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GCSE (9–1)

Delivery Guide

DESIGN AND TECHNOLOGY

J310
For first teaching in 2017

Topic Area 6: Technical understanding – Timbers

Version 1

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Contents

TOPIC AREA 6: TECHNICAL UNDERSTANDING – TIMBERS

Introduction

GCSE (9-1)

DESIGN AND TECHNOLOGY

A guide to approaching the teaching of the content related to Topic Area 6: Technical understanding – Timbers

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- **Content:** A clear outline of the content covered by the delivery guide;
- **Thinking Conceptually:** Expert guidance on the key concepts involved, common difficulties learners may have, approaches to teaching that can help learners understand these concepts and how this topic links conceptually to other areas of the subject;
- **Thinking Contextually:** A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk

Link to qualification:

http://www.ocr.org.uk/qualifications/gcse-design-and-technology-j310-from-2017/

Specification content (Sub Topic 1)

Sub Topic 1: Ensuring structural integrity

Exam content

6.1 What gives a product structural integrity?

a. How and why specific materials need to be reinforced or stiffened to withstand forces and stresses.

b. Awareness of the processes that can be used to ensure the structural integrity of a product, such as:
- triangulation
- reinforcing.

NEA content

a. Apply technical principles appropriately to ensure functional requirements are achieved when developing a design solution.

Thinking conceptually

General approaches:

For this topic, learners will be engaging with timber from the perspective of a material they are familiar with. The learners will likely appreciate the source of timber, the many varieties of species available, and the method by which the material is harvested, processed and available to designers in stock forms. These areas of learning will need to be achieved before the learner can consider the structural integrity of timber, how it responds to different forces, and eventually design with timber based this learning.

Learners will need to first engage with the fact that timber is a fibre-based material grown in nature, a composite and that the timber supply chain aims to give a consistent supply of material, so that designers can anticipate likely performance in use. This includes grades of material and data relating to properties, such as bending, strength, elasticity and density, to name a few. Timber has excellent strength-to-weight ratio, allowing for lighter weight structures, easier shipping and assembly and in prefabrication forms. The moisture content will play a large part in the durability and resistance properties of timber, which can be changed by the seasoning process. Decay of the material, or any natural deformation from the seasoning process will also play a part in the integrity of the timber in use.

In order to consider forces and stresses on a piece of timber, learners will need to understand that forces can be both static and dynamic. A static load does not move, whilst a dynamic load does. Dynamic loads will apply greater force because of this. Forces cause stress in timber. Different forces will act differently. Learners will need to learn about tension, compression, torsion, shear and bending. How these forces act on the timber will be an area in which learners should be able to make design predictions.

Opportunities to reinforce timber structures through triangulation or reinforcing will mean that learners will develop their understanding of forces to withstand stress through design. While other materials, like concrete, can be reinforced with a composite, a timber will likely improve through the shape and cross section of the part, the use of additional beams and joints, and potentially the finish applied to the material surface. When forces are applied to timbers, like all materials, the direction of travel will be important, as well as any fixed points connected to another part in the prototype.

One practical area of exploration specific to timbers is the process of lamination, where thinner materials can be layered with adhesive to create a stiffer and less flexible material that can perform better in applications like chairs, compared to solid materials.

The technical performance principles of timbers will be the focus on the NEA, where learners will decide if a timber is appropriate for use in a specific context and application, and its functional performance measures up to the needs in their design solution. The learning for this might be simply mathematical calculations, based on predicted use of the solution, or may be assisted by the use of CAD to simulate performance, especially where a part is uniquely shaped and hard to create standardised calculations. A workshop approach to testing samples of material under different amounts of force in use will provide a hands-on and practical approach equal in value to any CAD simulation approach.

Common misconceptions or difficulties learners may have:

Learners will perceive this topic as more applicable to other material areas like metals, because of the nature of performance expectations on steels, compared to that of timbers like oak. Often, the concept of using timber as a building material, including the development of super-structures and buildings using timber will dispel the misconception that timber is only suited to certain applications.

Learners will need to approach this topic with an understanding of forces, and that materials can perform well under different forces despite their perceived shortcomings in performance. Timbers will not compare well against steels and other very strong and tough materials, but under compression and tension have surprising qualities.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

This topic will lend well to the development of application for many of the mathematical elements in the course specification. Learners will engage with different numerical values for M1, and may advance to working with rations, fractions and percentages. They will need to be able to calculate surface area and volume, and may choose to plot results of multiple sample tests using a graph. Angles, the representation of shapes in 2D and 3D, and the use of triangles will help learners in communicating mathematical models of the material in use, and help justify NEA iterations in the prototype(s). The action of forces, transforming effects and levers will be well covered in this topic ready to apply this learning in context or in the examination.

Thinking contextually

Sample based approach

Using a series of samples for one material, potentially varying thicknesses and lengths of oak, for example, the learner can construct a test situation in which a static force is applied to the material to see if there is any response in the material. This might see the material bend, twist, or snap under an increasing load. The opportunity to bend and return to the original form might be a useful ability for some products and systems, while for others, the result of bending might be undesired. A test rig in which different forces as static loads will allow an experiment approach to be taken with unbiased and comparable results to be plotted and analysed.

Reinforcement of samples

Using the process of lamination, learners can approach the task of creating a series of laminate materials, using the same or different material layers, with varying numbers of layers, and where possible changing the adhesive used. The samples will be clamped under pressure until dry, then using a similar method to the previous example, be tested under different static forces, again with results being plotted and analysed.

Testing dynamic forces

Using parts manufactured with varying form, potentially different shapes and thicknesses, timbers could be tested under dynamic force. A handle for a hand tool, for example, could be tested in context and use, and the learner could reflect on performance as dynamic forces act on the object. This test approach might be more challenging to record, but by considering the test set up, and considering how the test will progressively increase force, the learner can potentially control this factor in some way to make a measurable test. Again, results will need to be recorded, plotted on a graph, and analysed.

Structural building

Using sections of material and an appropriate joining method, the learners can explore different shapes in order to create rigid, strong or reinforced structures onto which load can be applied. A typical classroom example would be a bridge structure or tower structure, in which the separate pieces can be assembled in different 3D patterns to create the outcome desired. Load applied once the structure is complete will mean that the outcome can be analysed under progressively larger load, and the point of fail or collapse providing learners with ideas and evidence of which structures are better suited to resist static force.

Learners can progress this testing further into functional products such as chairs and other load bearing products, and use weights to simulate the static load a user would act on the product.

Learner Resources – Activities

Title	Web link	Summary description	Additional description detail	Mapping to specification level
Ted Talks	https://www.ted.com/talks/michael_green_why_we_should_build_wooden_skyscrapers	Building a skyscraper? Forget about steel and concrete, says architect Michael Green, and build it out of … wood. As he details in this intriguing talk, it's not only possible to build safe wooden structures up to 30 stories tall (and, he hopes, higher), it's necessary.	This video takes a more sustainable focus, but outlines the concept of using timber in the building of skyscrapers and other similar buildings that previously are dominated by steels and concrete.	6.1
Ikea Poang case study	http://creativity-online.com/work/ikea-the-poang-chair-a-design-classic-built-on-friendship/48672	In this activity, the learner's task is to watch the video about the chairs history, and to read the article about the chair, before (ideally) experiencing it themselves and identifying the purpose behind creating the laminate design.	Learners can focus their case study on the forces and design of the chair and how it has been improved for application.	6.1
The LCW	https://www.youtube.com/watch?v=r_EXZYqTe-Y	A look at the history and design of the Lounge Chair Wood provides learners with an understanding of a famous historical and still relevant to today product made from laminated materials.	Learners can watch and learn about the famous chair and the process used to create rigid and flexible movement in the chair.	6.1

Learner Activity

Making a laminate plywood chair (model)

Introduction

In this activity, you are challenged with creating a laminate chair model using small thin strips of plywood (aero or flexi), PVA glue, clamps and MDF for the mould. You will need to use the strips to create a unique form, mark the design on the MDF pieces to create a suitable former, and laminate your layers with PVA into a design that will dry into position using the clamps. You will then test your finished form by adding weights to explore and establish stability, strength and flex.

The activity

Teacher to provide strips of material suitable for lamination.

Learners will need demonstration on how to create a laminate.

Learners provided the opportunity to explore and create a design for the MDF mould.

Teacher/technician to provide support for cutting the MDF former.

Learners glue and assemble their laminate using clamps to hold design in place.

Follow up:

Learners remove designs from the moulds and clean up using abrasive papers or equipment.

Learners document through photographs the chair design.

Learners apply growing values of weight until the chair model cracks, breaks or can no longer bear additional weight.

Learners reflect on the design, the layering approach, and the outcome.

Extension activities/questions:

Learners can use a laser cutting approach to change the shape of the layers and create a more unique design to the chair beyond simple strips. Learners can explore alternative materials to form layers within the lamination.

Specification content (Sub Topic 2)

Sub Topic 2: Finishing materials and products

Exam content

6.2 How can materials and products be finished for different purposes?

a. The processes used for finishing and adding surface treatments to materials and products for specific purposes, including:

i. function, such as: durability and added resistance to overcome environmental factors

ii. aesthetics.

NEA CONTENT

a. Apply technical principles appropriately to ensure functional requirements are achieved when developing a design solution.

b. Be able to use surface treatments and finishes for functional and aesthetic purposes.

Thinking conceptually

General approaches:

Learners will need to understand that the process of finishing timbers is an important step in the production of a product or system and that in aiming to make the design solution meet the technical specification, the choice of finish can have an impact on the potential success of the outcome. If considered early enough, it can change the choice of the base material all together.

For the NEA element of the course, the finishes selected for the final prototype must be appropriate to the materials being used and the planned application of the outcome. In order for learners to be in a position to differentiate between different choices in finishes, they will need to know the full range of material properties for timbers, and consider these during a process of either research and/or testing of the finishes available. Learners will want to test their finishes under simulated test situations, where the potential improvement to the performance of a material can be ratified. This will form important evidence to potential iterations in the manufacturing approach.

For learners to engage with the environmental aspects relating to material finishing, they will need to understand the issues associated with applied finishes, and the issue of subsequent recycling of the base material. Likewise, they may also need to be able to identify symbols located on the packaging or containers for finishes, and understand what actions are needed to be taken by manufacturers post-process. Where learners are looking to improve the aesthetic performance of a timber material, it will be important that they are able to access the views of other users to gain the critical opinion of others before committing to a final finish.

If learners are able to identify example situations in which surface treatments and finishes have been applied, and succeeded or failed, this will support a deeper case study-based learning approach and help learners to explain and justify choices in both the NEA and the examination. These can be organised into two categories, finishes for protection, and finishes for aesthetic improvement.

Common misconceptions or difficulties learners may have:

In this topic, learners will likely focus on the aesthetic improvements finishes and surface treatments offer. It is important that wherever aesthetic improvements are the focus, that this is understood by the learner. It can then be addressed separately that in order to improve performance characteristics for material finishes, a finish can both improve factors such as durability, along with the aesthetic improvement, but where both do not improve, a comparison of benefits to the stakeholders will be required. In this instance, the value of aesthetic improvement and the value of functional improvement in the context of use will need to be critiqued, which is a likely task that is new to the learner.

Where finishes and surface treatments are being discussed, it is also likely that learners will ignore the option to not finish the material, opting always to apply some form of a finish. There is merit wherever it can be considered, for learners to choose to not finish a material, which will itself present potential benefits and drawbacks to the outcome.

Often learners will need to learn about the nature of different materials, for example, wherever they are porous, and what this means to the approach manufacturers take to finish materials. Learners may learn about finishes quicker if they understand that materials that are porous will react differently to non porous materials.

Wherever learners engage with finishes, it will be common for them to forget the context of use the product or solution needs to perform. This should be an important starting point wherever finishes are being considered. Likewise, the stakeholder opinions should be important, and gathered in a way that allows the learner to help possible customers or users to make informed decisions about finishes, and the impact in both the short term and long term, to the maintenance requirements of the outcome.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Finishes and surface treatments will be a topic of learning that appears for each material area on offer. Learners will be able to apply learning from the topic of timber finishes to other material areas, and where the learning is reinforced with practical testing and reflection, the learner will develop the skills needed to evidence stages of iteration in the NEA work.

Thinking contextually

For the finish and surface treatments that relate to timbers, an approach of providing a holistic understanding of each will help learners achieve all of the desired learning outcomes both here and when studying other material areas.

This could include the following headings:

- a short description of the finish/surface treatment
- typical applications
- related processes
- practical outcomes including quality, aesthetic, durability, etc.
- design opportunities
- design considerations
- compatible materials
- a 'how to' approach including safety considerations
- costs
- environmental impact.

In order for learners to make a comparative analysis of different choices, a standardised material such as an MDF or pine could be an easy starting point for an activity. Both of these materials provide sufficient choice in terms of potential finishes, and learners will be able to apply many of these with minimal instruction or support, allowing for some level of independent research. Finishes such as a sealant, paint or varnish will all be applicable with a brush, while the application of veneers, polymer coatings or other more radical finish would be best achieved over multiple lessons allowing for drying time or curing.

By using standard sample sized cuts of materials, the learner would be able to create testing approaches ranging from industry standard approaches such as a Vickers Impact Test, or arrange materials into sets which can be critiqued for aesthetic appeal. Learners may wish to document many aspects of the approach from the step-by-step application to the final outcome(s), and would benefit from the opportunity to film or photograph the finishes.

Where learners are not able to apply a finish themselves, for example, pressure treating (tanalising) timber, samples could be cut from a larger piece of pre-finished material, and provided to each learner. For a surface treatment such as pressure treating, it will be an opportunity for the learner to consider both short- and long-term tests, potentially looking to critique the samples over a period of time in different environments. Learners could create small test pieces that are tested in context (e.g. outside) over a period of time. Where timbers are used to create durability, learners could simulate aggressive abrasion or use with a repeated action over a shorter time period, and account for this in their findings.

Where learners might wish to think about aesthetic considerations and explore these beyond a small group of material samples, secondary research into products and systems made with the finish applied could form a product or trend board, which learners can use as a tool to engage with their customers or stakeholders. Images that depict the surface detail of oaks, mahogany and similar timbers could provide the information needed to discuss aesthetics such as the appearance and comparison to other materials alongside the timber.

Title	Organisation/ Company	Web link	Summary description	Additional description detail	Mapping to specification level
Wood finishing basics		https://www.youtube.com/watch?v=bbiXJd_1l8Y	A useful blog video resource in which finishes for timbers are explored by a DIY blogger in the context of furniture.	This resource can be used to help learners see what different finishes look like when applied to materials and the stakeholder decisions that might take place by the manufacturer.	6.2ai
Wood finishes options UK supplier		https://www.youtube.com/watch?v=oFwWrAq47io	This resource is a UK based manufacturer who has logged about the different finishes available to their customer base and the difference in what is selected.	A useful short video in which learners can see and learn about the properties of the different finishes.	6.2ai
Tanalising Process		http://tate-fencing.co.uk/about/tanalising-process/	The resource is a UK based fencing company that offer a good summary of the process.		6.2ai
Useful wood finishes (example supplier)	Auro	http://www.auro-uk.com/	This resource is a website that provides a simple set of four options for different types of product or system that would need a finish, and a range of short descriptions.	The website allows for learners to read, compare finish and prices for typical timber finishes, as a research task.	6.2ai and 6.2aii
Raw Material Guide	Auro	https://www.auro.de/en/service/raw-materials-guide/	This resource is a website that offers a really useful and thorough guide to materials and elements related to finishing other materials.	This will offer great extension activity.	6.2ai and 6.2aii

Learner Activity

Explore and Experiment with timber finishes

Introduction

In this activity, you are going to explore different finishes. Using the help sheets/instructions/information from the demo, you are going to apply a finish to each of the samples prepared for you. The sample of MDF/pine/other will need to have the finish applied consistently each time, to allow for comparison later.

Complete the sheet handout for each finish you conduct, filling in either your ideas or the learning/discussion with peers and staff.

The activity

On a sheet of paper, use a table or note format to record the following information

about the finishes you are exploring:

- a short description of the finish/surface treatment you conducted
- typical applications as outlined in the data sheet/handout
- related processes similar to this one
- practical outcomes including quality, aesthetic, durability, etc.
- design opportunities for this finish
- design considerations for this finish
- compatible materials other than the sample
- a 'how to' approach applying the finish step-by-step, including safety considerations
- costs for this finish
- environmental impact of this finish including any warnings on the packaging.

Use a camera to document:

- the before appearance of the material
- the after appearance of the material
- the process as a step-by-step of application
- any testing you conduct during the lesson/activity.

Extension activities/questions:

In order to establish the improved qualities of the material, devise a test for:

1. judging the aesthetics with a user
2. testing the durability
3. analysing the improved contrast to other materials
4. another test to explore material improvements.

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