



FURNITURE AND LANGUAGE
INNOVATIVE INTEGRATED LEARNING
FOR SECTOR ATTRACTIVENESS
AND MOBILITY ENHANCEMENT

Module 2

Materials and finishing surfaces

FLAME

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www.erasmusflame.com

Authors:



OGÓLNOPOLSKA
IZBA
GOSPODARCZA
PRODUCENTÓW
MEBLI

CENFIM
Home & Contract
furnishings



net translations

Mendel
University
in Brno

WARSAW UNIVERSITY OF LIFE SCIENCES
SGGW

arnuebla cooperación empresarial



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Module 2

Material and finishing surfaces

AIM OF THE MODULE

This Module describes the principal information about technologies intended to enhance and decorate furniture. Furniture parts may be made of solid wood or wood-based materials, metal, and other materials. The surfaces of these materials may not remain untreated and the manner to decorate them dictates the appropriate technology that must be applied in each aspect.

LEARNING OUTCOMES

Knowledge

different basic materials
coatings and techniques to apply
different types of auxiliary material and its
properties and handling

Skills

prepare work pieces before coating
deal with materials by hand
deal with materials using machines
know different types of auxiliary materials
and their properties and handling

LEARNING PLAN

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Unit 2.2\ Finishing materials - pg. 10

Unit 2.3\ Application techniques - pg. 19

Unit 2.4\ Machines and tools - pg.27

Unit 2.5\ Types of auxiliary materials and their properties and handling - pg. 34

ESCO PROFILES

7522 Cabinet-makers and related workers

7534 Upholsterers and related workers

1324s Supply Chain manager (Supply, distribution and related managers)

9329 Factory hands – Manufacturing labours not elsewhere classified



814 Foam rubber mixer

7534 Mattress maker and related workers



Unit 2.1

Surfaces, materials to be finished

| EDUCATIONAL APPROACH | | | CONTENT | |
|---|--|---|--|--|
|  Course book |  Additional readings |  External links | |  Exercises and games |
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| | | | Surfaces of upholstery furniture 6 | |
| ASSESSMENT | DURATION | ECVET | | |
|  Quiz (at the end of the module) | 1 HOUR | 0.04 Credits/ 0.2 total of the module | | |



Unit 2.1 Surface materials to be finished

Correctly choosing the substrate and treating its property is decisive to the final result in all types of surface treatments. This section is focused on the most used substrates, which are finished during the furniture production. We recognise three kinds of finished surfaces:

- Surfaces of wooden-based materials
- Surfaces of non-wooden-based materials
- Substrate for finishing upholstery furniture

Surfaces of wooden-based materials

Finished surfaces are based on wood-based materials and non-wooden-based materials, which are the finishing by applying coats during furniture production. The finished surfaces and their properties have a major impact on the choice of coated materials and the finishing technique.

Different kinds of **softwoods (2)** and **hardwoods (1)** with their specific mechanical, physical, and chemical anisotropic properties belong among the wooden-based materials. The main tasks for finishing furniture made of solid wood parts are sanitation, stabilisation, improving durability, and decoration.

A group of **composite wooden-based materials (3)** are manufactured during furniture production, from **veneer plywood (4)**, or they consist of **chipboard (particle board)(5)**, **MDF board (Medium Density Fibreboard)(6)**, **High Pressure Laminate (HPL)(7)**, and **Multifunctional panel(8)**, which are the principal materials in the production of furniture and fittings. Chipboard is available in a number of different versions and qualities, geared to a range of different applications. It is manufactured with a number of different finishes: with a veneer; coated in paper, foil or melamine, or primed and sealed, featuring a surface smoothed with filler.

Each type of board requires its own special treatment. In melamine-coated board, which has become an interesting alternative – only one side needs to be coated: this requires special treatment to ensure good adhesion. Choosing the appropriate finishing technique is therefore decisive to cost efficiency, as well as to the end result.

MDF board, which has steadily gained significance and which has in principle replaced solid wood as the material of choice for machined and profiled wood products that are to be finished with a covering lacquer, also requires special pre-treatment and finishing. It is important to select the right type of steel and cutting angle when machining, and to fine sand the wood with sand paper of the correct grain size. MDF board always requires a finer grade of sand paper than solid wood. For more details, see the section “Fine sanding wood”. Special regulations apply when surface treating MDF board.

Surfaces of non-wooden-based materials

Metal, glass, and wicker belong among the non-wooden-based materials used in furniture production. Metal materials such as **stainless steel (9)** and **aluminium (10)** are typically the strongest and most durable materials for application in furniture especially for outdoor garden furniture. Because of their strength and durability they can be shaped into more complex designs than other options, giving manufacturers greater flexibility in terms of style. Metal is also a great choice when used in combination with other materials that have their own functional and aesthetic benefits. Various production techniques can create metal chairs and tables that do not require bolts, screws or other fasteners that make other types of furniture more susceptible to breaking down. Other treated materials in the production of non-wooden-based furniture include **plastics (11)**, **wicker (12)**, **tempered glass (13)** and **concrete (14)**.









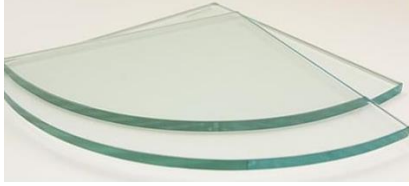

Surfaces of upholstery furniture

Upholstery furniture consists of construction frames and the finishing, filling, and covering materials. The construction frames of upholstery furniture are the part that bears the weight in upholstered furniture, which determines the shape, size and fastenings of the furniture such as the **seat (15)**, **pad board (16)**, **seat caning (17)** and the **rail and slats made of hardwood and softwoods (18)**. Upholstery furniture is made from hardwood, softwood, plywood, and composite agglomerated boards with chips such as **oriented strand board(OSB)(19)** with oriented stripes (chips), multifunctional panels, middle density fibre boards, high-density fibre boards and **upholstery cardboard(20)**. Several kinds of solid wood may be used for upholstery frames, including hardwoods and softwoods. The types of wood depend upon the final piece, including function, style, and quality.









| SURFACES OF WOODEN BASED MATERIALS | | |
|---|---|---|
| Keyword | Description | Image |
| (1) Massive Hardwood | These woods come from deciduous trees such as oaks or chestnuts. They grow slowly, have thick trunks, little resin, are very resistant, and difficult to work with. Hardwoods come in a wide variety of colours. |  |
| (2) Massive Softwood | These woods come from evergreens such as pines or fir trees. They grow quickly; usually have light colours, more marked rings, and a lot of resin. They are usually lighter and easier to work with than hardwoods. |  |
| (3) Plywood | Composite wood board formed by different sheets of unrolled wood veneer glued with the fibres transversely one above the other through strong pressure and heat. |  |
| (4) Composite board | Composite board consists of a central layer and a coating layer on both sides. The central layer can be of solid sheets or solid slats, among others, while the lateral ones can be of plywood. |  |
| (5) Particle chip board | Composite wood board made of chips from recycled pieces combined with synthetic resin glues and the application of heat and pressure. |  |
| (6) Middle Density Fibreboard | Composite wood boards manufactured from the decomposition of wood into fibres and the combination of these fibres with additional glues and waxes under different temperature and pressure conditions. |  |

| | | |
|--|---|---|
| <p>(7) High Pressure Laminate (HPL)</p> | <p>This composite is comprised of craft paper, impregnated with melamine formaldehyde resin and aluminium and then heated under high pressure to create an extremely hard, layered material, with a sleek look, resist to stains and scratches, with long-term durability, and possesses flame retardant and antibacterial properties. These materials are used as the material to boost and fill for the back and armrest.</p> |  |
| <p>(8) Multifunctional panel</p> | <p>Chipboards with chips on the top and unorganised chips in the middle layer.</p> |  |
| <p>SURFACES OF NON-WOODEN BASED MATERIALS</p> | | |
| <p><i>Keywords</i></p> | <p><i>Description</i></p> | <p><i>Image</i></p> |
| <p>(9) Stainless Steel</p> | <p>This sturdy metal alloy is extremely strong, a great material option for large weight-bearing outdoor dining tables, sofas and sectionals. Its high density helps prevent dents and other damage from frequent use.</p> |  |
| <p>(10) Aluminium</p> | <p>The most popular metal for outdoor furniture, lightweight, strong, durable and easily worked into a variety of shapes, relatively inexpensive, with low maintenance and it never rusts.</p> |  |
| <p>(11) Plastic</p> | <p>Synthetic polymeric resin and plastic, and hybrid compositions are a lightweight, inexpensive material. The colour of plastic furniture is inherent, so they do not require other coating materials. They are also easy to clean and maintain. They can be moulded into any decor style of furniture.</p> |  |
| <p>(12) Wicker</p> | <p>This natural material is made from a variety of organic sources such as rattan, cane, bamboo, rattan sea grass, bamboo, banana leaf, and even willow.</p> |  |





| | | |
|--|--|---|
| <p>(13) Tempered Glass</p> | <p>This material is resistant to temperature changes, but is very heavy and hard to move. Lacquering the glass increases its protection against harmful chemicals.</p> |  |
| <p>(14) Concrete</p> | <p>Concrete can serve as a sturdy base of furniture or as a table top sitting upon a metal frame. Concrete is a strong, timeless material, which can be poured into a variety of shapes and which, when reinforced with fibres, can be moulded into thinner constructions.</p> |  |

SURFACES OF UPHOLSTERY FURNITURE

| <i>Keywords</i> | <i>Description</i> | <i>Image</i> |
|--|--|---|
| <p>(15) Seat</p> | <p>Sitting surfaces for stools, chairs, sofa</p> |  |
| <p>(16) Pad board</p> | <p>Sitting surface upon which to affix upholstery</p> |  |
| <p>(17) Seat caning, seat wicker work</p> | <p>Handmade wickerwork. Wicker is a technique for making products woven from any one of a variety of pliable plants.</p> |  |
| <p>(18) Rail and slats made of hardwoods and softwoods</p> | <p>The most load-bearing parts in furniture especially rails and parts for fixing legs and glides.</p> |  |
| <p>(19) Oriented strand board</p> | <p>The type of engineered wood similar to particleboard, formed by adding adhesives and then compressing layers of wood strands.</p> |  |
| <p>(20) Upholstery cardboard</p> | <p>They are used for filling the surfaces of armrests.</p> |  |

Unit 2.2

Finishing materials

| EDUCATIONAL APPROACH | | | CONTENT |
|---|--|---|---|
|  Course book |  Additional readings |  External links | |
| ASSESSMENT | DURATION | ECVET | Finishing materials for wooden- and non-wooden-materials 11 Finishing upholstery furniture 11 Classical covering material for finishing upholstery furniture 12 Modern covering material for finishing upholstery furniture 12 Filling material for upholstery furniture 12 |
|  Quiz (at the end of the module) | 1 HOUR | 0.04 Credits / 0.2 total of the module | |



Unit 2.2 Finishing materials

Finishing materials for wooden- and non-wooden-materials

The **finishing (31)** process is intended to highlight the aesthetic qualities of wood, permanently incorporating a suitable tone, touch, and brightness without losing them due to the effect of light, changes in humidity, temperature variations, and erosion over time.

We have to prepare finished surfaces before applying the coating materials on their surface. We must prepare wooden and non-wooden-surface by sanding or smoothing surfaces in the first step of finishing, especially if the surfaces of the wooden-based materials have any dents, gouges, or scratches. The next step deals with the glue that is put on the surface.

Wooden-based materials and non-wooden substrates need finishing materials that are in liquid form during their application. Finishing surfaces requires changing the liquid coat into a fast-coating film. Finished surfaces consist of several coating films. The finished surfaces would consist of a minimum of two coated layers instead of powder-coated materials and wax coated materials. Both layers are very important because wooden grains rise after the application of the first layer of coated materials.

Wooden finishing materials consist primarily of **binders (23)**, **solvents (22)** and a range of additives. Colour paints additionally contain **pigments (24)** and fillers. Depending on which binders they contain, lacquers, **paints (21)**, and fillers pass through different phases during the curing and drying process, and may therefore be classified as follows: **solvent evaporative finishes (26)**, **waterborne products (27)** air-drying products, reaction-curing products, **acid-curing systems (25)**, **polyurethane systems (29)**, **UV-curing systems (28)**, surface staining, and treatment with oil wax.

The coating materials are divided into:

- transparent coating materials (coating materials that enhance the texture of finishing surfaces)
- pigmented coated materials (coating materials that change the colour of the coated materials) and
- **semi-transparent or opaque coating materials (30)** (which contain pigments and dyes to change the surface colour, but the texture of finished wooden surfaces is not covered)

Finishings for wooden and non-wooden surfaces include paints, varnishes, and stains, for example, and they give a desired appearance to the wooden products, protect wood surfaces, prolong the durability of furniture and provide cleanable surfaces. The great impacts on the quality of finished surfaces have the used finishing materials in the exact order given by the manufacturer.

Finishing upholstery furniture

Different types of fabric are used to cover and for the feel of upholstered furniture. These fabric and filling materials are assembled and finished. This furniture can be upholstered without prior varnishing. The upholstery varies according to the type of furniture and is generally used in:



- Sofas. This begins with the webbing, the process of stapling elastic rubber strips to cover the surface of the backrest and the seats. Subsequently, the support fabric is placed at the rear of the backrest and finally the entire frame is covered by gluing it with laminated foam fabric. The final upholstery fabric is stapled on top of the rubber. Foam cushions are lined in parallel. The hole under the base is also covered with fabric. Once the upholstery is finished, the sofa is packed with protective plastic.
- Chairs. The foam pillow is placed at the bottom of the chair, wrapped with the fabric and fixed with staples to the aprons. It is possible to choose to cover the backrest with laminated foam fabric and then staple the final upholstery.

Classic covering materials for finishing upholstered furniture

The most loaded parts are the seat rails and the materials for fixing must be fast and durable, so **Jute (52)** is used for wrapping sofas and chairs.

The following types of textiles are used for finishing both types of classical upholstered furniture: **chenille (32)**, **cotton (33)**, **silk (34)**, **wool (35)** and **linen(36)**.

Modern covering materials for finishing upholstered furniture

Polyester textile (37), **Faux suede /microfibre /Ultrasuede textile (38)**, **Polyamide textile (39)**, **Olefin textile (40)**, and **textile from acrylic fabrics (41)** have the function of covering materials when finishing modern upholstery furniture. Faux leather is a particular kind of expensive finishing **(44)**.

The cover textiles are prepared in different kinds of woven patterns with different properties such as **Basket weave/Tweed (42)**, **Jacquard (43)**, **Duck/Canvas (44)**.


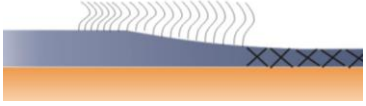

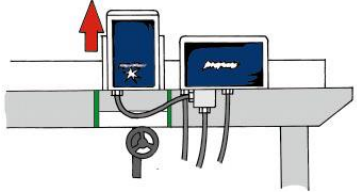


Filling material for upholstered furniture

The foams made from different polymer materials such as **Polyester Foam (45)**, **Core Foam (47)**, **Open Cell Foam (48)**, **Closed Cell Foam (floatation foam) (49)**, **Polyethylene Terephthalate (PET) Foam (50)**, **Polyurethane Foam (51)** and **sponge rubber (46)** and springs are used as the filling materials in upholstered furniture.

Mattresses are very important products among the upholstery products. They are put in the beds.



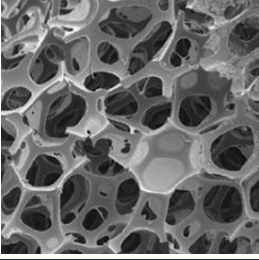
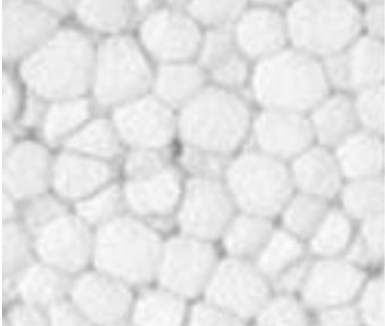

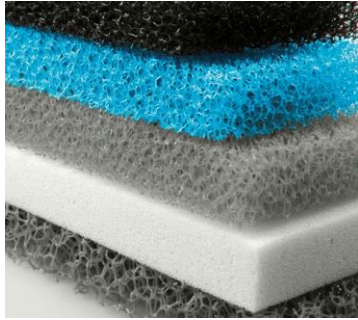

| FINISHING MATERIALS FOR WOODEN AND NON-WOODEN MATERIALS | | |
|--|--|---|
| Keyword | Description | Image |
| (21) Paint | A barrier or coupling coat used to seal the substrate or to increase adhesion and the finish layer of coats. |  |
| (22) Solvent | A liquid capable of dissolving a resin or solid and more broadly, the volatile portion of a coating mixture |  |
| (23) Binder, Resin | The general term for any polymer or monomer used as a binder or film former coating. The portion of the liquid part of a coating that does not evaporate. The binder is generally referred to as the resin. |  |
| (24) Pigment | In paint makers' parlance pigment is any dry particulate mineral and organic added to coatings, stains, fillers, etc. Pigments can be colourless, like the fine silica added to clear coating to reduce gloss, or it can be highly coloured, like the pigments ground into coating materials |  |
| (25) Acid curing (Catalysed lacquers) (varnish) | Two-pack acid-curing lacquers cure rapidly when the solvents evaporate. The hardener functions as an accelerating agent. At room temperature, most of the curing process is completed during the first 24 hours. This curing process can be sped up considerably with efficient ventilation and additional heat. The better the drying conditions (heat and ventilation), the better these finishes can meet the various demands placed upon them. This group comprises a wide range of products with different levels of surface resistance, some of which meet all combinations of standard requirements. This term includes all reactive, conversion, and catalysed finishes more specifically, for lacquers whose cure is initiated by an acid through a condensation reaction |  |

| | | |
|---|---|---|
| <p>(29) Polyurethane</p> | <p>Polyurethane lacquers and paints are cured as a result of a chemical reaction between the binder in the finish and the hardener based on the relative humidity. Drying and curing time can be reduced with proper ventilation and additional heat. The hardener is highly sensitive to moisture. Once opened, packages must therefore be resealed immediately after the desired dosage has been removed. In general, hardeners cannot be stored for an extended period. Pure urethane lacquers offer exceptional surface resistance.</p> |  |
| <p>(26) Solvent evaporative finish</p> | <p>Coatings (also called solvent release finishes) that form films by the evaporation of their volatile component, with no polymerisation or other cross-linking taking place during drying. Consequently, they can be dissolved again by their solvent at any time, even long after cure. Some examples are nitro lacquers.</p> |  |
| <p>(27) Acrylic waterborne lacquers coatings</p> | <p>Today's waterborne lacquers often satisfy very high resistance requirements. There is a versatile group of water borne and solvent binding agents with the highest performance with regards to light and weather resistance.</p> |  |
| <p>(28) UV curing</p> | <p>UV-curing lacquers are cured by ultraviolet radiation in special ovens. These lacquers often have a very high dry content and produce a full-bodied film in spite of the low quantity applied. The shelf life is more limited than for other lacquers, about 3-4 months. They normally satisfy the most stringent requirements.</p> |  |
| <p>(30) Semi-transparent opaque coating</p> | <p>These oil based lacquers, solvent-borne alkyd lacquers have more pigments that give additional protection to wood.</p> |  |
| <p>(31) Finishing</p> | <p>This is intended to highlight the aesthetic qualities of the wood, incorporating a suitable tone, touch, and brightness permanently.</p> |  |

| COVERING CLASSICAL MATERIAL FOR FINISHING UPHOLSTERY FURNITURE | | |
|--|---|---|
| Keyword | Description | Image |
| (32) Chenille | Comfortable velvet fabric that comes from natural silk fibres, but it can be made from synthetic materials like rayon |  |
| (33) Cotton | Natural cotton fabrics can be used in rough as well as light in texture, they are not fade resistant. The rough fabric collection comprises canvas and sailcloth. Delicate cotton materials include toile, gingham and chintz. This upholstery fabric is typically a blend, combining this stylish, nylon, comfortable and breathable natural fibres with polyester, linen etc. for added texture, strength, or resistance to soiling and wrinkling. The best quality cotton blends will generally contain about 46% to 60% cotton. |  |
| (34) Silk | Natural soft and luxurious material, silk feels perfect at home in a formal setting. Silk is sometimes backed with cotton to add weight and durability. Sunlight can cause silk to fade. |  |
| (35) Wool | The most natural durable upholstery fabric used as the covering materials for sofa, an accent chair is actually a blend of natural and synthetic fabric, with a great texture and feel. The piece keeps its shape and is less resistant to stain. Its blend helps fabrics stand up better to wear and makes it easier to clean |  |
| (36) Linen | Natural fabrics, classic, breathable, extremely strong textile fibre is made from flax. The textile from linen are soft, smooth and lustrous fabric that offers excellent durability and natural resistance to moths, pilling and abrasions |  |






| COVERING MODERN MATERIAL FOR FINISHING UPHOLSTERY FURNITURE | | |
|---|--|---|
| Keyword | Description | Image |
| (37) Polyester textile | Durable, flexible, easy to clean, strong, and resistant to water damage and staining, these fade faster than other synthetic textiles: This material is tear-resistant and dries quickly. It can be used as covering textiles and synthetic filling options. |  |
| (38) Faux suede/Microfiber/ Ultrasuede textile | Typically, a polyester multi weave fabric with surface abrasion treatment giving it a fuzzy, suede pile to mimic suede, this fabric is an excellent choice for heavy-use family rooms and pets. It is very strong, abrasion resistant and easy to clean. |  |
| (39) Polyamide textile | Polyamide durable, highly resistant to abrasion, easy to clean covering textile |  |
| (40) Olefin textile | Very durable fabric suitable for upholstery covers. |  |
| (41) Textile from acrylic Fabric | Outdoor acrylic fabrics are strong, resistant to weather and damage due to use, resistant to mould and mildew, resistant to rubbing and tearing, breathe able, and easy to clean. Very durable, colour fast, great for heavy use upholstery. |  |
| (42) Basketweave/Tweed | These texture woven fabrics that hide stains can be used in an upholstery application depending on their double rub rating. Higher double rubs will reduce pilling and fabric pulls. |  |

| | | |
|--|---|---|
| <p>(43) Jacquard</p> | <p>Typically, a heavier fabric, it has yarn dyed fibres that create a pattern, giving the fabric texture and style. A good fabric choice for home use, primarily moderate use and decorative pieces.</p> |  |
| <p>(44) Duck/Canvas</p> | <p>Strong plain weave fabrics, ideal for printed designs, made of cotton. This fabric shape can warp over time with heavy use, so it should be used on moderate-use furniture.</p> |  |
| <p>(44) Faux Leather</p> | <p>Easy to clean and makes a great choice for children's furniture and high-usage pieces. Clean and condition appropriately to reduce the risk of cracking</p> |  |
| FILLING MATERIAL FOR UPHOLSTERY FURNITURE | | |
| <p><i>Keyword</i></p> | <p><i>Description</i></p> | <p><i>Image</i></p> |
| <p>(45) Polyester Foam</p> | <p>Compressed foam is an inexpensive alternative to traditional foam. It dries quickly and is easy to wash. Polyester fibre-fill is another low-cost option that is machine washable and resistant to mildew. It is usually stuffed into an inner present cover that is then covered in outdoor fabric.</p> |  |
| <p>(46) Sponge rubber</p> | <p>Filling material is instead of spring</p> |  |
| <p>(47) Core Foam</p> | <p>Very good filling material for filling cushions and accent pillows for outdoor furniture. The foam core of your upholstery holds its shape and comfort level, it must be able to dry quickly and prevent damage from moisture too.</p> |  |

| | | |
|---|---|---|
| <p>(48) Open Cell Foam</p> | <p>Open-cell foam has pores that allow water and air to easily flow through it. It is built with an antimicrobial agent that protects the foam from mould and mildew growth that can occur in the drying process. Quick drying, comfortable and resists mould and mildew.</p> |  |
| <p>(49) Closed Cell Foam (floatation foam)</p> | <p>Foam repels water and is buoyant, making it a good choice for boat seating and life vests. It can be made from a variety of plastics including neoprene, polypropylene, polyethylene and polystyrene. Each version has its own unique characteristics and applications. Spongy neoprene, for example, is flexible and provides thermal and moisture insulation for wet suits. It repels water, floats and certain variations have benefits for specific applications</p> |  |
| <p>(50) Polyethylene terephthalate (PET) Foam</p> | <p>PET foam is durable, recyclable and provides optimum support for outdoor upholstery. They are firm and do not flatten out or lose their shape like some other materials. PET foam dries quickly, preventing moisture build-up that can lead to mildew and mould, and is supportive, eco-friendly, and quick drying.</p> |  |
| <p>(51) Polyurethane foam</p> | <p>This common affordable seating foam has a medium firmness and will soak up water if it gets wet. Most polyurethane foam is treated with a biocide that prevents fungus, mould and mildew from growing as the wet foam dries out. It is often wrapped in plastic for extra protection before being inserted into an outdoor cover. Positive properties are low price and resistant to biological issues.</p> |  |
| <p>(52) Jute</p> | <p>Natural fibres used for rope and matting. This a great material to accent rustic pieces such as ottomans, adding a somewhat rougher texture pairs well with wood and leather.</p> |  |

Unit 2.3

Application techniques

| EDUCATIONAL APPROACH | | | CONTENT | |
|---|--|---|--|--|
|  Course book |  Additional readings |  External links | |  Exercises and games |
| ASSESSMENT | DURATION | ECVET | | |
|  Quiz (at the end of the module) | 1 HOUR | 0.04 Credits / 0.2 total of the module | Drying and curing finished surfaces 21 Upholstery finishing techniques 21 | |



Unit 2.3 Application techniques

The finishing process of wooden and non-wooden materials consists of three steps:

1. The first step involves preparing the finishing surface by repairing the faults in the surface, by **sanding (67)**, bleaching or staining
2. The second step involves the coating treatment, which is a process to form a layer of material onto the surfaces.
3. The third step of the finishing process involves changing the liquid material on finishing surfaces into solid coating films by drying, that which by evaporating volatile organic compounds from coating layers or by curing, that means chemical reaction or resins of coating films or by curing UV or EBC radiation emitted UV lamps or EBC lamps.

Application techniques for finishing the surfaces of wooden materials

Machine-coated and handheld techniques are used to finish wooden and non-wooden furniture materials.

We can finish the surface of wooden by the following types of processes:

- manual finishing using handheld techniques and handheld tools, for instance **applying finishes by rag (53)**, **French polishing (54)**, **staining (55)**, **bleaching (56)**, **rubbing and polishing (57)**, **coating by brush (58)**, **pneumatic conventional spraying (59)**, **airless spraying (60)**, **airmix spraying (61)**.
- industrial finishing on assembly lines

Choosing manual or industrial finishing techniques depends on the amount of finished products, the shape and the size of the coated products, and the manner of finishing.

Industrial finishing involves coating finished surfaces using various methods of finishing including **roller coating (62)**, **curtain coating (63)**, **dip coating (64)**, **flow coating (65)**, spraying by robots or in automatic spraying, knife coating, hot melt coating, slot die coating, foam coating and printing and vacuum coating.

The most important industrial finishing techniques at present are **roller coating (62)** and spraying with an automatic spray machine.

Roller coating (62) is a rapid, simple and cost-efficient way of coating flat products and transferring the finish from the rollers to the object to be coated and has yielded excellent results. It has proved possible to increase the amount of finish applied, and the method can now even be used to achieve a premium quality topcoat. New rubber grades ensure that the rollers can withstand powerful solvents. They can also be manufactured with sufficient resilience to tolerate limited irregularities in the items to be coated.

The future of finishing techniques lies in robotic spraying.

Powder **coatings (66)** are a special type of environmental furniture finishing. This type of coating that is applied as a free-flowing, dry powder on the heated furniture surface. The powder lying on the surfaces melts into a liquid. The liquid coating later is usually cured by Ultraviolet light. The powder may be a thermoplastic or a thermosetting polymer. It is typically used to create a hard finish that is tougher than conventional paint. Powder coating is mainly used for coating of MDF and solid kinds of wood such as beech and birch.



Manual treatments use **brushes (58)**, **pads (53)**, rollers and three kinds of spray depending on the type of spray gun (conventional ("low pressure") **spraying (59)** which is divided into conventional spraying and HVLP spraying, airless spraying (60) and **air mix spraying (61)**. We can use also hot spraying and electrostatic spraying.

Drying and curing finished surfaces

Drying coating materials at room temperature normally takes a long time. This allows solvent emissions to spread, and results in an unnecessarily high environmental impact. This method also demands more storage space. The best way to speed up the drying process and at the same time reduce the occupational hazards posed by solvent emissions is to ensure that the process is "sealed" as far as possible. Curing at increased temperatures has been shown to enhance the properties of the finish.

We can differentiate the following manners of drying and curing

THERMALLY ACCELERATED DRYING AND CURING: the application of heat can sharply reduce curing times for several types of lacquers, for an acid-curing lacquer, for water-borne systems, for polyester systems and NC-modified PU-systems. The heat applied to the film of lacquer to accelerate the curing process may be transferred in several ways:

- by convection:
- by radiation –**Infrared drying (68)**
- by conduction

In the furniture industry, conduction heat is used to pre-heat the products in convection or radiation ovens. The film of lacquer is then heated by the substrate, causing rapid the solvents to evaporate rapidly.





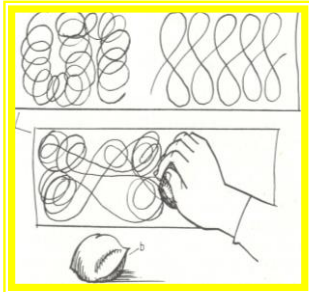

UV curing (69) in UV-curing ovens is a special kind of curing process. UV curing is the operation during which UV-reactive materials are cured by irradiating them with ultraviolet light. This leads to very short curing times. UV lamps may be mercury-vapour Ga and LED lamps, which are most appropriate for clear lacquers, or gallium lamps, which are required for curing paints. The power and wave-lengths of the lamps may vary. With UV-curing, there is normally no need to preheat the substrate or build evaporation or cooling zones. Consequently, finishing lines that include a UV-curing unit can be made much shorter and much more energy efficient than lines with equal capacity that feature conventional ovens. Old-style UV lamps generate more IR than UV radiation. Every industrial operation that uses UV radiation equipment should have access to metering equipment to control the process and to ensure that complete curing is always achieved. UV curing ovens feature reflectors in the first unit that can be raised or lowered in order to adjust the gloss level.

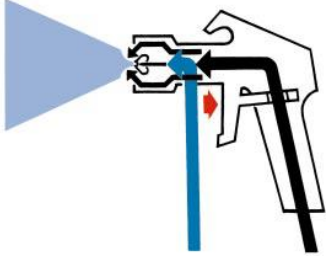
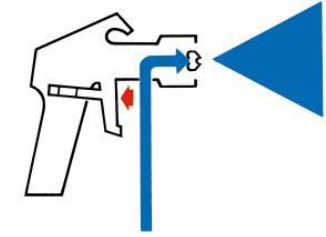
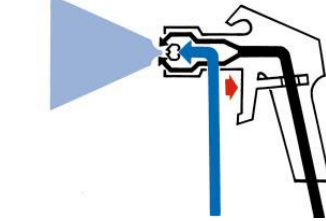
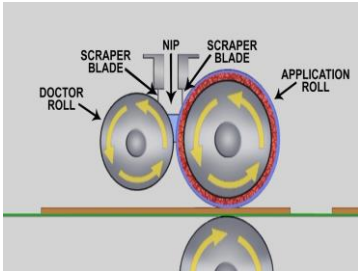
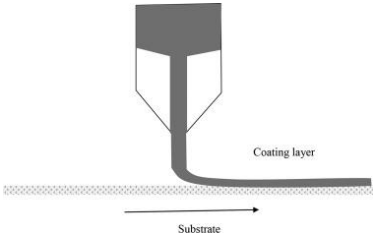
Upholstery techniques of finishing

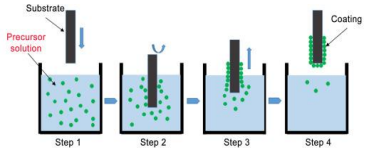


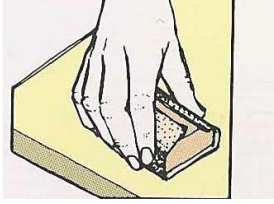
In **upholstery (75)** production there are no major differences in the manual and industrial techniques, which treat the finished materials during this kind of furniture production. These include **adding staples (70)**, **cutting fabrics and other flat upholstery materials (71)** and **upholstery sewing using sewing machines (72)** **spraying upholstery glue (73)**, **gluing by hot melt gun (74)** and **webbing(76)**.

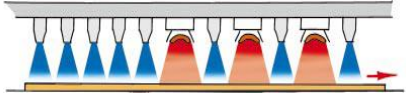

Industrial techniques only apply to **mattress production (77)**.




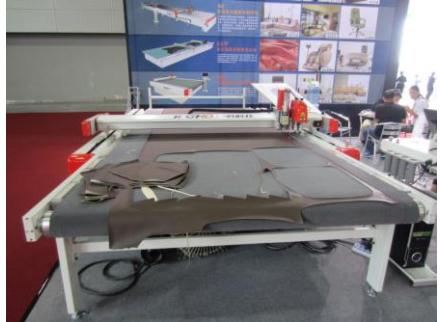

| APPLICATION TECHNIQUES FOR FINISHING SURFACES WOODEN MATERIALS | | |
|--|--|---|
| Keyword | Description | Image |
| (53) Applying finishes by rag | Applying the finish with a rag is simply a matter of wiping the finish on. This technique allows the operator to apply only a small amount of finish to stay on the wood |  |
| (54) French polishing | The process of the applying a thin, even coat of shellac with a cloth pad. |  |
| (55) Staining | This is the process of wood colouring by putting the colour (with dyes and pigments) directly onto raw wood. |  |
| (56) Bleaching | The process of lightening the wood surface colour through bleach |  |
| (57) Rubbing and polishing | The task of rubbing using abrasives, which are minerals, or steel wood |  |
| (58) Coating by brush | Applying the coats on the surface using different kinds of brushes |  |

| | | |
|---|--|---|
| <p>(59) Conventional pneumatic spray</p> | <p>During pneumatic spraying the liquid finish is mixed with air inside in the body of the spray gun. The liquid finish is atomised by mixing it with air to form small droplets. These droplets are propelled towards the surface of wood at a fairly high speed. When the droplets of finish hit the wood, droplets come together and form the coating film.</p> |  |
| <p>(60) Airless spray</p> | <p>This method is a high-pressure technology for spraying large projects without atomising the spray materials. It is a rapid method with minimum overspray. With airless spraying, the finishing material is fed forward to the spray-gun nozzle under high pressure (as much as 200 bar). It is atomised as it passes through the spray gun nozzle. The pressure is generated by a piston pump. The spray width and the quantity of paint/lacquer are adjusted by replacing the spray-gun nozzle. Airless spraying is now widely used when applying water-borne finishes with automated spray coating systems.</p> |  |
| <p>(61) Airmix spray</p> | <p>Airmix spraying is a combination of the methods described above. This is one of the most commonly used spraying methods in the wood finishing industry thanks to fine atomisation and minimum overspray. The combination features pneumatic spraying and airless.</p> |  |
| <p>(62) Roller coating</p> | <p>The principle of this type of finishing consists of applying a thick film of material after the roller gap by applying the roller onto the surface of the work piece. The roller gap is the gap between doctor roller and application roller. The film is rolled, passing through the roller gap by applying the roller against the work piece. As a result, the coating process finishes in a few seconds without any overcoat or waste. The transport system is very important.</p> |  |
| <p>(63) Curtain coating</p> | <p>Curtain coating is a type of coating operation with a coating layer that is formed in the head of the machine before it comes into contact with the substrate. Curtain coating process creates an uninterrupted curtain of fluid that falls onto a substrate of the object to be coated.</p> |  |

| | | |
|--|---|---|
| <p>(64) Dip coating</p> | <p>Dip coating is a process in which the substrate is immersed in a liquid and lifted out of the solution at pre-set parameters controlled by continuous motor.</p> |  |
| <p>(65) Flow coating</p> | <p>Flow coating is an automated method of applying industrial liquid coatings. It involves directing the speed of numerous individual streams of coating over one or multiple parts that move horizontally on a conveyor. Flow coating can be used to cover multi-dimensional surfaces of a variety of shapes.</p> |  |
| <p>(66) Powder coating</p> | <p>Powder coating uses dry powder to coat materials without the need for solvents to keep the binder and filler parts in liquid form. The powder particles are drawn to the surface of the coated material. It is applied by using electrostatics. These particles can easily be wiped off at this stage. To make the coating stick, the powder is cured in an oven, thereby creating a skin. This type of coating is more environmentally friendly than liquid coatings. The powder particles will reach everywhere, so you can cover nearly any object shape.</p> |  |
| <p>(67) Sanding</p> | <p>Sanding is tedious. The goal of the sanding is to get the surface smooth enough to finish the piece as quickly as possible. There are two primary reasons for sanding: to create the best possible surface, by removing raised fibres, burls, excess lacquer and any surface defects; and to ensure good adhesion between different coats of lacquer.</p> |  |

| DRYING AND CURING FINISHED SURFACES | | |
|-------------------------------------|--|---|
| Keyword | Description | Image |
| (68) Infrared drying | Infrared drying uses the energy from IR radiation to directly heat the bulk of the coating materials. The heat energy is applied directly into the finished surfaces. It is transfer from the finished surface into coating materials with no other transfer medium. |  |
| (69) UV curing | UV curing is the process by which ultraviolet light is used to initiate a photochemical reaction that generates a cross-linked network of polymers. The UV lamps, used for UV curing, are mercury lamps, LED lamps and Ga lamps. The major peaks are 350-420 nm. |  |

UPHOLSTERY TECHNIQUES OF FINISHING

| Keyword | Description | Image |
|---|--|---|
| (70) Adding staples | Furniture work with upholstery staple guns uses staples to connect the upholstery materials to the upholstery frames. The work is more precise and easier with staplers. |  |
| (71) Cutting fabrics and other flat upholstery materials | To cut fabrics and other flat upholstery materials a long surface with a built-in yardstick on one edge and a long groove for scissors going across the centre is typically used to divide the upholstery materials and fabrics. |  |
| (72) Upholstery sewing using sewing machines | Upholstery sewing machines are used to connect the upholstery fabrics through the process of sewing. |  |







| | | |
|--|---|---|
| <p>(73) Spraying upholstery glue</p> | <p>Spraying contact or water-borne adhesives on the surface of upholstery materials, which are connected by adhesion to both materials by adhesive film.</p> |  |
| <p>(74) Gluing by hot melt gun</p> | <p>Hot melt glues must be melted in a hot melt gun in front of the hot melt glue coating that is to be applied on the upholstery furniture surface.</p> |  |
| <p>(75) Upholstery</p> | <p>This consists of lining, using different types fabrics for furniture once it is assembled and finished. Some pieces of furniture that can be upholstered without prior varnishing.</p> |  |
| <p>(76) Webbing</p> | <p>The stapling process of elastic rubber strips to cover the surface of the backrest and the seats to be upholstered. It is used in both chairs and sofas.</p> |  |
| <p>(77) Mattress production</p> | <p>Mattresses belong among upholstery furniture and include filling and covering materials, the frame, coils, edge-guards, wiring and other related metal components.</p> |  |

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Unit 2.4

Machines and tools

| EDUCATIONAL APPROACH | | | CONTENT |
|--|--|---|---------|
|  Course book |  Additional readings |  External links | |
| <p>Machines and tools for finishing wooden and non-wooden furniture 28</p> <p>Machines and tools for finishing upholstery furniture 29</p> | | | |
| ASSESSMENT | DURATION | ECVET | |
|  Quiz (at the end of the module) | 1 HOUR | 0.04 Credits / 0.2 total of the module | |



Unit 2.4 Machines and tools

The quality of the appearance of finished surfaces and the physical-mechanical and chemical properties depends also on the techniques applied and on the quality of the machines and tools. The quantity, size, and shape of the finishing surface and the quantity and size of upholstery furniture play important roles in choosing the machines and tools.

Properly selecting the finishing machines and tools and upholstery machines and tools has become increasingly important to any company that does finishing or produces upholstery furniture due to the capital costs for finishing and producing upholstery furniture. Determining the correct finishing system and the equipment for upholstery production starts with an understanding of two general categories of finishing machines and tools.

Machines and tools for finishing wooden and non-wooden furniture

From the point of the quantity, the shape and the size of the products we can divide machine and tools into two groups:

- Manual finishing. Handheld manual tools, **finishing rags (78)**, **French polishing pad (79)**, different kinds of brushes, such as the **bristle brush (80)** and **foam brush (81)**, handheld rubber and **polishers, paint pad (82)**, grinders or handheld sanding machines, for instance **rubber and polisher sanders (83)**. Manual finishing involves carrying out the coating and drying process together on the finishing room floor.
- Spraying machines can be used in manual finishing and industrial finishing process. Workers can use sprays, or automatic spray machines **(91)** or **spraying robots (92)** can be equipped with the following types of spray guns: conventional **spray guns (84)**, **airless guns (85)** and **airmix guns (86)**.
- Mechanised industrial finishing uses machines, which improve the productivity and ensure the finished surface quality. Machines for coating and drying or curing and, of course, preparing the wooden and non-wooden surface are the components of finishing treatment assembly lines.

These finishing assembly lines consist of:

- ✓ **s curtain coater(87)**(one head or two or three heads)
- ✓ **a roller coating machine(88)**(which features two or three rollers).The rollers are separated in the roller coating machine with the synchronised application roller, relative process roller application and roller coating with reversible rollers.
- ✓ **spraying machines**(i.e.:automatic **spray machines (91)**)with transversal spray units of stationary strip spray or moving spraying guns, **spraying robots (92)** and **flow coaters (90)**
- ✓ a dip coater, **dip coating equipment (89)**

When considering the proposed potential volume, deciding whether to use manual or mechanised processes is an important starting point.

Assembly lines for preparing surfaces are equipped with different kinds of **sanders (93)**, with different sanding processes (belts, cross belts, and trans belt, and sanding rollers)and equipped with different kinds of **sandpaper (94)**.



The following are used for drying and curing the coats: UV curing tunnels with **UV curing lamps (95)**, chamber dryers, and drying rooms, along with speed ovens.

Machines and tools for finishing upholstery furniture





In upholstery product finishing there are no so great differences in the types of equipment between manual production and industrial production.

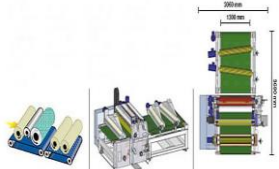
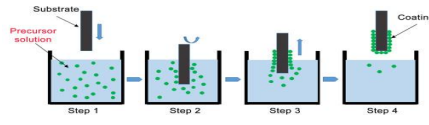



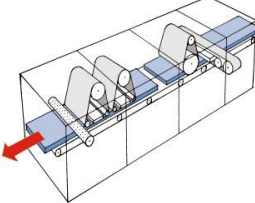

Both types of production use **upholstery sewing machines (96)**, **upholstery spray glue guns(97)**, **staplers (98)**, **tables for cutting fabrics (99)** and other flat upholstery materials for layering.

The differences are only in the size of the equipment and in the number of machines and tools.



| MACHINES AND TOOLS FOR FINISHING WOODEN AND NON-WOODEN FURNITURE | | |
|--|--|---|
| Keyword | Description | Image |
| (78) Finishing rag | Tool for simply applying a small amount of finish. |  |
| (79) French polishing pad | Used to apply a thin, even coat of shellac with a cloth pad. |  |
| (80) Bristle brush | This tool transfers virtually any finish to virtually any surface shape and spreads it without wasting any of the finish. These brushes come in many shapes and sizes and the bristles are made of different types of materials. |  |
| (81) Foam brush | Foam brushes look like a brush shaped chunk of dark grey foam rubber on wooden stick. |  |
| (82) Paint pad | The tool applies a lot of materials very quickly and works very well with clean water-borne lacquer. |  |
| (83) Rubber and polisher | The equipment used to rub with abrasives, which are minerals, or steel wood |  |






| | | |
|--|---|---|
| <p>(84) Conventional spray gun</p> | <p>Spray guns atomise liquid finish into tiny droplets and direct them in a controlled pattern toward the wood.</p> |  |
| <p>(85) Airless gun</p> | <p>Airless guns are pieces of equipment for spraying large projects without atomising the spraying materials, and which are under high pressure.</p> |  |
| <p>(86) Airmix gun</p> | <p>This gun is a combination of an airless and a conventional spray gun. This is one of the most commonly used devices in the wood finishing industry, thanks to fine atomisation and minimum overspray.</p> |  |
| <p>(87) Curtain coater</p> | <p>The machine for the curtain coating process, which creates an uninterrupted curtain of fluid that falls onto a substrate of the object to be coated. For optimum usage, the excess liquid can also be collected in a catch pan and be directed towards the holding tank to reuse for the same process.</p> |  |

| | | |
|---|--|---|
| <p>(88) Roller coater</p> | <p>Roller coaters are used for finishing with a thick film of material after the roller gap by the applying roller onto the surface of the finished surfaces.</p> |  |
| <p>(89) Dip coater</p> | <p>Dip coaters consist of a pool with coating liquid, in which the substrate is immersed in a liquid and lifted out of the solution at pre-set parameters controlled by continuous motor.</p> |  |
| <p>(90) Flow coater</p> | <p>This automated machine applies industrial liquid coatings. It involves directing the speed of numerous individual streams of coating over one or multiple parts that move horizontally on a conveyor.</p> |  |
| <p>(91) Automatic spray machine</p> | <p>This type machine with a spraying unit and a paint recovery system, works best with water-borne finishes, although can also be used successfully with solvent-based lacquers where a slow-evaporating solvent can be used. Modern automatic spray machines can operate at fairly high conveyor speeds: 8 metres per minute.</p> |  |
| <p>(92) Spraying robot</p> | <p>A machine that is equipped with a computer memory that can be programmed and is designed to carry out a physical task is called a robot. Robots offer an attractive alternative for heavy or monotonous jobs. They have limitations in painting large numbers of items of varying shapes and sizes. They are ideal for small to medium sized products, when looking for flexibility and productivity as well as cost-effective use.</p> |  |
| <p>(93) Sander</p> | <p>This type of sanding unit can be used for fine sanding wood and finished coats. They can include a transverse sanding belt, sanding pad, a wide belt sander with sanding pad, a roller sander or various combinations of any of these.</p> |  |
| <p>(94) Sandpaper</p> | <p>Sandpaper is made by gluing pieces of mineral or grit onto flat backing. The back can be paper, polyester, cloth or fibre.</p> |  |

| | | |
|---|--|---|
| <p>(95) UV lamps</p> | <p>UV HG, Ga and LED lamps emit UV radiation to cure UV coating materials</p> |  |
| <p>MACHINE AND TOOLS FOR FINISHING UPHOLSTERY FURNITURE</p> | | |
| <p><i>Keyword</i></p> | <p><i>Keyword</i></p> | <p><i>Keyword</i></p> |
| <p>(96) Upholstery sewing machine</p> | <p>Upholstery sewing machines are used to connect upholstery fabrics by sewing.</p> |  |
| <p>(97) Upholstery spray glue gun</p> | <p>The equipment for spraying contact or water-borne adhesives on the surface of upholstery materials, which are connected through the adhesion of both materials by an adhesive film.</p> |  |
| <p>(98) Stapler</p> | <p>Equipment to connect upholstery materials to upholstery frames using upholstery staples.</p> |  |
| <p>(99) Table for cutting fabrics and other flat upholstery materials</p> | <p>Equipment for cutting fabrics and other flat upholstery materials. This table is used for dividing the upholstery materials and fabrics usually on a long surface with a built-in yardstick on one edge and a long groove for scissors going across the centre.</p> |  |

Unit 2.5

Types of auxiliary materials and their properties and handling

| EDUCATIONAL APPROACH | | | CONTENT | |
|---|--|---|---------|--|
|  Course book |  Additional readings |  External links | |  Exercises and games |
| ASSESSMENT | DURATION | ECVET | | |
|  Quiz (at the end of the module) | 1 HOUR | 0.04 Credits / 0.2 total of the module | | |



Unit 2.5 Types of auxiliary materials and their properties and handling

The auxiliary materials in finishing wooden and non-wooden furniture and in upholstery furniture play a very important role.

This material improves product appearance, enhances furniture increases durability of the products or materials applied in furniture and helps to improve the quality of the furniture production.

Auxiliary materials for finishing wooden and non-wooden materials

Preparing special surfaces, measuring the quality of finished materials, removing bad or old finished surfaces with defects are all very important for the proper quality of finished surfaces.

Helping to repair the finished surfaces of quality furniture is possible by removing the coats from the surfaces using **strippers (100)** and **scrapers (101)**. Auxiliary materials can improve the quality of the finishing surface in order to reach the special surface shape and to improve the quality of finished surfaces by sanding coated surfaces using **steel wool (103)** and **wire brush (104)**. **Masking tape (102)** is a very important material used during the finishing making special patterns.

Checking the quality of the finishing materials and maintaining the technological processes during coating is one of the most important matters in order to at high-quality finished surfaces. Therefore the equipment to measure the properties of coating materials plays a very important role among tools used in furniture finishing.

The equipment to measure the quality and properties of coating materials, such as their viscosity with **viscosity cups (106)** and the amount of coated materials on surface through **wet film thickness gauge (105)**, is very important to achieve high-quality finished surfaces for the entire piece of furniture, because the “finished surface sells the product”.

Auxiliary materials for upholstery furniture

The quality and comfort of upholstery furniture can be improved by using special auxiliary materials such as buttons, zippers, staples, and nails especially in modern upholstery furniture, which add **buttons (107)**, small fasteners, and **zip fasteners (110)**. Buttons are now most commonly made of plastic, but also frequently made of metal, wood or seashell, which join two pieces of fabric together.

However, **buttons (107)** may be sewn onto garments and similar items exclusively for ornamentation purposes. Buttons serving as fasteners work by slipping through a fabric or thread loop, or by sliding through a buttonhole.

Staples (108) are a type of two-pronged fastener, usually made of metal, used to join or bind materials together. Large staples might be used with a hammer or staple



gun for masonry, roofing, corrugated boxes, and other heavy-duty uses. Smaller staples are used with a stapler to attach pieces of paper together; these staples are a more permanent and durable fastener for paper documents than paper clips.

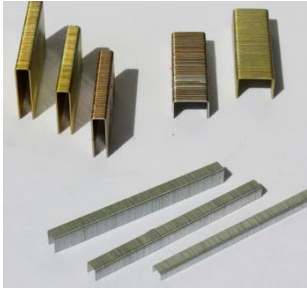

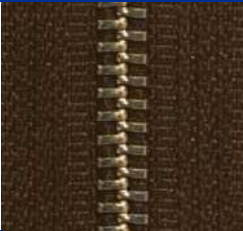


Other types of fasteners include zippers, Velcro, and magnets. Dingy, or **zip fasteners (110)**, formerly known as a clasp locker, are a commonly used device to bind the edges of an opening in fabric or other flexible material. Zippers come in all different sizes, shapes, and colours. The method, which is still in use today, is based on interlocking teeth. Initially, it was titled the "hookless fastener" and was later redesigned to become more reliable.

In upholstery woodworking and construction **nails (109) are used**, which are small objects made of metal (or wood, called a tree nail or "trunnel"). They are used as fasteners, as pegs to hang objects, or occasionally as decorations. Generally, nails have a sharp point on one end and a flattened head on the other, but headless nails are available. Nails are made in a great variety of forms for specialised purposes. The most common is a wire nail. Other types of nails include pins, tacks, brads, spikes, and cleats. Nails hold materials together by friction in the axial direction and shear strength laterally. The point of the nail is also sometimes bent over or clinched after driving it in to prevent the nail from being pulled out.

Springs (111) in particular **coil springs (112)**, have been used as materials in upholstery furniture for a long time. Springs allow for soft, bulky shapes with maximum resiliency.



| TYPES OF AUXILIARY MATERIALS AND THEIR PROPERTIES AND HANDLING FOR FINISHING FURNITURE | | |
|--|--|---|
| <i>Keyword</i> | <i>Description</i> | <i>Image</i> |
| (100) Stripper | Chemical medium that is used for removing old finishes. |  |
| (101) Scraper | The mechanical tool with a blade edge for removing old finished surfaces without taking paint out of the wood's pores. |  |
| (102) Masking tape | This tape helps isolate an area while an adjacent section is being stained. It is also used to separate paint colours on multi-coloured pieces and to keep glue joints clean during finishing furniture parts. |  |
| (103) Steel wool | Equipment for cleaning and preparing wood. |  |
| (104) Wire brush | Equipment for cleaning and preparing wood. |  |
| (105) Wet film thickness gauge | Tools used to measure wet coating. The gauge leave marks in the finish, so it is in an inconspicuous area. |  |
| (106) Viscosity cup | Small cup with a hole at the bottom for measuring the seconds it takes to empty a full cup. |  |
| TYPES OF AUXILIARY MATERIALS AND THEIR PROPERTIES FOR UPHOLSTERY FURNITURE | | |
| <i>Keyword</i> | <i>Description</i> | <i>Image</i> |
| (107) Button | A small fastener, now most commonly made of plastic, but also frequently made of metal, wood or sea shell, which joins two pieces of fabric together. |  |

| | | |
|---|--|---|
| <p>(108) Staple</p> | <p>A type of two-pronged fastener, usually made of metal, used for joining or binding materials together. Large staples might be used with a hammer or staple gun for masonry, roofing, corrugated boxes and other heavy-duty uses. Smaller staples are used with a stapler to attach pieces of paper together; such staples are a more permanent and durable fastener for paper documents than paper clips.</p> |  |
| <p>(109) Nail</p> | <p>Small object made of metal (when made of wood, they are called a tree nail or "trunnel") which is used as a fastener, as a peg to hang objects, or occasionally as a decoration. Nails have a sharp point on one end and a flattened head on the other, but headless nails are available. Nails are made in a great variety of forms for specialised purposes. The most common is a wire nail. Other types of nails include pins, tacks, brads, spikes etc. A nail holds materials together by friction in the axial direction and shear strength laterally. The point of the nail is also sometimes bent over or clinched after driving it in to prevent the nail from being pulled out.</p> |  |
| <p>(110) Clasp locker zip,fly,dingy, orzip fastener,</p> | <p>Device for binding the edges of an opening of fabric or other flexible material. Zippers come in all different sizes, shapes, and colours. Zippers are based on inter-locking teeth. Initially, it was called the "hookless fastener"</p> |  |
| <p>(111) Springs,</p> | <p>They are permitted soft, bulky shapes; they are later flattened for maximum resiliency.</p> |  |
| <p>(112) Coil springs</p> | <p>Mechanical devices which are typically used to store and subsequently release energy.</p> |  |

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