

Module Production engineering-Technology, process maintenance

Learning Unit 1-Material Properties

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Learning outcomes

- This module will enable you to:
Understand the importance of materials and the connection between materials' properties and engineering technologies required to process them.
- Understand and critically evaluate aspects related to production organisation and optimisation
- Understand and critically evaluate aspects related to automation in furniture manufacturing
- Ability to understand and critically analyse the eco-sustainability aspects in furniture production

How to learn?

- This course could be taken using a “self directed” learning approach.
- For those attending “full time” courses a lecturer will be directing your learning using the learning materials available.
- For those enrolled on a “part time” basis a mixed approach could be employed.
- Please see below recommendations for each of the situations:

How to learn? Self directed approach

- We suggest the following sequence:
- Read the slides, watch the videos and reflect on the content.
- Read the additional text available where information is more detailed.
- If possible discuss with a colleague or register for a “Forum” and express your views.
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How to learn? Full time approach

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How to learn? Mixed approach

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- Production technology, process and maintenance module is exploring engineering: origins, methods and context.
- It explores some key principles of engineering, while helping you to improve your study skills and develop as an independent learner.
- This module will outline the main advancements, developments, styles and materials in furniture design highlighting the identifying features of each period, the materials used and show images of some of the most significant pieces of furniture ever designed.

Wooden Furniture Manufacturing Process

- Video link: <https://www.youtube.com/watch?v=x4t5jRGt3M0>
- Short description: This short video clip shows how production is organised for the manufacturing of wooden furniture. It shows materials, different processes and gives a viewer a good idea of the operations involved from the beginning to the end.
- Duration: 7.08 min

A brief history of materials

- In the early days of human civilisation, people used only naturally occurring materials: stones and wood, but also animal hides, hair, grease and bone, and other vegetable products, like bark, leaves and fibres.
- All the processes used at that time worked with the natural properties of the materials. Shapes were changed (by cutting, breaking or grinding) and parts were assembled (using thread, for example), but no attempts were made to change the properties of the materials themselves..



Video Basic materials used in furniture

- Video link: <https://www.youtube.com/watch?v=LzYTKzS40xg>
- Short description: Do you know the difference between particle board, MDF, plywood and solid wood? Do you get confused by these terms when you are buying furniture? This short introductory video from Adona Woods will show the difference between engineered wood (particle board, MDF, plywood) and solid wood (hardwood and softwood). You will also know what costs more and what should be cheaper.
- Duration: 1:45 min

Iron and steel

- The extraction of iron from iron ore provides another useful material, with different properties. The advantage of iron over copper or copper alloys like bronze is that iron ore is very common.
- Higher temperatures are needed to melt iron, and the carbon used for the chemical process of extraction dissolves in the iron, which affects its properties. Not all the ore reacts, leaving slag within the metal.
- Because of this, the initial result of the early attempts at extraction of iron (around 2000 BCE) was a dull, brittle metal, not much more use than the ore from which it had been extracted.



Modern materials-aluminium

- Essentially, right up to the twentieth century, there were just two structural metals: copper (and its alloys) and iron (including steel). Now, wherever you look you find aluminium: in saucepans, kitchen foil, drink cans, window frames, power cables, aeroplanes, cars, and many more.
- Aluminium is the metal used for building aircraft; it is also finding use in some lightweight car bodies. It is light, strong, doesn't corrode easily, and is easily formed and machined. It can be hardened by alloying with a little copper.



(a)



(b)



(c)



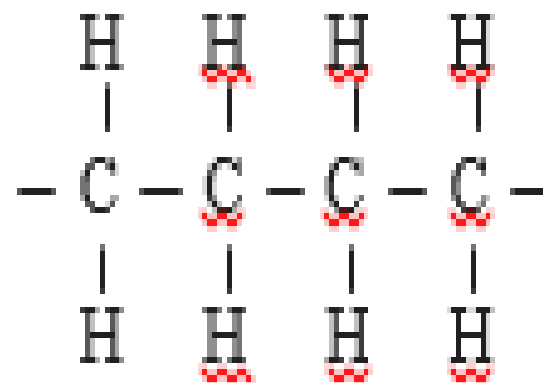
(d)



(e)

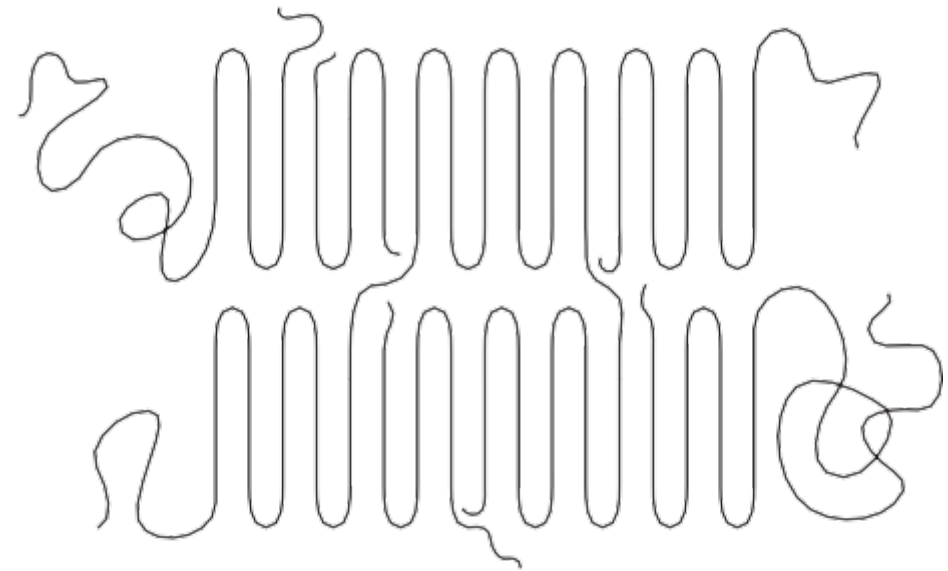
Polymers

- Plastics and other polymers consist of very long molecules, usually based on chains of several hundred to a few thousand carbon atoms with various other atoms, or groups of atoms, hanging off the sides.
- The chemical structure of the simplest of all plastics, polyethene (often called polyethylene or Polythene), is shown in Figure 2. The molecules consist of a long, long string of carbon atoms with hydrogen atoms linked onto the sides of the chain.



Complex polymers

- There are typically many thousands of atoms in a polyethene chain: the open bonds at the end of the section shown indicate that this is not the whole structure, but that it continues in the same pattern, repeated many times.
- String is a good analogy, because these long molecules of polyethene are flexible. When the solid forms, they can organise themselves into regular structures by folding back on themselves.



Polyethene

- High density polyethene (HDPE) consists of long individual chains, which may crystallise or be tangled together but remain essentially separate.
- This is a strong, tough and lightweight material widely used for household items like food containers, as well as in more sophisticated applications such as providing a hard-wearing surface for bearings in artificial joints for hips and knees.
- In low density polyethene (LDPE) the chains are chemically linked together (known as crosslinking) to form a loose network. This results in a very flexible transparent material used, for instance, for wrapping food.



Video Furniture manufacturing process- plastic furniture

- Video link: <https://www.youtube.com/watch?v=ezdJNR2stog>
- Short description: ATC Furniture Furnishings is leading manufacturer, vendor and exporter in Vietnam. ATC Furniture provides complete outdoor and indoor solutions. ATC Furniture Furnishings uses the latest development in lacquering, water hyacinth treatment, Polyethylene UV and Water Resistant materials to make a high quality versatile range of exterior and interior patio, lounge and dining furniture
- Duration: 3.50 min

Carbon-based materials

- Carbon is one of the most common elements on our planet. As well as providing the backbone for polymers, it exists in several different forms in a pure, or almost pure, state.
- Coal, diamond and graphite have very different physical properties. Coal is a weak and brittle material, not much use for making things.



(a)



(b)

Carbon based materials 2

- More sophisticated carbon-based materials are also under development. Tiny particles shaped like balls and tubes (Buckminsterfullerene, a molecule containing 60 carbon atoms in the shape of a football, is probably the most well-known) are of great interest to chemists, but have yet to find bulk applications.
- Graphene, which consists of a layer of carbon atoms just one atom thick, has more potential for engineering. It is exceptionally strong (about 200 times stronger than steel by weight) and a very good conductor of heat and electricity, while being reasonably flexible and almost transparent.



(a)

(b)

Material resources for engineering

- The word 'material' is used here in the general sense of a substance, which will usually fall into the category of metal, ceramic, polymer, or some combination of the three.
- Different materials are carefully chosen for various purposes in engineering, depending on the requirements of the situation and very specific terms are used to distinguish certain properties to help engineers to select the appropriate material for a particular job.



Product property, process and price

- Many of the outputs of engineering are physical products, either for a consumer to use directly (cars, televisions, washing machines, clothing) or as steps towards a wide range of other products (tools, machinery, chemicals, fabrics). Such products are made of some form of material.
- To fulfil the proposed function of a product, whatever it is, materials are chosen for their particular properties. For instance, a pen has to be rigid, a floor beam has to be stiff, and clothing needs to be flexible.
- These four words – product, property, process and price – are all interlinked. The final choice of material for a given situation will usually be a compromise between all four.

Describing materials

- The range of words used to describe materials, and the associated properties used to measure them, is vast.
- Strength and stiffness are examples of mechanical properties, which are generally connected with how a material responds to an applied force.
- Other characteristics of materials, such as their electrical and magnetic properties, are not so easy to see but may be equally important for some applications.
- In modern engineering, quantification of such properties, by measurement and tabulation, is essential to help select the most appropriate material for a specific application.



Describing materials

Term	Meaning	Example	Opposite
Strong	Capable of withstanding large forces before failing (and the way it fails depends on what it is).	Metals like iron are strong; an iron bridge can withstand considerable weight of traffic without breaking.	Weak
Tough	Not easily broken, resistant to cracking.	Wood is a tough material – trees may sway in high winds but they rarely break.	Fragile
Hard	Does not deform easily under a compressive force. Resistant to scratching or denting.	Stone is a hard material, often used for buildings and structures that need to stay the same shape.	Soft
Stiff, rigid	Not easily bent, or changed in shape.	A material can be stiff without being hard – for instance, a plastic CD case is stiff, but quite easy to scratch or dent.	Floppy, flexible
Elastic	Can be deformed, and will return to its original shape once the force is removed.	Rubber can stretch a lot and recover, without being permanently deformed.	Plastic
Dense	A dense material is one that has a large mass for a given volume.	Lead is a particularly dense metal, often used to add mass to something.	Light (for its volume), low density

Describing materials

- Some of the words commonly used in engineering to describe the mechanical properties of materials.
- Some of these words may seem very similar and the differences between them can be quite subtle. To confuse matters, some of the words are used in everyday language in a slightly different way. For instance, 'plastic' is used here to describe a physical property, not a class of material.
- A material behaves in a plastic way if it is deformed by a force and does not return to its original shape when the force is removed. You might not immediately think of describing a metal as either 'elastic' or 'plastic', but in fact most metals can display either of these properties, depending on the size of force they are subjected to.

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Video Furniture production and materials

- Video link: <https://www.youtube.com/watch?v=8vuCst3X2hg>
- Short description: A documentary about the different processes at a furniture industry. Made at the Rawat Furniture Factory in Pune.
- Duration: 6.58 min

Describing materials

- It is the combination of different properties that differentiates one material from another. Metals are usually hard and strong, but are also tough and flexible.
- Glass is hard and strong, but is also brittle and stiff. Nevertheless, glass has the useful property of transparency!



Prototyping

- The use of realistic looking 3D computer models has, in many instances, removed the need for physical prototypes, particularly where designs are incremental changes on existing design solutions.
- Many CAD modelling systems are so sophisticated that videos and walkthroughs of products or buildings are very realistic.
- In other design situations it is important to create and evaluate prototypes within the design team or with potential users to find out their responses to the product in terms of feel, size, features and other factors.



Computer Numeric Controlled prototyping

- CNC is widely used to manufacture components or to create the tools to manufacture furniture products. However, it may also be used to make prototype parts and components if the design is appropriate for the techniques used.
- The basis of CNC is that the machine shapes a block (billet) of material using cutting tools such as lathes, milling machines or routers.
- The limitations of CNC are that complex shapes may be very difficult or expensive to achieve if special equipment is needed.



Video Full automatic Intelligent CNC Router S2 for Cabinet furniture production

- Video link: <https://www.youtube.com/watch?v=GDZlhkJMyZg>
- Short description: Full automatic Intelligent CNC Router S2 for Cabinet furniture production has multi-functions of carving, engraving, milling, slotting, grooving, cutting, chamfer edge. Full automatic Intelligent CNC Router S2 is mainly used in furniture making industry, furniture decoration industry, wood craft industry, wood decoration industry, automotive tooling industry, solid wood furniture, solid wood door, classical furniture, decoration material, door cabinets, computer tables, plate furniture, office furniture, wooden sound box, wooden kitchen furniture and other processing.
- Duration: 6:50 min

Additive prototyping

- Prototyping, uses the build-up of layers of material to create physical prototypes and products. The range of materials that can be used in this way is growing all the time.
- Early machines used nylons and plastics to build prototypes, but the results were often very fragile.
- Additive techniques are now being used with plastics, metals, ceramics, concrete and even sand to create products that range in scale from small pieces of jewellery to furniture and buildings.



Module Production engineering-Technology, process maintenance

Learning Unit 2-Production technology and production optimisation

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Video Different types of furniture styles

- Video link: <https://www.youtube.com/watch?v=K9pXMeoeVxc>
- Short description: Without familiarizing yourself with a furniture styles guide, how will you know what type of furniture you're looking for in your home? If you want to go for a classic look, do you choose antique, traditional, or mid-century style furniture? And what is the difference between contemporary and modern? Everyone has a unique taste in the furniture by which they decorate their homes, but it can be hard to find "your look" if you don't know what it's called. A Brief History of Types of Furniture Styles
- Duration: 1.45 min

Traditional and modern furniture production methods

- The traditional large-factory, mass-production furniture industry has largely disappeared. Domestic furniture manufacturing in the future will hardly resemble yesterday's furniture industry.
- The industry developed around the biannual High Point market and typically spent months developing newly designed groups to send to market, hoping for sufficient orders to make the group viable.
- Bottlenecks in design and engineering resulted in a lengthy development process. If enough orders were placed during the market, then a large production run created warehouse stock for retailers to order.
- Furniture factories had been built to produce large batches of new product and as a result, they did not handle small batches efficiently, nor could they be flexible.



Video Furniture manufacturing plant in Denmark

- Video link: https://www.youtube.com/watch?v=kROXPaPC_tU
- Short description: The video shows a range of processes in a factory that manufactures furniture in Denmark. Old and very modern equipment sits side by side.
- Duration: 5.55 min

Comparing the Old Industry Model to the New Furniture Industry

- The new domestic furniture strategy focuses specifically upon customers' needs.
- This is not the commodity producer of yesterday that employed hundreds to manufacture in batches of thousands.
- The departure of those companies from the domestic manufacturing scene provides an opportunity for energetic, smart entrepreneurs with a keen sense of the market and a knack for manufacturing organisation to prosper.
- The new furniture companies are likely to be much smaller, energetic enterprises prepared to seize new opportunity in the marketplace by profitably manufacturing in batches of one.



Comparing the Old Industry Model to the New Furniture Industry

- The technology and manufacturing methods to quickly provide a customised or semi-customised product to the customer exist today. For example, a company could offer a standard product line with rapid order completion
- This business strategy contrasts sharply with the old industry, which mass-produced large batches with no customisation. Being able to communicate face-to-face with customers and responding to their needs will be a branding attribute of the new industry, focused on customer service, fast product delivery, and the ability to say “Yes!” to customer requests.
- The new factory concept includes constant innovation capabilities that add shapes and features easily and at low costs.
- This domestic industry will also be able to leverage a growing niche market demand for sustainable, green, solid wood products by using domestically grown woods.

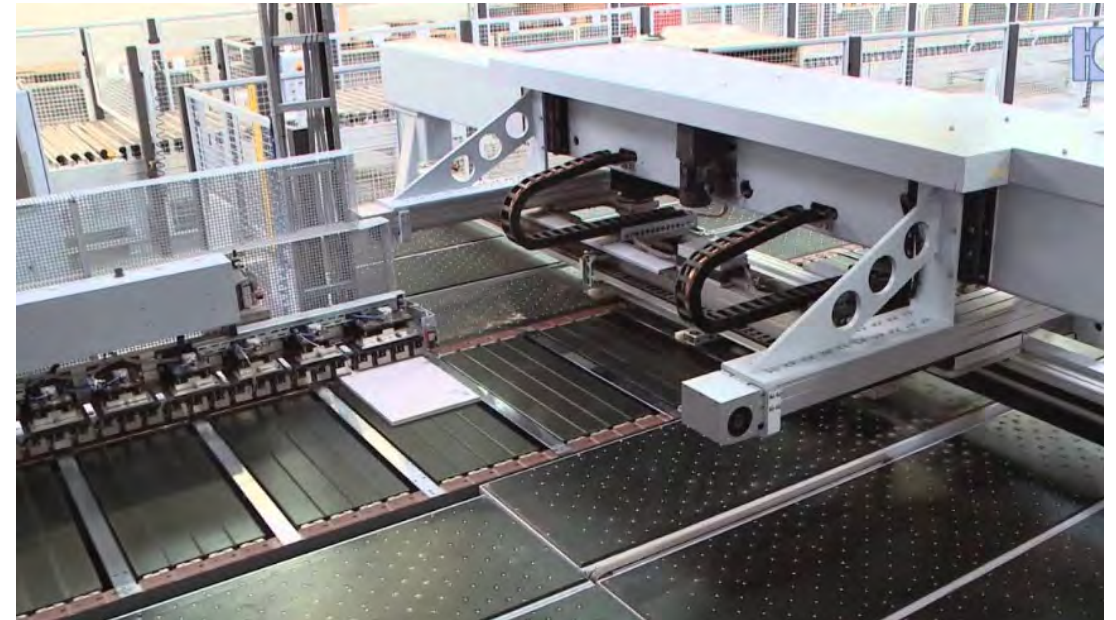


Video Smellink Classics EU furniture manufacturer

- Video link: <https://www.youtube.com/watch?v=qQZVrkzmbNo>
- Short description: Processes and operations in a very traditional furniture factory in Europe. They produce classic exceptionally good quality furniture using classic and modern technologies.
- Duration: 3.30 min

Comparison old industry and the modern one

- In the past, large case-good plants employed 300 to 500 low-skilled employees. The new case-good plant will be considerably smaller, employing 50 to 250 people.
- Because the new workforce will be better paid, more empowered, and self-motivated, it will be able to create a flexible workplace with minimum support or management supervision.
- Factory floor management will be open and visual, using simple computer networks accessible to production workers to track production and visual techniques to improve flow throughout.
- No longer will the supervisor keep the schedule on a piece of paper in his pocket



Comparison old industry and the modern one

	Traditional Concept	New Concept
Main Bottleneck	Design and Engineering	Plant Capacity
Quickness to Respond to Change	Very Poor	Very Agile
Investment in Raw Materials	Large	Small
Investment in Work-In-Process Inventory	Large	Small
Investment in Finished Goods	Large	Small
Investment in Equipment	Large	Moderate to Small
Investment in Facilities	Large	Moderate to Small
Cost of Sales Force	Large	Moderate to Small
Cost to Design/Engineer Products	Large	Moderate to Small
Labor Productivity-in Sales \$/Employee	Low	Moderate to High

Relationship between production methods and technology

- Modern Manufacturing Methods allow a case-goods factory to quickly manufacture and deliver a semi-custom or custom product to the customer at a low manufacturing cost.
- The controlling principles are efficient material and information flow and manufacturing flexibility throughout the process.
- The major Modern Manufacturing Methods help European factories take advantage of their close proximity to raw materials and markets.



Fast Track Engineering.

- The goal of this concept is to eliminate the design and engineering bottleneck of traditional furniture plants and decrease the time from idea generation to production and marketing. Ways to do that include:
 - a. Use pre-engineered designs that present different styles.
 - b. Offer a variety of products (SKUs) that share components. For instance, a chest of drawers, vanity, and nightstand in the same style will have many common parts (same drawer sizes, parting rails, etc.).
 - c. Using standard-sized parts and panels will facilitate the design process, as they will be already available in the parts library.
 - d. Offer set options on a basic model that vary the style or configuration, and set up a menu or chart that allows clients to choose quickly.
 - e. Incorporate 3-D design software that automates the modification of pre-engineered products and creates a bill of materials and part drawings from the user's choices.



Video Nobilia Kitchen Design & Manufacturing - German Kitchen Engineering

- Video link: <https://www.youtube.com/watch?v=32Dpi8NRhLc>
- Short description: Nobilia kitchens are well thought-out in every detail. Nobilia produces more kitchen cabinets every year than any other single brand kitchen cabinets manufacturer. Kitchens offer designers and consumers nearly endless design possibilities all to deliver perfect kitchens.
- Duration: 6.14 min

Flexibility and flow

- The old case-goods lumber cut-up operations were designed to handle large volumes of the same lumber, cutting the same thickness and species for hours or days.
- In the modern manufacturing factory, we want to flow parts and components through as quickly as possible and to speed needed information from order entry to the floor. Fast Track Engineering accomplishes this rapid flow of information.
- The design of the new factory needs to allow process flexibility so that quick changes can be made Multiple lines or workstations in the assembly area allow more than one item to be produced if needed.
- Finishing might be complete prior to assembly. Rather than having a long conveyor line, it may be more flexible to use carts to apply stains and a short conveyor to spray clear finishes.



Short Production Line

- The old case-goods factories were set up for large runs exemplified by the long conveyors used on the assembly and finishing lines.
- To achieve the flexibility previously discussed, the modern furniture factory is organised for small runs of high variety SKUs using short production lines.
- Flexible processing lines or work cells will eliminate material handling and load movement by combining operations.
- Short production lines provide a higher part quality because production can be better monitored when work isn't scattered across multiple workstations.
- Higher labour productivity, shorter throughput time, reduced scrap parts, and greater customization can be achieved by carefully using short production lines in machining, assembly, and finishing operations.



Reduced Set-Up Time

- Quick set up creates flexibility for the case-goods furniture manufacturer. Small batch sizes are possible only when set-up times are eliminated or significantly reduced.
- Converting several manual operations to a single CNC machining operation is a simple method to reduce overall set-up time.
- Modern Manufacturing Methods are only possible when set-up time is significantly reduced.



Quality Improvement.

- The elimination of large batches and development of short production lines will result in a close-coupled process.
- Manufacturing problems will surface and be corrected earlier, and the reduced inventory will make it easier to locate parts and less likely that they will be damaged in transit and storage.
- Simplifying and streamlining the manufacturing process eliminates much of the rework, repair, and replacement. Interrupting jobs to generate replacement parts required in assembly will become the exception rather than the rule.
- Quality improvement greatly reduces manufacturing costs and increase throughput.



Lot Sizes Small But Profitable

- The modern manufacturing factory is produce a customised, high-end product.
- The high average value of each unit will not require large daily volumes to support profitable manufacturing.
- The operation is streamlined with a flat management structure, more efficient engineering, standardisation of parts and panels, increased manufacturing flexibility, reduced rework and repair, and elimination of finished goods inventory.
- These efficiencies allows manufacturers to produce a limited, customised product in much smaller lot sizes.



Eliminate Most Finished Goods Inventory

- The make-to-order manufacturing strategy eliminates all finished goods inventory except those products awaiting shipment at the loading dock.
- This offers an advantage over the manufacturers that have abundant inventory tied up in warehouses and container ships.
- The future furniture industry initially focus on satisfying the market for customised products—a need the industry is currently not addressing.
- Satisfying the demand for customised, quality furniture with rapid order completion strategies will create a new market for furniture.



Video The IKEA Design Process for the FJÄLLBERGET Chair

- Video link: https://www.youtube.com/watch?v=R3zIlubmw_s
- Short description: the most famous artists are Louis Majorelle, Emile Gallé, Victor Horta, Alfons Mucha, Hector Guimard this is available in Nancy (musée de l'école de Nancy) in Paris (Musée des arts décoratifs, Musée d'Orsay, Musée Carnavalet
- Duration: 17.07 min

Empowered Employees

- Effective, skilled employees will reduce labour costs.
- Though these factory floor employees will require greater compensation, they will have the responsibility and the information required to be self-directed.
- These fully supported employees will be supplied with schedules, directions, drawings, and training to make decisions immediately. High job satisfaction among employees will reduce turnover.
- Indirect labour will be reduced by the improved flow of materials, assemblies, and information, which will reduce the need for supervision, material handlers, office support, parts storage employees, and repair personnel.



Visual Shop Floor Management.

- The visual shop floor will use visual indicators to quickly and effectively communicate the production status, inventory levels, materials placement, and order schedule and commitments.
- The goal is to create a workplace where problems are immediately obvious and which employees can quickly correct.
- Modern Manufacturing Methods can eliminate most of the facility, equipment, and inventory costs borne by the former large-factory case-goods industry and create a new case-goods industry offering high quality, high labour productivity, quick delivery, low capital and inventory investment, and high profitability.



Production technology, design and machinery

- Manufacturing processes for the development of a product are the fundamental bases that make up the operating lines within a company.
- All these correctly defined and aligned lines allow the generation of a product flow coordinated by the manufacturing system implanted in the company.



Module Production engineering-Technology, process maintenance

Learning Unit 3-Production technology and design machinery

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Video Elite Office Furniture Production Process

- Video link: <https://www.youtube.com/watch?v=wP0qWpcyLuo>
- Short description: The production process at Elite Office Furniture.
- Duration: 6.47 min

Production technology, design and machinery

- Manufacturing processes for the development of a product are the fundamental bases that make up the operating lines within a company.
- All these correctly defined and aligned lines allow the generation of a product flow coordinated by the manufacturing system implanted in the company.



Video Assembly line for furniture production

- Video link: <https://www.youtube.com/watch?v=itBJ599pUO4>
- Short description: Turnkey assembly line for furniture production. Designed & Manufactured in Sweden by Mindsource AB
- Duration: 3.48 min

Design and technology

- Design is one of the fundamental processes in the furniture manufacturing of any product. If you want to get a product efficiently and effectively you need to have it perfectly defined.
- The main requirements when designing a piece of furniture are to prepare the plans for the manufacture and assembly of the new carpentry and furniture products applying the rules of representation and defining the components for their manufacture:
- The specification and definition of the carpentry and furniture model is achieved by elaborating the views, sections and details according to the regulations.
- The drawing of the plans of products to be elaborated is made to scale, according to the specifications, manually or using the technique of design assisted by computer in two and three dimensions.
- .



How design influences technology

- The cutting plans are made incorporating the necessary information for the understanding of the model and indicating the sufficient dimensions for its later manufacture.
- The codification in the plane of the different pieces (scales, materials, level of finish), is carried out, to assure the objectives of manufacture of the product (aesthetically, technically and technically).
- Adjustments and tolerances are set according to the function of the parts and the type of fabrication.
- The components (screws, fitting) involved in a cabinet or carpentry construction are detailed and performed in the respective drawings, and the technical characteristics are specified for collection and valuation.



Video Furniture production on the way to Industry 4.0

- Video link: <https://www.youtube.com/watch?v=KUKI-c5uWbM>
- Short description: The HOMAG Group already fulfils many of the criteria of the Industry 4.0 vision. In recent years customers in the furniture industry have implemented a number of networked production concepts. This has enabled furniture manufacturers in trade and industry to produce millions of furniture designs and minimize delivery times using fully networked and highly flexible batch size 1 systems.
- Duration: 3.32 min

Cutting

- The machining of the wood allows obtaining pieces or planks of some dimensions and pre-established forms for the manufacture of furniture.
- Generally, the machining of solid wood requires operations such as marking, parting, sawing, planning, regrading, custom cutting, milling, drilling, turning, etc.
- Therefore, generally before making the cut to size it is necessary to obtain pieces or planks of wood with the necessary dimensions for the product designed or with the characteristics that our suppliers can adjust more to those we want.



Technologies for veneering edges

- Modern Manufacturing Methods allow a case-goods factory to quickly manufacture and deliver a semi-custom or custom product to the customer at a low manufacturing cost.
- The controlling principles are efficient material and information flow and manufacturing flexibility throughout the process.
- The major Modern Manufacturing Methods help European factories take advantage of their close proximity to raw materials and markets.



Technologies for edges and surfaces

- Edge machining comprises the operations performed to modify the edge geometry. Machining near the edge is also considered within this section, since the operation and the machines are the same.



Video IKEA to introduce furniture that snaps together in minutes without requiring tools

- Video link: https://www.youtube.com/watch?v=TOq3Bgln_K0
- Short description: The fiddly ritual of assembling IKEA products is set to become a thing of the past as the furniture giant introduces products that snap together “like a jigsaw puzzle”.
- Duration: 4.59 min

Technologies for grooving

- The object of the grooving is the insertion of a moulding in the edge, or the assembly of another piece on the face (for example, the back of the furniture on one side). The grooving can be performed over the entire length of the piece (through), or without covering the entire length (blind).



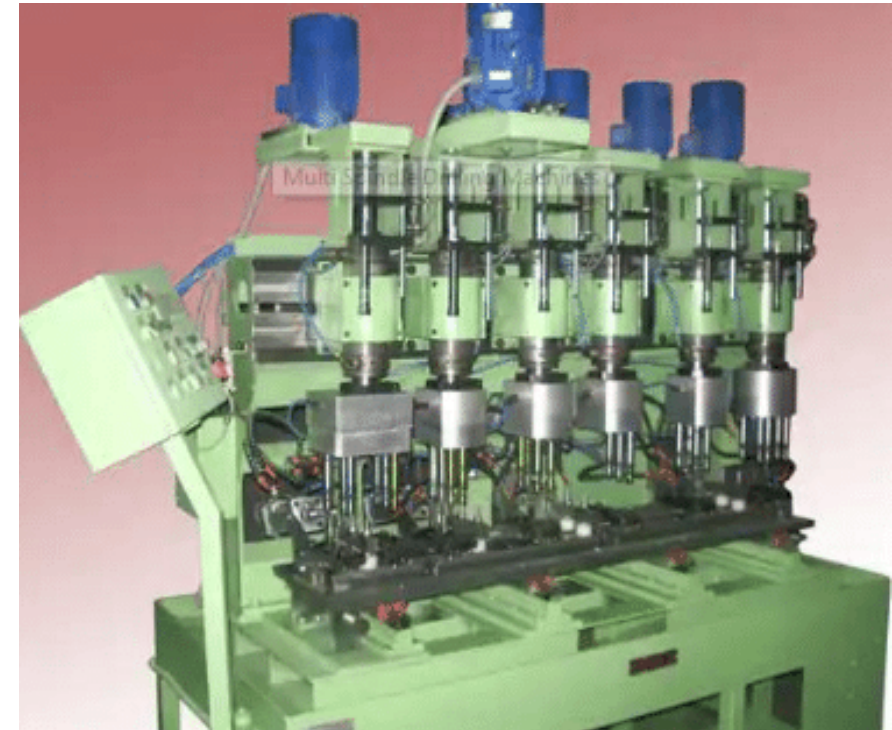
Technologies for rebating

- This operation consists of obtaining a profile at right angles to the same edge, forming a kind of step. It is intended to serve as a seat to another piece that forms a right angle with the machined part. It is usually used on the back of a module's costs, so the back is adjusted in step.



Technologies for surfaces=drilling

- We consider as surface machining all those machining operations performed on the faces of the part.
- Obtain a relief or figure on a surface.
- Make an emptying in one piece: frames.
- Obtain a surface with moulded edges: doors, covers, etc



Technologies for surfaces=sanding edges and surfaces

- The sanding of edges and planes are done with the objective of obtaining flat surfaces, clean of impurities of the previous processes.
- This process will allow the finishing and joining of parts to be performed correctly.

Technologies for assembly

- It consists of the final assembly or conformation of the modules, usually realized in presses of arm or by screw according to the particular design of the furniture:
- Mounting of frames
- Assembly of doors
- Assembly of drawers
- Assembly of accessories



Technologies for finishing

- Sanding and refinishing:
 - To fill imperfections, use mixture of white glue with powder of the same wood. Allow to dry thoroughly to be able to pass the sanding.
 - Use small-grain sandpaper to remove streaks, imperfections, soften and polish the piece. It must be sanded following the direction of the veins to hide imperfections and scratches.
- Inking Materials to apply chosen colour:
 - Colour base alcohol of desired colour, dye without varnish. Can be brushed or towed.
 - Sealant.
 - Varnish or polyurethane sealant.
 - Thinner
 - Sandpaper, it is made ball with the hand and rubs on a piece of rough wood to entangle it.
 - Sock, stockings or fabric for application.
 - Paint gun.



Video Wooden chairs production technology

- Video link: <https://www.youtube.com/watch?v=BMPIR87HcMA>
- Short description: The whole process from the beginning to the end with each operation shown in details to the finishing of the product.
- Duration: 3.47 min

Technologies for sawing

- In this topic we are going to study the main machines used to transform the wood. There are a lot of processes by which the wood can be treated, here we will see the main ones, from the small tools to machines with robots of four axes.
- **Circular Saw:** Saw that gives a great functionality, allows cutting to boards not very big, also allows cuts with mitre. It is ideal for use as a portable saw.



Technologies for sawing

- **Square saw:** it is mainly used for the sawmill of boards, cuts straight to squad or with different angles, with manual thrust. In some cases, it is used to open strips of solid wood.
- The structural base of the machine is electro-welded steel. The cutting tool is a circular saw of different diameters.



Sliding table saw

- All settings can be made in automatic or manual mode. The quality of the finishing cut is very important. It is a machine that offers high stability and absence of vibrations. Allows secure support and a perfect finish.



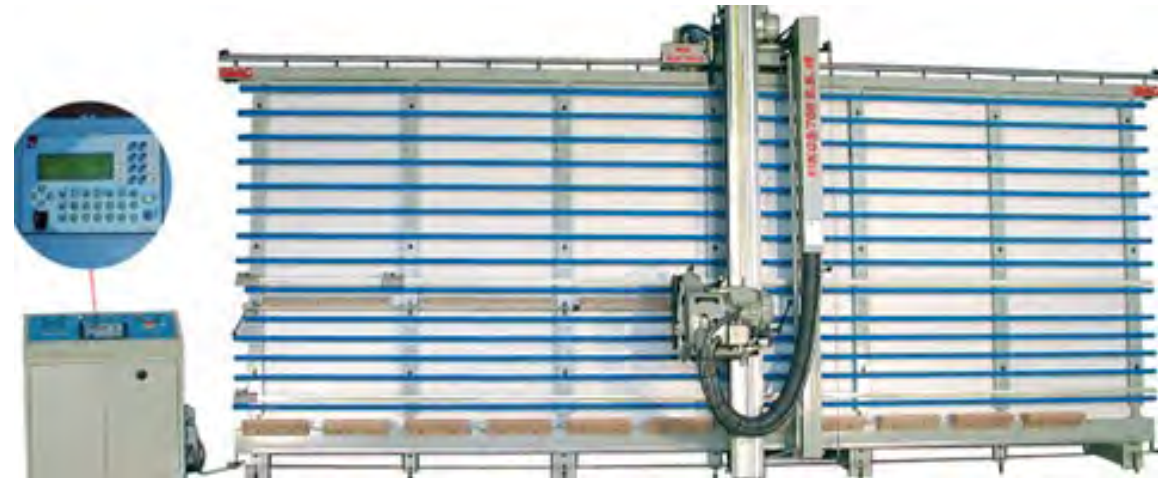
Beam saws

- Supplied tools are changing fast and profitable way. The machine works by program Numerical Control Computer will be which will give orders to the machine tool. The main function is cutting the board (chipboard, MDF, plywood) to sides of sofas, other areas of seating furniture



Vertical saw

- A one-piece structure, rigid and stable, reduces the maximum dimensions, allows to cut the panels in a minimum space



Edge banding technologies

- It is a machine whose main function is veneering (by natural or artificial veneer) edges of pieces of hardboard or another substitute. They are machines that allow veneering by a face or two parallel faces. These machines also operate by numerical control or can be operated manually.



Boring technologies

- Horizontal boring machines. Made of steel, are machines for drills, one at a time horizontally, both in solid wood and particleboard, MDF, actually can make holes in many areas, although these are the most common.



Multi boring machines

- It is to make multiple holes in horizontal or vertical position. They are several drill bits 21,27 and 35. The bench drill is used to drill holes through materials that include a range of woods, plastics and metals. It is usually bolted to a bench so that it cannot be pushed and that larger pieces of material can be drilled safely. The larger version of the machine drill is called the pillar drill.



Planner and wood thickening technologies

- It is built to flatten and straighten the first side of raw wood or wood-like (multilayered panels, plastic, etc ...) material by a horizontal rotary tool, located between two tables, used to position and hold the workpiece



Carving technologies

- Wood carving is a form of working wood with a cutting tool (knife) in a hand or a two-handed chisel with one hand on a chisel and a hand in a mallet, resulting in a wooden figure or figurine, or in the sculptural ornamentation of a wooden object. The phrase can also refer to the finished product, from individual sculptures to handmade mouldings that make up part of a tracery.



Video Uncovering the production process of Teochew wood carving in 100s

- Video link: <https://www.youtube.com/watch?v=GcwSNvGGJ8w>
- Short description: Teochew wood carving is a distinctive school of Chinese woodcarving art. It absorbs reflects the characteristics of the folk arts such as stone caving, painting, clay sculpture and Teochew opera. It has been widely applied to architectural ornamentation, religious article decoration and home improvement. Dongyang wood carving, Anhui wood carving and Teochew wood carving are known as the three major schools of Chinese woodcarving art.
- Duration: 1 min

Module Production engineering-Technology, process maintenance

Learning Unit 4- Production organisation and business administration

Authors

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Dr Lyndon Buck-Buckinghamshire New University-UK

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Understand the importance of materials and the connection between materials' properties and engineering technologies required to process them.
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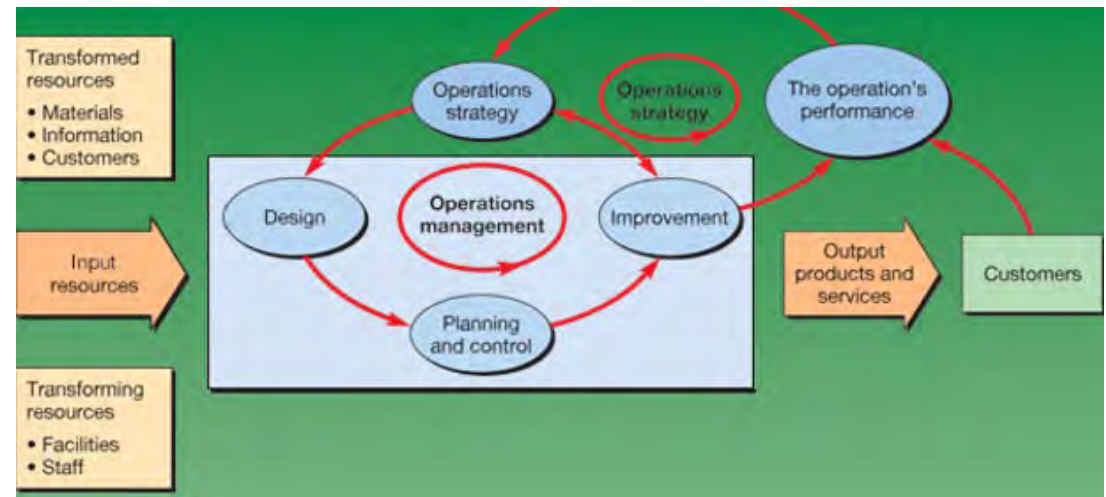
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Video HOMAG Group Batch Size One Production - Furniture Manufacturing Case Study

- Video link: <https://www.youtube.com/watch?v=uMcLMKp8ZuI>
- Short description: High-end European office furniture manufacturer, Sedus explains the company's success with their modern Batch Size One plant of HOMAG Group technology. The plant is operated by the HOMAG Group production control system and exclusively produces customised parts. Every 11 seconds a finished part leaves the networked production. By entering into networked production, Sedus is reacting to increasingly individual customer requirements.
- Duration: 5.42 min

Production organisation and business administration

- Production organisation is about how organisations produce goods and services. Everything you wear, eat, sit on, use, read or knock about on the furniture sector comes to you courtesy of the operations managers who organised its production.



Video Furniture manufacturing software

- Video link: <https://www.youtube.com/watch?v=nTO-yAhu0Ls>
- Short description: The video explains how operations could be assisted by computers and manufacturing processes could be enhanced and made more economical.
- Duration: 6.17 min

Production organisation

- Production organisation is the activity of managing the resources which produce and deliver products and services. The operations function is the part of the organization that is responsible for this activity.
- Every organization has an operations function because every organisation produces some type of products and/or services.
- Not all types of organisation will necessarily call the operations function by this name



Operations in an organisation

- The operations function is central to the organization because it produces the goods and services which are its reason for existing, but it is not the only function. It is, however, one of the three core functions of any organization.



Video Why furniture retailers need to advertise on Facebook

- Video link: https://www.youtube.com/watch?v=mUWxhgVI_Yo
- Short description: Seth Weisblatt of Sam's Furniture in Fort Worth, Texas, explains why Facebook advertising is the best way to target market to consumers since Google Adwords.
- Duration: 3.06 min

Marketing

The marketing (including sales) function – which is responsible for communicating the organization's products and services to its markets in order to generate customer requests for service;



Product or service development

- The product or service development function is responsible for creating new and modified products and services in order to generate future customer requests for service



Operations

- The operations function – which is responsible for fulfilling customer requests for service through the production and delivery of products and services.

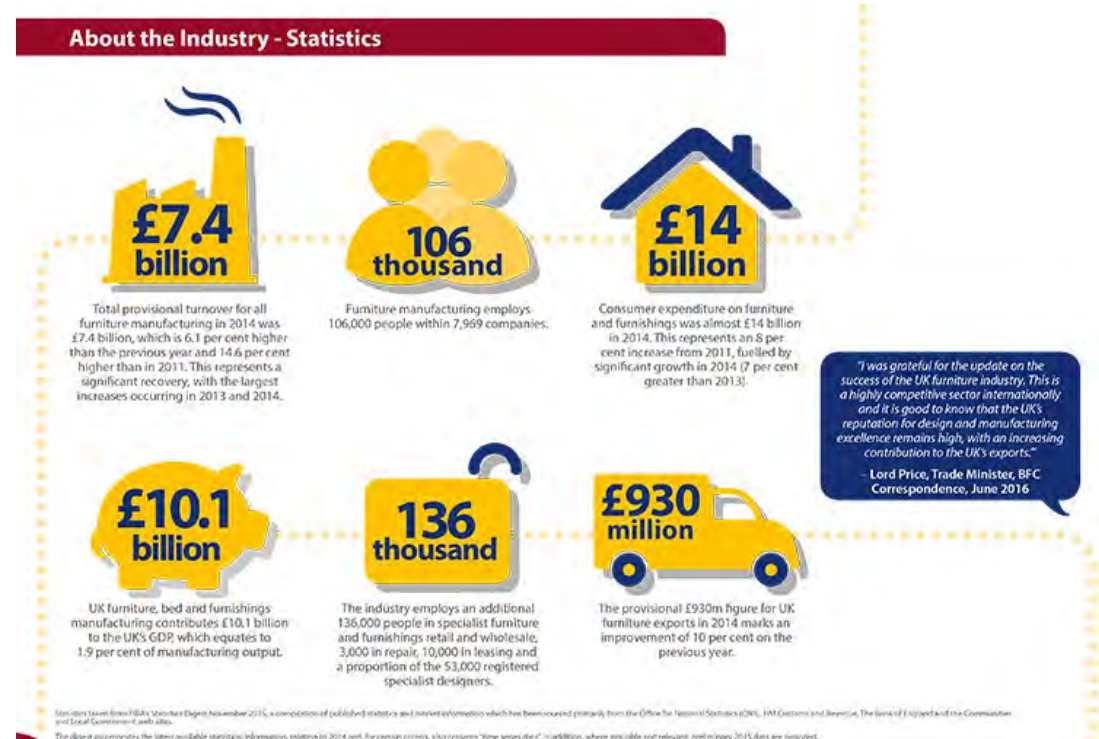


Video Viva furniture market

- Video link: <https://www.youtube.com/watch?v=oPof01EHp0I>
- Short description: A behind-the-scenes look at the Las Vegas Furniture Market. View through 5,000,000 square feet of showroom space to find the best in home furnishings and bring it back to Gates so that your house wins!
- Duration: 5.26 min

Accounting and finance

- The accounting and finance function – which provides the information to help economic decision-making and manages the financial resources of the organization



Human resource function

- The human resources function recruits and develops the organization's staff as well as looking after their welfare.



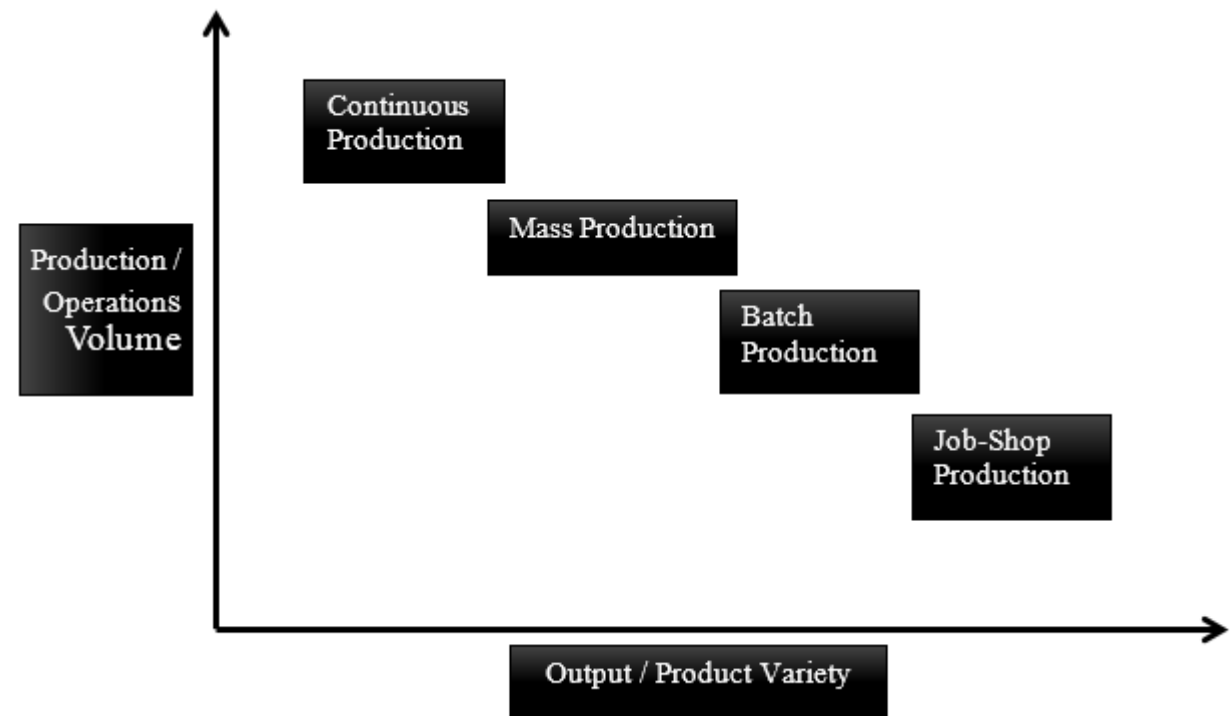
Roles of various functions

- In practice, there is not always a clear division between the three core functions or between core and support functions.
- This leads to some confusion over where the boundaries of the operations function should be drawn. In this book we use a relatively broad definition of operations.
- We treat much of the product/service development, technical and information systems activities and some of the human resource, marketing, and accounting and finance activities as coming within the sphere of operations management.
- We view the operations function as comprising all the activities necessary for the day-to-day fulfilment of customer requests.
- This includes sourcing products and services from suppliers and transporting products and services to customers.

Core functional activities	Internet service provider (ISP)	Fast food chain	International aid charity	Furniture manufacturer
Marketing and sales	Promote services to users and get registrations Sell advertising space	Advertise on TV Devise promotional materials	Develop funding contracts Mail out appeals for donations	Advertise in magazines Determine pricing policy Sell to stores
Product /service development	Devise new services and commission new information content	Design hamburgers, pizzas, etc. Design décor for restaurants	Develop new appeals campaigns Design new assistance programmes	Design new furniture Coordinate with fashionable colours
Operations	Maintain hardware, software and content Implement new links and services	Make burgers, pizzas etc. Serve customers Clear away Maintain equipment	Give service to the beneficiaries of the charity	Make components Assemble furniture

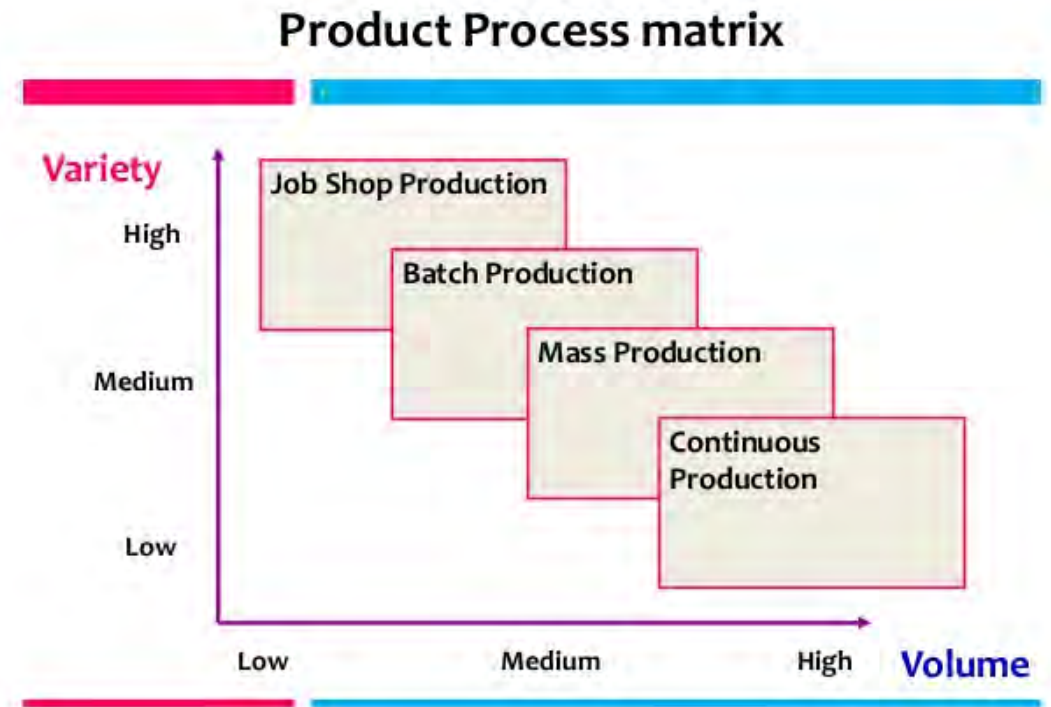
Types of production

- The types of production depend on two variables – the quantity of product that is manufactured and the variety of this product.



Continuous Production

- Continuous Process: it is used when the product is highly standard and required in high volumes. For such process type, capital is required at large scale. It is operated round the clock for optimum utilization of resources and equipment. e.g., Cement, Paper, Petroleum products.
- Continuous production is used under the following circumstances:
- Dedicated plant and equipment with zero flexibility.
- Material handling is fully automated.
- Process follows a predetermined sequence of operations.
- Component materials cannot be readily identified with final product.
- Planning and scheduling is a routine action.



Continuous production advantages disadvantages

- **Advantages** of continuous production:
- Standardisation of product and process sequence.
- Higher rate of production with reduced cycle time.
- Higher capacity utilisation due to line balancing.
- Manpower is not required for material handling as it is completely automatic.
- Person with limited skills can be used on the production line.
- Unit cost is lower due to high volume of production.
- Following are the **limitations** of continuous production:
- Flexibility to accommodate and process number of products does not exist.
- Very high investment for setting flow lines.
- Product differentiation is limited.



Video differences between mass production and craft furniture

- Video link: <https://www.youtube.com/watch?v=TmQo-eclbf0>
- In his Design Museum lecture 'Exploring the differences between mass production and craft furniture' . the topics Jeremy Broun discussed in 1996 are highly relevant today such as the socio economic factors determining furniture appreciation.
- Duration: 3.56 min

Mass production

- Manufacture of discrete parts or assemblies using a continuous process are called mass production. This production system is justified by very large volume of production. The machines are arranged in a line or product layout. Product and process standardisation exists and all outputs follow the same path.
- Mass production is used under the following circumstances:
- Standardisation of product and process sequence.
- Dedicated special purpose machines having higher production capacities and output rates.
- Large volume of products.
- Shorter cycle time of production.
- Lower in process inventory.
- Perfectly balanced production lines.
- Flow of materials, components and parts is continuous and without any back tracking.
- Production planning and control is easy.



Advantages of mass production

- Following are the advantages of mass production:
- Higher rate of production with reduced cycle time.
- Higher capacity utilisation due to line balancing.
- Less skilled operators are required.
- Low process inventory.
- Manufacturing cost per unit is low.



Disadvantages of mass production

- Following are the limitations of mass production:
- Breakdown of one machine will stop an entire production line.
- Line layout needs major change with the changes in the product design.
- High investment in production facilities.
- The cycle time is determined by the slowest operation.



Batch production

- Batch production is defined “as a form of manufacturing in which the job passes through the functional departments in lots or batches and each lot may have a different routing.” It is characterised by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.
- Batch production system is used under the following circumstances:
- When there are shorter production runs.
- When plant and machinery are flexible.
- When plant and machinery set up is used for the production of item in a batch and change of set up is required for processing the next batch.
- When manufacturing lead time and cost are lower as compared to job order production.



Advantages of batch production

- Following are the advantages of batch production:
- Better utilisation of plant and machinery.
- Promotes functional specialisation.
- Cost per unit is lower as compared to job order production.
- Lower investment in plant and machinery.
- Flexibility to accommodate and process number of products.
- Job satisfaction exists for operators



Limitations of batch production

- Following are the limitations of batch production:
- Material handling is complex because of irregular and longer flows.
- Production planning and control is complex.
- Work in process inventory is higher compared to continuous production.
- Higher set up costs due to frequent changes in set up.



Job shop production

- Job shop production are characterised by manufacturing of one or few quantity of products designed and produced as per the specification of customers within prefixed time and cost.
- The distinguishing feature of this is low volume and high variety of products.
- The Job-shop production system is followed when there is:
- High variety of products and low volume.
- Use of general purpose machines and facilities.
- Highly skilled operators who can take up each job as a challenge because of uniqueness.
- Large inventory of materials, tools, parts.
- Detailed planning is essential for sequencing the requirements of each product, capacities for each work centre and order priorities



Advantages of job shop production

- Following are the advantages of job shop production:
- Because of general purpose machines and facilities variety of products can be produced.
- Operators will become more skilled and competent, as each job gives them learning opportunities.
- Full potential of operators can be utilised.
- Opportunity exists for creative methods and innovative ideas.



Limitations of job shop production

- Following are the limitations of job shop production:
- Higher cost due to frequent set up changes.
- Higher level of inventory at all levels and hence higher inventory cost.
- Production planning is complicated.
- Larger space requirements.



Module Production engineering-Technology, process maintenance

Learning Unit 5- Furniture business administration

Authors

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Dr Lyndon Buck-Buckinghamshire New University-UK

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Video Furniture industry organisation

- Video link: <https://www.youtube.com/watch?v=8vuCst3X2hg>
- Short description: A documentary about the different processes at a furniture industry. Made at the Rawat Furniture Factory in Pune.
- Duration: 1.45 min

Furniture business administration

- Production organisation is about how organisations produce goods and services.
- Two of the major factors that are able to control production are competitiveness and productivity.



Video Manufacturing of luxury classic furniture

- Video link: <https://www.youtube.com/watch?v=W4UAXoQ7dR4>
- Short description: What distinguishes the manufacturing of luxury classic furniture? The answer is in the quality of furnishings entirely crafted by hand, an unreachable achievement by any other technique that is not the ability of the hands of expert craftsmen and that makes each product unique, unequaled. In an interesting video, luxury classic furniture Vimercati present themselves, showing each stage of their production: from the initial cutting of the wood to the final treatment before delivery of the furniture. Everything, of course, is handmade in Italy and behold revealed the secret of luxury classic furniture really unique and precious
- Duration: 2.28 min

Competitiveness

- Competitiveness is the capacity in which a company can produce goods and services that meet the test of international markets and can compete in them



Productivity

- It is the ratio between outputs and inputs.
- Outputs
Sales made, products produced, customers served, meals delivered, or calls answered
- Inputs
Labour hours, investment in equipment, material usage, or square footage



Video Assembly line for furniture production

- Video link: <https://www.youtube.com/watch?v=itBJ599pUO4>
- Short description: Turnkey assembly line for furniture production. Designed & Manufactured in Sweden by Mindsource AB
- Duration: 3.48 min

Variables of productivity

- Increases in productivity depend on three variables, good management of them for the purpose of improving productivity to be essential:
- Work
- Capital
- Management



Work

- The improvement in the contribution of labour productivity is a result of having a better educated and trained, better fed and healthier workforce.
- Three key variables in improving labour productivity are:
- Basic training appropriate for an effective labour.
- The supply of labour.
- The social costs that enable access to work, such as transportation and health.



Capital

- When the capital invested per employee is decreased, we can expect a drop in productivity. We say that it can be possible, not guaranteed, because with better design work systems, more training, better shaping processes, and the like, can be offset against lower net investment growth in capital goods.



Video The rise of online furniture outlets | Made in Germany

- Video link: <https://www.youtube.com/watch?v=nZweuydRFFY>
- Short description: Online furniture outlets like US mail order firm Wayfair and German market leader Home24 are looking to mix it up on the European market. Both companies have their German headquarters in Berlin, and they're both looking to increase their share of the European market.
- Duration: 4.25 min

Management

- Business management as a production factor and an economic resource. It is responsible for optimal combination of human and material resources, leading and motivating staff for the purpose of an excellent use of resources. Your obligation is to ensure that technology, training and knowledge are used effectively.



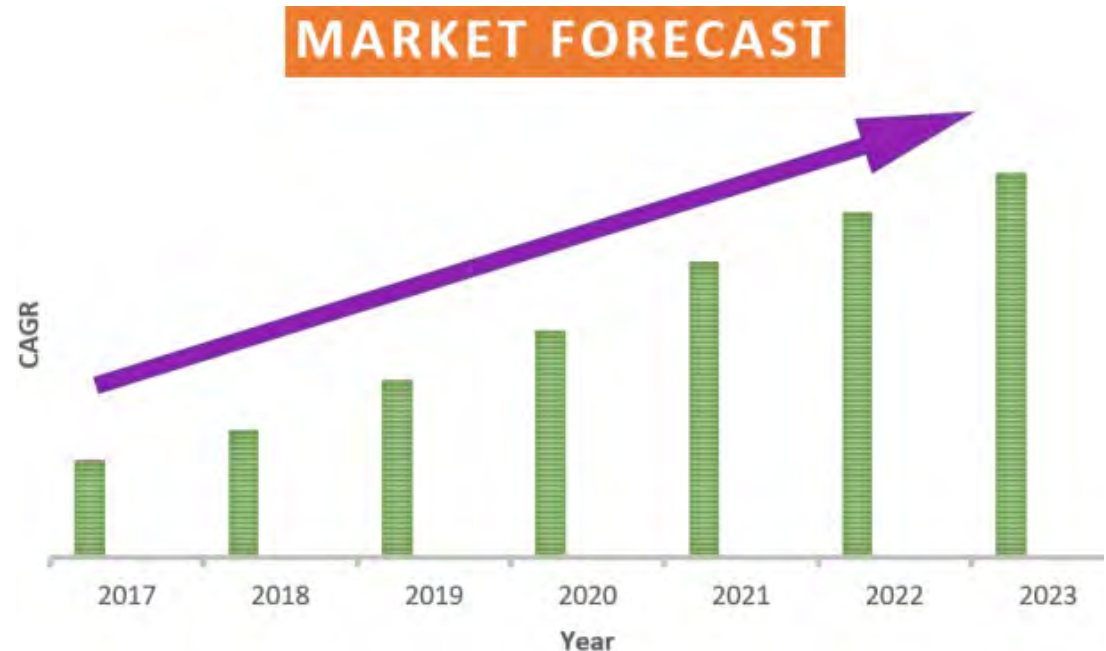
Types of production planning

- The production planning is to define the volume and timing of product manufacturing establishments a balance between production and capacity at various levels, in search of the desired competitiveness.
- Planning is the function that seeks to define, in turn, the structure of the most appropriate organization, as formulated strategies, the objectives and the level of change in the socio - economic environment.



Planning strategy based on demand prediction

- Production planning is a process used by manufacturing companies to optimize the efficiency of their processes.
- Objectives:
- Effectively use limited resources in the production of goods to meet the demands of customers and create a benefit for investors. Resources include production facilities, labour and materials. Limitations include resource availability, product delivery times, and management policies.
- **MTS**: Make To Stock
- **MTO**: Make to Order
- **ATO**: Assemble To Order
- **CTO**: Configure To Order
- **ETO**: Engineer To Order



Aggregate production plan

- The types of production depend on two variables – the quantity of product that is manufactured and the variety of this product.



Aggregate production plan-main issues

- **Smoothing.** Refers to the costs and disruptions that result from making changes from one period to the next
- **Bottleneck Planning.** Problem of meeting peak demand in the face of capacity restrictions
- **Planning Horizon.** Assumed given (T), but what is “right” value? Rolling horizons and end of horizon effect are both important issues
- **Treatment of Demand.** Assume demand is known. Ignores uncertainty to focus on the predictable or systematic variations in demand, such as seasonality



Basic Strategies For Aggregate Planning

- Level capacity strategy
- Maintaining a steady rate of regular-time output while meeting variations in demand by a combination of options.
- Advantages
- Stable output rates and workforce
- Disadvantages
- Greater inventory costs
- Increased overtime and idle time
- Resource utilizations vary over time
- Chase demand strategy



Master production schedule

- The anticipated build schedule for those items assigned to the master scheduler.
- It represents what the company plans to produce expressed in specific configurations, quantities, and Dates.
- The Master production Schedule is not a sales forecast that represents a statement of demand.
- The Master Production Schedule must take into account the forecast, the production plan, and other important considerations such as backlog, availability of material, availability of capacity, and management policies and goals.



Master production schedule-components

- **Breaks down, or disaggregates, the production plan into product families:** The production plan is broken into product families for the Master Production Schedule and Production is planned based on demand forecasts provided by marketing.
- **Promotes valid order promises:** Order promises can be made against planned production.
- **Provides a communication medium between Marketing/Sales and Operations.** When more product has been promised than will be produced, marketing and operations must work together to develop a strategy to meet customer requirements.
- **Proactively control ability to deliver goods to customers:** The MPS allows for better understanding of capacity and gives visibility to capacity shortfalls



Capacity requirement planning

- Capacity is the upper limit or ceiling on the load that an operating unit can handle.
- Capacity also includes:
- Equipment
- Space
- Employee skills
- The basic questions in capacity handling are:
- What kind of capacity is needed?
- How much is needed?
- When is it needed?



Capacity planning

- Capacity planning is the process of determining the production capacity needed by an organization to meet changing demands for its products.



Capacity Requirement Planning

- Capacity requirement planning is the process of determining the amount of labour and machine resources needed to achieve the required production.



Capacity requirement planning

- Use of Capacity Requirements Planning
- Determining capacity that is available and required.
- Alleviating bottleneck work centres.
- Helping planners make the right decisions on scheduling before problems develop.
- Verifies that you have sufficient capacity available to meet the capacity requirements for MRP plans.
- To identify potential problems before they occur.
- Importance Of Capacity Requirements Planning
- Impacts ability to meet future demands
- Affects operating costs
- Major determinant of initial costs
- Involves long-term commitment



Bills and materials

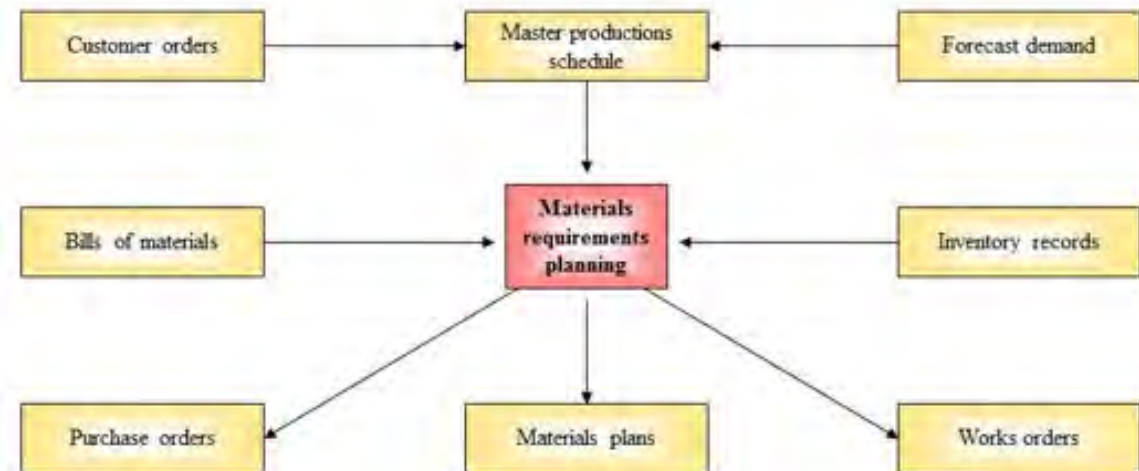
- A listing of all the subassemblies, intermediates, parts, and raw materials that go into a parent assembly showing the quantity of each required to make an assembly.
- A bill of material (BOM) is a complete list of the components making up an object or assembly.
- It is also part of material requirements planning (MRP)
- Processes That Use BOM
 - Production
 - Materials planning
 - Product costing
 - Plant maintenance



Materials requirement planning

- Material requirements planning (MRP) is a production planning and inventory control system. An MRP integrates data from production schedules with that from inventory and the bill of materials (BOM) to calculate purchasing and shipping schedules for the parts or components required to build a product.

Material Requirement Planning



Cost evaluation for production

- Cost control is one of the most basic parts of the company's management. If it is not accurately controlled, it is very possible that the company is in a situation that is dangerous for its survival.
- In order to perform a good cost management, you must know exactly the structure within the company and answer the five questions: What? Where?, How?, How much? And why?
- What? Determine which product or service is going to be commercialized and which product family are the main ones in the company.
- Where? Where it is going to be manufactured, where it is going to be commercialized and in which market it is going to compete.
- How? What means does the company have, how will the cost be measured, how will the product or service be developed.
- When? It is necessary to determine a period of time, if not determined cannot be compared with other deadlines.



Definition of costs

- You can define the cost as the measure in monetary terms of the resources needed to achieve a specific goal.
- For example, producing a product requires a sacrifice that, valued in monetary terms, constitutes its cost of manufacture.
- Therefore, costs are a consumption of goods and services necessary for the manufacture of goods and services.
- So that consumptions that involve some waste or that are due to mismanagement will be lost and not costs.



Aspects to be taken into account when calculating costs

- Two aspects to measure costs must be taken into account:
- Technical: they are objective, and the company uses them to produce the product, such as working hours per person, kilograms, meters, liters of raw material, kilowatt hours, etc.
- Economic: They have a subjective character and are usually the euros that cost the units of consumption described in the previous point



Investment

- they are goods that are bought and used for the production of the products.
- *For example*, machinery, tools, ERPs, industrial plant, etc. All these assets are charged as costs through amortization.



Expenditure

- it is the sum of money of the goods that the company acquires.
- It is only costs that are incurred in the production of a particular good or service.
- The difference with costs is that the costs that we call costs are incurred as a result of the production of a particular good or service. —*For example*, purchase of machinery and industrial plant, labour or energy consumption are all expenses.
- Costs are the raw materials whose purchase becomes a cost as they are incorporated into the production process that adds value to the material.



Amortisation

- From an economic-accounting point of view, amortisation funds are those that are created to compensate for the loss of value or depreciation experienced by certain assets.
- The depreciation funds are created by the allowances that are made each year for a certain amount, so that at the end of the economic life of the depreciated good, the company can replenish it with the accumulation of the endowments made.
- The annual allocation is the accounting reflection of the depreciation suffered by the assets, which is called amortization.



Module Production engineering-Technology, process maintenance

Learning Unit 6- Mechanical engineering and automation

Authors

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- The project is implemented within the framework of the **Cooperation for Innovation and the Exchange of Good Practices** Key Action and is funded by the **Erasmus+ Programme** of the **European Union**.

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- This module will enable you to:
Understand the importance of materials and the connection between materials' properties and engineering technologies required to process them.
- Understand and critically evaluate aspects related to production organisation and optimisation
- Understand and critically evaluate aspects related to automation in furniture manufacturing
- Ability to understand and critically analyse the eco-sustainability aspects in furniture production

How to learn?

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- It explores some key principles of engineering, while helping you to improve your study skills and develop as an independent learner.
- This module will outline the main advancements, developments, styles and materials in furniture design highlighting the identifying features of each period, the materials used and show images of some of the most significant pieces of furniture ever designed.

Video The Cabinet Manufacturing Process

- Video link: <https://www.youtube.com/watch?v=SYf1yGOjOvU>
- Short description: Have you ever wondered how your kitchen cabinets go from raw bits of material to the beautifully finished units in your home? We take you behind the scenes in our Auckland factory, so you can see the complete manufacturing process from start to finish.
- Duration: 6.14 min

Mechanical engineering and automation

- After 2000, quality in furniture has been found as one of the most important factors – criteria of purchase from the consumers' side, as well as of the enterprising activities.
- The furniture industries that realise this consumers' behaviour, try to come up to the requirements by differentiating many times their production procedure, having though as a basis the marketing department, that will promote and show the quality of as a competitive advantage



Video Furniture production automation

- Video link: <https://www.youtube.com/watch?v=KUKI-c5uWbM>
- Short description: The HOMAG Group already fulfils many of the criteria of the Industry 4.0 vision. In recent years, our customers in the furniture industry have implemented a number of networked production concepts. This has enabled furniture manufacturers in trade and industry to produce millions of furniture designs and minimize delivery times using our fully networked and highly flexible batch size 1 systems.
- Duration: 3.22 min

Automation in furniture industry

- Furniture production requires a very high number of individual processes. Furniture manufacturing still involves working with wood.
- However, wood is one of the most difficult materials to measure, and its properties and colours are many and varied, which poses a great challenge when it comes to image processing.
- A lot of money has been invested in automated processes, in order to ensure that top results are achieved for the challenges set by the industry.
- No company is in a position to tolerate unreliable production processes anymore



Accuracy

- To ensure accuracy a series of tools have been developed and are currently available on the market. These tools take spot samples, during serial production, or monitor procedures and check measurements.
- All of these are meant to ensure that furniture products meet the required specifications each time.
- Measuring tables, ensure the accuracy of dimensions, drill-hole positions, radii, parallelism and other values. In the furniture and woodworking industries measuring systems must meet the high demands set by production and contribute significantly to quality assurance.



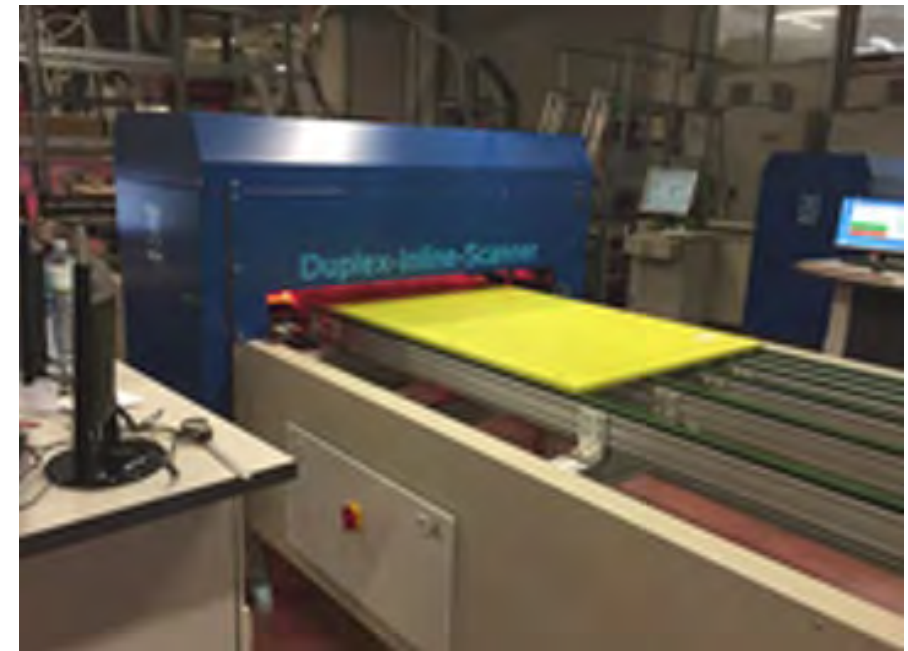
Automation using 4i-Inline scanner

- The 4i-Scanner is the solution for high process control in modern automatic furniture production- for serial- or batch size 1 production. Precise and fast dimension control inline is the norm. In modern machines the drilling hole control is located directly after the drilling line and is realised with high speed.



Automation using Duplex Inline-Scanners

- The Duplex-Inline-Scanner is the usual solution for total control in Batch 1 manufacture and for precise and rapid dimension control during each run.
- Using the Duplex-Inline-Scanner, measurements can be made at high speed, directly in the drilling line.



Automation using Inline Scanner e-frame models

- The Inline-Scanner permits accurate and rapid dimension checks during production. The measurement of length, width and angles or freeform shapes is carried out at high speed. Furthermore, the positioning of drill holes and diameters can be measured from one side.



Video collection of 16,17,18 century furniture

- Video link: <https://www.youtube.com/watch?v=19y7TRnqQIY>
- Short description: In the heart of the Périgord Noir, close to the famous Lascaux Cave, come and discover a unique collection of period pottery and furniture, a wealth of veritable chefs-d'œuvre from the different regions of France.
- Duration: 2.33 min

Automation using free measurement machines

OptoDesQ V max type

- The fully automated Opto-DesQ Vmax type tables are used in the contact-free measurement of all geometric dimensions in industrial furniture manufacturing.
- With the Opto-DesQ Vmax type, quality control becomes part of manufacturing and guarantees the quality of manufacturing processes.



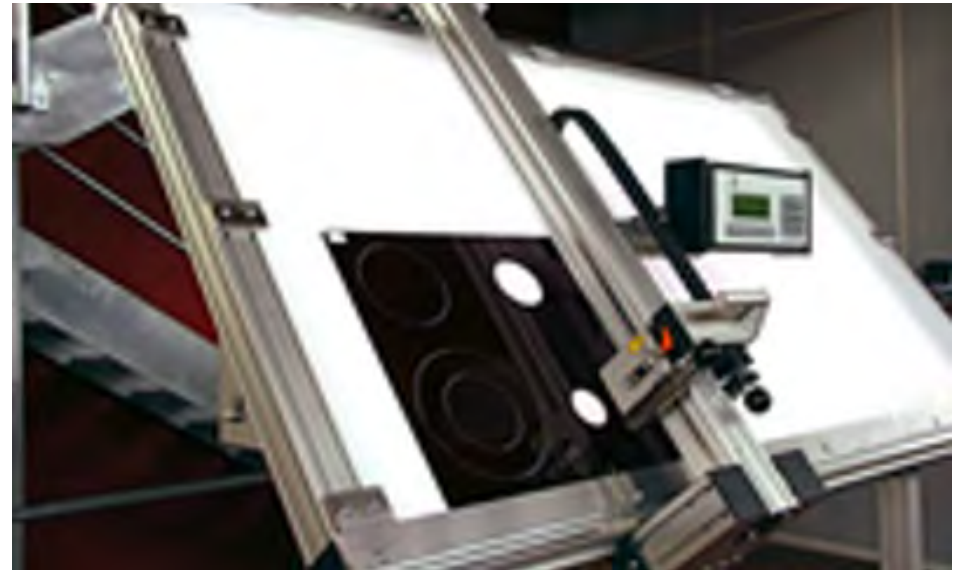
Automation using PC-DesQ measuring tables

- The PC-DesQ measuring tables are designed for the accurate manual measurement of parts in the furniture, metal and plastics industries.
- Thanks to a well-designed operator-guidance system with a touch-screen monitor, parts and individual components of all types can be measured quickly and reliably.
- The programmes deliver fully traceable and repeatable results, together with comprehensive records for later analysis.



Standard Des Q type of automation

- The Standard-DesQ type allows for the precise measurement of flat components and is employed in the furniture, metal and plastics industries.
- A high degree of accuracy and ease of operation are the prominent features of this measuring equipment.
- No software is necessary for its operation.



Automation using *ultra-DesQ measurement tables*

- The range of applications for Ultra-DesQ type include:
- Scanning a large number of spot samples directly from the machines.
- For regular testing in the test laboratory.
- Scanning prototypes and serial parts when testing components and initial samples.
- Minimising set-up times for machines and systems.
- Can be deployed in many different areas, using special measuring adaptors.



Automation using thermo-DesQ measurement table

- Parts which are difficult to measure due their material or shape can be measured with vision software and thermal camera.
- Such tools use different camera types for measuring plates which have materials inside which are hardly to see.
- The selection of the camera type is done automatically during the generation of the measuring programme



Automation using laser-DesQ

- For the measurement of flexible shapes a 3 axis coordinate measuring table is equipped with several sensors.
- The sensors measure on different points geometry and edges



Video Lumber Defect Scanner

- Video link: <https://www.youtube.com/watch?v=ek48mpOo30w>
- Short description: Lumber defect scanner working with complex grading rules for the furniture industry.
- Duration: 3.53 min

Automation using linear measuring equipment

- The lightweight **ASB universal stop** type of tools are adapted for companies that perform various types of work, e.g. for use as a static calliper gauge for inspection work, as a stop for mitre saws or for measuring drill hole distances.
- The ASB measuring stop can be mounted on a base plate using M8 screws.
- The standard length is 1.5 m, though versions can be made available up to 6 m in length.



ASB-DesQ length stop

- The ASB-DesQ is used for the measurement of lengths and widths. The distinctive features of the ASB-DesQ are the simplicity. Measurements are shown on a display, so that checking of the dimensions of flat components is carried out swiftly and efficiently.
- The ASB-DesQ is completely contaminant-resistant and can therefore be mounted directly within the manufacturing process at a size that corresponds to the measurement range that is needed



Automation using robots and robotic work-cells

- Material handling robots can automate some of the most tedious, dull, and unsafe tasks in a production line and is one of the easiest ways to add automation.
- Material handling robots enhance the efficiency of your production line and increase customer satisfaction by providing quality products in a timely manner.



Robot Worx has created our own line of pre-engineered work-cells.

- These Robot Worx RW work-cells are all compatible with FANUC, Motoman or ABB robots.
- These robotic work-cells include multiple configurations, sizes, part loading and safety options.



RobotWorx RW850

- The **RobotWorx RW850** robotic work-cell has a bi-fold hinged front door with handles for loading parts onto a stationary index table. It is compatible with FANUC, Motoman, ABB and KUKA robots.



RobotWorx RW900

- The **RobotWorx RW900** custom work-cell features a 180 degree manual turn table. A fully enclosed cell and integrated safety circuit make the RW900 an ideal system for any shop that is looking to increase productivity and cut the cost of automation.
- The manual turn table top is 1524 mm (5 ft) in diameter and does not require light curtains or a floor mat, reducing the size of the overall footprint required to 2073 mm x 2083 mm. The divider on the turn table blocks welding arc glare from the operator.



The RW1000 work-cell by RobotWorx

- The RW1000 work-cell by RobotWorx is a customizable robot system with dual stationary work tables with 2 pneumatic up/down doors to protect operators from the robot and arc flash. The centre divider wall also minimizes arc flash while the operator is loading the opposite station.
- The tables are each 609.6 mm squares (2' x 2') and the overall footprint of the work-cell is 3429 mm x 3035 mm (11.25' x 9.96').



RobotWorx RW1050

- The RobotWorx RW1050 robot work-cell has a 180 degree indexing turn table, allowing dual station operations. One side of the table positioner can be loaded while the other side performs robotic welding on a part. This adds speed and simplicity to production.
- *The RW1050 comes with a total safety environment that is easily tailored to fit customer needs. The entire system is enclosed with rigid steel beams. The two doors on either side of the robot are constructed from hard fencing doors and equipped with interlocks.*
- An arc-glare divider protects workers loading one side of the turntable. Light curtains or safety mats are available to keep workers safe and regulate the indexing turntable



Module Production engineering-Technology, process maintenance

Learning Unit 7- Maintenance management and tracking programmes

Authors

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Video Maintenance software

- Video link: <https://www.youtube.com/watch?v=yJU8r1fR8pQ>
- Short description: Use Maintenance Pro for Windows to keep track of facility, plant, machinery, aircraft, marine, vessels, tools, apparatus, and more. This versatile Windows based computerized maintenance management software (CMMS) is utilized for tracking various assets in any industry.
- Duration: 6.20 min

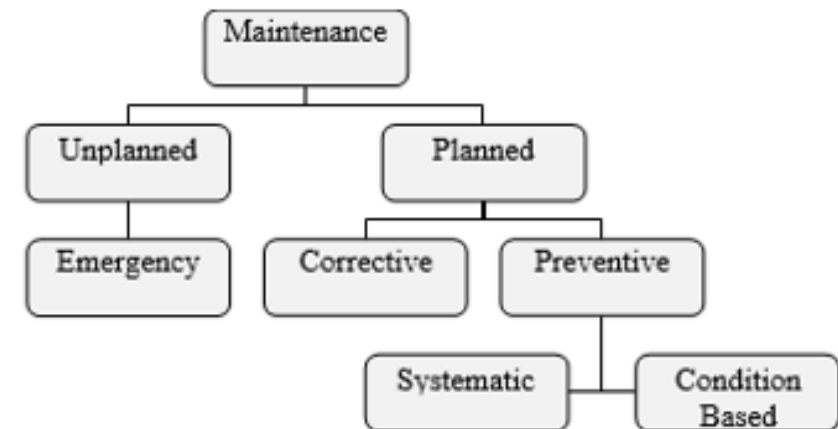
Maintenance management and tracking programmes

- Maintenance is an essential part of the production process.
- Without it the machinery will not be able to function when they are needed, the quality of the products could suffer and the length of usage could be seriously diminished.
- In practice there are a couple of preventative maintenance steps that are often used.



Maintenance activities in an organisation

- Maintenance work at the factory resides in performing systematic preventive interventions, condition-based maintenance and corrective maintenance actions.



Video Traditional English oak furniture

- Video link: <https://www.youtube.com/watch?v=tgKrZwyeWtg>
- Short description: Tudor Oak Furniture has a core team of experienced, knowledgeable and passionate people, who take inspiration from history and believe that good design and high quality of craftsmanship should and can complement modern living..
- Duration: 2 min

Schedule maintenance

- Some machines prompt the operator to perform certain maintenance tasks, waiting until this happens can interfere with production.
- If tasks are scheduled in advance, they're less likely to be postponed or forgotten.
- The more you use a machine, the more abuse it takes, so plan machine maintenance frequencies accordingly



Preventive maintenance tips

- Ensure that the preventive maintenance tasks being performed are beneficial to the equipment.
- Greasing the rack and pinion of a beam saw, for instance, can cause grease and saw dust to solidify inside the gears over time, eventually preventing them from moving.
- If you're unsure which tasks are beneficial to each piece of equipment, ask your equipment representative



Video Workshop layout and maintenance

- Video link: <https://www.youtube.com/watch?v=NeN4s-vzH7s>
- Short description: Short trailer from Peter Sefton's Wood Machining Series
- Duration: 5.28 min

Preventive maintenance tips

- Buy spare parts before they're needed.
- Ask your equipment provider for a recommended spare parts list.
- You need not buy everything on the list, but when service technicians are in your plant, ask what they recommend that you keep in your plant.
- The most needed parts usually can be purchased inexpensively, minimizing downtime when they're needed



Preventive maintenance tips

- Let employees learn from equipment service personnel.
- When a technician is working on a machine, have appropriate personnel watch and ask questions.
- After a few visits with a service tech, your operator may be able to troubleshoot, fix simple problems, and know when to call for expert help.
- The technician can tell you which preventive maintenance procedures your operator may be competent to perform.



Preventive maintenance tips

- Document service visits. When you schedule a maintenance visit with an equipment manufacturer, make sure that the service tech will record the inspection.
- It's important to document not only the date of service, but also what parts of the machine have been checked and what service was performed.
- Have the rep provide a copy of the inspection record.
- This checklist will function as a record to the manufacturer and will help you identify items your employees should be inspecting on their own..



Video Facilities Maintenance Workshop

- Video link: <https://www.youtube.com/watch?v=NjFI4XDd6bs>
- Short description: 27 customers attended from across the UK, covering a multitude of industries including food manufacture, housing associations, architects, defence and local councils and were given the opportunity to meet the team at Belzona and gain an insight into what Belzona has to offer. The aim of the open day was to give attendees a better understanding of the composite solutions offered to repair, protect and improve their facilities and to educate on traditional repair methods versus using modern materials.
- Duration: 3.24 min

Ways of conducting maintenance

- Maintenance can be organised based on:
- 1. a reactive model (i.e. equipment breaks down, you fix it)
- 2. a periodic model (i.e. you have scheduled maintenance)
- 3. via a pro-active model (i.e. you perform maintenance on small defects in order to prevent your equipment from failing).



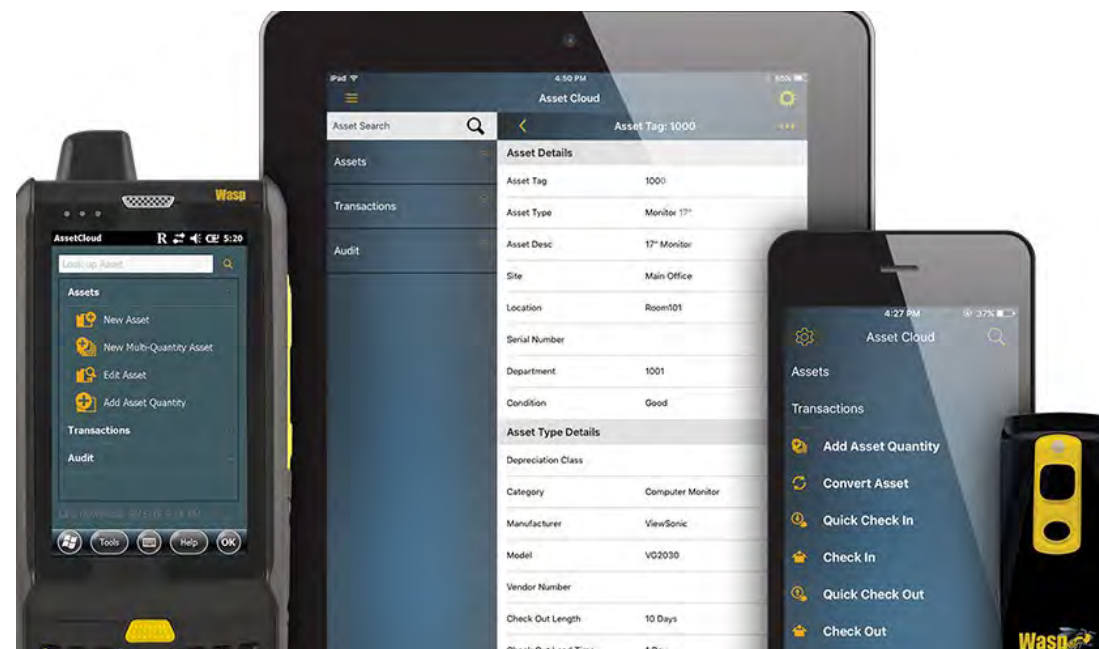
Preventive maintenance. How to do it?

- Start from a business perspective. Start by (1) calculating how accurate you'll need to be to achieve your desired savings & (2) reflecting on what you would actually need to predict (& if this is measurable)
- Then do a data mapping exercise: what data do you have, what's tracked, how do I track it from now on, how do I validate if a prediction is correct, etc.
- Get started with a Proof of Concept & show through historical data it's feasible to be done.



Asset tracking

- Asset tracking is an essential activity that helps managers organise production and keep a good record of the efficiency of the equipment and of its maintenance. One of the most effective programme commonly used to track assets is the Maintenance Pro.

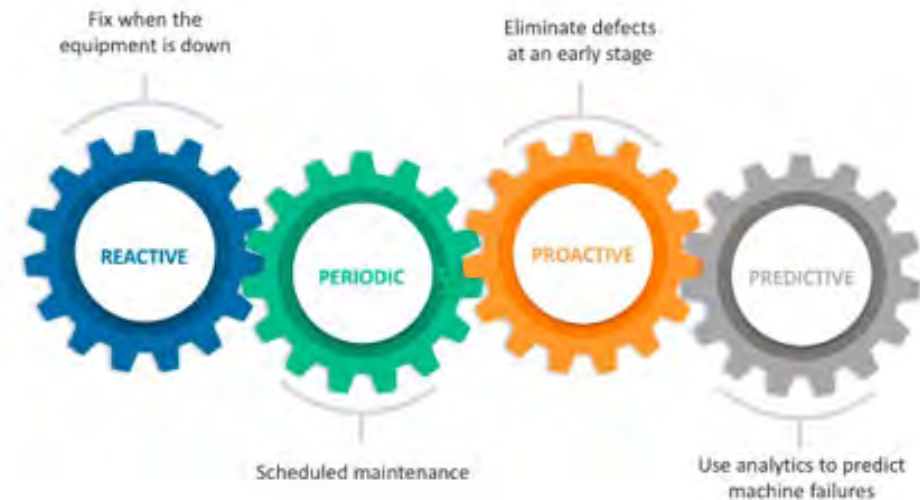


Maintenance Pro main features

- With Maintenance Pro, you can track an unlimited number of pieces of equipment.
- Management is easier, since you can store a description, make, model, serial number, photos, and more for each piece of equipment
- 30 custom fields provide the flexibility you need to store information unique to your equipment.
- Meter tracking options include hours, miles, kilometres, revolutions, gallons, counts, copies, or define your own customized meter type for any piece of equipment.

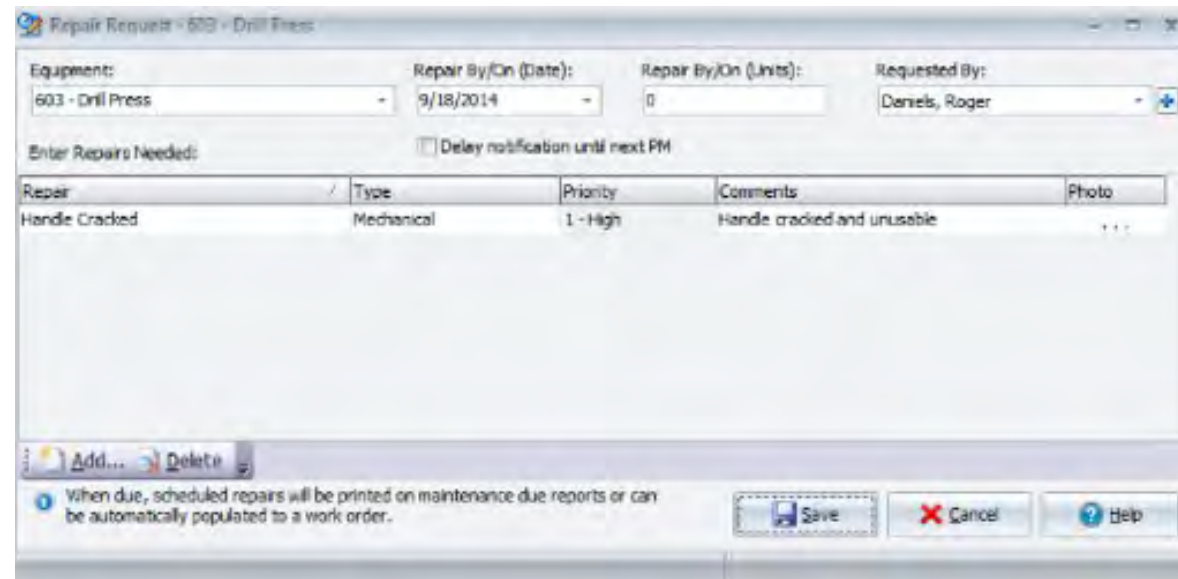
Preventive maintenance with Maintenance Pro

- Maintenance Pro makes it easy to see when a vehicle or piece of equipment is due for service.
- Automated and color-coded preventive maintenance alerts will automatically display upon program start-up.
- Equipment due (or overdue) for service will be shaded red, while equipment soon due for service will be shaded yellow.
- This provides an excellent visual of where your assets stand at any given time.
- Maintenance Pro provides a wide range of preventive maintenance services that are already defined for you.
- However, you can easily customize the list or create your own maintenance schedules based on the tracking requirements of your equipment.
- You can track your preventive maintenance by date, mileage, hours, kilometres, or your own meter type.



Repair maintenance

- Effectively manage breakdowns or unexpected issues that occur with your assets.
- Operators or inspectors can also indicate potential problems so they can be rectified before costly breakdowns occur.
- Monitor Maintenance Trends & Schedule Repairs
- Repair maintenance tracking is essential to your equipment management.
- Maintenance Pro enables to track and monitor trends in repair maintenance, so you can decide whether to keep or retire a piece of equipment.
- Maintenance Pro-automatically notifies when repairs are due.



Repair Request - 603 - Drill Press

Equipment: 603 - Drill Press Repair By/On (Date): 9/18/2014 Repair By/On (Units): 0 Requested By: Daniels, Roger

Enter Repairs Needed: ☐ Deley notification until next PM

Repair	Type	Priority	Comments	Photo
Handle Cracked	Mechanical	1 - High	Handle cracked and unusable	...

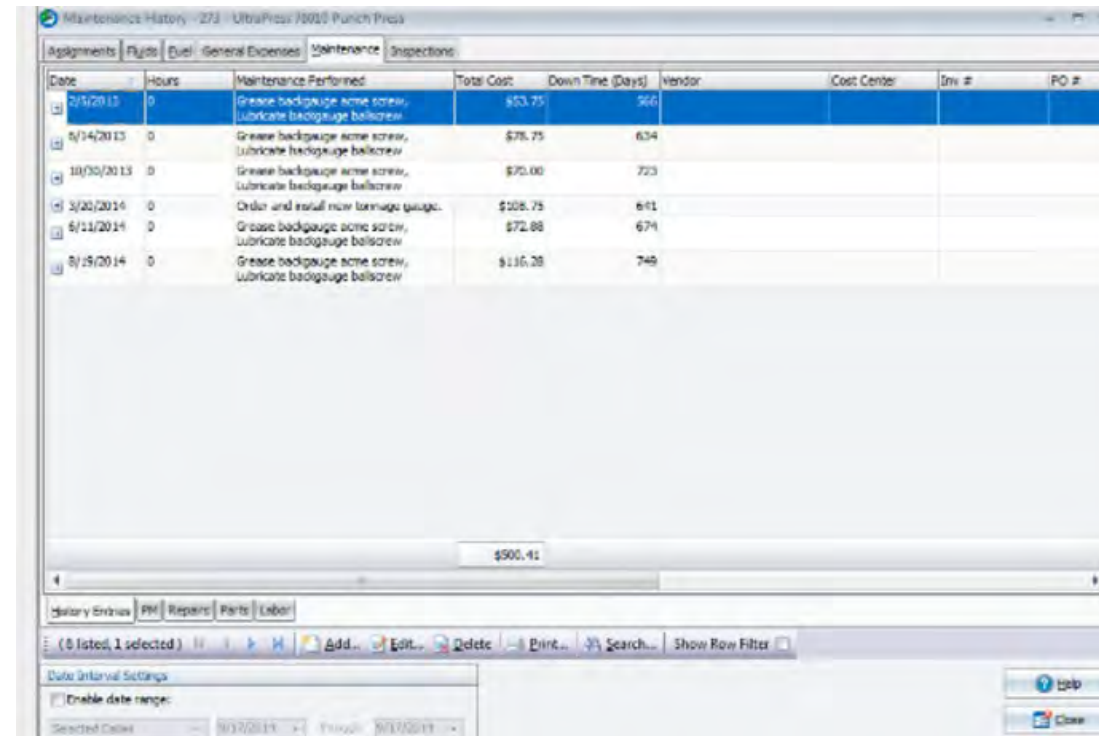
Add... Delete

When due, scheduled repairs will be printed on maintenance due reports or can be automatically populated to a work order.

Save Cancel Help

History recording

- Evaluating the maintenance history of your equipment decreases downtime and outlines future financial requirements for the equipment vital to your company.
- Each history record includes the fundamental date, meter reading, and description of work performed, as well as a detailed breakdown of the individual PM, repairs, labour, and parts involved.
- Maintenance Pro also stores itemized costs and taxes for each detail of your history entries.



Maintenance History - 273 - UltraPress 70010 Punch Press

Date	Hours	Maintenance Performed	Total Cost	Downtime (Days)	Vendor	Cost Center	Inv #	PO #
2/15/2013	0	Grease backgauge screw, lubricate backgauge ballscrew	\$53.75	966				
5/14/2013	0	Grease backgauge screw, lubricate backgauge ballscrew	\$78.75	634				
10/30/2013	0	Grease backgauge screw, lubricate backgauge ballscrew	\$70.00	723				
3/20/2014	0	Order and install new torque gauge.	\$108.75	811				
6/11/2014	0	Grease backgauge screw, lubricate backgauge ballscrew	\$72.88	674				
8/15/2014	0	Grease backgauge screw, lubricate backgauge ballscrew	\$116.28	749				

\$500.41

History Entries PM Repairs Parts Labor

(0 listed, 1 selected)

Add Edit Delete Print Search Show Row Filter

Date Interval Settings

Enable date range:

Selected Dates: 8/1/2014 Through: 8/1/2014

Help Close

Maintenance notifications

- Maintenance Pro automatically calculates when preventive maintenance and repairs are due for your equipment and informs you of the results.
- At all times, the main screen highlights equipment which requires attention.
- For quick visual identification, equipment due (or overdue) for service is shaded “red”, while equipment soon due for service is shaded “yellow”.

PM and Repair Maintenance Status - 302 - Troy Clark Saw

Service Description		Tracking Interval(s)		Date		Hours	
PM Service Name	Type	WO #	Date	Hours	Last	Progression	Next
Change oil in gear reducers.	Replace			1,000	10/1/2007	0	1,000
Check all guards and safety devices.	Inspection			40	12/7/2011	0	40
Check blade drive belt for proper tension	Inspection			40	12/7/2011	0	40
Check chip collection barrel. Empty if n	Inspection				10/1/2007	0	
Check compressed air supply filter /lubric	Inspection			40	12/7/2011	0	40
Check mounting and integrity of all senso	Inspection			160	12/1/2011	0	160
Check oil levels in gear reducers.	Inspection			500	12/29/2007	0	500
Check operation of saw blade lubrication.	Inspection			25	12/7/2011	0	25
Check saw blade lubrication.	Inspection			40	12/7/2011	0	40
Check squareness of cut. Retrain if neces	Inspection			1,000	10/1/2007	0	1,000
Clean chips/coolant/debris.	Inspection				10/1/2007	0	
Grease saw slide bearings.	Lubrication			40	12/7/2011	0	40
Inspect saw blade.	Inspection				10/1/2007	0	

13 service(s) listed

View Options: ☐ Show only maintenance due ☐ Show only maintenance soon due

Current Information:
 Date: 8/18/2014 Hours: 24

Generate WO Print Help Close

Parts inventory

- The comprehensive Maintenance Pro parts system allows you to itemize the parts your equipment needs.
- You can record part details, such as part numbers, descriptions, unit costs, vendors, etc.
- The built-in reports provide part data in the format you need to keep your parts well organized.
- You can manage your part stock with re-order notifications, part associations, and a built-in purchase order system.

Parts Inventory Management

Warehouse: All Locations Category: All Categories Show: All Parts

Part #	Name	Description	Vendor	Manufacturer	Category	Unit Cost	Unit of Meas.	Markup	Inventory Bal
01	Hydra 46	Hydraulic fluid		Valvoline	Fluids	\$1.11	Gallon	0	0
02	Trans Fluid	ATF	Devo's Auto Parts	Castrol	Transmission Fluid	\$1.24	Quart	0	0
00060302	Truck-Hydr Filter	For City Trash Trucks	Wagner C&T	Puroktor	Filters	\$174.79		0	0
03	Hydr #32 32 wt	32 wt. Oil	Devo's Auto Parts	Castrol	Oil	\$1.03		0	0
04	80/90 gear oil	Differential Oil	Wagner C&T	Valvoline	Fluids	\$1.42		0	0
05	Deron III	ATF	Devo's Auto Parts	GM	Transmission Fluid	\$4.53	Quart	0	0
06	30 wt Oil	30 wt.		Mobil 1	Oil	\$1.48		0	0
07	15W-40 oil		Devo's Auto Parts	Castrol	Oil	\$1.30	Quart	0	0
08	For Dr 32 wt Oil	32 wt Oil	WR Equipment	Valvoline	Oil	\$1.48		0	0
09	For Dr 32 wt					\$1.48		0	0
10	Multipurpose 320 32 wt	Mult. General use oil - road equipment		Castrol		\$1.22		0	0
1145	Oil Filter	Oil Filter - for 1 1/2 inch oil and for many 7 Devo's Auto Parts	FRAM	Oil Filter		\$13.00		0	0
12	80/90 gear oil	80/90 gear oil		Valvoline	Fluids	\$14.48	Gallon	0	0
13	90 1 qt and 1 qt capacity 1 for 10 House machines		John Deere	Transmission Fluid		\$8.88	Gallon	0	0
14	Summit Super Coolant	-40 degree F protection	Franklin	Coolant		\$1.08	Gallon	0	0
15	50/50 AntiFreeze	Protection to -30F, no need to mix with Devo's Auto Parts	Tecum	Coolant		\$3.87	Gallon	0	0
244070	Air Filter	Paper Air Filter - paper	WR Equipment	FRAM	Air Filter	\$10.47	Each	0	0
2455	Truck Air Filter	For Komatsu heavy machinery	Puroktor	Air Filter		\$12.46	Each	0	0
50000	Wash. part					\$15.00		0	0
6001	Air Filter	Paper Air Filter - standard-spec		FRAM	Air Filter	\$10.28	Each	0	0
600700	Brake Pad	Low Dust Brake Pad - front	Devo's Auto Parts	Perko	Brakes	\$56.71	Set	0	30

4 21 items, 3 selected

Highlight parts that need to be reordered Highlight parts assigned to a Purchase Order

Help Close

Work orders

- The work order system generates work orders based on the maintenance due for each piece of equipment.
- After the work has been performed, and you close the work order, Maintenance Pro automatically updates all related services for that piece of equipment and stores the entire work order in the history database.
- Work order reports complete this feature, by allowing you to view the data in detailed and summary formats.

Work Order Management

WO #	Equipment	% Complete	Status	Date Issued	Date Complete	Down Time (Days)	Meter	Priority
1115	T200 - 2008 Ford F-250 Super Duty	100%	Closed	3/26/2013	3/31/2013	3	4,872	
1118	C001 - 2011 Ford F-150 4x4	100%	Closed	4/21/2013	4/21/2013	0	67,112	
1119	E142 - 15' 1517 John Deere Mower	100%	Closed	3/1/2013	3/6/2013	3	0	
1131	Q076 - D58 Cat Dozer	100%	Closed	4/13/2013	4/22/2013	3	6,883	NORMAL
1132	M276 - Ingersoll-Rand Air Compressor	100%	Closed	4/9/2013	4/16/2013	3	2,118	NORMAL
1133	M336 - Onan Generator	100%	Closed	3/11/2013	3/18/2013	2	307	NORMAL
1135	E142 - 15' 1517 John Deere Mower	100%	Closed	2/20/2013	2/22/2013	0	234	NORMAL
1139	A003 - 2013 Chevy Silverado 3/4 4x4	100%	Closed	0/5/2013	0/7/2013	1.51	52,539	NORMAL
1140	V-001 - 2009 Chevy Express 2500	100%	Closed	5/4/2013	5/5/2013	0	6,280	NORMAL
1255	A003 - 2013 Chevy Silverado 3/4 4x4	100%	Closed	9/10/2014	9/10/2014	0	52,539	NORMAL
1256	A002 - John Doe's Truck	100%	Closed	9/10/2014	9/10/2014	0	95,481	NORMAL
1257	M276 - Ingersoll-Rand Air Compressor	100%	Closed	9/15/2014	10/16/2014	22.81	2,118	NORMAL
1258	C054 - 2014 GMC 3500 1 Ton	62%	Open	10/11/2016			43,200	NORMAL
1259	E142 - 15' 1517 John Deere Mower	0%	Open	10/11/2016			242	NORMAL
1260	E158 - 2009 Chevy Express 2500	50%	Open	10/11/2016			18,854	NORMAL
1261	M276 - Ingersoll-Rand Air Compressor	33%	Open	10/11/2016			2,118	NORMAL
1262	V-004 - Komatsu WA 380 Loader	0%	Open	10/11/2016			3,012	NORMAL

(86 listed, 1 selected)

☐ Highlight outstanding work orders
☐ Group by Work Order #

Add... Edit... Delete Print... Filter... Search... Show Row Filter ☐ Toggle Status

Help Close

Reporting maintenance

- From simple equipment listing reports to detailed periodical cost analysis reports, everything you need is included.
- The built-in report designer lets you easily make adjustments to any of the stock reports included with Maintenance Pro.
- It also includes employee and vendor databases, purchase orders, billing and programme security.

Report Viewer

Show: All Equipment | Status: Any Status | Date Range: | Additional Criteria: | Apply

History (Cost Summary)

Your Company Name/Location #1/Cars & Trucks

Equipment	PM Cost	Repair Cost	Parts Cost	Labor Cost	Tax
A001 - 2011 Crown Vic	\$60.08	\$335.03	\$198.01	\$29.25	\$0.00
A002 - John Doe's Truck	\$35.26	\$96.26	\$133.51	\$38.26	\$0.00
A003 - 2013 Chevy Silverado 3/4 4x4	\$36.00	\$1,715.00	\$1,734.00	\$17.00	\$0.00
C001 - 2011 Ford F-150 4x4	\$84.05	\$40.49	\$114.82	\$40.50	\$0.00
C054 - 2014 GMC 3500 1 Ton	\$9.72	\$66.45	\$76.17	\$15.75	\$0.00
C146 - Maroon Youth & Family Van	\$23.63	\$136.06	\$159.69	\$22.50	\$0.00
ST330 - 2013 Ford Expedition	\$125.00	\$234.09	\$192.40	\$81.00	\$0.00
Category Subtotal:	\$355.60	\$2,625.37	\$3,006.68	\$244.25	\$0.00

Your Company Name/Location #1/Compressors / Generators

Equipment	PM Cost	Repair Cost	Parts Cost	Labor Cost	Tax
M276 - Ingersoll-Rand Air Compressor	\$58.48	\$117.37	\$175.85	\$2.25	\$0.00
M106 - Onan Generator	\$34.78	\$0.00	\$34.76	\$0.00	\$0.00
Category Subtotal:	\$93.24	\$117.37	\$210.61	\$2.25	\$0.00

Hazards during maintenance

- Undertaking maintenance activities can potentially expose the workers involved (and others) to all sorts of hazards, but there are four issues that merit particular attention because of the severity of the harm that could be involved, and because they are commonly encountered during plant and building maintenance.



Hazards during maintenance-asbestos

- The health consequences of disturbing asbestos when drilling holes into the building fabric or replacing panels can be severe, as can the clean up costs involved.



Hazards during maintenance-falls from height

- Maintenance work often involves using access equipment to reach roofs, gutters, building services, and raised sections of plant and machinery. It can be all too easy to fall from these positions, or to drop things onto people beneath.
- Isolation and permits to work
- Isolation and lock off arrangements, and in some cases permits to work, are essential to enable maintenance work to be conducted safely.



Hazards during maintenance-Falls of heavy items

- Heavy items sometimes have to be moved, or get disturbed, during maintenance work.
- If one of these falls, the results can be fatal.
- There may well be cranes, fork lift trucks or props available for use, but maintenance tasks can sometimes involve one-off situations and the handling of heavy loads isn't always properly planned.



Hazards during maintenance-Selection of contractors

- You may do some or most of your plant and building maintenance in-house, but there will always be tasks that are too big or specialised and require contractors.
- To enable both in-house and contracted staff to work in safety you will need to properly brief them on your site and processes, and you will need them to follow safe working practices.



Module Production engineering-Technology, process maintenance

Learning Unit 8- Eco-sustainability

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- The project is implemented within the framework of the **Cooperation for Innovation and the Exchange of Good Practices** Key Action and is funded by the **Erasmus+ Programme** of the **European Union**.

Learning outcomes

- This module will enable you to:
Understand the importance of materials and the connection between materials' properties and engineering technologies required to process them.
- Understand and critically evaluate aspects related to production organisation and optimisation
- Understand and critically evaluate aspects related to automation in furniture manufacturing
- Ability to understand and critically analyse the eco-sustainability aspects in furniture production

How to learn?

- This course could be taken using a “self directed” learning approach.
- For those attending “full time” courses a lecturer will be directing your learning using the learning materials available.
- For those enrolled on a “part time” basis a mixed approach could be employed.
- Please see below recommendations for each of the situations:

How to learn? Self directed approach

- We suggest the following sequence:
- Read the slides, watch the videos and reflect on the content.
- Read the additional text available where information is more detailed.
- If possible discuss with a colleague or register for a “Forum” and express your views.
- Test your understanding by taking the test at the end of the PowerPoint Presentation. Aim to score at least 70%
- If there are aspects that you find interesting and want to explore further access one of the texts recommended in the Bibliography

How to learn? Full time approach

- Attend all classes and the lecturer will provide explanations while showing the slides.
- Read the additional text available where information is more detailed.
- The lecturer will organise opportunities for you to discuss the content of the course so that you understand.
- Test your understanding by taking the test at the end of the PowerPoint Presentation. Aim to score at least 70%
- The lecturer will present a task for you to complete that will enable you to better understand the topic. The nature of the task depends on particular circumstances.
- If there are aspects that you find interesting and want to explore further access one of the texts recommended in the Bibliography

How to learn? Mixed approach

- Read the additional text available before attending the face to face classes.
- Attend all classes and the lecturer will provide explanations while showing the slides.
- The lecturer will organise opportunities for you to discuss the content of the course.
- Test your understanding by taking the test at the end of the PowerPoint Presentation. Aim to score at least 70%
- The lecturer will present a task for you to complete that will enable you to better understand the topic. The nature of the task depends on particular circumstances.
- If there are aspects that you find interesting and want to explore further access one of the texts recommended in the Bibliography

Why study Production Technology?

- Production technology, process and maintenance module is exploring engineering: origins, methods and context.
- It explores some key principles of engineering, while helping you to improve your study skills and develop as an independent learner.
- This module will outline the main advancements, developments, styles and materials in furniture design highlighting the identifying features of each period, the materials used and show images of some of the most significant pieces of furniture ever designed.

Video Sustainable furniture: the Mazzali corporate video

- Video link: <https://www.youtube.com/watch?v=D-UD2pAGBv4>
- Short description: The concepts of social responsibility and sustainable development are becoming increasingly the pattern of the new industrial outlook. Searching for coherent and constructive partnership with the territory then becomes an important means by which to construct this new entrepreneurial vision. "There will be no business in a dead planet" emphasises David Brower, the great and sympathetic ecologist, speaking of the relationship between industry and land - a richly significant phrase, and one of sad augury, to underline how the increase in social development and safeguard for the environment will ever increasingly become conditioning factors in industrial activity.
- Duration: 1.45 min

Eco-sustainability of furniture production

- Since a quarter of global furniture is manufactured in Europe, there is a high potential to make an impactful transition towards a more sustainable furniture production within the European Union.
- The environmental and health impact of the furniture production chain can include deforestation, and the emission of toxic substances.
- The EU Ecolabel criteria aim to reduce the environmental impact of furniture production and are aligned with the EU Green Public Procurement (GPP) criteria to make it easier for public organisations to purchase responsible furniture in Europe.



EU Eco-label

- The EU Ecolabel criteria require sustainable wood sourcing to contribute towards limiting deforestation.
- This is a pressing concern since at the current rate of deforestation, the world's rainforests could vanish within the next hundred years.
- Wood, cork, bamboo and rattan used in EU Ecolabel furniture must be non-GMO and have a sustainable forest management label from an independent third-party certification system such as FSC.
- The EU GPP plays a key role in the EU's efforts to become a more resource-efficient economy and aims to stimulate a critical mass demand for sustainable furniture and promote eco-innovation especially when it comes to the B2B sector.



Video Traditional English oak furniture

- Video link: <https://www.youtube.com/watch?v=tgKrZwyeWtg>
- Short description: Tudor Oak Furniture has a core team of experienced, knowledgeable and passionate people, who take inspiration from history and believe that good design and high quality of craftsmanship should and can complement modern living..
- Duration: 2 min

Eco-sustainability standards

- ISO 14001 2015 refers to environmental aspects. It tells us that a company must determine the aspects that can control and those in which they can influence, as well as all the environmental aspects that are associated.
- This work can become complicated for many companies that wish to have the benefits of having an Environmental Management System according to ISO 14001 2015.



Definitions

- The environment could be defined as the natural environment in which the company operates to carry out its activity and in which its facilities are located.
- Within this environment we can include the natural resources, flora, fauna and human beings with which it interacts.
- Air, water or soil, which, although of great importance, are often seen as much more general and intangible aspects



Video Eco materials Solid wood from English Woodlands Timber

- Video link: <https://www.youtube.com/watch?v=lixIUz7G91M>
- Short description: English Woodlands Timber sell wood that comes from local woodlands in England. It is a product that is at the top of the sustainability chain, I mean it is as sustainable as you can get, so if you had a range of 0 to 100% it would be around 95% to give you an idea from my head.
- Duration: 3.54 min

Environmental impact

- Environmental impact is any change that occurs in the environment being the result of everyone's action.
- Environmental impacts can be beneficial or adverse to the environment.
- Not all impacts carry negative situations for the natural environment. .



Elements of furniture manufacturing that could have a detrimental impact on the environment

- Exploitation of forests
- Deforestation impact on soil
- Impact of deforestation on animals
- Use of fuel and electricity
- Residual materials
- Disposal of furniture



Environmental management

- An Environmental Management System can be used by the furniture company to assist the environmental management, providing guidance and evaluation on the operation of said system to ensure the operations that are carried out in a way consistent with the regulation and the environmental policy dictated by the organisation.



Video Raising awareness about sustainability in the furniture industry

- Video link: <https://www.youtube.com/watch?v=6R3y-rZiwaQ>
- Short description: How to raise awareness for customers about the sustainability in the furniture industry in Netherlands?
- Duration: 3.40 min

Environmental Management System

- The EMS is the central part of a management system that includes the organizational structure, the planning of all the activities carried out by the company, the responsibilities, procedures, processes and resources that are to be implemented or developed, in addition to keep environmental policy up to date.



What is an Environmental Management System?

An environmental management system brings together the people, policies, plans, review mechanisms, and procedures used to manage environmental issues at a facility or in an organization.



Requirements of EMS

- Identify legal requirements and environmental impacts associated with their activities, services or products.
- The company should evaluate all legal aspects and develop a policy to make sure they fully comply with all aspects from sourcing raw materials to selling.



Requirements of EMS

- Promote the responsibility of the management of the organisation and workers in the protection of the environment.
- The managers should learn what responsibilities fall in their remit and develop internal policies and procedures that take into account the impact on the environment.



Requirements of EMS

- Carry out the life cycle to be able to carry out activities that do not negatively influence the environment.
- Assessing the life-cycle of any product could help the organisation comply with all aspects of responsible manufacturing



Requirements of EMS

- Generate systems that facilitate the achievement of environmental objectives.
- The organisation should put in place systems that ensure the production of furniture does not have a negative impact on the environment.



Requirements of EMS

- Encourage suppliers to establish Environmental Management Systems.
- The furniture manufacturer has a duty to collaborate with suppliers that have in place EMS.



Requirements of EMS

- Evaluate all the results obtained based on the environmental policy and the objectives set by the organization.
- Principles and policies are good but the evaluation of the impact of the products must be evaluated as there are always situations that could be improved.



Principles of environmental management

- Prevention: control pollution with the implementation of a regular plan for all environmental issues, as it is a way to prevent pollution from one medium to another.
- Environmental control should be integrated into all activities of the local community, so that dangerous situations are anticipated in advance.



Principles of environmental management

- Caution: When we have many doubts about the consequences of a particular action we must go with caution.
- We must carry out an activity with an unknown environmental impact, pending the final scientific test to tell us if it is too late to counteract the harmful effects.



Principles of environmental management

- "Polluter pays":
- The polluter should be responsible for the costs of repairing the damage.
- It should be accompanied by industrial improvements and working methods in order to reduce waste and pollution.



Principles of environmental management

- Cooperation: all people and organizations that are affected by environmental plans and must participate in training.
- The environmental problems that are generated at the borders are not circumscribed.



Principles of environmental management

- Work within an ecosystem: takes into account the carrying capacity of local ecosystems.
- Natural systems have a great ability to purify the level of pollution.



Common errors in environmental management

- The management of the company is the one that makes the decision to include environmental management in the organisation's strategy, which is why it starts from the beginning of the company, but it is also the first one that has a lack of involvement and commitment.



Common errors in environmental management

- Environmental management excluded from the company's overall strategy
- The environment must be part of the culture of the organization. When it is something outside the organizational strategy, it is as if it did not exist.
- It does not exist because it is not recognized as an important part of the value chain, as a process that helps other areas achieve their objectives and indirectly helps the economic sustainability of the business.



Common errors in environmental management

- There must be an involvement of the Environment leader in the overall operation of the company. In the acquisition of new materials, in the development of new products, in the definition of any working procedure, in the implementation of new projects.
- In all activities developed by the company there will be an environmental component that must be properly managed. In all of them, at one time or another, decisions will have to be made that will affect our environmental management.



Common errors in environmental management

- The company does not know where they are
- If the company does not know when and where it deviates from the right path, if it lacks data to show how procedures are being met or actions are effective, how will they assess the adequacy of the management environmental? How will they know if they are on the right track?

