn less frequently used by hand weavers, but of considerable interest, is made from *ramie,* a plant native to the Orient. The plant, sometimes known as "China grass," produces a fiber with exceptional properties. It is thin, light in weight, and has a tensile strength that exceeds any known natural fiber. Varied atmospheric conditions do not affect the fiber; while it will absorb moisture, it dries quickly. Lack of elasticity, however, causes it to wrinkle easily. Ramie has pronounced luster and is believed to have been used at one time in some parts of China as a substitute for silk.

Ramie is difficult to process. The fibers in the stem of the plant are bound together by an adhesive gum and, in separating them, many are broken into various lengths. It is necessary either to sort these lengths or to cut them into a uniform size in order to spin a good grade of yarn. Special equipment is needed for spinning. Ramie is now cultivated in Florida, the Philippines, and, to a limited extent, in Mexico, the West Indies, and southern Europe.

Many kinds of leaf and stem fibers are utilized by the cordage industry for rope and twine. A few applicable to handweaving are mentioned here. Some, like jute, are spun into yarn, either using the jute fiber alone, or combining it with others within a given yarn.

To most of us, *jute* is associated with burlap, a fabric usually made from that fiber. There are many grades of jute, however; the color range may run from a tawny brown through many intermediate shades to a clear ecru tone. This is found in the finest grade, which is soft and smooth, and possesses considerable luster. Weavers, as a rule, prefer to use jute in natural tones; the fiber doesn't bleach easily, and most colors tend to impair rather than enhance the beauty of the fiber. Like tow linen, however, the natural jute might be dyed by the hand weaver in subdued shades and used as an alternate filler to good effect.

Jute has its limitations as textile material; the fiber lacks strength and, with age, loses much of its luster. It is sensitive to atmospheric conditions—more than any other natural fiber. Its major uses are for commercial products like bagging, sacks, and twine. Jute production ranks next to cotton among the natural vegetable fibers; almost all jute is produced in the province of Bengal, in Pakistan.

*Hemp* has a coarse fiber; it compares favorably with linen for strength and pliability. The plant is cultivated in many parts of the world, but the more competitive fibers have displaced it for many uses. Hemp, as a name, has come to be used generically in trade. It includes many leaf fibers that, while similar in appearance, are different in many respects from the true fiber.

*Sisal*, or henequen, often called "sisal hemp," is from the leaves of a tropical plant grown extensively in the West Indies. The fibers are often 5 feet in length and, like many of the leaf fibers, are heavy bodied, stiff, and shiny. Sisal and hemp are mainly rope fibers but the hand weaver may find them useful in floor coverings or other heavy materials.

*Silk grass* pertains to fibers that come from various species of the pineapple family. The name is descriptive of the natural fiber which is often used unspun. Delicate, crisp fabrics are made from it and they have surprising strength and considerable beauty. The plants are cultivated extensively in the tropics.

*Coir* is a coarse, brown fiber taken from the outer covering of the

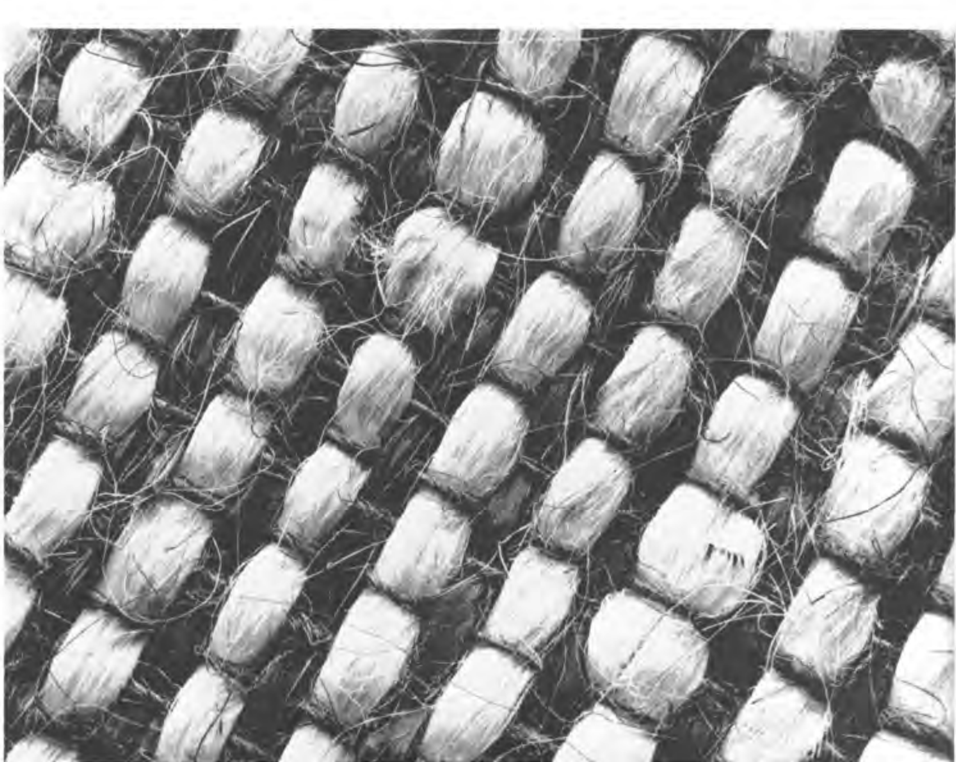


Fig. 3.1—Rug of maguey fiber, palm leaf, and cocoanut cord, by Geraldine Funk.

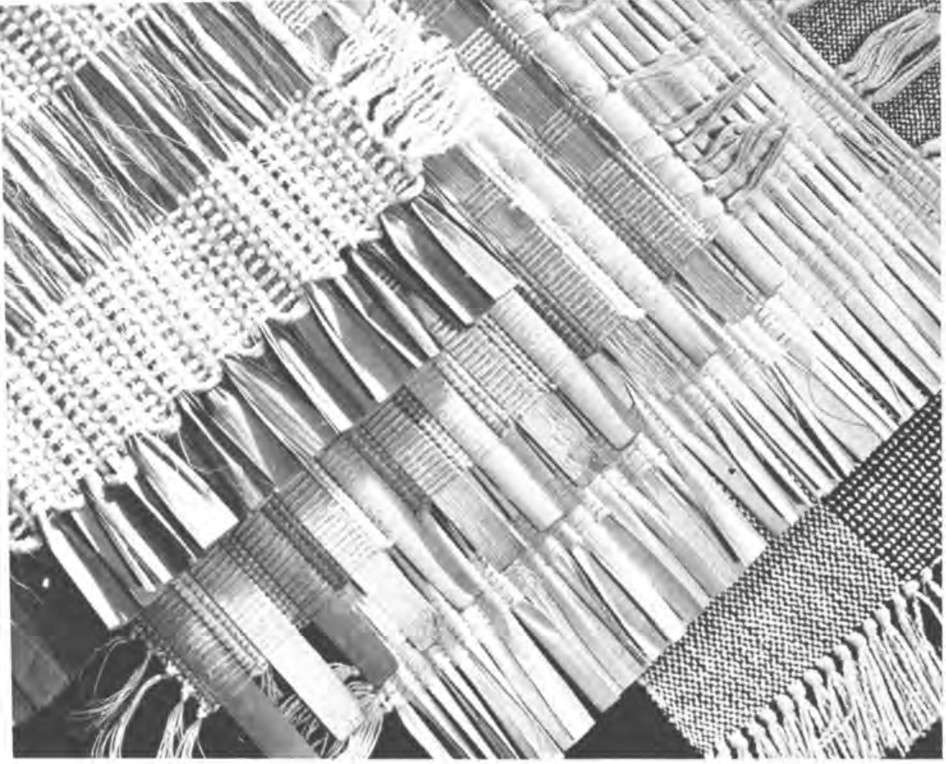


Fig. 3.2—Bamboo, royal palm, enea, maguey, junco, and cogollo were used in these mats woven in Puerto Rico, by Geraldine Funk. (Courtesy "Craft Horizons.") Many materials from faraway places are finding their way to our markets.

cocoanut. It is exceedingly strong and is used for weaving mats as well as for making brushes, rope, and other commercial products.

*Raffia* is known to most weavers. The material consists of strips of leaves taken from a species of palm found in Madagascar. It is pliable, sturdy, and takes a dye much the same as jute. Weavers frequently use raffia for mats and bags and, since it does not disintegrate easily, sometimes employ it in upholstery and drapery material.

*Bamboo, reeds, wood slats,* and other organic materials can be utilized for weaving screens, shades, and decorative panels. The possibilities of native material should not be overlooked by the hand weaver. An example of such possibilities is shown in Figures 3.1 and 3.2, a project in handweaving supervised by Geraldine Funk in Puerto Rico.

Yarns made from animal fibers fall into three main groups:

WOOL, the fleece from sheep

HAIR, from the goat, alpaca, and other animals

SILK FILAMENT, produced by the silkworm

*Wool* attracts many weavers. It requires different handling than other fibers but once a weaver works with it and finds he is successful, he often prefers it to any other fiber, including, incidentally, hair fibers.

The characteristic elasticity of wool—the qualities of springiness and softness—comes from the structure of the fiber, which differs from that of hair. A wool fiber is curly and is covered with a series of scales or serrations that resemble sections of a pine cone. These two factors—curliness and the serrations—make it easy for the fibers to cling and interlock; relatively sheer fabrics may be woven from wool without danger of slippage that would normally occur with other fibers. The finer the fiber, the closer are the serrations.

There are two types of wool yarns resulting from different spinning methods: *worsted* and *woolen*. They can usually be distinguished from each other upon examination of the yarn: worsted yarns are relatively smooth; woolen present a fuzzy texture. In making worsted yarns the fibers are combed so they lie parallel prior to spinning. No attempt is made to straighten the fibers of woolen yarns, aside from carding. Worsted yarns, which are used for weaving smooth fabrics, generally require long fibers. The method of spinning woolen yarns permits the use of short lengths.

Most commonly used of the hair fibers is *mohair,* which is produced from Angora goat hair. It is a soft, lustrous fiber, sometimes as much as 12 inches in length. It has a smooth, slippery quality and is more elastic than wool. Yarn from mohair is easily dyed and is capable of producing many rich colors. It is often used by hand weavers in upholstery, pile fabrics, drapery, and apparel materials. The Angora goat is raised extensively in Texas and throughout the Southwest.

*Alpaca* fiber is similar to mohair in many respects. The fiber approximates the size and length of mohair but is considerably stronger. The color range of the natural fiber extends from light gray through the beiges to a nut brown. The alpaca is a member of the llama family and native to South America.

There are other animals that yield fibers in limited quantity—fibers that are desirable to the hand weaver but, because of the limited supply, are quite expensive. Among these is the Cashmere goat, an inhabitant of the high Himalayan Mountains. Fine, down-like underhair is plucked from the goats in the spring of the year when the animals molt. This is called *cashmere,* a fiber that is as lustrous and elastic as mohair, and finer than the finest wool. It is seldom used alone but combined with other fibers such as wool. The colors of the natural fiber run through white, gray, and brown, to black.

In an effort to achieve weaving yarns with a soft "hand," or texture, hair from the Angora rabbit is sometimes combined with wool or other fibers. These fibers are long enough for spinning, and absorb dye readily. *Angora* is spun alone as a knitting item and enjoys much popularity because of its soft texture.

*Silk* is an animal fiber produced by the silkworm. In the process of changing from a worm, or caterpillar, to the chrysalis stage, the silkworm wraps himself in a cocoon formed of filaments extruded from a tiny aperture on either side of the head. The two filaments are joined by a gum, and may be twelve hundred yards in length. Attendants take the filaments from several cocoons, usually 4 to 6, and join them; these are reeled into skeins. Silk in this form is known as *raw silk.* A large amount of silk fiber is in short lengths, due to damaged cocoons or irregular sized filaments. This is spun into yarn and known as *spun silk.* In making spun silk the shortest fibers are combed out and these are processed into *silk noil.* Spun silk has less luster than *thrown* or *reeled silk.* Filaments from cocoons that develop under natural conditions are coarser and less regular in size than those from "cultivated" cocoons, where the growth and feeding of the worms and the care and processing of the cocoons are under carefully controlled conditions. The greatest amount of silk fiber comes from cultivated silk, though a small amount of wild silk, called *tussah,* is also produced by worms feeding on oak or other leaves. In harvesting, these cocoons are usually damaged, resulting in short or broken filaments.

Silk is expensive because of its limited quantity and the hand labor necessary in producing and processing it. However, it is popular because of its desirable qualities: a high luster, great strength, elasticity, a light hand, and its great affinity for dye.

Of the natural mineral fibers, *Fiberglas* and *asbestos* are important commercially because of their fire-resistant qualities. While Fiberglas has been used to a limited extent by hand weavers, both it and asbestos are primarily important in products outside the scope of handweaving.

Yarns from metals have been used by weavers for centuries. Records dating as early as the third century B.C. indicate that strands of beaten gold were at that time interwoven in priestly vestments, probably by embroidering. Today the metallic yarns offered the hand weaver are nontarnishable. These are made from bonded aluminum foil and coated with a clear or colored plastic. The yarn may have one or two filaments, such as rayon or silk, twisted about it to give added strength. This yarn, called *supported* yarn, can be used in warp.

Yarns can be made from any one of these fibers alone or from a combination of these materials. As many as four different fibers might be used within a single yarn, making a blend that would incorporate their collective advantages and minimize their individual disadvantages for a specific purpose. Since 1950 textile engineers have developed many yarns by blending; these have not only raised the quality of fabric but have decreased its cost appreciably.

### ► MAN-MADE FIBERS

The man-made (synthetic) fibers can be put into two classes: those that are made from the vegetable-matter cellulose—the rayons and acetate; and those that are derivatives of mineral elements as, to name a popular one, nylon.

Synthetic fibers were known as early as 1880. Their development on a commercial basis, however, has occurred since 1900, and particularly since 1940. The synthetics have properties and characteristics that tend to supplement the natural fibers rather than displace them. Synthetic fibers of contrasting texture may be woven together to make interesting designs, as in Figures 3.3 and 3.4.

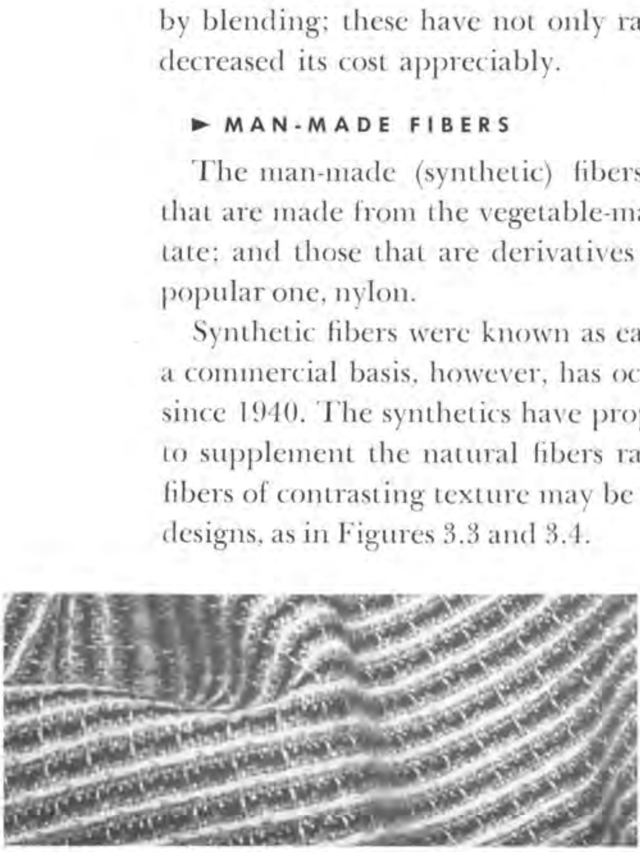


Fig. 3.3—"Web-Rib," a fabric of dynel and spun saran, designed by Marli Ehrman for the Edwin Raphael Company. (Courtesy "Arts and Architecture.")

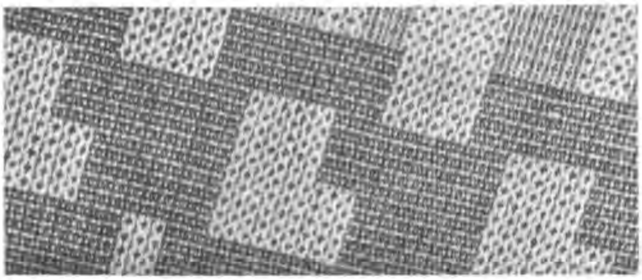


Fig. 3.4—"Form Play," of dynel and spun saran, in a heavy construction, reversible and fireproof, designed by Marli Ehrman for the Edwin Raphael Company. (Courtesy "Arts and Architecture.") These are exact copies of hand-woven designs, mass-produced by the Lumite Division of Chicopee Mills.

Aside from the fact that they can be made to resemble such fibers as linen, wool, and silk, synthetics embrace such qualities as being wrinkle proof and resistant to moths and mildew; they are washable, dry quickly, do not stain easily, and can be made into fabrics having various degrees of warmth and coolness. These qualities are often capitalized by combining synthetic fibers with natural fibers in a yarn—a practice known as *blending*—where the limitations of these fibers are minimized while their advantages are exploited. Wool, for instance, is commonly blended with various synthetics to make it crease resistant, light weight, and durable. Similar examples might be given with other fibers.

The basic steps in the production of the synthetics is first to reduce raw material into a solid, then change the solid into a liquid, and finally transform the liquid back into a solid by extruding it through a spinneret, thus forming a filament, as shown in Figure 3.5. The diameter of

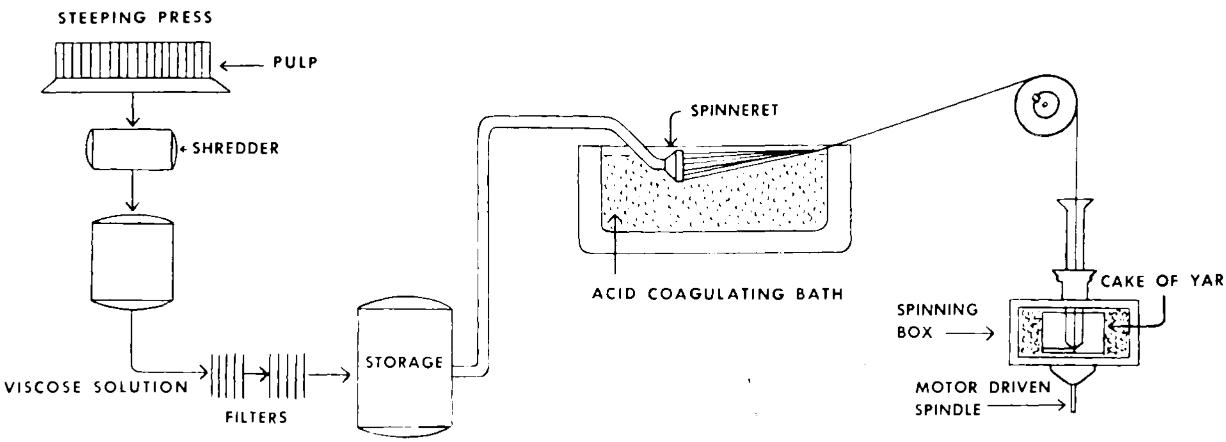



Fig. 3.5—Steps in the production of viscose rayon yarn. (Courtesy American Viscose Corporation.) A solid, either wood pulp or cotton linters, is reduced to a liquid solution which, in turn, is changed to a solid in the form of filaments, or yarn.

the individual filament can be controlled by the manufacturing processes; it can be minute, in which case many filaments might be twisted together by throwing; or the diameter of the individual strand can be increased, making a *monofilament* yarn. *Multifilament* yarns would result from twisting these last elements together. In nylon, monofilament yarn is used for making very sheer hosiery, since it is both smooth and strong. Filament yarns are used mainly where a luxurious, silky finish is desired. A soft or dull finish is generally attained by spinning filaments which have been cut into short lengths.

An important group of fibers has been developed by scientists from cellulose. These fibers are made from wood pulp and cotton linters and have generally been known as *rayon*. There are two distinct types, however, that differ not only in their physical properties but in the method of manufacture. In September, 1951, the Federal Trade Commission established names that would differentiate these fibers. Those that were developed from regenerated cellulose (viscose and cuprammonium) would be designated as *rayon*, while the product from unregenerated cellulose would be termed *acetate*.

The classification is important to hand weavers as well as industry. Viscose rayon has greater strength than acetate, but less elasticity. If stretched to a certain point, rayon does not spring back when tension is removed. This factor should be remembered in selecting warp yarns; and if rayon is used, it may be necessary to introduce a stabilizing fiber along with it depending, of course, upon the fabric. Rayon absorbs moisture more readily than acetate, but is less sensitive to heat, so rayon will take a warmer iron than acetate. Both fibers have their place in textiles, and rayon and acetate today comprise more than 90 per cent of the man-made fibers used.

*Vicara* is a synthetic made from corn protein and is not affected by mildew or moths. It resembles wool and is used generally as a blend. Its shrink-resistant characteristic helps fabrics hold their shape, and it has an additional quality of having a very soft cashmere-like texture.

*Nylon*, which was first introduced in the late 1930's, has been widely used for many purposes, from sheer dress goods to fish lines. It is notable for its strength, being stronger than any of the natural fibers. It also resists abrasion to a marked degree, and is being used in commercial products subjected to this type of wear. The fiber shows considerable elasticity, and the percentage of recovery from tension is large. Like many synthetics, it does not take dye as readily as do many of the natural fibers. Prolonged exposure to sunlight weakens the fiber.

*Orlon*, a fiber that appeared in 1948, is a synthetic that is not seriously affected by prolonged exposure to sun and weather. Orlon is light in weight, strong, and washes and dries easily. Spun orlon makes a soft, fluffy yarn which is used extensively in fabrics for outer wear.

*Dacron,* another synthetic fiber, has been in demand for yarns used in clothing fabrics. It is washable, quick drying, and wrinkle resistant. Dacron is a warm fiber that holds its shape when woven into fabric and is resistant to both mildew and moths.

*Dynel* was introduced in 1950. This fiber, too, is washable, and can be spun into soft, fluffy yarn which is resistant to weathering, moths, and mildew. The fiber is creamy white in its natural state but can be bleached and, when dyed, is fast to sunlight. It has been used in blankets because of its warmth. Often blended with wool and other fibers, dynel has been used in apparel and household textiles, and in pile fabrics. While extremely sensitive to heat, it will not support combustion. It is highly resistant to chemicals.

*Acrilan* is a warm, soft fiber that has qualities of weather resistance. It is light weight, can be dyed with wool dyes, and is frequently blended with that fiber. While washable and quick drying, it shrinks in hot water. This fiber is especially suitable for brushed and napped fabrics.

*Saran* is familiar to us as the material commonly used in covering porch furniture and automobile seats, and for screening. It does not absorb moisture, is strong, and resists abrasion. It is rapidly becoming an important yarn in carpeting.

In making a selection of these fibers the hand weaver must consider their limitations and possibilities on the hand loom and in fabric. Much of this information will come from practical experience.

### ► KINDS OF YARNS

Fibers vary in length; the only ones that are continuous strands are those made by Man or the silkworm, and these are termed *filaments.* A group of filaments may be twisted together loosely by a *throwing* method and made into yarn; often, however, in the case of synthetics, they are cut into short lengths, called *staple.* They are then twisted and drawn into a strand by the process of spinning.

Staple is a trade reference that applies to the relative length and fineness of any given fiber; a cotton, for example, may be graded as *long staple* or *short staple;* with the man-made fibers, while the dimensions may vary, this factor is controlled entirely by manufacturing processes.

The simple yarn that results from spinning is known as a *single-ply yarn* or a *singles.* When two singles are twisted together they make a 2-

ply yarn; and three would make a 3-ply. The hand weaver, by untwisting the end of a ply yarn, can separate and identify the number of singles that have gone into its construction.

To the weaver, a single-ply yarn is generally considered as a filler yarn —not strong enough for warp. Certain woolen yarns, however, and linen singles that are wet spun, present no great difficulty to the experienced weaver. It is characteristic of most singles to have little twist. Such yarns produce a soft effect in woven material and have better filling qualities than hard-twisted yarns.

When several ply yarns are twisted together we have a *cable,* or *cord yarn.* This gives an unusually strong construction and is used chiefly for rope and twine where strength is important. Household sewing thread, however, is a cable, usually of 6-cord construction.

There is another class of yarns known as *novelties.* These are made from one or more singles or ply elements and are manipulated through twisting to form a yarn with uneven, irregular surface characteristics. When woven in fabric they contribute textural interest. The various types are identified by such names as *bouclé, ratiné, flake, chenille, slub, loop, nub, corkscrew,* and *frill.* The names given these types have a general rather than a specific application and some constructions may, on occasion, closely resemble each other. Brief descriptions of these yarns are given in the glossary.

## ► SIZES OF YARNS

Since novelty yarns, in construction, are extremely varied in their fiber combinations, standardization of sizes is difficult. Manufacturers, in offering such yarn, always state the yardage there is in one pound of yarn. With other types of yarn this is indicated by a size number. The size of most spun yarns (which are those used by the weaver in the majority of cases) is based on yards per pound. With filaments this number is based on the *denier* size—a unit of weight that indicates the fineness of the filament.

In dealing with filaments, the larger the number, the *heavier* the yarn. A 30-denier nylon monofilament, used in making service-weight hose, is 3 times larger than a 10-denier one that is used for sheer hosiery.

With spun yarns, the larger the number, the *finer* the yarn. A Size 20 singles cotton, for instance, is twice as small as a Size 10.

The basis for computing spun yarns differs, depending on the fiber and the spinning method used. Different fibers often can be spun on the same system. Silk, as an example, can be spun with the same equipment used for cotton. Some man-made fibers can be spun on all systems. Rayon owes much of its commercial popularity to the fact it can be spun with equal success on cotton, flax, worsted, and woolen equipment.

The cotton count starts with a Size 1 singles, which has 840 yards of yarn to the pound. A Size 5 singles would yield 5 times that amount: 4,200 yards per pound; or a Size 20 singles: 16,800. These sizes would appear as 1/1, 5/1, or 20/1; or they may appear as 1's, 5's, or 20's.

If two strands of the same size singles were twisted together, we would have 2-ply yarns that, in the above instances, would appear on the yarn package as 1/2, 5/2, or 20/2. The yardage would now be reduced one half; that is, to 420, 2,100, and 8,400 yards per pound, respectively. Similarly with 3-ply cotton yarns, divide the basic quantities by 3: they appear as 1/3, 5/3, or 20/3, and have 840 ÷ 3, or 280 yards; 4,200 ÷ 3, or 1,200 yards; and 16,800 ÷ 3, or 5,600 yards per pound.

This same procedure applies to other spun fibers but the basic unit differs: for linen, the unit is the *lea* and is 300 yards per pound; with worsted yarn, 560 yards per pound; woolen yarn, indicated in *runs,* would be 1,600 yards per pound or, if indicated in *cuts,* 300 yards per pound.

The denier is based on the number of grams which 9,000 meters of yarn will weigh. This unit of measurement is used for reeled silk and man-made filaments, but the hand weaver in buying yarn will rarely have occasion to refer to deniers since the manufacturer generally transposes this factor into yards per pound. A thrown filament yarn—one that consists of a number of filaments twisted loosely together—might be indicated as 120/30, meaning: this yarn is composed of 30 filaments and the size of each filament is 120 deniers.

### ► DYEING PROCESSES

Color can be produced in yarns by several methods. Aside from *piece dyeing,* which involves dipping material already woven, yarns are dyed in three ways. In one, the fibers are dyed preliminary to spinning, which is known as *stock dyeing.* Wool yarn so dyed gave rise to the expression "dyed in the wool." While this is the most expensive way to dye yarn, it enables the spinner to create unusual effects by mixing different hues of fiber. Many oxford grays and the variegated hues, such as heathers, are made in this manner. The popular "fleck" wools, which have spots of bright color interspersed, are effected by introducing small amounts of dyed fibers in the late stages of spinning.

Finished yarns may be dyed either in skein put-up, or when on perforated tubes—a method called *package dyeing.*

With some of the man-made fibers a new method has appeared. Instead of employing the principle of absorption in dyeing, the pigment is mixed in the raw material while in the liquid state; this solution is then extruded in the usual manner into filament, the color becoming an integral part of the fiber. The method is termed *dope dyeing* and it provides a yarn whose color is virtually permanent; color intensity can be maintained, and the hue is not affected by any of the usual cleaning processes.

Fig. 3.6—Fabrics of Estron (acetate) plus other materials such as silk, wool, or cotton can be dyed in two-tone effects by the process "cross dyeing." (Courtesy Tennessee Eastman Company.) Acetate resists the dyes that color the other fibers and they, in turn, resist the acetate dyes.

All of our dyestuffs today are the result of chemical research in this field: some have been developed for color range, some for fastness to certain conditions of fabric use and care, and others for their affinity for certain fibers. The degree of permanency is always relative, since no pigment remains unchanged from exposure to air and light. Dye specifications on many of the yarns the weaver buys are unavailable. Under these circumstances he must conduct his own tests to see if the yarn meets his requirements. This can often be done from the samples submitted by the dealer. When a combination of yarns is to be woven together into fabric and this material is to be piece dyed, the weaver should consult his local dyer and be advised on the practicability of using certain fibers.

In *cross dyeing*, the weaver should first become informed as to the fibers that could be used in this type of dyeing, for cross dyeing is based on the fact that one of the fibers in the piece will accept the color while the others will reject it. This is illustrated in Figure 3.6.

The hand weaver can supplement his information concerning materials from many sources: historic materials are displayed in museums and galleries; products from our modern mills are readily available; and newspapers and the popular magazines frequently carry articles that are both interesting and informative.

# CHAPTER 4

# AN APPROACH TO DESIGN

THE TERM DESIGN HAS WIDE USAGE TODAY. It is associated with many fields of activity, technical as well as aesthetic. And while the aims may differ, the basic problem in all cases is essentially the same: it involves or implies organization—the establishment of coherent relationships.

From an aesthetic point of view the primary objective of design is to achieve significant and articulate spatial relationships: the framework for an art expression. This is true of all graphic arts.

With products of utility, the emphasis is on a more concrete structural planning. The problem here is to devise a functional relationship between elements that will effect an integrated and efficient working unit.

Both activities have certain aspects in common. One, however, depends on acute intuitive response, the other chiefly on a logical method. Effective designs in most areas will be a composite reflection of these two attitudes.

## ► GOOD DESIGN IN TEXTILES

All designs are necessarily motivated by purpose. The aims may be large or limited in scope. The hand weaver, for instance, may set out to create a textile, beautiful alone, as a unit in itself—a valid objective, as a means of personal expression. If the material is to be developed for a specific situation, however, it can no longer be considered as an isolated entity. On an architectural level, textiles are secondary matters, but can perform a useful function: they can be provocative and exhibit individual character, but it is necessary that they also be correlated with the larger concept in order to be effective. This calls for restraint—a measure of simplicity in design and the elimination of pronounced detail. Anni Albers, a prominent designer, says:

> Textiles for interior use can be regarded as architectural elements. In contrast to other elements their special characteristic is their dynamic quality. Fabrics above all else are pliable, and being pliable they can change their position. We draw a curtain to let in light or to shut it out; to close off a section of space or to open it up; we spread out a cover or fold it. Where fabrics are used statically they lose their sovereignty and have competitors in other materials, leather competing with upholstery fabrics, paper with wall-covering fabrics. Where the unique characteristic of pliability is the primary consideration, as in drapery materials, there is no substitute for textiles.[1]

Such fabrics will exploit the inherent qualities of the materials used in their construction.

A fundamental quality of all woven material is *texture;* the words *weaving* and *texture* are, in fact, synonymous. This tactile and visual aspect of things—rough, smooth, dull, bright, soft, hard, or similar distinctions—is an integral characteristic of all raw material. Yarns possess these qualities and can be combined in a woven construction to produce an endless variety of textural effects.

Hand-woven fabrics are characterized by an interesting textural quality, the slight irregularities that naturally occur in the process of handweaving. The power loom, in contrast, is relentlessly precise, producing an exact number of *picks* (or number of filling yarns) per inch at regularly recurring intervals. Such uniformity makes for a strong fabric—stronger perhaps than that normally attained by handweaving—but, being mechanical, it lacks the personal and intimate qualities that are unconsciously transmitted by the craftsman. It is this variable factor that gives charm to many of the old tapestries and early Indian rugs. The surface of the fabric has been broken up into minute and irregular areas of light and shade by slight variations of beating, by the method used, and from modulations of color that inevitably occur in yarns that have been hand spun and hand dyed. The mixture of slightly unevenly dyed fibers gives an added depth to the texture.

### ► EXPERIMENTING WITH SMALL WARPS

For the beginner, the study of fabric design should start with fundamentals: a basic knowledge of fibers and yarns, and of simple fabric

[1] Anni Albers, "Fabrics," *Arts and Architecture,* March, 1948, p. 33.

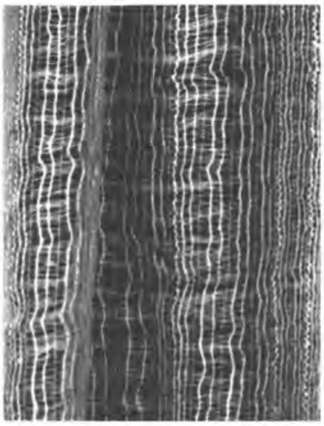


Fig. 4.1A


Fig. 4.1B

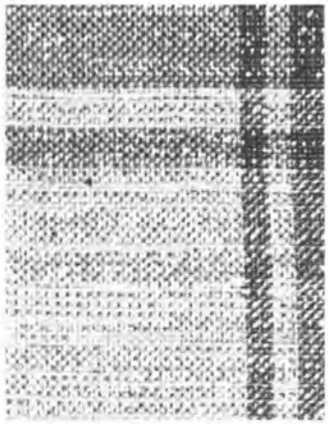


Fig. 4.1C

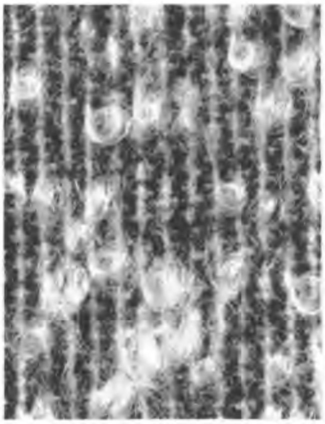


Fig. 4.1D


Fig. 4.1E


Fig. 4.1F

Fig. 4.1A—Sheer drapery of mohair; warp unit of four different sizes of 2-ply mohair yarns, filler a singles mohair. Fig. 4.1B—Upholstery with tiny checks produced by alternating a heavy, dark-textured wool with a small, light, smooth linen and metal yarn in a tabby weave on a light gray warp of linen and cotton. Fig.4.1C—Napery where the slick, bright surface is obtained by using single-ply linen and silver in a tabby weave on a warp of cotton and linen. Fig. 4.1D—Coating fabric using loop mohair yarn in warp to give texture. Fig. 4.1E—Upholstery of fine, smooth cotton and slub rayon yarns set 20 ends to the inch in warp; large nubby cotton filler, woven in a broken twill treadling. Fig. 4.1F—Rayon upholstery with yarns of different construction used as warp; and the "nail head" texture obtained by alternating heavy rayon roving with a very fine yarn in a broken twill weave. This group of six fabrics shows possibilities of texture through use of yarns of varying sizes and constructions.

structure. Such knowledge is best obtained from experimental work with yarn elements, and small fabric samples should be woven. These can employ different sizes, types, and colors of yarns—used alone, or in combination with each other. Such samples may be small, no larger than

6 to 8 inches square. On a warp $1\frac{1}{2}$ to 2 yards long, as many as 8 distinct swatches can be woven.

The use of natural and bleached yarns is recommended at first. Only the simple weaves should be employed—the tabby, the plain twill, and possibly one of the broken twills. In the initial design unit, emphasis is placed upon the development of texture with no regard for end use.

There are definite advantages in this procedure for the beginner:

1. He becomes familiar with a variety of yarn elements and will recognize their limitations as well as their potentialities in fabric.
2. He quickly develops skill and understanding of his instrument by repeatedly making small warps and going through all the manual operations, such as winding the warp, setting up the loom, and practicing other details attendant to weaving.
3. With a growing sense of mastery over manual problems, the weaver is free to concentrate on design development.
4. The weaver acquires new experiences and visual impacts with every group of samples he makes. He develops an awareness of textural and color values, and a keener appreciation of textiles in general. This simple practice with materials and resources, using freedom and imagination, is the basis for all good weaving design.

### ► SELECTION OF WARP YARNS

After preliminary exercises with simple ply elements, the weaver can then turn to combinations that include different types of yarns. From a group of 12 or more, natural or bleached, he can select 3, 5, or 7 of these, as he likes, as the basis of a warp unit. This unit will appear successively throughout the width of the warp and will set the theme for the fabric.

Before selecting these yarns the weaver should study each of them, handle them, compare them, consider their inherent qualities, and develop a personal feeling about them. In this way he will acquire an appreciation of his materials, and will discover that yarns have individual characteristics such as:

Fiber quality: elasticity, pliability, dryness, or warmth
Difference in size
Variety of construction
Distinct surface finishes
Different degrees of shrinkage and color fastness

These factors make each yarn a potential design element.

To study the effect of these qualities in cloth, it is suggested the weaver try combining yarns of different size—large with small; try those with different surface finishes—mat with gloss or smooth with rough; consider yarn combinations of different fiber content—linen, rayon, wool, jute, silk, and others that may have been blended. Figure 4.2 illustrates the effectiveness of combining strongly contrasting yarns.

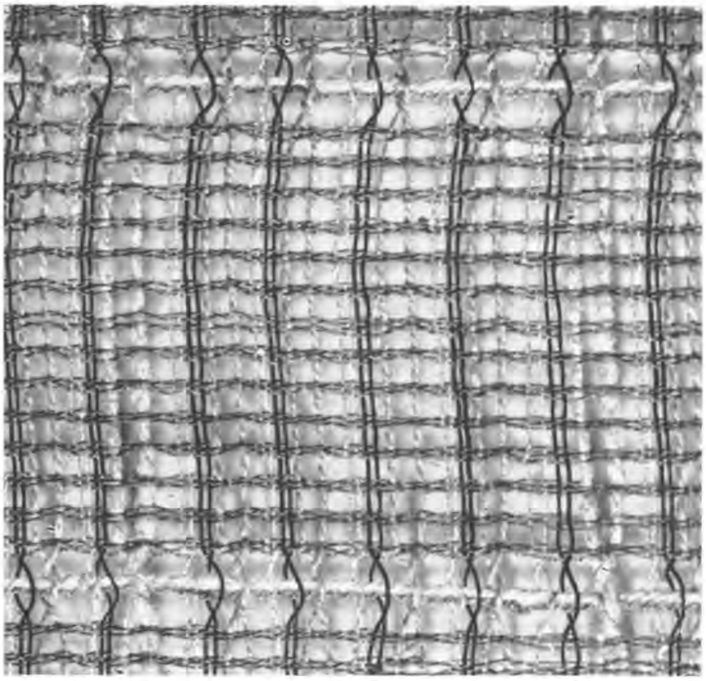


Fig. 4.2—Casement cloth showing mixed fibers and variations in weave, by Leah Van P. Miller. (In the Brooklyn Museum Collection.)

In an initial selection of warp elements, there may be a predominance of effect yarns, those of novelty constructions. To establish balance, the weaver should introduce a simple strong yarn, such as a ply cotton, that can be used every third end to help attain uniform tension in the warp. Examples of a few warp units are illustrated in Figure 4.3, A–D and show typical yarn arrangements that have been assembled to achieve an interesting warp distribution.

After the warp unit has been decided upon, the next step is to consider the order, or arrangement, of the yarns. A tentative method of arriving at a satisfactory arrangement is to wrap the yarns in sequence around the index finger, interchanging one with the other until an

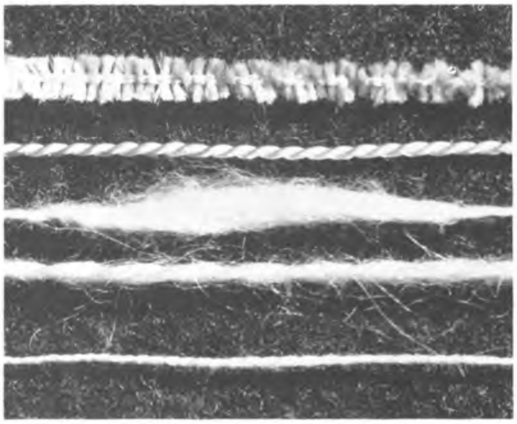


Fig. 4.3A

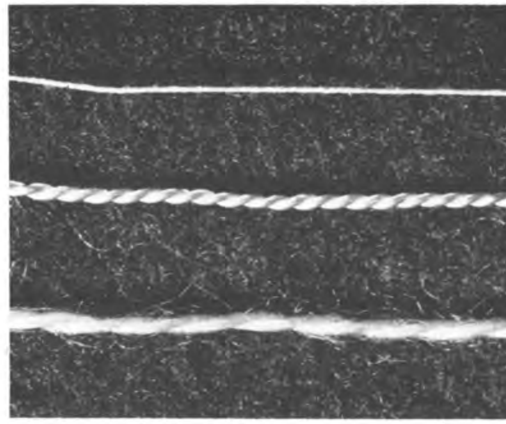


Fig. 4.3B

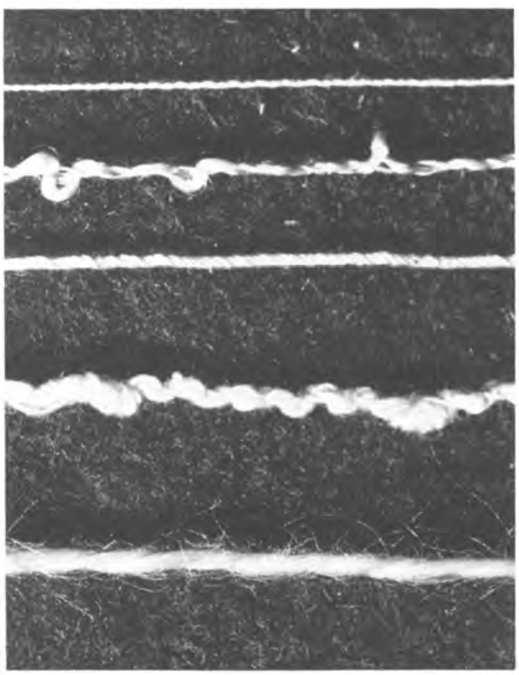


Fig. 4.3C

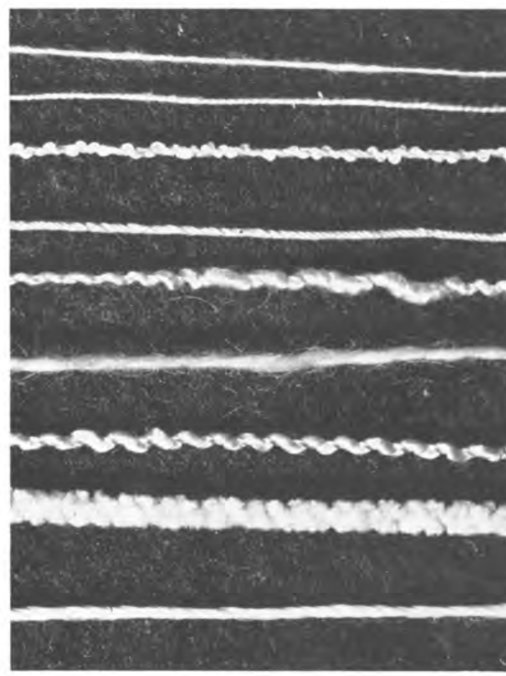


Fig. 4.3D

Fig. 4.3A—Warp unit with chenille, a smooth 2-ply yarn, a flake or slub yarn showing the loosely twisted section, and two softly twisted ply yarns. Fig. 4.3B—A grouping of three ply yarns varying in size and tightness of twist. Fig. 4.3C—Three ply yarns, two of them smooth and firm, are combined with a curl or loop yarn, second from top, and a very irregular lumpy yarn, second from bottom, called knop, nub, or spot. Fig. 4.3D—This unit has added a soft chenille, a ply composed of two sizes of yarn and a bouclé, these being strengthened by three firm ply yarns. These four illustrations are offered as suggestions for possible warp units. Note each uses one or more ply yarns.

agreeable unit is found. To determine the spacing, the weaver can thread 2 or 3 repeats of the unit through reeds of different size. Figures 4.4 and 4.5 demonstrate this method. Since no particular type of fabric is under consideration—the sole objective being the creation of an interesting texture—the weaver can use his imagination freely and experiment as widely as he chooses. He will find that many of these experimental samples can be adapted later to specific ends; for the moment,

Fig. 4.4—Finding a suitable warp unit, by arranging yarns in different sequences until the most satisfactory one is found.

Fig. 4.5—To determine the spacing before winding the warp, the yarns selected are threaded through the reed. If they seem too close or too far apart a different reed may be selected or the yarns may be regrouped.

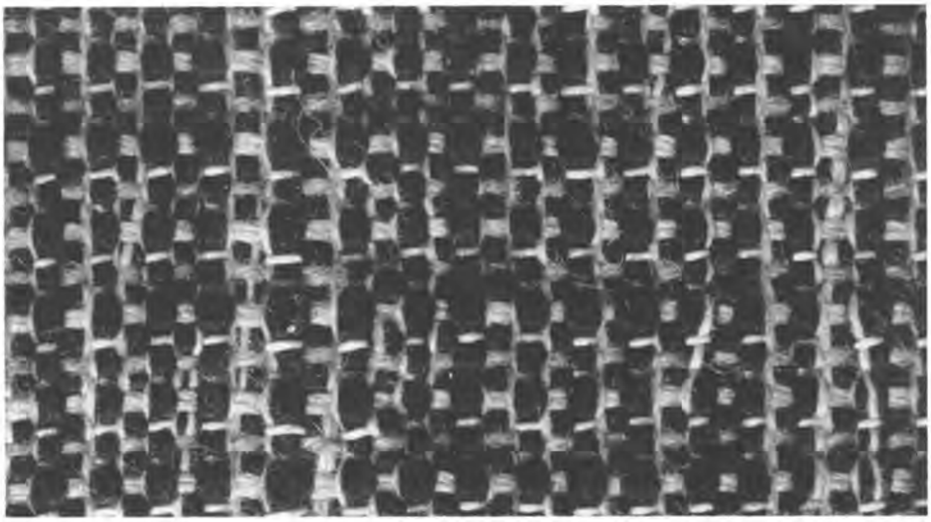


Fig. 4.6—Combination weave in strongly contrasing colors of black and wheat, by Evelyn Hill for Knoll Associates. (Courtesy "Arts and Architecture.")

however, he is interested in learning about his materials: seeing how they behave under different conditions, and comparing the visual aspects they present. Figure 4.6 illustrates an interesting choice of contrasting yarns and colors.

### ► THREADING THE LOOM

Assistance in setting up the loom and weaving these sample warps can be found in the three chapters immediately following, where directions for setting up a loom and weaving are given in detail. The procedure is the same whether the project is a full width piece of drapery or a narrow warp to be used for experimental purposes as suggested here. By following the directions and the accompanying illustrations the beginner is introduced, step by step, to the mechanical processes of weaving. In these narrow experimental warps mistakes can easily be detected and corrected and the samples are quickly completed.

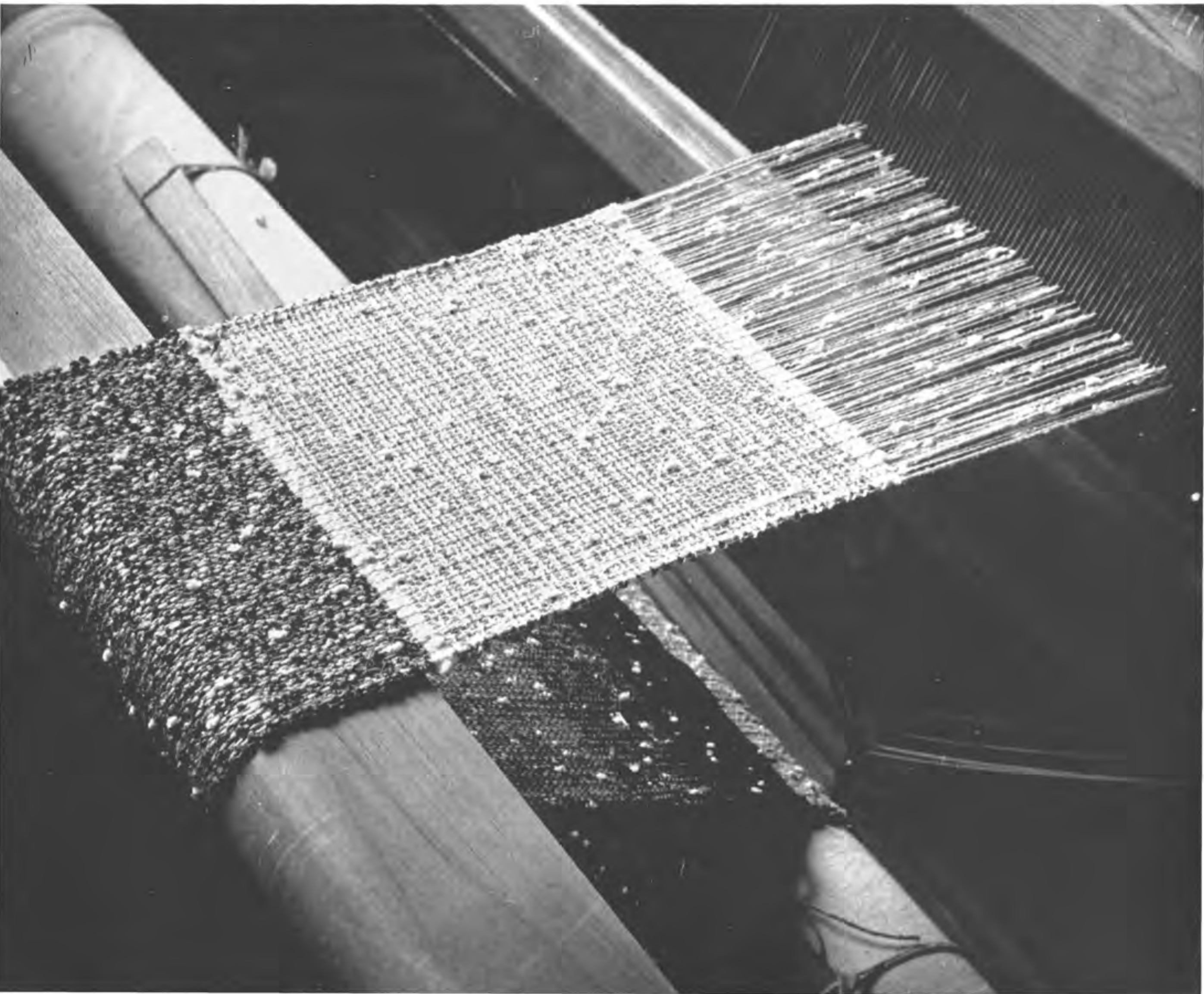
The first warp should be kept simple, using no more than three different yarns in the design unit, as shown in Figures 4.3B and 4.7. Sixteen warp yarns, or ends, to the inch is a satisfactory arrangement for warps used for experimental purposes. With this warp use an 8-dent reed, threading two warp ends through each dent. Instructions for threading the reed are given in Chapter 6. The warp should measure $1\frac{1}{2}$ to 2 yards long and 6 to 8 inches wide.

The steps in making the samples are as follows:

1. Wind the warp as directed in Chapter 5. Tie the cross and ends as shown in Figure 5.4 for a large warp.

   Insert the lease sticks and wind onto the warp beam, being careful to keep the warp in the center of the loom. This will aid in evenness of beating and weaving. Beginners should use a spreader for the sample warp so the warp

Fig. 4.7—Sample warp centered on the loom. Warp is heavy linen in natural, white nubby rayon, and 2-ply cotton. Differences of texture and value, due to selection of filler yarns, are evident in the individual samples.



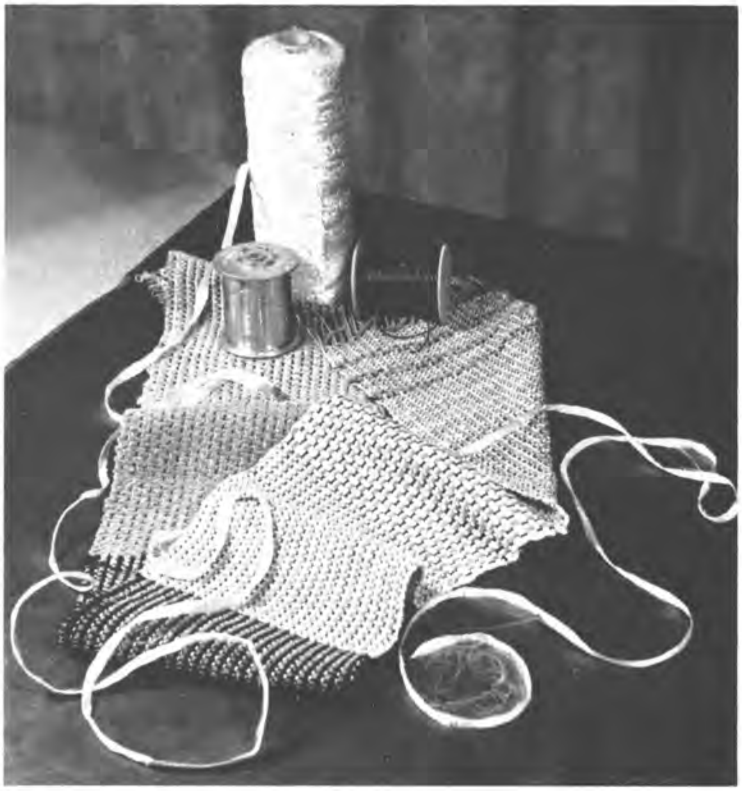


Fig. 4.8—A sample warp removed from the loom. Rayon roving weft or filler, black cord, heavy linen, and chenille used in the warp.

may be kept at its full width while it is being wound onto the warp beam. Then it should be threaded according to the twill draft, the 4, 3, 2, 1 sequence described in Chapter 6. The illustrations and directions show how to hold the warp ends and how to thread the heddles. Continue with the succeeding steps until the loom is ready for weaving. The check list at the end of Chapter 6 briefly summarizes these processes.

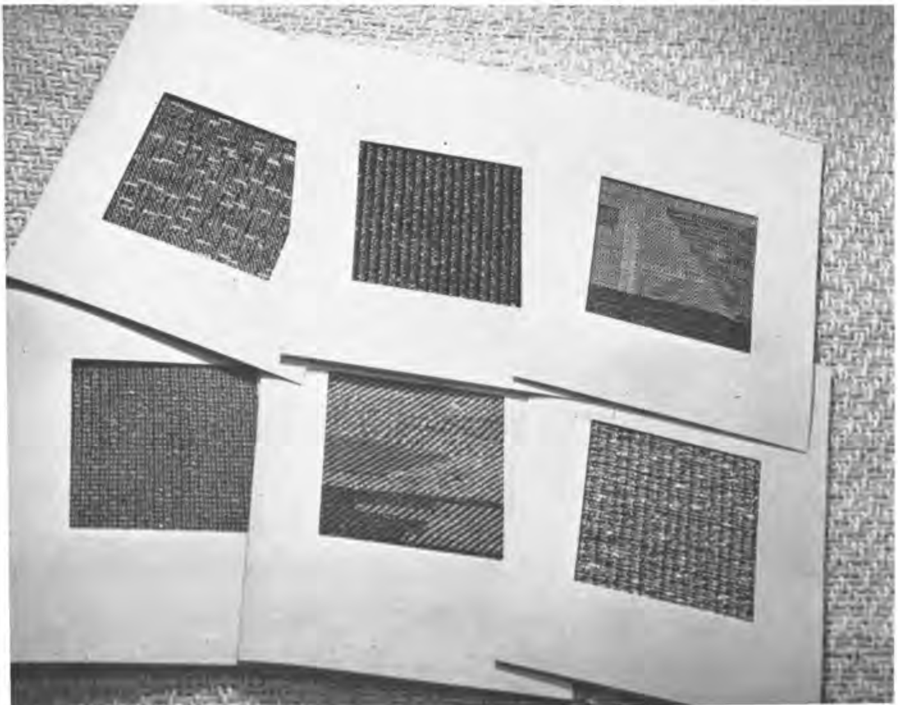
2. Next, wind small bobbins from a number of different yarns. (*See* Chapter 7 for instruction on winding bobbins.)
3. Weave the samples 6 to 7 inches long. Place a few shots of filler yarn of contrasting color before and after each sample to define the length of each design. Weave to the end of the warp or as long as the shed permits.
4. After completing the warp, remove it from the loom and stitch twice between the samples; with space between the stitching so they can be cut apart without raveling.
5. Steam-press, wash, or finish as the material requires.
6. The samples then may be mounted in a folder for future study and reference.

Later, when the weaver plans to make fabric for a specific purpose, the design sample first must be tested to see if it meets the structural requirements of the job. This is extremely important with fabrics that are subjected to stress and strain, such as upholstery and suiting. Textile mills make experimental tests before weaving yardage and it is equally important for the hand weaver. With limited facilities, he can improvise tests that will satisfy him on the soundness of his structure and its suitability for his purpose. Certain yarns may need to be substituted, the denting or beating perhaps changed, or different finishing methods used. The texture may be slightly altered in this process, but to proceed without first making such an appraisal might be disastrous.

### ► WEAVING THE SAMPLES

With the warp on the loom, the weaver can now select filler yarns and develop the texture. There can be considerable latitude in the selection of filler yarns since, unlike warp elements, they are not subjected to great tension. Soft, single-ply cottons may be used, or grasses, ribbon, rags, leather, reeds, or short fibers of little strength and of almost any description. Many possibilities will suggest themselves even though the variety of yarns may be limited. In weaving these small samples, however, be careful not to beat too firmly. Figures 4.7, 4.8, and 4.9 show: a sample warp on the loom; a warp removed from the loom; and mounted swatches.

Fig. 4.9—Mounted samples showing possibilities of the 4-harness loom. In the upper left a textured weft predominates; the upper right is an example of flat tapestry; the lower center is flat tapestry with twill weave; the other three samples emphasize interesting warps by using simple wefts.



The beginning weaver who is undecided in choosing a procedure for developing the samples will find help in the suggestions which follow.

1. If the warp is sufficiently interesting in itself, the selection of one filler yarn might be effective.
2. Repeat one of the warp yarns in the filler. This will introduce a dominant note of texture or color.
3. Try repeating the entire warp unit, if there are not too many yarns involved.

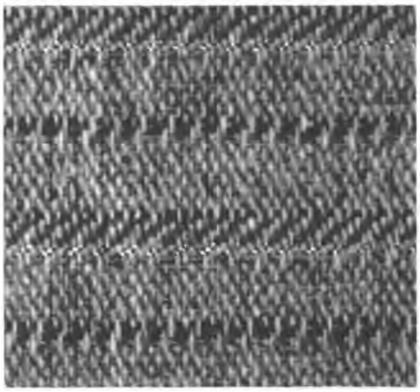


Fig. 4.10

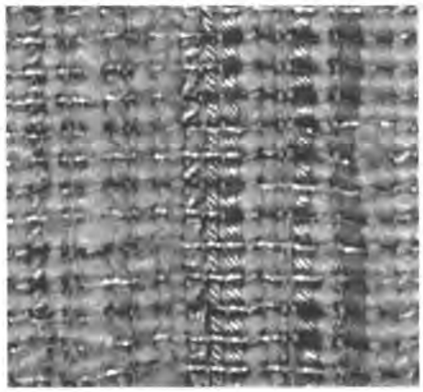


Fig. 4.11

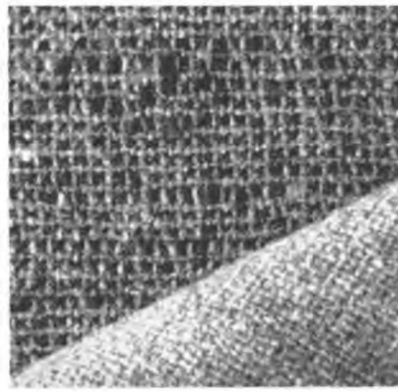


Fig. 4.1

Fig. 4.10—Effect of different treadling. Fabric shows twill, tabby, and broken twill. Woolen and worsted yarns in brown, rust, and fawn with metal.

Fig. 4.11—Ribbed effect obtained by using alternately a large and small filler yarn; colors natural and white.

Fig. 4.12—Warp of gray-blue wool set 20 ends to the inch it is woven with the same warp yarn alternated with worsted for a light-weight dress fabric, and a textured woc of darker tone used as filler for the coat fabric. (Studen project at the State University of Iowa.) Plain weave.

4. Experiment with different treadlings. Change treadling within the same sample. Using the twill threading, try different tie-ups. The tie-up is explained in Chapter 6 and fabric structure is discussed in Chapter 9. Figures 4.10, 4.11, and 4.12 show: effect of different treadlings; of alternating large and small filler yarns; and two samples of combined wool and worsted yarns.
5. Wind two or more yarns together on one bobbin, as shown in Chapter 7. These yarns may be different in size, construction, or fiber. It may be difficult at the start to keep the tension uniform but do not let that stop the experiment.
6. Try variations in beating, to give firmness, sheerness, or other effects, all explained in Chapter 7.
7. Two or more shuttles can be run alternately or in any grouping or sequence desired. If they are not run alternately, watch for tension difficulty in the width of the material. For example, if an inch or more is woven with a soft wool followed by a small area using cotton or linen, the difference in shrinkage and elasticity of these yarns would cause a drawn or puckered effect. Figure 4.13 illustrates the effectiveness of unusual groupings in weft pattern.

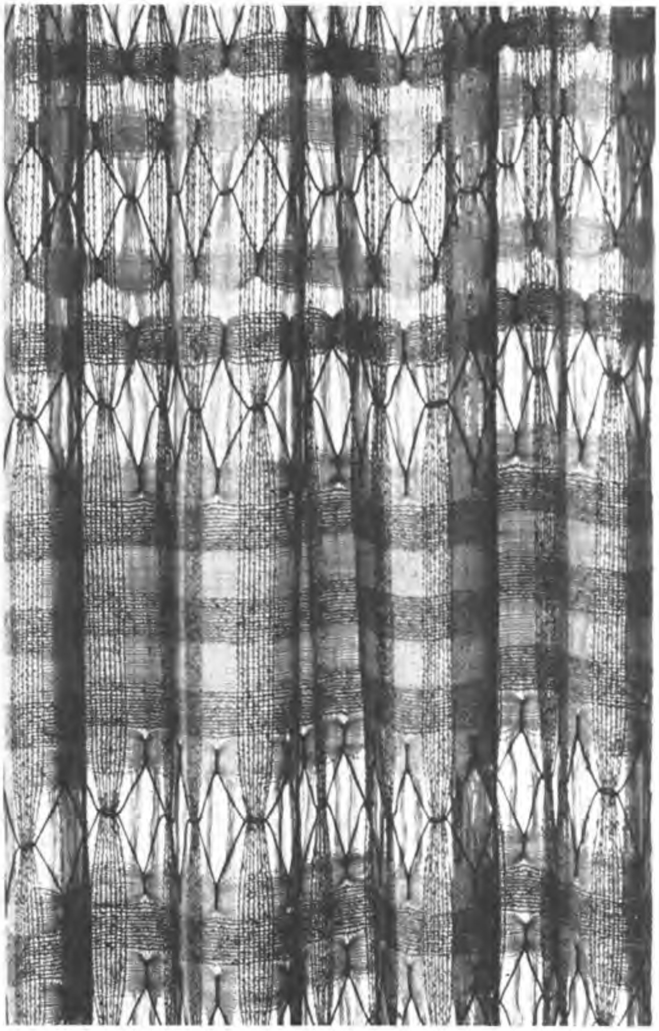


Fig. 4.13—Casement cloth by Roy A. Ginstrom. (In the Brooklyn Museum Collection.)

8. Run a large yarn in a twill shed, alternated with a small yarn in a tabby shed. It will be noted that this emphasizes the large yarn and plays down the small one, or it may accent the warp if the ends are set very close together in the reed. This procedure is often effective in keeping a metallic yarn, or one of brilliant hue, from becoming too dominant. It also produces a ribbed effect that is frequently seen in fabric designs. Example: with a tie-up such as Harnesses 1 and 3, 1 and 2, 2 and 4, 3 and 4, when treadling Harnesses 1 and 3 or 2 and 4, insert the small bright yarn; when treadling 1 and 2 or 3 and 4, insert the larger yarn.
9. Try exaggerated "bubbling" to give additional textural effect. In rug making this is done to cover the warp yarns. The explanation of the "bubbling" technique is given in Chapter 7.

## ► COLOR NOTES

One of the most fascinating things about weaving is the discovery of what happens when yarns of different colors are interwoven in fabric. In the process of weaving, the colors are broken up into small areas; in the case of two adjacent hues, each will modify the other to a notable degree, and in some instances cause them to lose their individual identity.

When the hand weaver starts combining different colored yarns, he will discover he is not dealing with pigment-color mixing, but the effect of light upon the color combinations. Blue and yellow pigments mixed together give a reflected tone of green. But when two yarns of these colors are interwoven, the resultant color is often a white or grayish tone when viewed from a distance. Similarly, red and green sometimes reflect a yellow cast; and gold against a purple ground may appear as silver. The various results from a juxtaposition of colors will depend on the relative strength of the hues of the color areas.

Other important factors influence the results of this color fusion, however: the relative sizes of yarns, individual fiber qualities, and the type of yarn constructions that have been used. Each of these in itself is a variable, and the resultant tone from any combination of colors is often difficult to anticipate.

For the hand weaver a cumulative knowledge of color blending is best derived from actual practice and experiments with samples, rather than from detailed technical study. There are no formulas to follow, no aides to abide by. The weaver, in creating designs, is not restricted in any way—he is free to be guided by his instincts and strike out for himself.

Often the beginner is hesitant in making a selection of color combinations, even though the work be experimental. The following observations are made to help him overcome his reticence. They may serve as a starting point, from which he can proceed and gain experience on his own.

Color is often used in warp, or filler, as stripes; this is evident in checks and plaids. Each stripe can be enriched by combining yarns of different sizes and construction if all have the *same relative hue.*

Any combination of colors might be alternated in the warp—blue, orchid, and green; orange, chartreuse, and tan; brown, black, and purple—and if they have relatively the same *value* (the light–dark quality of color) they will present a unified and harmonious allover effect.

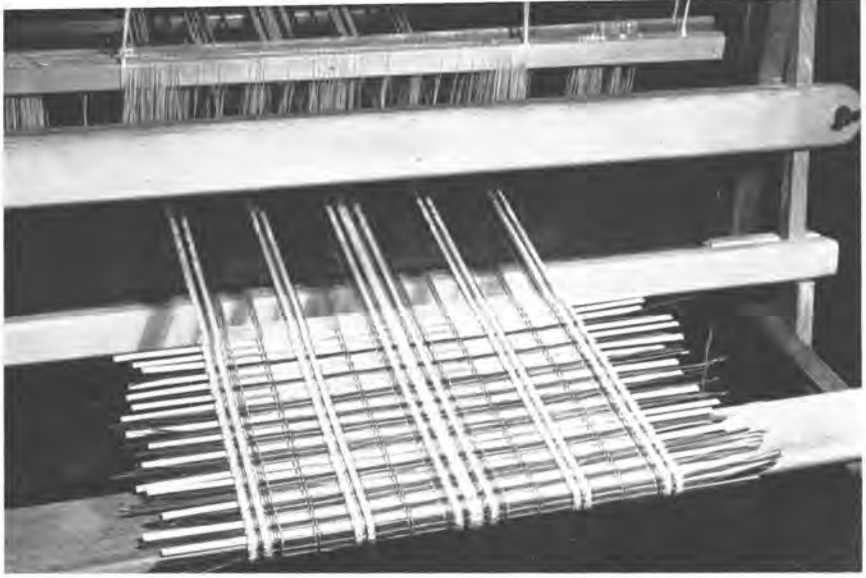


Fig. 4.14—Design for place mats showing open spacing in the reed. Note the harnesses here consist of parallel bars of wood to hold cord heddles in place. Threading is twill, weave is tabby. Warp is brown linen, chartreuse mercerized cotton, and white chenille; filler is natural bamboo and brown Nigerian reed. (Student project at the State University of Iowa.)

Yarns in contrasting value in juxtaposition (a light against a dark) will tend to maintain their original values and appear as modified stripes in the material. Figure 4.14 illustrates definite color distinction attained by contrasting fibers as well as colors.

Accents of intense, brilliant color on neutral backgrounds, if used in the right amounts, may be effective notes, as shown in Figure 4.15.

An interplay of yarns having the same relative hue and value, but with different surface finishes, produces textural interest, as demonstrated in Figures 4.16 and 4.17. Example: wool, smooth linen, and bright rayon each possess different degrees of gloss and dullness. When combined, these qualities are accented. In this connection, fabrics are often woven from yarns of different fiber in an "undyed" state; the finished material is later piece dyed giving an interesting monotone, each fiber absorbing the dye to a greater or lesser degree.

Composing color is largely an intuitive process. The designer unconsciously considers contrasting qualities such as warm colors used with cold colors, light with dark, bright with dull, and then attempts to establish certain interesting and satisfying relationships between these opposing factors as is typified in Figures 4.18 and 4.19. Through experimentation the weaver develops a personal mode of color expression.

It is stimulating to study the work of others: the contemporary fabrics from the mills; those shown in exhibitions of artist-craftsmen; and the great textiles of the past. All of these will enlarge the outlook of the weaver and give him a broader concept of design. He will soon find

Fig. 4.15—Rug in tapestry and Rollakan weave, by Mildred Allmendinger. (In the Brooklyn Museum Collection.)

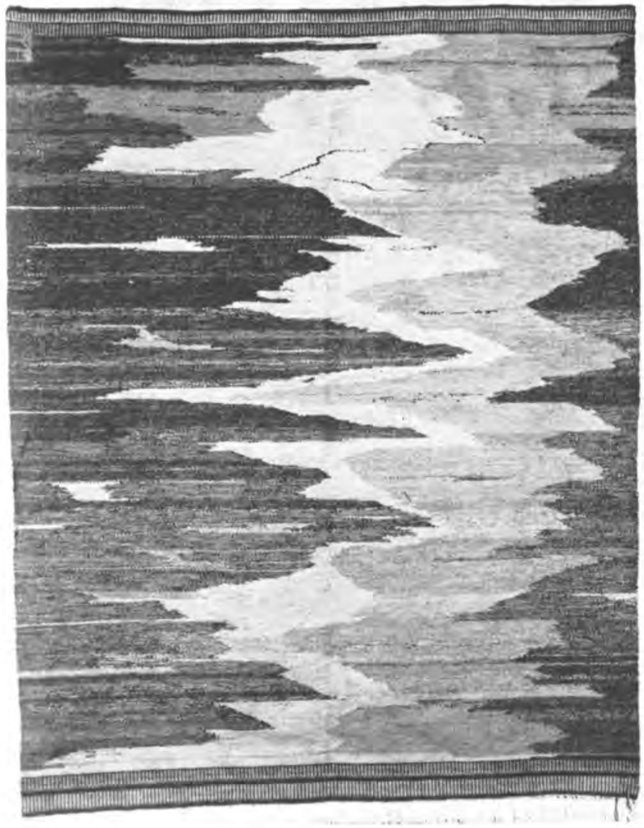


Fig. 4.16—Transparent drapery material of spun rayon and wool ratiné in white, by Lili Blumenau. (Courtesy "Handweaver and Craftsman.") Effect of transparency is enhanced by variation in spacing in the reed.

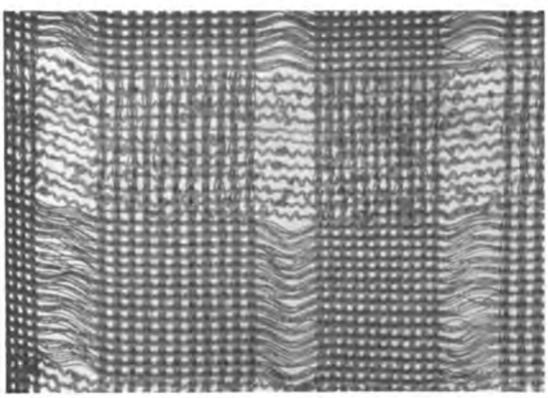
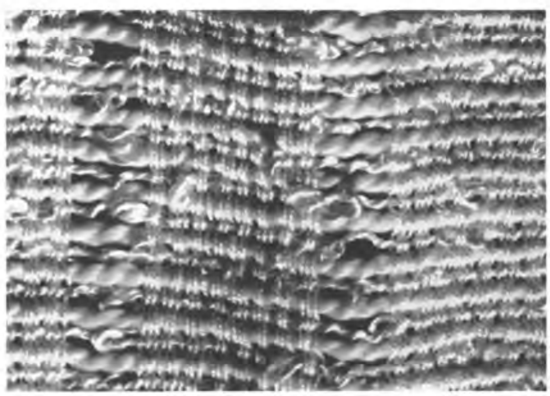


Fig. 4.17—Drapery material woven by Lili Blumenau on the same warp as the transparent fabric in Figure 4.16. (Courtesy "Handweaver and Craftsman.") Here the corded effect with less transparency was achieved by using a heavy filler yarn.



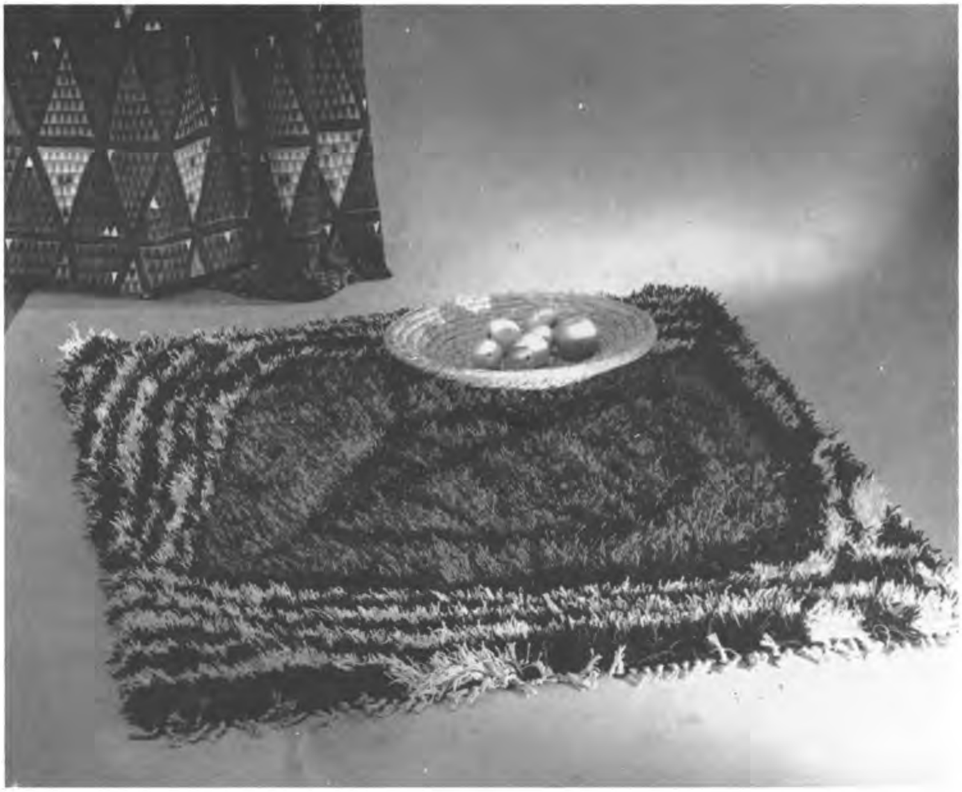


Fig. 4.18—Deep-pile rug by Viola Grästen of Nordiska Kompaniet, Stockholm, Sweden. It is a rya technique in black, white, and red, shown with hanging of printed linen in red, green, and black.

himself critical of his own work, and at the same time he will be developing new ideas, more perhaps than he can ever realize in fabric.

### ► RECORDS

With the construction of fabric samples it is advisable to record all the details of production. The weaver will find this information useful, and a timesaver, if he later wishes to reproduce the fabric. If a convenient record form is available, it is quite easy to list all of the details instead of depending upon memory. Any improvised form will serve, but it should have provision for the inclusion of all the necessary data, such as the one shown in Figure 4.20.

Samples of all the warp yarns should be attached to this form, and arranged in the order in which they were used in the warp unit.

A record of the draft will be shown. This includes:

- Order in which the heddles are threaded
- Sleying
- Tie-up
- Order of treadling

Each texture or sample will probably employ different filler yarns, and samples of these should be attached to the record with a notation on how they were combined for each shuttle. The firmness of the beating will be noted by the number of picks per inch.

Many weavers have found it worth while to compute an estimated cost for each sample. This can then be used to estimate costs per square yard, or cost per article. In constructing a fabric this figure will sometimes need to be adjusted because of a necessary substitution of yarns.

Fig. 4.19—All-linen table mat and napkin, by Joan Patterson. Warp, 20/2 green and natural; weft, blue-green and natural in 14/1 with ribs of 1½ lea blue-green linen. Napkin is 20/2 natural warp, 14/1 natural weft.

Code No. ____________ Classification ____________

Warp Yarns ____ Description ____ Source ____ Price Per Lb. ____

1. ____________

2. ____________

3. ____________

4. ____________

5. ____________

6. ____________

7. ____________

Reed Size ____ Yarn Order Per Warp Unit ____________

Tie-Up

Threading of Heddles

Remarks ____________

Filler Yarns ____ Description ____ Source ____ Price Per Lb. ____

1. ____________

2. ____________

3. ____________

4. ____________

5. ____________

6. ____________

7. ____________

8. ____________

9. ____________

| | | |
|---|---|---|
| Sample No. 1 ____ | Sample No. 2 ____ | Sample No. 3 ____ |
| Shuttle No. 1 ____ | Shuttle No. 1 ____ | Shuttle No. 1 ____ |
| Shuttle No. 2 ____ | Shuttle No. 2 ____ | Shuttle No. 2 ____ |
| Shuttle No. 3 ____ | Shuttle No. 3 ____ | Shuttle No. 3 ____ |
| Treadle ____ | Treadle ____ | Treadle ____ |
| Picks Per In. ____ | Picks Per In. ____ | Picks Per In. ____ |
| Approx. Price Per Yd. ____ | Approx. Price Per Yd. ____ | Approx. Price Per Yd. ____ |

**NOTE---Use reverse side for additional samples.**

Fig. 4.20—Record Sheet. As weavers accumulate samples for various types of fabrics, a code number helps in classifying and filing samples. This record sheet provides space for samples of warp and filler yarns. More or less than the numbers indicated may be used. The order of yarns used in the warp unit should be indicated with an attached sample. This is very important where the unit includes several yarns. The number of ends per dent should follow reed size, as 12/2. Suggestions below are for important information relating to the individual woven samples.

Space should be allocated for suggestions or remarks. Any structural disadvantage in the sample can be noted with comments on how the material might be improved. If a single linen, for example, was found unsatisfactory in the sample, a ply linen of like diameter might be substituted with no appreciable change in the appearance of the fabric. Also, the finishing methods should be indicated, since the character of many materials is changed in this process. The shrinkage should also be noted as a basis for estimating warp widths and lengths.

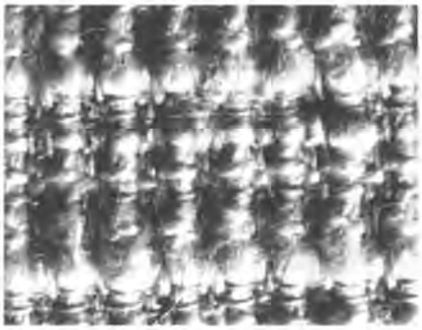


Fig. 4.21A—Upholstery fabric of natural and white linen, by Joan Patterson. A sturdy and attractive fabric with warp of 9/2, 7/2 rug 1½ lea linen with cotton nub; weft 7/1 and 6/2 linen.

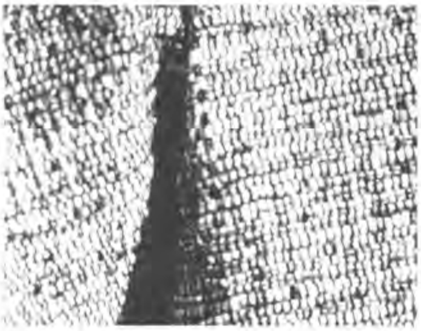


Fig. 4.21B—Upholstery fabric of natural yarns on a dark warp, by Marianne Strengell. Of wool, mohair, and cotton, the heavy filler yarn is balanced by fine, strong yarns, giving a hard texture.

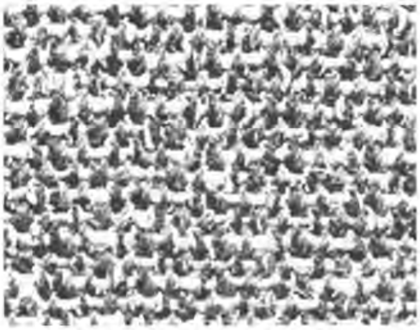


Fig. 4.21C—Upholstery with warp of black, brown, and purple; filler, soft green rug linen alternated with black silk and copper-toned metallic yarn. Upholstery fabrics can be made of a variety of yarns as these illustrations show. Because of its resiliency, some wool is advisable.

### ► DESIGNING SPECIFIC MATERIALS

As the weaver develops designs for specific fabrics he will find there are controlling factors to be considered if the textile is to serve its purpose satisfactorily. Certain fabrics are subjected to various degrees of stress and wear in the course of their usage; the most common of these are upholstery, drapery, rugs, and suiting. In planning such materials the hand weaver will consider the conditions under which they will be used, note the necessary functional requirements, and incorporate these in his design.

An *upholstery* fabric should be sturdy enough to withstand the strains imposed in applying the material to furniture, it should be reasonably resistant to frictional wear, and not too difficult to clean. While a variety of different yarns can be used in the warp it is advisable to select rather coarse, strong yarns, set, as a rule, from 15 to 20 ends per inch. This is the basis for a firm, durable structure. Figures 4.21 A, B, and C illustrate these factors.

The possibility of cleaning is an important consideration. Many weavers use a certain percentage of wool in the filler for this reason, and some of the newer synthetics should not be overlooked, as they combine well with wool and other fibers, or may be used alone. While upholstery fabrics should be firm, they need not be stiff. This firmness is attained by double beating; the first beat is in an open shed, then the treadles are changed and a second beat given in a closed shed. In planning material for a specific piece of furniture, it is advisable first to consult the upholsterer to determine the width most practical to weave.

In the design of *draperies* the weaver will be interested in such practical considerations as sag, drapability, resistance to light, and cleaning requirements. As a rule, draperies are loosely woven materials—close enough to secure privacy, yet transparent enough to permit the transmission of light as in Figures 4.16 and 11.5. If unlined, their textural interest is increased, a quality that can be exploited in place of color. Figures 4.22, 4.23, 4.24, and 4.25 show a few of the variety of weaves stressing textural interest.

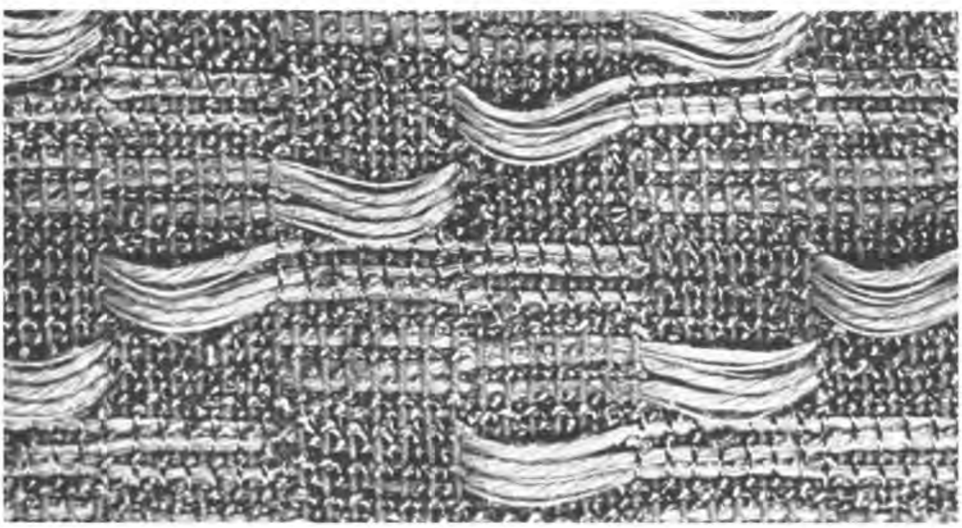


Fig. 4.22—Drapery fabric of chartreuse bouclé and linen yarns, by Else Regensteiner and Julia McVicker.

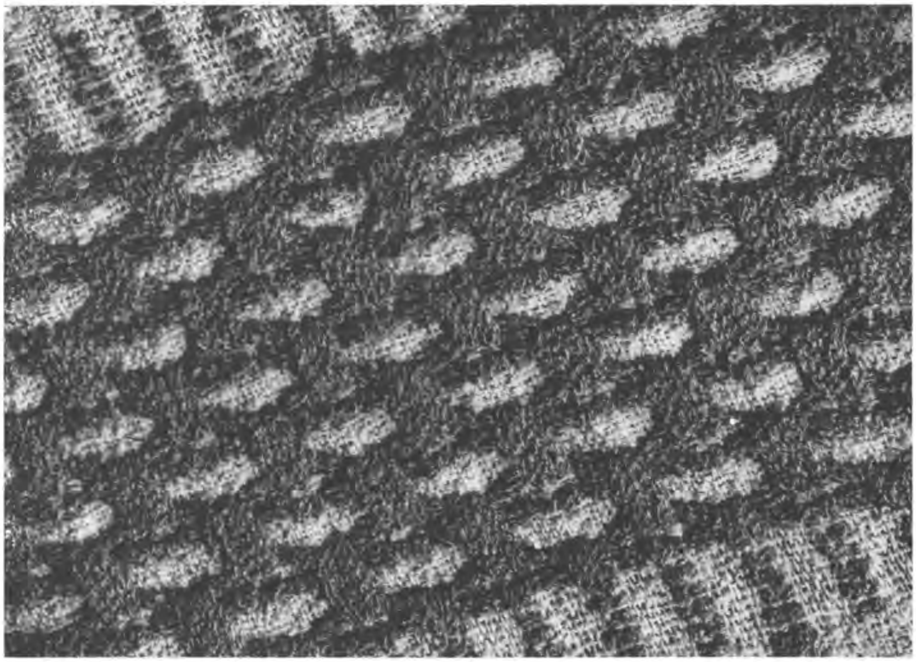


Fig. 4.23—Fabric by Maria Kipp showing rough texture resulting from choice of yarns and weave. (Courtesy "Handweaver and Craftsman.")

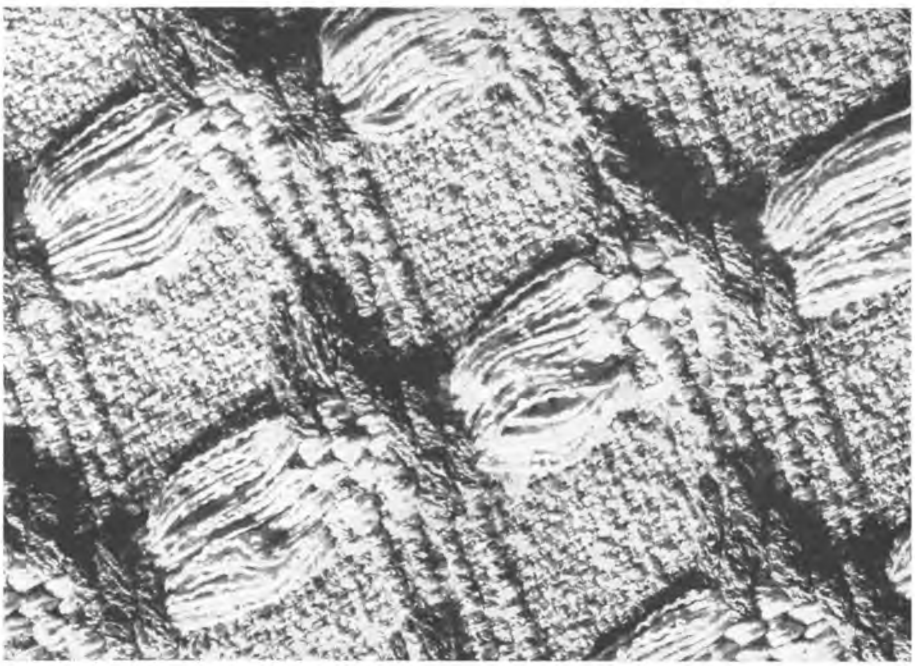


Fig. 4.24—Drapery woven on a double warp-beam loom, by Maria Kipp. (Courtesy "Handweaver and Craftsman.")

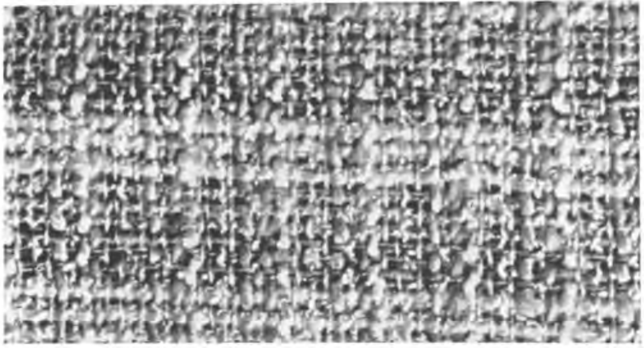


Fig. 4.25A—Self-striped drapery from natural to medium blue-gray; warp and filler of rayon, cotton, silk, and wool in a plain weave.

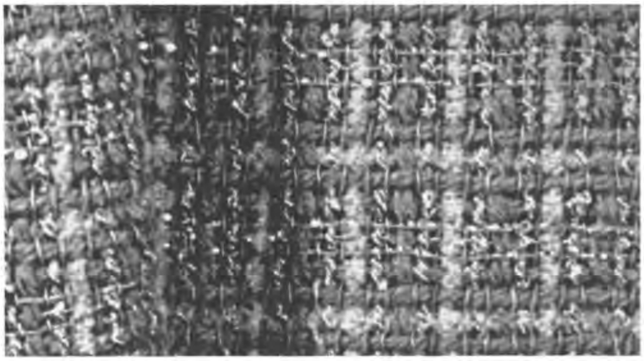


Fig. 4.25B—Sheer drapery of mohair chenille, wool, and rayon in tones of green with copper-toned metallic yarn.

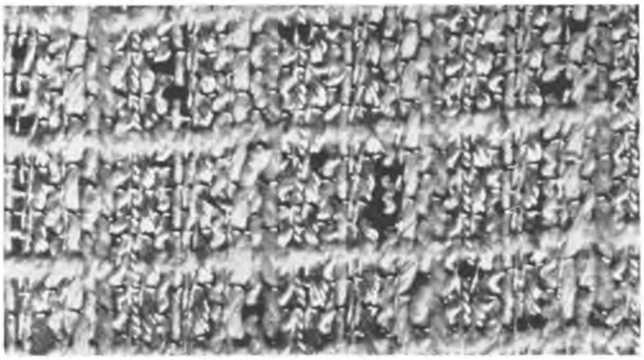


Fig. 4.25C—Filler of chenille and black-and-white nubby silk; warp of several yarn constructions in natural and white.

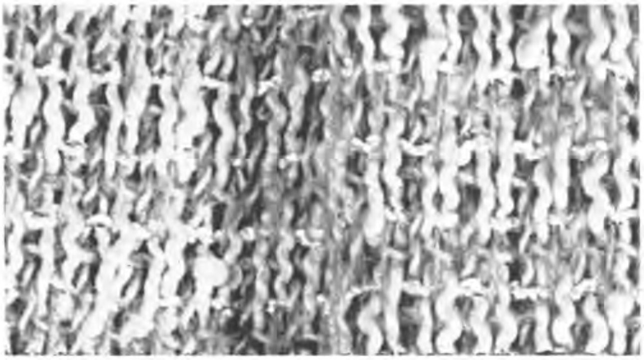


Fig. 4.25D—Sheer drapery where textured yarns give stability. Warp is yellow nubby cotton alternated with yellow rayon ratiné and a 2-ply wool of gray and white; weave is broken twill.

Fig. 4.25E—Drapery with a rich, textured surface. Warp is a 2-ply wool of gray and white alternated with white rayon ratiné; filler, a novelty yarn of wool in black, natural, and flakes of yellow, twisted together. Weave is broken twill.

These draperies suggest countless variations possible with simple weaves and the many yarns available. Such fabrics admit light, yet give privacy.

While the suspended weight of a drapery may not be great, it is essential to use stable warp elements at regular intervals throughout the width to counteract the tendency to sag. Drapability will be achieved by using more flexible yarns in the filler than in the warp. Whenever possible, yarns selected should be of fibers that show no rapid deterioration from the effects of light and sun. Some of the synthetics have remarkable resistance in this regard.

*Rugs* present a somewhat different design problem for the element of interest is reversed. In most instances the warp is chosen for strength and wear alone and is usually covered by the filler yarn but, if exposed, it is rarely emphasized. The warp will probably be a heavy ply cotton or linen set 6 to 10 ends per inch.

Filler yarns may be woven flat and "bubbled" (*see* Chapter 7) to cover the warp or it may be woven with a pile by one of the knot techniques. The pile may be long or short, cut or uncut; or the pile and flat weaves may be combined.

While a single, over-all texture may be planned for rugs, more often weavers use two or three textures in combination to point up the design. The usual procedure is explained under Fabric Structure, Chapter 9.

Since rug making is slow and involves much detail it would seem worth while to use good materials, selecting them for their wearing qualities as well as for their beauty.

Some of the materials commonly used are linen, wools (including mohair), nylon, hemp, jute, grasses, sisal, strips of woolen or other cloth, and blends of the natural fibers with synthetics for accent. Mohair and rayon blends are effective with wool, or wool and linen. Several yarns may be combined to form the knot in the flossa or rya rug, and are wound together to make the "butterfly" (*see* Chapter 9).

Designing for *wearing apparel* presents a real challenge to the weaver. The material must be soft, sometimes sheer and light in weight, yet able to stand up under hard wear and repeated cleanings. Such fabric must be properly finished to prevent further shrinkage and to hold its shape after tailoring.

The selection of yarns for each design will be determined largely by the weight of the fabric desired. Many types of yarn suitable for apparel fabrics are available to the hand weaver. Yarns of different fiber content may be combined in both warp and filler. A few suggestions are: silk and

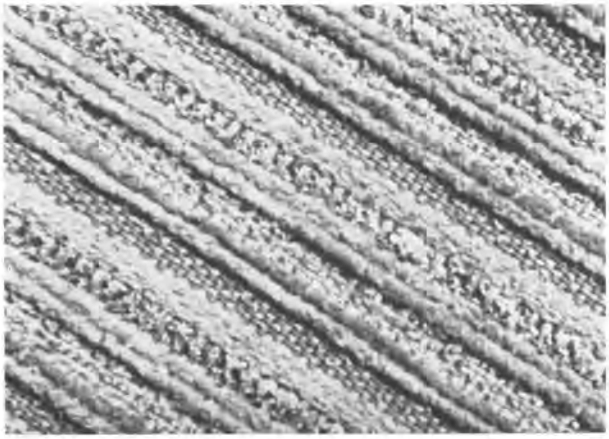


Fig. 4.26—Designing with novelty yarns and yarns of different sizes gives a sculptured effect to a fabric by Kay Geary. (Courtesy "Handweaver and Craftsman.") Note the sharp contrast and appearance of depth between stripes.

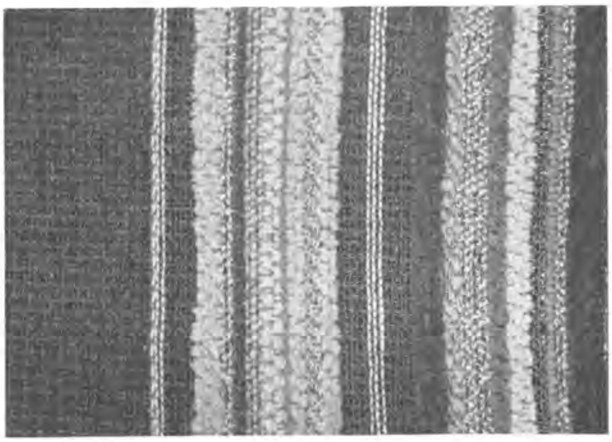


Fig. 4.27—Hand-woven skirt accented by effective use of novelty yarns, including chenille, bouclé, rayon frill, and lurex; woven by Ethel Guy of yarns dyed by Mr. and Mrs. Guy. (Courtesy "Handweaver and Craftsman.") Stripes run weftwise.

wool; alpaca, dacron, and silk; cotton, orlon, and linen; or vicara, wool, and nylon. Supported metallic yarns may be used with any of the fibers in either warp or filler. Effectiveness of novelty yarn is seen in Figures 4.26 and 4.27.

Wools are probably the most satisfactory to work with since they present fewer problems in the finished textile. They may be woven fairly sheer without danger of separation at the seams when worn. Wools are light in weight, relatively color fast, and will withstand hard wear. The yarns may be purchased in both the simple and novelty constructions. The weaver often finds that, with experiment, he can introduce yarns of other fibers in a fabric without losing the desirable qualities of wool. Variety of color in design is illustrated in Figures 4.28 and 4.29A and B.

Apparel fabrics must have draping qualities. This results from proper

Fig. 4.28—Fabric for a coat in twill weave. (Student project at the State University of Iowa.) Warp of black worsted and dark blue woolen yarns, light stripe of white loop mohair with a textured yarn in blue and white; filler of the same yarns.

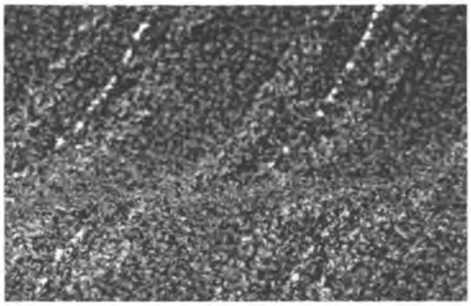


Fig. 4.29A—Fabric for a coat using black wool warp; filler of black and brown textured wool and copper lurex. Fabric by Mary Walker Phillips.

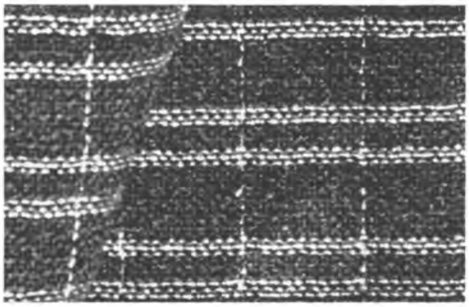


Fig. 4.29B—Sheer suiting material. Black loop wool and spun silk, alternated in both warp and filler, with fine, gold, gimp stripes. Smooth, fine yarns produce sharper contrasts than the textured woolen yarns in Figure 4.29A, where the metal thread is almost buried.

weaving and finishing. If the warp yarns have been set too close in the reed, or the filler yarns have been beaten too firmly, the material will not lend itself to draping or tailoring. Material for men's wear is usually woven narrower than that for women's wear, the latter varying according to the pattern chosen.

The technique of *tapestry* weaving is primitive and very simple but, like rug weaving, it is slow and tedious. The method for weaving tapestries is explained in Chapter 9, Fabric Structure.

To produce a successful tapestry calls for a play of imagination combined with a feeling for color, color blending, and design. Since tapestries are decorative pieces, considerable freedom may be used in the choice of yarns. Old tapestries (Fig 9.16) were woven on a linen or wool warp using silk, wool, or metal for filler. Modern weavers (Fig. 4.30) follow much the same plan but use a wider variety of materials with greater freedom in their designs. Tapestry weaving is perhaps one of the most satisfying of the weaving techniques, and is particularly so when the filler materials are spun, dyed, or tinted by the weaver.

Fig. 4.30—Polish Kilim, "The Dancers," by Eleanora Plutynska. (Courtesy of the Detroit Institute of Arts.) Kilim technique, used in the Middle East for rugs and hangings, is similar to that of the Navajo blankets and rugs. Polish weavers are masters of this art.

# CHAPTER 5

# MAKING THE WARP

THE WARP INCLUDES ALL THE YARNS which run lengthwise in a fabric. In its preparation the usual procedure is to:

Estimate the amount of yarn needed
Assemble the yarns
Wind the warp
Remove the warp from the reel

## ► ESTIMATING AMOUNT OF YARN NEEDED

The amount of yarn needed for a warp depends on three factors:

Number of warp ends per inch
Width of the warp
Length of the warp

When planning a project, it is usual for the weaver to weave first a small sample of the fabric he thinks suitable for his purpose. From this sample he gets the first factor, the number of warp ends per inch.

Let us say the sample was set up 16 ends per inch, and that the fabric was to be woven on a warp 36 inches wide: $16 \times 36 = 576$, the total number of warp ends in the material.

If the fabric is to have 576 warp ends, and the warp is to be 10 yards long, the total amount of yarn in the warp would be 5,760 yards.

There is no rule covering the widths of warps. In drapery it is wise to wind the warp as wide as the loom permits. In upholstery, the piece to

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Chapters 5, 6, 7, and 8 deal with the manual procedures involved in weaving a fabric. They explain in an orderly sequence the steps for preparing the loom for weaving, the actual weaving process, and how to finish the woven material.

be covered should be considered, so consult the upholsterer first and he will indicate the most economical width to weave. For men's garments we usually plan to have the material finish 27 to 30 inches wide; for women's wear we weave the width that the pattern calls for, which usually varies from 36 to 42 inches. It is wise for the beginner to select narrow widths whenever possible, as it will be easier to maintain a more even "beat" and width with a narrow warp.

Selvages, if used, call for extra warp ends. In most cases we eliminate the selvage entirely and depend on the slight pull-in at the sides to give sufficient edge. However, there are instances when a selvage may be desirable. In making a narrow selvage, put one extra end in each of the two outside dents. For a heavier one, an extra end may be threaded in any number of dents. A good edge results from threading one extra end in each of the four outside dents. Whatever number is used, the weaver must remember to add them to the total number of warp ends in computing the yarn needs.

If a weaver's design sample has more than one kind of yarn in the warp, it is necessary to compute the yardage requirement for each yarn. We must first find the number of times any given yarn occurs in the warp. This is done by dividing the total number of warp ends by the number of yarns in the design unit. This amount is then multiplied by the length of the warp.

In weaving, the up-and-down interlacing of yarns causes a certain amount of take-up, widthwise and lengthwise. This factor must be considered in planning the warp, and an allowance of 10 to 15 per cent is added to the width and length estimates to compensate for this loss. *In addition*, the weaver must allow an extra yard to permit a warp tie at the front and the usual waste at the warp beam.

It is important to have sufficient yarn for the complete warp. Each yarn has a given yardage per pound. After the weaver has determined the number of yards he needs, he should then weigh the yarns he has before starting the warp. When using color, care must be taken to have all yarn for the complete warp from one dye lot.

### ► WINDING THE WARP

A complete warp should be wound at one time; if a part of the warp is wound now, then completed later on, variations in tension will in-

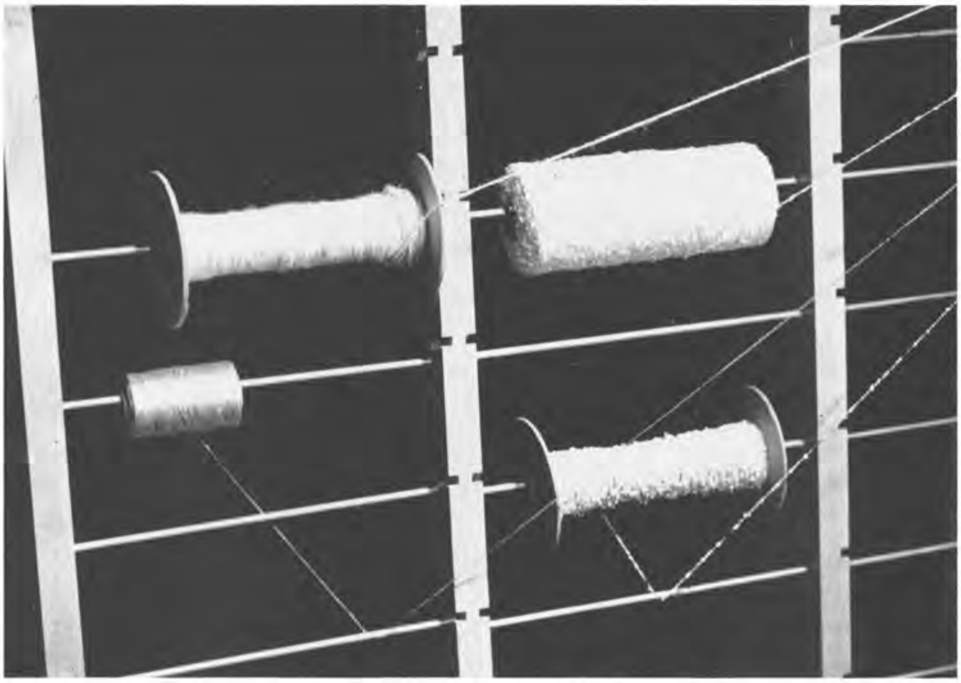


Fig. 5.1—Spools of warp yarns arranged on spool rack ready to wind a warp, the lower two spools showing tension control.

variably result from possible changes in atmospheric conditions or from the human element.

Arrange the spools or tubes of yarn on the spool rack or frame. To secure an equal tension all spools should be approximately the same weight. If some of the yarns are in the form of skeins, these should be wound on spools. Some yarns, particularly the metallics and certain rayons, unwind more rapidly than others and need to be slowed down. An effective way of retarding this rapidly turning spool is to thread the yarn in and out of several bars on the spool rack as shown in the lower spools of Figure 5.1. A fairly accurate test for tension is to pull the group of yarns forward gently to test the "feel" of even tension, then relax the pull and see if they sag, or drape, evenly.

Next, measure a piece of heavy, contrastingly colored cord the length of the planned warp. Attach this cord to the peg at the lower right in Figure 5.4 and wind around the reel in reverse (from right to left) to establish the position of the peg at the top. This peg becomes the *starting*

Fig. 5.2—Ends of the yarns in the warp unit have been tied together and slipped over the starting peg.

*peg* for winding the warp, and the colored cord becomes the guide for the warp yarns to follow.

To start winding the warp, gather the ends of the yarns together, and tie in a firm knot. Slip this over the starting peg (Fig. 5.2). This is a single peg and is at the opposite end from the three pegs which will form the cross. As the reel is revolved let the yarns slide easily through the hand, with no feeling of tautness in any one yarn. As many as five yarns can be wound together by this method without undue twisting. If the yarns are all linen they should be wound not more than two ends at a time. If more than five yarns are included in the warp unit, a paddle should be used to keep the yarns in their order. A common method for using the paddle for warping is explained in Figures 5.6–5.11.

Note the three pegs on the warping reel at the position of the cross in Figure 5.3. The last peg represents the position of the warp stick while the other two pegs represent the positions of the lease sticks. There will be a cross between these pegs. In this figure the group of five yarns is being wound as a unit. In approaching the series of three pegs, these yarns go over the first, under the second, over and around the third, or end peg. The reverse is true as the yarns return. The reel is revolved, returning the yarn to the starting peg. This process is repeated until the required number of warp yarns has been wound, as shown in Figure 5.4. Some warp reels have the three pegs at the top, but in either case, follow the same method of winding. A reel with two pegs may be used, in which instance the warp stick and one lease stick will be in the same cross, the position of the last peg. If the paddle is to be used, however, the third peg is necessary to make a complete cross.

### ▶ TYING WARP TO SECURE THE CROSS

The weaver will have estimated how many yarns he will use in an inch of warp. For example, if his warp calls for 20 yarns per inch, and he has chosen an arrangement of 5 yarns, it will take 4 groups of 5 yarns to complete an inch of warp. Unless the weaver is using a paddle (as explained later in this chapter) this will take 2 complete revolutions

Fig. 5.3—Yarns in the unit are wound together around the three pegs at lower end to form the cross.

Fig. 5.4—Warping reel with completed warp, showing how it was looped around the starting peg, the cross in place at the bottom, all ties in place, the whole warp ready to be removed.

of the reel—twice forward and twice reversed—to complete the unit of 20 yarns. At this point he will use a yarn of contrasting color to separate the 1-inch groups by looping the yarn around the 1-inch units, near the cross end, between the second and third peg from the end. As can be seen in the chained warp (Figures 5.5 and 5.6) this is laced rather than tied. This division of the warp yarns will make it easy to distribute the yarns in the spreader.

When the warp is completed, it is tied at each lease peg and also at the starting peg to secure the separation in the yarns at these positions. Colored yarns are used for these ties in Figure 5.5, though large blanket pins may be used. A soft rag or blanket pin tying the yarns at the starting peg will simplify cutting the warp ends after the warp is wound on the loom.

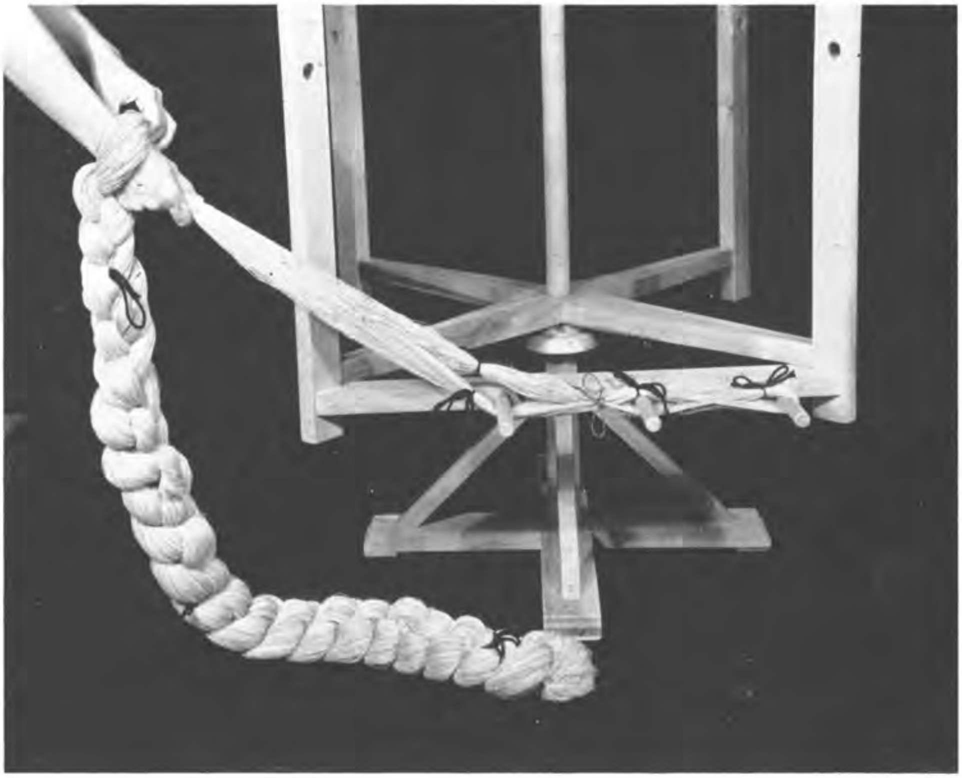


Fig. 5.5—Warp is "chained" from the reel, beginning with the peg at top.

In long warps it is advisable for beginners to tie the warp at intervals of approximately 2 yards. At a position of about $1\frac{1}{2}$ yards from the cross, this tie should be very tight to prevent the warp from slipping out of place while arranging it in the spreader.

### ► MAKING THE CHAIN

The warp is removed from the reel by crocheting it into a *chain*. This is done by inserting the hand into the loop of the warp when the starting peg is removed, and pulling the warp back upon itself by a series of loops similar to a crocheted chain, as illustrated in Figure 5.5. The warp should be grasped firmly before removing the peg, and the reel should be turned slowly to prevent the warp from slipping and becoming disarranged. In this form the warp is shortened and is easily handled. If the warp is prepared on a warping board the same procedure is followed. The warp is now ready to be wound onto the loom.

Fig. 5.6—Completed chain. Second and third ties from the end in the foreground secure the cross; interlacing yarn between separates the warp in inches; tie at the right keeps looped yarn in order as it is wound around the last peg.

## ► USING THE PADDLE

The warp may consist of many combinations of yarns which may be arranged in various ways. The weaver may take 5 to 20 yarns, group them together in an agreeable order, then repeat this unit throughout the width of the warp. In winding the warp, however, he will want to keep them in sequence. To do this under ordinary circumstances it would be necessary to cut and tie each different yarn to its successor and would, of course, involve winding one yarn at a time.

With a paddle he can take as many as 20 different yarns (assuming there are that many in the warp unit) and wind them all at once with the yarns consecutively alternated over the pegs as they would occur if each yarn were wound separately. When more than 5 yarns are in the warp unit, this saves considerable time and prevents sticking and twisting of the individual yarns.

The operation of the paddle is easily understood. The one shown in Figure 2.7 has two rows of holes evenly spaced with the bottom row located slightly in advance of the top row. This bottom row accommodates the odd-numbered yarns while the top row is for the even-numbered ones.

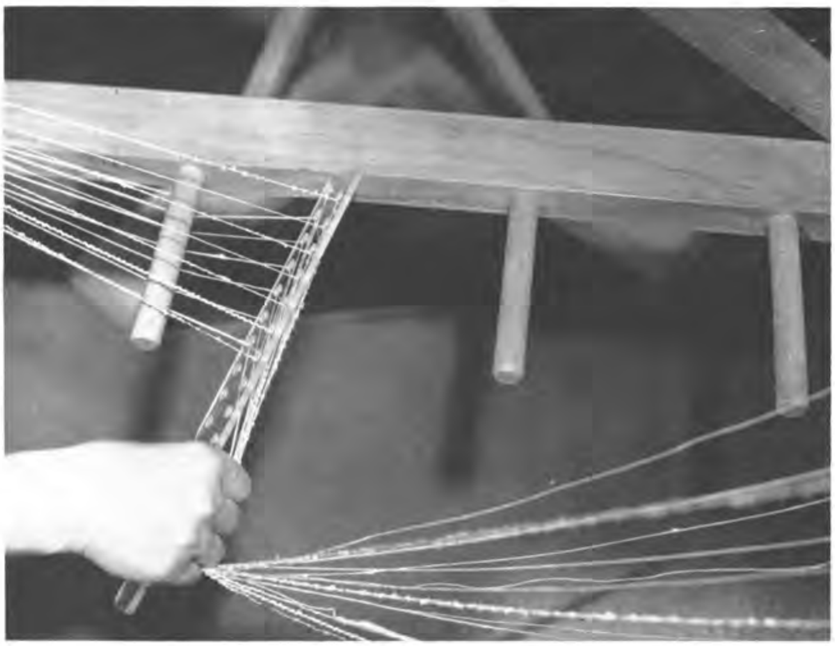
The weaver first charts the exact order of the yarns in the warp unit. Spools for the odd-numbered yarns are placed on one side of the spool rack, ones for the even-numbered yarns on the other. (See Fig. 2.5.)

The paddle is threaded starting with the first hole in the bottom row; this takes yarn Number 1. The second yarn is threaded through the hole in the top row. Number 3 is threaded through the second hole in the bottom and this pattern continued until all the odd-numbered yarns are in the bottom row and all the even-numbered ones in the top.

To wind the warp, tie all ends together and place the knot over the starting peg. The paddle is held between the thumb and forefinger and the yarn is allowed to run freely between the ring and little finger as shown in Figure 5.7. Hole Number 1 must be down.

Approaching the first peg, the paddle is tipped vertically so that as it is advanced forward the even-numbered yarns may be slipped over the peg, the odd-numbered ones below the peg, as in Figure 5.7.

Fig. 5.7—First step in using the paddle at the cross. With odd-numbered yarns on the bottom, even-numbered yarns may be slipped over the top of the first peg.



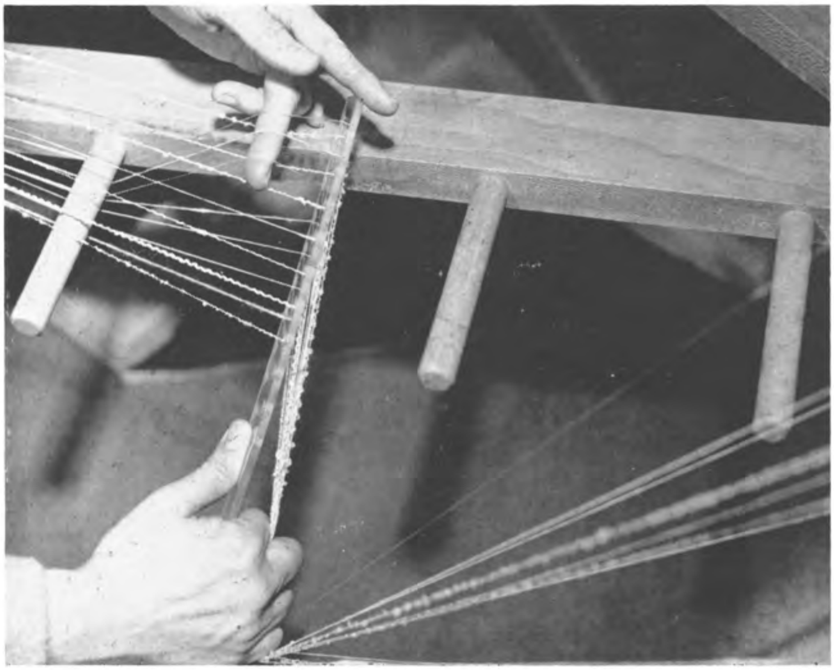
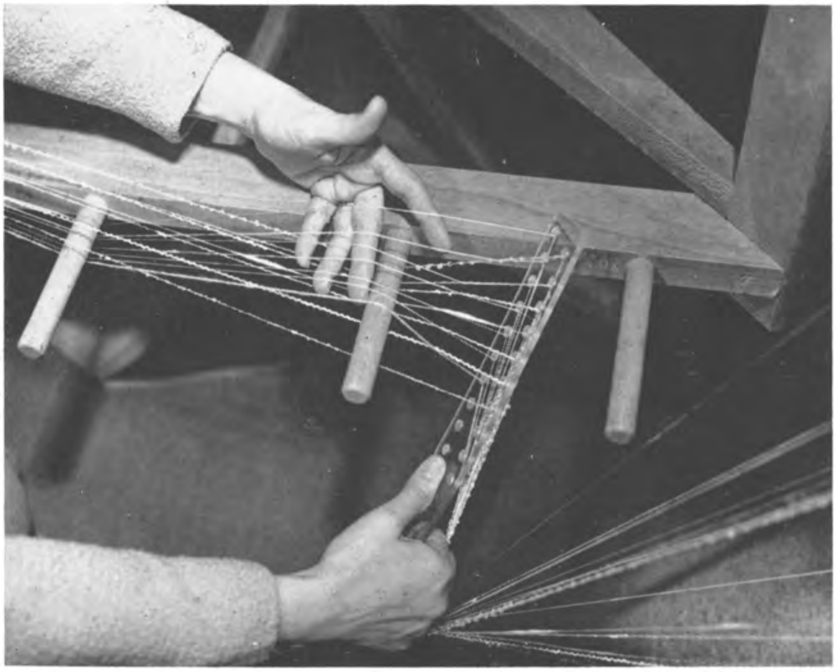


Fig. 5.8—Approaching the second peg. Odd-numbered yarns are picked up and held above the even-numbered, and slipped in this order over the second peg.

Fig. 5.9—Position at the second peg.



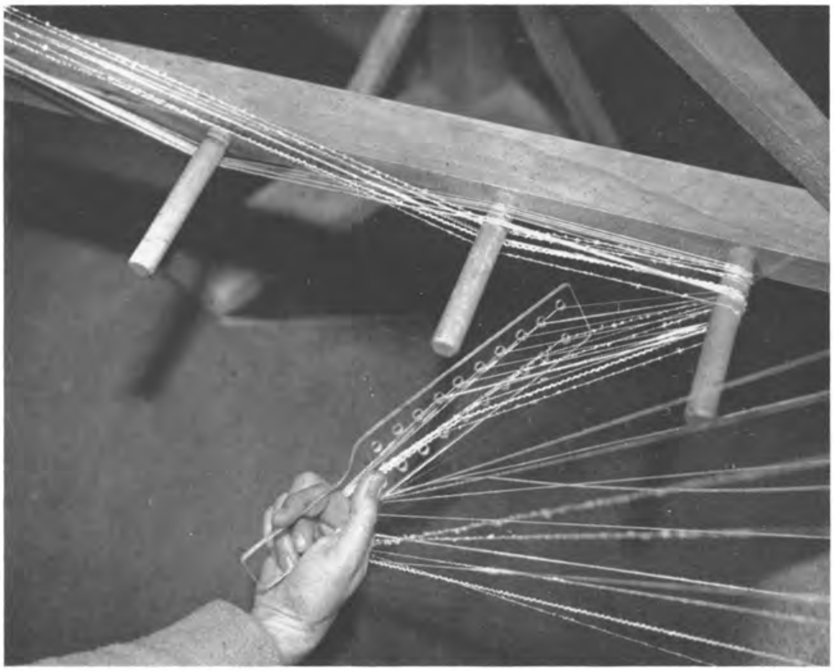


Fig. 5.10—Paddle passed around the end peg, ready to make the return cross. Note the wrist is turned to the right with Number 1 hole on top.

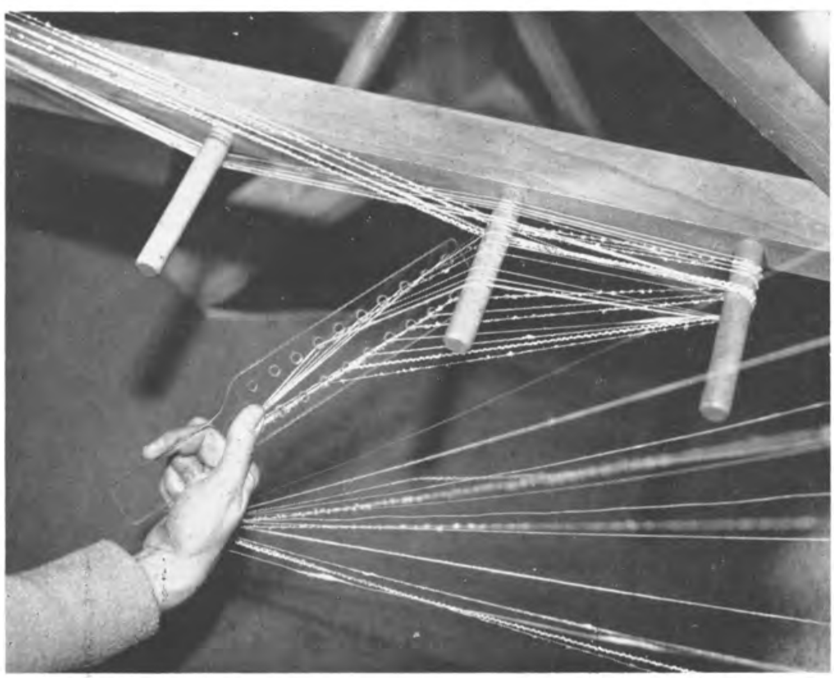


Fig. 5.11—Yarns in proper order for returning over the middle peg. Odd-numbered warp ends are on top, even-numbered on bottom, when an even number of ends are used in the paddle. If an odd number of ends are used, pick up the even-numbered ends and place them on top of the middle peg. Note the turned wrist.

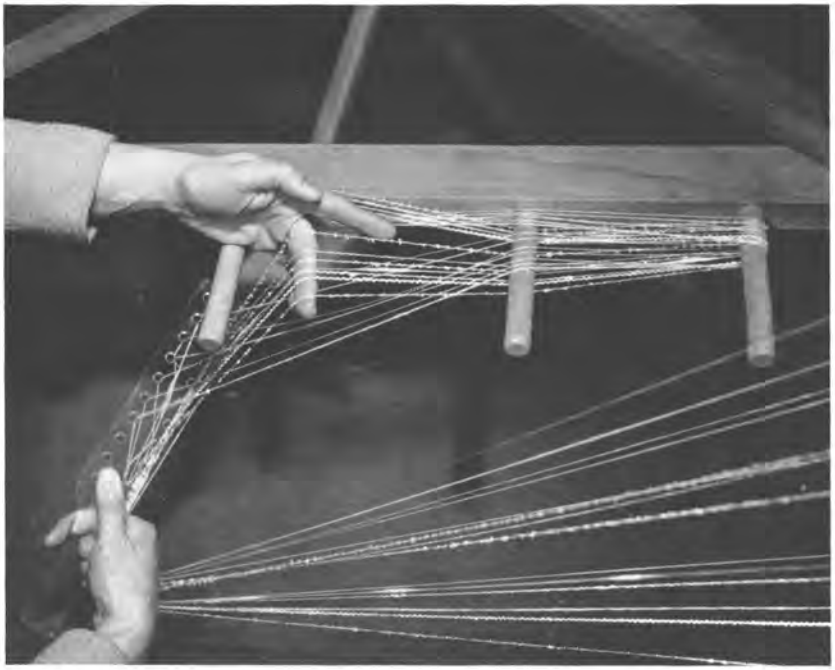


Fig. 5.12—Last peg on the return. When an even number of ends is used in the paddle, the even-numbered ones are picked up to pass over the peg, while the odd-numbered yarns will pass below. Note wrist still turned to the right. After slipping the yarn over this peg, the wrist is turned back to normal position.

On the second peg, to make the cross, the odd-numbered yarns are lifted so they can pass over the peg (Fig. 5.8). Pick up Number 1, go over Number 2, and pick up Number 3, lifting all odd-numbered yarns. These are slipped on the second peg (Fig. 5.9), and the weaver then passes all yarns over the last peg.

In turning for the return trip the wrist is turned to the right; this puts the paddle in position to make the return cross. Make sure not to turn the paddle in the hand. Figure 5.10 shows the paddle approaching the middle peg on the return.

At this point the weaver will consider the number of yarns he has in the paddle. If there is an odd number, the yarns on the bottom (with the wrist still turned to the right) are lifted over the center peg; if there is an even number, the yarns are in position and are merely slipped over the peg (Fig. 5.11).

The last peg on this return is governed by what was done on the middle peg: to make the cross, the position of the yarns would be reversed. The yarns are then returned to the starting peg with the wrist back in normal position (Fig. 5.12).

The weaver will have no difficulty with the paddle if he remembers that all yarns must be alternated over the pegs. This results in the separation of the individual yarns in the lease sticks in the proper sequence for threading through the heddles. This is but one of several ways the paddle can be used for warping. Familiarity with the appliance will suggest other ways it can be used to advantage.

A carefully planned and wound warp is the first essential in producing a good piece of weaving. Sufficient time should be allowed so that the winding is not hurried, counting can be done accurately, and the warp can be removed properly from the reel.

CHAPTER 6

# PREPARING THE LOOM

THIS PART OF THE WEAVING PROCEDURE is often called *dressing the loom.* It includes:

- Winding the warp onto the warp beam
- Threading the heddles
- Threading the reed
- Attaching the warp to the cloth beam
- Making the tie-up: connecting the treadles to the lams and these to the harnesses
- Making the various adjustments preliminary to the actual weaving

## ► WINDING WARP ONTO WARP BEAM

Place two sticks or bars just inside the loom uprights, one on either side of the loom from front to back. They should rest on the breast beam and back beam and will support the spreader and lease sticks. Next, place the spreader across the loom in front of the uprights and tie to the supporting sticks and the uprights at the sides of the loom. (Figure 6.2 shows this arrangement.)

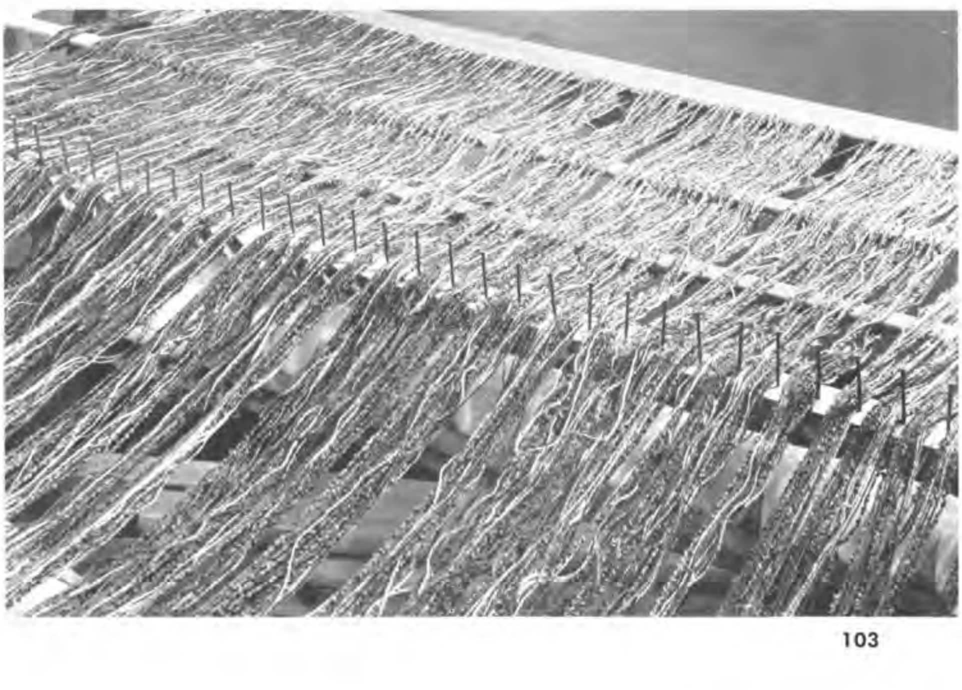
If a wide warp is being used, remove the harnesses from the loom. Tie the harnesses together securely to prevent the heddles from shifting their position and to make them easy to handle. If the warp is narrow the harnesses need not be removed from the loom. Simply push the heddles to either side of the center until sufficient space is cleared to allow the warp to pass through.

Lay the warp chain across the loom, the end containing the three crosses at the back beam, with the end that had been at the starting peg falling across the breast beam.

Now insert the lease sticks in the warp through the openings made by the two pegs on the warping reel to keep the cross in position. Place a temporary warp stick (or the permanent one if the loom is equipped with ropes instead of canvas) through the loop made by the last peg on the warping reel. Figure 6.1 shows these sticks keeping the warp crosses in place. Insert a cord through the ends of the lease sticks. After tying the ends to the top of the loom there should be sufficient length of cord to allow the lease sticks to slide independently and freely to the back of the loom as the warp is wound. As the lease sticks are not fastened tightly together they can be moved forward individually, a decided advantage in handling a warp that is inclined to be sticky.

With the warp stick fastened to the back beam the cords which were used to tie the crosses can be removed. The warp is now arranged from the front to the back of the loom with the bulk of the warp chain at the

Fig. 6.1—Warp spread across the loom and spaced by inches in the spreader. Lease sticks, just back of the spreader, maintain the cross while the temporary warp stick holds the end of the warp. Next, warp will be put on the permanent warp stick in the canvas attached to the warp beam. Harnesses have been removed.



front. Beginning at the center, arrange the warp in the spreader by inches; or, by placing the last inch counted at the proper distance from the center, work toward the center and on to the opposite side. Do not break up the 1-inch units or warp groupings.

Suppose a warp of 36 inches is being put on the loom. Slip the last inch that was counted during the winding into the 18th space from the center, the next inch section in the 17th space from the center, the next inch section in the 16th space, and continue. By the time the last inch, or section, is in place the cord used to tie, or lace, them will have been removed and the warp will lie in a straight line from the back of the loom toward the front, as shown in Figure 6.1. Handle the warp gently to avoid stretching or shifting the yarns out of place. Tie a rod or heavy cord to the spreader back of the dividers to hold the warp sections in place during winding. Now that the warp is spread across the loom it can be slipped onto the permanent warp stick if not already there.

At this point a yarn of contrasting color is looped through the lease sticks to mark the center.

The person who is to hold the warp at the front of the loom during the winding should grasp it tightly and ease out snarls or irregularities by slapping it against the breast beam. Running the fingers across the warp will help to separate sticky yarns without stretching them. The warp should not be combed or pulled lengthwise, as this stretches the more elastic yarns beyond the tension maintained when winding the warp. To minimize any variation in tension it is important that one person hold the warp while winding. Furthermore, it should be held together in a bundle below and in front of the breast beam, over which it rides as winding proceeds. This position is illustrated in Figure 6.2. This will insure a tight tension for the outside sections of the warp.

In winding a warp of mixed yarns some of the less elastic yarns will have a tendency to "drip" and hang below the regular warp. However, this unevenness in tension will adjust itself once the warp is on the loom.

As the warp is wound onto the warp beam allow the lease sticks to move toward the back. If irregularities of tension have caused the warp to tangle in front of the lease sticks remove such tangles by separating with an up-and-down or crosswise movement of the fingers until first one then the other lease stick can be moved forward close to the spreader. Then proceed with the winding. Keep a close watch immediately in

Fig. 6.2—Warp gathered together and held down firmly over the breast beam. Cord and rod at the spreader hold warp yarns in place. Spreader and lease sticks are supported by slats which reach from front to back and are tied to the loom uprights. Harnesses have been removed.

front of the spreader for loose or stretched yarns which might twist around the separating nails.

To keep the warp from piling up and becoming irregular in length as it is wound onto the warp beam, use plenty of sticks, winding these in with the warp. This is especially true of textured yarns and of long warps. The sticks should be as long as the warp beam. Heavy paper can be used with the shorter warps, but even here it is best to use some sticks with the paper. Note these sticks in Figure 6.3.

When most of the warp has been wound onto the beam, leaving the final 15 to 18 inches for threading, cut the ends at the position of the beginning peg, trim any uneven ends, divide in half, and tie in easy slip knots. Then remove the spreader and allow the warp ends to hang in front of the lease sticks.

## ▶ THREADING THE HEDDLES

Remove the breast beam if the loom permits, in order to work close to the harnesses. Hang the harnesses in place at a convenient level for threading, usually slightly higher than the position for weaving, for threading is easier if the heddle eye is level with the line of vision. The lease sticks should be supported and lifted also.

Before beginning to thread, it is important that there are enough heddles and that they are properly distributed on the four harnesses for the threading desired. For twill threading the number of heddles on each harness should be ¼ the total number of warp ends.

When the warp unit includes a variety of yarns, a sample to show the order of threading should be taped to the front of the loom for easy reference while threading.

Fig. 6.3—Warp sticks wound in with the warp to prevent piling up and to maintain an even tension. Note one stick being placed while others are spaced around the beam and wound in with the warp.

Fig. 6.4—Threading the warp. Yarns are held between the fingers for a simple twill threading. The four yarns are brought forward from the front lease stick without crossing each other. Yarns at right have been threaded through heddles. Warp yet to be threaded can be seen hanging over lease sticks at left. If harnesses were removed to wind the warp onto the warp beam, they have now been hung in place as before.

Fig. 6.5—Threading the heddles. Starting at the back harness, the yarn that was held between the thumb and first finger has been threaded through the heddle on Harness 4; yarn held between first and middle finger, through heddle on Harness 3; third yarn in the left hand is being threaded through heddle on Harness 2; and the fourth warp end farthest to the left will be threaded through heddle on Harness 1.

Where the design is dependent upon the character and combination of yarns used, the twill threading is the most satisfactory, and that one will be explained here. Other threading patterns will be explained in Chapter 9.

To begin threading, clear the center of the harnesses by pushing the heddles to the right and left from the center. Pull one heddle from each harness on the right side of the center. Arrange the heddles to form a diagonal from left at front to right toward the back. Choose four warp yarns in proper sequence as shown in Figure 6.4.

The warp yarn for Heddle 1 lies between the little finger and ring finger of the left hand, the yarn for Heddle 2 between the ring finger and middle finger, and so on. Figure 6.4 shows the position of these yarns in the hand.

Begin by threading, from back to front, the heddle on the back harness with the yarn lying between the first finger and thumb, pulling the yarn forward to the right of all four heddles. Proceed, letting each yarn fall to the right of the next heddle. The last heddle (on the front harness) will be threaded with the yarn lying between the little finger and the ring finger (Fig. 6.5). Continue in this order until the right half of the warp is threaded.

Return to the center and thread the left half of the loom in the same manner, using exactly the same position of the hand and being careful not to change the sequence of yarns in the unit. There must be no twisting of warp yarns between the lease sticks and the heddles.

When using two warp yarns, alternating a novelty and a smooth yarn, the position of the yarns will be as follows: starting with the smooth, all smooth yarns will be on Harnesses 1 and 3; all novelty on 2 and 4.

When using three warp yarns—for example, red, white, and blue—the first set of four heddles will be red on Heddle 1, white on 2, blue on 3, red on 4; the second set of four heddles will be white on 1, blue on 2, red on 3, white on 4, with yarns on 1 and 4 always the same.

With four warp yarns, the sequence of yarns will be the same for each set of heddles.

The threading for sequence of yarns of any number of units can be worked out in a similar manner. However, if the paddle has been used in winding the warp the individual yarns will appear in their proper sequence.

In general, leave sufficient length of warp for threading so that warp ends can fall clear in front of the harnesses. Tie the warp ends in easy slip knots in any desired unit size. Check frequently for mistakes.

### ► THREADING THE REED

This process is also called *sleying*.

Place a supporting slat on either side, resting on the front and back of the loom frame.

Lay the reed flat on these slats.

Untie the knots of warp and pull the yarns through the reed with a reed hook or other device such as the back of a case knife. Adjust the heddles so the yarns will be in a straight line from front to back as they are pulled through the reed. Figure 6.6 shows the reed flat and in process of being threaded.

Begin threading at the right side of the reed, measuring from the center to find the starting point. If the warp is wide, measurement must be exact to avoid leftover warp ends.

The warp ends must be pulled through the reed in the same sequence in which they were threaded through the heddles or the shed will not open clearly.

If a selvage has been planned, the extra ends will be threaded as planned. Check the reed frequently to avoid any mistakes such as extra yarns through a dent or empty dents. Again tie the yarns in front of the reed in any convenient grouping in soft slip knots.

Arrange the reed in the beater. Measure to be sure the warp is in the center of the loom. Replace the breast beam.

### ► ATTACHING WARP TO THE CLOTH BEAM

There are several ways of tying the warp in preparation for weaving, and each weaver usually has his favorite. One that has proved satisfactory is described here.

Begin at the center. Pick up a group of yarns, covering approximately a 1-inch space in the reed.

Holding the yarns as a group, work out any unevenness of tension, by gently pulling or sliding the warp ends through the fingers, working from the back toward the front.

Bring the group of yarns forward over the top of the cloth stick to which the yarns are to be tied, divide into two equal parts, cross them

Fig. 6.6—Reed is threaded according to a planned spacing. Note the reed is in position across the front, resting on the front-to-back bars. After threading is completed, reed will be placed in position in the beater. Warp is for a bamboo screen.

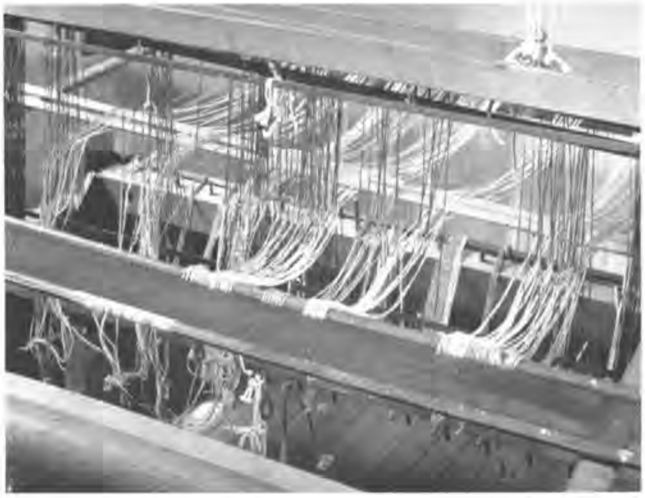


Fig. 6.7—Tying warp to cloth apron. In the first step, a unit of yarns coming through the reed is brought over the warp stick and divided into two sections. Warp stick has been tied to cloth apron at regularly spaced intervals.

Fig. 6.8—Second step is to tie the temporary knot. Divided sections are brought around outside and over whole group and tied in a simple knot.

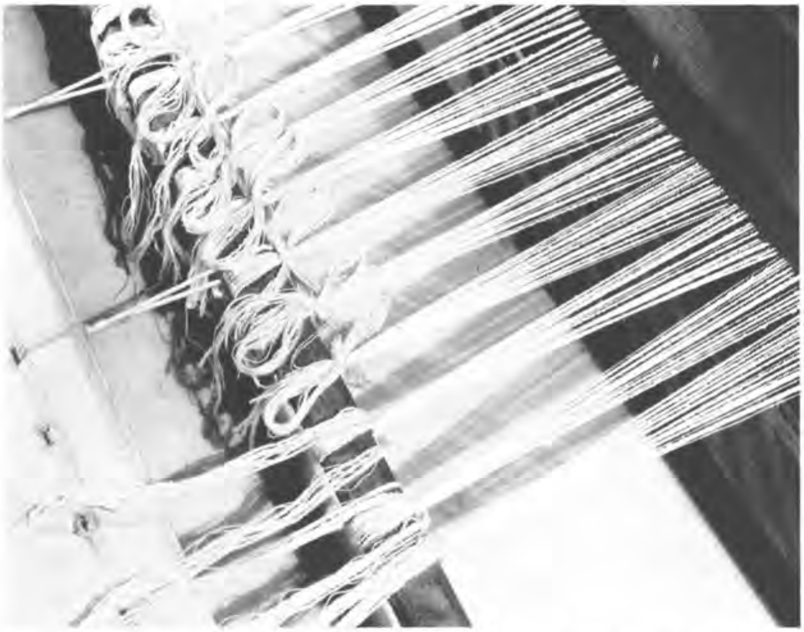


Fig. 6.9—Third step shows single knot pulled up firmly and tied in a bowknot. Illustration shows both temporary and finished knots. In the final adjustment, tying is done from the center toward either side to insure tight selvages.

underneath, bring a section up on either side of the original group and tie them in a simple knot.

Begin the preliminary tying of these knots on either side of the center, then tie the outsides, then near the center, alternating until all the warp ends have been tied. Adjust the tension and re-tie with a bow knot. In this second, or permanent tying, begin at the center and tie back and forth on either side of the center, *tying the outside knots last.* This is necessary to make sure the warp yarns are tight at the selvage. Follow these steps in Figures 6.7, 6.8, and 6.9.

## ► TIE-UP OF HARNESSES, LAMS, AND TREADLES

The interest in most contemporary fabrics is produced by the combination of yarns rather than the threading or more intricate tie-ups. Most contemporary weaving is based upon the twill threading and one of three tie-ups, which will be explained here. The tie-ups used are:

*Tabby* or *plain weave*, in which 2 treadles only are used, tied respectively to Lams 1 and 3, and 2 and 4 (Fig. 6.10).

*Plain twill,* in which 4 treadles are used, tied to Lams 1 and 2, 2 and 3, 3 and 4, 4 and 1, respectively, and treadled 1, 2, 3, and 4 (Fig. 6.11).

A *combination of tabby and twill,* for example, selecting any pair of twill treadles to be alternated with the plain, or tabby, treadles. In Figure 6.12, the *standard* tie-up, this might be Treadles 6, 1, 5, 3, with treadles numbered from left to right. Disconnect those treadles not to be used.

### ► ADJUSTING THE LOOM

Check the harnesses, lams, and treadles for the proper position. Begin at the top by tying the harnesses together and adjusting their height until the warp yarns form a straight line from the back beam to the breast beam. All harnesses must be at *exactly* the same height. The lams should hang parallel to the floor or slightly higher, all equally distant from the harnesses or from the floor. Adjust the treadles last, keeping them at a height comfortable for the worker and at a position that will open a good shed when the treadles are depressed.

Untie the harnesses and check for a clean shed—the triangular open-

Fig. 6.10—Treadle tie-up for plain or tabby weave. Treadles at lower front are attached by cords to the lams (wooden bars running crosswise), and these in turn are hooked to metal rods fastened to the harnesses. Right treadle is hooked to Lams 1 and 3; left treadle to Lams 2 and 4.

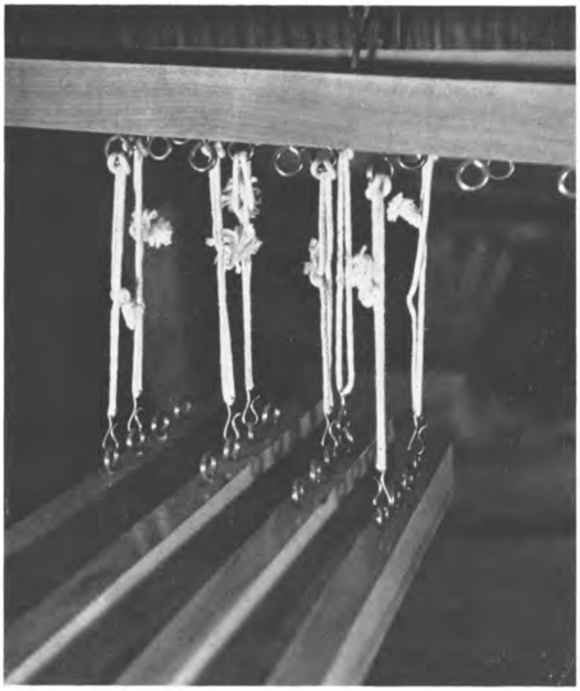


Fig. 6.11—Tie-up for simple twill. Note the 1 and 2, 2 and 3, 3 and 4, 1 and 4 combinations. A twill results when treadled either from right to left, or left to right.

Fig. 6.12—Standard tie-up uses all six treadles. Here the tabby treadles are at the right, tied to Lams 1 and 3, 2 and 4, the four twill treadles at the left. Other arrangements are possible to suit comfort of weaver.

ing in front of the reed, formed by separating the odd and the even warp yarns. A perfect shed results when the yarns on the pair of harnesses being raised are at identical levels. Sagging yarns interfere with the smooth movement of the shuttle. The pair of harnesses that are lowered must present the same picture. Figure 7.1 illustrates a clean, or clear, shed.

If the shed is not clear the trouble may be caused by any one of several reasons, all easily corrected. Some of the most common ones are:

Uneven height of harnesses
Uneven tie-up of lams or treadles
Yarns out of order in the reed
Yarns crossed in the harnesses
Uneven tension of yarns

After the shed has been corrected, a few rows of heavy material are woven in, which will close the spaces formed by the knots where the warp is tied to the cloth beam.

At this stage mistakes in threading the heddles or the reed become quite obvious. Mistakes in threading the reed are not difficult to correct, but a heddle out of order presents a more troublesome problem. Therefore, it is very important to maintain a careful watch as the heddles are threaded to make certain every warp end is threaded, and in the proper sequence. A rechecking at two to four inch intervals will save much time, for an uncorrected error may necessitate rethreading the entire loom.

The loom is now ready for weaving.

### ► CHECK LIST FOR WARPING THE LOOM

1. Remove the harnesses if the warp is wide.
2. Place a stick from front to back on either side of the loom.
3. Place the spreader across sticks and tie securely to the uprights.
4. Hold the warp end containing the three crosses at the back beam and lay the warp chain across the breast beam.
5. Put the warp stick through the loop at the end of the chain.
6. Put the lease sticks through the second and third loops of the cross and tie the sticks securely to the loom.
7. Tie a colored yarn in the lease sticks to divide the warp in half.
8. Cut the yarns holding the crosses; spread the warp across the back beam.
9. Start from the center or at either side and put the warp in the spreader by inches.
10. Tie a cord or extra lease stick across the top of the spreader.

11. Wind the warp onto the warp beam; check the tension frequently.
12. Use sufficient sticks to prevent piling-up of the warp.
13. Remove the spreader; remove the breast beam.
14. Cut the ends of the warp, trim to even length.
15. If harnesses have been removed, replace them.
16. Start from the center and thread the heddles on one side of the loom.
17. Repeat on the opposite side.
18. Replace the breast beam. Lay sticks from the front to the back *again*.
19. Place the reed across the sticks; sley and tie the warp ends in groups.
20. Remove the sticks; place the reed in the beater.
21. Tie the warp to the cloth beam.
22. Start from center and, working from either side of center, *re-tie* in a single bow. Tie the outsides last.
23. Adjust the loom.
24. Test for mistakes.
25. Weave in a heading of heavy yarn to start the web.

# CHAPTER 7
# PROCESSES OF WEAVING

WEAVING CONSISTS IN INTERLACING a weft or filler yarn with the warp yarns at right angles. There are four operations as follows:

Forming the shed by stepping on the treadles
Throwing the shuttle across through this opening
Changing the shed
Bringing the beater forward to push filling yarn into position

## ► FORMING THE SHED

In the counterbalanced loom when one pair of harnesses is pulled down by stepping on a treadle, the other pair is automatically raised. The action of the harnesses in the jack-type loom is slightly different. Stepping on a treadle lifts the harnesses tied to that treadle while the other harnesses remain stationary. In either case the odd yarns will be down while the even yarns will be lifted. This separates the yarns into the triangular opening called the shed, as shown in Figure 7.1. The shed should be large enough for the shuttle to slide through easily. All the lower yarns should be of even tension and should offer a smooth, taut surface for the shuttle to pass across.

## ► WINDING THE BOBBIN

The shuttle carries the bobbin of yarn back and forth across the warp. Properly wound bobbins are absolutely essential to good weaving. Bobbins must be wound so as to be firm, even hard, and must not slip nor snarl at the ends. The various types of bobbins call for different methods of winding. If using the paper quill, begin by building a ridge of yarn

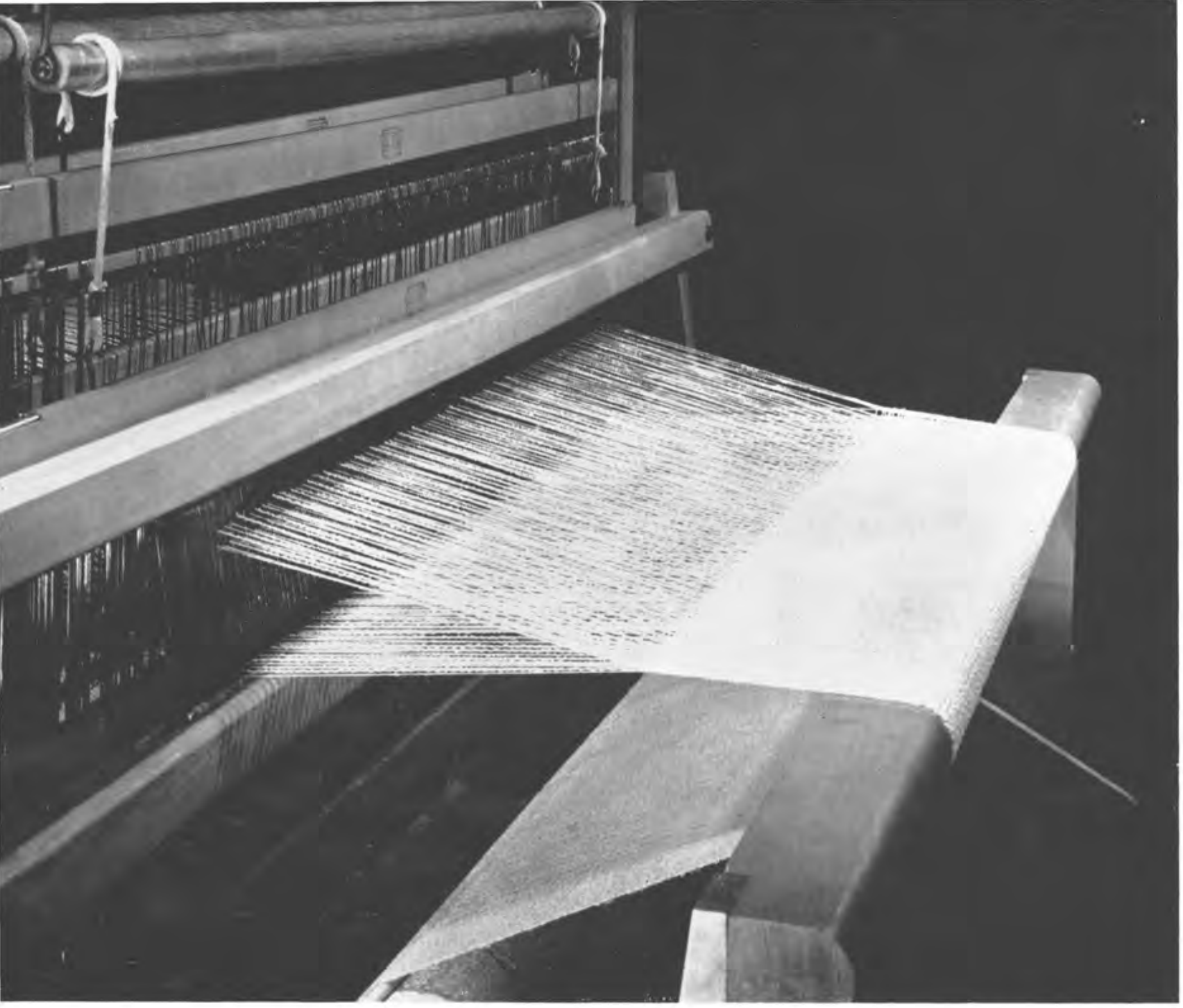


Fig. 7.1—A clean shed. Lower warp yarns lie in a level plane along base of the reed, forming a smooth path for the shuttle to move across.

at each end of the quill, then proceed to fill in the center between these ridges. Leave a small margin of paper at each end. To wind a bobbin which is firm and will not slip off the ends of the quill, hold the hand which is guiding the yarn close to the bobbin and keep it moving from right to left in short quick movements. Figure 7.2 shows these stages of winding. Another factor in securing firmness is to hold the yarn at considerable tension while winding. When the bobbin has been wound, secure the end of the yarn with a slip knot.

When winding bobbins from two or more spools that unwind at different speeds or tensions, the yarn which unwinds more rapidly can be slowed down by threading it in and out of two or more bars of the spool rack (*see* Fig. 5.1). The same method can be used when making a bob-

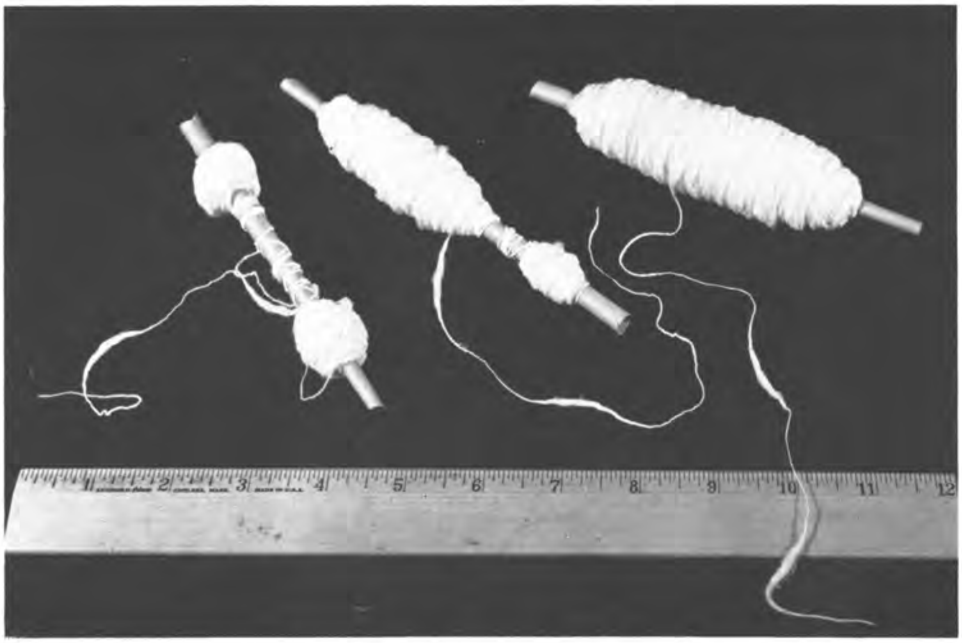


Fig. 7.2—Properly wound bobbins are a necessity for efficient weaving. Bobbins should be hard and should not slip at the ends. Illustrations show how to wind bobbins on a paper quill: at left the ends have been formed; the center illustration shows the middle of the bobbin being filled; completed bobbin is at right. Yarn is a single flake or slub novelty. Rough texture of the bobbin results from the quick right and left movement in guiding the yarn.

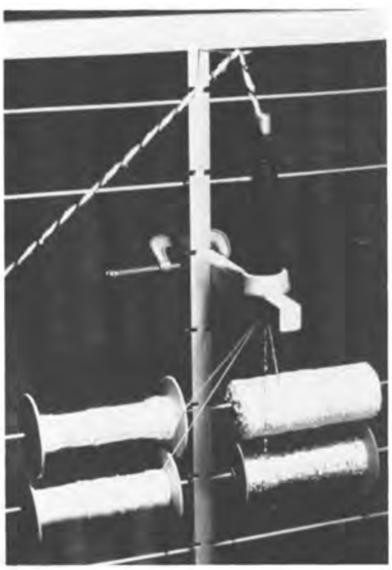


Fig. 7.3—Device used when winding bobbins with two or more yarns. (Courtesy A. J. Underwood.) Hollow, upright shaft on crossbar is treated as a bobbin, and yarn is wound from its base, tapering toward the end. Additional weft yarns are threaded through this shaft, caught with the yarn wound around the outside of the shaft, and guided through a screw eye toward the bobbin winder. Yarn from the outside of the shaft twists around those coming from the inside and prevents variation in length and tension of the individual yarns.

bin of two yarns of different elasticity, such as wool and rayon. Increase the tension of the rayon, the less elastic yarn, by threading it through the bars of the spool rack. Beginners should experiment by winding only one bobbin at a time until the proper tension can be judged. A device such as the one shown in Figure 7.3 may be used to twist the yarns while winding the bobbin, thus eliminating tension difficulty.

### ► THROWING THE SHUTTLE

For smooth and rapid weaving the shuttle should be thrown through the shed with one movement. In passing the shuttle from right to left, hold it in the right hand with the thumb on top, the first finger curved around the end, and the shuttle resting on the other three fingers. Receive the shuttle with the left hand in the same manner as it emerges from the shed (Fig. 7.4). The position of the shuttle in the shed should be close to the reed. Shuttles with a straight and a curved side should be thrown across with the straight side next to the reed to avoid catching

Fig. 7.4—Throwing the shuttle. Holding the shuttle as illustrated, it is pointed slightly toward the beater and thrown across close to the beater. Properly thrown in a good shed, the shuttle moves across smoothly and quickly.

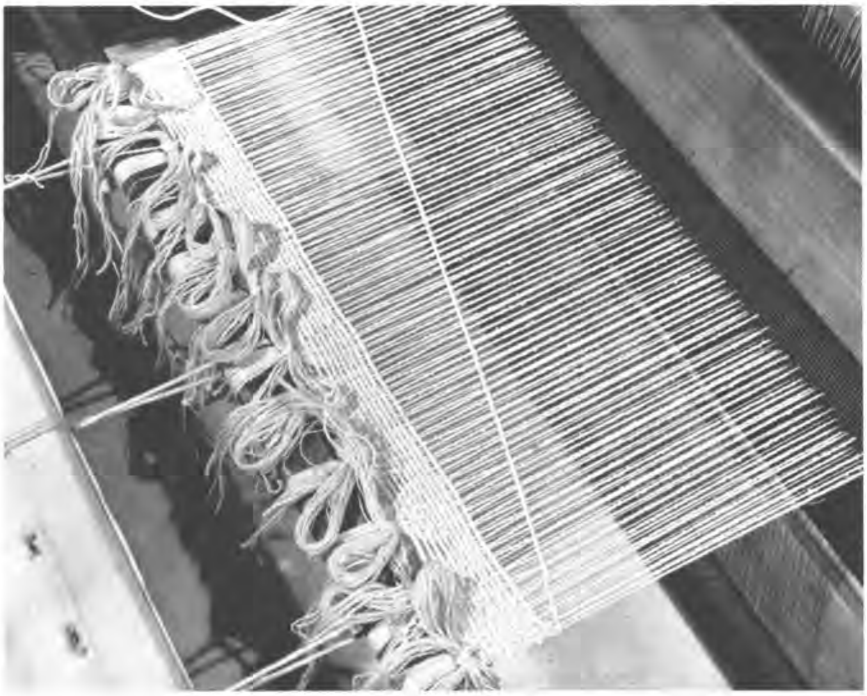


Fig. 7.5A—Securing ease in filler yarns. Preliminary to weaving, a few shots of some heavy filler yarn are woven in to close the spaces which resulted from tying the units, to adjust the tension, and to establish, or start, the web. To prevent drawing the fabric in at the edges as weaving progresses, the yarn must be allowed some ease in the open shed. One method shown here is to have the yarn lie diagonally in the shed before beating. Ease in the filler yarn must be kept in mind throughout the weaving process.

the tip of the shuttle in the warp yarns. In entering the shed the shuttle should be tipped slightly to prevent catching in the warp yarns. Change the treadles as the shuttle leaves the shed, thus changing the shed, and bring the beater forward to push the filling yarn into its proper position. The shuttle is held in the left hand and thrown from left to right in the same manner.

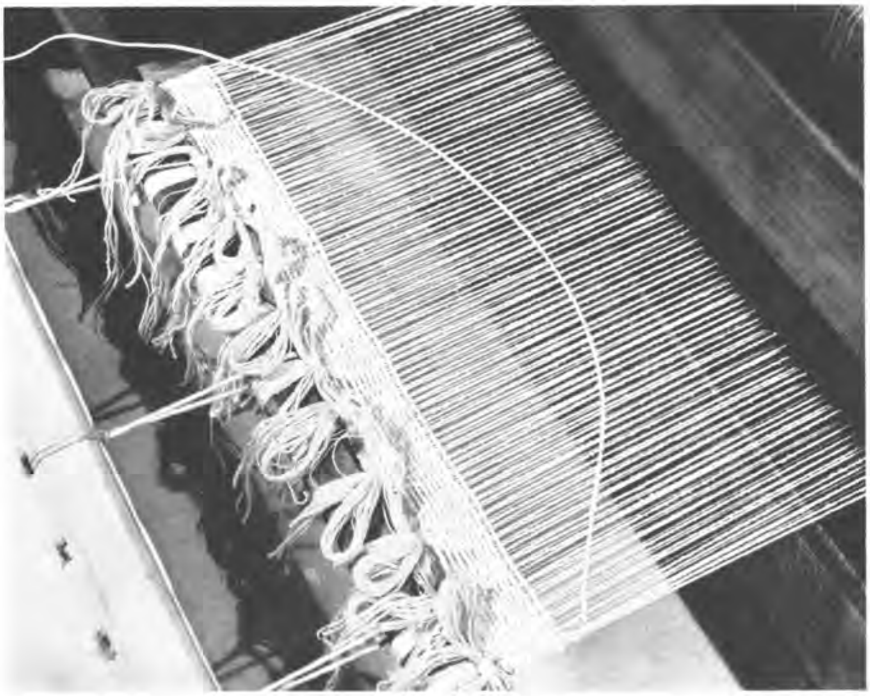
Closeness of beating depends upon the number of warp yarns per inch and the effect desired. In most fabrics there are more warp than filling yarns per inch while weaving. In the finishing process, however, the two sets of yarns become more nearly equal, especially if the yarns are of similar size.

### ► SECURING EASE OF FILLER

It is very important to secure ease of tension in the filling yarns to prevent narrowing the fabric as weaving progresses. Two methods commonly used are: to let the filling yarn lie at an angle (Fig. 7.5A) ; or to form an arc in the open shed with the filling yarn (Fig. 7.5B) .

If the fabric is pulled in along the sides in the weaving, broken selvage

Fig. 7.5B—Filler yarn also may be formed in an arc to secure needed ease and prevent drawing in.



yarns usually result, and an uneven and unsatisfactory fabric will be produced. This is due to the strain put upon these edge yarns and the wear they receive from rubbing against the reed.

In some fabrics, especially in rugs, it may be desired to completely cover the warp. This can be done by exaggerating the ease in the filling yarn by *bubbling*. As Figure 7.6 shows, bubbling is produced by throwing the shuttle through the shed with a generous allowance in ease, then the bubbles, or scallops, are made with the fingers.

### ► USING THE BEATER

The beater can be used to secure various effects of openness or closeness in the weave. *Beating* is the process of bringing the beater forward to push the filler into place against the woven section, or web. Various degrees of force can be used, from a very gentle pull for a sheer fabric, to a hard beat in heavy fabrics such as rugs.

For upholstery or any material where firmness is desired, use a double beat; first, bring the beater forward with an open shed just after the shuttle has been thrown across, then change the shed and bring the beater forward again, usually with some force.

For sheer or open weave, do not beat. Use the beater in a closed shed and gently pull the filling yarn into the position desired.

Always grasp the beater in the center to insure even beating across the width of the fabric. When the shuttle is thrown from left to right, beat with the left hand; when it is thrown from right to left, beat with the right hand.

To prevent streaking and to secure evenness of weaving in soft materials such as suiting and soft woolens, it is important to roll the warp forward frequently. Experienced weavers tell us that we should weave within a 2-inch area. This area should be at approximately the same position between the breast beam and harnesses throughout the weaving process. Since looms vary in weaving space, the weaver must experiment to find the best place to locate this area. Do not crowd the weaving toward the beater until the angle or arc is diminished. This will result in uneven tension of the filling, and the web will show thick and thin spots. There is also danger of narrowing the fabric.

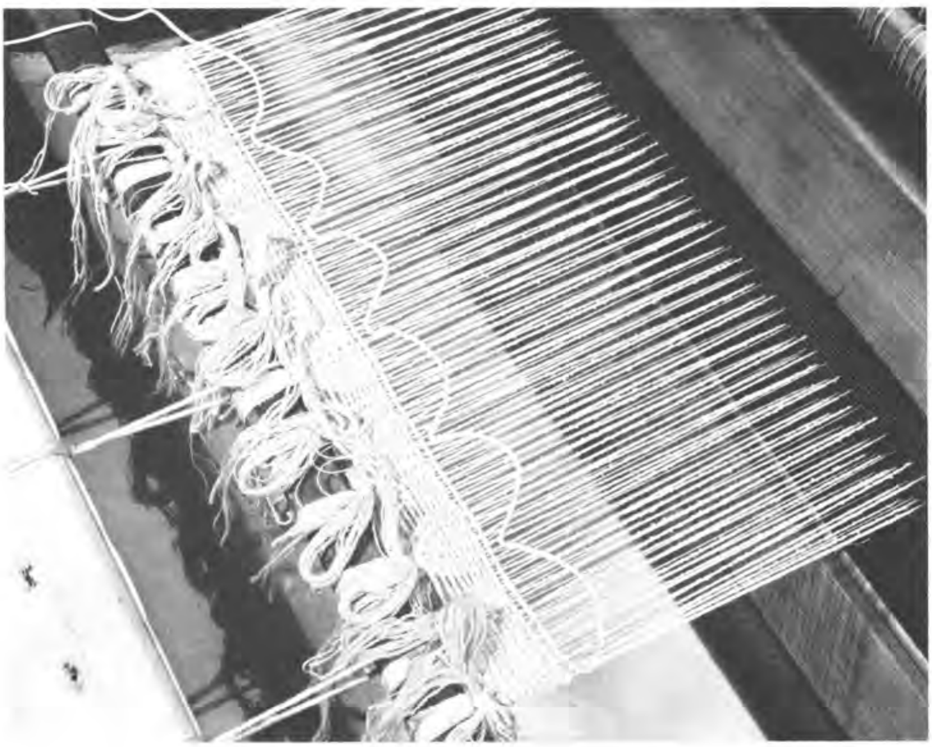


Fig. 7.6—Looping the yarn, scallop fashion, gives extra ease to the filler. This method is used where it is desired to have the filler yarn cover the warp as in rugs. It is sometimes called "bubbling."

## ► MENDING BROKEN YARNS

When winding the warp, all broken yarns and knots are mended near the beginning or ending pegs. However, if a knot appears in the filler, the yarn is pulled back to the selvage and clipped off. When ending one bobbin and starting a new one, we also end and start at the selvage. This prevents the appearance of a patched spot in the cloth. It is neither necessary nor desirable to bring the clipped ends back into the material.

If a warp yarn should break while weaving, it can be mended as follows: darn one end of a yard length of the same yarn into the section of woven material alongside the broken yarn for about $5/8$ of an inch. Thread the other end of the yarn through the proper space in the reed and heddle, and tie in a simple knot to the end of the broken warp yarn at the back of the loom. Back of this knot make a slip knot in the original warp yarn to take up the excess length. Pull forward the warp end, which was darned in at the front, until the tension is the same as the rest of the warp. If the yarn is wool this will be sufficient, but other yarns may need to be held in the proper tension by wrapping the end around a pin until a few inches have been woven. When the weaving has progressed until the knot at the back is near the harnesses, the slip knot can be pulled out, the warp yarn pulled forward, and the spliced warp yarn can be darned into the cloth.

While the hand weaver does not expect to reproduce the precision and evenness of machine weaving, he should be able to produce a good cloth free of faults. Good weaving depends to a very great extent upon good habits of weaving. Take it slowly at first; the manipulation of the loom will become automatic, then speed and rhythm will follow.

# CHAPTER 8

# FINISHING TECHNIQUES

WEAVERS HAVE ALWAYS SOUGHT WAYS and means to improve their textiles to make them more durable and better adapted to the purposes they had in mind. For years this interest was centered on such improvements as could be effected through manual proficiency. Flax, wool, and cotton were fibers found amenable to spinning and, although the methods remained essentially the same, spinners developed such skill with these fibers that they were able to make yarns with more and more uniform twist. This marked an important step toward the improvement of textile quality.

Technical progress in the field of finishing would probably date from 1850, when mercerization was discovered. John Mercer, an English calico-printer, accidentally dropped a cotton cloth into an alkali solution. When it was discovered, he removed the cloth and stretched it on a frame to dry. Later, he was surprised to find it had taken on luster. Moreover, on testing the material, he found it had apparently lost none of its strength. Further experiment with caustic alkalies resulted in the process known today as mercerization—a process that not only gives luster to cotton but greatly increases its strength and affinity for dye.

## ► COMMERCIAL PROCESSES

Since then numerous chemical and mechanical innovations have appeared. With our modern technology it is now possible to alter completely the natural characteristics of a fiber or a cloth after the cloth is woven. As an example, a cotton cloth of plain weave can be converted to simulate the appearance and "feel" of silk, linen, or wool. Or, after being subjected to various chemical reagents, it may emerge as a crisp organdy, a transparent muslin, or as a soft, sheer fabric.

Other processes can be used to effect decorative changes. From one process alone—using a combination of resins, heat, and mechanical pressures—a basic woven cloth can be changed into as many as a dozen distinct types of fabric.

Through its finishing methods, the wool industry has been able to achieve close control of the shrinkage factor in woolen and worsted fabrics. They have also found means to prevent knit and sheer woolens from losing their shape. Many of the soft textures, such as camel-hair cloth, owe their effects chiefly to mechanical processes that involve napping and shearing.

These examples are typical of what has occurred with fabrics of other

Fig. 8.1—Work of beginning students in a student project at the State University of Iowa. After experimenting with yarns in small samples, students choose a major project in which design and execution are stressed. Mat at top is of cotton; the other two are of bamboo woven with cotton and rayon. Designs show interesting spacing and contrast in light and dark.

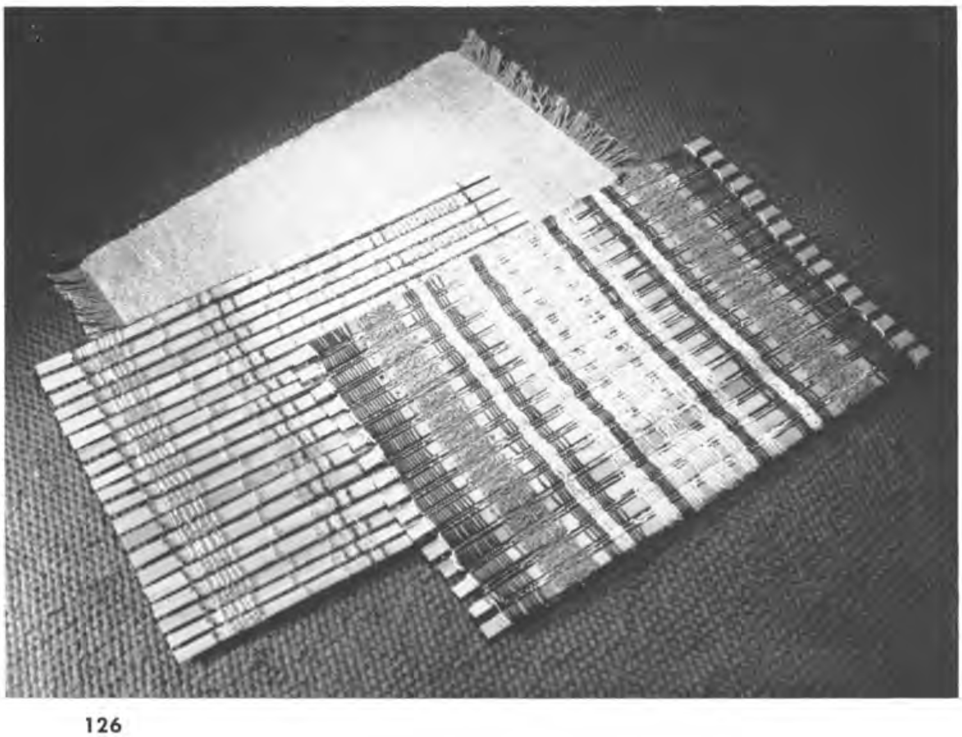


Fig. 8.2—Heavy drapery in a twill variation, by Ed Rossbach. Wool weft on a warp of chenille, wool, and rayon; in white, brown, and gray. Richness obtained through depth of texture and play of values.

fibers, man-made as well as natural. It is common practice to make material crease resistant, shrinkproof, waterproof, mildew and spot resistant, and even fireproof. All of these accomplishments are the result of finishing processes.

## ► HOME PRACTICES

It is impossible, or questionable, for the hand weaver to attempt such results. He is restricted to limited means in finishing his fabrics and he uses these, not primarily to enhance the material, but to resolve some of the practical needs. Dry cleaning, washing, bleaching, preshrinking, and piece dyeing are elementary procedures, but to the hand weaver they present special problems.

The primary considerations in finishing hand woven textiles include:

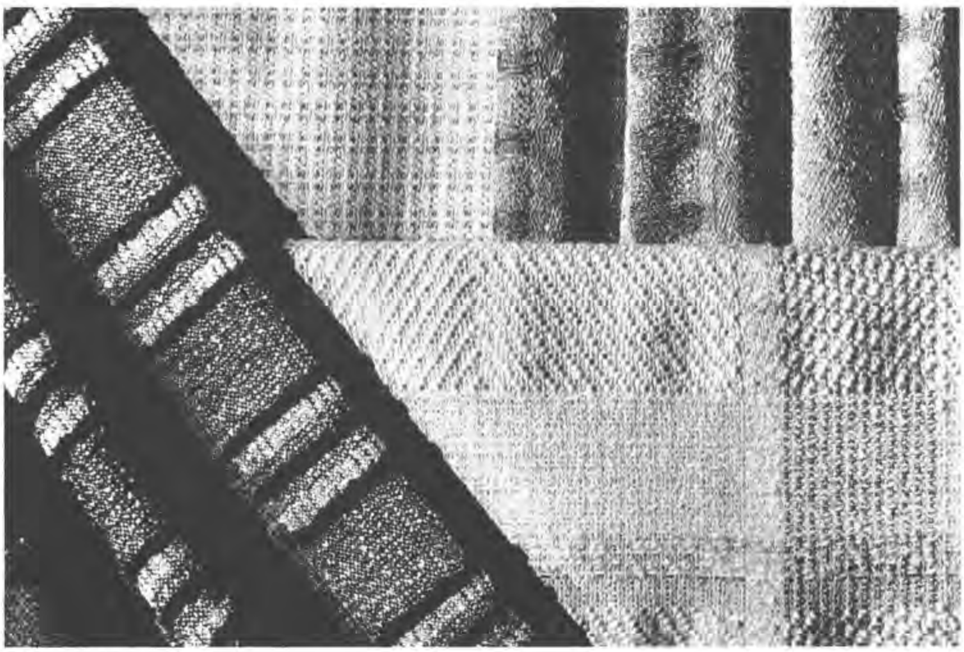
Removal of dust, lint, soil, and spinning dressings
Means of softening fibers, such as wool and linen
Shrinkage control

After removal from the loom, a fabric should be placed under a strong light and examined carefully on both sides to see that all repairs have been made. It is difficult to make adequate repairs after the finishing process is completed, since yarns often become closely interlocked by shrinking. It is advisable at this point to clip all loose ends, to shake and brush well to remove dust and lint.

The next step depends upon the fabric—its end use, and the fibers from which it is woven. Some fibers require very little in the way of processing; others, a great deal. Screens and mats, for example, made from bamboo, reeds, rushes, and other woody materials, are generally cleaned before weaving. The only attention they require would be inspection for repairs, clipping loose ends, and brushing. When they become soiled, wiping with a damp cloth is usually sufficient. They may, however, be immersed in lukewarm, soapy water, rinsed thoroughly, and laid flat to dry.

Linen fabrics, as they come from the loom, are stiff and unyielding. To be softened they should be washed in hot water, thoroughly rinsed, then pressed with a hot iron while still very damp. When linen yarn is combined with yarns of other fibers, as is often done in textiles, the temperature of the water and the iron is governed by the limitations of

Fig. 8.3—Drapery fabrics showing variety in structure and yarns, by Georgia Chingren. Upper left: cotton chenille, pearl cotton, rayon nub, and irregular, colored lurex; color, yellow-gold and chartreuse. Upper right: heavy and fine pearl cotton, rayon nub, and irregular, heavy, linen nub; color, two shades of gray, soft blue, and white; over-all effect, gray-blue. Lower left: cotton chenille, curly silk chenille, wool loop, pearl cotton, linen, and rayon irregular; color, gold and black. Lower right: wool loop and nub, mohair loop, pearl cotton, colored lurex, and spun glass.



the most perishable fiber. Rough surface textures of novelty yarns may be retained in these fabrics by pressing, face down, on a turkish towel.

Shrinkage is an important factor. Allowances must be made at the planning stage. If this is not done, the weaver may find, among other things, that he lacks sufficient yardage to complete his project.

### ▶ PRECAUTIONS FOR MIXED FIBERS

Textiles the weaver creates will often be composed of different yarns. From one fabric to another these will vary—in size, type, and fiber content. This influences the percentage of shrinkage of the woven materials; one fabric will be found to shrink more than another with a variance that is sometimes considerable. The weaver soon discovers this fact from his experience in finishing design samples; since these, however, are generally small in size, he sometimes neglects to transpose this factor accurately to yardage.

In making a design sample, to be duplicated later in a large piece, shrinkage that occurs in the sample should be measured closely, widthwise as well as lengthwise. This factor is then computed on the basis of shrinkage per yard. Any change or adjustment that might be made in the original sample would necessitate separate finishing and computation. The weaver can well avoid any pat formulas for estimating shrinkage—there are too many variables involved. He may weave many samples to arrive at a satisfactory design, but the design is judged after finishing, not before.

Cleaning methods are contingent upon the yarns; and an important consideration here is whether they are color fast to washing or merely sunfast (fast to light). Some yarns may be relatively fast to both light and washing, others may have only one or neither of these qualities. The end use of the textile determines which yarn to choose. Often the weaver must discover by his own experimenting if the yarn is washable or fast to light only.

Yardage for drapery and upholstery is given preliminary inspection for repairs, then brushed and sent to the dry cleaner for preshrinking. If such textiles are soiled, it is better to have them dry cleaned than to attempt washing. Different fibers are often used in the construction of this type of fabric. The length and weight of such yardage usually prohibits individual handling in home laundries, since quick and efficient

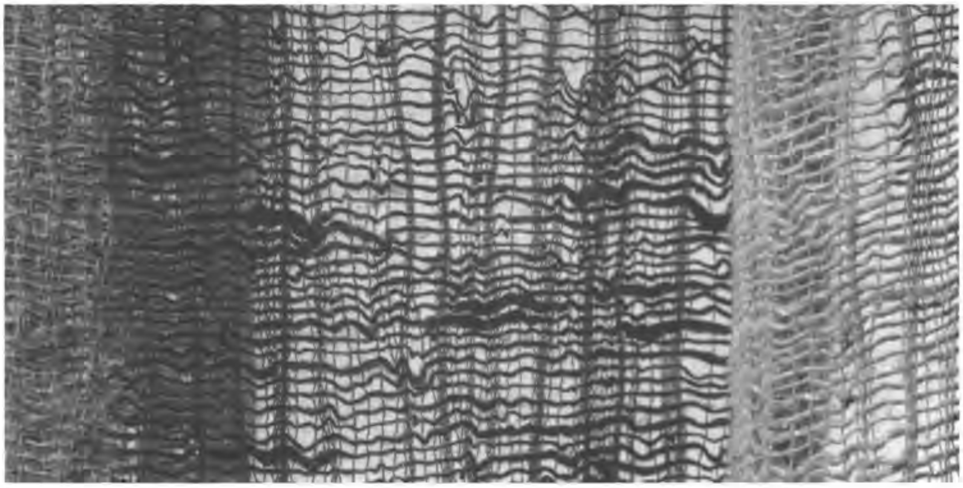


Fig. 8.4—Casement fabric of 20/2 unbleached mercerized cotton warp with a rayon-jute singles filler, by Maxwell Hawker.

water extraction is necessary to prevent spotting. Sheer draperies are especially susceptible to damage by washing.

A different problem is presented with woolen textiles. The apparel fabrics, mohair, alpaca, and other animal fibers that fall in the category of wool, react differently under finishing processes. Before the weaver attempts yardage he should make samples from the yarns he expects to use and study these fibers—alone or in combination—noting their behavior in respect to shrinkage, firmness, and filling quality.

A fabric constructed from soft, clean woolen or worsted yarns that contain very little spinning oil may be sent to the dry cleaner to be cleaned, preshrunk, and pressed. If these operations are properly done further shrinkage is unlikely.

Coarse wools, often single ply, may contain considerable oil and a certain amount of foreign matter. Cloth from such yarns first should be sent to the dry cleaner for processing (as above), then washed, and sent again to be pressed. In washing, use a heavy solution of mild soap or a detergent in a small amount of water. Washing has been found most successful in an automatic machine run about five minutes. If there is considerable soil, the washing will have to be repeated. Finish by several rinsings to remove all soap. The water for both washing and rinsing should be the same temperature—about 120°, or fairly warm to the

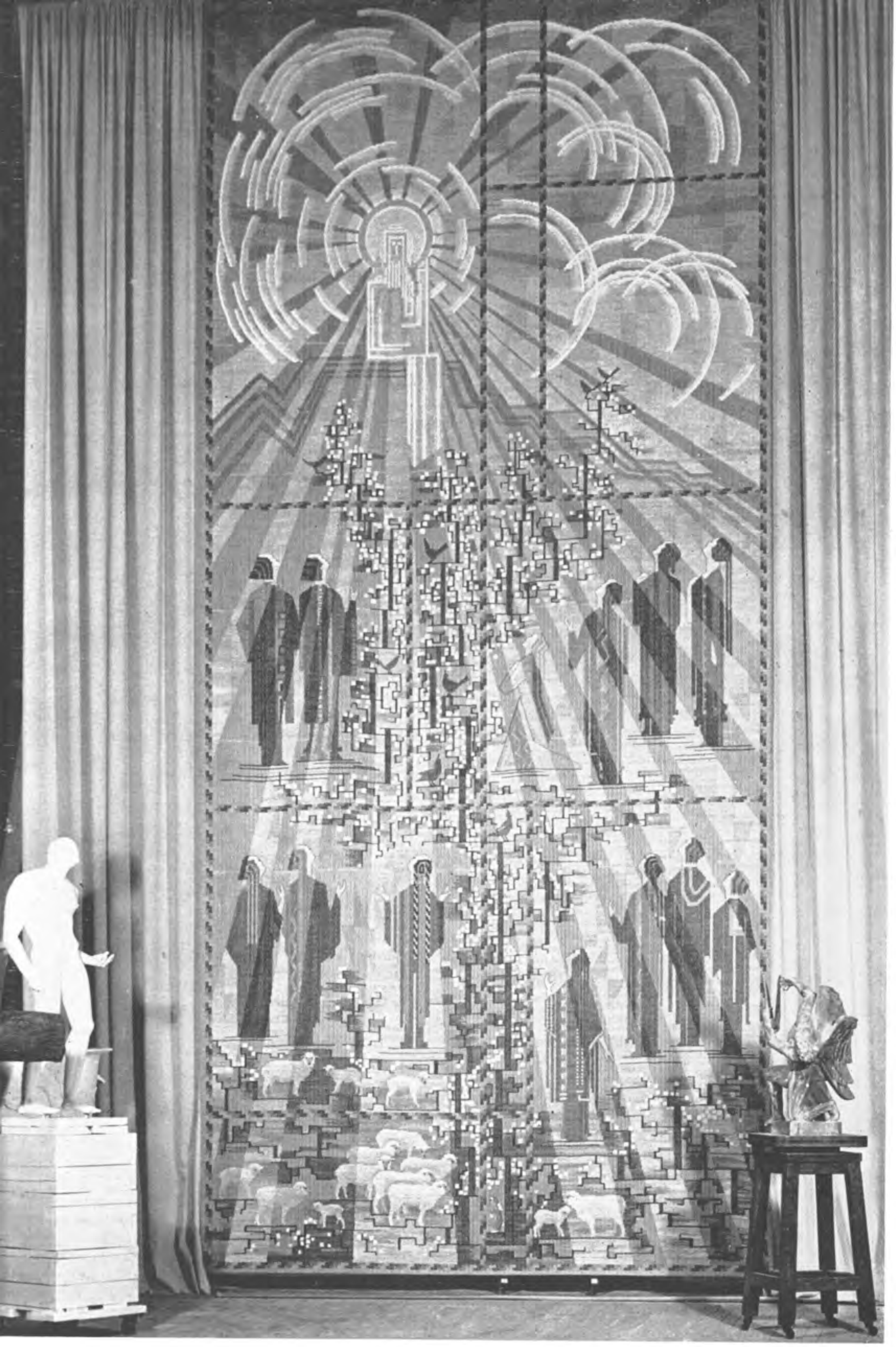


Fig. 8.5—Tapestry for Tabernacle Christ Church, Columbus, Indiana, called "Sermon on the Mount." Designed by the late Eliel Saarinen, it was woven by Loja Saarinen. (Courtesy Mrs. Saarinen.)

hand. It is important that the water be extracted quickly and thoroughly; otherwise, spotting will take place. If the machine is not equipped with an extractor or spinner, washing of yardage should not be attempted.

Small woolen pieces can, of course, be successfully washed by hand. Simply press and squeeze the fabric, alternately, for 10 or 15 minutes. The weaver must be careful not to wring the cloth as wringing a woolen fabric at this point causes creases and wrinkles that are almost impossible to remove. The material should be well rinsed and hung in the air to dry. When completed, it should look fresh and alive.

Apparel fabrics that combine synthetic fibers with animal fibers should be finished the same as drapery. Each fabric will be different from the one before, and allowances and adjustments must be made in finishing to meet the individual situation. This must be done at the planning stage, with design samples, and not after the fabric has been woven. Successful finishing may take some experimenting to bring about the desired results. Weavers often weave a strip of duplicate samples, after a satisfactory design has been decided upon. This enables them to explore several possibilities of finishing a given material.

Only general directions can be given for finishing tapestries and handwoven rugs. Tapestries may need pressing only. If they have become soiled in weaving they should be dry cleaned.

There are many rug types and combinations being woven today so each rug must be considered separately. Rugs firmly woven of wool, especially pile rugs, may need only clipping of loose ends and brushing, providing they lie flat when placed on the floor. To shrink and flatten, rugs may be tacked to a wooden frame the same size as the rug. Tack the rug face down at half-inch intervals around the border. With a sponge, dampen thoroughly on the wrong side. Allow to dry completely before removing. This method is almost a "must" for rugs made of jute, hemp, sisal, and such materials.

It is well to remember that finishing is the last step in the completion of a fabric. A badly designed or a carelessly woven textile cannot be changed to a satisfactory one by any finishing process.

# CHAPTER 9
# FABRIC STRUCTURE

THE STRUCTURE OF FABRIC IS DETERMINED by the arrangement and method by which fibers and yarns are combined. The basic methods of fabric construction include braiding, knitting, looping, and knotting, as well as weaving. In making certain types of textiles, such as lace, a combination of these techniques may be required.

In addition to yarn and thread elements, unspun fibers are sometimes used to make cloth. When properly treated, these fibers may be compressed into a homogeneous material classified as fabric. A common example of this process is *felt.*

## ► THE THREE FUNDAMENTAL WEAVES

Weaving, perhaps, offers more latitude for structural variety than any other method. The simplest form of woven structure— the *plain weave* —has warp and filler yarns interlaced successively; that is, each yarn passes over one and under another, alternately. With the introduction of multiple harnesses, two other fundamental structures became common, the twill (Figs. 9.1A,B, and 9.2), and the satin weaves. A *twill weave* is created when a weft yarn passes first under, then over a set number of warp ends and is woven to produce diagonal lines in the cloth. In the *satin weave,* the diagonal line is broken up and the warp and filler yarns are interlaced irregularly, producing a smooth surface. These three weaves, the plain, the twill, and the satin, are the bases for countless variations of pattern.

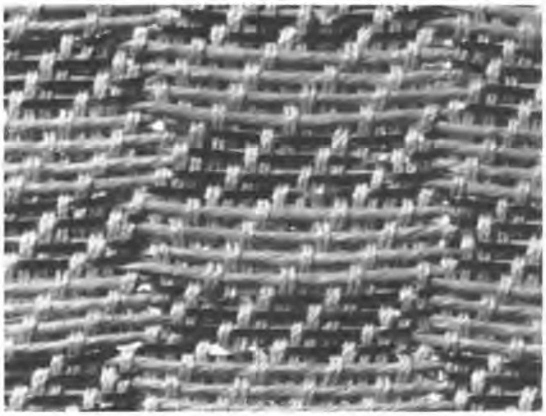


Fig. 9.1A—Fabric structure, by Anni Albers. (Courtesy "Arts and Architecture.") Pattern and texture achieved on the twill threading.

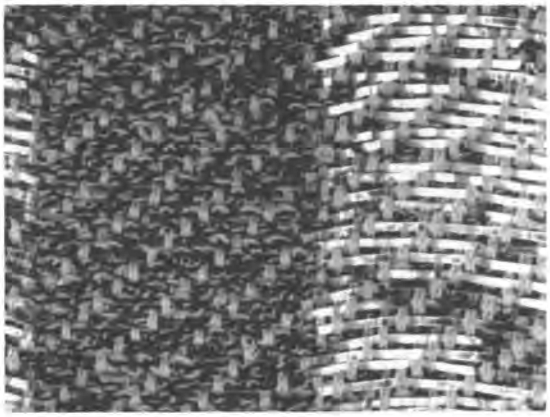


Fig. 9.1B—A twill with smooth and textured yarns used in filler, by Anni Albers. (Courtesy "Arts and Architecture.")

## ► WEAVING VARIATIONS

Depth and dimension were given fabrics by pile weaving. Examples are seen in rugs, carpets, and velvets where yarns rise vertically from the basic structure. *Pile weaving* is accomplished by two methods: either by the use of extra filler yarn, employing a knotting technique, or by the use of an additional series of warp yarns with an extra warp beam.

Open mesh effects are achieved with *gauze weaves*. This involves a method of twisting warp yarns, in pairs, about each other and following with a weft shot. The twisting locks the filler yarn and prevents slippage, and at the same time creates the "openness" characteristic of the weave. Special devices such as beads or half heddles, called *doups*, are needed to create the twist. An example of gauze weave is shown in Figure 1.12.

## ► WEAVING DRAFTS

The specific procedures necessary in setting up a loom to achieve the desired pattern for a fabric—the definite order of threading heddles, the tie-up, and the order in which the treadles are operated—must be recorded in order to communicate this information to others. Years ago a system was devised for diagraming these instructions, known as *weaving drafts*, and they are still used by weavers today. Authorities differ somewhat on the details of writing drafts, but if the underlying principles are understood, translation will not be difficult.

Fig. 9.2—Drapery of rayon in a twill weave, with background stripe of white and two tones of turquoise, by Astrid Sampe, Nordiska Kompaniet, Stockholm, Sweden. Double weave produces a stripe of fringed linen across the warp stripes.

Figure 4.28 illustrates a fabric woven in a "plain twill" and a typical draft for this weave is shown and explained in Figure 9.3. The draft is drawn for a 4-harness, 6-treadle loom. It is not necessary to tie up all 6 treadles as shown in the draft, only those that are to be used on a project. These may be arranged in any order convenient for the weaver to use. To weave twill only, Treadles 1 to 4 would be used.

By alternately depressing Treadles 5 and 6 with this tie-up, the weaver achieves the "plain weave" or "tabby," as it is popularly called. This weave is often used alone in making fabric, it is generally used to start and finish all woven material, and is commonly employed to tie in overshots in weaving pattern designs.

With the same threading order shown in this draft, the weaver can get a variation of pattern by merely changing the tie-up (Figs. 9.4 and 9.5). One of the variations resulting from such a change is shown in Figure 9.6. This is one of the many "broken twills" possible. Endless modifications can be developed in this manner. Figure 4.10 is an illustration of a fabric showing the variety possible with the simple twill

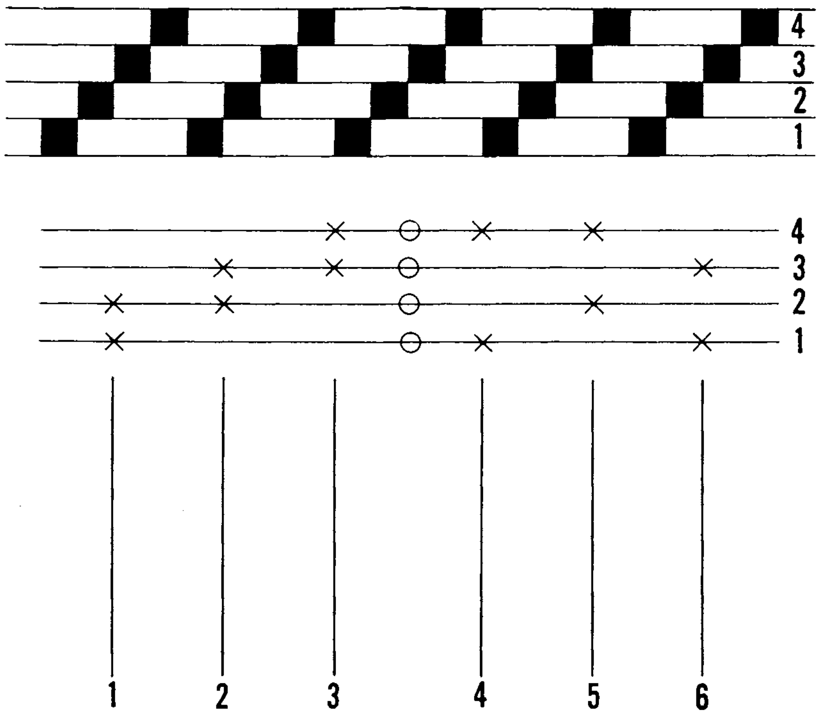



Fig. 9.3—Draft for twill threading and standard tie-up. The horizontal spaces numbered 1, 2, 3, and 4 represent the harnesses, numbered from front to back. The black squares indicate the position of the heddles when threaded to plain twill. Threading begins at the right; the threading draft, therefore, should be read from right to left—not left to right as in normal reading. The first warp yarn is threaded through the first heddle of Harness 4; second warp yarn through the first heddle of Harness 3; next through the first heddle of Harness 2, and so on.

The horizontal lines numbered 1, 2, 3, and 4 represent the lams, attached to Harnesses 1, 2, 3, and 4 respectively at the center points, indicated by the small circle.

The vertical lines indicate the Treadles 1, 2, 3, 4, 5, and 6. The "X" indicates where a lam is tied to a treadle. It can be seen that Treadle 1 is tied to Lams 1 and 2; Treadle 2 to Lams 2 and 3; Treadle 3 to Lams 3 and 4, and so on. This lam–treadle tie-up is known as the standard tie-up. While the pairs of harnesses used together remain the same, their order of tying to the treadles can be changed. For example, some weavers like to use the two center treadles for tabby, the 2-and-4, and the 1-and-3 combination. The first four treadles, which give a simple twill when depressed in order, can be rearranged to better accommodate a weaver who likes to alternate the left and right foot. Treadle 2 would then be moved to the position of Treadle 4, Treadle 3 to second from left, and Treadle 4 to third from left. Illustrations of the lam–treadle tie-ups are shown in Figures 6.10, 6.11, and 6.12.

Treadles 5 and 6 are used for the plain or tabby weave.

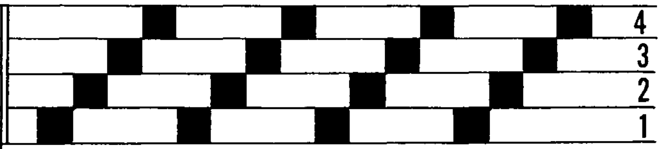
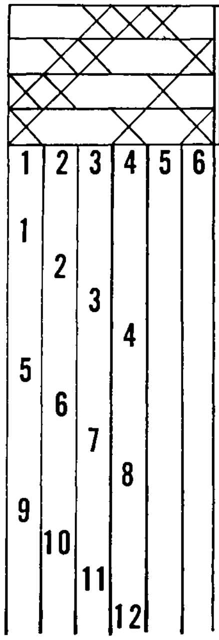




Fig. 9.4—This diagram combines directions for the threading, tie-up, and treadling. Threading and tie-up are the same as that in Figure 9.3. The numbers 1 to 6 placed horizontally indicate the treadles with the standard tie-up. Figures arranged diagonally in the vertical spaces show sequence for depressing the treadles in weaving a plain twill.

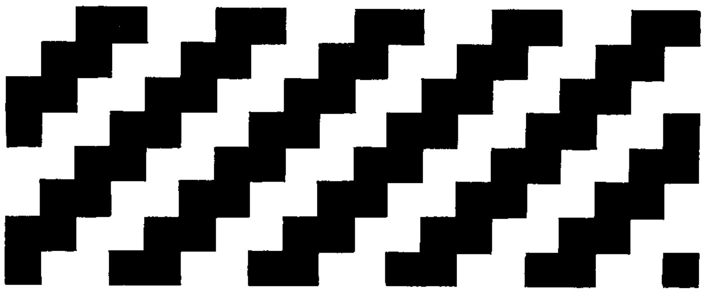


Fig. 9.5—Simple twill with a 2-and-2 sequence. The dark blocks represent the filler passing over two and under two warp yarns in regular sequence. Each successive shot of filler advances one warp yarn, thus producing the clearly defined diagonal. Treadles used would be 1, 2, 3, and 4 as shown in Figure 9.3.

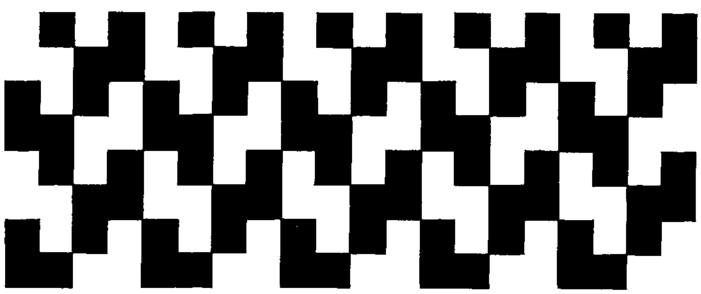


Fig. 9.6—Broken twill using two twill harness combinations with the tabby tie-ups. These are 1 and 3, 1 and 2, 2 and 4, and 3 and 4. Treadles used are 6, 1, 5, and 3. Or, treadles can be arranged to suit the convenience of the weaver, which is especially important when a large amount of yardage is to be woven.

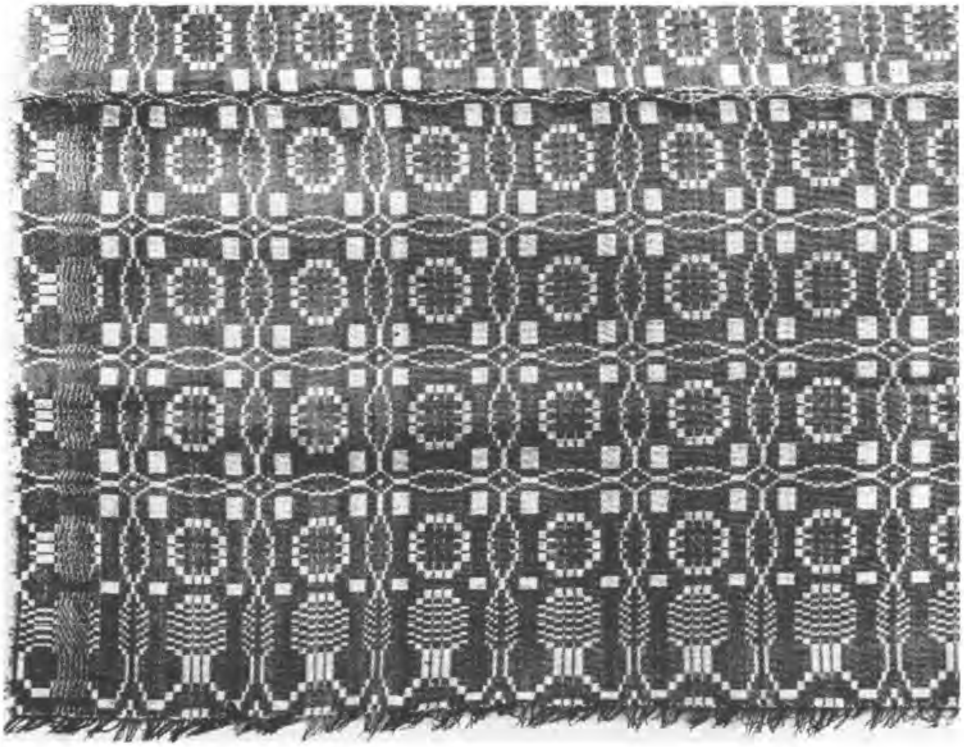
threading, stripes of twill alternating with plain, or tabby, and broken twill. This fabric also illustrates how variation in the width of stripes can add interest to a pattern.

While most weavers confine themselves to the simple structures, emphasizing textural and color values, experienced weavers do not overlook the possibilities of pattern in combination with this approach. Many interesting fabrics may result from this treatment.

### ► THREADING FOR PATTERN

The method of preparing the warp, winding it onto the warp beam, and threading it through the heddles is essentially the same whether the fabric is to be plain or patterned. The difference is chiefly in the order in which the heddles are threaded. As pointed out earlier, the usual

Fig. 9.7—Early American hand-woven coverlet, "Single Snowball" with "Pine Tree" border. (From the Smithsonian Institution. Courtesy "Craft Horizons.") Here two 38-inch widths have been sewn together. Woven in a reversed twill weave, warp is of unbleached cotton, filler of indigo-dyed wool, three sides fringed by the extension of both warp and filler.



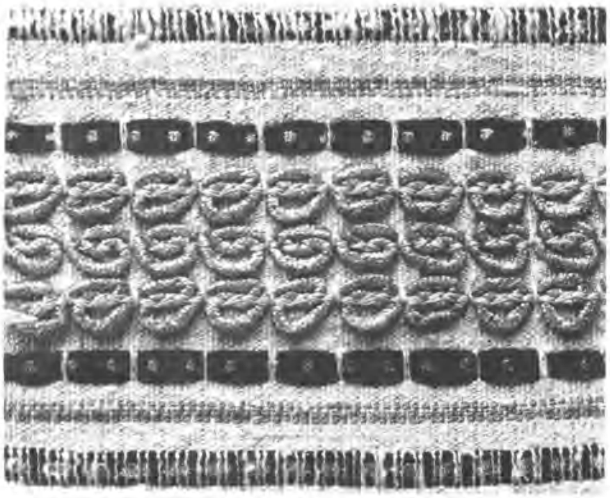


Fig. 9.8—Roman-style design for a silk dress, woven by Howard Heath. Warp is a 3-ply silk set 32 ends to the inch, weft is natural raw-silk noil, gold braid, and black and gold ribbon. By drawing in the warp on first two harnesses, lock yarns for braid can be drawn in at whatever place is most suitable. In this case the braids come together every half inch, so the lock yarns were used on Harnesses 3 and 4 with half-inch spacings. This border might easily be adapted for other uses.

threading for a 4-harness loom is a simple twill, that is, a sequence of 1, 2, 3, 4; or 4, 3, 2, 1.

For pattern weaving, the threading varies with the particular pattern being used. Figures 9.7 and 9.8 show two of the many variations possible. The motif may be a series of 8 ends for a very small figure, as in the popular "rose path," or as many as a hundred or more ends, as is found in old counterpanes and complex damask patterns.

### ► USE OF SHUTTLES

Pattern weaving may call for one or more shuttles. If more than one is used it will be shown on the draft, or the term "use tabby" will be stated. One shuttle will carry the background or tabby yarn and is usually woven on the 1 and 3, 2 and 4 harness combinations. This tabby yarn may be the same as the warp yarn, or a similar one. Together with the warp it forms the background structure of the cloth and at the same time binds down the pattern yarn, or *floats*.

The pattern yarn that is carried by Shuttle 2 is usually a yarn contrasting to the tabby; the difference may be one of size, of color, or of texture. Pattern is developed by passing the shuttle over two or more warp yarns, causing the yarn to "float" over the warp. This type of weaving in some instances is called *overshot* because these yarns float over, or are shot over a background of plain or tabby weaving. This can be seen clearly in Figure 9.8. Overshot weaving has many decorative possibilities, but it has its functional limitations also. Where the pattern yarn floats over three or more warp ends, this exposed length can easily be caught and pulled or abraded. Care should be exercised in the choice of yarns and patterns to make sure they are compatible with the use of the product being woven.

In planning projects that are not the result of the "thrown" shuttle, the approach differs. This group includes many rug, tapestry, inlay, and other techniques that embody figurative or abstract designs in the fabric and must be either tied on or laid in by hand.

In these projects, a rough sketch is made of the design on drawing or water-color paper using soft drawing pencils, charcoal, or other mediums. This sketch may later be refined to arrive at more satisfying relationships of area and color. It is then transferred to graph paper, or any paper that the weaver may mark off in accurate squares. In using, for example, the knot technique in rug weaving, each square will represent two warp ends or one knot. While it is possible to work from a graph in reduced scale, the usual practice is to make one that is full sized.

### ▸ TECHNIQUE FOR PILE RUG

If a pile rug is planned the pile is usually formed by the use of one of the rug knots. The pile may be made by either of two methods. In one, the yarn is cut into lengths according to the depth of the pile desired. These are then tied individually to the warp yarns. In the other method, the yarn is used in a continuous length to tie a series of knots. The yarn is first knotted around two warp ends, then passed around a stick or rod before the next knot is formed. The height of the stick or rod determines the depth of the pile. After a tabby shot, this stick can be removed, leaving an uncut pile. For a cut pile, a sharp knife or a razor blade is run down the center of the top edge of the stick. The stick is generally grooved to form a guide line for the cutting, insuring an even height of pile. Each row of knots is followed by two or more filler shots, to fill in the back of the rug and to give a firm background. Figure 9.9 shows the detail of the cut and uncut flossa.

If the flossa technique is followed, three filler yarns usually follow each row of knots; the pile in this way will stand at right angles to the warp. In the rya technique, where the pile lies flat, many rows of filler may be used. The number of filler yarns depends on the length of the

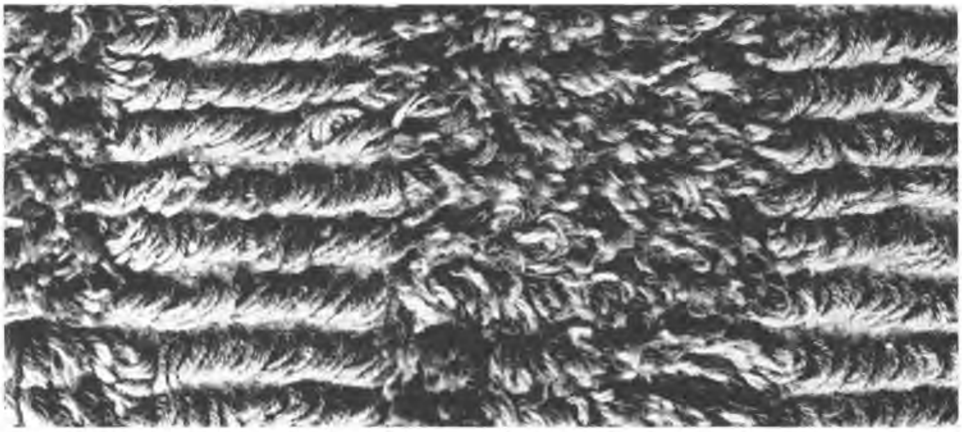


Fig. 9.9—Detail of a rug of cut and uncut flossa, woven by Ruben Eshkanian. (In the Brooklyn Museum Collection.)

pile since the pile, when lying flat, should cover the background yarns.

The most common knot used in the flossa or rya techniques is the Turkish, or Ghiordes, knot illustrated in Figure 9.10.

If the weaver is using yarn to make a continuous series of knots, a length of yarn is first formed into a bow arrangement called a *butterfly*. The butterfly is made by winding the yarn around the thumb and little finger in the form of a figure eight, leaving the starting end lying in the palm of the hand. When the winding is completed, the remaining end is wound and tied about the center of the bow. Yarn can then be withdrawn from the inside of the bow by pulling the starting end. The butterfly in this way acts as a bobbin.

Important points to consider in making a rug in the knot technique are as follows:

Use a Number six- or eight-dent reed, six usually preferred.

The warp, made of heavy ply yarn, must contain an even number of ends.

Two warp ends are threaded in each of the outside dents.

Knots are made over pairs of warp ends, in a closed shed.

No knot is made on the two outside warp ends.

To make the knot, start at the left side omitting the two selvage yarns. The knot will be made over the first pair of warp yarns next to the selvage yarns as follows: put the butterfly under the left warp from right to left, slide down close to the stick; then throw to the right over

the pair of warps and slip the butterfly under the right warp from right to left; complete the knot by slipping the butterfly under the stick, toward the weaver, and pull up tight. Continue across the warp. Figures 9.11, 9.12, 9.13, and 9.14 show other variations of the flossa and Ghiordes knot techniques.

### ► MAKING THE SELVAGE

To make the selvage use the background yarn or filler, wrapping this yarn tightly, 3 times around the 2 outside warp yarns. Using the same yarn, cross to the other side with a tabby shot and wrap these 2 outside warps. Put in 2 more filler shots. This will give 1 row of knots and 3 rows of filler. Filler yarn may be bubbled to cover the warp.

Cut the pile after the first filler yarn is woven in. For uncut flossa remove the flossa stick after the first row of filler.

The warp tension must be kept very tight, and the filler yarns beaten in firmly. The filler yarn should be heavy and strong. Some weavers use narrow strips of rags, cotton preferred, for filler yarn.

### ► INLAY TECHNIQUE

An isolated motif is sometimes desired in small textiles. This is generally woven by the *inlay* technique. In this method a secondary filler yarn, generally heavier and of a different color than the background, is used to develop the design. Inlay yarns are wound on small bobbins, one for each color. The filler is "laid in" to the width of the motif; then followed by one or two tabby shots across the width of the warp before the next inlay yarn is inserted.

The customary procedure in inlay weaving is first to make a sketch of the design or motif. This sketch is then transferred to graph paper, each square representing a definite number of warp ends. If, for ex-

Fig. 9.10 (opposite page)—Ghiordes knot used in making a flossa rug is illustrated by Joan Patterson. (Courtesy "Handweaver and Craftsman.") Yarn coming from over top of flossa rod has been passed under left warp of the pair being used to make the knot. Passed over and above the two warps, it will be passed under right warp being lifted with the finger of left hand, then under metal rod and pulled tight before going over rod for next knot. Knots are made with warp flat, no shed. Using tabby sheds, shots of weft will be passed through before next row of knots is made. This is an all-linen rug; warp is 6/3 gray tow, weft is 1½ lea rug yarn. Type of flossa bar or rod used here consists of two metal rods welded together at the ends, double rods making knot-cutting easier.

Fig. 9.11—Sample rug showing variations of the flossa techniques using cut and uncut flossa knots and a combination of flossa and flat weaves. Warp is a 16-ply cotton, 8 ends per inch; filler between rows of knots and between samples is "bubbled," thus covering the warp and making the background stiff and firm.

Fig. 9.12—Created and designed by Leo Mahsoud, tufted rug is of cotton and hemp, based on the Ghiordian knot principle.

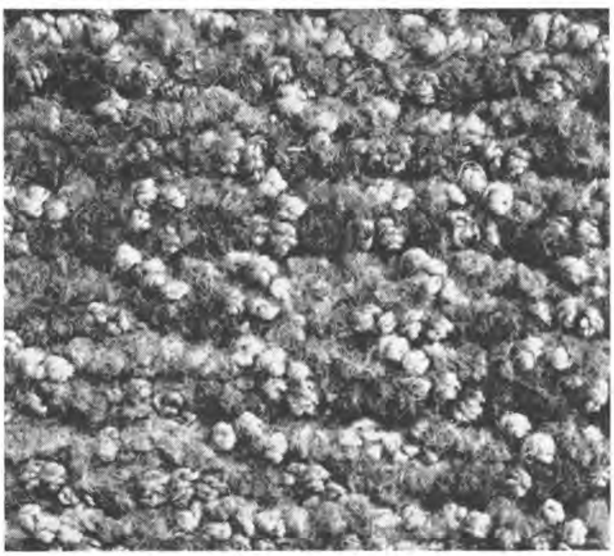


Fig. 9.13—"Bombay," a jute-striped rug by Joseph Blumfield. Warp is brown cotton set 6 ends per inch; filler is 3 strands of roving cotton yarn mixed with metallic; raised portion is a chenille of jute yarns, looped and partially cut and uncut. Colors are soft gray-greens to tan or straw. Rugs may be woven from 4 to 15 feet wide.

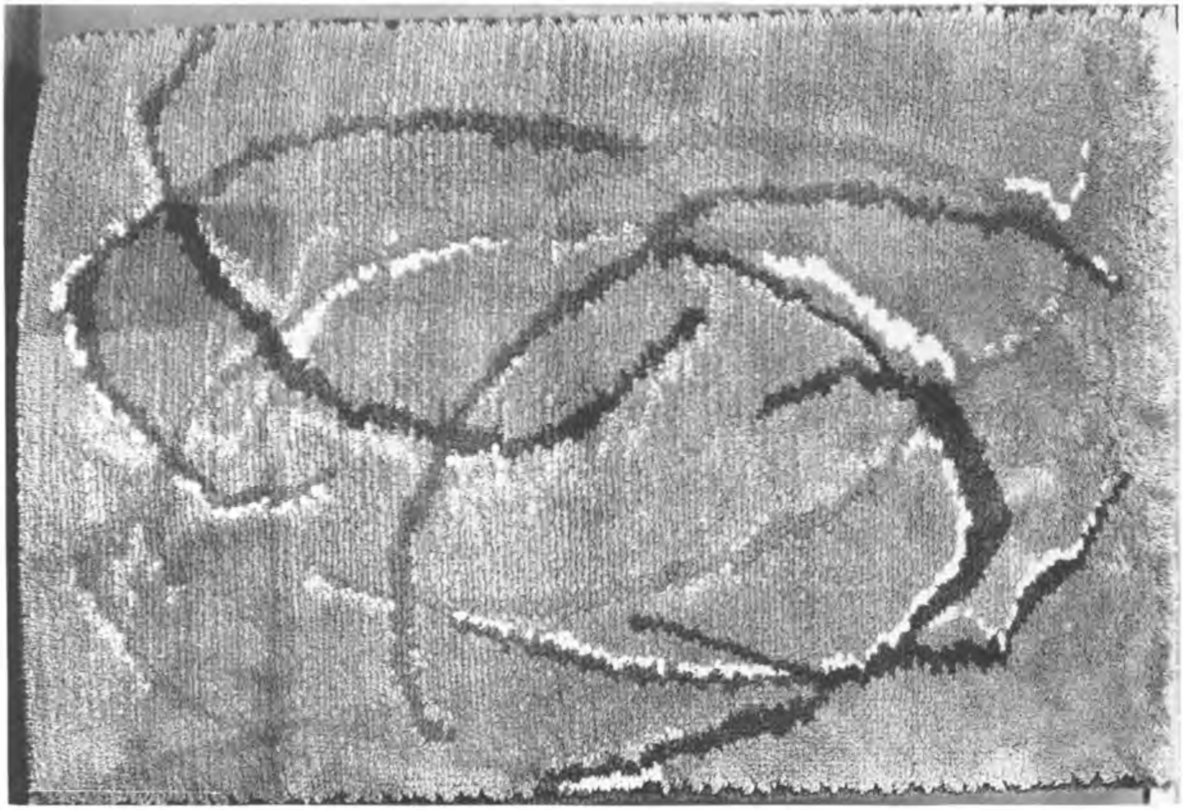


Fig. 9.14—Free design in a flossa rug, by Sonja J. Leach. (Courtesy of the Detroit Institute of Arts.) This technique permits variety in design as knots can be placed anywhere weaver desires. Deep, cut pile gives softness to the design outline.

ample, the inlay yarn passes over 3 warp ends and under 1, each square will represent 4 ends. Such an overshot (3 over and 1 under) gives definition and prominence to the design since the majority of the warp yarns are covered, exposing only the inlay. If the motif is to appear subdued, the inlay is simply placed in the tabby shed rather than used as an overshot and is known as *laid-in* design.

### ► TAPESTRY TECHNIQUE

In tapestry weaving the filler yarns are inserted by hand with the aid of small bobbins, one for each color area. No tabby shuttle is used in true tapestry weaving; the filler yarn does not carry across the width of the warp, only back and forth for each color area. The need for separate

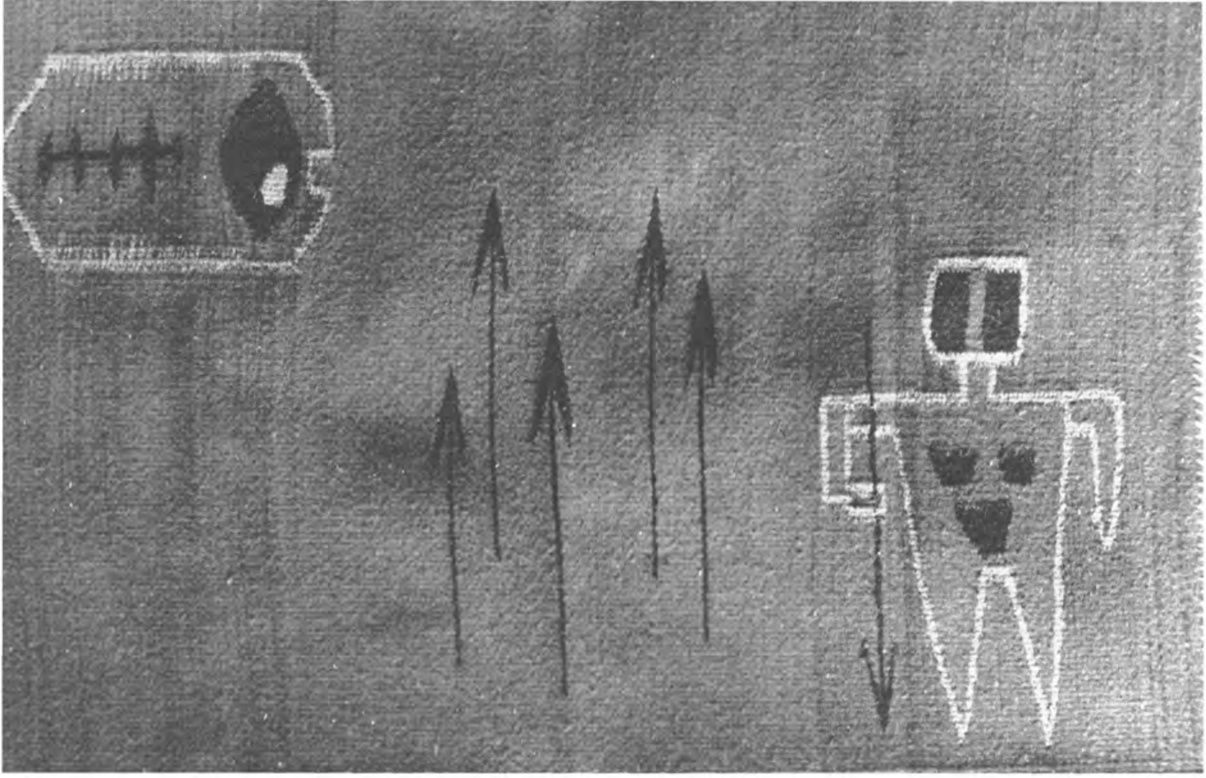


Fig. 9.15—Modern tapestry, by Saul Borisov. (Courtesy "Craft Horizons.") A painter, weaving in Mexico, creates a tapestry for contemporary interiors.

Fig. 9.16—Tapestry cushion from Skane, Sweden, in yellow, blue, black, and red wool. (From the Florence Dibell Bartlett Collection. Courtesy of the Art Institute of Chicago.)

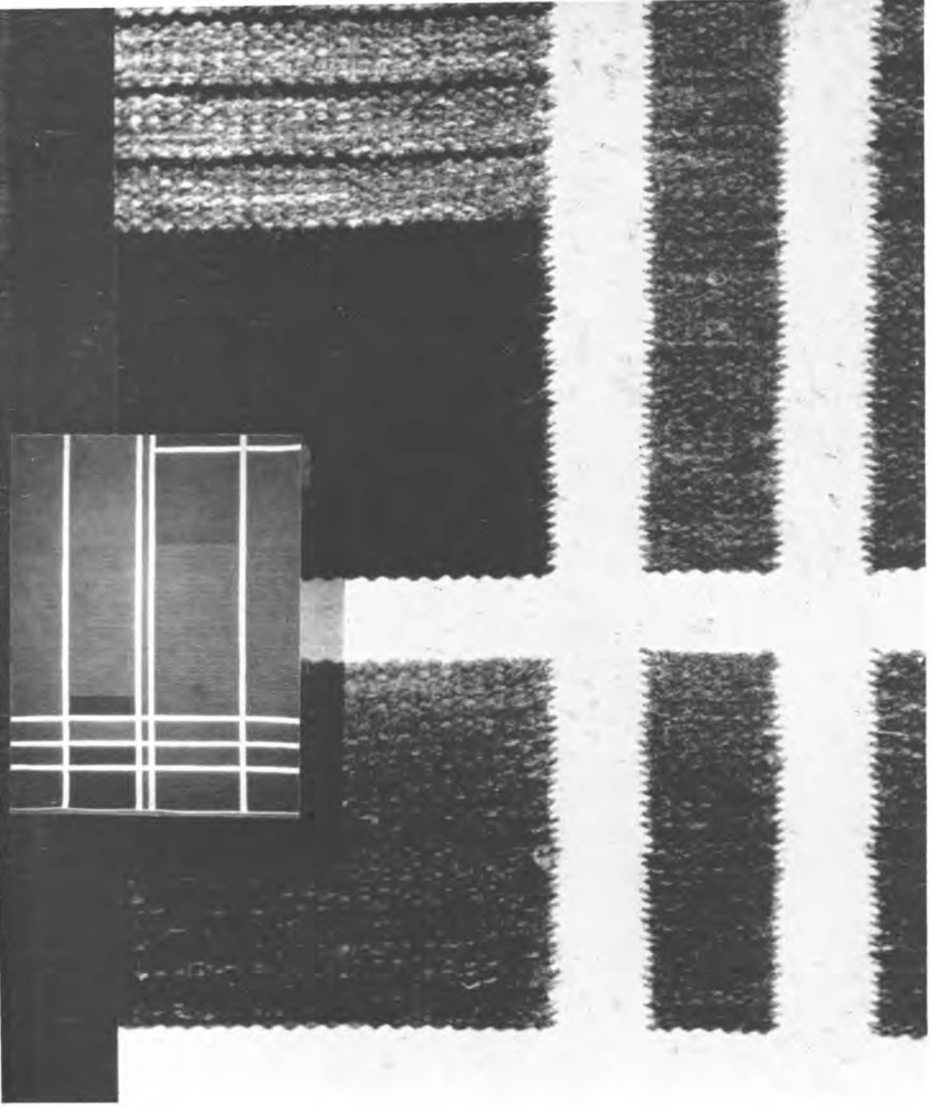


Fig. 9.17—Rug in a flat tapestry weave, woven by Astrid Sampe of Nordiska Kompaniet, Stockholm, Sweden. Small diagram shows how design is first drawn in a small-scale pattern.

color bobbins is apparent in tapestries such as the ones shown in Figures 9.15 and 9.16.

The warp yarns in tapestry weaving are usually set 10 to 20 ends per inch, often closer to 10 if it is the desire of the weaver to cover the warp yarns completely. The filler is beaten down in each area as it is woven, with a small comblike hand tool, generally made of wood.

The tapestry weaver works from a sketch in color, known as a *cartoon*, that is attached directly under, or behind, the warp. Modern weavers sometimes work with the cartoon at their side, or it may be attached to the framework of the loom. The cartoon is usually made to approximate the size of the finished tapestry, though it may be scaled down as shown in Figure 9.17.

While this is the method for weaving true tapestries, weavers often devise their own methods, such as running a very small tabby yarn between rows of pattern to bind the pattern units together. Others use a laid-in technique to develop the design, sometimes on a plain background, sometimes on a textured background.

The old, true tapestries were woven on vertical looms, but the horizontal loom is used by most hand weavers at the present time. Such techniques as tapestry, inlay, the flossa knot, and many others are woven with the twill threading and plain or tabby weave tie-up for treadling.

The techniques discussed in this chapter are those most commonly used in weaving materials for wearing apparel, upholstery, and drapery fabrics. Numerous variations can be developed that will use the many possibilities for tie-ups and the wealth of yarns now available.

# CHAPTER 10

# SOLVING YOUR PROBLEMS

THE BEGINNING WEAVER SHOULD NOT EXPECT to reach perfection with his first efforts. As in other crafts, skill is developed slowly and numerous difficulties may be encountered in the process. In each case, when the cause is understood a solution is usually possible. Not every problem can be anticipated but some of the most common are listed here with their causes and directions or suggestions for their solution.

| PROBLEM | CAUSE | SOLUTION |
|---|---|---|
| 1. Broken warp yarns | a. Using yarns of insufficient strength | a. The strength of the warp yarns will be ascertained in weaving the preliminary samples. Singles wool should be handled as little as possible. Singles linen will work satisfactorily if dressed with skimmed milk or is wet spun. |
| | b. A weak spot or a knot in a yarn | b. Mend according to instructions in Chapter 7. |
| | c. While making the warp some yarns may have been held at a greater tension than others. | c. Weave a few inches to see if the warp will adjust itself. If it does not, and the tension is present all through the warp, wind it forward onto the cloth beam and re-wind onto the warp beam, adjusting the tension. |

| PROBLEM | CAUSE | SOLUTION |
| --- | --- | --- |
| | d. Inept shuttle control | d. This is corrected with practice. |
| | e. A rough or splintered shuttle may catch and break warp yarns. | e. Shuttles may be kept smooth by sanding or using steel wool. |
| | f. Selvage may have pulled in. This lack of "ease" narrows the web, and when the beater is pulled forward the reed cuts the outer warp yarns. | f. Allow sufficient ease in the filler yarn as shown in Figures 7.5 and 7.6. |
| 2. Puckering of the cloth, warpwise or fillerwise | a. When using yarns of different fibers such as wool and cotton in the same fabric it must be remembered each fiber has a different percentage of shrinkage. If any one fiber is woven in a concentrated area, puckering will appear in the cloth. | a. These different fibers should be intermixed in both warp and filler. A stable yarn should be used every few ends in the warp and no one fiber isolated in too great an area in the filler. |
| 3. Selvage difficulties<br>a. Floating selvage yarns | a. Floating selvage yarns are likely to appear in any of the twills or patterns where the use of the tabby yarn is not employed. | a. Most weavers ignore the floating yarn, clipping it off after weaving is completed. It can be corrected by changing the threading of the outside warp yarn forward one harness, or back one harness. Using two shuttles will also correct the difficulty; two shuttles, however, mean slower weaving. |
| b. Broken selvage yarns | b. Narrowing the web from too great a pull-in | b. (*See* f. under broken warp yarns.) |
| c. Ragged selvages | c. (1) Inexperience | c. (1) Rhythm and control come with practice. |
| | (2) Inflexible filler yarns | (2) Wiry and inflexible yarns do not weave in smoothly. Such yarns as linen and jute are more pliable when wet. The bobbins may be wound and soaked in water or wrapped in a damp towel. |

| PROBLEM | CAUSE | SOLUTION |
| --- | --- | --- |
| | (3) Weaving too close to the reed narrows the angle or arc, making it necessary to stretch the selvage ends. | (3) Move the web forward frequently while weaving. |
| 4. The shed fails to open properly<br>a. If the entire shed fails to open | a. Lease sticks may be too close to the harnesses. | a. The lease sticks may be removed after checking for mistakes. If they remain in the warp it is important to keep them near the back beam. |
| | b. Insufficient warp tension | b. Tighten the tension. |
| | c. Uneven shed—yarns on one harness may not be level with the others. | c. Adjust the tie-up. |
| | d. Yarns may stick or cling to each other preventing a clean shed. This is often true of woolen yarns. | d. Allow the filler yarn to lie in a wide arc in the shed. Change the shed before pulling the beater forward. Continue in this manner as long as the clinging persists. The beater helps to separate the sticky yarns. |
| b. If only a few yarns fail to rise | a. Yarns may be crossed in the reed. | a. Check by lifting the yarns back of the beater. If they are crossed, re-sley. |
| | b. Warp ends may be crossed in the heddles or in front of the lease sticks. | b. Re-thread the crossed yarns. |
| | c. A loose warp end will not rise with the other yarns. | c. Pull the loose end up to the proper tension and re-tie. |
| | d. A warp yarn may break and wrap around adjacent yarns. | d. Untangle and mend the broken yarn. |
| | e. Heddle eye might have been missed in threading. | e. Re-thread the warp yarn. |
| 5. Skips in warp and filler | a. Relaxed or loose warp ends fail to weave in. | a. Adjust the warp tension of the relaxed yarns. |

| PROBLEM | CAUSE | SOLUTION |
| --- | --- | --- |
| | b. Lack of shuttle control—the shuttle may have been thrown over or under warp ends. | b. Rhythm and shuttle control will come with practice. |
| | c. Shed was separated unevenly. | c. Check tie-up. |
| 6. Streaking of the cloth warpwise and fillerwise | | |
| a. Warpwise streaks | a. Skipping a dent in the reed will leave a space in the web. | a. Re-sley to correct. |
| | b. Putting an extra warp end in a dent will create a heavy line. | b. Re-sley to correct. |
| | c. In a warp unit of mixed yarns an end may be threaded out of order. For example, if the unit consists of 5 different yarns they must follow in a planned sequence. | c. Re-thread to correct. Threading should be checked repeatedly to avoid mistakes. |
| | d. A heddle may have been skipped in threading. | d. Re-thread. This usually means re-threading from the mistake to the nearest edge. |
| | e. Using yarns from different dye lots | e. Yarns from different dye lots may be used if they are alternated throughout the entire width of the warp. |
| b. Fillerwise streaks | a. Treadling in incorrect order, or skipping a treadle will cause streaks. | a. Unweave to correct. |
| | b. Uneven beating will increase or decrease the number of planned picks per inch. | b. Unweave to correct. Practice to improve weaving rhythm. |
| | c. When weaving with soft wools the use of a dark filler over a light warp, or vice versa, will often cause streaks. This results from the inability to beat precisely. | c. Change the filler yarn to one having a closer value to the warp yarns. Dark and light combinations in soft wools are for the experienced weaver. |

| PROBLEM | CAUSE | SOLUTION |
| --- | --- | --- |
| | d. The unweaving of soft yarns (especially wool) may leave a fuzzy streak across the warp. | d. To unweave, cut the filler yarns every few inches and carefully pull out the cut ends. |
| | e. Using yarns from different dye lots will show definite streaks. | e. Sufficient yarn should be procured to complete a project. Yarns from different dye lots may be used by alternating them throughout the fabric. |
| | f. Weaving too close to the breast beam or the reed causes streaking. | f. Move the web forward frequently. Many weavers use a space of no more than 2 or 3 inches before moving the cloth forward. |
| 7. Warp tensions | a. While preparing the warp the weaver may hold the warp yarns under varied degrees of tension, or some yarns may unwind from the warp spools at an unequal tension. | a. If possible wind the warp in one section and at one sitting. Allow the warp yarns to run freely through the hand while winding the warp. All yarns in the unit should pull at the same tension. |
| | b. In winding the warp on the warp beam, the individual holding the chain at the front of the loom may hold some sections at a greater tension than others. | b. Frequently check the warp near the lease sticks while it is being wound on the warp beam. The tension of the selvage yarns will be greater than the rest of the warp. If an uneven tension appears after weaving has begun, it will be necessary to wind the entire warp forward on the cloth beam and rewind onto the warp beam adjusting the tension while winding. |
| | c. Insufficient use of warp sticks will cause the warp to pile up, or the sticks may be too short allowing the warp to fall over the ends causing selvage tension. | c. Sticks of the proper length, used frequently, will eliminate the piling-up of warp yarns. |

| PROBLEM | CAUSE | SOLUTION |
|---|---|---|
| 8. Irregular filler lines | | |
| a. Sections of the cloth or selvage pulling toward the breast beam or toward the reed | a. The warp ends in the area involved are not tied at the same tension as the remainder of the warp. | a. Re-tie the group of warp ends causing the trouble. |
| b. Cloth weaving diagonally | b. Holding the beater off center will cause the cloth to weave in a diagonal line. | b. Mark the center of the beater and grasp at that position. |

# CHAPTER 11
# EVALUATION

HANDWEAVING, LIKE OTHER CRAFTS, has an inviting appeal today. Of those attracted to it, none are more appreciative of its value than individuals who, in the course of the day, are engaged in a specialized occupational activity. In these days of intensive specialization, boundaries are more or less defined, and the time element is often emphasized.

Handweaving offers a wide scope for creativity when an individual has acquired a fair degree of skill. Since its practice is mainly avocational, the weaver is free to work leisurely, with imagination and complete independence. He can create, develop, and produce a product alone, as a personal responsibility, and the result represents an individual achievement.

Further satisfaction is derived from the realization that the product, aside from whatever distinctiveness it may have, is generally one of utilitarian value. Weavers make many fabrics for their home, materials for apparel, and innumerable articles that may be given to friends and family, and some find a market for their work.

### ► WEAVING GUILDS

Many localities throughout the country have organized weaving guilds. Some have been in existence many years and it is mainly through the efforts of these groups, in the lean years of craft work, that the activity has been kept alive. Guilds have stimulated the desire for honest craftsmanship and have made it possible for many beginners to learn the craft when no other source of instruction was available. The mutual

Fig. 11.1—Hand woven by Marianne Strengell, these draperies are for the lobby-gallery of the Des Moines Art Center. (Courtesy of the Des Moines Art Center.)

Fig. 11.2—Screen using ½- and ¼-inch outside peel bamboo, textured rayon yarns, and rayon ribbon as filler. Warp is an interesting grouping of chenille and novelty rayon yarns with cotton and a rayon ribbon. Colorful warps are in order when using bamboo, reeds, and other natural materials which are usually neutral in tone.

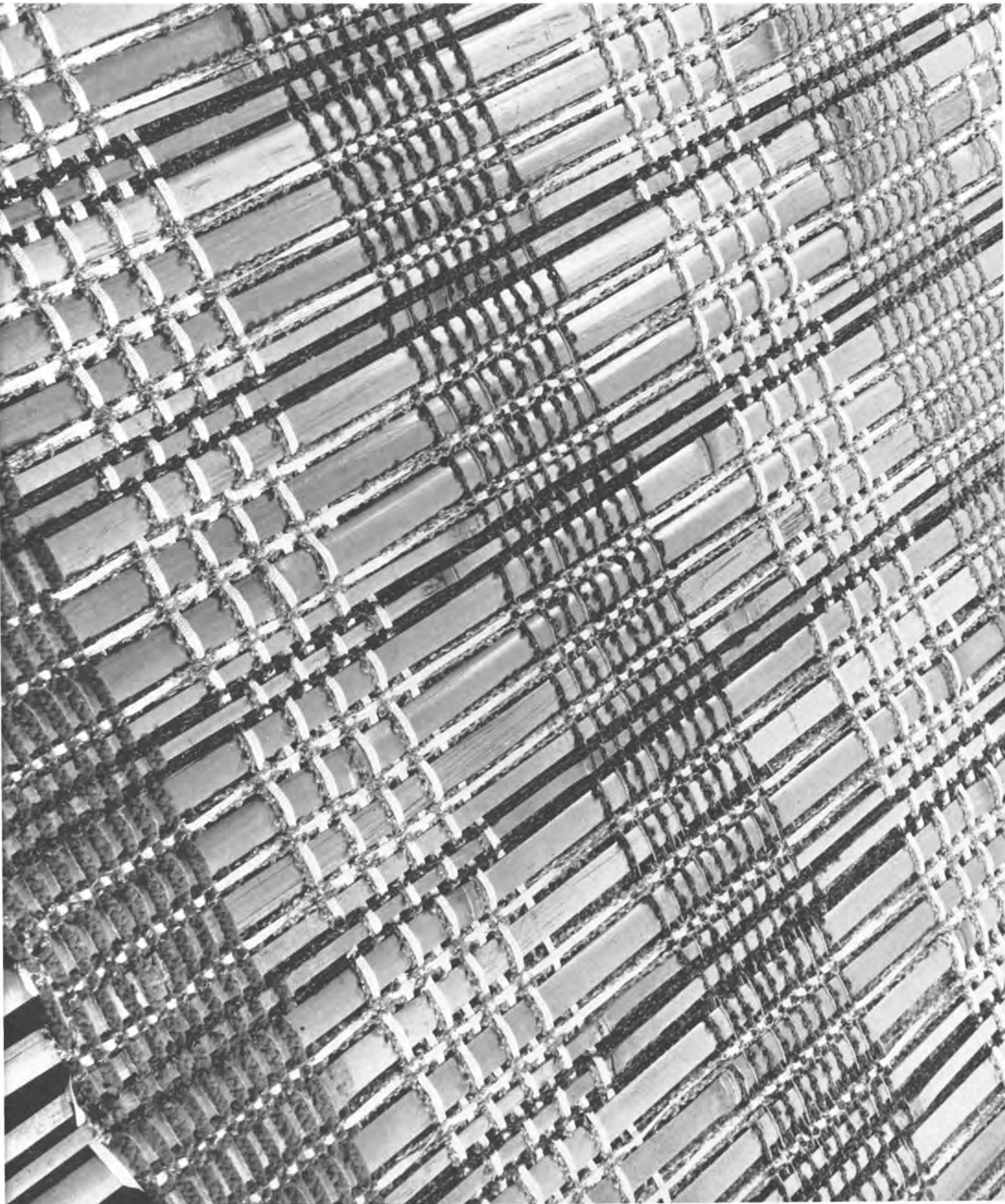


Fig. 11.3—Sheer curtains of linen, nylon, cellophane, and silk, by Karl Laurell, used with Widdicomb furniture in the Grand Rapids, Michigan, Furniture Museum. (Courtesy "Handweaver and Craftsman.")

exchange of ideas within guilds has exerted considerable influence on weaving trends.

Guild members in some sections have generously contributed their time and experience to hospitals, assisting therapists in their work with patients. In the field of therapy, handweaving has received general recognition as a corrective medium. The therapist's work begins upon the recommendation of the doctor, and it is used chiefly for rehabilitation, for mental and physical restoration, and for pre-vocational training for the handicapped. Floor and table-type looms are adapted to the individual needs of the patient to accomplish the desired therapy.

## ► THERAPEUTIC VALUE

Successful therapy involves a combination of physical and mental stimulation. Each case must be considered as a separate problem; but with whatever equipment used, a loom or other apparatus, the mental attitude is frequently as important as the physical activity. Aside from

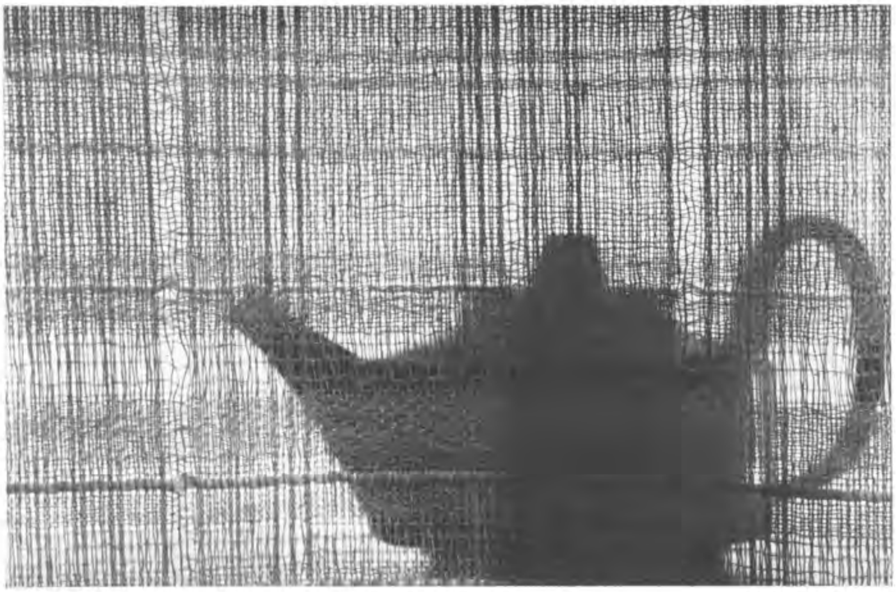
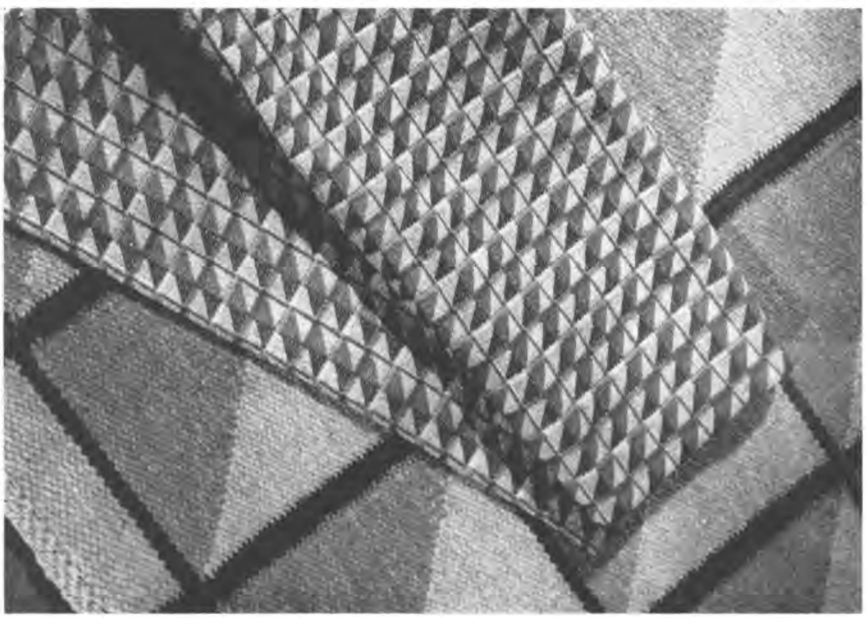


Fig. 11.4—Casement cloth of plain and twill weave in natural linen, mohair, cellophane, and silk, by Karl Laurell. (Courtesy "Handweaver and Craftsman.") Note the occasional heavy filler yarn and the more closely beaten sections that give stability to a sheer fabric.

Fig. 11.5—Matched carpeting and upholstering for guest rooms at the Grand Hotel, Stockholm, by Astrid Sampe of Nordiska Kompaniet, Stockholm, Sweden. Made of cowhair, the squares are light gray and dark sand, with borders in deep red and sea blue. Furniture fabric is same design on a smaller scale, of bleached linen yarn in two shades of bright blue.



the application of special resistance attachments, maximum physical activity on a loom can be attained by use of the simplest threading and tie-ups. The patient's interest may be stimulated in most cases by a colorful selection of yarns; these may be of different constructions and, whenever feasible, of the patient's own selection. In cases where the therapy has been carried over into the vocational rehabilitation program of the patient, he has, in many instances, found a modest market for his products. The more creative have been able to compete favorably with other weavers in exhibitions.


Fig. 11.6—Rug "Mimosa," by Henri Matisse, commissioned by Alexander Smith, Yonkers, New York. (Courtesy of the Detroit Institute of Arts.) The design was created by cut-out, pasted paper, then transferred to graph paper, each square to represent one tuft. From this guide, an edition of 500 rugs was woven.

Fig. 11.7—Modern dining chairs upholstered with hand-woven, tweed-type fabric, emphasizing the contrast in textures of wood and fabric.

## ► INDIVIDUAL POSSIBILITIES

There is a small class of weavers interested primarily in individual expression. This group seeks adventure in the search for the new and interesting combinations of texture, pattern, and color. Endless experiments are conducted with different fibers and yarn combinations, and scores of samples are made. Such weavers devote much time to their dye pots, tinting and shading yarns, to arrive at critically correct color balance for a given structure. In consummating a project, a commercial dyer may be asked to duplicate many of the colors.

Fig. 11.8—Flossa rug by Loja Saarinen, used with modern furniture and textiles in the home of Siggan Sjunneson, Detroit.

The work of these weavers is found often in competitive exhibitions, and some have been chosen for permanent collections. Though few weavers design expressly for the textile mills, many of their fabrics that show promise of being adapted to the power loom are acquired by the mills. These are accepted usually because of some particular quality of color or texture they possess rather than because of technical adaptability. On the other hand, manufacturers of fabrics who are looking for the unusual often turn to the hand weaver as a consultant or designer.

It is difficult to make a transposition of a hand-woven material to a power-loomed product without losing much of the character of the former. Conversely, hand weavers soon realize that it is pointless to attempt certain materials that can best be done by the power loom. The

Fig. 11.9 (opposite page)—Hand-woven fabric used in the St. Claire of Montafalco Church in Detroit. (Courtesy Diehl and Diehl, Architects.) The fifteen-foot screen on rear wall, one of a pair used to cover openings for the organ pipes, has a warp of heavy chenille, cotton, metal, and linen in aqua, natural, red, brown, and gold; filler of heavy bunches of brown reeds spaced with nubby red rayon and cotton, twisted with metal. Draperies back of the statues and communion rail are also hand woven.


Sanctus Sanctus Sanctus

power loom, together with the complex finishing equipment used for making commercial fabrics, is a highly technical device and, as such, operates with mechanical precision. A hand loom should be considered rather as an instrument since, being humanly controlled and operated, it in many ways reflects the individual temperament of the weaver. In this respect, every hand-woven fabric may be said to bear the personal imprint and signature of its maker.

Fig. 11.10—Hanging of stalk and yarn, by Lyda Kahn. (In the Brooklyn Museum Collection.)

# GLOSSARY

ACETATE—Synthetic fiber derived from cellulose acetate; formerly called rayon acetate.

ACRILAN—Synthetic fiber of the acrylic group; frequently blended with wool and rayon fibers.

ALPACA—Soft, lustrous, hair fibers of the alpaca, a member of the llama family, native to South America.

ANGORA—Hair from the Angora rabbit; usually blended with wool to make a soft knitting yarn.

APRON—Canvas attached to the cloth beam (sometimes to the warp beam) to serve primarily as a warp extension.

ASBESTOS—Silky mineral fiber mined from volcanic rock formations found chiefly in Canada. It is the world's oldest fiber and possesses fire-resistant qualities.

BAST FIBER—Obtained from the stems of plants: flax, ramie, hemp, and jute.

BEAMS

*Back beam*—Upper, stationary beam at the back of the loom over which the warp passes from the warp beam.

*Breast beam*—Stationary beams at front of loom over which the cloth passes as it is woven.

*Cloth beam*—Roller on which the cloth is wound as it comes from the breast beam.

*Knee beam*—Beam located in front of the loom uprights to keep the cloth off the knees of the weaver.

*Sectional beam*—The warp beam is termed a sectional beam if it is divided into 2-inch sections that are separated by pegs.

*Warp beam*—Roller at the back of the loom on which the warp is wound.

BEATER (or BATTEN) — That part of the loom which holds the reed in position for weaving.

BLEND—Composition of different fibers blended together to produce a yarn.

BOBBIN—Paper quill or spool on which filler yarn is wound before inserting in the shuttle.

BOUCLÉ—From the French, meaning "buckle," and broadly used to describe a type of novelty yarn, usually consisting of 3 yarn elements.

BROCADE—Patterned fabric, produced by a variation of weave, that has a raised effect on the right side and floating yarns on the wrong side.

BUBBLING—Method of obtaining additional "ease" in the filler yarn when weaving.

BUTTERFLY—Miniature skein, made by looping the yarn about the thumb and little finger, describing a figure eight; used in making rug knots.

CABLE YARN—see *Yarns.*

CASHMERE—Soft silken fiber obtained from the Cashmere goat of India.

CHAIN—Warp drawn into continuous interlocking loops as it is removed from the reel, to shorten it and facilitate handling.

CHENILLE—From the French, meaning "caterpillar," and applying to types of novelty yarn that simulate this texture.

CLOTH BEAM—see *Beams.*

COMPLEX YARNS—see *Yarns.*

CORKSCREW—Descriptive of a type of novelty yarn.

CROSS—The alternating of warp yarns around the pegs of the warping reel describes a *cross.* The purpose of the cross is to keep the yarns in proper order for threading.

DACRON—Synthetic fiber of the polyester group.

DAMASK—Patterned fabric produced by a combination of satin and sateen weaves.

DENIER—Unit of weight of French origin which indicates the size of a continuous filament, such as silk or any of the synthetic filaments.

DENT—Single space in the reed. The size of the reed is designated by the number of spaces or dents per inch.

DOUP—Special heddle used for gauze weaving.

DRAFT—Diagram showing the threading, tie-up, and treadling for a particular pattern or design.

DURENE—Trade name adopted by a group of associated yarn manufacturers to identify the plied mercerized cotton yarns they produce.

DYNEL—True synthetic fiber that has strong resistance to combustion; generally combined with other fibers in a blend.

EASE—To free the tension that occurs naturally when a weft yarn is thrown through the shed; correction is made either by having the yarn describe an arc or laying it diagonally in the shed.

ENDS—Individual warp yarns.

FIBER—Smallest unit of a yarn.

FIBERGLAS—Trade-mark name for fine filaments of glass spun into yarn.

FILAMENT—Any fiber of continuous length, as silk and most synthetics.

FILLER—Yarn interwoven with warp yarns to make cloth, also called "weft."

FLAKE—Type of novelty yarn that has pronounced thick and thin areas.

FLOATS—Yarns which do not follow the regular sequence of over one and under one, but skip over two or more yarns. There may be warp floats as well as filler floats.

FLOSSA—Technique for creating a pile by hand-knotting the filler yarn.

FRILL—Small novelty yarn characterized by waviness.

GAUZE—Sheer fabric in which the warp yarns, in pairs, have been twisted about each other following a shot of filler; also known as "leno."

HARNESS—Frame to support heddles.

HEDDLES—Cord, wire, or flat strips of metal, with eyes in the center through which the warp ends are threaded.

HEMP—Bast fiber commonly used for ropes and cordage.

HUE—Color of a pigment.

INLAY—Extra filler yarn that is used to delineate a motif.

INTENSITY—The brightness or dullness of a color.

JACK TYPE—see *Looms.*

JUTE—Coarse, brown, bast fiber from the plant bearing the same name.

KILIM—Type of weave common in Poland and Central Europe. The technique is similar to that used by the Navajo Indians.

KNOP—Decorative yarn having different colored specks of fiber interspersed throughout the yarn.

LAMS—Horizontal bars that are connected one to each harness and attached in turn to the treadles.

LEASE (or LEASH)—see *Cross.*

LEASE (or LEASH) STICKS—Sticks inserted in the openings made by the cross; their function is to keep yarns in order while winding on the warp beam and while threading the loom.

LENO—see *Gauze.*

LINEN—Yarn made of fibers from the flax plant.

LOOM—Any device for holding the warp in place while weaving.

*Counterbalanced loom*—A type in which harnesses are operated in pairs.

*Jack-type loom*—Each harness can be operated individually.

*Jacquard loom*—Power loom in which individual warp yarns are controlled mechanically by perforated cards.

LOOP YARN—Novelty yarn, usually of wool, formed in a series of loops.

MANDREL—see *Spindle.*

MOHAIR—Long, silky fiber from the Angora goat, now raised extensively in southwestern United States.

NOIL—Short fibers that are combed from wool or silk.

NOVELTY YARNS—see *Yarns.*

NUB—A form of novelty yarn having intermittent knobs or knops.

NYLON—Fiber produced synthetically from coal, air, and water, known as a polyamide fiber. Outstanding for strength, elasticity, and resistance to abrasion.

ORLON—Synthetic fiber of the acrylic group; notably resistant to heat, sunlight, and gases.

OVERSHOT—A weave in which filler yarns pass over, or float over, several warp ends at the same time.

PADDLE—An accessory that facilitates the winding of a multiple number of warp ends at the same time.

PEARL (or PERLE)—Soft, twisted mercerized yarn.

PICK—One throw of the shuttle, or one filler yarn; also called "shot."

PIMA—Fine, long-staple cotton grown in Arizona.

PLAIN WEAVE—The simplest of all weaves in which the filling yarn passes over and under successive warp yarns; also known as "tabby."

PLY YARN—Two or more yarns twisted together.

RAFFIA—Fiber from the leaves of a species of palm tree.

RAMIE—Bast fiber resembling the flax fiber.

RATINÉ—An undulating type of novelty yarn, usually made from 2 yarn elements.

RAW SILK—Continuous silk filaments in their natural state, before degumming.

RAYON—Synthetic fiber made from the cellulose of wood pulp or cotton linters that have been chemically treated.

REED—Comblike device used to hold warp ends in place which, when drawn forward with the beater, pushes the filler yarn ahead making the web. The name is derived from the early ones which were made of reed.

REED HOOK—Accessory used to pull warp ends through the reed.

REEL—Revolving frame used to wind the warp.

ROVING—A strand of loose fibers, preliminary to being drawn out and twisted into yarn.

RYA—Knot technique used in weaving rugs.

SARAN—Synthetic fiber resistant to moisture and especially suitable for outdoor use.

SATIN WEAVE—Warp and filler yarns interlaced irregularly to produce a smooth surface.

SEA ISLAND—A species of long-staple cotton.

SECTIONAL BEAM—see *Beam.*

SELVAGE—Warpwise edge of the cloth, sometimes reinforced with extra yarns, formed in the process of weaving.

SHED—The V-shaped opening formed in the warp yarns allowing the shuttle to pass through.

SHOT—see *Pick.*

SHUTTLE—Device that passes the filler yarn back and forth through the warp shed.

SILK—Filaments obtained from the silkworm.

SILK GRASS—Fiber from the leaves of various plants of the pineapple and similar families.

SIMPLE YARNS—Yarns of single, ply, or cable twist.

SINGLES—One strand of twisted yarn.

SISAL—Tough fiber from the leaves of a tropical plant.

SKEIN—Yarn packaged in the form of a loose coil.

SLEYING—Drawing the ends of the warp through the reed.

SLUB—Yarn having intervals of untwisted fibers.

SPINDLE—Extended shaft from a motor or hand winder on which bobbins or spools are wound.

SPINNING—Twisting together of fibers to form yarn.

SPREADER—Comblike accessory divided in intervals of ½, 1, or more inches. It is used to spread out the warp in preparation for winding it on the warp beam.

SPUN SILK—Yarn spun from natural silk waste and pierced cocoons.

STAPLE—Fibers of indefinite lengths, classified as *long* or *short* according to recognized standards.

SWIFT—Adjustable equipment for holding skeins so they may be unwound easily.

TABBY—see *Plain Weave.*

TAPESTRY—Decorative fabric in which each area of color is woven separately with individual bobbins; the shuttle is not passed from selvage to selvage as in other fabrics.

THREAD—Smooth yarn with a special finish used by the sewing trade.

TIE-UP—The selective order in which treadles are attached to the lams.

TOW—Yarn made of short combings or broken fibers.

TREADLES—Foot pedals that operate the harnesses.

TWILL—Weave that produces parallel lines in echelon formation.

VALUE—Lightness or darkness of a color.

VICARA—Synthetic protein fiber made from corn and having qualities somewhat like wool.

VINYON—Fiber from vinyl resins which are derived chemically from air, water, and natural gas.

VISCOSE RAYON—A rayon made of regenerated cellulose—see *Rayon.*

WARP—Series of yarns extending from front to back of the loom; these form the firm foundation of woven fabrics.

WARP REEL—see *Reel.*

WEB—The woven fabric.

WEFT—see *Filler.*

WHORL—Circle of clay, bone, or ivory attached to the lower part of a spindle, which acts as a flywheel causing the spindle to rotate.

WOOL—Strictly speaking, the fiber from sheep; generally applicable to the hair of the Angora or Cashmere goat and the specialty fibers from the camel, alpaca, llama, and vicuna.

WOOL COUNT—System of grading the coarseness or fineness of the wool fiber which determines its spinning limits; average range starts approximately with 44's for the coarsest and runs to 70's for a fine grade.

WOOLEN—Yarn made from *carded* wool fibers.

WORSTED—Yarn made from *combed* wool fibers.

YARN—Fibers or filaments twisted to form a continuous strand.

*Cable*—Yarn constructed of two or more ply yarns.

*Complex*—Term that includes all of the novelty yarns.

*Metal*—Yarns made predominately of metal.

*Novelty*—Yarns that have been twisted in an unusual manner to give unique surface qualities.

*Ply*—Yarn composed of two or more singles twisted together.

*Simple*—Singles, ply, and cable yarns having similar components.

*Singles*—Yarn in which the fibers have been carded and given sufficient twist to form a strand.

*Synthetic*—Any filament that can be produced chemically.

# FOR FURTHER READING

*This list of books and periodicals gives information on the history of textiles, designing, and technical information for those who wish to explore these aspects further.*

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*American Fabrics,* Empire State Building, New York 1, N.Y.

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