Year 9

Design and Technology Workbook

I will explain the needs of the project and teach a broad range of skills and knowledge to you. I will demonstrate how to use tools and equipment safely and effectively and expect you to apply your new and existing learning to this project.

WE will learn about the work of other designers and movements. We will learn to use of different materials, tools, processes and understand the importance of health and safety in a practical environment. We will carefully watch and learn from practical demonstrations and apply our learning to our individual project.

YOU will use your skills, knowledge and understanding to independently draw, design, plan, make and evaluate the product to a quality standard.

Name:_____ Class:_____

Grade Achieved:_____

Contents

D&T subject specific vocabulary

In Design and Technology, there a great many technical words and phrases that are regularly used in your lessons- both theory and practical

Below are definitions of key terms used in our in our project that you should be familiar with and gain an understanding of these terms so that you can talk and write like a true designer and maker!

Abrasive: A material which smoothes and removes marks from wood, plastics and metal; see **glass paper** and **sand paper**

Adhesive: A substance used to stick materials together; examples include PVA glue, low temperature hot melt glue

Annotations: Brief notes added to design sketches to make things clearer or to give more detail

Client: A person using the services of a designer. For example, in a school the client is likely to be the person who is going to use the product but in the world outside the client is often a manufacturer and it is their customers who use the final product

Consumable materials: Materials used to make products e.g. Paper, card, wooden strip, plastic sheet, metal rod. These materials get used up and have to be replaced if pupils are to continue designing and making.

Decoration: The application of colour, texture and pattern to a surface to improve its appearance

Design brief: A summary of the aims of a design and the kind of product that is needed. A closed brief says what the product will be. An open brief leaves it for the designer to decide

Design criteria: A list describing the standards that a design must meet if it is to be successful

Design decisions: A product is the result of the design decisions made by the designer about things such as Why (is it needed?); Who (is the outcome meant for?, is to be involved in its production?); What (should the outcome do?, should it be made from?, shape/colour should it be?

Design proposal: A response to a design brief, a description of the product to be made in sufficient detail that the designer and/or the client can decide whether it is worth developing the proposal further

Designer: Any person who designs things

Drill bit: The cutting tool used in a drill. It is held in the chuck and cuts into the material as it rotates

Environment: The surroundings, e.g. A room, a town, a park, a forest

Evaluate: Assess how well a product or service meets the design criteria or specification

File: A tool for removing burs from freshly sawn metal or wood

Finishing techniques: Methods used to make the surface of wood, metal and plastic smooth; these usually involve the use of **abrasive** papers

Fitness for purpose: A criteria used in evaluating a product; the evaluator asks how well the product performs the function for which it was designed. If the product performs well then the product is said to have fitness for purpose

Fixings: Things used to fix materials together, e.g. Nails, screws, nuts and bolts

Flow chart: A way of planning how to carry out a task by drawing a sequence of boxes joined by arrows. Each box contains a short statement about one stage

Function: The purpose of a product or part of a product as in the function of a whisk is to mix the eggs with the milk and the function of the handle in the whisk is to make the gear go round to drive the blades

Functional decoration: A decoration that also has a practical purpose e.g. wrapping a handle with string not only makes the handle look more attractive it also improves the grip

G-clamp: A device you can use to clamp bench hooks to tables for added stability and/or to hold work steady or to keep parts assembled while glue dries

Health and safety: The activities carried out in your classroom must meet health and safety requirements. You can ensure that this is the case by carrying out risk assessments and organising the activities so that all risks are controlled.

Identifying needs: The process of looking at the behaviour and conditions of people and other living things and identifying what they need to be healthy, comfortable, interested, at ease etc.

Investigate: To find out by personal enquiry and experiment.

Manufacturing: This is the word used to describe the way that products are made in the world outside school. It usually implies making in quantity. For example, biscuits such as Kitkats are manufactured at a rate of many thousands per hour.

Market research: The process of finding out which products and services people want and what they are likely to spend to get them

Mass production: refers to the process (sometimes called 'Volume production') of manufacturing in the world outside school where products are made in there thousands. This requires the use of machines as well as people. Increasingly people are being replaced by machines that are computer controlled and can work 24 hours per day without rest.

Materials: The matter from which things are made e.g. Wood, metal, plastic, fabric, food

Modelling design ideas: The process of representing ideas from `inside the head' in a form that can be shared with oneself and others. The form of the model can be either 2D e.g. A sketch or diagram perhaps with notes, or 3D e.g. A construction from paper, card, straws, pipe cleaners.

One-off production: This is the way we usually make things in school. You make a single item of your design idea, sometimes referred to as a one off. In the world outside school one offs are often very expensive to buy as a lot of time and effort goes into producing the item.

Reliability: The quality of sound and consistent performance or behaviour

Risk assessment: The process by which you consider the seriousness of any risks in a learning activity and then devise ways to reduce the hazard e.g. Clear instruction and close supervision

Sanding block: A piece of cork or wood or plastic wrapped round with sandpaper. It is often easier for young children to work with a sanding block than with a piece of sandpaper when they are smoothing a flat surface

Sheet material: Material in a form where the length and width are much greater than the thickness e.g. Paper, card, **fabric**, **corrugated plastic**

Template: A template is a device that allows a shape to be drawn accurately and repeatedly onto a sheet of materials e.g. Paper, card, fabric. It can be a thin sheet of plastic in the shape of the shape to be transferred, in which case a pencil is held against the *outside* edge and follows the edge around the shape thus drawing the shape on the sheet of material beneath. Or it can be a thin sheet of plastic in which there is a hole in the shape of the shape to be transferred. In this case the pencil is held against the *inside* edge and follows the edge around the shape thus drawing the shape on the sheet of material beneath.

Testing: Investigating a product or material to find out how it performs in use

Tools: Devices to cut, shape, form and mix materials

User needs: People who use goods and services do so because those good and services meet their needs e.g. A food product meets the need of hunger, a pair of gloves meets the need of keeping warm

User preferences: People who use goods and services show preferences towards particular goods and services that appeal to them in some way e.g. A woolly hat that is bright red with yellow bobbles might appeal to a child but is unlikely to appeal to an adult

Working drawing: Plans which show how a product may be made

Date:_____

Big Questions

- **Why is a design Brief important in Design?**
- **What are the 6R's?**
- **Why is it helpful to look at other designers during the designing process?**
- **What is a passive amplifier?**
- **How does a passive amplifier work?**
- **How does sound travel?**
- **How do you ensure safe use of the scroll saw?**
- **What does "quality control" mean?**
- **What is needed to write a good evaluation?**
- **How could you use sentence starters to help to explain your ideas?**
- **What is the iterative design process?**

Literacy Skills: Sentence Starters

Big Question: How could you use sentence starters to help to explain your ideas?

In Design and Technology, **its important that you can communicate your thoughts and ideas through a range of methods**. Speaking and writing are often used but it can be difficult, sometimes, to get your ideas across to others, eg a teacher, a student or an Examiner. Using sentence starters to get your ideas across is a great way to get yourself started!

If explaining or writing a **Design Brief**

- *I am going to design and make…*
- *...the problem I am solving with my [product] is…*
- *My [product] will be made of…*
- *The aesthetics will be in the style of…*
- *The exterior will feature smooth curves and bold colours to capture…..*
- *The design should engage and educate children...*
- *The intended function of the [product] will be…*
- *The [product] will demonstrate various movements such as……*

If explaining or writing a **Design Specification**

- *The style of the [product] will be…*
- *The finish I intend to use on the [product] will be…*
- *To ensure my [product] is safe to I will…*
- *The intended user for my [product] is aimed at…*
- *I will be making my product out of...*
- *My research tells me that…*
- *The [product] needs to be the following dimensions…. mm*
- *I intend to spend £...making the [product] and I intend to sell the [product] for £… making a profit*

Annotations– these are often used when designing a product or listing out ideas and thoughts

- *In this design I have used...this style….*
- *I intend to use this finish… with my design*
- *I will use… processes to create this design*
- *I feel this will be a suitable design to make because …*
- *I don't like this design because…*
- *By making these changes I can*

Evaluation- use this to explain how successful/not an outcome or product is

- *Overall I am feel my [product] is a [success/ failure] because…*
- *I found the making process [hard/difficult/easy]… because...*
- *If I was going to do the project again I would change… to improve it*
- *I would like to add this… to the [product]*

Product Analysis– here, think about cost, materials, quality, aesthetics, etc. of existing products already in use

- *I have found that products in my target market have a similar…*
- *I will take inspiration from this product by…*
- *This product has… which I can use in my design*
- *I like the way this product has been made to...*
- *This product could be adapted by adding...*

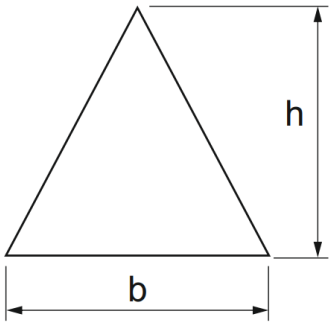
Date:_____

Numeracy Skills

Big Question: Do you know the importance of calculating the area of shapes? Do you know how to analyse data correctly?

In the world of Design and Technology, even the simplest shapes hold significant importance. Among these, the triangle stands out as a fundamental geometric figure, its area serving as a cornerstone for various applications. Understanding the area of a triangle is essential in design and technology for several practical reasons. Whether it's estimating material requirements, ensuring structural stability, or crafting aesthetically pleasing designs, the ability to calculate triangle areas lays the groundwork for innovation and precision in numerous creative projects.

Your task: Calculate the area of the triangle using the formula below:

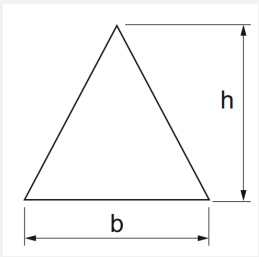
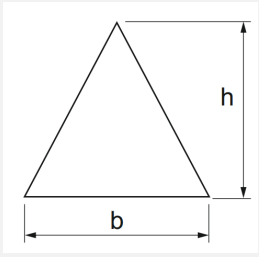


FORMULA

AREA = 1/2 X BASE X HEIGHT

AREA = 1/2 b x h

$$\text{AREA} = \frac{b \times h}{2}$$

 A triangle has a base of 30mm and a height of 70mm	b x h 30 x 70= 2100 2100x 1/2= A= 1050	 A triangle has a base of 25mm and a height of 60mm	b x h 25 x 60= 1500 1500 x1/2= A=750
A triangle has a base of 100mm and a height of 120mm	*Your answer…*	A triangle has a base of 60mm and a height of 80mm	
A triangle has a base of 75mm and a height of 50mm		A triangle has a base of 40mm and a height of 50mm	
A triangle has a base of 45mm and a height of 55mm		A triangle has a base of 70mm and a height of 90mm	

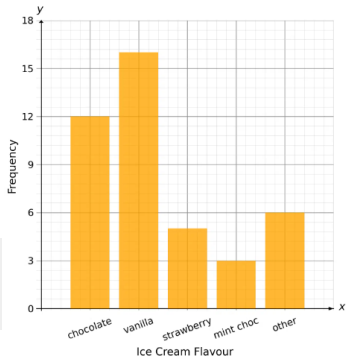
Date:_____

Numeracy Skills

Big Question: Do you know the importance of calculating the area of shapes? Do you know how to analyse data correctly?

Example:

A survey was conducted asking people about their favourite flavour of ice cream. The results of this survey are displayed on the **bar chart**.



a) Use the bar graph to fill in the gaps in the table.

Answer: To fill in the missing gaps in the table, we must read off the height of their corresponding bars from the bar chart.

Ice cream flavour	Frequency
Chocolate	12
Vanilla	16
Strawberry	5
Mint choc	3
Other	6

b) Calculate the percentage of people surveyed whose favourite flavour is strawberry.

Answer: From the table, we can clearly see that 5 people chose strawberry as their favourite. To find out what this is as a percentage, we need to work out how many people there were in total.

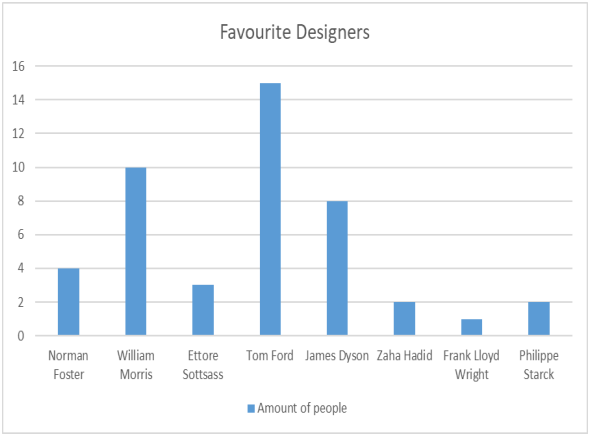
Total= 12+16+5+3+6=42

Therefore, the percentage of people who chose strawberry is

5/42 x 100= 11.9% (1 dp)

Your task:

A survey was conducted asking people about their favourite designer. The results of this survey are displayed on the **bar chart**.



a) Use the bar graph to fill in the gaps in the table.

Designers	
Norman Foster	4
William Morris	
Ettore Sottsass	
Tom Ford	15
James Dyson	8
Zaha Hadid	
Frank Lloyd Wright	1
Philippe Starck	2

b) Calculate the percentage of people surveyed whose favourite designer is William Morris.

Answer: _____ (1dp)

During Year 9, you will….

Progress your skills by: Understand the concept of Sustainability (materials) - Present design ideas – Be able to explain Function Vs Aesthetics – Use advanced measuring/marking – Show quality design presentation - Produce models and test pieces (iteration) – Show developmental decision making – Understand different production techniques - Manufacture

Develop Literacy skills:

Literacy: There are a range of extended writing opportunities for each of the projects -both within and outside of the class setting

Oracy: Students will answer questions in full sentences during discussion work and encouraged to read out loud where appropriate

Keywords: Construct, Annotate, Specification, Promote, Blending, Shaping, Finishing, Design Client, Justify, Modify, Analyse, Adapt, Input, Process, Output, Modular, Sustainability, Iteration, Development

Develop Numeracy skills:

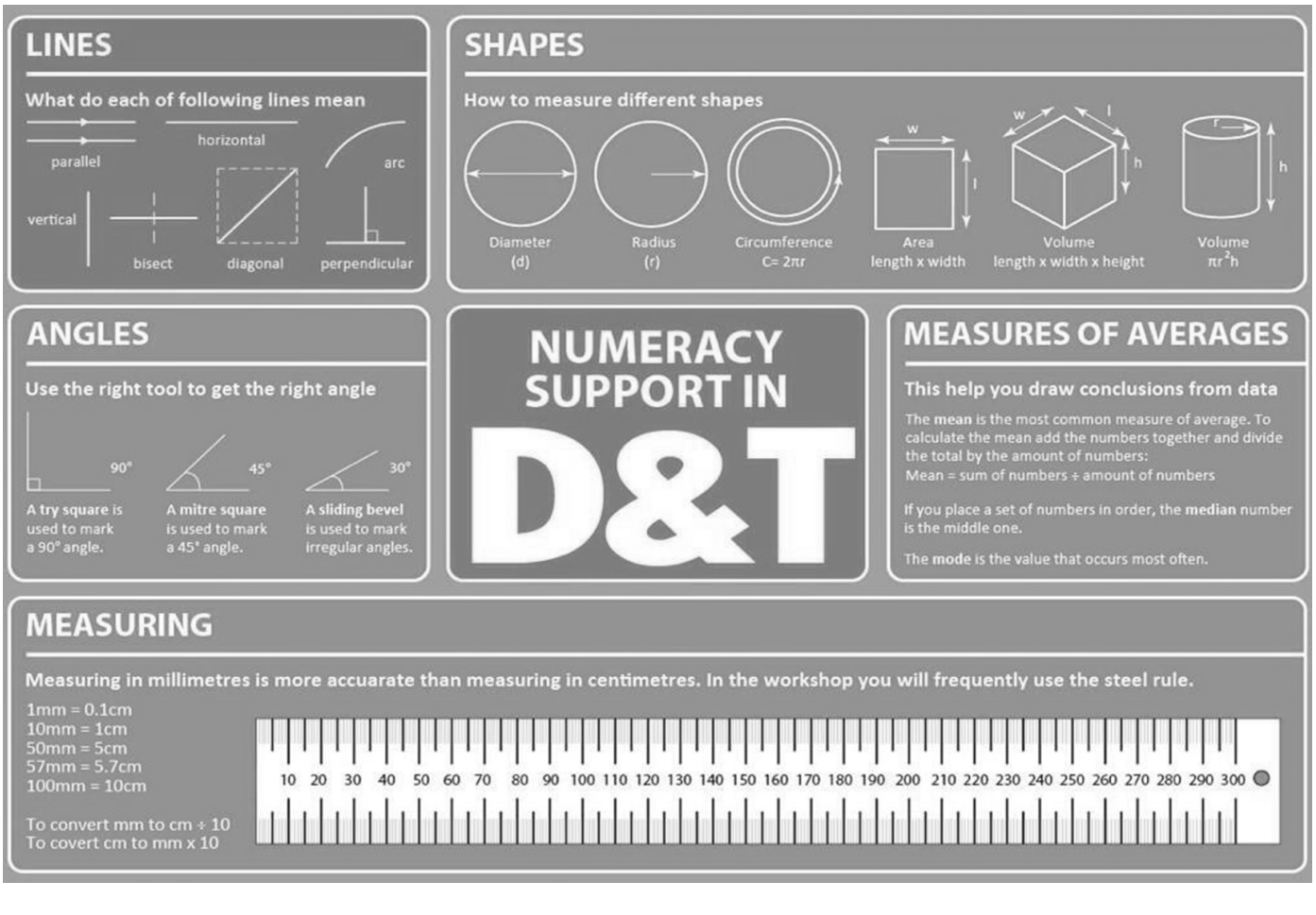
- Calculations of sizes
- Scaling drawings
- Determining the amount of materials required
- Graphic presentation of ideas to others
- Use of metric systems
- Analysis of client survey responses
- Accurate measurement and marking out

Develop Science skills:

- Use of scientific principles when developing a brief or specification
- Measurement of materials and selection of components or materials
- Classification of materials and their properties
- Protecting materials from corrosion
- Thermal conductivity
- Knowledge of material properties to be applied when designing and making
- Sustainability and recycling

Final Endpoints– by the end of the project, you should be able to:

Confidently use a range of independently collected research and data to develop and realise a product via the manipulation of a range of materials, components, tools and processes (to include iterative modelling) for an identified target client/ groups



Personal Machine Training Record

Date:_____

As part of your D&T course, you will be expected to use a range of equipment to help make your work to the highest standard.

You will be taught how to use the equipment either individually, or as part of a group and as this happens you will be asked to tick and date the chart, below, to show that you are trained and confident.

Under no circumstances should you use equipment that you have not been trained to use!

Equipment Name	Date	Trained (tick)
Tenon saw		
Chisel		
Scroll Saw		
Sander/ Linisher		
Pillar Drill		
Flame Torch		
Ceramic Chip Hearth		
Strip Heater		
Centre Lathe		
Kitchen knives		
Ovens		
Hobs		
Kitchen utensils		

Note:

Make sure that you have made yourself aware of the safety signage and information located within your practical area

If you require further instruction on the machinery during your lessons, ask!

Notes

Project 1

Acoustic Dock

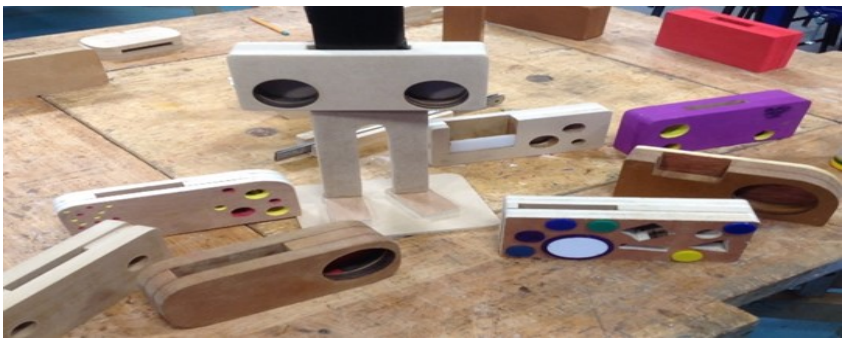
I will explain the needs of the project and teach a broad range of skills and knowledge to you. I will demonstrate how to use tools and equipment safely and effectively and expect you to apply your new and existing learning to this project.

WE will learn about the work of other designers and movements. We will learn to use of different materials, tools, processes and understand the importance of health and safety in a practical environment. We will carefully watch and learn from practical demonstrations and apply our learning to our individual project.

YOU will use your skills, knowledge and understanding to independently draw, design, plan, make and evaluate the 'Acoustic Dock' product to a quality standard.

Date:_____

What does Success look like?



This project will build on your knowledge and understanding from previous years and introduce you to new skills and GCSE theory content in readiness for further study next year. **In order to be successful in this project, you will need to show evidence of:**

• **Your use of research and investigation to create a range of appropriate design**			• **Your selection and use of tools and processes appropriately and with skill.**		
Met	**Partially met**	**Not Met**	**Met**	**Partially met**	**Not Met**
• **Accuracy in your measuring and marking out of materials.**			• **Your use of a range of materials and joints to assemble your product to a high level of accuracy and finish.**		
Met	**Partially met**	**Not Met**	**Met**	**Partially met**	**Not Met**

How you will be assessed?

Whole Class Feedback Sheet

Praise:

- Excellent quality cuts made
- Accurate use of ruler
- Good quality of joints used in assembly

Common Practical Mistakes:

- Hold the tools correctly, as shown.
- Watch the demonstrations.
- Listen to all instructions and follow them.
- Check that the set task is correct before moving on.
- Improve the quality of the final piece.

SPAG Errors:

- Student's name missing from work.
- Missing capital letters for names and places.
- Keywords misspelt.
- Punctuation marks missing

Interpreting the Design Brief:

- To be able to produce and orthographic projection.
- To transfer the 2D drawing to 3D onto wood.
- To recognise the correct shape for a box.
- Recognise the three different joints and know their names and purpose.

Design/Drawing Skills:

- Orthographic projection drawn accurately.
- Measurements are accurate.
- Straight lines created using a ruler.
- Small arrowheads.
- Positioned correctly on the page.
- Designs to be annotated describing techniques and tools to be used.

Wider Understanding:

- Produce a minimum of 150 words.
- Written in own words?
- Have images have been included?
- Personal opinion on the subject and images.
- Conclusion?
- Bibliography has been included.

Date:_____

Design Scenario and Brief

Scenario:

A high street electrical retailer has invited you to develop an eco friendly, passive acoustic phone dock for sale in its flagship Northampton store.

Brief:

You are to create a personalised response to the Scenario which will lead to the creation of a product which will:

- Amplify the existing speaker(s) of a phone to a satisfactory level
- Be aesthetically pleasing—showing a link to a Contemporary Artist, Designer or Movement
- Use no electrical circuitry
- Be suitable for use in the home environment—either as a static or portable device

Use the table below to track your progress:

Need	Completed?
A personalised Brief and Specification	
Research sheets: • Design Movement • 'What is Sound?'	
Design sheet 1 (front and rear panels)	
Design sheet 2 (acoustic panels)	
Flowchart Planning/Risk assessment	
Prototype card model	
Final outcome	
Evaluation	

As you go through the different stages of the project, remember that your work will be assessed regularly—so you must ensure that, at each point, you are working to the very best of your abilities!

Date:_____

Your Personal Brief: What is it that you intend to do response to the Scenario?

_____

_____

_____

_____

_____

_____

Product Specification: What must your product be able to do in order to be judged a success? For each point, explain **why** it is important. Use **ACCESSFM** as a guide.

Specification Point	Justification

Date:_____

Design Movements research sheet:

Understanding the work of others is key to developing yourself as a designer! As part of this project you will have been asked to look at a wide range of designers, artists and design movements. You will be asked to further research and apply some of these findings to you own work.

As a start, look at the work of the super famous:

- **Aldo Rossi**
- **Gerrit Reitveld**
- **Ettore Sottsass**
- **Braun Design Company**

Rossi

Braun

Sottsass

Reitveld

Sottsass

Rossi

Date:_____

Design Movements Research Sheet:

Date:_____

What is Sound?

- What is a **PASSIVE AMPLIFIER?**

_____

_____

_____

- How does it work?

_____

_____

_____

- How does **SOUND** travel?

_____

_____

_____

_____

_____

_____

_____

- Make notes on a megaphone

_____

_____

_____

_____

_____

_____

_____

- How are you going to use this information with your own designs?

_____

_____

_____

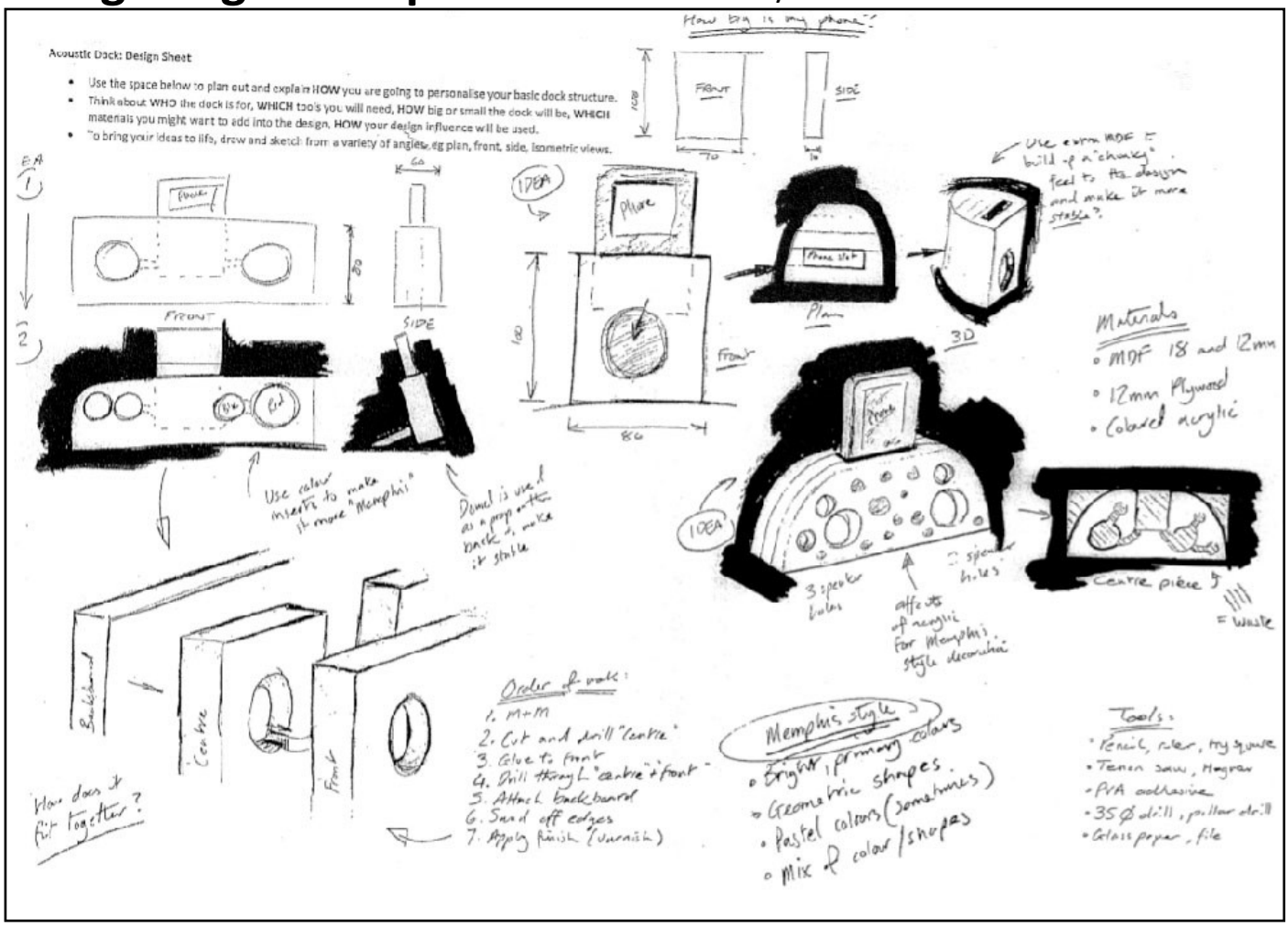
_____

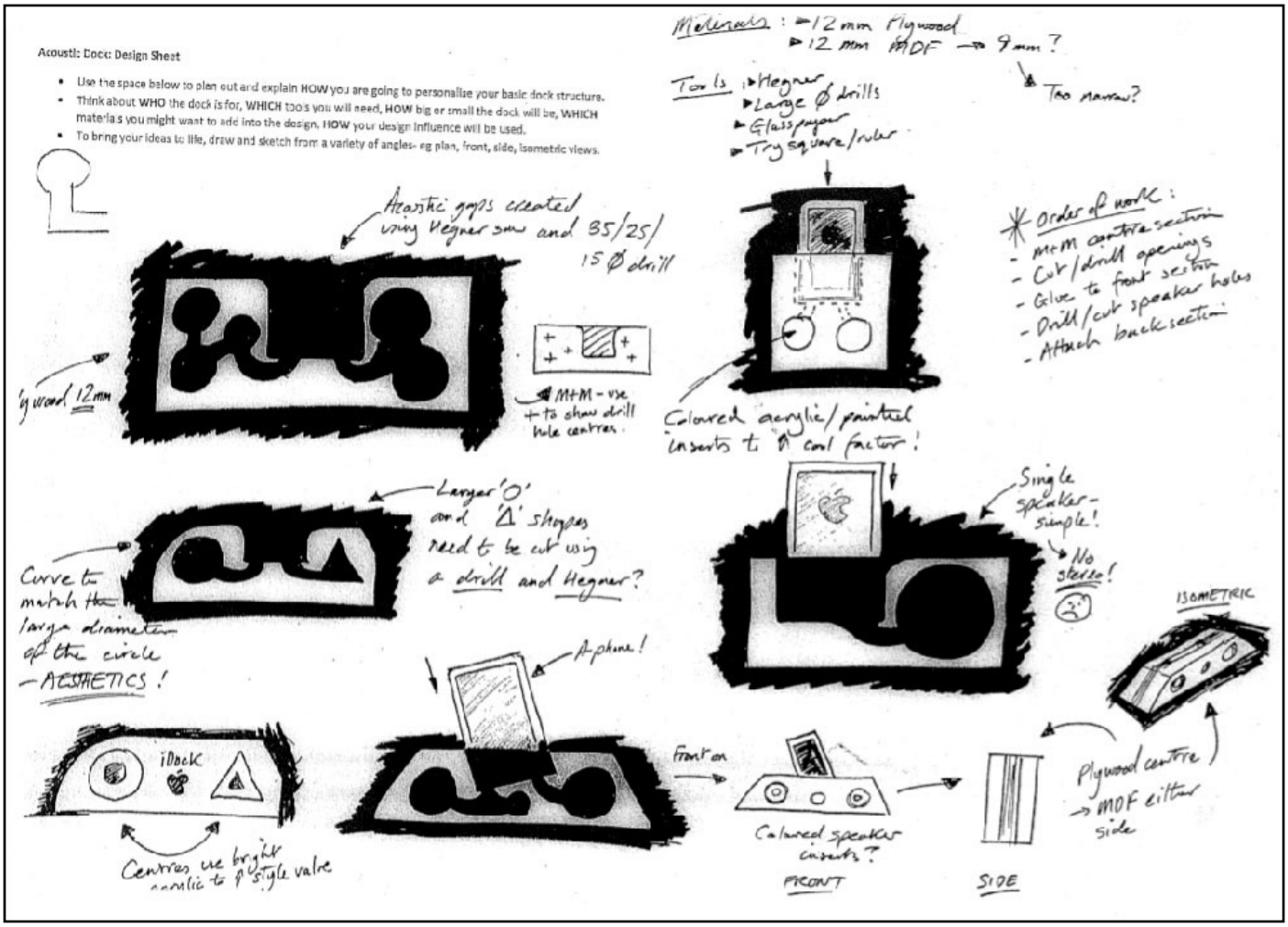
_____

_____

Date:_____

Design Page Exemplars– what details can you see?





Design Sheet 1- (Show the front and rear panels)

- Use the space below to sketch out and explain **HOW** you are going to personalise your basic dock structure.
- Consider and annotate **WHO** the dock is for, **WHICH** tools you will need, How big the dock will be, **WHICH** materials you might want to use in the design, **HOW** your design influence will be used.
- To bring your ideas to life, draw and sketch from a variety of angles-eg front, plan, side and isometric views. Remember to include dimensions in millimetres.

Date:_____

Design Sheet 2- (acoustic panels/ centre sections)

Date:_____

- To bring your ideas to life, draw and sketch from a variety of angles-eg front, plan, side and isometric views. Remember to add in dimensions.

Acoustic Dock Flowchart

Use the space below to draw a flowchart to show the planned steps of making of the acoustic dock. Make sure you include quality control decisions.

Symbol	Name	Function
	Start/end	An oval represents a start or end point
	Arrows	A line is a connector that shows relationships between the representative shapes
	Process	A rectangle represents a process
	Decision	A diamond indicates a decision

Date:_____

Date:_____

Big question: What are the main manufactured board types?

As part of your KS3 course, it is important that you understand where materials come from and their properties. This project will be giving you the opportunity to use a range of 3 manufactured board types. Read the notes, below, then answer the questions to, perhaps, help you to decide on your own final choice

Plywood

Plywood is made by gluing together a number of thin veneers or 'plies' of softwood or hardwood.

Advantages:

- There is always an odd number of veneers and each ply is at a right angle to the one below, this gives the material its strength. The more veneers used, the stronger the plywood becomes.
- The finish quality of plywood varies considerably, some plywood have attractive grains while others can contain knots.
- Plywood may be used inside and outside. Plywood is quality graded for exterior or interior use depending upon the water resistance of the glue used to stick the plies together. To help designers, builders and manufacturers make the right choice, code letters shows this grading on each sheet.
- Plywood is sold in 2440 x 1220mm and 1525 x 1525mm sheets. The most common thicknesses are 4, 6, 9 and 12 mm. Plywood can be nailed and screwed. Thin plywood is flexible and can be formed into curved shapes

Medium Density Fibreboard (MDF)

MDF is a type of hardboard, which is made from wood fibres glued under heat and pressure.

Advantages:

- There are a number of reasons why MDF may be used instead of plywood or chipboard. It is:
    - dense
    - flat
    - rigid
    - has no knots
    - easily machined
- MDF can be painted to produce a smooth quality surface or be veneered with a high end wood or laminate finish
- Because MDF has no grain, it can be cut, drilled, machined and filed without damaging the surface

Disadvantages:

MDF can be dangerous as it contains a substance called urea formaldehyde, which may be released from the material through cutting and sanding. Urea formaldehyde may cause irritation to the eyes and lungs. Proper ventilation is required when using it and facemasks are needed when sanding or cutting large quantities of MDF with machinery. The dust produced when machining MDF is dangerous, so masks and goggles should always be worn.

Date:_____

Big question: What are the main manufactured board types?

Chipboard

Made by gluing together wood particles with an adhesive, under heat and pressure makes chipboard. This creates a rigid board with a relatively smooth surface. Chipboard is available in a number of densities: -normal, medium and high-density. It is often used for kitchen tops (which are laminated with melamine) and fire doors. All grades of chipboard except the high-density variety tend to soak up water. Once it is water logged, chipboard tends to swell and breakdown. Iron/ gluing on strips of veneer may be needed to disguise the unattractive edge of veneered chipboard (see the edge of your school desk)

Questions:

1. Name 3 thicknesses that manufactured boards can come in

_____

_____

2. How are the plies of plywood joined together?

_____

_____

3. What does 'MDF' stand for?

_____

_____

4. What are the two types of plywood?

_____

_____

5. Name two benefits to a designer or manufacturer of using a manufactured board

_____

_____

6. Name three manufactured boards

_____

_____

7. Name three advantages that MDF has as a material

_____

_____

8. Which manufactured board would be most likely used to make a kitchen worktop or a school desk? How would it be visually or functionally enhanced?

_____

9. Name two pieces of PPE that should be used when processing large amounts of MDF eg in a furniture factory

_____

_____

Date:_____

Design Sheet:

It's all about the base

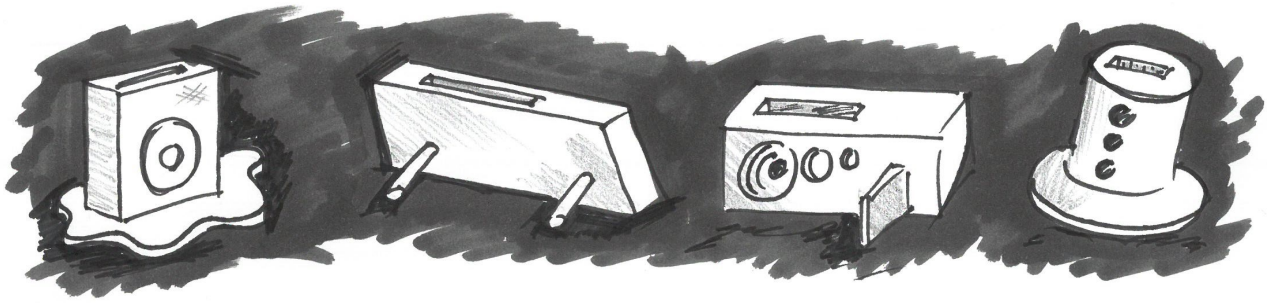
Design development is very important- it allows a good product to become a great product. Virtually everything that has been created has developed over time.

By now, your 'Acoustic dock' will be nearing completion so it's time to think about any new developments that can be made to either make it to either function or look better...

One key point for development that regularly comes up is 'stability'- ask yourself, "If I put my phone into my dock and it gets accidentally knocked, will it all fall over and smash my screen? (or worse)"

To do:

- Look critically at your product, and see if you can see where this problem might happen to you/ the User
- Sketch out 3 ideas which show how the problem might be solved- see examples, below
- Model the solution (if appropriate) before adding in the change to the product itself



Risk Assessment

Health and Safety is an essential element of your course. GCSE Examination Boards expect you to be able to plan your work as safely as possible for yourself and others before you start work—this can be the potential risks and dangers from the processes, finishes, joins and tools that you intend to use. Use the table below, to **identify the potential risks** to yourself/others and **how you could either avoid or minimise** the problem.

Tools or Process	Use	Risk	Avoidance	Minimisation
Tenon saw	*Cutting different types of materials eg softwood or MDF*	• *Cuts to hands* • *Breathing in of wood particles*	• *Use of a scroll saw*	• *Ensure room is well ventilated* • *Work is clamped down firmly using a G clamp* • *Use of a bench hook*

Date:_____

Date:_____

Big question: What is needed to write a good evaluation?

Acoustic Dock: Evaluation

I will explain the purpose and value of completing a project evaluation and explain all of the main elements needed to make it a success!

1. What do you think of the overall design ? What changes would you make ?
2. Are you happy with the materials you chose ? Would you make adjustments next time ?
4. Did the project take too long to make ?
5. Would it be easy to set up a production line for the manufacture of your solution ?
6. Is your solution safe ? Could it be made safer ?
7. Are the techniques you used to make your solution adequate or would you use a different range of manufacturing techniques ?
8. Is the solution the right size/shape ?
9. What are the views of other people regarding your design ?
10. Does it work ? What changes are required ?

We will read through the model example and highlight the key details that have been discussed:

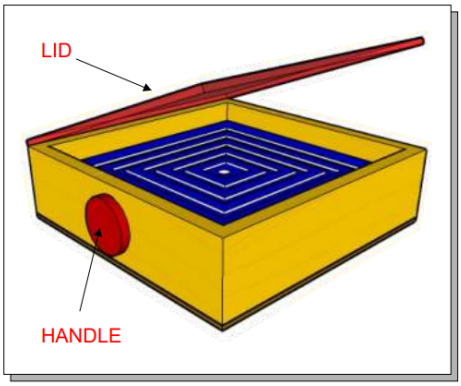
EVALUATION

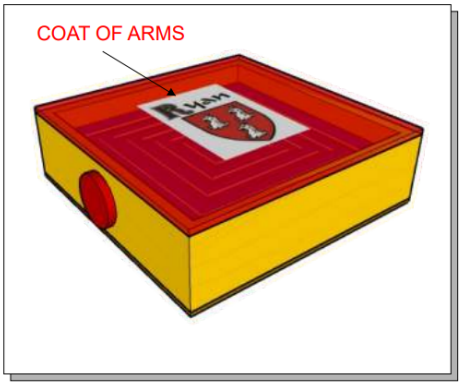
GOOD POINTS

I like the overall design of my project. It is a suitable game for a young child as it helps in the development of hand/eye coordination. The game and its container are safe as the edges are not sharp and there are no small pieces that could be swallowed.
The joints are accurate and hold the sides together permanently. The wood is pine and this is quite cheap to buy and yet strong and able to withstand everyday knocks.
I like the colour scheme as it reflects the results of my questionnaire. The perspex lid is red as this was found to be the favourite of children aged 5 to 9 years of age.
The lid closes quite smoothly and the butterfly hinges work well. The translucent lid allows the internal maze to be seen and the pattern looks quite interesting.
I like the position of the coat of arms. This has been machined on a CNC machine.

Overall the game works well. The maze is complex but with effort it can be beaten.

PRODUCT PHOTOGRAPHS





IMPROVEMENTS

Although I like my maze game it could be improved and be even better:

A selection of woods could be available so that parents could choose the type they like best. A wood such as mahogany would increase the price but I think parents would be prepared to pay a higher price for a quality product.

A selection of handle shapes would allow the user to choose the shape they like best. The game could be supplied with a variety of shapes making the game more interesting to look at and play.

Customers could select lids from a range of colours including translucent and transparent perspex.

The coat of arms could be chosen by the customer to reflect the family name. This would personalise the product and lift the price of sale.

In future the maze game could be based on a rectangular, circular or even triangular shape.

Date:_____

Acoustic Dock: Your evaluation

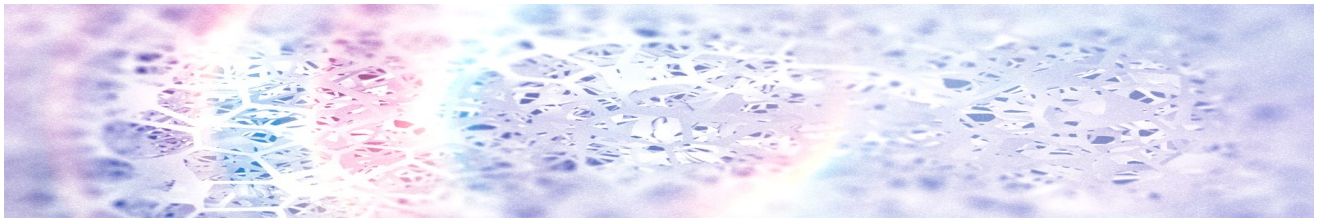
Use the box below to write out your **personal evaluation**. You could focus your comments on some of the **following points**:

- What was the most and least successful part of the project for you?
- Have you consider a designer influence with your final prototype?
- How have you made the product suitable for home use?

Date:_____

Big Question: What is biomimicry and how can nature help us solve our problems?

Biomimicry: 10 Creations Inspired by Nature



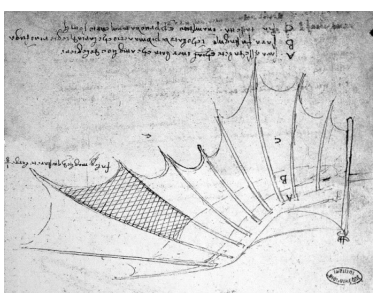
Mimicking and being influenced by the wonder of nature can be incredibly valuable in the challenge of creating a sustainable world that operates in a perfect harmony as nature does. We can see nature has had an essential role in innovation and creativity, a practice known as **biomimicry, which could well be a major player in the fight to save the environment** and develop the products of the future

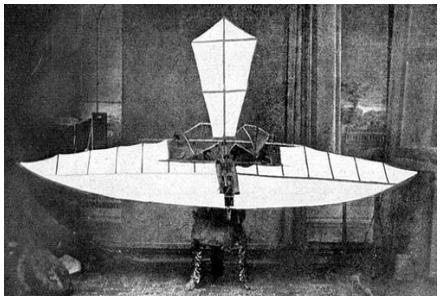
1. Flight

Leonardo da Vinci is arguably the founding father of biomimicry. As a polymath (someone who is good at many different things) with a fascination with both art and science, his extensive drawings explore how the natural world can be a source of inspiration for humanity.

His detailed study of birds' anatomy led to a design of human 'wings' with which he intended to glide through the air with a flapping motion. Of course, the actual functionality was not up to this task, but it serves as **one of the earliest examples of biomimicry in creation and innovation**.

The imitation of birds was used later in the pursuit of flight: John Stringfellow (a famous aircraft designer) is said to have drawn inspiration from **albatross' wings** in his design of a glider in 1856. The Wright Brothers, who are credited with the creation of the world's first motor-operated aeroplane, were keen bird watchers and it is said that they studied pigeons to understand the physics behind staying aloft. Nowadays, of course, aeronautical technology has developed much further, but the basic principles are still found in nature: **birds**.





Da Vinci design for a wing and John Stringfellow's glider, 1848

2. The Eastgate Centre, Harare, Zimbabwe

According to the **World Green Building Council**, as of 2017 building and construction '**are responsible for 39% of all carbon emissions in the world**'. Furthermore, a major issue office blocks face is cooling down or heating up the offices. They use pollutant, energy-intensive air conditioning units that recycle the air that is already within the offices, resulting in air pollution within the building. So how can we combat this by using nature as a source of innovation?

Zimbabwean architect **Mick Pearce** came up with a unique solution in his ground-breaking design of the Eastgate Centre in Harare, Zimbabwe in 1996. This shopping centre and office block has a structure very similar to that of a **termite mound**. **Termites farm fungi** which must be kept at exactly 30.5°C, while external temperatures range from 1-40°C. They maintain a constant internal temperature by opening and closing heating and cooling vents, which are found towards the top and bottom of the mound respectively.

Similarly, in the Eastgate Centre, during the day the building warms with sunshine and human and computer activity, although not to a significant extent since the very fabric of the building has a high heat capacity. As the external temperatures drop in the evening, the 'warm internal air is vented up through chimneys, assisted by fans but also rising naturally because it is less dense, and drawing in denser cool air at the bottom of the building'. During the night, more cool air is drawn in by filtered air vents at the bottom of the building, creating an ideal temperature within the building with fresh, not recycled (and polluted) air for the start of the day. The exterior also prevents the building from overheating with overhangs that provide shade and vegetation on the walls.

The result: the **Eastgate Centre uses less than 10% of the energy of a conventional building of its size**, resulting in a large capital saving for the owners and office tenants, and much fewer carbon emissions. This is the perfect example of drawing inspiration from nature to create a sustainable building practice. No doubt as the world continues to heat up, these practices are becoming ever more necessary.

3. Mimicking Aquatic Organisms in Engineering

A lot can be learned from the **oceans**: they cover 71% of the Earth's surface, they support 80% of life on Earth and they produce over half the world's oxygen, yet **we've only explored 20% of them**. Many innovations and creations have been inspired by life we have discovered in the ocean. The 30 St Mary Axe skyscraper in London – often called **"The Gherkin" – was inspired by a marine animal called a Venus flower basket**. This sea sponge is supported by a network of spikes arranged '**vertically, horizontally and diagonally to create a cage-like structure**'. It turns out that this lattice formation is incredibly strong and structurally sound, and as such it was incorporated into the external structure of the Gherkin building, making it very stable.

Furthermore, the cylindrical shape of the skyscraper allows air to flow around it more easily and quickly than a traditional building with rectangular sides. This air is sucked in via vents and funnelled upwards through the building, halving the use of air conditioning.

Date:_____

Regeneration: What the axolotl can teach us about regrowing human limbs. Source: ***Harvard University****, 2018*

Looking at an example in biology, scientists have studied an aquatic salamander called an **axolotl**. It has the ability to regrow a tail, and scientists have found that it is because they **have a gene that regenerates cells at the site of a wound, allowing a tail to grow back**. It is thought that this gene is "turned off" in humans, and according to a **YouthStem** article, genetic engineers are aiming to 'find a way to send a signal to these genes in humans, turning them on and activating the **ability to regenerate tissue**'.

4. Velcro

One of the more **famous examples of biomimicry** is Velcro. **George de Mestral**, a Swiss engineer, observed how the **seeds of the burdock plant** stuck to his socks and his dog when walking in the mountains. Upon further inspection, he noticed that the seed, referred to as a '**bur**', had **tiny hooks that fastened themselves to soft fur or fabric**. Inspired, de Mestral invented an applicable product founded on this basis, with tiny strong hooks attaching themselves to softer fabric, known as 'loops'. He called it Velcro and it has been used internationally in a wide variety of applications since the late 1950s.

Cocklebur, the inspiration for hook and loop fasteners (Photo: Matt Lavin). Source: **WIPO**

5. Bullet Train

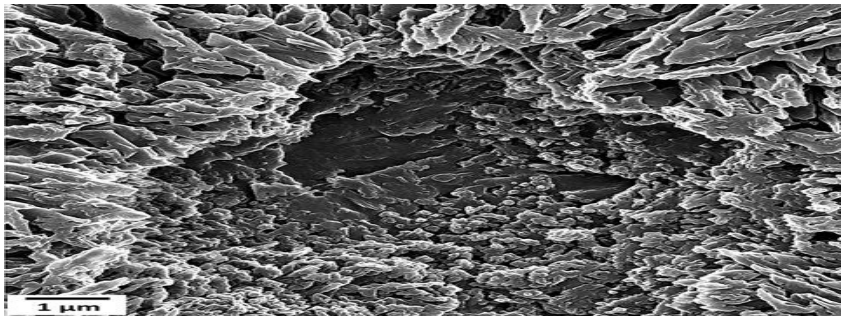
Early high-speed trains in Japan created sonic booms when exiting tunnels due to the build up of air pressure as the train travelled through the tunnel. These loud bursts of air disturbed local residents. **Eiji Nakatsu**, the General Manager of the Technical department, was a keen bird watcher. He noticed that **when kingfishers enter the water to catch prey they barely make a splash due to the shape of their beaks**. After testing several 'bullet' designs, the one deemed most efficient and functional was that modelled most closely to the beak of the kingfisher.

The steadily increasing diameter design of the front of the train made it more aerodynamic, reducing the air pressure when travelling through tunnels, thus reducing the noise pollution at the exit of the tunnel, and rendering it acceptable to national regulation. Furthermore, it '**allowed the train to travel 10% faster using 15% less electricity**'. **Reducing emissions and making the train more energy efficient** was made more simple **thanks to nature**.

Bullet train design compared to a Kingfisher. Source: Jolie Li, ***Medium 2021***

6. Cement

As previously mentioned, the built environment accounts for nearly **40% of the world's carbon emissions**. One company, **Calera**, has found a unique solution to the wasteful and energy intensive production of cement. The founder, **Brent Constantz**, is a **biomineralization expert** at Stanford University. From his study of sea **corals**, he noticed that the hard exoskeletons of corals are created from calcium carbonate, formed by oxygen, carbon dioxide, and calcium found in seawater. Calera **applies this technique to make cement**.



Source: **Inhabitat**, 2011*A magnified calcification center on coral, surrounded by microsized argonite crystals. | Viacheslav Manichev and Stanislas Von Euw/ Rutgers University*. Source: **AAAS**, 2017

In a simplification of the process, flue (exhaust) gas is taken from a plant in Moss Landing, Monterey Bay, California, and mixed with seawater from the nearby bay. The carbon dioxide in the flue gas and the calcium in the sea-water **react to make calcium carbonate**, which falls to the bottom of the solution and is dried out with the heat from the hot flue gas in a renewable method. The **powder leftover is the cement, which can be used to create concrete**.

The largest advantage of this method is that it is a form of **carbon sequestration**. Using waste carbon dioxide to make cement ensures that the **carbon is trapped** in the cement and anything made from it, like concrete or synthetic limestone. This means that instead of the carbon dioxide acting as a greenhouse gas and warming the planet, it is being used as foundations for our houses and to build bridges.

7. LEDs

Chang-Jiang Chen, a doctoral student in electrical engineering, noticed that **fireflies** have '**asymmetric microstructures in their lanterns**' which have a larger surface area than that of a flat surface and hence allow a greater interaction of light with that surface, trapping less light. Moreover, when the light hits the slopes of the asymmetric pyramids, '**there is a greater randomization effect of the reflections, which gives light a second chance to escape**'.

Chen is not the only scientist who has explored this concept: a team of researchers from Belgium, France, and Canada found that this method '**increased LED light extraction by up to 55 percent**'. LEDs more efficient than conventional bulbs, but they also last up to 20 times longer and do not contain toxic chemicals like fluorescent tube lights that contain mercury.

When considering the global scale on which LEDs are used and their much-improved energy efficiency and features, it is clear that this invention has had and will continue to have a less damaging effect on the environment than conventional bulbs. They lose less energy, resulting in fewer carbon dioxide emissions as well as not harming nature and biodiversity with toxic chemicals.

Source: **Futurity**, 2019

8. Biomimicry: Bee inspired

Bees are essential to our livelihoods and the environment. Put simply, they pollinate plants that grow the food we eat as well as that support numerous other organisms. Bee hives have inspired buildings for hundreds of years. And it is not without good reason: not only are hexagonal structures aesthetically pleasing, they also are structurally sound. As the mathematician **Thomas Hales** (author of **The Honeycomb Conjecture**) explains, structures of **hexagons have 'high compression strength' and 'a hexagonal honeycomb is the way to fit the most area with the least perimeter**'. Such space efficiency is used in the built environment extensively.

Milesian beehive house near Ventry, on the Dingle peninsula, Ireland

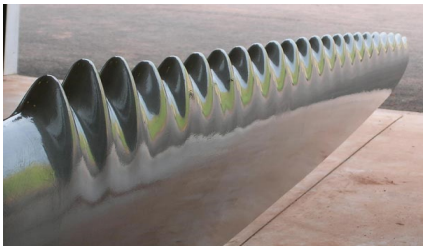
The first example is found over 4,000 years ago, in the beehive houses typical of the **Celtic dwellings in Scotland and Ireland**. Simply stacking flat stones to create a domed house ensured structural stability, heat retention in the winter, and for rain to flow off easily.

A more modern example is **The Vessel** in Hudson Yards, New York City. It is a network of staircases and landings that resemble a bee hive both in the overall shape of the structure, as well as the hexagonal design. As of now it serves no function other than a place for tourists to gather and admire the views of the city and the Hudson River, however group leader at the design studio Stewart Wood says that **'over time its use will evolve in ways we can't even imagine right now'**.

As for a more practical example, the **Duo Towers in Singapore by Büro Ole Scheeren** feature an attractive façade of a **metal honeycomb structure**. The hexagons engulfing the tower provide shade from the sun – therefore reducing the internal temperature – whilst not comprising the views of the city, and represent the hive of activity within the building. And a hive of activity it is: it contains offices, residencies, a hotel and a retail gallery.

The Vessel, New York. Source: ***ArquitecturaViva****Duo Twin Towers, Singapore. Source:* ***wordsearch***

Date:_____



Humpback whale fin. ***Source****.Wind turbine blade at WhalePower. Source:* ***Technology Review****, 2008*

It was previously thought that smooth blades for wind turbines and aeroplane wings would be the most efficient design and result in the least drag and most lift. However, when **researchers from Harvard University** were studying the movement of humpback whales, they noticed that they moved through the water with surprising speed and efficiency. The reason is due to the bumps they have on their fins. It turns out that the bumps help generate lift, reduce drag, and even delay stall, which is a dramatic loss of lift when the angle of attack of a wing is too steep.

These **'bumps'** – or 'tubercles' as they are known – **can be applied to wind turbines, water turbines, aeroplane wings and submarine fins** to 'reduce drag by a third and improve lift by 30%' according to the **US Naval Academy**. The use of such designs is still in the early stages of development, but one Canadian venture, **WhalePower**, is leading the way by designing wind turbine blades with these tubercles and have found them to be more '**stable, quiet, and durable than conventional blades**'. On a smaller scale, they have found that '**industrial ceiling fans can operate 20 percent more efficiently than conventional blades**'. No doubt, the study of whale fins has allowed more efficient design, and therefore more efficient energy use and generation, which benefits the environment and increases the appeal of renewable energy sources.

10. Spider glass

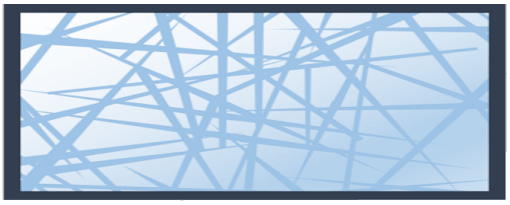
In 2012, a **special coating on the glass of the Lindisfarne lookout tower** off the coast of North East England was implemented, and it was inspired by spider webs. Specifically, by the web of an **Orb weaver spider, whose web's silk reflects ultraviolet rays**, making them visible to birds who steer clear and do not destroy the web.

Spirals Through Time: Evolution of Orb-weaver Webs. Source: **Roundglass**

A German company called **Arnold Glas** incorporated a coating of ultraviolet light reflective material in a similar pattern to that of a spider's web. The results showed that '**76% of birds managed to recognise and avoid the glass laced with ultraviolet-reflective patterns**'. Interestingly, this coating is not visible to the human eye, yet still warns birds to stay away, thus potentially saving their lives.

This system has been included in the lookout tower of Lindisfarne, both saving birds' lives and allowing visitors to enjoy the stunning views from the island.

What people see



What birds see

Conclusion: Biomimicry and Sustainability

It is clear that mimicking nature to inspire creations can provide value in so many ways: it can reduce carbon emissions, save money, reduce waste, and create a more harmonious and efficient world. There is a lot to learn from nature and now is the time to look at business processes to see where nature can lend a helping hand.

With the recent **Taskforce on Nature-related Financial Disclosures (TNFD), nature and biodiversity has been placed at the forefront of business and regulation**: fragile natural environments are not only vital to businesses but to every human's livelihood and the future of our planet.

Questions:

1 What percentage of the worlds carbon emissions are attributed to the built environment?

_____

_____

2 Which mammal has been highly influential in the development of wind turbine blades and in what way?

_____

_____

3 How much longer do LEDs last compared to a conventional fluorescent tube light?

_____

_____

_____

Date:_____

4 The Eastgate Centre in Zimbabwe had its design heavily influenced by which insect? What method is used to ventilate the building?

_____

_____

5 Since the before the time of Leonardo Da Vinci, which sphere of design and engineering has been influenced by the study of birds wings?

_____

_____

6 The study of which aquatic creature is giving biologists' great ideas for how limbs could be regenerated?

_____

_____

7 The ability of birds to see ultra violet light is being used to help develop which material?

_____

_____

8 By using the aerodynamic principles of the Kingfishers beak, by how much fuel and speed efficiency has the Japanese Bullet Train been improved?

_____

_____

9 Bees like a hexagon. What type of particular strength are hexagons known to be able to resist?

_____

_____

10 Which genius product did George de Mestral, a Swiss engineer, come up with when he observed how the seeds of the burdock plant stuck to his socks and his dog when walking in the mountains? What is the principle behind the idea?

_____

_____

Feedback Sheets

Glue your whole class feedback sheets here