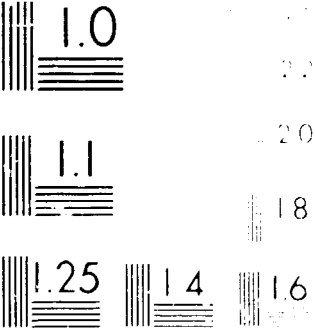
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

MANUAL ON UPHOLSTERY TECHNOLOGY

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UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna

MANUAL ON UPHOLSTERY TECHNOLOGY

UNITED NATIONS
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Explanatory notes

The following abbreviations have been used in this manual:

BSI	British Standards Institution
FIRA	Furniture Industry Research Association
N	newton
PVC	polyvinyl chloride
swg	standard wire gauge

Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

Preface

Upholstered furniture, in one form or another, is found at all levels of society, and its demand has generated the specialist upholstery factory within the furniture industry. However, in most developing countries, upholstery is still carried out by individual craftsmen employed in a multiplicity of tiny workshops similar to those in the tailoring trades. Because of the low level of investment required to convert such workshops into industrial enterprises and the high labour intensity of the work, the industrial production of upholstery could become export oriented for those countries that have access to appropriate designs and raw materials.

In recent years, many technical developments have taken place in the production of upholstery in developed countries. The aim of this manual is to familiarize producers of this type of furniture in developing countries with these new techniques.

The views expressed in this publication are those of the author, Desmond P. Cody, a free-lance industrial consultant to the furniture industry. They do not necessarily reflect the views of the secretariat of the United Nations Industrial Development Organization (UNIDO).

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Introduction

Despite the many innovations and technical changes that have taken place in upholstery production, the industry still depends heavily on traditional and largely manual skills. The changes that have taken place are therefore more directly related to the use of new or substitute materials and the mechanization of certain processes; but the fundamental design characteristics remain unaltered, since ergonomic and comfort requirements for seating must always suit the human frame. The industry has therefore much in common with clothing and garment manufacturing, which nowadays is highly developed; and many of the advances that have taken place in garment manufacturing can be used to advantage in upholstery production.

This point is important, especially when the reorganization of existing upholstery factories or the establishment of new ones in developing countries is being considered. Despite the growing demand for upholstery products, many potential manufacturers are discouraged from setting up factories or even workshops because of the apparent lack of appropriate skills or technical know-how. If, however, it is realized that a source for such skills already exists, namely, the local tailoring trade, which uses the same basic techniques, then the problems associated with establishing such an industry may not be as formidable as they might once have appeared to be. Furthermore, the industry remains highly labour intensive, can be quite profitable, and, compared with other sectors of the furniture industry, requires only a modest capital investment to be viable.

Efficient modern upholstery production may accurately be described as a combination of the skills of the fabric cutter, sewing-machine operator and cover upholsterer allied to the use of many ready-made materials that both simplify and speed up the work. It is therefore largely a component industry, and single enterprises may choose between "buying in" components such as frames and cushions springs or making them up themselves. Whichever approach is decided upon, the factory will still operate on the basis of a series of subactivities concerned with cover cutting and sewing, springing, cushioning and upholstery covering, which are carried out more or less independently of one another. This approach offers many advantages to both small and larger manufacturers, but should hold many additional attractions for the latter in terms of better productivity, ease of handling, more accurate costing and improved quality. Even traditional upholstery will benefit from the use of new and improved materials such as synthetic foams, which have almost totally replaced materials like flock, horsehair and eider feathers.

The purpose of this manual is to familiarize factory managers and other interested persons in developing countries with modern materials, machinery, equipment and production techniques in upholstery, to enable them to upgrade their own operations and to establish priorities for such improvement. It is also intended as a guide to those who are contemplating the establishment of upholstery factories in their own localities, and it is also designed for both students and teachers of the subject.

Annex I contains a description of performance tests for chairs and settees, suitable for developing countries, while annex II lists documents of British origin containing methods of test applicable to upholstered furniture and upholstery materials.

I. Upholstery work—traditional and modern

The basic difference between traditional and modern upholstery is in the materials used. This is also the area in which the greatest changes have occurred, and the same is true of frame and cushioning as well as fabric. For many years the principal form of frame construction has been the assembly by means of dowels and other joints of hardwood members to which the cushioning and fabric are subsequently attached. This system is still widely used, but in the case of traditional furniture it has been made immensely complicated by the special requirements of jute webbing, coil springs and various kinds of stuffing. Consequently, the upholsterer has had to be highly skilled and has usually required many years to learn his craft thoroughly.

Figure 1 shows the traditional method of upholstering an armchair to the stage when the first stuffing has been completed. The second stuffing entails additional layers of cotton linters stitched in place, over which the outside cover or fabric is fitted. The whole is an intricate mass of springs, webbing and other materials. Figure 2 shows the same frame upholstered by the much simpler present-day method. The elaborate springing and stuffing have been replaced by resilient webbing on the seat, tension springs on the back and latex or plastic foam cushioning. The armchair can be upholstered in only a fraction of the time required by the traditional method, far less skill is needed, and it is probably more comfortable. It performs equally well in use and is much easier to repair.

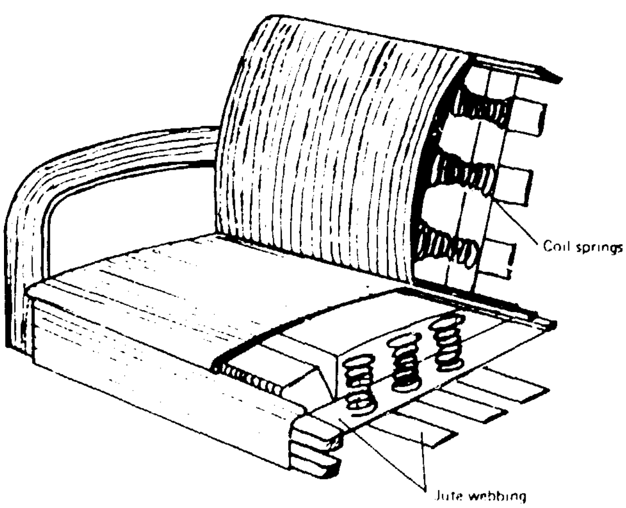


Figure 1. Traditional upholstery

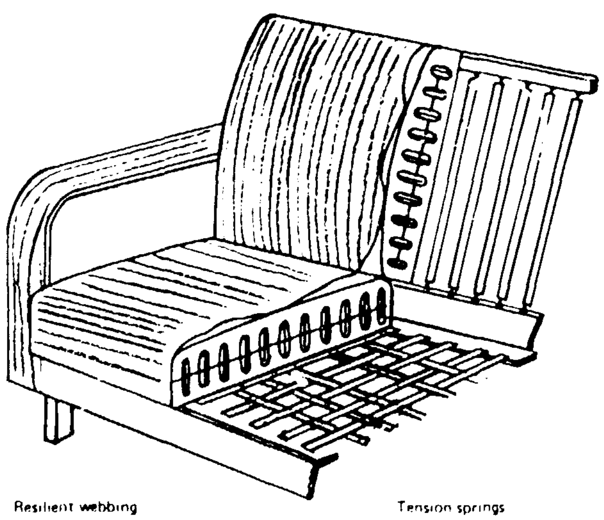


Figure 2. Modern upholstery

Upholstery frames

The function of the frame already described is to provide structural support and to contribute to the shape and style of the end-product. The same effect can also be achieved just as well and much more easily and cheaply by using replacement materials such as plywood, particle board, metal, plastics and combinations of these materials. If properly used, the resulting structure will usually be lighter and therefore easier to handle.

Figure 3 shows a sectional side elevation of a typical upholstery frame made from hardwood components. In addition to the two end frames and cross rails, it provides, by means of additional rails, for the upholstering of the seat and back. The alternative, as shown in figure 4, is to manufacture each end in plywood or particle board. This not only reduces substantially the number of components required but also permits a higher degree of standardization and greater versatility in design. This type of frame also enables screws to be used better and staples to be made instead of the more traditional dowelled joint, with equally good effect.

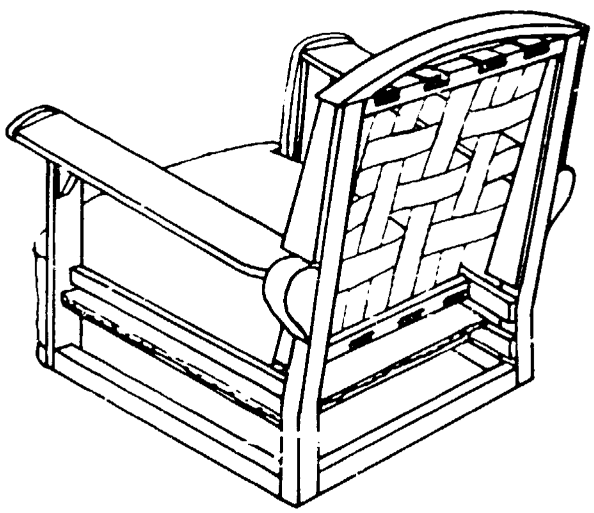


Figure 3 Wooden upholstery frame

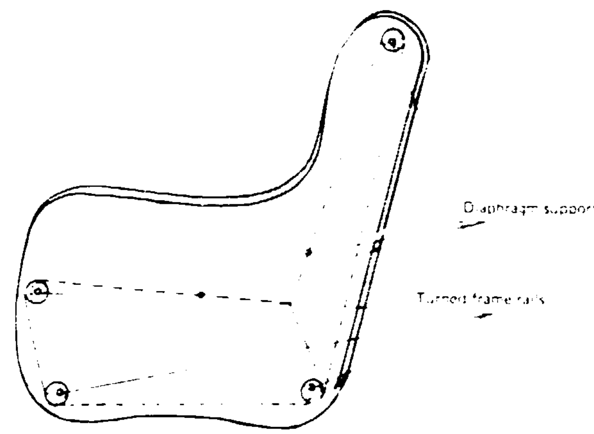


Figure 4. Sectional side elevation of frame with particle-board sides

Moulded plastic shells

Even more varied shapes are possible by the use of the rigid foams that are normally produced from either polystyrene or polyurethane. Frames in these materials are formed by chemical action within an enclosed mould, with the final product consisting of a light, foam-like solid material that takes up exactly the shape of the mould within which the chemical reaction takes place (see figures 5 and 6). The cushioning is subsequently attached, although a method has been developed recently whereby the flexible foam cushioning may also be produced in the same mould as the rigid foam by a similar process, thus combining two of the stages in the production of a finished chair into one.

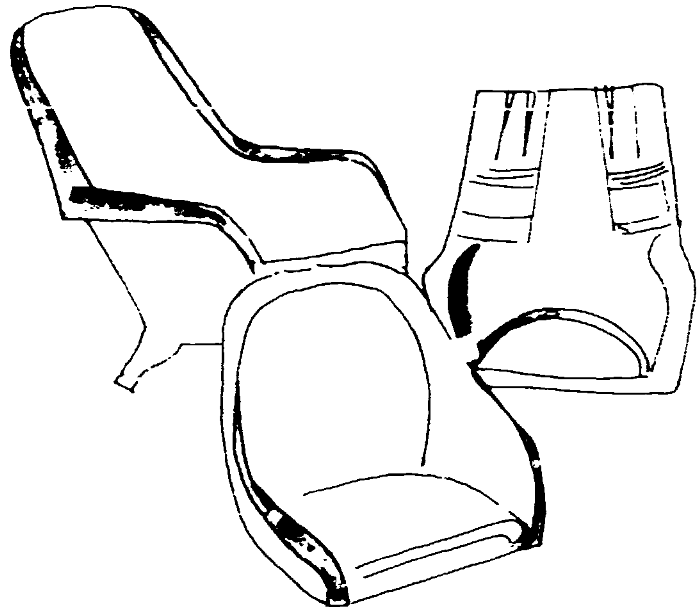


Figure 5. Expanded polystyrene chair shells with hessian reinforcement

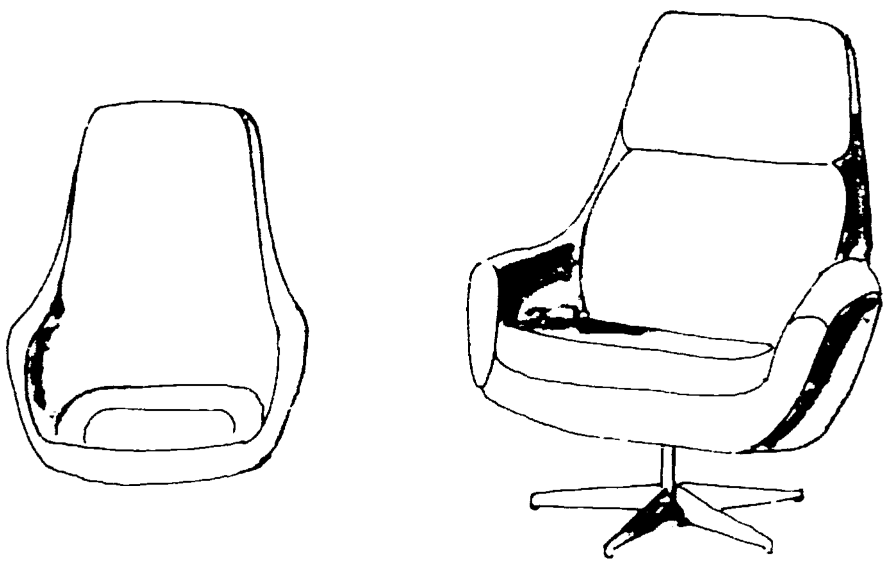


Figure 6. Moulded urethane chair shells

In general, the production of plastic chair shells, especially by the small or medium-sized enterprise, is not to be recommended. Production runs are usually too small to justify the considerable financial outlay in materials, equipment and tooling or mould costs, which in those circumstances are difficult to recover.

For runs up to 100 it will probably be more economical to buy in shells from a supplier. For runs of a few hundred, autoclave moulding (pressurized tank) is a practical consideration, while for a firm considering large runs of at least 5,000 each of several designs, then press moulding (using an automatic moulding press) is the most economical process. Methods of upholstering plastic chair shells are described in chapter IV, which deals with production equipment and technology.

Metal frames

Metal frames (figure 7) are used mainly for upright or dining-room chairs and stools and are generally unsuitable for deep upholstery. If they are used, special wooden inserts are required for tacking upholstery materials.

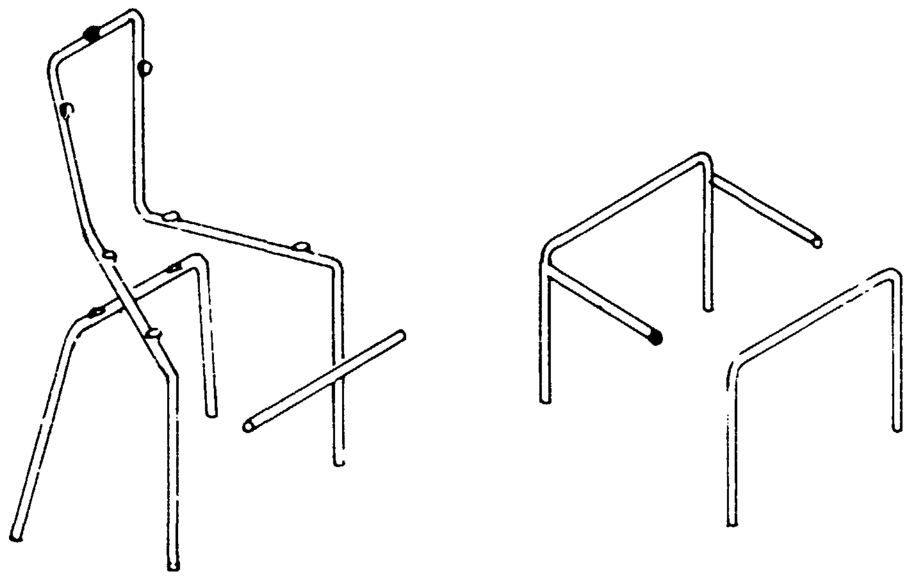


Figure 7. Metal frame chair and stool

II. Upholstery materials and techniques

Suspension systems

Coil spring and spring unit

Most traditional forms of seating have been built around the coil, or "hour-glass", spring, which requires an elaborate frame structure and is largely associated with traditional hand stitches and expensive upholstery. The coil springs (figure 8) are supported on a platform of jute webbing to which they are lashed using spring twine. The springs must also be tied at the top of both the spring and frame as well as to each other.

Spring units are assembled units that are used for slats, arms and backs (figure 9). They have a flexible wire mesh surface into which coil springs are threaded, and the mesh usually has a framing of rigid wire. The coil springs are riveted to steel laths at the base of the spring.

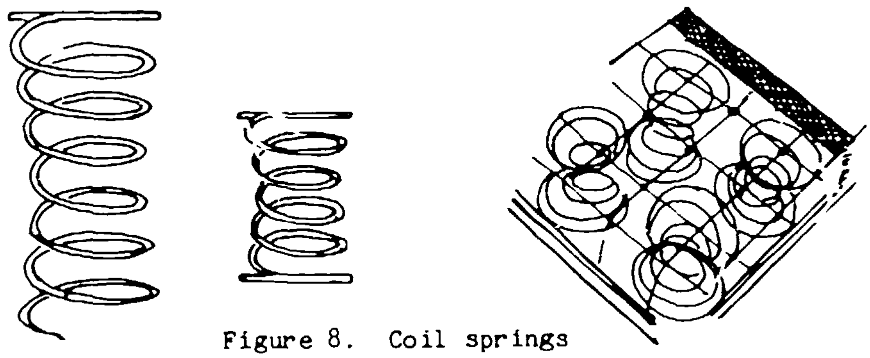


Figure 8. Coil springs

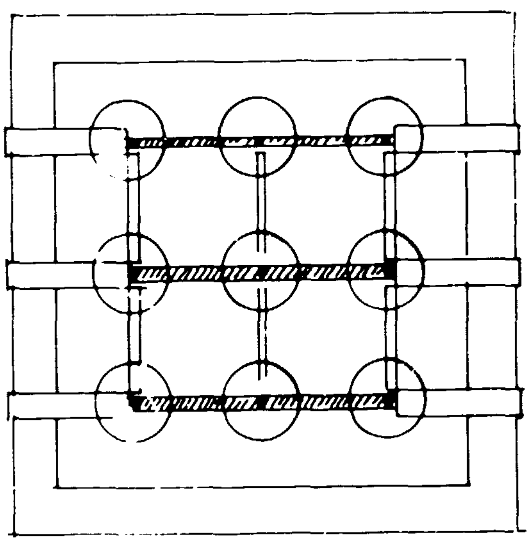


Figure 9. Spring unit

To be effective, coil springing requires a strongly built conventional frame of hardwood. The seating that results is resilient and long-lasting, but can pose many difficult problems for the designer. It makes the model heavy, unwieldy and lacking in individuality. It is also expensive to produce, but is still popular throughout the world.

Tension springs

Tension springs are used to support seats and backs where the design of the frame does not permit the use of coil springs as, for example, in "show wood" (i.e., with polished arms and legs) seating. The springs may be plain metal or coated with plastic if coming into contact with loose cushions or exposed. They are supplied in 1.22-2.03 mm swg (14-18 gauge) wire and in a variety of lengths. The tension on the springs has an opposite action to the compression undergone by coil springs in use. The springs are either nailed directly to the frame or fixed to the frame by metal plates (see figure 10).

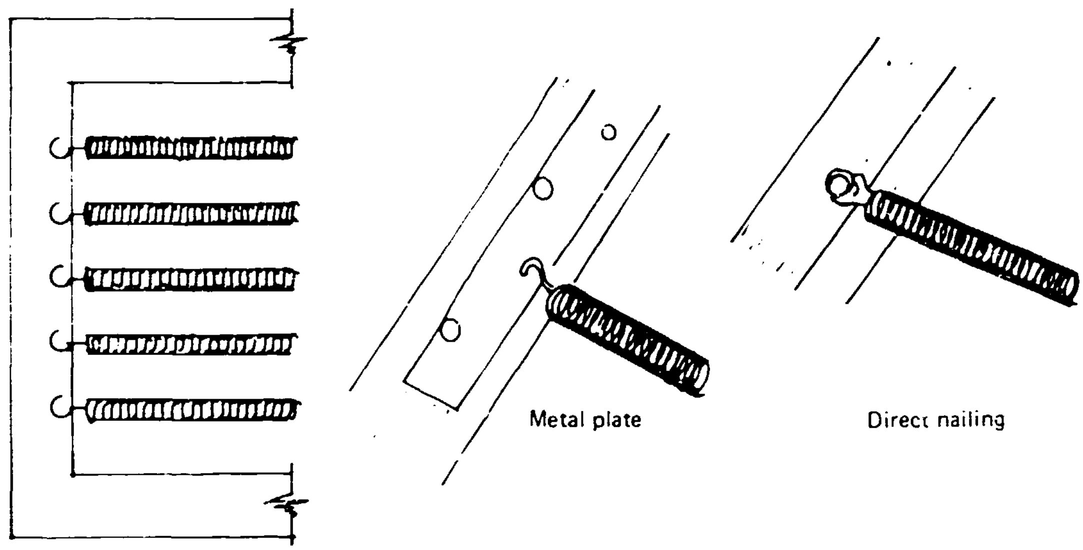


Figure 10. Methods of fixing tension springs

Resilient webbing

Resilient webbing may be all rubber, in which case each strap is moulded separately, or reinforced rubber, which has a core of rubber sandwiched between two layers of rayon cord cut to the bias, i.e., diagonally (see figure 11). The latter is supplied in rolls, usually in three grades for seat application, depending on the degree of resiliency and comfort required, and one grade for back application. The seating grades permit freedom to choose degrees of firmness or feel in a seat. The grades can be used to produce a firm, medium firm and soft seating, and the webbing is available in 38 mm, 51 mm and 57 mm widths. Webbings for back applications, which are usually narrower, are available in 19 mm, 25 mm and 29 mm widths.

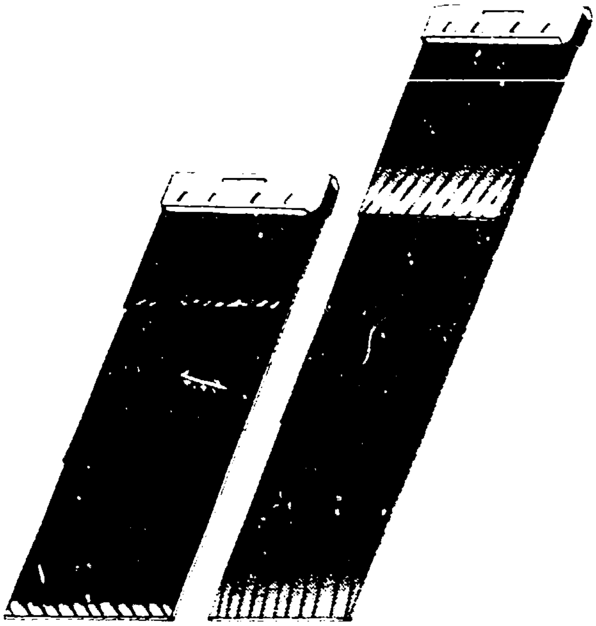


Figure 11. Rubber webbing

Environmental conditions can affect the durability of resilient webbings, and exposure to strong sunlight should be avoided. In furniture that is to be continuously exposed out of doors or in tropical regions, natural rubber should be replaced by neoprene.

With webbings, the choice lies between buying the material in roll form and then measuring it, fixing it with staples and cutting it, or buying precut lengths that can have end clips already attached. Factors that will influence the decision include quality control of tensioning, production costs, neatness, operation time and availability of skilled labour. Where staples are used, they should not be underdriven or overdriven into the material. Detailed methods of attaching webbings are shown in figure 12. Figure 13 shows resilient webbing used in easy chairs.

Serpentine ("no-sag") springs

The serpentine springing illustrated in figure 14 is particularly suitable for small seats such as dining-room chairs and easy chairs. Each length is in the form of a flattened curve, and it is this curvature combined with the springiness of the metal that creates the resiliency. Serpentine springing is available in rolls or cut lengths, and a thicker gauge spring should be used on the seat than on the back.

The springs are fixed to the frame by special clips, of which there is a variety for different applications. Connecting links can be used to join the springs together so that they perform as a single unit. If the links are unavailable, strong twine should be used instead.

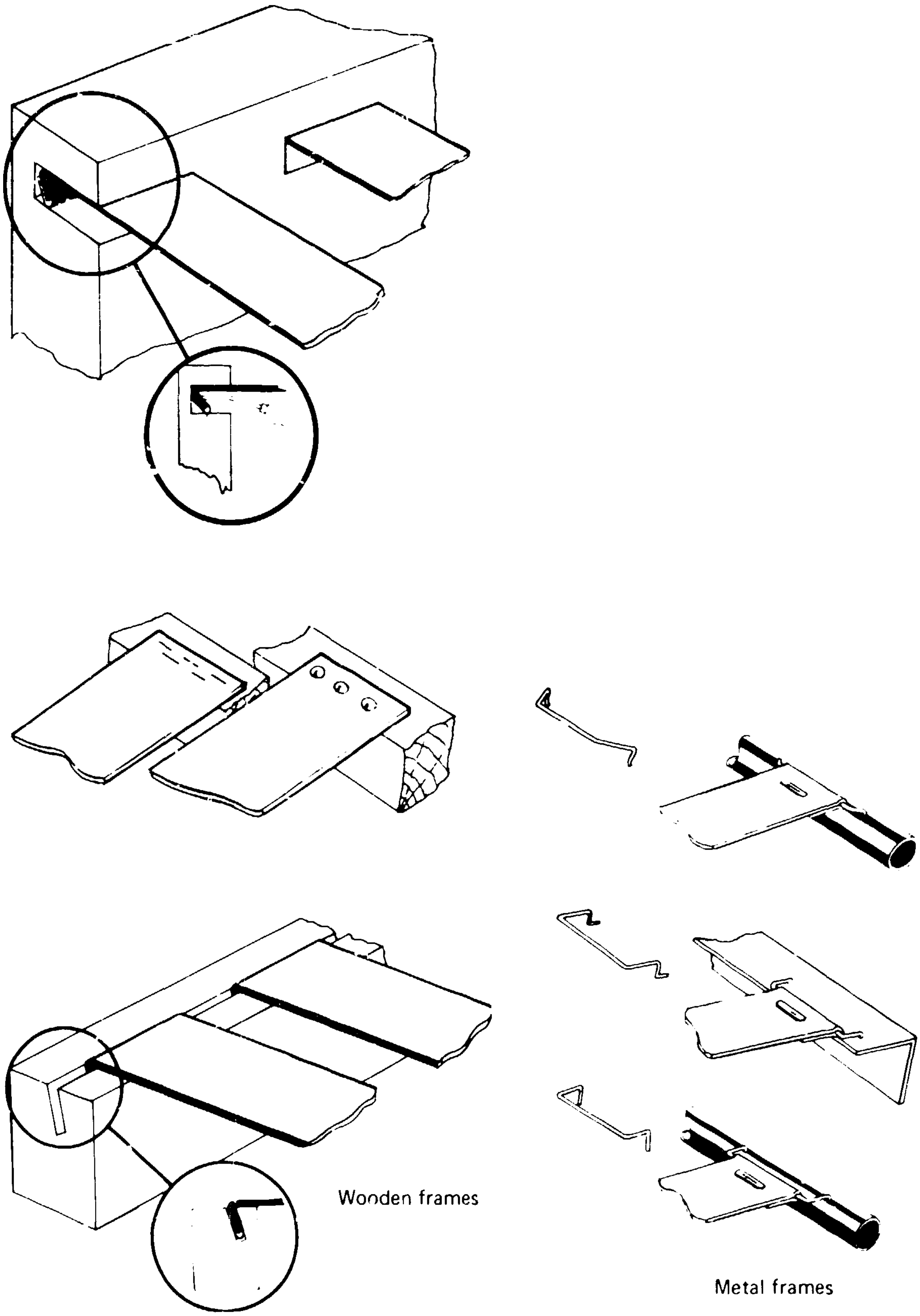


Figure 12. Methods of fixing rubber webbing

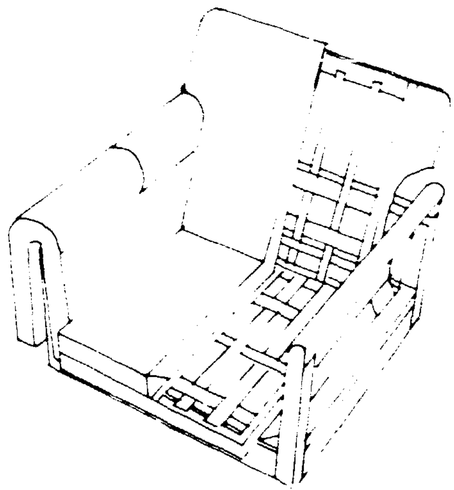


Figure 13. Resilient webbing used in easy chairs

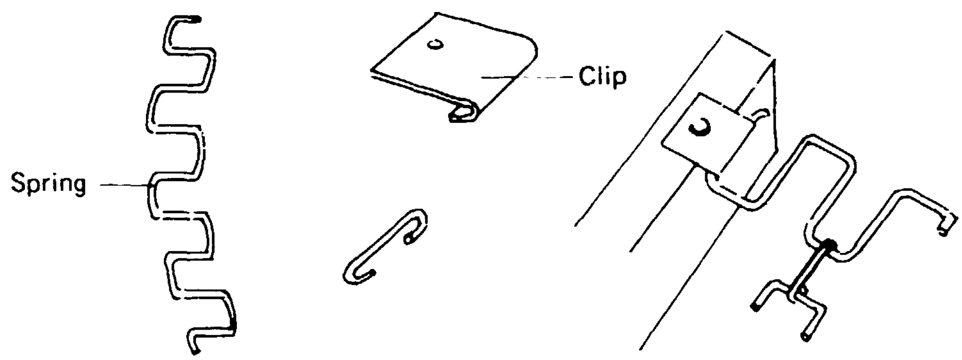


Figure 14. Serpentine or "no-sag" springing

Resilient platforms

The latest and most interesting of the various suspension systems is the resilient platform or diaphragm for seats, which is suspended from four points (figure 15). It is manufactured in ethylene propylene elastomer, which has both the resilience and appearance of natural rubber while being considerably superior to rubber in other properties.

The platform is attached to the frame at the four corners under tension of 8-15 per cent of the unstretched size. The manufacturers maintain that it provides furniture designers with the freedom to provide deep comfort with simplicity of line.

A further development of platform seating incorporates resilient webbing covering the whole seating area in a single panel (figure 16).

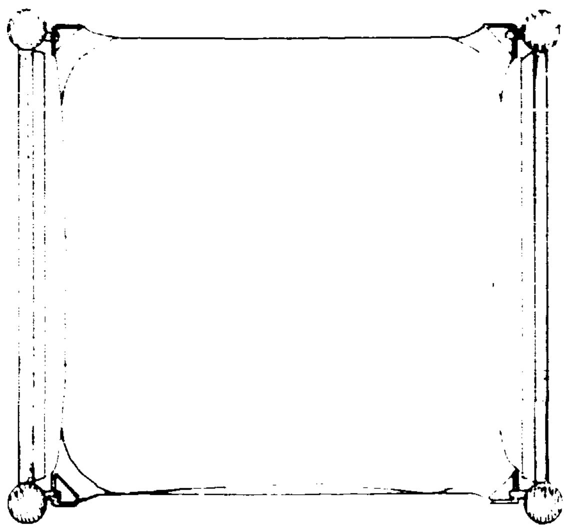


Figure 15. Four-point resilient platform

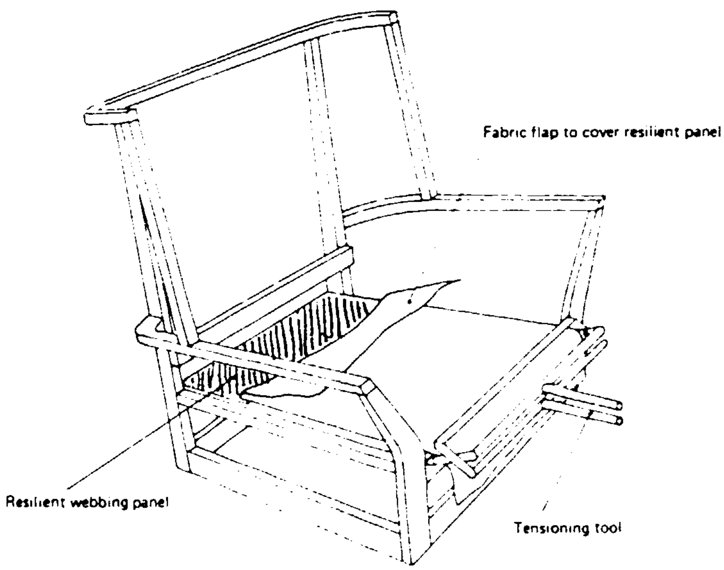


Figure 16. Example of platform support

Cushioning

The two basic types of cushioning are (a) fixed and (b) loose; and the use of either or both depends on the required design characteristics such as appearance, function and degree of comfort. Fixed cushioning is generally associated with traditional types of upholstery (see figure 17) in which the fillings mainly used are horsehair, coconut fibre, rubberized hair, flock and wadding in conjunction with coil spring units.

In the late 1950s, new cushioning materials were introduced, the most notable being latex foam, which is made from liquid foam rubber and is an extremely satisfactory cushioning material. A further development of this

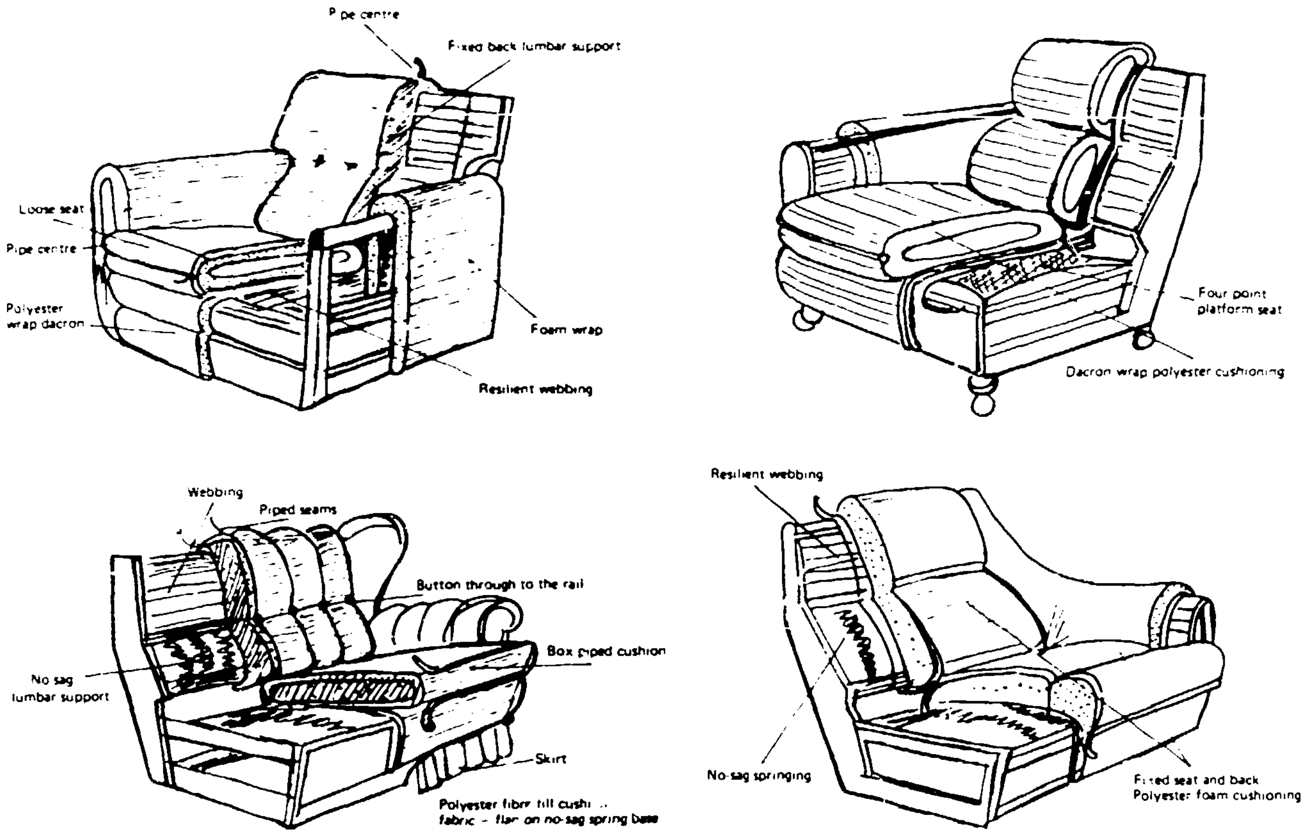


Figure 17. Modern upholstery construction

cushion is the high-resilience foam, with significant improvement in its load-bearing properties and resiliency. Later, foam was followed by flexible urethane foam, or polyether as it is more commonly called, and subsequent variations have included moulded flexible urethane foam and moulded high resilient flexible foam (cold cure).

Latex foam

Four types of latex foam are used:

(a) Non-reversible (figure 18). Here the top surface is smooth and the underside has cavities. It is used for fixed cushioning.

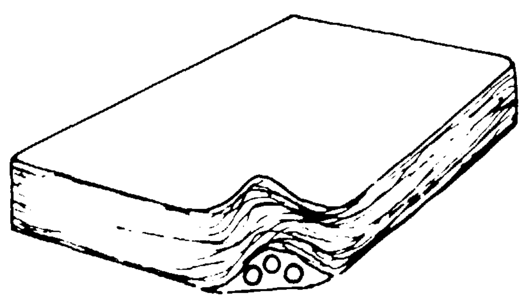


Figure 18. Non-reversible latex cushion

(b) Cavity sheet (figures 19 and 20). Cavity sheet is manufactured in sheets up to 1,800 mm by 1,400 mm and 25-100 mm in thickness. It is used in building up cushions of various thicknesses. Some of these sheets have pinholes for better aeration.

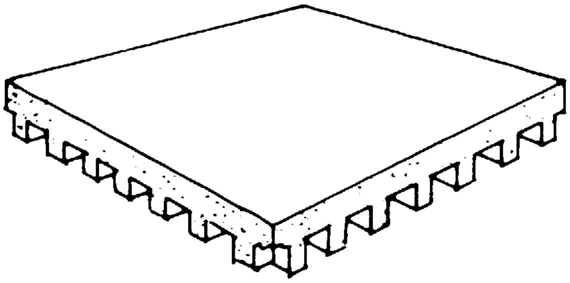


Figure 19. Cavity sheet latex

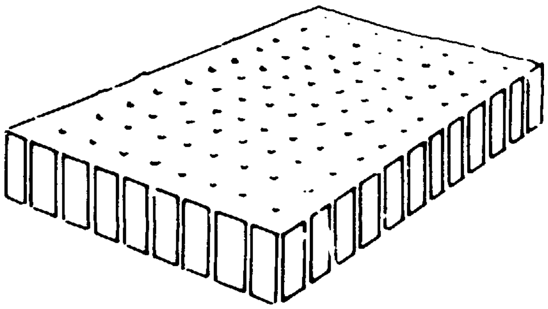


Figure 20. Pin core cavity latex

(c) Plain sheet, reversible (figure 21). The sheet sizes are up to 1,800 mm by 1,400 mm and 12-30 mm in thickness. This cushioning is used for upholstered arms, dining-room chairs, and hand-building.

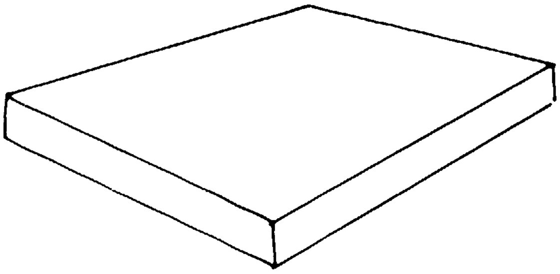


Figure 21. Plain sheet

(d) Hand-built reversible (figure 22). Two non-reversible cushions are bonded together with the cavities on the inside. This type of foam is used for loose cushions.

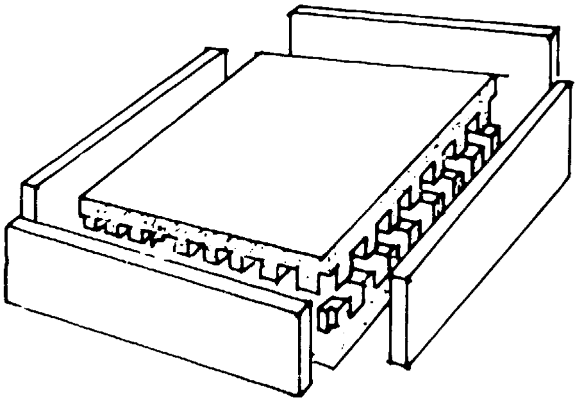


Figure 22. Hand-building a reversible cushion

Foam rubber may be cut quite easily with a band-saw or scissors. Melting the cutting edges with warm water will help, since water is a natural lubricant for rubber. Tailor's chalk or a ball-point pen will give good marking lines. The foam should be cut oversize, allowing an extra 6-12 mm on every 250 mm cut, so that when it is fitted into the cushion fabric it will be under slight tension and thus ensure wrinkle-free cushions. If the covering material does not breathe air easily, e.g., rexines or leather cloths, then it will be necessary to sew in ventilation eyelets or make up one side from an open-weave cloth. Otherwise, air cannot escape when the cushion is compressed, and the cushion will eventually burst.

Cushions can be made up by hand by cutting pieces of foam from sheets and joining them together using a rubber adhesive in accordance with the manufacturer's instructions. These adhesives are usually flammable, and appropriate precautions should be taken.

Urethane foam

Urethane foam is open-cell polyurethane ether foam, and it is the type of foam normally used in upholstery. Polyether is cheaper than latex foam, is available in a variety of densities and thicknesses and therefore offers greater versatility in use. However, the upholstery manufacturer should be familiar with the specifications of each type so that the material may be used satisfactorily and economically. The British Standards Institution (BSI) has issued BS 3379, 1975, "Specification for flexible urethane foam for load-bearing applications", which permits furniture manufacturers to simplify their requirements and provides a means of readily assessing the suitability of any urethane foam on offer. The main advantage in this specification is that it distinguishes between the two major characteristics of the foam, namely, its hardness and density; failure to make such a distinction previously led to much confusion and misunderstanding, often resulting in unsatisfactory use of the material.

According to this standard, the foam is characterized by three factors: type, class and grade.

Type

The following types are distinguished:

- B Block or slab stock
- CB Cold cured (high resilience) block
- M Conventional moulded
- CM Cold cured (high resilience) moulded
- RE Reconstituted

All are subtypes of urethane (or polyurethane) foam.

Class

All types, excluding RE, are classified according to their performance in a constant-load pounding test, which approximates to performance in use and provides a valuable indication of suitability for specific purposes.

Table 1 lists the type of service and recommended application for each class of foam.

Table 1. Applications recommended for each class of urethane foam

Class	Usage	Recommended application
V	Very severe	Public transport seats, cinema and theatre seats, contract furniture seats
S	Severe	Private and commercial vehicle seats, domestic furniture seats, public transport backs and armrests, cinema and theatre backs and armrests, contract furniture backs and armrests
A	Average	Private vehicle backs and armrests, domestic furniture backs and armrests
L	Light	Padding, scatter cushions, pillows

In addition to the pounding test, the foam must also meet minimum levels for compression set, tensil strength, elongation, heat and humidity, ageing, low-temperature flexibility and staining of organic materials.

Grade

Grade is based on the indentation hardness index of the foam measured in newtons (N) and is best regarded as a numerical indication of the "feel" of the foam. With experience it will be possible to relate the grade number roughly with the support offered by the foam. Urethane foam can be built, marked and cut in the same way as latex foam. When shaped or profiled cushions are being produced, a thin cardboard template should be made around which the shape can be marked.

Foam should be attached to the frame by calico strips, which are glued to the foam and then tacked to the frame.

Thin urethane foam is used for padding or softening the basic frame, but this use is largely negated if is employed to correct faults inherent in the structure.

Bonded chipfoam

Bonded chipform is reconstituted material and varies in thickness from 2 mm upwards. It is available in many grades, has good fatigue properties and is used principally for reinforcement purposes. In upholstery of good quality it is used as a base layer, over which a softer padding material is fitted. It can be used to advantage, together with a moulded rubber edge profile, over a seat spring

Polyester fibre-fill

The most recent innovation in cushioning is the wholly or partly filled polyester fibre cushion (figures 23 and 24). The fibre itself may vary according to the way it is processed, i.e., by crimping the fibres in different ways and varying the number of crimps. The fibre has good bulking

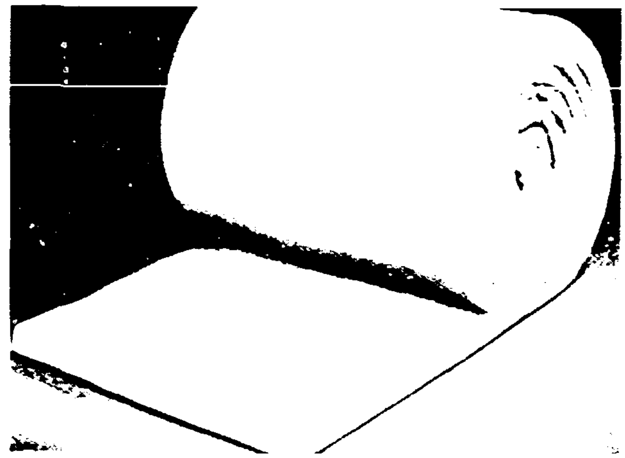
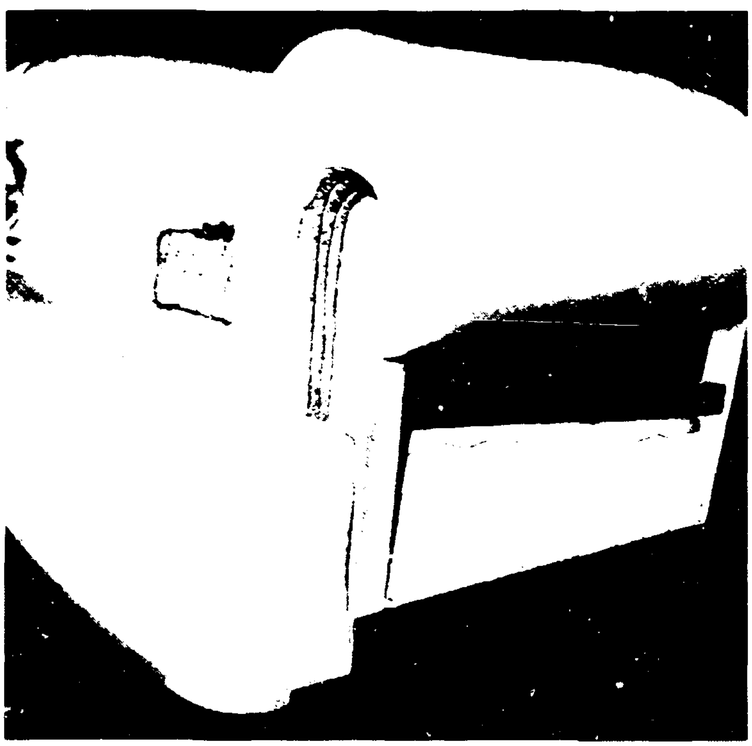


Figure 23. Fibre-fill roll



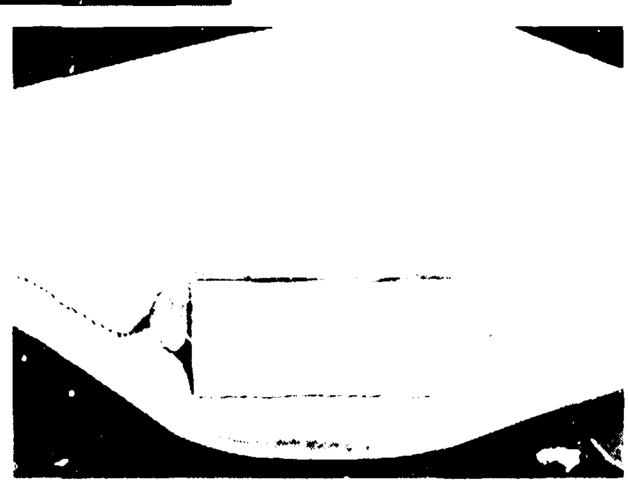


Figure 24. Fibre-fill cushion with urethane foam core

power, and cushions filled with the material look full and recover well from compression. Fibre-filled cushions may be reduced in cost by incorporating a core of polyurethane or latex in the cushions around which the fibre is wrapped. Tests by the Furniture Industry Research Association (FIRA) of the United Kingdom of Great Britain and Northern Ireland indicate that there is little appreciable difference in use between the two types of cushion if the foam core accounts for no more than 25 per cent of the thickness of the cushion. However, a high filling density should be used for seat cushions; a lower filling density is satisfactory for arms and backs and other applications with a lower load level. Examples of the application of various combinations of cushioning systems in modern upholstery construction are shown in figure 17.

Other cushioning materials

Fibre

Fibre fillings have been largely replaced by latex and urethane foams. However, coir fibre is still used and is obtained from the coconut husk. It is the most resilient of the fibres and, when made up into fibre pads, is particularly suitable for mattresses. Sri Lanka is a major supplier of coir fibre.

Curled hair

Curled hair is a mixture of hair from horses, cattle and pigs; it is treated to achieve the curls and thus its resiliency. It is now seldom used.

Rubberized hair

Rubberized hair is available in sheets of varying thicknesses and densities. It is made by bonding curled hair with rubber latex to the required thickness and density.

Felt

Felt is used as an outer layer over fibre and hair and prevents them from working their way through the covering material. It is made from cotton linters, which are obtained from the waste of the cotton plant after the cotton fibres have been extracted. The linters are then pressed into an even layer.

III. Upholstery fabrics

The variety of upholstery fabrics currently available to the manufacturer is almost limitless. There are the traditional wool and cotton fibres that have proved their usefulness over centuries; rayons; and a multiplicity of synthetic fibres, including nylons, polyesters, acrylics, polyolefins and combinations of any or all of these. There are further variations in colour, shade, pattern and texture, which, while adding to the choice available, can, if not properly controlled, cause serious problems for the unwary upholstery manufacturer.

Fifteen or 20 years ago it was simply a choice between one uninspiring moquette and another equally uninspiring one, since at that time this type of material accounted for up to 90 per cent of the fabrics used by the industry. Now it almost seems necessary for a manufacturer of any size to have at least one textile technologist on his staff to guide in the selection and use of the current large assortment of fabrics. Problems can arise in respect of the wearability of the material, its colour-fastness, its variation in pattern and shading even in the same roll, its stretch factor, its resistance to the effects of soiling, its cleanability, its propensity for seam slippage, its variation in width from roll to roll and so on. Manufacturers in tropical countries have to face additional hazards such as those relating to climate, e.g., strong sunlight and heat, humidity and insect attack. Since the cover fabric can account for as much as 30 per cent of the total cost of producing a single upholstered unit, the selection of the wrong material can have serious consequences. Furthermore, the fabric is an integral part of the design of the seating and can enhance considerably an item's attractiveness.

Woven fabrics

The principal woven fabrics used for upholstery are defined below.

Corduroy. Cut pile fabric with ribs running in the warp direction. It is a hard-wearing fabric made from cotton and man-made fibres and is in the medium-to-high price range.

Denim. A handwoven coarse cotton twill fabric that is inexpensive.

Moquette. A fabric having a pile that is cut, uncut, or in a combination of both. It is extremely hard-wearing, can be obtained in many designs in both man-made and natural fibres, but is expensive.

Repp. A plain woven fabric with ribs in the direction of the weft. It is a hard-wearing material in the medium price range.

Tapestry. A Jacquard-figured fabric made from part or all wool, with coarse yarns that can be made in a variety of weaves. It can be obtained in many colours and is expensive.

Tweed. A simple twill weave fabric with a smooth, hard-wearing surface. It is usually all wool, but other fibres may also be used. It is not expensive.

Velour. A warp pile fabric with a very short pile.

Velvet. A cloth with a pile formerly made of silk but now usually of synthetic materials.

Well-known trade names associated with synthetic fabrics are "Dacron" and "Terylene".

Knitted fabrics

Knitted fabrics are an economic type of covering material particularly suited for covering the curved form of plastic moulded chairs. They are liable to damage by loop pulling and laddering and may be damaged during sewing and fitting of the cover. Laddering can be caused by piercing the fabric with sewing needle, tacks and staples. These fabrics can also be damaged if too rigid a seam is used for sewing. This causes the fabric to be torn by the thread when it is being stretched during upholstering or use. Foam or rubber backing on the fabric lessens the chance of laddering.

Warp knitted fabrics

Warp knitted fabrics have been given this name because the threads run along the length of the fabric. They are woven mainly from continuous filament yarns, and different surface textures can be produced with either an open or closed structure.

Weft knitted fabrics

Weft knitted fabrics have good stretch properties and are therefore very suitable for upholstering. The fabric is made up of a series of interlocking loops of yarn formed across the fabric with a single thread. There are three basic types of weft knitted fabric: single jersey, which is a plain knitted fabric and prone to laddering; double jersey, which has a rib structure that gives it a double thickness; and interlock, which is also a double rib fabric but has interlocking cross yarns that prevent it from damaging easily.

Coated fabrics

The properties of a coated fabric depend on the backing fabric, the type, content and thickness of the coating material, the adhesion between, the method of application of the coating to the fabric and the decoration of the surface.

Known as PVC fabrics, polyvinyl chloride fabrics have good abrasion resistance, are easily cleaned, can be obtained in a variety of colours and are very suitable for upholstery. Many types of backing are used to strengthen the coating surface, and Vynide has a woven backing fabric with good abrasion and flexing properties. Other PVC materials have knitted fabric backings that make upholstering easier.

Expanded and unexpanded PVCs are used in making coatings. Examples of expanded are Ambla and Cirrus, which are softer and warmer than plain PVC fabrics. They are made by incorporating a blowing agent that expands the mixture to give a thin layer of foam with an integral skin of solid PVC.

Polyurethane

Polyurethane fabrics are more like leather than other synthetic materials. Like PVC, they are permeable to air, have good stain and abrasion resistance and are easy to clean and use for upholstery work. They can be finished with a matt or glossy wet-look. Some types tend to be sticky.

Direct coating

The polyurethane is spread as a viscous liquid directly on the base fabric by rollers. The resulting materials tend to be thicker and less flexible.

Transfer coating

Transfer coating is more suitable for lighter coatings and is applied to knitted fabrics. The coating is applied to the backing fabric by a strong embossed, kraft release paper that transmits the pattern to the coating and is subsequently pulled off for further use. The fabric characteristics depend on the effectiveness of the coating process and the adhesion and thickness of the coating.

Leather

Leather is an ideal material for upholstery not only because of its appearance and durability, but also because of the status traditionally associated with it. Among the physical properties that give it a special place in the industry are:

- High tensile strength
- Resistance to tear and puncture
- Resistance to flexual fatigue
- Controlled area stability, i.e., can be made dimensionally stable or stretchable
- Permeability to water vapour, i.e., can absorb perspiration, which is later dissipated
- Mouldability, with the capacity to retain its new shape
- Resistance to water and fire
- Resistance to fungi

Traditionally leather was used in Chesterfield-style seating in which the many deep buttoning points ensured that the cover was held relatively tightly in position. This method of upholstering suited the relatively tough and inelastic nature of vegetable-tanned leather. Today the demand is for a softer and more informal style of upholstery and a wider variety of colour shades. As a result, the type of leather supplied now for upholstery has changed; it is almost always chrome tanned, which is more extensible and flexible than vegetable tanned and can be dyed in more colours, including both dark and light shades. One problem is that dye does not penetrate leather well by textile dyeing standards, and the colour-fastness properties are generally inadequate, e.g., the material will readily fade.

Cowhides, about 3.3 m^2 in size, are supplied in irregular shapes either as whole or half hides. The outer side is called the grain side and the inner the flesh side. Since leather crushes easily, it should be rolled neatly with the grain on the outside. Joins can be made by skiving pieces together; pieces to be joined are cut at an angle to obtain greater surface adhesion.

Particular care must be exercised in sewing leather, since nearly all stitching remains visible and wrongly located needle holes cannot be easily concealed.

Decorative trimmings

The principal decorative trimmings are defined below.

Self-piping. Piping made from the same material as the covering material. It is sewn with a piping foot attachment on the sewing machine, which enables a seam to be made close to the piping cord.

Ruche. Frill or gathering of lace etc. It is a further alternative to having plain seams along cushion borders and other upholstered edges. It is available in colours and shades to match the covering fabric. One edge is suitable for sewing into the seams of the fabric. Cut ruche. A continuous closely woven thread with a cut pile surface. Loop ruche. Similar to cut ruche but the pile is uncut. Rope ruche. Made in the form of a rope with decorative threads on the surface.

Braid and gimp. A decorative band of material glued or gimp-pinned along the edge of upholstery particularly where the cover finishes against a show-wood frame.

Fringe. Gimp-pinned or sewn around the edge of upholstery as an added decoration. It consists of loose twisted threads hanging from a length of braid. Sometimes tassels are added.

Upholstery nails. Nails having domed heads with a brass or bronzed finish. They are used as an alternative to slip stitching and are hammered into the frame at regular intervals after the edge of the covering material has been turned in.

Underlays

Underlays are materials used immediately under the outer cover or to separate sections of the cushioning. The most common underlays are defined below.

Hessian. A closely woven jute fibre cloth used to cover springs and webbings. It is also used for making flies, i.e., extension pieces sewn to the outer covering that are not seen. This material is available in different weights related to usage.

Scrim. Similar to hessian but lighter and having a more open weave. It is used for internal covering of filling materials.

Calico. A lightweight bleached cotton fabric used as a base for upholstery or for fixing foam cushioning to a frame.

Assessing the suitability of fabrics

Careful selection of the most suitable fabric for a particular upholstery application is imperative, particularly in view of the wide variety of materials now in use and their inability to perform equally well in all circumstances. In the past, the upholstery manufacturer could depend with reasonable assurance on his experience with firmly established fabrics such as moquettes and judge them by their appearance and handling properties. The situation has changed, and it is essential to check at the outset for defects and imperfections that not only create problems during the course of manufacture but also may be the cause of consumer complaints later.

Among the problems most commonly encountered by upholstery manufacturers in respect of covering materials are the following: variations in width, pattern and shading from roll to roll of the same material; absence of colour range rationalization by textile manufacturers; poor resistance to soiling and abrasion; lack of uniformity in the stretch of certain fabrics; poor resistance to moth and insect attack; flex cracking in imitation leather; pilling, where small pieces of weaker fibres break away from the fabric; seam slippage and breakdown caused by fraying; fading and delamination of coated fabrics; and flammability.

There can be no real substitute for testing the fabric properly, i.e., in accordance with established test methods and procedures, but since such testing is not always practicable from an upholstery manufacturer's point of view, a few rule-of-thumb checks may be applied that will indicate whether the material meets the necessary standard in certain respects.

Stretch the fabric between the finger and thumbs. If it can be split, then it is not strong enough for upholstery. If it is possible to slide the weft threads over the warp or vice versa to show a bruised effect on the surface of the material then it will slip open at the seams. For tearability, compare a new material with a familiar one that has given good service; if the new material tears much more easily, it may give trouble. Wrap a white handkerchief around the index finger and rub it steadily over a fabric for about 20 rubs each of roughly 100 mm. The amount of colour that rubs off will indicate its performance in this respect in future use.

Standards and specifications for fabrics are included in annex II.

IV. Production technology—methods and equipment

While the upholstery industry cannot compare in terms of technical sophistication with, for example, the clothing industry, they both have sufficient processes in common to enable the one to be influenced by the other with regard to production technology. This has been particularly true for specific items of equipment and production methods, e.g., those for laying up, marking, cutting and sewing, where the upholstery industry continues to adopt and adapt machines and methods suited to its own needs and standards and has accelerated the change from a traditional craft-based industry to one more mechanized and less labour intensive. This trend appears likely to continue with the rising costs of raw materials and, to some extent, of labour and the greater need for higher productivity. Other factors that have influenced the development of the industry are the use of moulded plastic chair frames and parts and the breakdown by manufacturers of individual pieces into sections or subassemblies that can be upholstered more easily and quickly before final assembly. Many upholstery firms do not manufacture their own frames, preferring to "buy them in" ready-made from a frame producer. Indeed, there is now a greater tendency to regard the industry as one of components, e.g., frames, cushions, springs, covering materials and fittings, which are made elsewhere and largely assembled into the finished product by the industry. There are many advantages in this approach, particularly from investment and cost-benefit points of view, but it requires an efficient back-up service from the supply industries concerned.

Fabric inspection, handling and storage

Inspection

Since a covering fabric can account for as much as 30 per cent of the total cost of manufacture of an upholstered product, the importance of a good inspection system at the point of delivery can be readily appreciated. Otherwise, serious faults in structure, shading, patterning and dimensioning may go undetected until the material is about to be used, and then it is usually too late to take remedial action. Consequently, particular emphasis is now laid on a careful examination of the material so that if found unsuitable it may be returned to the textile supplier immediately.

Many types of proprietary fabric inspection tables are available on the market, but an enterprising upholstery manufacturer can make up his own easily and cheaply. Usually it consists of a glass-topped illuminated table fitted with a winding device, over which the material is passed for visual inspection. Fluorescent lighting has been found to be the most effective, especially for colour matching and shading. While the fabric is being rewound over the inspection table it may also be checked for length, and at the same time a paper measuring tape may be inserted in the roll, thus permitting the amount of fabric remaining to be known after each cutting. A counter fitted to the winding device enables accurate measurement of each roll.

Defects to be watched for during the course of inspection include broken threads, staining or discoloration, variations in pattern and shading, creasing, crushed pile, bowing of yarns, sloping lines of knitting in knitted fabrics and distorted patterns.

Handling and storage

Since most manufacturers are required to carry a large stock of upholstery fabrics, particular attention should be paid to their handling and storage. Storage is usually fixed or mobile.

Fixed storage

Fixed storage consists of multistorey racks that sometimes incorporate paper or plastic tubing in which rolls of small diameter can be conveniently housed. Use of this system makes it easy to pull out individual rolls and saves space (figure 25).

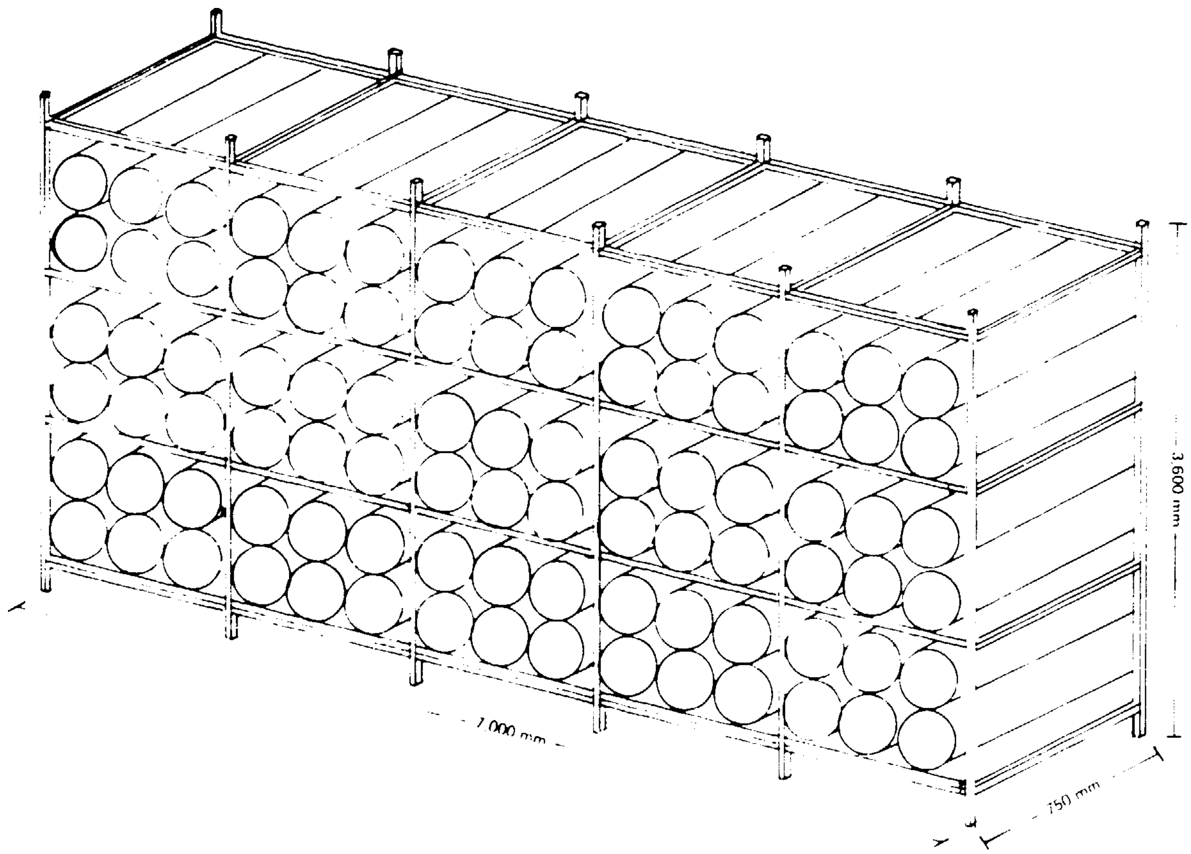


Figure 25. Fixed storage for rolls of covering fabric

Mobile storage

Rolls of upholstery fabric are heavy and unwieldy and often prove to be beyond the capacity of workers, especially of female markers and cutters, to carry them from static storage racks to the cutting tables. One widely adpoted way of overcoming this problem is to use castorized trolleys (figure 26) on which the rolls of fabric are stored. These can be quickly and easily rolled to the cutting table when the fabric is unwound. If sufficient space is available in or near the cutting room, then all fabrics should be stored in this manner. More sophisticated storage and unrolling systems based on this principle can incorporate as many as 15 rolls and are electrically operated so that any required roll can be positioned for unwinding and spreading at the touch of a button. The trolleys described here can be easily made up from tubular steel parts welded together.

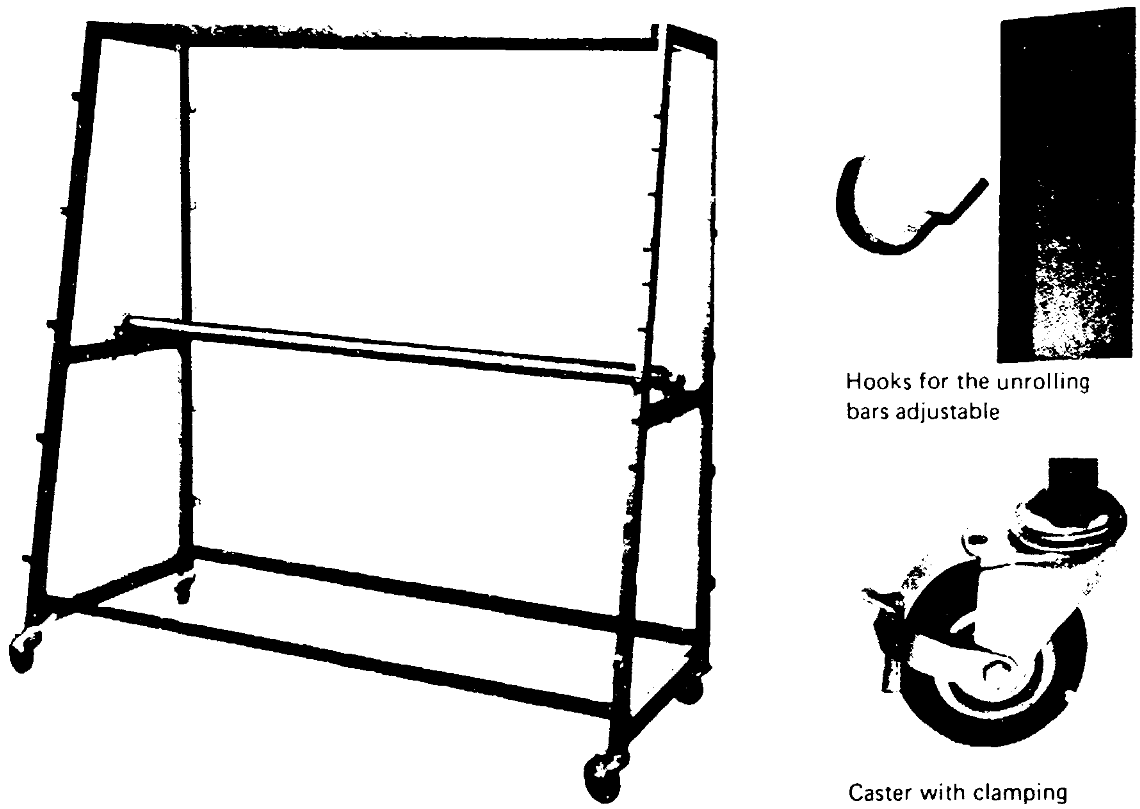


Figure 26. Mobile storage and transport for fabric rolls

Fabric laying, marking, cutting and sorting

Arrangements in the cutting room will naturally depend on the size and output of the enterprise concerned. The small manufacturer producing one model at a time will be content with the traditional cutting table, French chalk and scissors, while the larger factory will think seriously about methods of increasing productivity through rationalized production and the opportunity it offers for a greater degree of mechanization and materials utilization. At best it will be a combination of both systems, since most manufacturers sell many designs in a wide variety of covers. Only when there is a limited number of designs in a standard range of fabrics can multiple cutting be used to advantage.

Cutting table

The dimensions of the cutting table-top (figure 27) must be such that they accommodate the standard widths of fabric used for upholstery as well as the required length. For most cloths the width will be 1,550 mm, and the table should be made up in multiple lengths each of 2,000 mm. The surface should be clean and smooth and free from protruding nails and other defects. It is a good idea to cover the top with a plastic laminate or heavy-duty linoleum, and a metal tape measure could be incorporated with advantage along each side. Drawers or shelves could also be incorporated to provide storage for cut covers, remnants, and cutting and measuring tools.

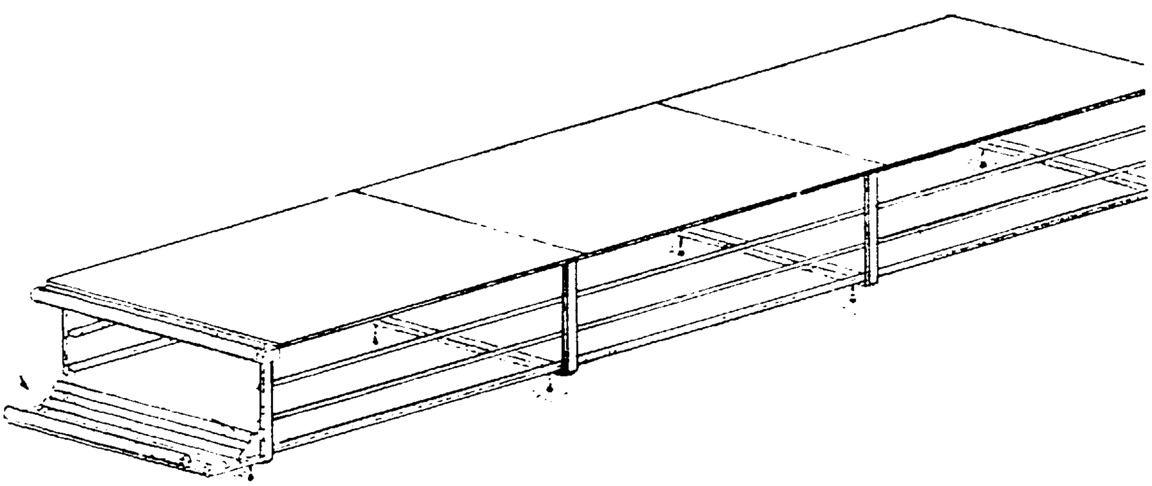


Figure 27. Cutting table for upholstery fabrics

Fabric laying and spreading

Except in very large factories, laying and spreading of the fabric is done manually, but it can be made easier, especially when using long lengths of material, by using an mobile overhead spreader cradle (figure 28), which traverses the cutting table on tracking that is built into the table. The number of lays to be spread depends on the batch size and the thickness of material being used. Some piles of fabrics such as velvets and dralons tend to crush if subjected to weight or pressure, so that fewer of these should be cut on a multilay basis. Each lay must be laid square against one edge of the cutting table and held firmly by clamps to avoid creasing or bunching the fabric. Additional needles or pins can also be placed at intervals along the material for this purpose. Particular care should be taken with striped and patterned materials to ensure that each succeeding lay is placed directly over the preceding one.

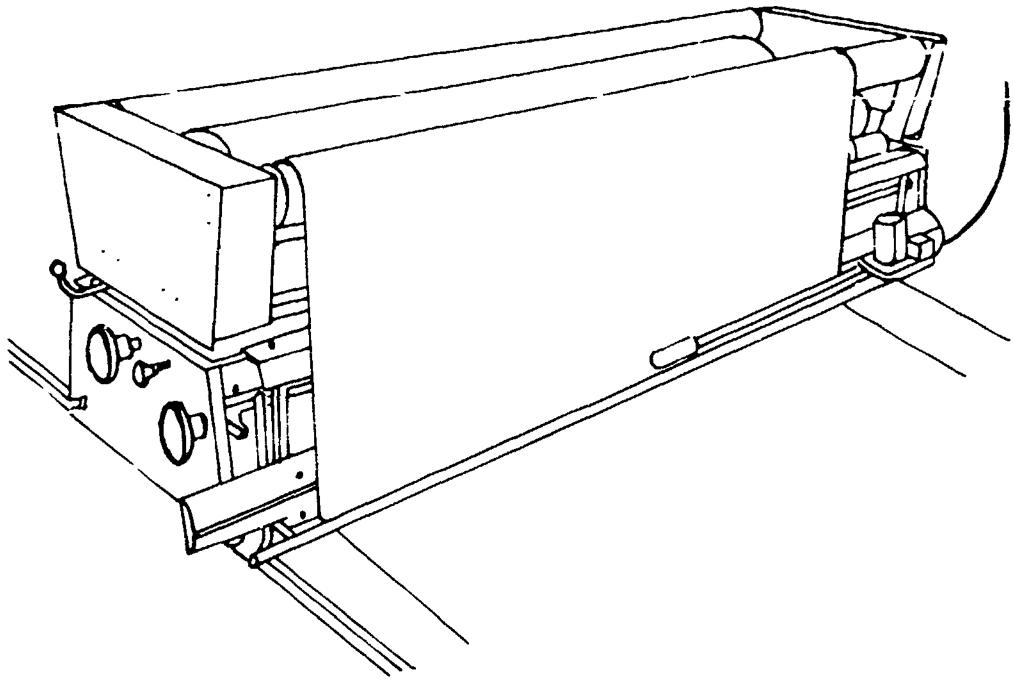


Figure 28. Mobile overhead cloth spreader

Machine for cloth laying and cutting off

In building up the series of lays a unit for cutting ends off and clamping should be used. Figure 29 shows a machine for laying and cutting off cloth, which is used for laying in single layers or in pairs (with the nap). It is equally suitable for plastic sheeting, artificial leathers and other similar synthetic materials; it can deal with lays of material up to about 200 mm in height. The cutter rail and cloth holder are raised vertically, which permits the edges to be cut flush by the cutting machine that travels along the cutter rail, ensures that all cut pieces are exactly the same length and have squared ends and almost eliminates offcuts.

Measuring

The frame (or cushion) to be upholstered must be measured accurately, especially when patterned fabrics, where motifs must be centred and accurate joinings made, are used. As each part to be covered is measured it is scaled down 5 to 1 to enable a miniature pattern of the pieces to be drawn. When all parts have been drawn to scale they are laid side by side to the best advantage, i.e., minimum waste, on a long sheet of pattern paper representing to the same scale the width of the fabric that will be subsequently cut. This will then act as a guide for the fabric cutters. Full-size patterns or templates are also made up using a plastic laminate on similar hard-wearing material. Since these marking guides will be used a considerable number of times, they should be clearly identified in relation to the model concerned and carefully stored either in drawers or in vertical racks alongside the cutting table, or in a similarly safe place.

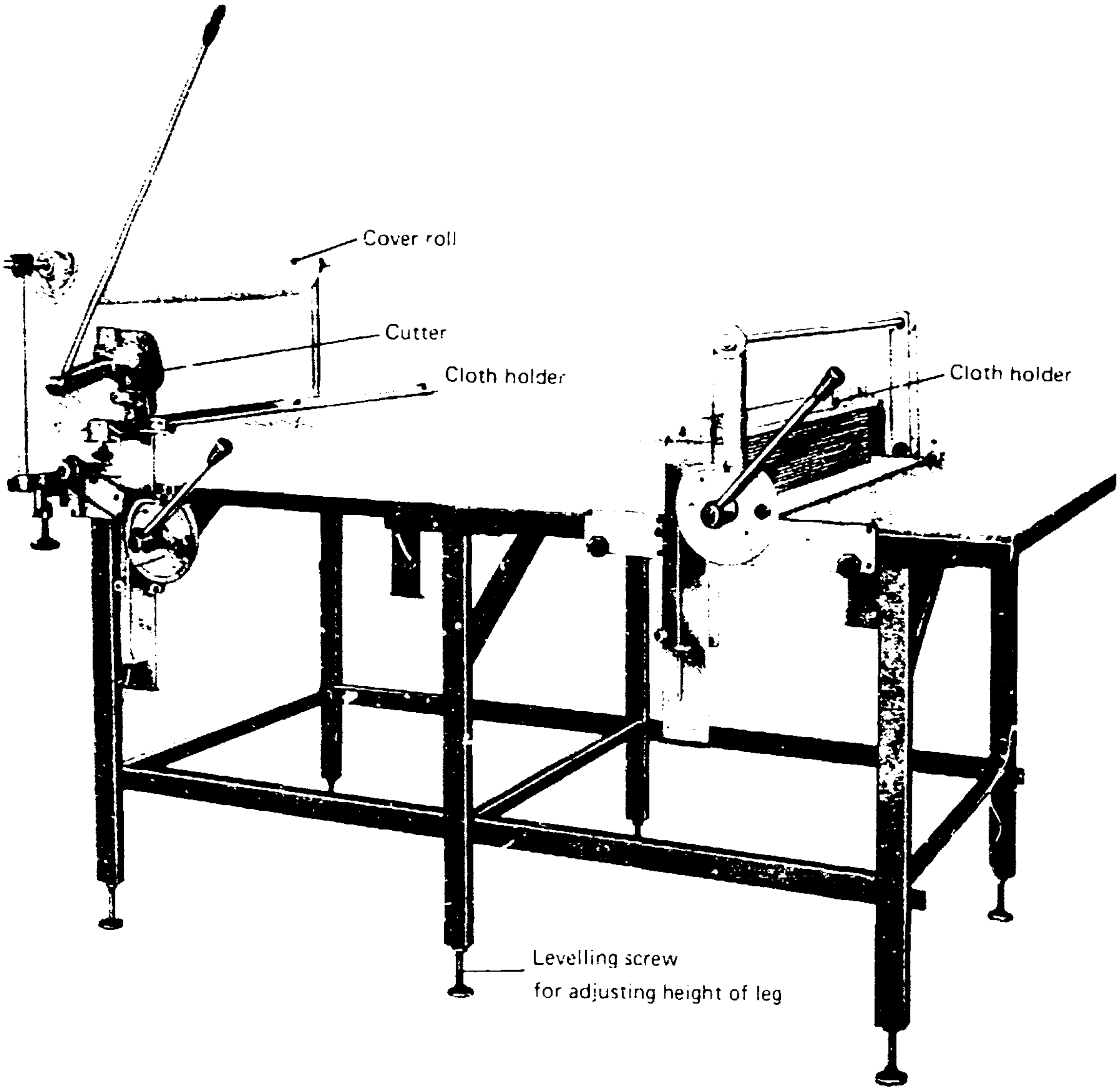


Figure 29. Machine for laying and cutting off cloth

Marking

The usual method of marking out is to chalk around the pattern board or template using easily removable chalks such as standard or French chalks. The latter, which are waxed, disappear with ironing or steaming. Lay powder is also used, but with perforated pattern sheets on which the pattern is punched and the powdered chalk is then dusted over them. This leaves the dotted chalk outline on the fabric. The perforations are made with a pattern perforator (figure 30). By following the cutting line with the guide the pattern can be punched out and the use of different punches permits perforation sizes of (mm) 1.2, 1.6, 2.0, or 2.4.

Other marking systems that are used for very high-volume production include miniature lay planning, which is a further semi-automated development of the marking system described above; paint marking, where the paint is atomized by air pressure and spread in a thin film over cut-out pattern sheets, which are then removed, leaving a cutting outline; and automatic marking and cutting using routed profile patterns.

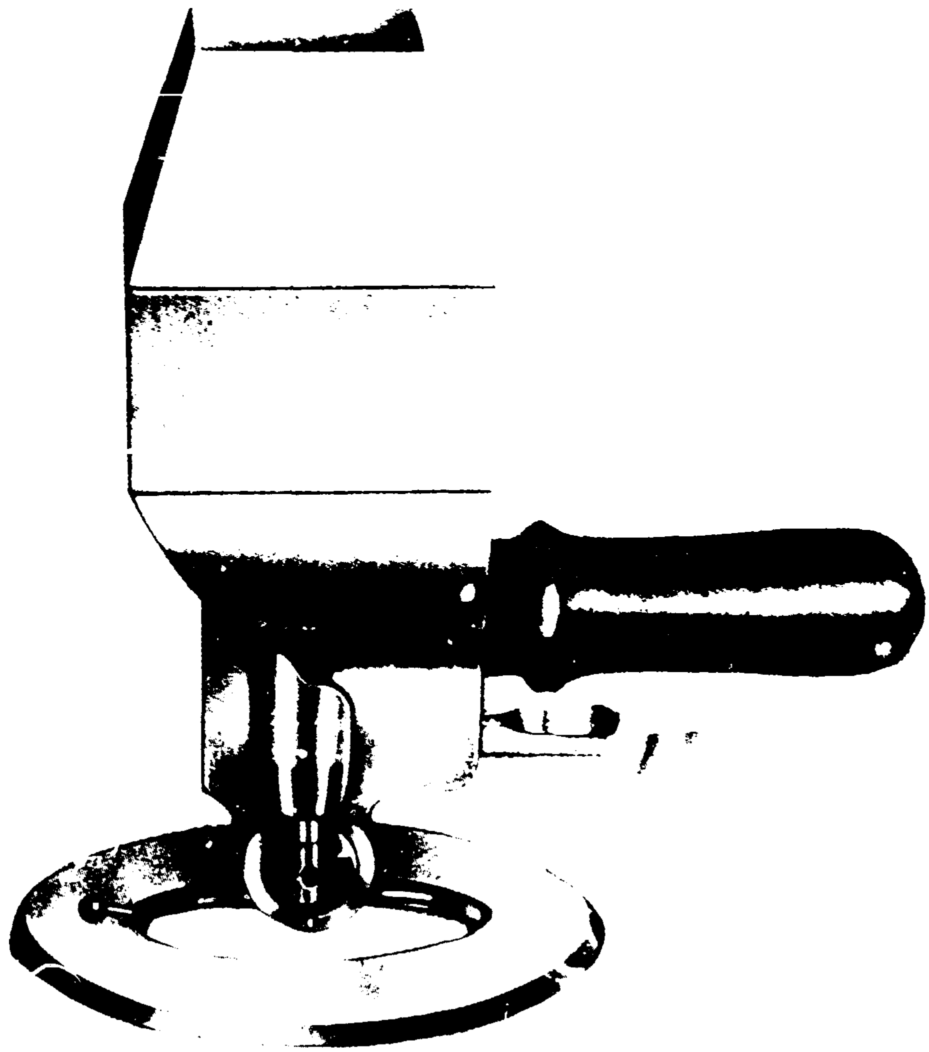


Figure 30. Pattern perforator

Fabric cutting

Hand shears, which may be powered electrically or pneumatically, are normally used for single lay cutting. They are fitted with either 4-, 6-, 8- or 10-sided convex-shaped cutter blades with a spring-loaded counter blade and have built-in grinders for resharpening the blade without removal from the tool. For cutting leather (i.e., hides and skins) a pair of shears with a circular blade is recommended. Base plates are removable for trimming.

Rotary blade, or round-knife, cutting machines (figure 31) are used primarily for making long, straight cuts and are particularly suited for cutting knitted and jersey materials. They are a more sophisticated version of the hand shears described above.

Straight-knife cutting machines (figure 32) are used for multilay cutting and are particularly suited to cutting high lays (11 cm - 20 cm), sharp curves and acute angles. The machines are self-lubricating and in-

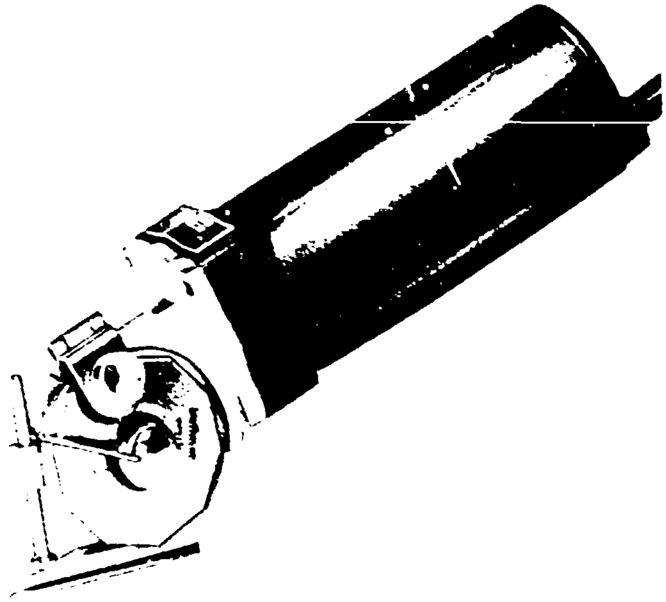


Figure 31. Rotary-blade cutting machine

corporate either abrasive belts or stones for maintaining cutting edges. Cutting blades may be sawtooth, straight or wavy edge, their use depending upon the characteristics of the fabric being cut.

Figure 32. Straight-knife fabric cutter

All machines are fitted with a permanently attached cable, which is not only a good safety factor but also enables easy coupling to a cable suspension system as shown in figure 33.

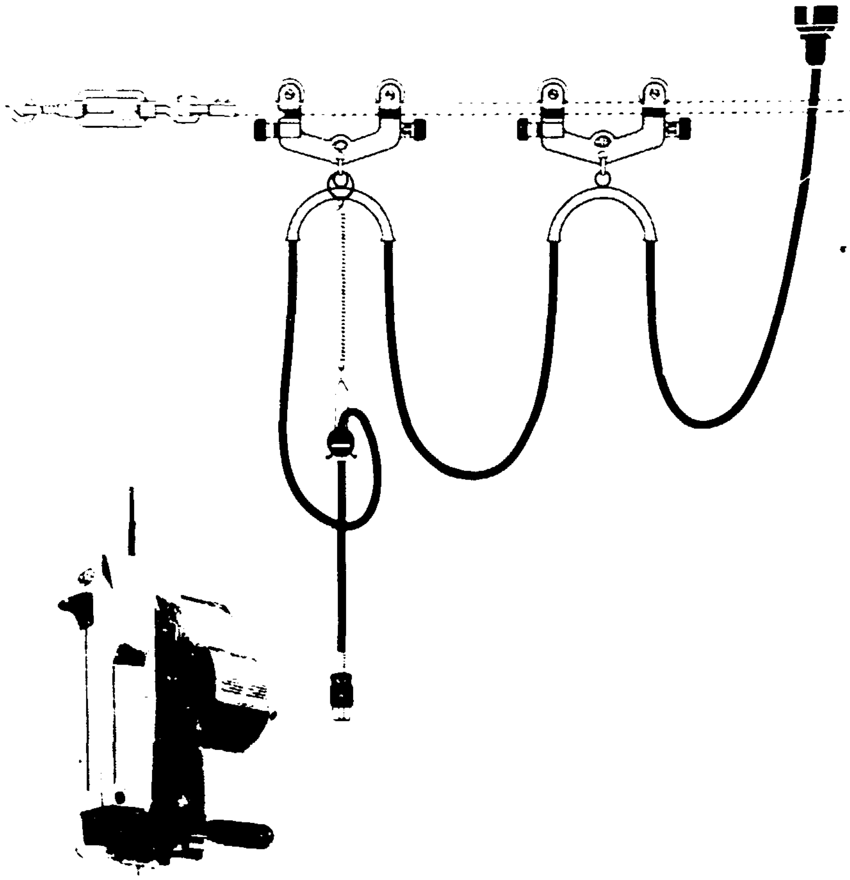


Figure 33. Mobile cable suspension system

Sorting

The objective of sorting is to ensure that materials that have to be sewn are transported to the various sewing stations, while those that are not will be held in a classification centre for subsequent distribution to upholstery assembly. To simplify this procedure and to avoid confusion, especially among the sewers, each layer of fabric should be numbered on the back after cutting; and the same number is then used for each cover part of the same model. This procedure also eliminates variations in the shade of the fabric.

Sewing

The nature of modern upholstery design and the availability of a wide variety of fabrics, cushions and other components have resulted in greater emphasis being placed on cutting and sewing. This has resulted in far higher productivity, since it is much easier and faster to produce than traditional upholstery. An immediate effect has been to increase the ratio of sewing operatives to upholstery assemblers from 4:1 to as high as 1:1 or higher, and this trend is likely to continue as the component nature of the industry develops.

Thus upholstery manufacturers and suppliers of cutting and sewing equipment have developed the technology of this sector of the industry to the stage where it compares favourably with that of its more developed sister, the clothing industry. Indeed, the sewing room has become the focal point and most instrumental department in achieving a wide variety of styles and special characteristics, particularly since such a high proportion of upholstered seating is today made up of loose cushioning in one form or another, all of which must be cut and sewn. Sewing machines and sewing operations therefore play a vital role in achieving quality and productivity.

The upholsterer's sewing machine

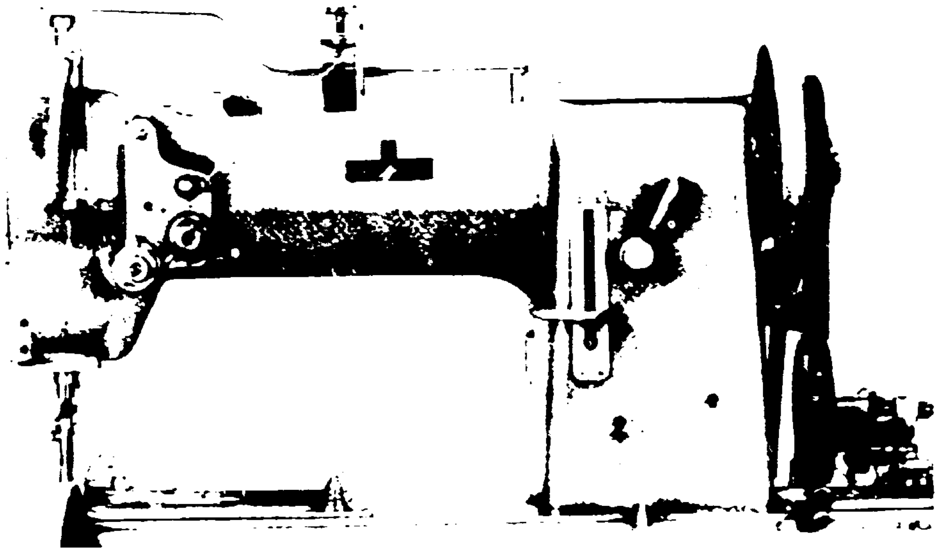
While the quality, durability, adaptability and performance of sewing machines have improved considerably, the basic unit for upholstering is still the single- or double-needle lock-stitch model that uses a needle thread and bobbin thread (figure 34). A loop of the needle thread passes through the material and is interlaced with the bobbin thread. The needle thread is pulled back so that the interlacing comes midway between surfaces of the fabric(s) being sewn. Lock-stitch machines are available as single-needle models and two-needle models. Which types are suitable and economic for a factory will depend on the volume of production, design and styling, the need for versatility and the required level of productivity. The more widely used and important variations of these machines are described below.

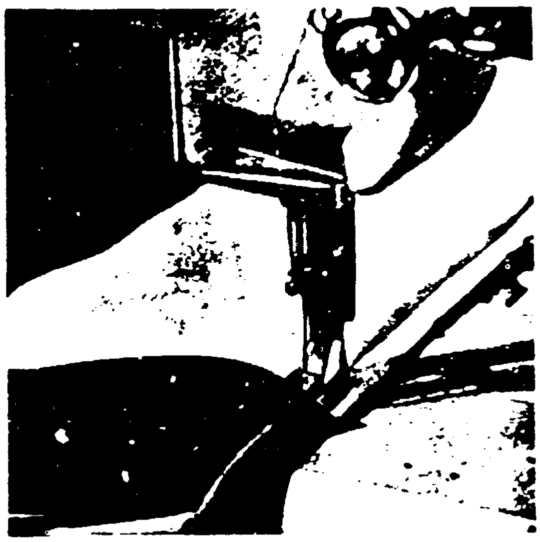
The basic-feed machine employs a mechanism whereby the fabric is fed forward by a bottom feed with the presser foot held against the feed surface by spring pressure. The feeding action takes place only when the needle is clear of the fabric. This machine is suitable for most sewing operations using light- to medium-weight fabrics but has the disadvantage of allowing the fabric to move against the stationary pressure foot, which causes a differential rate of feed between the upper and lower layers of fabric.

A compound-feed machine uses a mechanism whereby the needle passing through the fabric moves forward with the feed ensuring that fabric layers are fed forward uniformly, the basic feed requirement for upholstery work.

A compound-feed machine with alternating presser feet has two presser feet so arranged that they alternate in pressing down upon the work, and actual feed motion is caused by the feed needle and the inner of the two presser feet moving in unison.

A differential-feed machine employs a mechanism that varies the speed of the top and bottom layers relative to each other. A greater front-feed travel gathers the material as it is fed and sewn; a shorter front-feed travel stretches the material as it is fed and sewn. The latest models can engage or disengage the gathering or stretching so that straight-curved-straight seams may be sewn without interruption. Differential-feed machines can be used with special presser feet to gather the bottom of two layers of fabric or to gather a single ply of fabric and attach an ungathered reinforcing tape to the top side. The machine can be set to give the exact amount of gather desired so that accuracy in make-up of the cover assists in fitting to the frame.





Inserting piping

Inserting braid

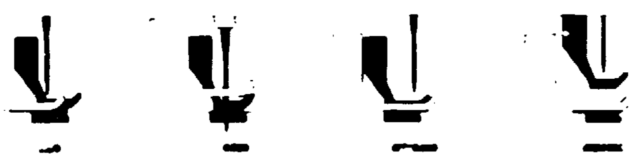


Diagram of upper feed motion

Bobbin sizes

Figure 34. Standard sewing machine for upholstery fabrics

Further refinements include prewound bobbins; high-lift needles and presser feet enabling a greater variety of fabric weights to be accommodated: reverse-feed mechanisms for tacking and seam reinforcement; zip-insertion sewing units that can sew both sides of th zip in one wrinkle-free operation; a double welter that cuts the fabric, forms and sews the welt; cushion-boxing machine with automatic skip-stitch device that simultaneously handles both sides of the band and the welt and can be adjusted to sew band widths from 33 mm to 115 mm and wider; a reverse-feed mechanism that permits stitching backwards and forwards without turning the fabric; a double-needle machine that is fitted with a device to stop one needle in advance of the other to avoid stitching across corners; a unit that does both back-stitch, outline quilting and trapunto; a unit that turns back the stitched seam and applies reinforcing tape in one operation; and cushion-closing machines, either cylinder bed or cup feed to facilitate sewing the edge of the closed cushion.

Sewing needles and their application

The most important consideration in machine sewing is the selection of the most suitable needle. Like upholstery fabrics, needles come in a bewildering variety of designs and functions that must be carefully considered in relation to purpose and suitability for different types of covering materials. The main types are cloth points, which have a round section and sharp tip; ball points also with a round section and ball tip; and cutting points, which come in a variety of sections. For upholstery purposes the cloth point is the most suitable, and most sewing problems in this respect may be overcome through a choice of point styles. The ball-tipped cloth needle, the tip of which is rounded rather than cone shaped, deflects rather than pierces the yarn and prevents pulling or cutting of the fabric. It is available with light, medium or heavy ball at needle point, and normally a medium ball should be used. Leather points are used for stitching leather or other similar materials for which a round pointed needle would not be suitable.

Needles vary not only in respect of shape and function but also in size. A good rule of thumb is to choose the smallest needle consistent with thread and sewing requirements. The blade must be heavy enough to provide the strength necessary to penetrate the fabric without forming too large a hole. It must also be heavy enough to avoid deflection as it enters the fabric. If deflection occurs to any considerable extent, it will not only produce a bad seam, but will also damage the needle as well as the machine. The eye of the needle must accommodate the thickness of thread easily so that during stitching the thread may be drawn freely through the eye and grooves. Conversely, the thread should not be too light so that the needle thread loop cannot be formed correctly.

For most upholstery work, needle sizes 20, 21 and 22 are used, but in any case upholstery manufacturers should consult the sewing machine manufacturers concering their specific needles. It is advisable to submit each new fabric to a sewability test so that the right needle and thread will be used for that particular fabric.

Sewing threads

Just as with needles, equal care should be taken in selecting the most suitable sewing thread. Many types of thread are suitable for upholstery sewing, including cotton, nylon, polyester and combinations of cotton and polyester known as core spuns. Whichever thread is chosen it must fulfill the following requirements:

- Have high tensile strength
- Have good loop formation
- Be resistant to abrasion
- Be heat-resistant
- Be colour-fast
- Be non-inflammable
- Be resistant to fungus and insect attack
- Be resistant to shrinkage
- Be unaffected by dry-cleaning solvents and other chemicals

Monofilament threads, especially those of a cotton polyester blend, are becoming increasingly popular with upholstery manufacturers. As well as having the characteristics already referred to they are also translucent and can blend with every material shade. Thus stocks of coloured thread can be eliminated along with the problem of matching threads in stock with fabric ranges varying in colour, shading and texture from season to season.

Sewing productivity

Sewing productivity is directly related to the time actually spent sewing by the sewing-machine operator as distinct from other activities such as work handling, work positioning at machine, trimming, cutting apart, bobbin changing and rethreading. Thus any measures taken to give more stitching time will obviously increase productivity. They should begin with the layout of each sewing machine or sewing station (figure 35) as it is now called and should take the following into consideration:

- Reduction in operator fatigue
- Provision for good handling arrangements, particularly important when dealing with bulky materials
- Good arrangements for distributing work

Where practicable, cutting and sewing should be carried on in the same area, with both activities grouped according to the nature of the work and the prevailing production system. An allowance of 6 m^2 should be made for each sewing station to include an aisle and access. Since repetitive sewing is monotonous, it has been found helpful to have alternate machines in the line facing in the opposite direction (figure 36); and, since many sewers in cold countries complain of cold feet during the winter, underfloor heating would be an advantage.

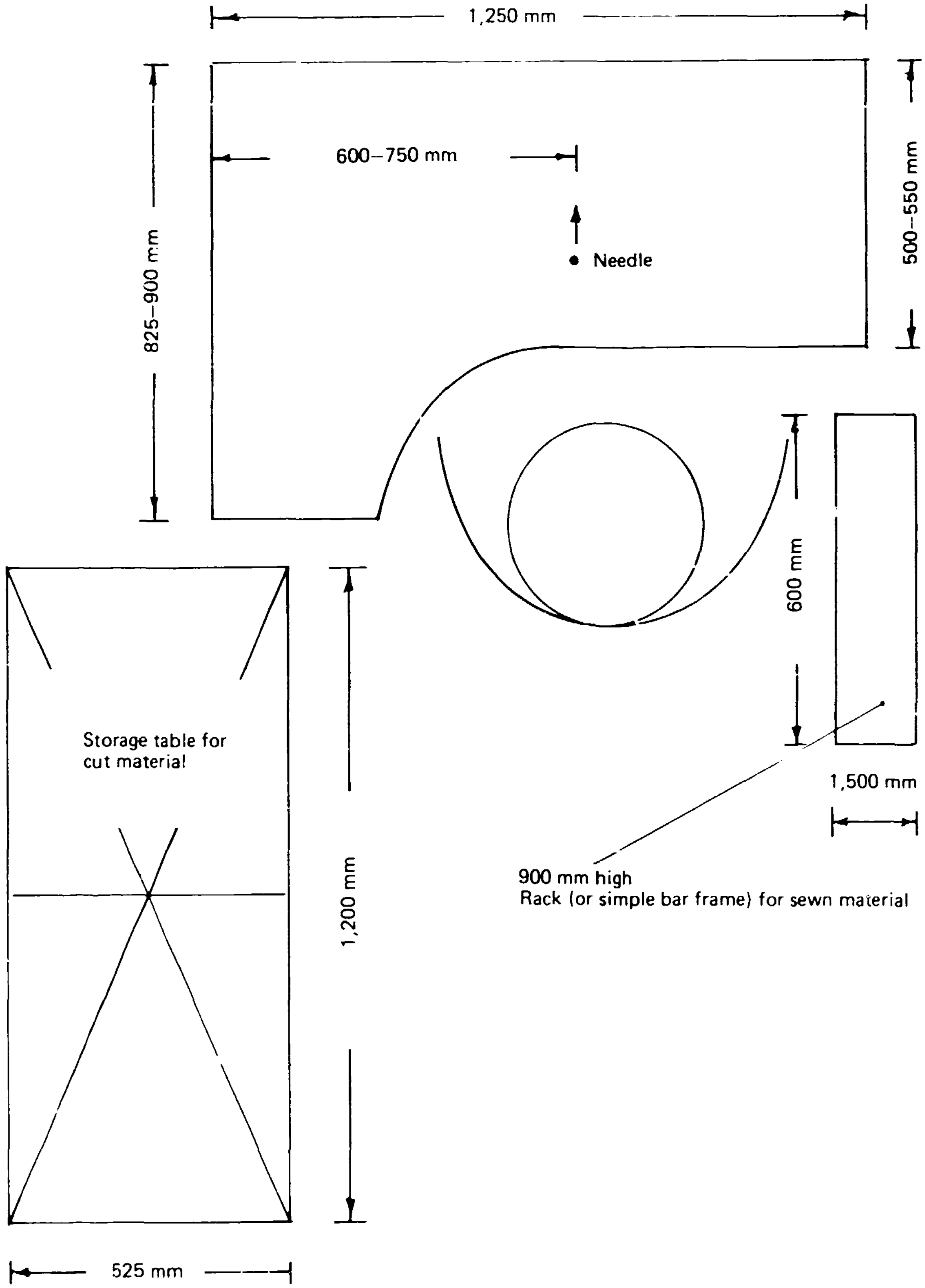


Figure 35. Standard sewing-machine station layout (sewing station)

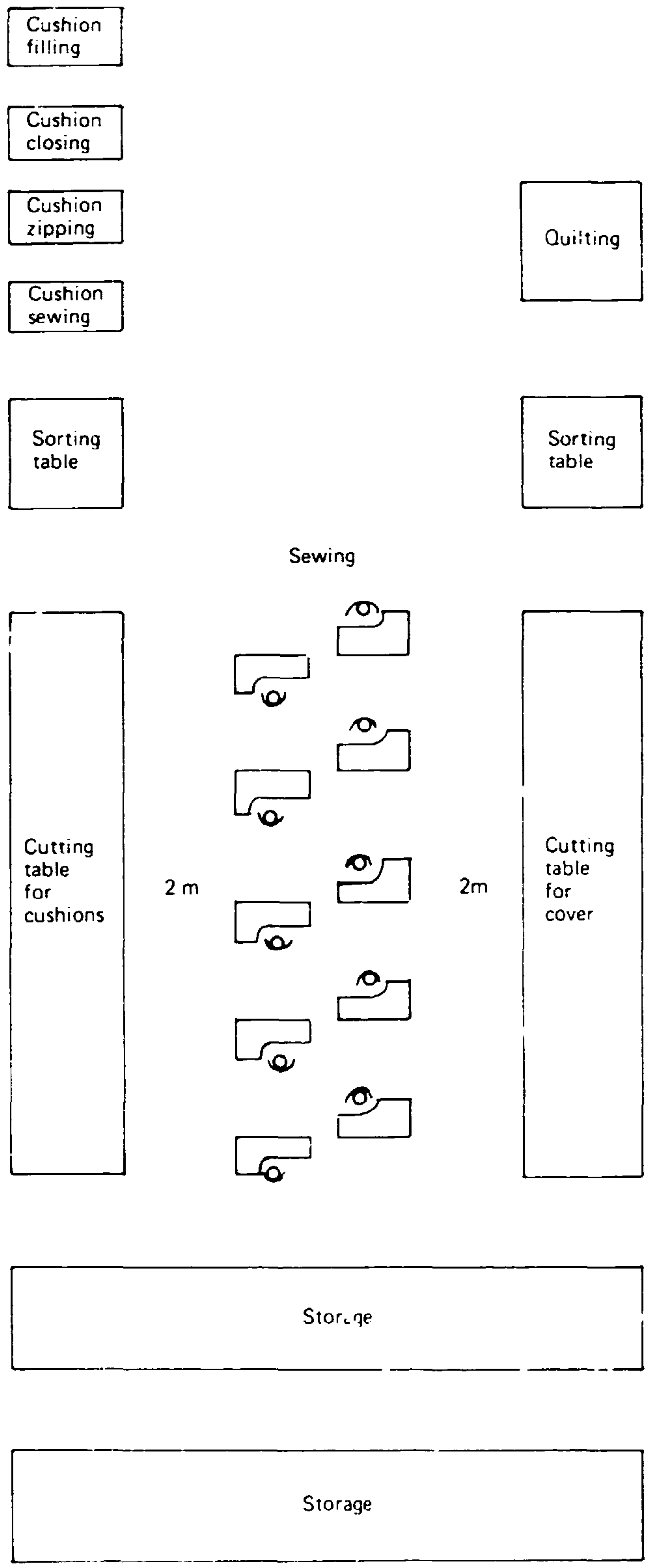


Figure 36. Schematic layout for cutting and sewing department

Sewing-machine maintenance

Since machine sewing contributes in such large measure to modern efficient upholstery production, the importance of maintaining the machines in top order cannot be exaggerated. Maintenance should begin with an appropriate record card detailing the history of each machine, date of purchase, name of supplier or agent, major parts replaced, and dates and causes of breakdowns. Filed with this card should be any literature supplied by the manufacturer - installation and operation instructions, lubrication methods and spares. Correct maintenance will include operator training not only in the use of the machine, but also in how to maintain it. Maintenance also includes regular oiling and for self-lubricating models topping up the oil reservoirs, orderly stocking of minor parts that need frequent replacement such as hooks, loops, screws, needles, bobbins, presser feet and belts to minimize down time.

Most upholstery factories of any size employ at least one full-time sewing-machine technician whose job is to maintain the machines in full working order. It is also an advantage to have additional spare machines available to minimize the effects of machine breakdown.

Quilting and buttoning

Quilting

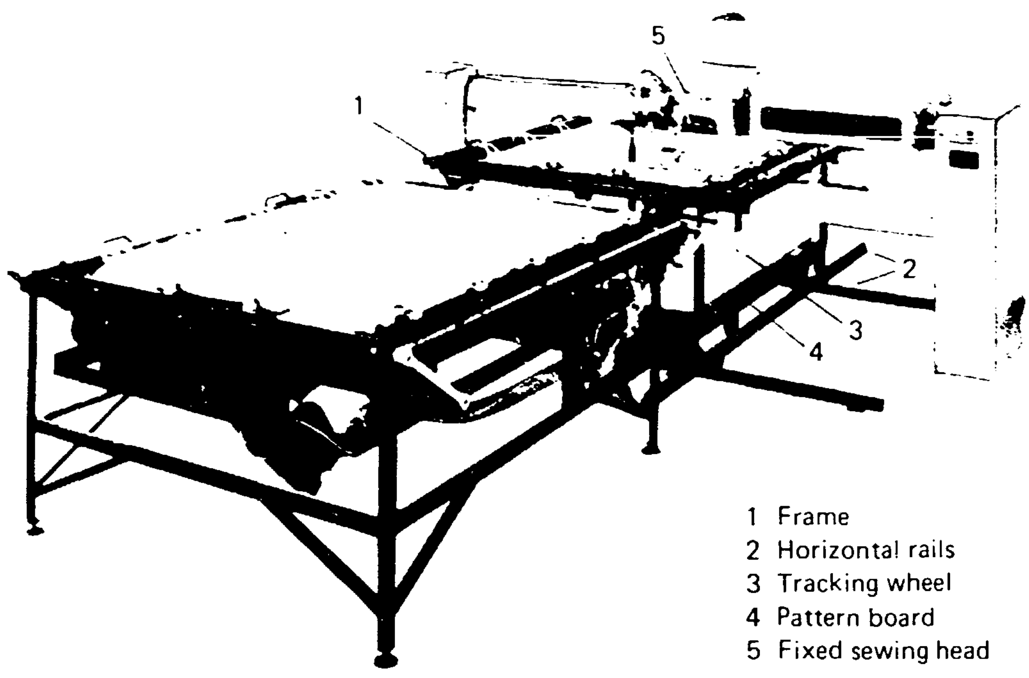
Quilting is a decorative upholstery effect achieved by sewing a continuous pattern on a filled panel of fabric, which not only holds the materials together, but also provides additional geometric designs. The depth of the quilting varies to give a deep or moulded effect, or it may be shallow. The infill between the outer layers of fabric may be wadding or thin urethane foam.

A heavy-duty industrial sewing machine can be used for straightforward fluted quilting, but care must be exercised in selecting the most suitable needle and thread, which must penetrate combinations of cover, filling, and backing cloths up to 50-75 mm in thickness. For larger areas and more complex geometric patterns, a long-arm sewing machine is used. It can be quite satisfactory, provided that the sewing capacity of the machine is adequate and there is sufficient distance from the sewing head to the body of the machine to accommodate the pattern width required.

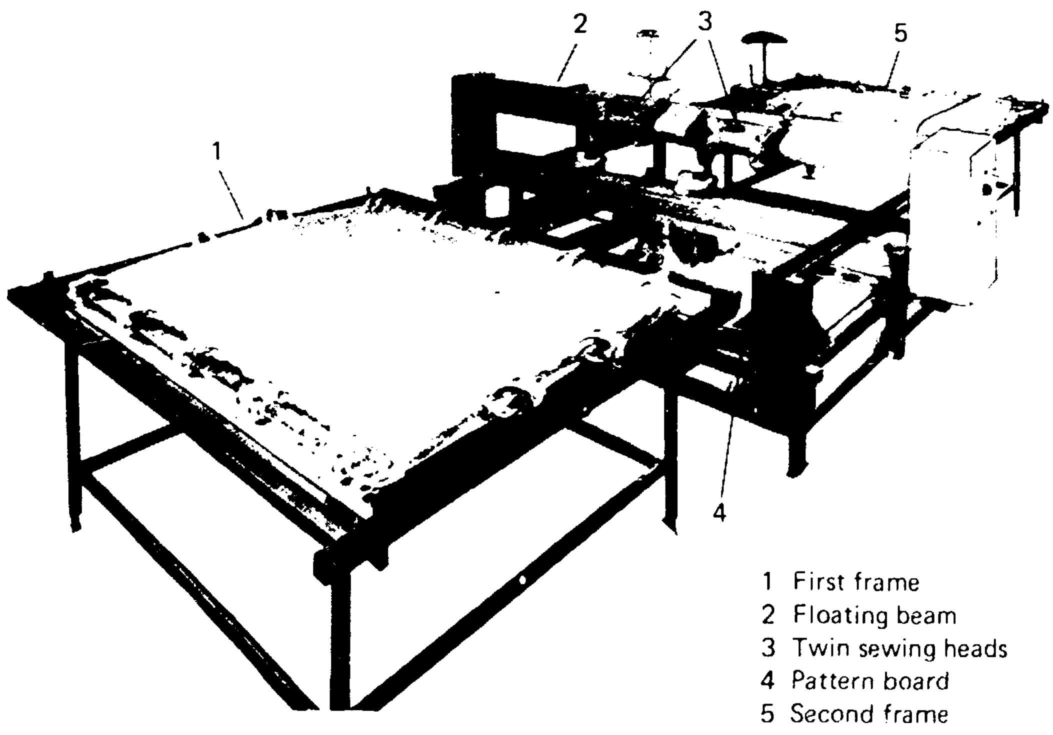
If production volume permits, a quilting machine designed specifically for upholstery may be used. The principal characteristic of this machine is the sewing head, which is mounted on a floating beam and is controllable, in any particular direction by the operator free-hand or by a prerouted pattern board (figure 37). Panels to be stitched are stretched within frames inserted into the machine and remain stationary. The sewing head moves over the material, accurately reproducing the predetermined pattern.

Buttoning

Upholstery buttoning serves a dual purpose: to prevent the interior fillings of cushioning from moving about and to provide an additional decorative feature especially where there is a large area of plain fabric. It is very much a traditional upholstery technique and in the past required a high degree of skill for its application. Nowadays, with less complicated designs and the use of simpler filling materials, buttoning requires far less skill and can be applied with ease to both fixed and loose cushion forms of upholstery.



Single head



Twin head

Figure 37. Quilting machines

Many proprietary types of buttoning (figure 38) are available to the manufacturer, the most important of which are:

Type	Use
Wire plastic loop back	General
Screw type	Removable covers
Snap fastener	Loose cushions
Anchor back	Loose cushions
Prong washer	Fixed upholstery
Cloth-tufted back	General
Stud	Arm and seat fronts

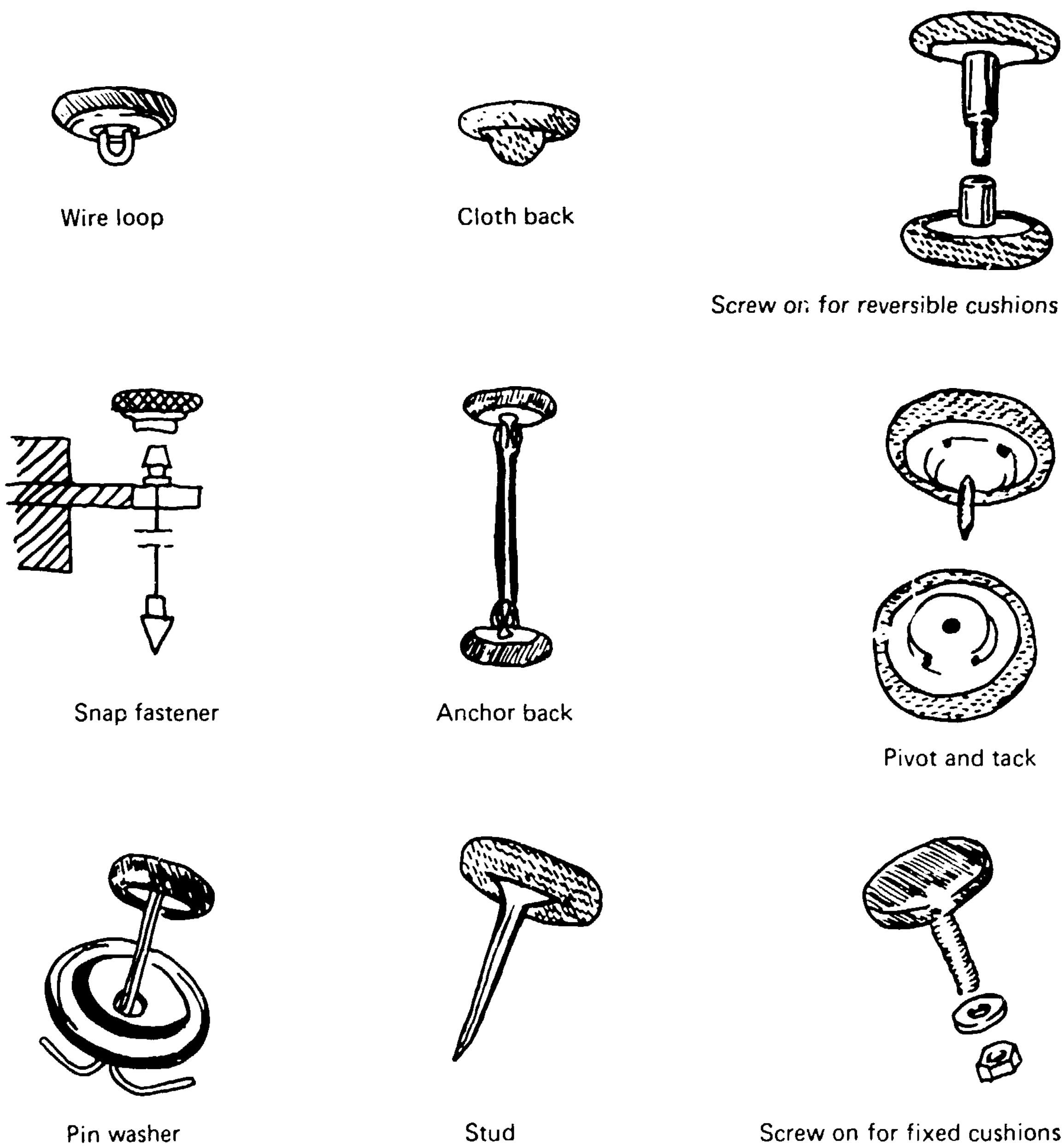


Figure 38. Buttoning systems

The method of linking buttons is very important, since the major causes of button failure are premature severance of the linking material as a result of abrasion, over-tension or an inherent weakness in the material. Commonly used linking includes nylon and terylene twines, pretied loops, chain-links, straps, tapes and fasteners.

Button application

Hand buttoning is still the method used by most manufacturers. The button positions are marked on the outer covering with either chalk or skewers. Using a threaded stitching needle of suitable size, the worker pushes the button through the fabric and cushioning. Two pieces of twine are joined with a slip knot, and a tuft of cloth is inserted between the knot and the inside stuffing to prevent the knot from pulling through when it is tightened. The slip knot is then tightened to the required tension, and care should be taken to ensure that all buttons are kept at the same depth. Reversible cushions can be buttoned in the same manner using one of the proprietary buttons already described.

Buttons may be bought ir already covered, or, as is usually the case, the manufacturer covers the buttons himself with the same or matching material used for upholstering. Simple two-piece dies are used in covering, the button back being placed in one and the cover and button shell in the other. The two are then brought together with the aid of a lever-operated of foot-pedal machine (figure 39). The cloth cover for the button may be punched out on a simple cutting press either manually or mechanically.

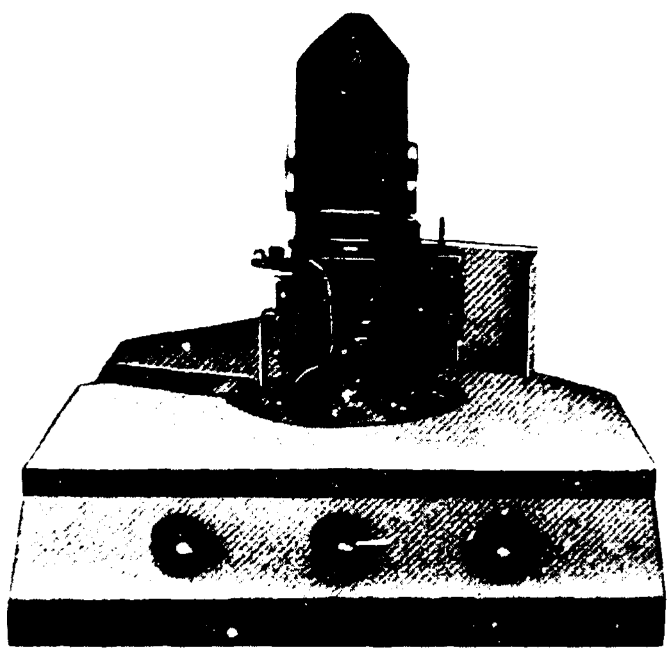


Figure 39. Button-covering machine

Buttoning needles

The most suitable needles for buttoning are straight tufting needles with oval eyes and long tapering points. They should be capable of penetrating the cushioning materials without damaging them or requiring a great effort on the part of the operator. Normally the button supplier provides a needle appropriate to a particular buttoning system. Fibre-fill cushioning requires a bayonet-point needle for easy penetration.

Semi-mechanized buttoning

The simplest method of semi-mechanized buttoning is to use a buttoning jig made from plywood or similar material. A suitable cramping mechanism can be attached, and the cushion compressed, which permits the operator to attach the buttoning without undue difficulty. Many buttoning machines with varying degrees of flexibility in their use are available commercially (figures 40 and 41), and a decision as to which is the most suitable will depend on the design being produced and the degree of mechanization required. Cushions are sometimes available with premoulded holes to accommodate button location and fixing. Polyether cushions may be similarly drilled for buttoning.

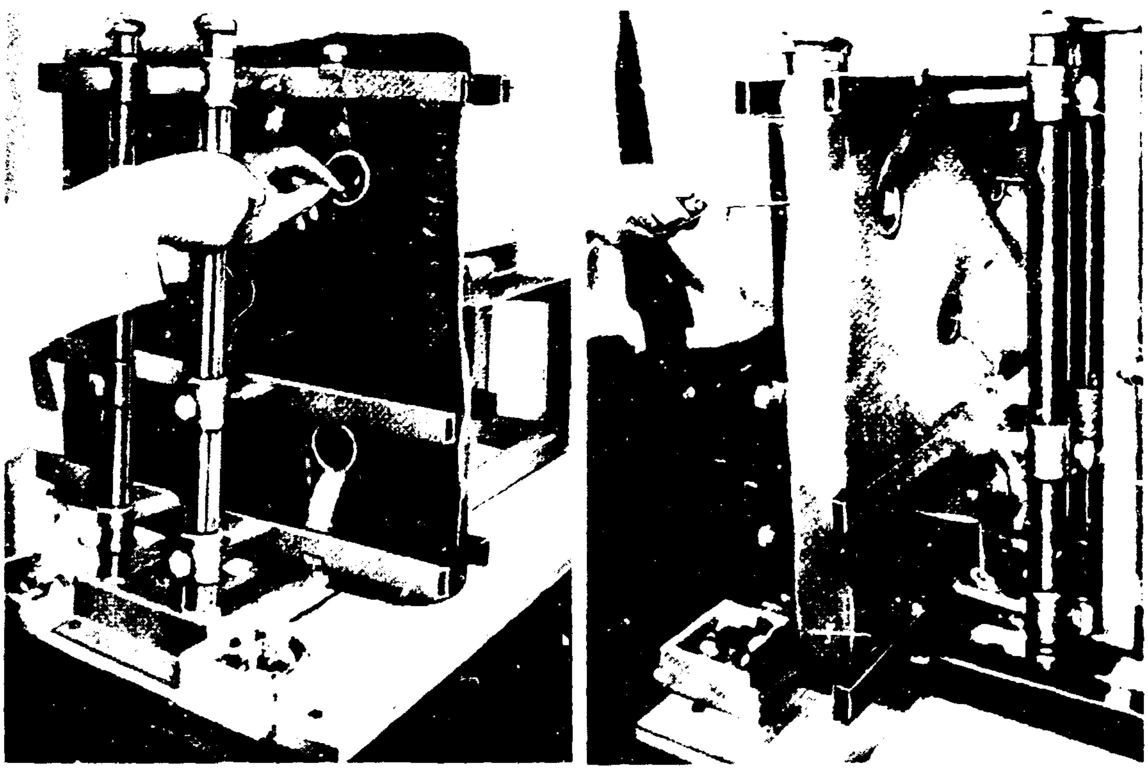


Figure 40. Manual buttoning machine

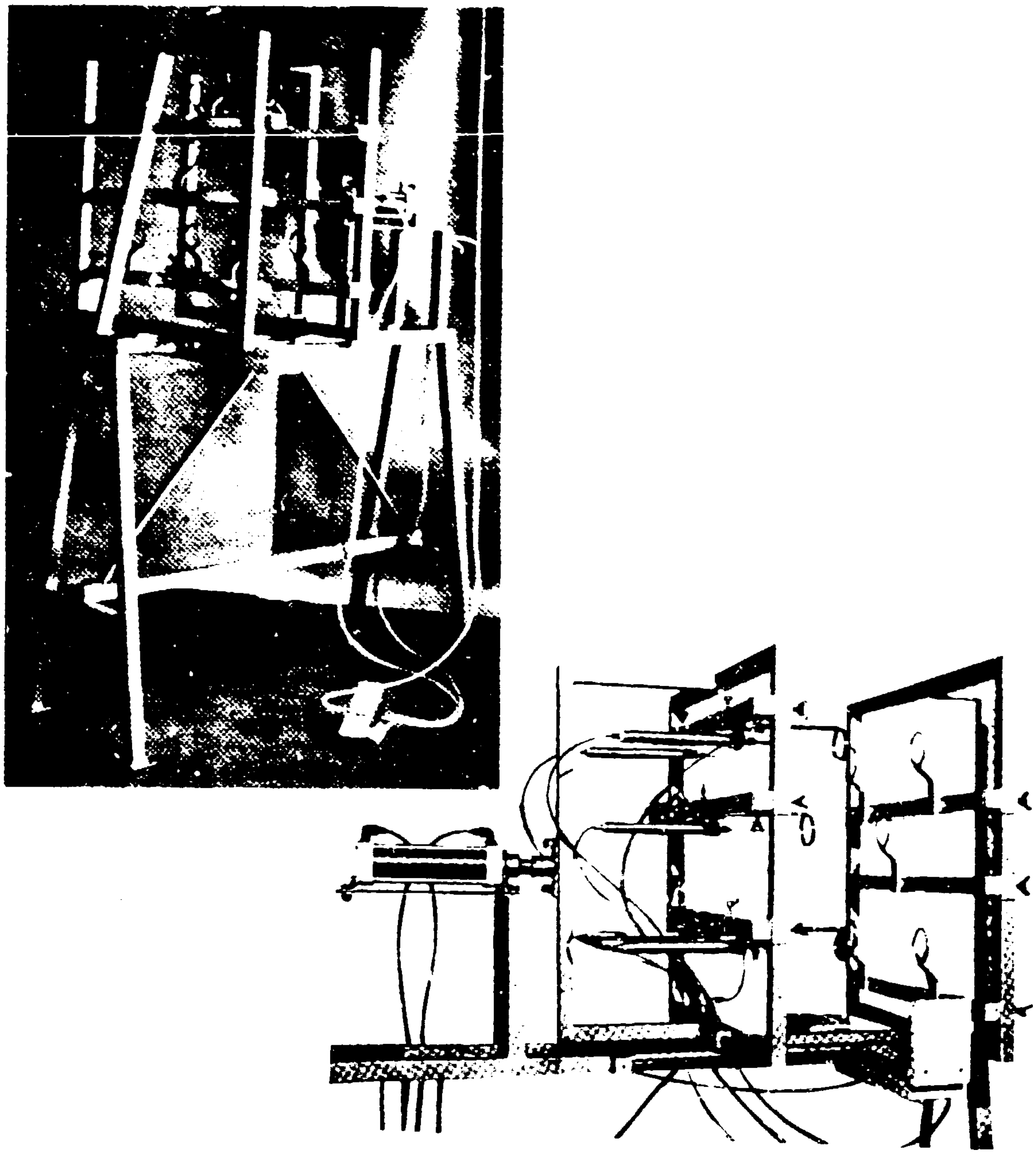


Figure 41. Semi-mechanized buttoning machine

Automatic buttoning

Cushions to be buttoned automatically are positioned between two vertical compression frames, one of which is fitted with adjustable plastic covered cones giving localized compression at the buttoning points. Patented needles each carrying a supply of buttons and loops are individually mounted on horizontal pneumatic pistons. These assemblies can be easily adjusted within the frames to obtain various pattern arrangements and can also be isolated individually. A keyboard enables the operator to select the pattern required, including the isolating of unwanted needles. The machine is open-sided and allows for the progress of any length of cushioning.

Upholstery assembly

Tools

For the small upholstery manufacturer using mainly manual methods of production, the tools of his trade have changed little over the years. They include:

Magnetic tacking hammer, now being replaced by pneumatic or electrically operated staple gun

Metal measuring tape

Pincers and staple extractor

Mallet and ripping chisel

Webbing stretcher

Upholstery bench or frame trestles

Regulators, skewers, straight and circular needles

Even in upholstery factories producing modern simplified designs where the volume of production required is sufficient to justify a more mechanized approach product n is still highly labour intensive, with the frames, cushioning and c ering being processed independently of each other and brought together at the final upholstery or assembly stage. In the circumstances most effort has been concentrated on improving assembly, introducing a wide variety of proprietary materials to replace traditional manual processes and improving handling methods.

Upholsterer's work bench

Although the traditional upholsterer's trestle (figure 42) is being replaced by a work bench more suited to modern upholstery production, it still has its uses, especially for reupholstering and repairing of traditional designs. A good working height is about 700 mm and size of its top, 750 mm by 200 mm. The top should be padded to prevent damaging the frame. The upholsterer's work bench (figure 43) can incorporate storage for tools, staples etc. It also should have protective padding on the top surface.

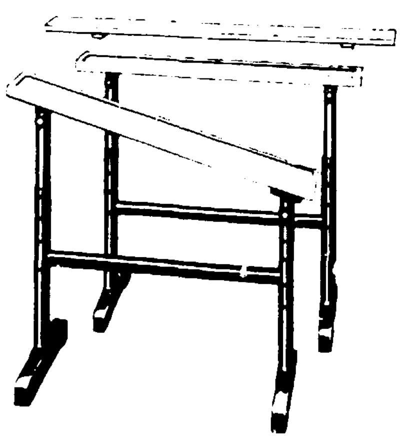
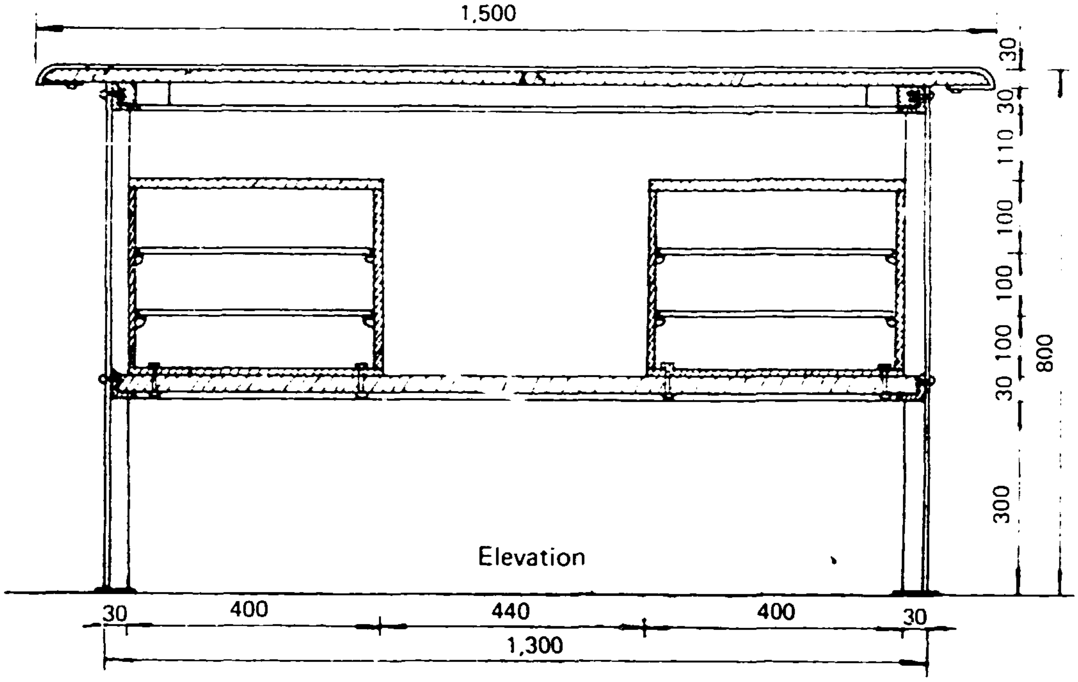


Figure 42. Upholsterer's trestles



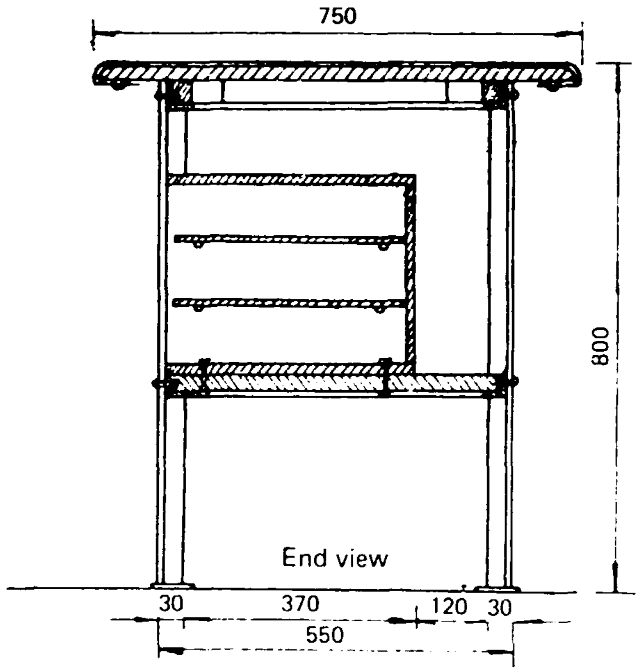


Figure 43. Upholsterer's work bench (dimensions in mm)

Work holders

The work holder (figure 44) serves as a replacement for the upholsterer's work bench. It incorporates a vertical column with a universal ball-and-socket joint and holding fixture into which the frame to be upholstered is clamped by a suction holder or pneumatic clamp. The frame is accessible from all sides, and the upholsterer has both hands free and can operate from an upright position. The work holder can be adapted to suit most frames and subassemblies.

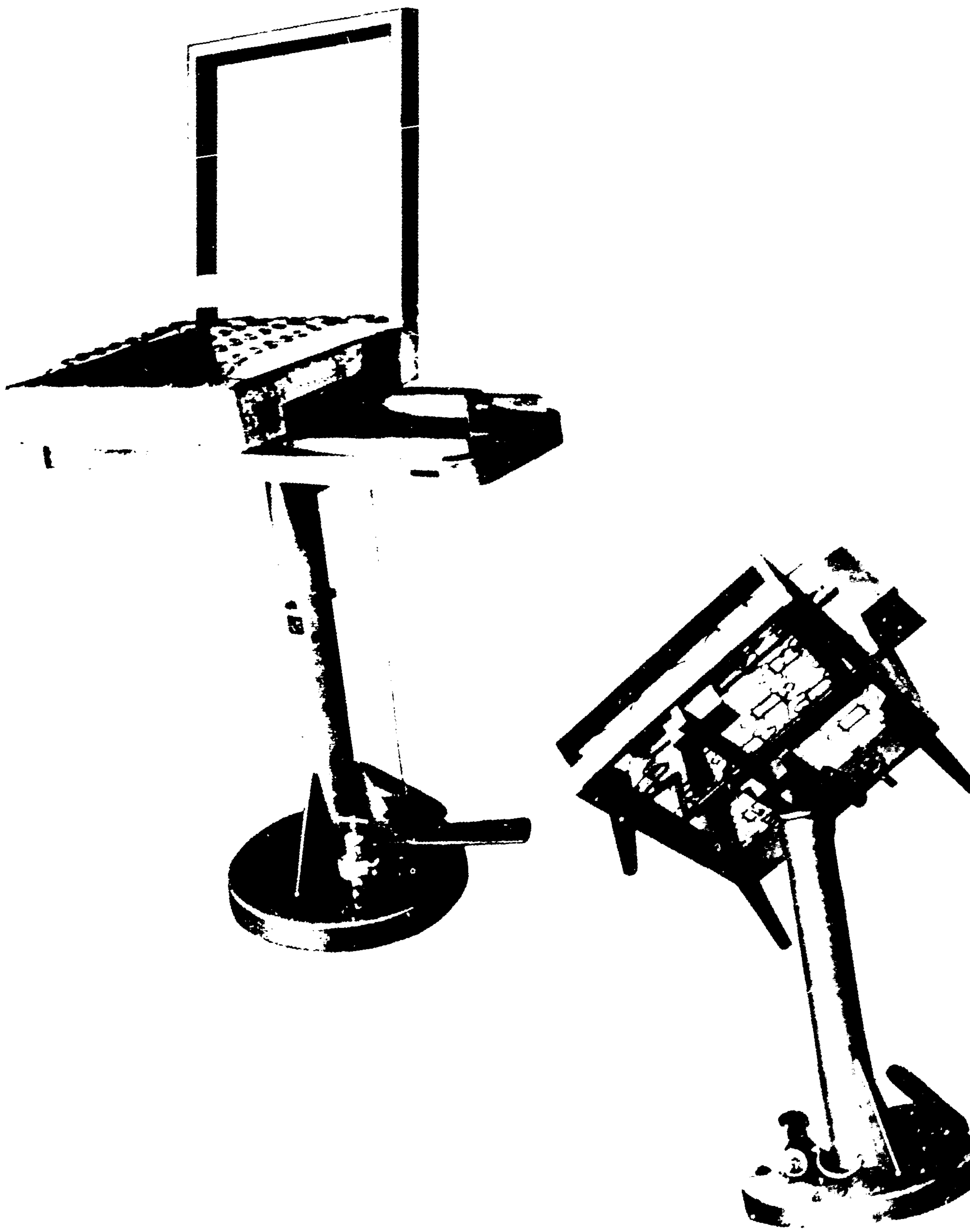


Figure 44. Upholstery work holder

Work press

The most widely used work press is the loose-seat press to upholster loose seats of dining chairs (figure 45). The press consists of a jig to hold the frame and a pneumatic ram to compress the cushioning.

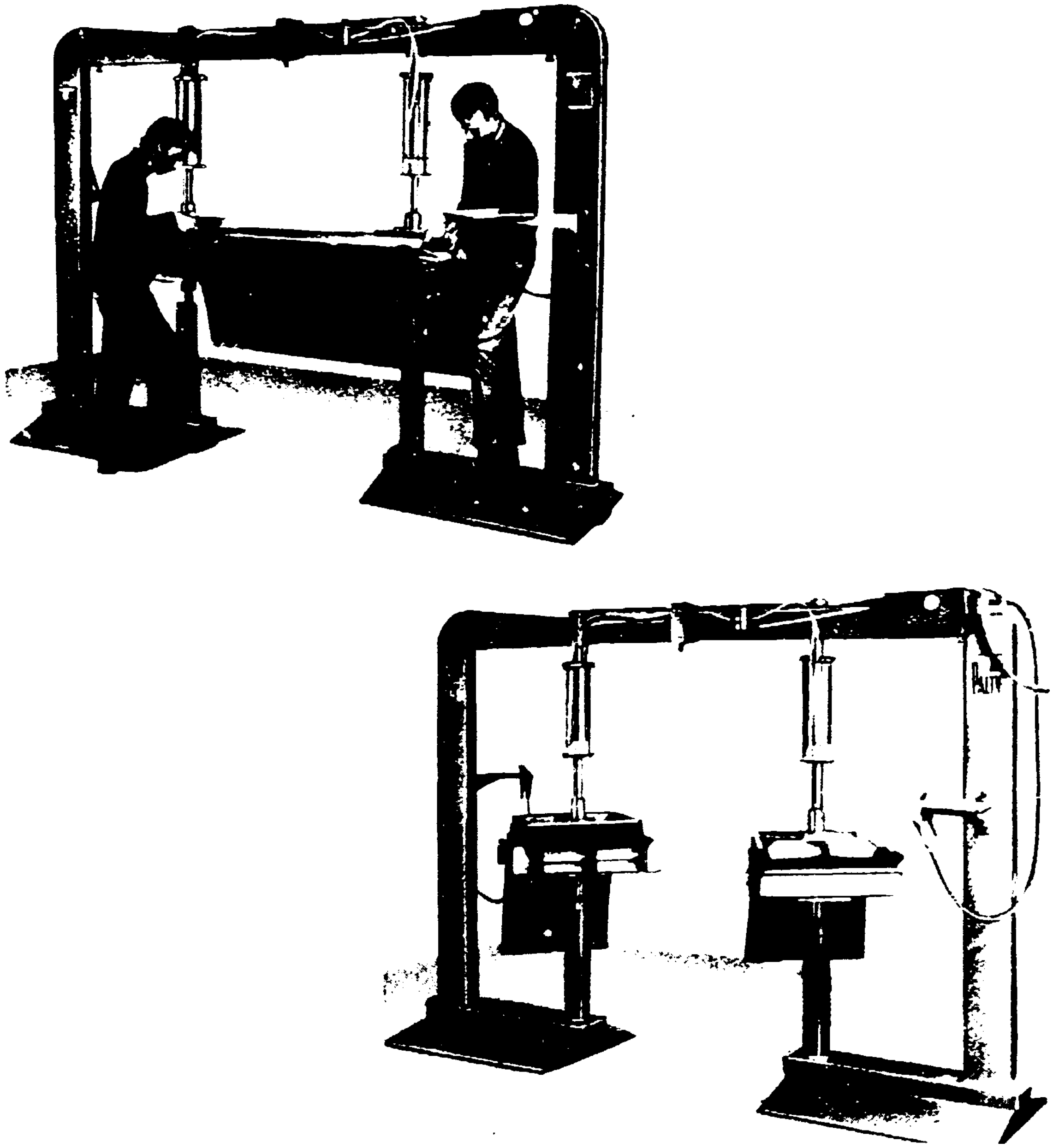


Figure 45. Loose seat press

The cover is placed upside down in the jig followed by the cushioning and the seat frame, already webbed. The ram compresses the cushioning to the seat frame, and the cover is then drawn over the seat frame and stapled. This type of press may also be used for seats and backs of sectionalized upholstery such as armchairs, settees, and studio couches which are subsequently assembled. The tables for this process can be mounted on castors so that preparatory work may be done independently of the press, thus improving throughput for this operation.

Multiple assembly press

The multiple assembly press (figure 46) can cope with a variety of processes without having to move the seating to different assembly stations. These processes include frame assembly, springing up, upholstering of seats and backs, fixing of arm rests to frame, sewing or stapling outside back and bottom and fixing castors and other fittings.

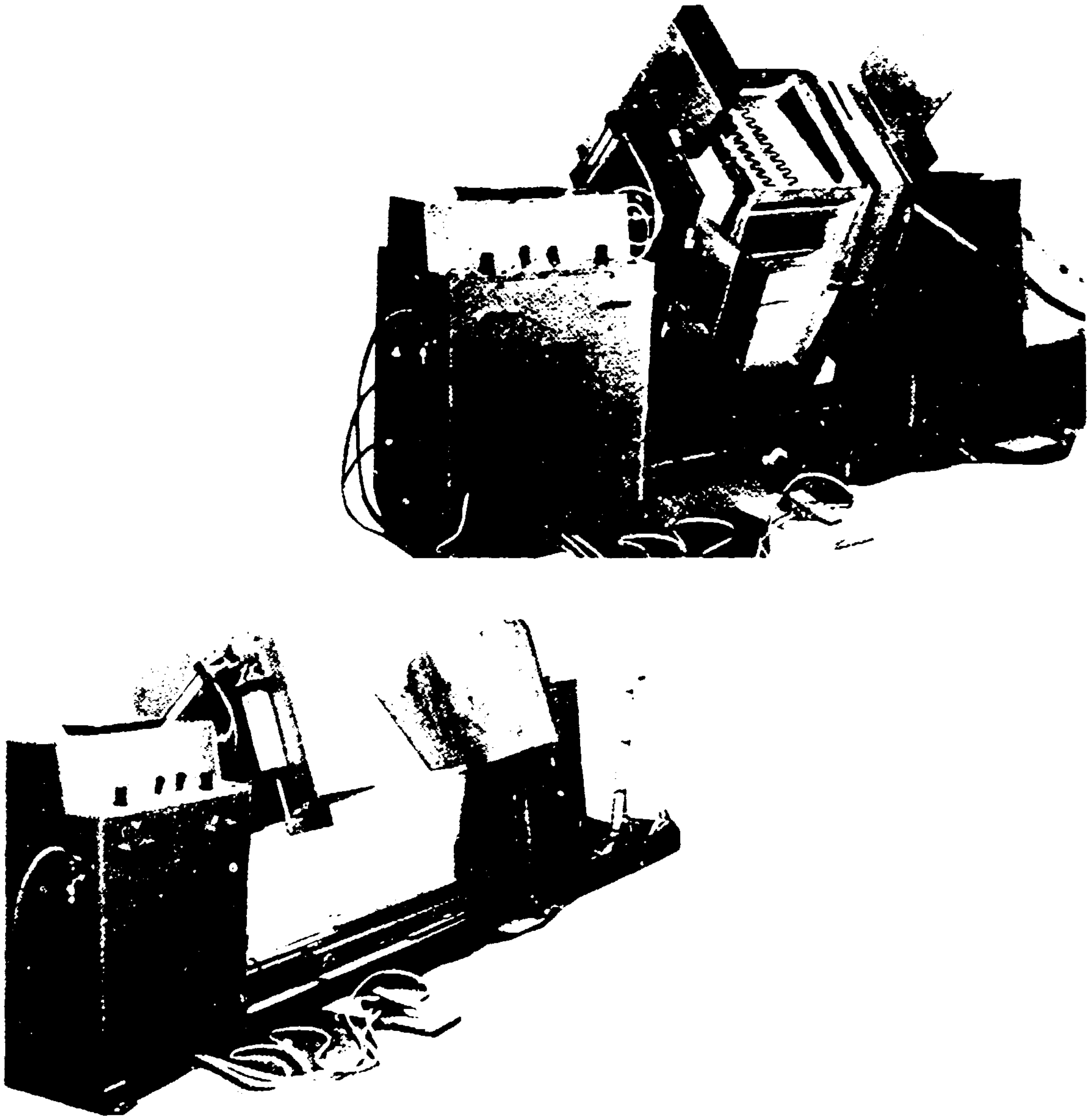


Figure 46. Multiple assembly press

Cushion-filling machine

The cushion-filling machine (figure 47) compresses the cushioning materials in a box that is subsequently fed at intervals into the presewn cushion cover so that it is properly adjusted before the box is withdrawn and the cushion can be zipped closed. This machine is particularly suitable for fibre-filled cushions.

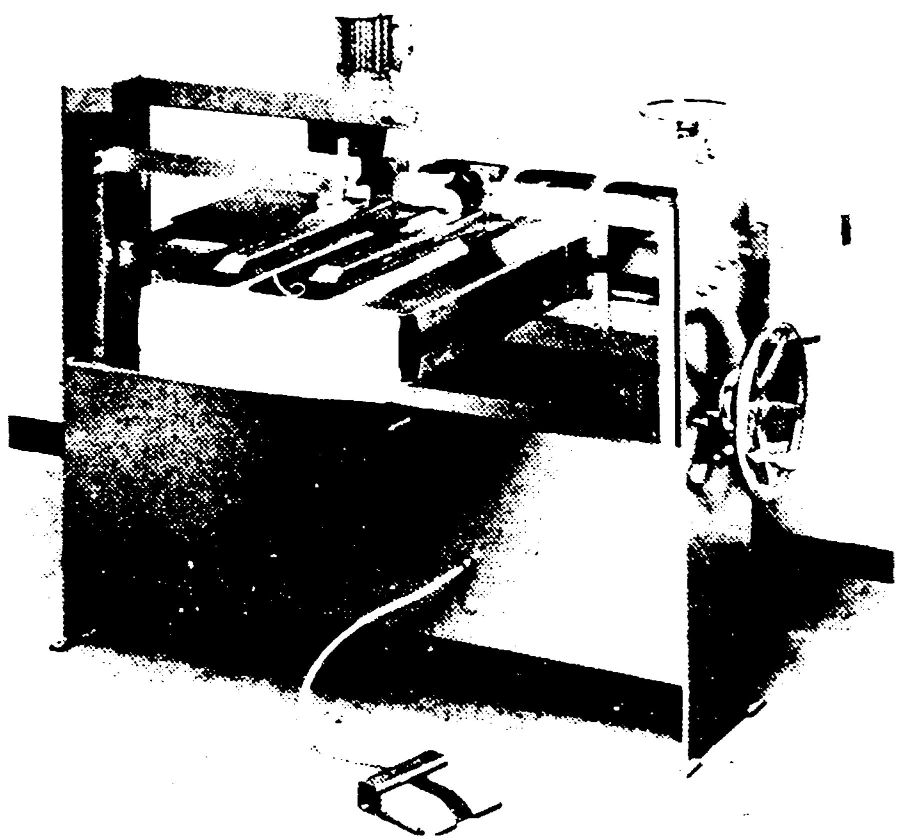


Figure 47. Cushion-filling machine

Cushion closing

When zip fastening is not used in cushioning, the cushion may be closed by hand stitching or by using a cup feed sewing head, which is a special proprietary type of mechanism that enables filled cushion covers to be closed without difficulty.

Blind-seam profiling

..ind-seam profiling is a proprietary method of treating edges and seams on a variety of upholstery styles without the use of elaborate sewing and seam-making techniques. It consists of a range of plastic profiles of different contours and with varying application, which are stapled through the covering material or to the frame (figure 48). The profiles may also be pre-sewn into the cover, but require a special sewing attachment. This technique simplifies production methods and cuts costs. When tacking the profiles it is important to use a tacker with a slender guide body (i.e., where the staple is ejected). This helps to press the material between the beadings, so that after stapling the profile can collapse inwardly to trap and grip the fabric as well as hide the staple crowns. Profiles can be used to considerable effect for all shaped or rounded parts such as arm rests, wings, panels and backs.

Upholstery of moulded chair shells

One of the advantages of upholstering moulded polystyrene and polyurethane chair shells is that fixing points for upholstery components such as webbing, quilting and buttoning may be incorporated into the shell at the moulding stage, thus making the subsequent upholstering comparatively simple. In addition, the smooth roundness of most models means that the outer cover may be presewn to conform accurately to the shape of the shell. Normally the seat is made up separately and is then fixed to the shell so that the method of fixing is not readily apparent. For outside arms and backs a thin sheet of foam is glued to the shell. Inside arms may be finished in a similar fashion, but the seat and back are usually provided with a heavier cushion. The presewn cover is drawn over the foam-covered shell and fastened to its base using staples or chair string (i.e., lacing the fabric on the under part of the shell using string) as in the case of removable covers. Seats and backs may also be fitted with loose, reversible cushions. Seating manufactured from flexible urethane foam is usually covered in a presewn fabric incorporating zip fasteners that enable the cover to be removed for cleaning.

Bonding of urethane foam

Bonding of urethane foam is achieved with a high-strength, fast-setting foam adhesive that bonds within about 30 seconds after the adhesive has been sprayed on. It may be used to bond foam to foam (e.g., for constituted cushions) or foam to particle board, plywood and metal. Because of its fast-setting properties, cushions and other assemblies may be handled almost immediately.

The adhesive is applied with inexpensive low-pressure spray equipment and provides soft, invisible glue lines with good resistance to water and heat. It is usually supplied in an easily distinguishable colour so that it is clearly visible when sprayed on the foam.

Materials handling

The bulky nature of the materials used in upholstery production means that good materials handling arrangements not only between individual work stations in one department, but also between various departments, are important. In addition to reducing handling times, good arrangements will also improve housekeeping standards and reduce wastage of valuable materials. An added advantage is the facility they provide especially to female workers (cutters and sewers) in handling very heavy rolls of upholstery fabrics.

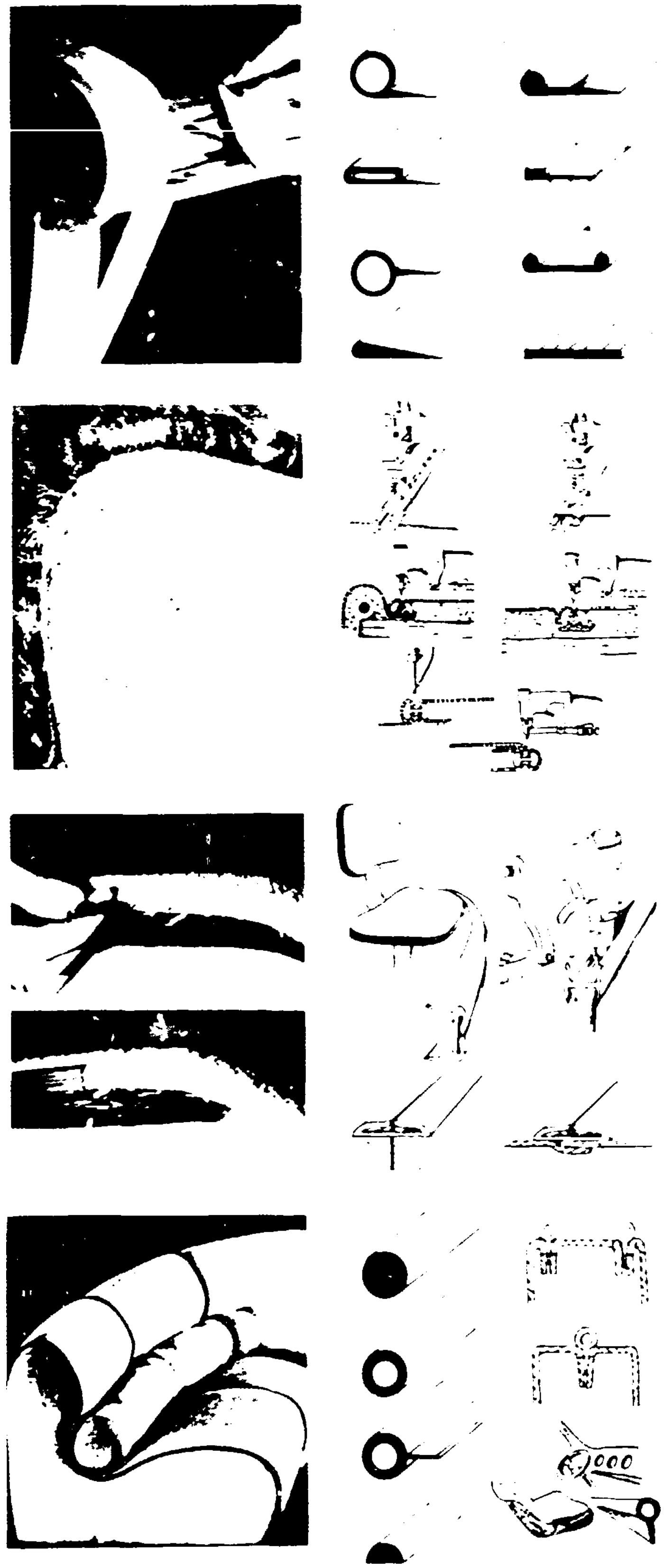


Figure 48. Examples of blind-seam profiling

Few factories are large enough to accommodate automatic or even semi-automatic conveyor systems, but most could introduce a manually operated mobile transport system with advantage. Such a system must be designed specially to fulfill a particular function, e.g., the storage and transport of rolls of covering fabric, upholstery frames, springing, cushioning and completed units. Figure 49 shows a type of trolley that would be suitable for this purpose.

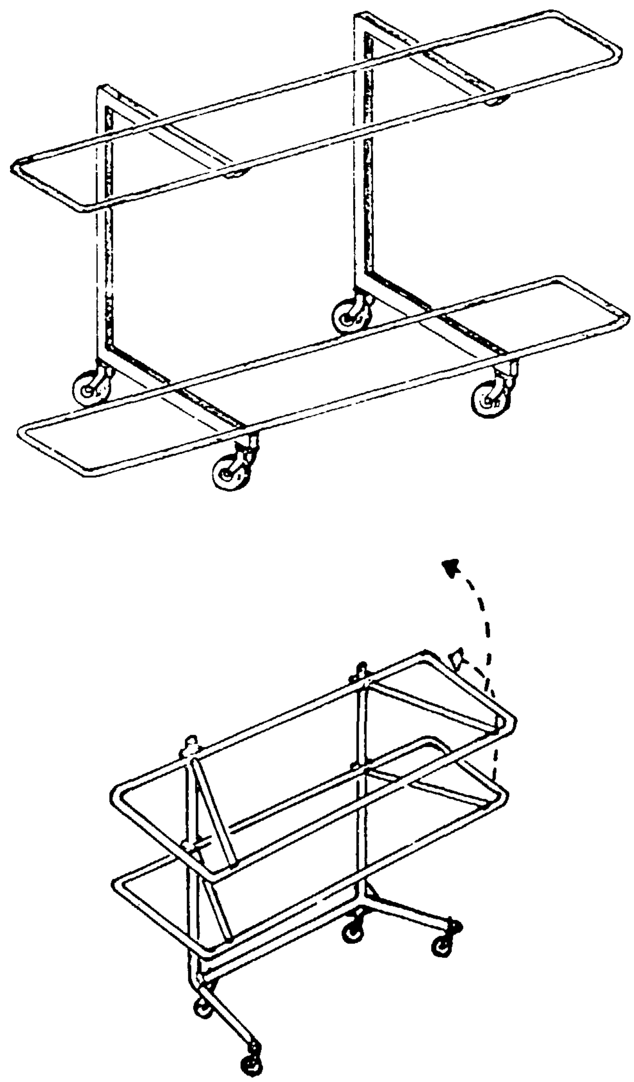


Figure 49. Mobile transport for finished upholstery frames

V. Factory design and management

Factory planning and layout

Even though most types of building are suitable for upholstery production, in planning new enterprises or reorganizing existing ones it is important to take into account from the outset factors affecting growth and technological development.

Those factors may be summarized as follows:

(a) Market potential of the product as indicated by a thorough analysis;

(b) Changes that may occur in design, structure and materials utilization of the product;

(c) High production rates that may be achieved through optimum use of up-to-date machinery, equipment and techniques;

(d) High levels of productivity per worker that may be achieved through better factory organization and production planning and control systems.

Among the most significant changes that have occurred in the modern upholstery industry has been the growth in space required for manufacturing purposes. In many instances it has trebled; while production space has increased at the rate of 20 per cent, storage areas both for work in progress and for finished goods have increased fourfold. This is because the degree of mechanization currently in use and more standardized designs have made it necessary to set much higher limits for storage of processed components and raw materials. This in turn has made additional space for production planning and control, internal transport, organization and administration necessary.

With regard to building disposal and layout to achieve optimum production efficiency, a building module of 7.5 metres has been found to be advantageous. Many types of building layouts have been tried, including E, F, and H types, but the U type of building, with two long parallel halls connected to one another at one end, making the whole production line in the factory a complete circuit, has been found to be the ideal shape. Figure 50 shows the layout of a typical factory using a U layout and indicates how it can be expanded until the entire site is utilized.

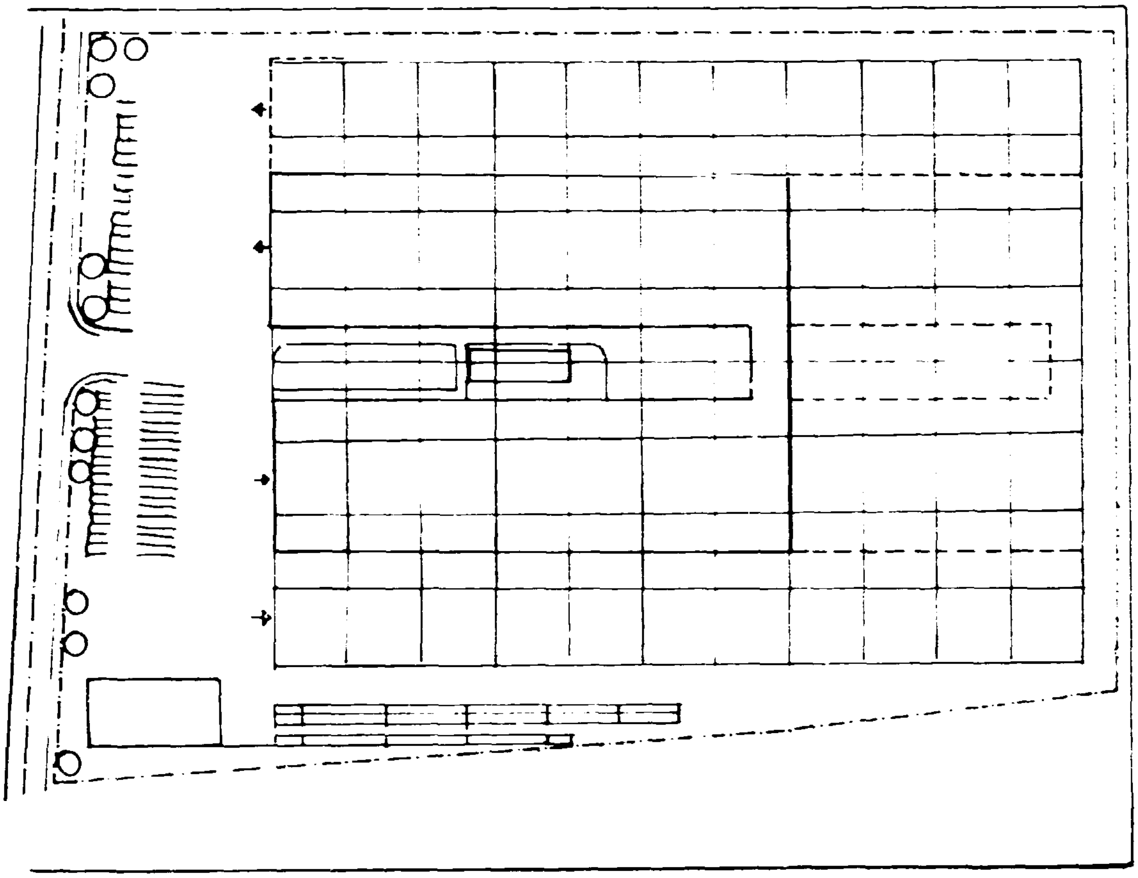


Figure 50. Factory plan using U layout and showing stages of growth

The production flow is interrupted only when the material is fed in and at the point of dispatch. This layout has the following advantages:

(a) Extension is possible on three sides;

(b) Each production, storage or control area, although independent, can be expanded;

(c) Raw materials supply and dispatch can be located on one side;

(d) The inner yard is a fire lane;

(e) Building costs are lower;

(f) The main and auxiliary services are centrally located.

The main building, which determines the future building needs of the enterprise, should be considered to have a 20-year life. Subsequently, department layout and work flow are produced in block form according to manufacturing requirements and a logical sequence of operations. The criteria that apply in respect of storage and manufacturing activities are determined by the range and volume of models produced.

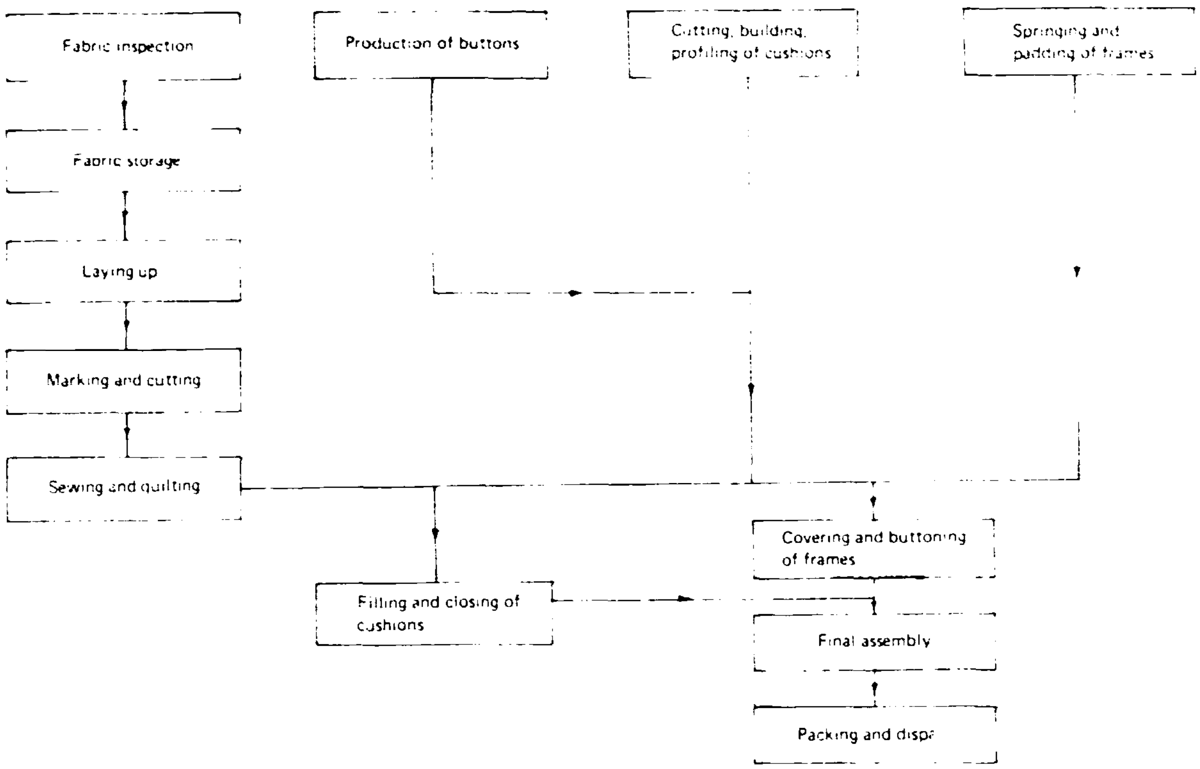


Figure 51. Flow process chart for upholstery production

Sequence or work flow

Figure 51 gives a flow chart for the sequence of operations in upholstery production. The various work centres, intermediate storage areas and flow of work are as follows:

Storage and cutting

Storage and cutting of jute materials

Fixing of serpentine and "no-sag" springing and resilient webbing

Fixing of cardboard on frames (stapling)

Foam padding glued to frames

Frame assembly for suites

Intermediate storage for assembled frames

Frame assembly for studio couches

Fixing jute to springs

Fixing coil spring units on studio couch frames

Cutting of small foam shapes (figure 52)

Vertical foam cutting (figure 53)

Horizontal foam cutting (figure 54)

Cushion profiling (figures 55 - 58)

Foam granulation (figure 59)

Intermediate storage for foam elements

Cushion filling and closing

Intermediate storage for filled cushions

Cotton storage

Fabric storage

Cutting cotton and covering fabrics

Cover sewing

Quilting

Control, collection, intermediate storage, distribution area for all elements and components

Covering of arms and small components

Covering of studio couches

Armchair assembly

Couches assembly

Packing

Dispatch

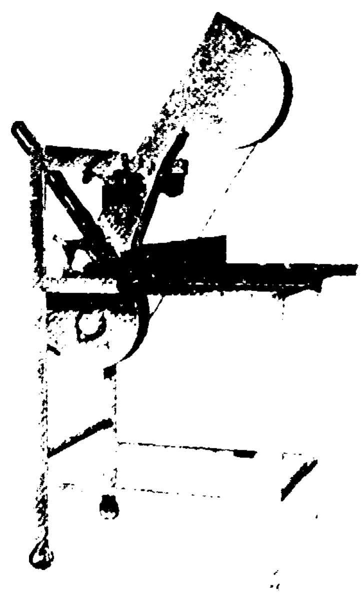


Figure 52. Cutter for small foam shapes

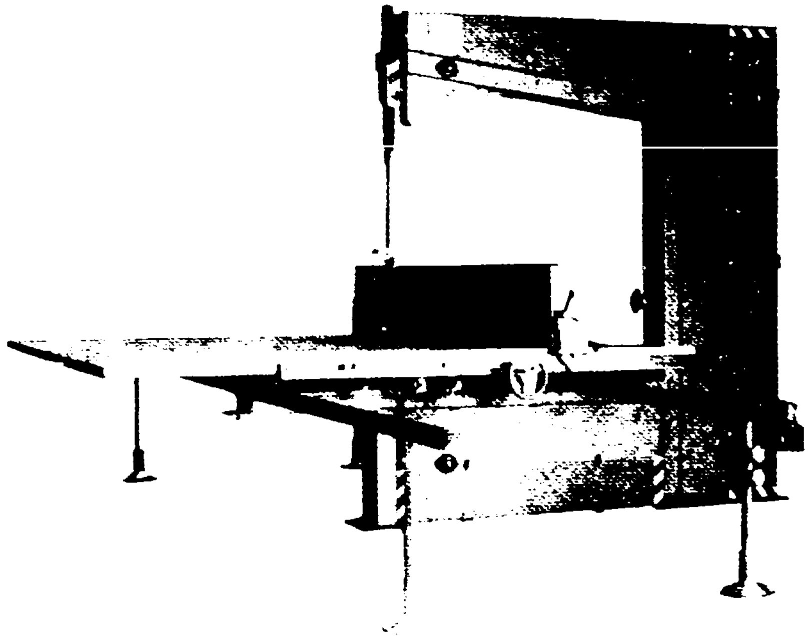


Figure 53. Vertical foam-cutting machine

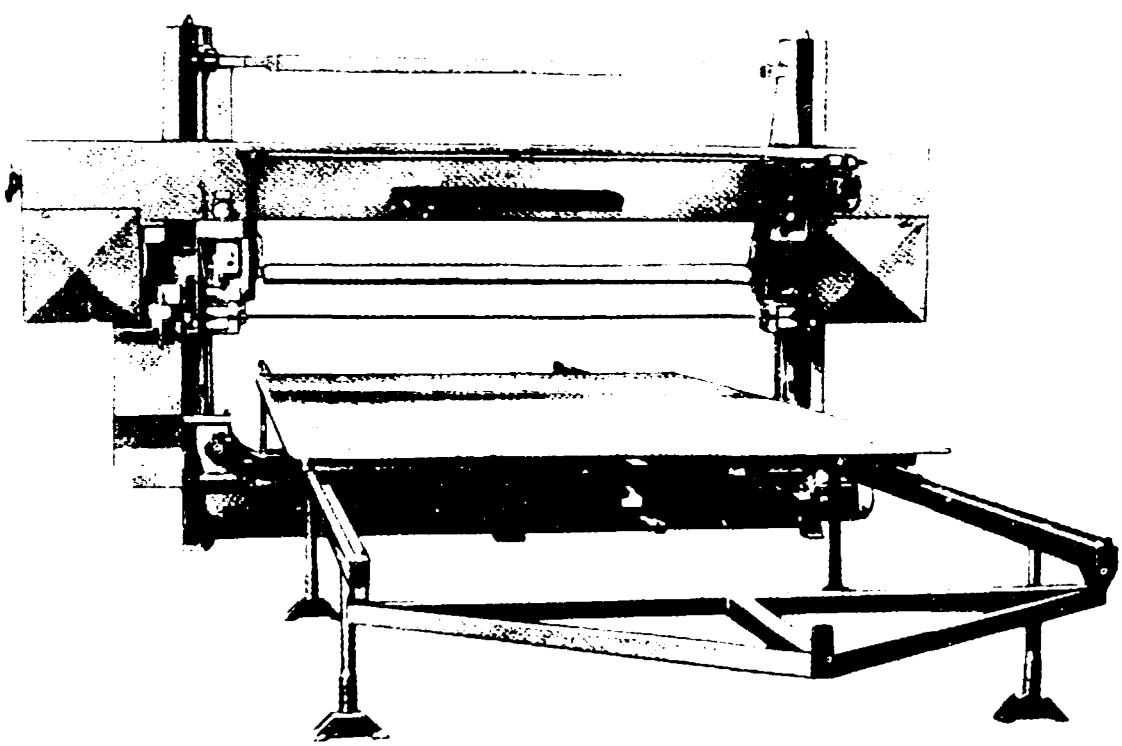
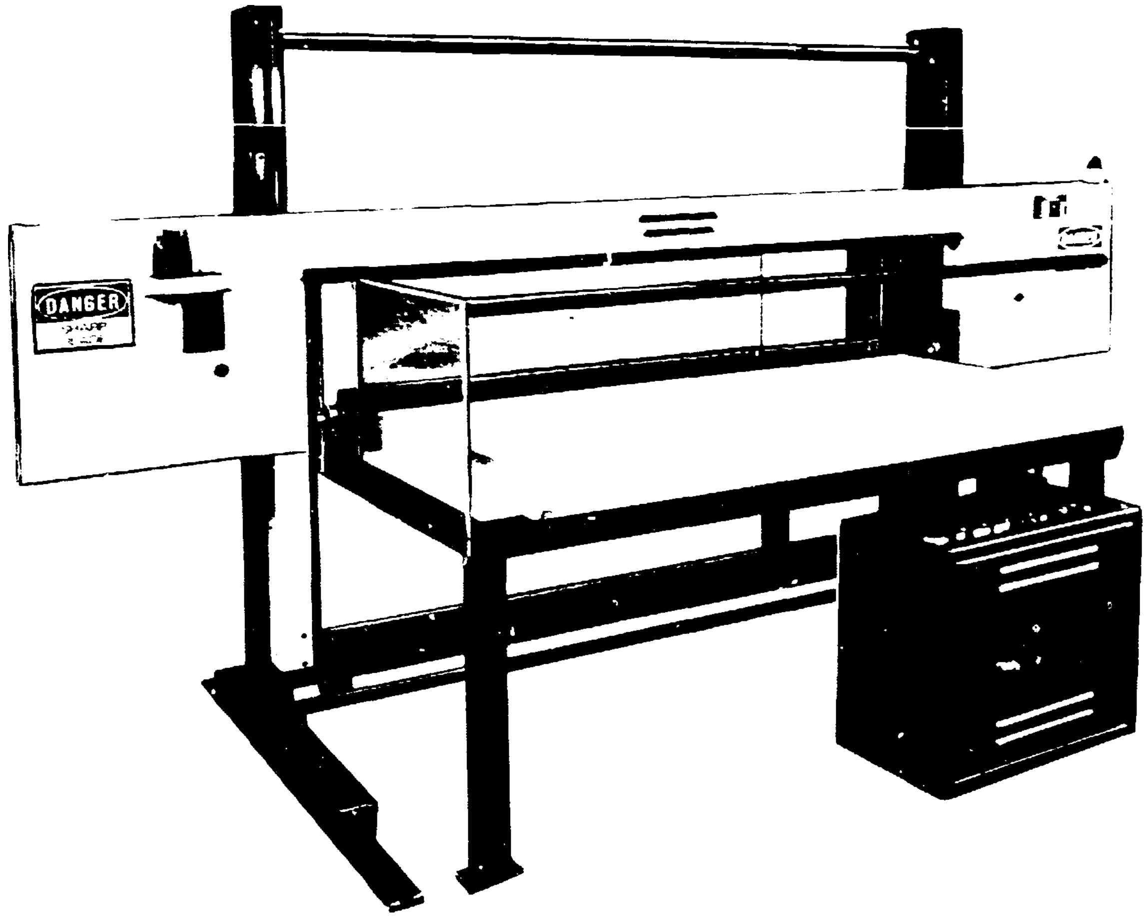
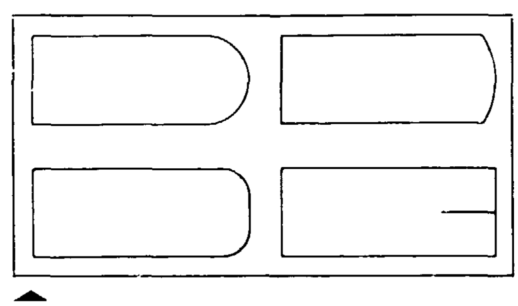
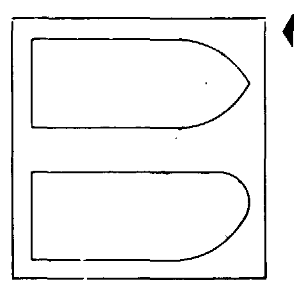


Figure 5[illegible]. Horizontal foam-cutting machine





One-cut rounded cushions



Two-cut rounded cushions

Figure 55. Cushion-profiling machine

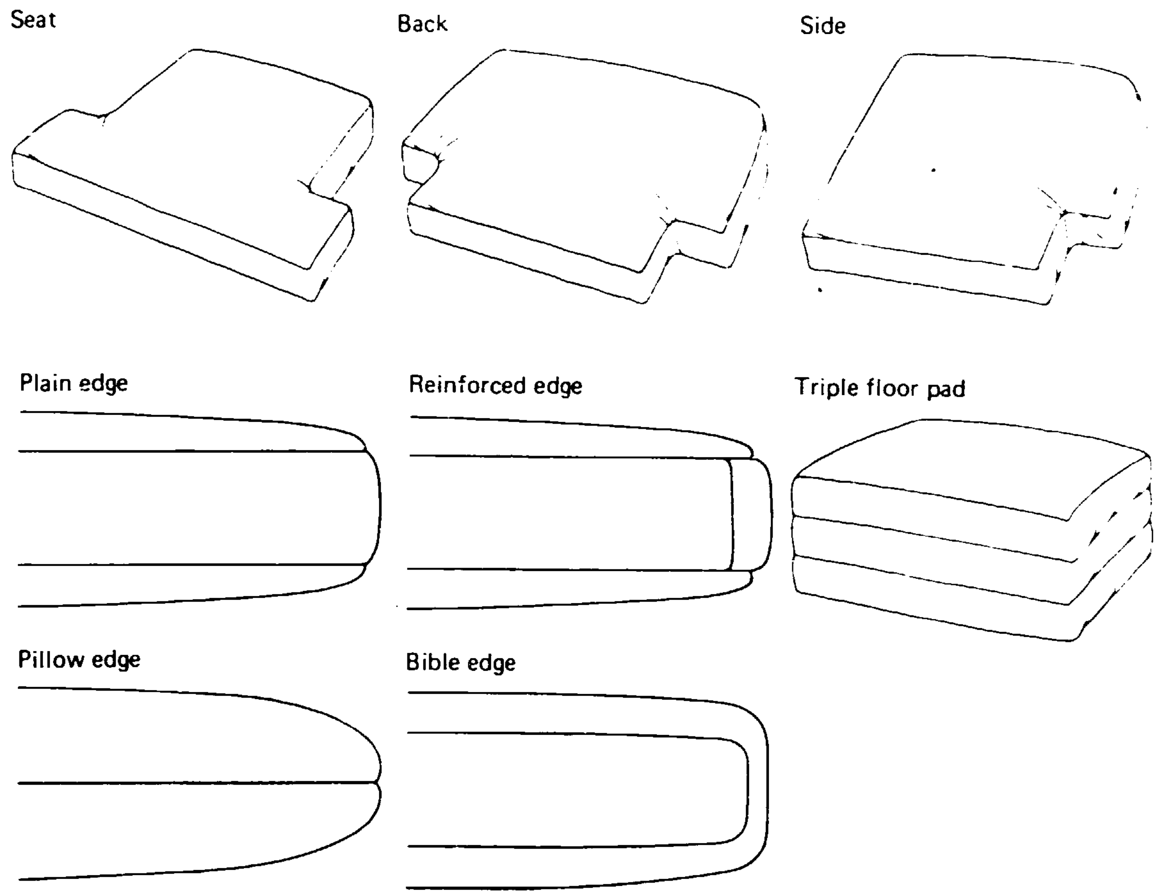


Figure 56. Ways of treating cushions

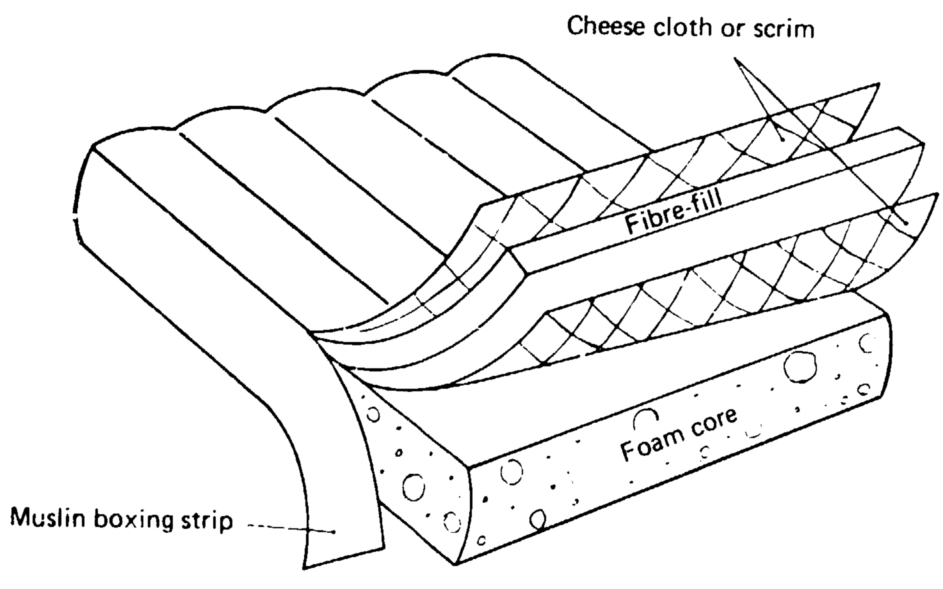


Figure 57. Complete cushion unit with single wrap

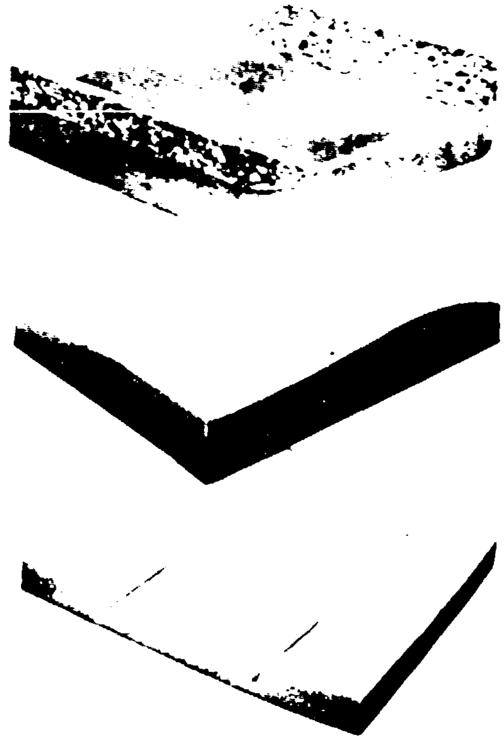


Figure 58. Examples of moulded cushions

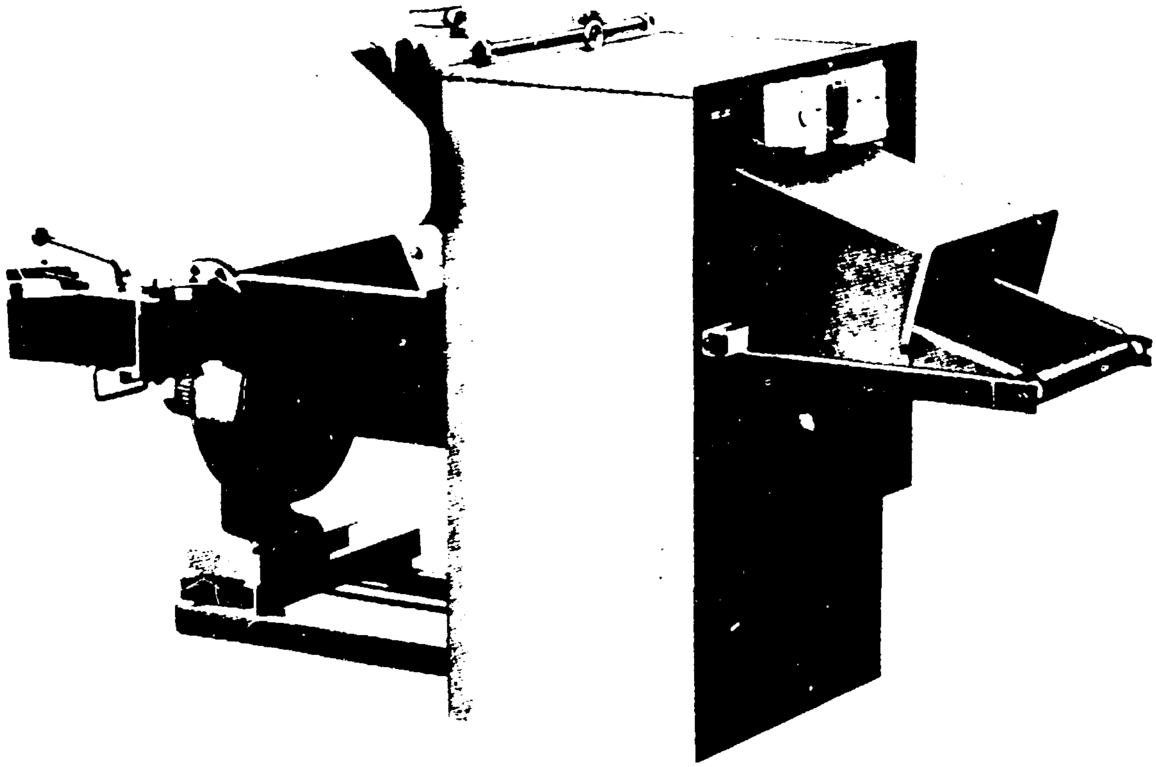


Figure 59. Foam granulating machine

The modern upholstery factory is designed to permit the maximum use of "bought in", or preprocessed components, and the pre-assembly of a maximum number of parts and elements. Pre-assembly and final assembly are accomplished at organized work stations where similar items are produced on a repetitive basis allowing each worker to become highly skilled in a very short time. The use of powered and manual conveyors reduces considerably the lifting, carrying and manual handling characteristic of traditional upholstery production. In the cutting and sewing room the transport system may be mechanized by placing a conveyor belt between two rows of sewing machines; the belt delivers the cut fabric to each sewing station and after sewing conveys it in plastic boxes to the inspection and sorting area.

While most component and frame parts begin their cycles independently, they eventually converge on a central collection and intermediate sorting area before final upholstery and assembly. Specially designed trolleys carry the prepared frame, its covering material and anything else required to the upholsterer's work bench. When the work is completed, the frame is reloaded on the same trolley and delivered to dispatch for final fitting before storage and dispatch. A further development would be to introduce a fully automated overhead conveyor system.

Operations (work centres)

Cutting and sewing

After inspection and measuring of the fabrics required for a given work period, the fabrics are conveyed by fork-lift to trolleys and thence to the cutting tables. One table is devoted to cutting secondary materials or barrier cloths (linen, muslim, hessian) in multiple lays. These materials and covering fabrics are cut by reciprocating knives powered through an overhead spring-loaded cable. The cutting tables incorporate an overhead manual or electrically operated gantry for accurate spreading of the fabric and equal stretch per lay; special holding devices ensure correct marking and cutting.

After cutting, materials are taken by manual conveyor to a fabric classification centre where they are sorted. Non-sewing parts go to a mobile storage hook where they are lined up in accordance with production programming. Work tickets, already prepared, state on which production line and in which production period the cut fabric is to be used.

Sewing centres are classified according to the kind of sewing required. Provision is made for straight sewing and seaming, cushion boxing and ruffling, zip insertion, welting, leather and vinyl sewing and piping. The pieces go to the appropriate stations, with small flatwork being done by less experienced sewers. Button making and quilting are also located in this area.

Work for cushions flows through zipper sewing and cushion boxing; and after these and outside backs have been sewn, the cushions are transported to an inspection and sorting centre on castorized trolleys. From here they are dispatched to cushion- and back-filling stations, respectively. After closing, regulating, and buttoning they are removed to a central intermediate storage and collection area.

Frame preparation

Frame preparation includes both fully assembled frames and subassemblies, such as arms, seats and backs. Depending on the springing system to be used (i.e., coil spring unit, serpentine "no-sag", resilient webbing or 4-point resilient platform), each frame will be "sprung up" and preprofiled cardboard infills stapled where necessary to the frame. It then goes to the frame padding area, where a thin sheet of polyurethane foam is glued to the outer surface areas by a spray-on adhesive. Heavier cushioning is fixed to arm rests, seats and backs, and the various types of frames that are now ready for cover assembly are transported to the central storage and collection area.

Foam cushioning preparation

Foam cushioning is usually delivered in blocks or slabs. In the foam preparation department the blocks are cut into the required surface dimensions and thickness by vertical band knives and horizontal slitting knives. Some cushions have the same foam density throughout while others are made up of a variety of densities, being softer on the outside and harder on the inside, the density depending on anticipated usage. Waste foam is reconstituted in the form of crumbs or spaghetti by a special foam-shredding machine and is used as an additional form of cushion filling in channel case cushioning, which is subsequently covered with low hardness polyester sheeting. A fairly high percentage of cushioning is made from a combination of polyester fibre with a core of urethane foam. Solid foam cushions are further shaped and profiled according to design requirements, but foam and other types of cushioning referred to are transported on specially constructed trolleys to the cushion-filling and cushion-closing machines that are located close to the central collection and intermediate storage area.

Work in progress

All components, subassemblies, fully assembled frames, finished cushions, sewn covers and all other materials required for final assembly converge on the centrally located collection and storage area. Complete sets for each chair or settee are attached to the appropriate frame according to the line-up instructions on the work tickets, and then the whole piece of furniture is placed on a castorized trolley for delivery to the appropriate cover assembly line. Each trolley accommodates either a settee or two armchairs, and these are lined up in readiness for final assembly. Provision is made in the assembly area for a line of loaded trolleys so that the cover assembly lines are never without work. When the upholsterer or cover assembler has finished his work, the completed frame is loaded on the same trolley and conveyed to final assembly and packing. At this stage castors, glides, and, for the studio couch, mechanized movements, are fitted to the frames. Each upholstered frame complete with cushions is then shrink-wrapped in polythene before dispatch.

Production planning and control

Even though production is carried out independently of sales, its planning is directly influenced by such factors as sales trends of fabrics, colours and patterns sold and produced, frame style, raw materials specification for each model, productivity per department, unit check-list, programming check for one week, and production plan for two weeks.

From data supplied with the production order a work ticket for each unit is prepared. This sheet contains several perforated sections containing all the information necessary to produce the model. There are tickets for cutting, sewing, springing, cushioning, frame, finish, cover assembly, fittings and packing. As each process is completed the relevant ticket is pulled and returned to control until all processes have been completed.

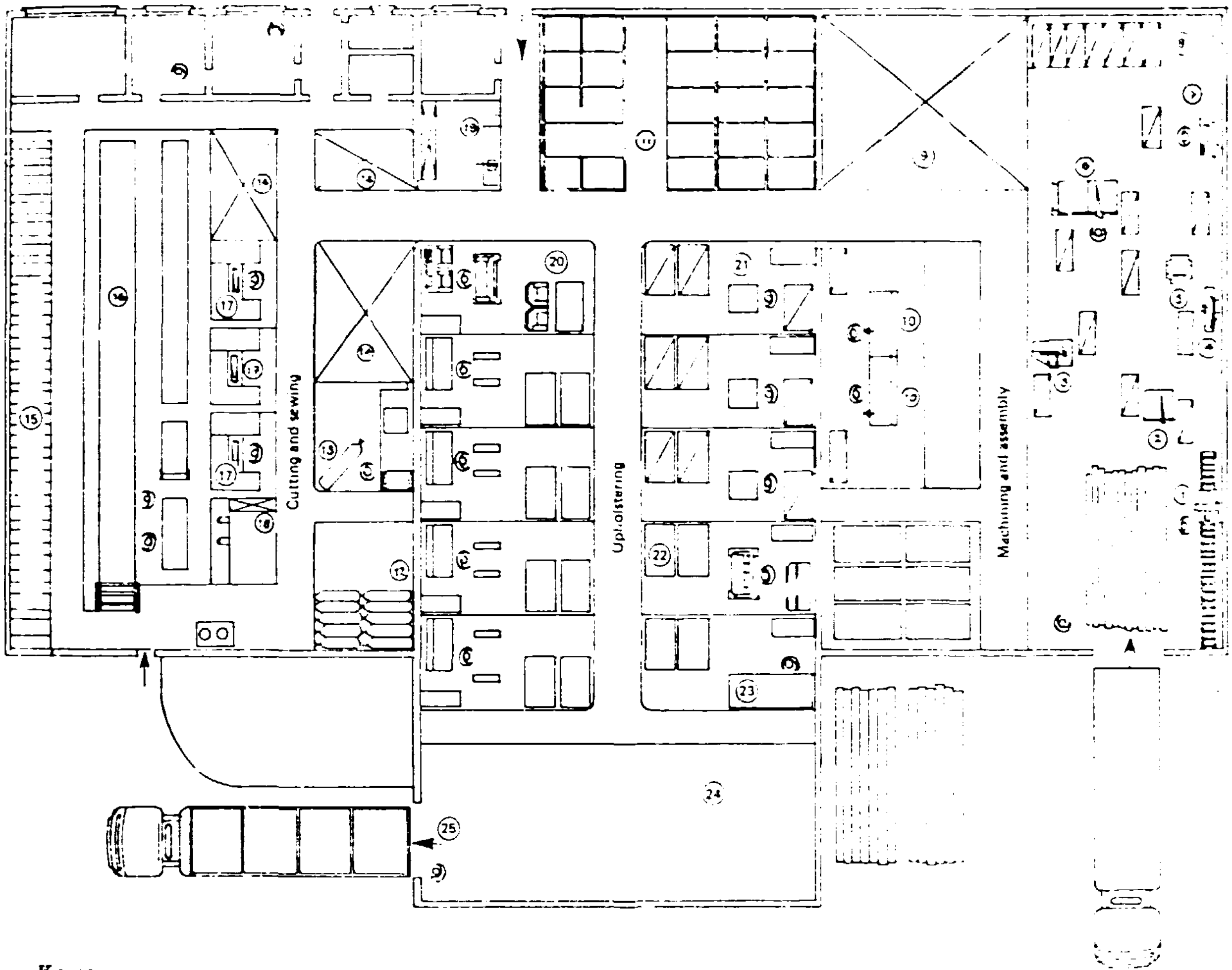
Every three days a production order is issued, which for planning and control purposes is divided into six four-hour periods. Each period is given an identification letter - A, B, C, D, E or F. The letter is printed on each production ticket for easy identification. Each department or work centre is then given a schedule stating when each letter should be completed by that department. In this way, progress, or lack of it, is monitored. A numeral is also added to the ticket, which indicates on which production line it is to be run. For instance, 3-B means that the item is to be worked on production line 3 during period B.

The numbered and lettered tickets are also colour-coded for easy identification, and they also assist those responsible for placing items in the intermediate storage and central collection area. They also make it easy to match and sort items in the cutting and sewing department.

The small upholstery production unit

Many small entrepreneurs still prefer to carry on all aspects of manufacturing themselves and therefore have a woodworking section that produces wooden frames. This arrangement undoubtedly provides considerable additional flexibility in production and also ensures that the frames incorporate all the requirements necessary for efficient upholstery production. Figure 60 shows a typical layout for this type of upholstery unit. It is approximately 1,500 m^2 in area (50 m x 30 m) employs 30-40 persons, and has a projected output of 10 suites (i.e., made up of 30 armchairs and/or settees) per day or its equivalent.

The production flow in a small factory is roughly similar to that in a larger factory with the addition of frame production. However, it is much more labour intensive, and most processes are either semi-mechanized or done manually. Provision is made for the free flow of materials and work in progress by means of clearways that link every part of the factory.



Key:

1. Cross cutting saw
2. Circular saw
3. Band-saw
4. Surface planer
5. Thickness planer
6. Dimension saw
7. Double-head boring machine
8. Single-head boring machine
9. Intermediate storage of piece parts
10. Frame assembly
11. Assembled frame storage
12. Storage for daily requirements of foam, cushioning and fibre-fill
13. Storage for filled and buttoned cushions
14. Storage for sewn and cut covers
15. Storage for fabric rolls
16. Fabric laying and cutting table
17. Sewing stations
18. Button preparation
19. Springs and resilient webbing, storage and cutting
20. Fully assembled upholstery
21. Sectionalized upholstery
22. Studio couches
23. Packing and dispatch
24. Storage of finished products
25. Loading gate

Figure 60. Layout for small upholstery plant

VI. Processing of flexible foams

Slabstock flexible urethane foam

Flexible polyurethane, or polyether, is a result of a reaction between a polymeric polyol and a polyisocyanate, utilizing catalysts, stabilizers and water. By varying the combination of the chemical mix, foam differing in density and hardness can be produced.

The metering of these ingredients is of prime importance; care must be taken to make sure they are properly mixed and that strict control on temperature is maintained.

The foam mixture is poured into a moving kraft paper trough in which it rises and cures to form a continuous length of foam. The paper prevents the unhardened foam from sticking to the sides of the trough.

Blocks are cut from the length of continuously moving foam and are subsequently check-weighed and passed along a series of roller conveyors to stock areas where the foam is permitted to mature. The blocks are then slit down into sheets and cut into shapes for final fabrication into upholstery or cushioning units.

Figure 61 shows a typical layout for a medium-sized foam factory with an annual production capacity of approximately 200-500 tons of foam. The production equipment required is as follows:

Quantity	Item
1	Foaming machine with 3 tanks with a capacity of 1,000 litres and 1 tank with a capacity of 500 litres (7)[1/]
1	Block cutter, semi-automatic: Cutting width: 160 cm (8) Cutting height: 100 cm
1	Horizontal stock slitting machine (6)
1	Vertical cutting machine (4)
1	Ver cal cutting machine for small and shaped foam components
1	Granulating machine (10)
1	Air compresser (9)
1	Floor scale (0 - 100 kg)
1	Table scale (0 - 20 kg)

1/ Numbers refer to figure 61.

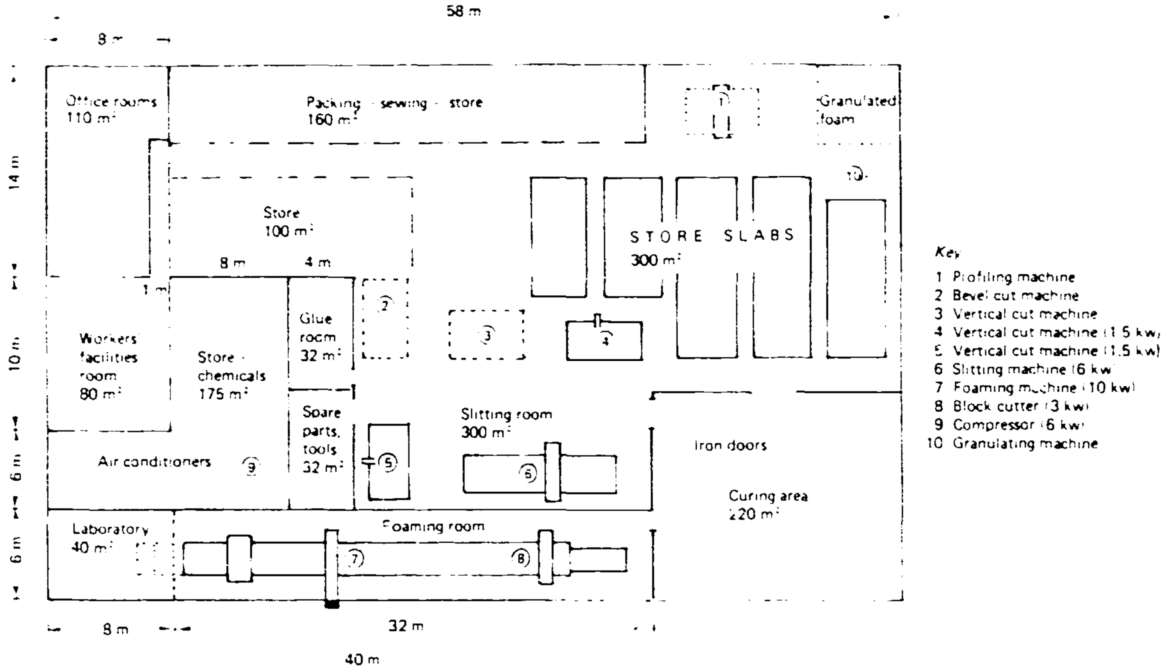


Figure 61. Layout for medium-sized foam factory

Between 9 and 11 persons are required to operate a plant of this nature:

Production manager	1
Assistant production manager	1
Fitter or mechanic	1
Operators, including an electrician	6 - 8

The foam required for a mattress with dimensions 190 cm x 90 cm x 10 cm is 0.17m^3. These mattresses usually have densities of 15 and 20 (15 kg/m^3 and 20 kg/m^3). The corresponding requirements in chemicals are 2.6 kg and 3.4 kg per mattress, or, for a monthly production of 10,000 mattresses, 26 tons and 34 tons of chemicals.

If production is confined to mattresses, a wastage factor of approximately 20 per cent must be allowed. However, approximately half of this amount may be regained through foam granulation. Annual requirements therefore for the densities given above would be as follows:

26 tons x 12 months plus 10 per cent waste = 350 tons

34 tons x 12 months plus 10 per cent waste = 450 tons

The corresponding requirements (in slab form) for seating (for a 3-piece suite consisting of a 3-seater settee and 2 armchairs = 10 cushions) is 0.18 m^3. Therefore, 1 m^3 foam is needed for 5 suites (5 settees, 10 armchairs). The foam used for such seating usually has a density of 25 (25 kg/m^3). Hence approximately 0.5 kg per cushion is required. For 100 suites (10 cushions per suite, or 1,000 cushions) 500 kg of chemicals is needed.

Moulded flexible urethane foam

While the chemistry for moulded flexible urethane foam is similar to that of slabstock, the metering and mixing of the raw material differ considerably. Each chemical component is metered and transferred at controlled temperatures and pressures from its individual storage tank to the mixing and dispensing chamber and thence into the mould.

From the curing ovens the moulds go to the demoulding area, where the products are stripped manually from the moulds and trimmed. The moulds used for hot-area polyurethane foam are usually cast aluminium, hinged at one end and clamped at the other. The design of the mould is extremely important and greatly influences the performance of the units produced from it. The inside cavity must be 2 per cent oversize to compensate for a 2 per cent shrinkage in the foam unit when it is removed from the mould.

Moulded high resilient flexible urethane foam (cold cure)

As the term indicates, "cold cure" foam can be produced without the need for an external heat source for curing, but it may also be produced on the same mould as that required for hot-curing. The basic chemistry, however, is very different, as becomes evident when the unit is stripped from the mould. At this stage the foam has a semi-closed cell structure, which must be broken down to permit the foam to achieve its natural characteristics. A set of tapered crushing rollers is used for this purpose.

To complete the cure, the units are passed through a post-cure chamber for 30 minutes (at approximately 100°C) and then transferred to the trimming section. The moulds are usually polyester or epoxy resin fibreglass laminates about 10 mm thick. The internal pressure on the mould is considerable, and it should therefore be heavily ribbed and the clamping substantial. The mould may be filled through a single orifice in the lid.

Properties of foam

Density

Density is the weight of a given volume of foam and is expressed either in kilograms per cubic metre or pounds per cubic foot. The density is not necessarily related to hardness and can be varied independently. Density is the property considered to have the biggest single effect on the fatigue properties of the foam.

Indentation hardness

Indentation hardness is one aspect of the load-bearing properties of the foam and is measured by preconditioning a unit and then indenting it by 40 or 50 per cent of its thickness and after 30 seconds recording the corresponding force. The hardness value is governed by the purpose for which the foam is used. For example, a person sitting down should not feel the frame underneath ("bottoming"). When soft cushions are used, the depth of foam should be increased to compensate.

Tensile strength and elongation

The tensile strength is determined by extending a test piece of foam until it ruptures. The force to cause the rupture is divided by the original cross-sectional area of the test piece. The resulting strength is expressed in lb/ft^2 or kN/m^2 (minimum). The elongation is the percentage increase in length of a given section of the specimen after the test piece has been extended and is measured at the breaking point.

Compression set

The compression set is measured by subjecting a test piece to preset conditions of heat, time and a constant deflection. The compression set is the lack of recovery of height of the test piece and is expressed as a percentage of the original height. The maximum allowed in British Standard 3379 is 10 per cent.

Fatigue

Fatigue is usually measured by simulating the results that would be achieved by a cushion in actual service. The cushion is subjected to a constant-load pounding test for a given number of cycles. On completion the loss in hardness and height is measured. This loss is usually expressed as a percentage of the original.

Examples of flexible urethane foam furniture are given in figure 62.

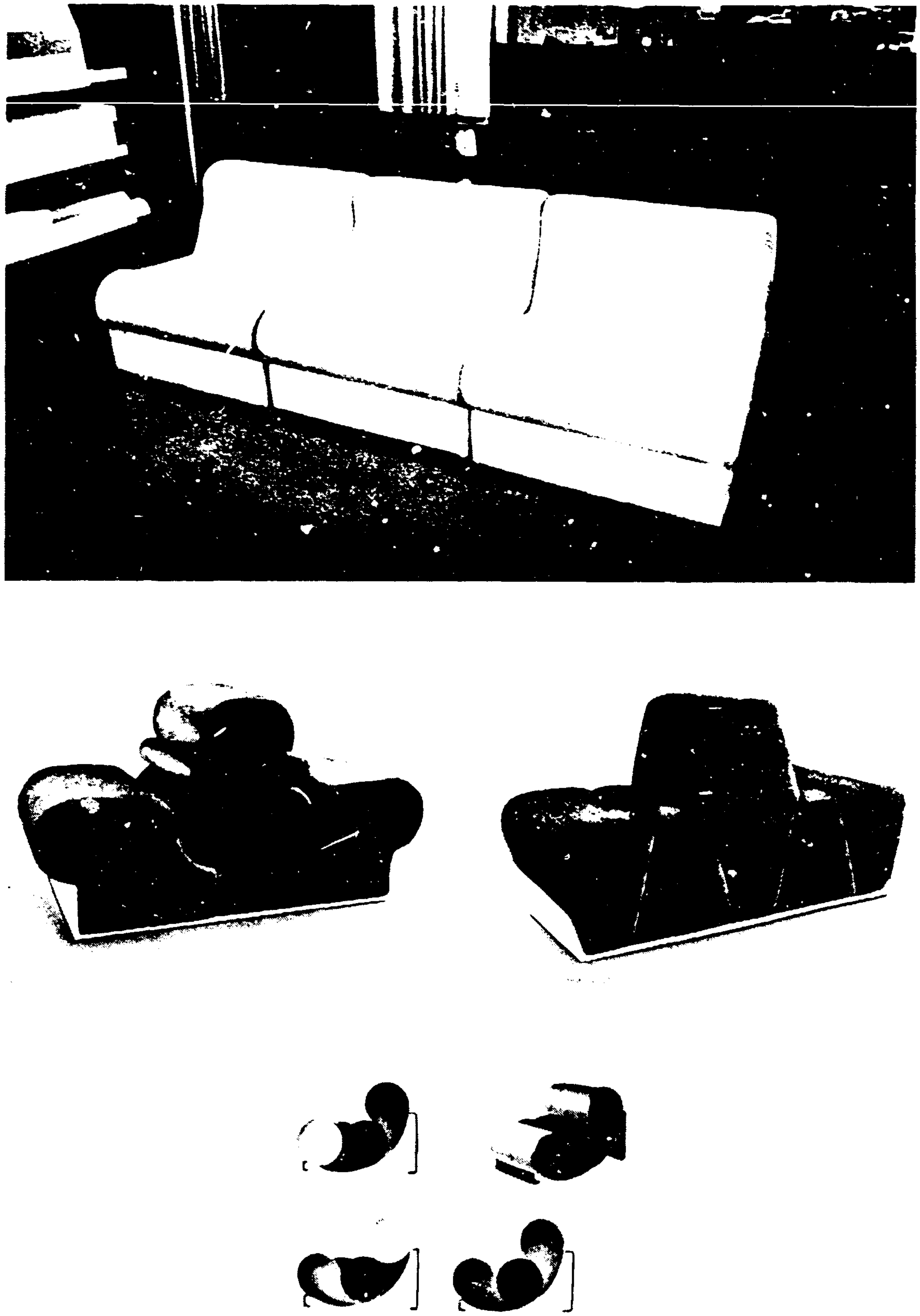


Figure 62. Examples of flexible urethane foam seating

Annex I

Performance tests for furniture for seating: easy chairs and settees

Performance tests are graded into three categories of severity of use. The same methods of test for seat, back and arms and for the drop test are used in each grade; but the loads are increased from grade to grade for the static and impact tests and the drop heights in the drop tests, while the number of applications of a fixed load is increased from grade to grade for the fatigue tests.

The separate seat and back load tests of tests 1 and 4 (for the static loadings) may be combined to give a representative cycle of seat load on, back load on, back load off and seat load off under static conditions. Tests 2 and 5 (for the fatigue loadings on seat and back) may be similarly combined to give a representative cycle of seat and back loads under fatigue conditions.

The article to be tested is submitted in turn to each of the 14 tests described below with the force and number of applications, appropriate to the grade for which it is being tested, shown in table 2 or table 3.

Moisture content and temperature of the article during testing

If the article contains items made of materials whose properties depend significantly on moisture content and it is suspected that the moisture content is unduly high, it is conditioned before testing in an atmosphere at $20^{\circ} \pm 2^{\circ}C$ and 65 per cent ± 5 per cent relative humidity. Since the properties of some plastics are strongly dependent on temperature, a record of the variation in temperature and relative humidity should, if possible, be taken in the long-term fatigue tests on plastic articles. The moisture content and temperature during the other tests are recorded at the time of test.

Initial inspection

Immediately before testing, each article is thoroughly inspected. In the case of upholstered articles, as much of the cover on the bottom is removed as is necessary to permit thorough inspection of joints etc. Any apparent defect is noted, so that it will not be attributed to the test loadings.

Table 2. Seat, back and arm tests: number of applications and test loading - easy chairs and settees

Test number	Test loading	Point of application	Grade of severity		
			Light duty	Medium duty	Heavy duty
	Seat				
1	Static	Anywhere	10 x 780 N	10 x 1 000 N	10 x 1 250 N
2	Fatigue	Standard	25 000 x 1 000 N	50 000 x 1 000 N	100 000 x 1 000 N
3	Impact	Anywhere	10 x 25 kg x 90 mm	10 x 25 kg x 200 mm	10 x 25 kg x 300 mm
	Back				
4	Static	Standard	10 x 620 N	10 x 780 N	10 x 1 000 N
5	Fatigue	Standard	25 000 x 400 N	50 000 x 400 N	100 000 x 400 N
6	Impact	Top of back	10 x 6.5 kg x 0.75 m/s	10 x 6.5 kg x 1.5 m/s	10 x 6.5 kg x 3.0 m/s
	Arm sideways				
	Simultaneously to each arm,				
7	Static (outwards)	Anywhere	10 x 300 N	10 x 420 N	10 x 600 N
8	Fatigue (inwards) if inside arms 655 mm or less apart, otherwise outwards	Standard	25 000 x 110 N	50 000 x 110 N	100 000 x 110 N
9	Impact	Anywhere	10 x 6.5 kg x 0.75 m/s	10 x 6.5 kg x 1.5 m/s	10 x 6.5 kg x 3.0 m/s
	Arm downwards				
10	Static, to one arm	Anywhere	10 x 710 N	10 x 1 000 N	10 x 1 250 N
11	Fatigue, to both arms	Standard	25 000 x 340 N	50 000 x 340 N	100 000 x 340 N

Table 3. Drop and diagonal base load tests: number of applications and test loading - easy chairs and settees

Test number	Test loading	Grade of severity Light duty	Medium duty	Heavy duty
	Drop test			
12	Rear foot	10 x 75 mm	10 x 100 mm	10 x 150 mm
	Front foot	10 x 75 mm	10 x 100 mm	10 x 150 mm
	Diagonal base load			
13	Static	10 x 250 N	10 x 375 N	10 x 500 N
	Swivelling test			
14	1,000 N downwards seat force and rotate ± 45°	25 000 times	50 000 times	100 000 times

Test 1 - seat static load test

A downwards force is applied repeatedly 10 times at a rate not exceeding 40 times a minute by a 200-mm-diameter loading pad, faced with a 25-mm-thick layer of hard polyether foam, at right angles to the surface of the seat to any position along the fore and aft centre line of the seat likely to cause failure (see figure 63).

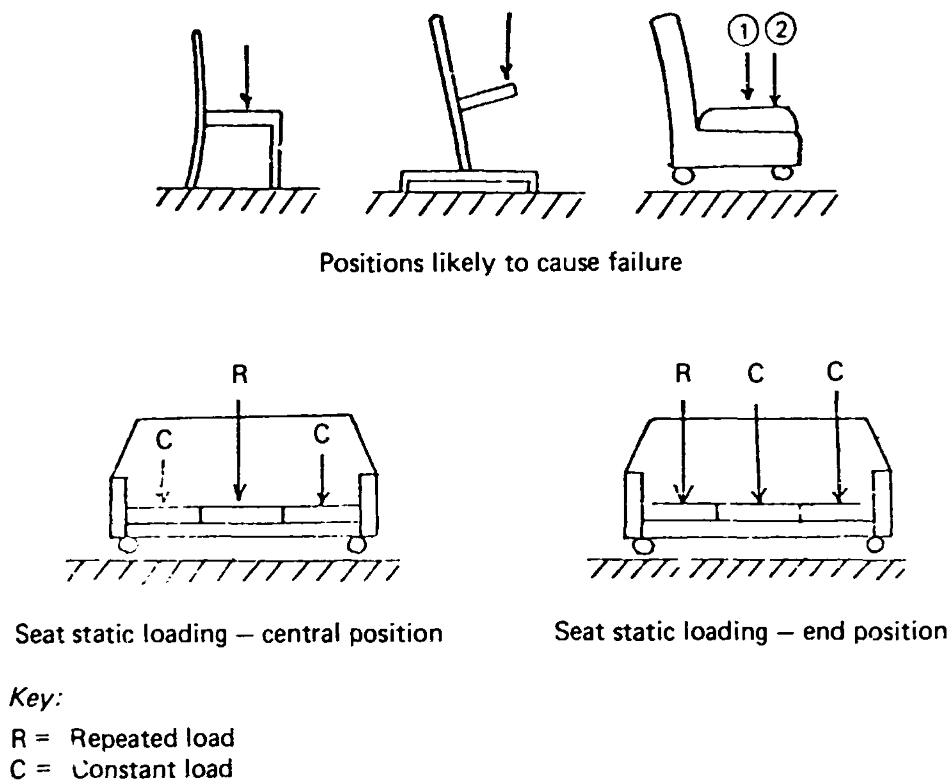


Figure 63. Seat static load test

As it may not be clear which of several possible positions is most likely to cause failure, each of the positions, up to a maximum of three, may be loaded 10 times.

The seat static load magnitudes are those specified for test 1 in table 2.

Test 2 - seat fatigue load test

The seat fatigue load (figure 64) test is applied as for test 1 except that the size of the load and number of applications are those specified for test 2 in table 2 and the centre of the seat loading pad is 175 mm forward of the intersection of the centre lines of the seat and back surfaces.

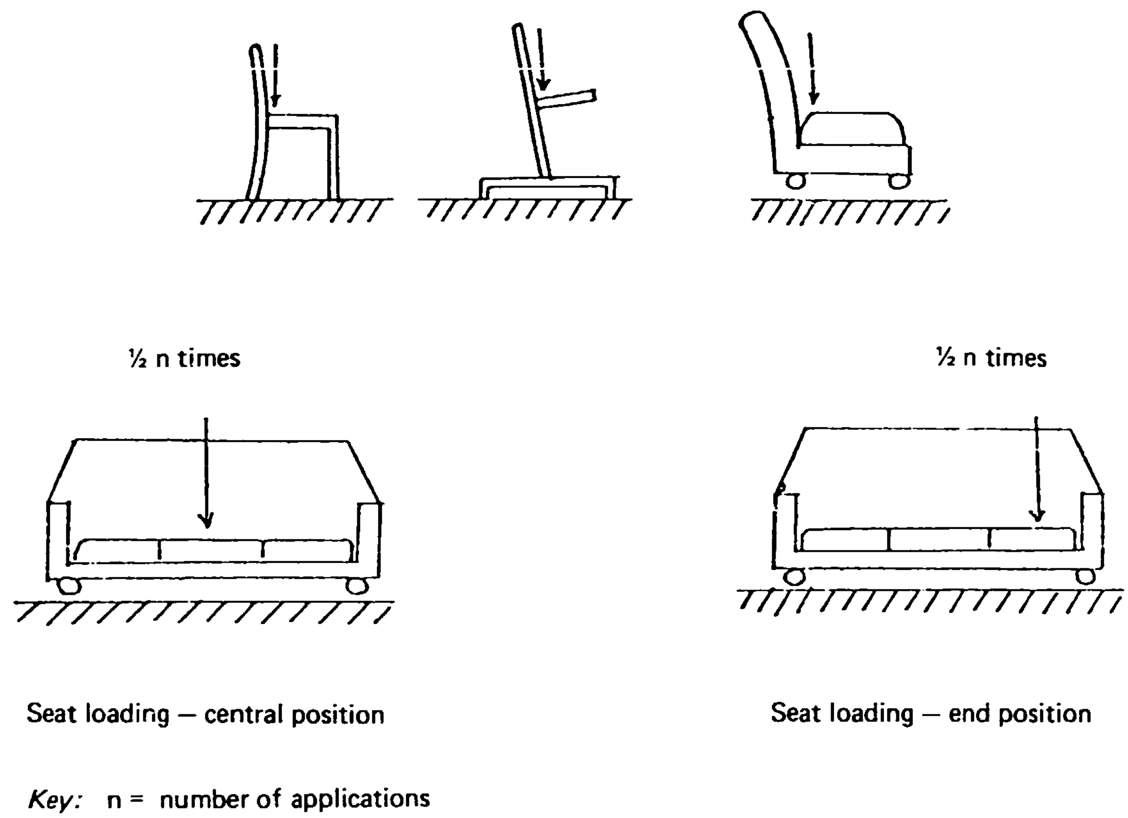


Figure 64. Seat fatigue test

Test 3 - seat impact test

In the seat impact test (figure 65) the seat impact load is applied by allowing a seat impact pad, weighing 25 kg and having a 200-mm-diameter striking surface of leather or similar material filled with fine, dry sand, to fall freely from the heights and for the number of times specified for test 3 in table 2. The impact load is applied anywhere a person is likely to sit, at the position most likely to cause a failure, up to a maximum of three positions.

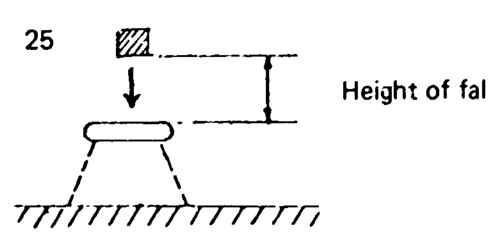


Figure 65. Seat impact test

Test 4 - back static load test

In the back static load test (figure 66) a load is repeatedly applied 10 times at a rate not exeeding 40 times a minute at right angles to the surface of the back by means of a rectangular loading pad, 200 mm high and 250 mm wide faced with a 25-mm layer of hard polyether foam. The centre of the pad is at a distance above the intersection point of the centre lines of the seat and back surface equal to 230 mm for soft seats, 265 mm for medium seats, 300 mm for hard seats, or 100 mm below the top of the back, whichever is the lower, except for back rests less than 200 mm in height, when the centre of the load pad is at the centre of such back rests. The article is prevented from moving rearwards by stops placed behind the rear feet or castors etc. During this test the seat is loaded by a constant force specified for test 1 in table 2 by means of a 200-mm-diameter loading pad applied at right angles to the seat surface anywhere along the centre line of the seat, but not more than 250 mm forward of the intersection of the centre lines.

The test is performed by the repeated application of the back load 10 times at a rate not exceeding 40 times a minute of the force specified in table 1 for test 4, with the seat load in the position that just permits

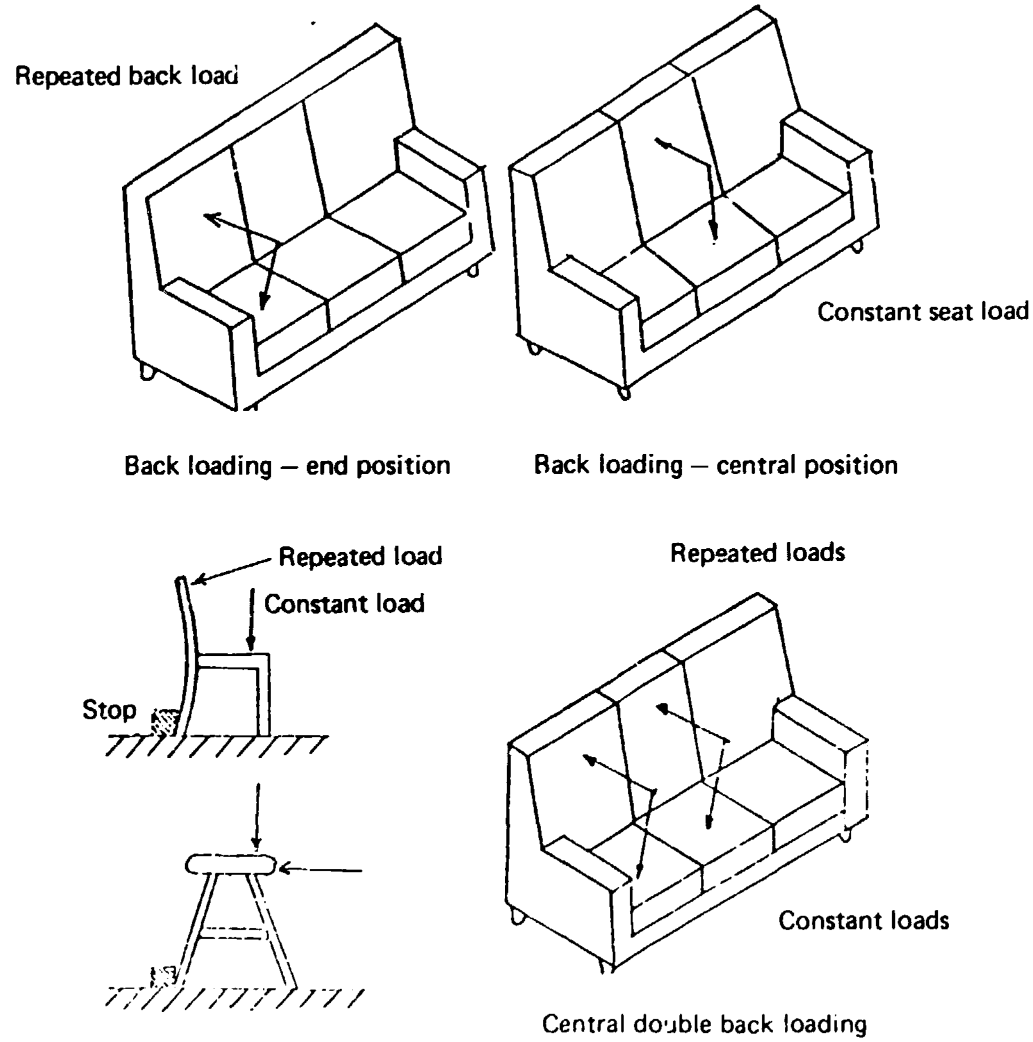


Figure 66. Back static load test

the front feet to lift away from the floor except at the rear of the base If the article tends to overbalance with the seat load in its most forward position, the back load is reduced to the degree that will just prevent rearwards overbalancing, and the actual force is reported. The back load is not to be less than 620 N, and the seat load, in its most forward position, is to be increased above the value specified in table 2 for test 1 if necessary to prevent overbalancing, and the actual force used is reported.

Test 5 - back fatigue load test

In the back fatigue load test (figure 67) the back load is applied as for test 4 except that the size and number of applications of the back load are those specified for test 5 in table 2. The article is prevented from moving to the rear by floor stops behind the rear feet, castors etc.; and overbalancing is prevented by a constant seat force of 1,000 N with the centre of the seat loading pad at 175 mm forward of the intersection point of the centre lines of the seat back surfaces. If the article tends to overbalance, the back load is reduced to the extent that will just prevent rearwards overbalancing, and the actual force is reported. When the article is fitted with a spring rocking-action base having a tension adjustment, the tension is reduced, so that the maximum possible rocking movement is obtained without causing impacts on the rocker stops. When the test is applied to a stool without a back rest or with a very low one, the backwards force is applied horizontally to the front edge of the seat.

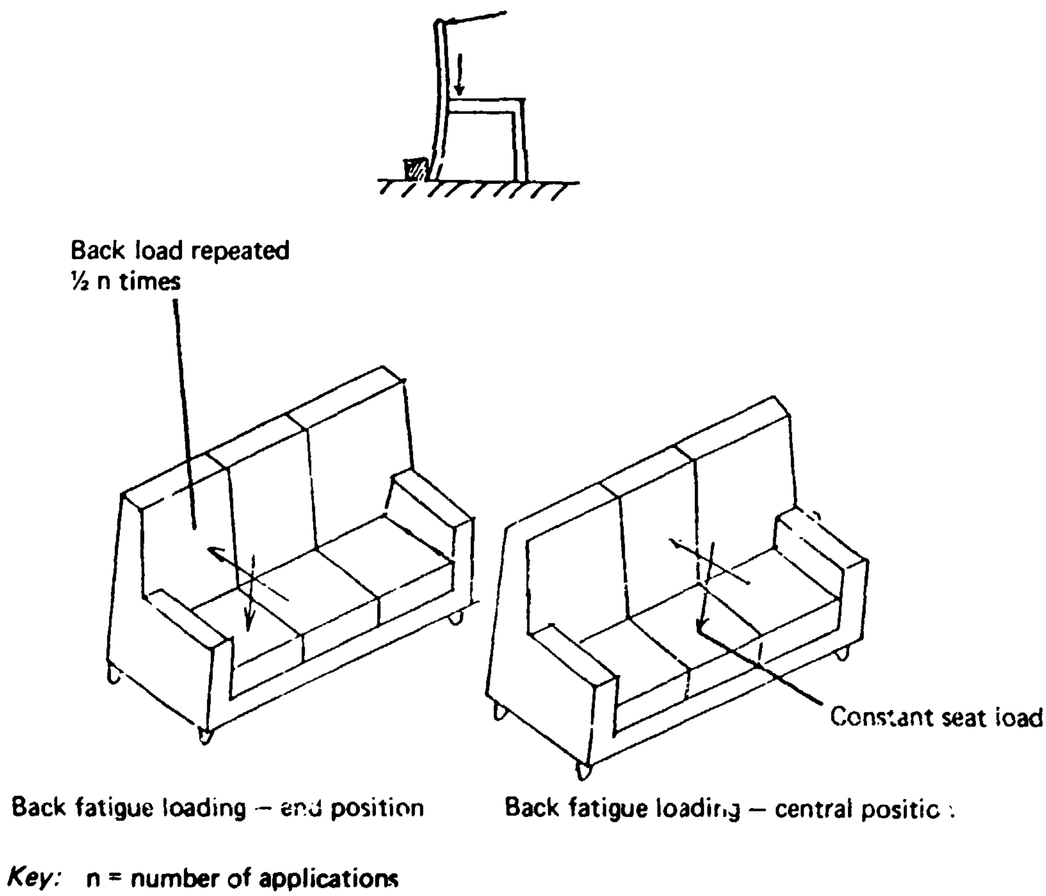


Figure 67. Back fatigue load test

Test 6 - back impact test

In the back impact test (figure 68) the article is placed in its normal position with its front feet prevented from moving forwards by means of stops. A weight of 6.5 kg is permitted to strike the centre of the top of the outside of the back in a forwards direction. The weight has a 100-mm-diameter striking surface, suitably padded so as not to damage the surface, and strikes the article horizontally at the speed specified for test 6 in table 2. The article is permitted to rotate freely forwards about the front feet 10 times at a rate of 10 times a minute.

If the article has wings, the test is repeated with the mass striking the outside of the top of the wing at right angles to its surface and in a position most likely to cause failure. If the article has a swivel base, then the direction of the impact force must pass through the vertical axis of the swivel. To prevent the article from moving across the floor, the stops may be placed by the side feet.

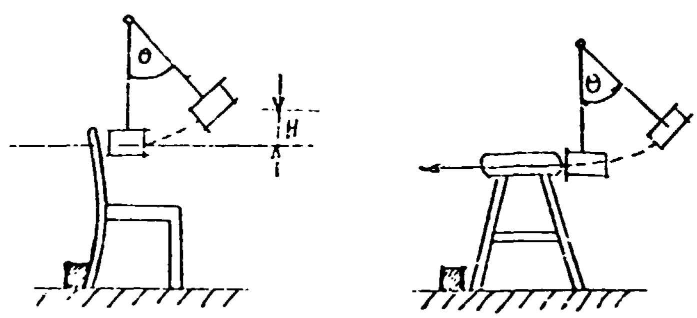


Figure 68. Back impact test

Test 7 - sideways arm static load test

In the sideways arm static load test (figure 69) a pair of horizontal outward loads of the size given in table 3 for the appropriate grade is applied 10 times by means of 100-mm-diameter load pads to any position along the inside of the uppermost part of the arms most likely to cause failure. Since it may not be clear which of several positions is most likely to cause failure, each of the positions up to a maximum of three may be loaded 10 times.

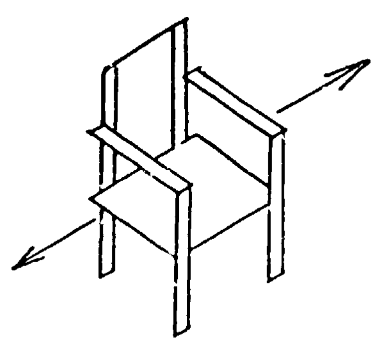


Figure 69. Sideways arm static load test

Test 8 - sideways arm fatigue load test

The sideways arm fatigue load test is applied as for test 7 except that the size of the loads is 110 N and the number of applications is as specified in table 2 for test 8. The point of application of the load is 50 mm behind the front edge of the arm. The direction of the pair of loads is inwards if the inside arms are 655 mm or less apart, but is outwards if the inside arms are further apart.

Test 9 - sideways arm impact load test

The sideways arm impact load test (figure 70) is applied as for test 6 except that the impact blow is applied in an inwards direction to the outside face of the arm at any of the positions where a failure is most likely to occur 10 times in each position up to a maximum of three. The article is placed in its normal position with a pair of side feet prevented from moving sideways by stops. If the article has a swivel base, then the direction of the impact force must pass through the vertical axis of the swivel.

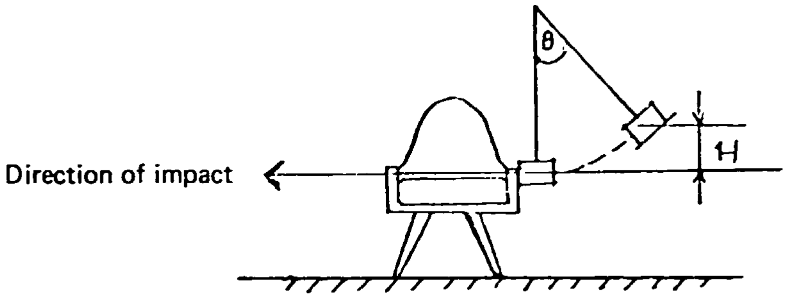


Figure 70. Sideways arm impact test

Test 10 - downwards arm static load test

In the downwards arm static load test (figure 71) a vertical downwards force of the magnitude for test 10 in table 2 is applied at a rate not exceeding 40 times a minute 10 times to the upper surface of one arm by means of a 100-mm-diameter pad to any point along the arm most likely to cause a failure, with a counterbalancing vertical force of 750 N applied to the seat if necessary to prevent overbalancing.

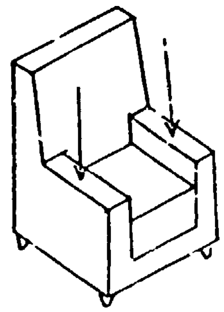


Figure 71. Downwards arm static load test

Test 11 - downwards arm fatigue load test

In the downwards arm fatigue load test a vertical downwards force of 340 N is applied simultaneously to each arm by means of a 100-mm-diameter pad at a rate not exceeding 40 times a minute for the number of applications specified in table 2 for test 11, and the point of application is 50 mm behind the front edge of the arm.

Static, fatigue and impact tests for settees and similar articles

For articles intended to seat more than two persons, tests 1-6 inclusive are applied to seat units selected by the test operator in accordance with the following: if the number of seating units is not obvious from inspection, the article is to be regarded as consisting of a number of equal units, each being not more than 560 mm in width at the front and not less than 380 mm at the rear of the seat.

Tests on "seating units" of settees

Static loading

The loading is applied, in turn, to one end position and to a central position, while each of the other "seating units" supports a constant vertical force of 750 N, except for a two-seat settee, when the central loading is not accompanied by any additional load.

Fatigue loading

Half the specified number of loading cycles are applied first to a central position and the remainder to an end position.

Impact loading

The loading is applied to an end position and to a central position.

Tests on backs

Static loading

A double back static loading is applied by a pair of back loading pads situated with their centres 500 mm apart with a corresponding pair of constant seat forces. For two-seat settees the double back static load is applied to positions equidistant from the centre of width. For settees with three or more positions the double back static loading is applied to two adjacent positions at one end and then to two positions equidistant from the centre of width.

Fatigue loading

Half the specified number of loading cycles are applied to a central position, the remainder to one end position.

Impact loading

The loading is applied to an end position and to a central position and also to a wing if one exists.

Other tests

The other tests applied to arms and bases are performed as described for chairs.

Test 12 - chair drop test

For chairs

The chair is supported so that at impact on one foot the line joining that foot to the diagonally opposite foot is inclined at 10° to the horizontal, while the line joining the remaining feet is horizontal. The chair is lifted up and allowed to fall freely on a concrete floor. The height of fall is that specified for test 12 in table 3 appropriate to the grade. The chair is dropped in this way 10 times on a front leg and 10 times on a rear leg.

For settees

The settee is lifted up at one end and allowed to fall freely so that the impacting feet or castors strike a concrete floor at the same level as the non-lifted feet or castors. The heights of fall are those specified for test 12 in table 3. The settee is dropped in this way 10 times (see figure 72).

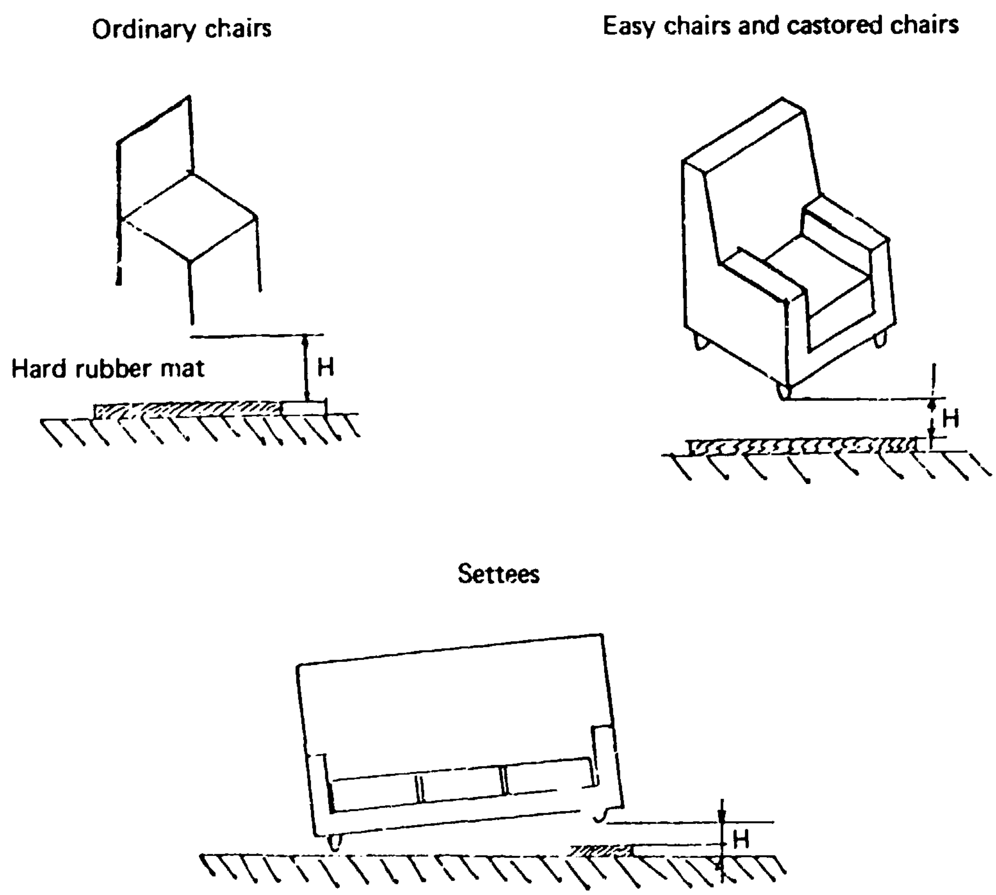


Figure 72. Chair drop test

Test 13 - diagonal base load test

In the diagonal base load test (figure 73) two opposing forces of the magnitude specified for test 13 in table 3 are applied simultaneously to diagonally opposite legs or corners of the article, as near as possible to the lowest point. Application of these forces is made in an inwards direction 10 times at about 20 times a minute.

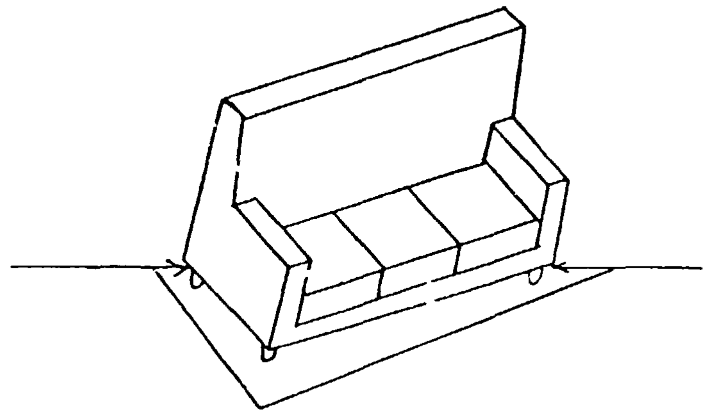


Figure 73. Diagonal base load test for easy chairs and settees

Test 14 - swivelling test

For an article with a swivel action, a vertical downwards force of 1,000 N is applied to the seat by means of a 200-mm-diameter pad with its centre 175 mm forward of the intersection point of the centre lines of the seat and back surfaces. The seat of the article is to be rotated 45° relative to the base at 30 ± 10 cycles a minute for the number of cycles specified for test 14 in table 3.

Conditions for acceptance

The article shall not develop as a result of the test any:

(a) Fracture of any member or joint;

(b) Fracture or extensive cracking through the thickness of any part of a structural shell;

(c) Loosening, shown to be permanent by hand pressure applied to suitable members, of joints intended to be rigid;

(d) Loosening of the underframe or base inserts moulded into a structural shell relative to the shell surface shown to be permanent by hand pressure applied to the underframe or base.

Any free movement in the back, arms or legs of the article noted in the final inspection shall not be noticeably greater than initially.

No part of the article shall develop any deformation that will adversely affect its function, nor shall any cracks develop that will spoil its appearance.

Annex II

List of documents of British origin containing methods of test applicable to upholstered furniture and upholstery materials

Published by the British Standards Institute, London

106 : Part 5 : 1954	Domestic furniture, part 5. Upholstered furniture
1006 : 1971	Methods for the determination of the colour fastness of textiles to light and weathering.
1425 : 1960	Cleanliness of fillings and stuffings for bedding, upholstery, toys and other domestic articles.
1664 : 1962	Woven cotton webbings.
2453 : 1970	Woven upholstery fabrics.
2570 : 1962	Natural fibre twines.
2576 : 1967	Methods for the determination of breaking load extention of strips of woollen textile fabrics.
2661-2686 : 1961	Methods for the determination of the colour fastness of textiles.
2824 : 1957	New wood wool fillings for furniture etc.
2963 : 1958	Tests for the flammability of fabrics.
3129 : 1959	Latex foam rubber components for furniture.
3157 : 1960	Latex foam rubber components for transport seating.
3320 : 1970	Method for the determination of seam slippage of woven fabrics.
3379 : 1961	Flexible load bearing urethane components (polyether type) for vehicles.
3400 : 1967	Methods of test for dust in filling material.
3424 : 1961	Methods of test for coated fabrics.
3661 : 1961	Methods for the determination of the colour fastness of textiles.

3667 : Parts 1 and 2 : 1963	Method of testing flexibility of polyurethane foams.
3667 : Parts 3 to 10 : 1963	Methods of testing flexible polyurethane foams.
4443 : Part 2 : 1972	Methods of test for flexible cellular material. Indentation hardness tests.
4443 : 1969	Methods of testing flexible cellular materials.
4569 : 1970	Surface flash in pile fabrics.
4655 : 1970	Pile loss of woven cut-pile upholstery fabrics.
4723 : 1971	Nylon stretch covers for upholstered furniture.
3870 : 1960	Schedule of stitches, seams and stitching.
4735 : 1971	Method of test for ignitability and self extinguishing characteristics of plastics and rubber cellular materials.
5852 : Part 1 : 1979	Fire tests for furniture.

Published by the Furniture Industry Research Association, Stevenage, Hertfordshire

Graded performance tests for furniture for seating.

Easy chairs and settees.

Upright chairs and stools.

Martindale test for upholstery fabrics. 1968. (DJM/AF/3265)

The performance testing and behaviour in service of flexible polyether foam. Constant load indentation pounding test. In FIRA Technical Report No. 23. 1966.

The performance testing and behaviour in service of flexible polyether foam. Dynamic indentation recorder. In FIRA Technical Report No. 23. 1966.

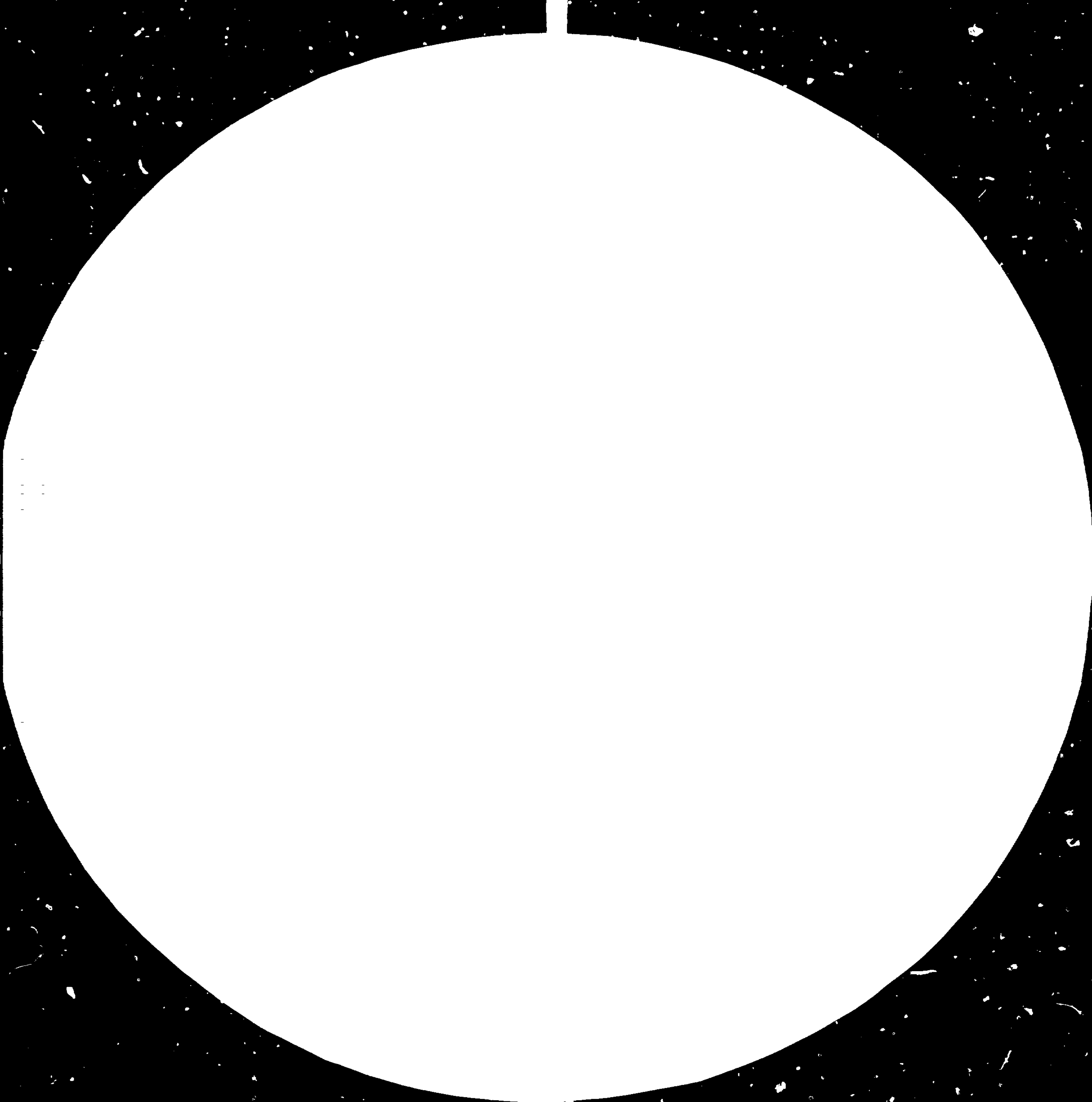
Published by Imperial Chemical Industries Ltd, Fibres Division, London

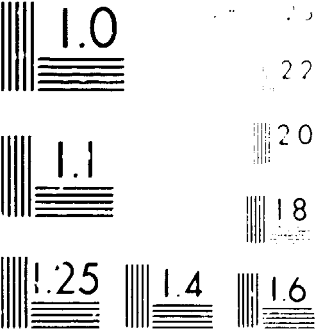
Assessing of the snagging propensity of "Crimpilene" fabrics. Standard test procedure No. 335.

Pilling. Method of test and interpretation of results.

Published by the Textile Institute, Manchester

The assessment of the soiling properties of upholstery fabrics. Textile Institute and industry. December 1971.




1.0
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