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| **Design and create a pewter cast medal** | | | |
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| Make your own medal for the World Cup | | | |
| **Subject(s):** Design and Technology, Engineering  **Approx time:** 120 – 150 minutes |  | | **Key words / topics:**   * Pewter * CAD * Casting * Molten * Metal * Fettling * Gauntlets |
| **Stay safe**  Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for:  • ensuring that any equipment used for this activity is in good working condition  • behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others  Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ | | | |
| **Suggested learning outcomes** |  | |  |
| * To understand the principles of pewter casting * To be able to design a product using CAD drawing * To produce a mould for casting using a laser cutter * To be able to fettle and finish a metal product | | | |
| **Introduction** |  | |  |
| This is one of a series of resources designed to allow learners to use the theme of the men’s football World Cup to develop their knowledge and skills in Design and Technology and Engineering. This resource is focused on designing and making a pewter cast medal for the World Cup. It introduces the concept of CAD design, pewter casting and how this can be used to create something for a major event.  Metal casting is a manufacturing process that involves pouring molten metal into a mould to create a 3D metal part. The mould contains a hollow cavity of a desired geometrical shape, and the molten metal is allowed to cool down to form a solidified part. The term ‘casting’ also refers to the part made by the casting process, which dates back 6000 years. Historically it is used to make complex and large parts, which would have been difficult or expensive to manufacture using other manufacturing processes. | | | |
| **Purpose of this activity**  In this activity learners will use the theme of the World Cup to design and make a World Cup medal using pewter casting. This includes designing the medal, casting the pewter and fettling and finishing the medal.  This could be a short focussed practical task or part of a longer run series of lessons about casting, designing or industrial finishing. | | | |
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| **Activity** |  | | **Teacher notes** |
| **Introduction (10-15 minutes)**  Teacher to introduce the activity and the theme of the 2022 men’s World Cup. Teacher to describe the principles of pewter casting using the presentation.  **Designing the medal on paper (15-20 minutes)**  Learners to create initial designs for their medals on the worksheet, then select features from their initial ideas to create their final design.  **CAD drawing (20 minutes)**  Learners draw their final design using a 2D CAD drawing package. This should include the mould with a sprue for filling, and the shape of any inserted acrylic parts.  **Laser cutting (15 minutes)** ⚠  Learners then export their designs to the teacher/technician for laser cutting (depending on individual school setting/protocols), adjust the settings for MDF (under supervision) and cut out their design.  This process should be repeated for any acrylic inserts required, using appropriate settings on the laser cutter.  **Casting (30 minutes, including cooling time)** ⚠  If acrylic inserts are being used, learners should use wet and dry paper to lightly round over the edges of the acrylic – this will help the pewter to grip onto the acrylic in the cast item. A small amount of double-sided sticky tape could be used to secure the acrylic inserts in place within the mould – this must not overlap the edges of the acrylic, to prevent it coming in direct contact with the pewter.  Learners’ designs should be cast under direct supervision or with a teacher or technician performing the activity. After an appropriate time (for example: 20 mins) the mould should be safe to open – however, it should still be handled with care (and appropriate PPE such as gauntlets).  **Finishing (30- 50 minutes)** ⚠  After removing from mould, learners then fettle the pewter first with a flat file, then emery cloth, and then wet and dry paper until smooth and shiny. They can also drill a small hole (for example, 4 mm diameter) so that the medal can be hung from a ribbon. |  | | The duration of this activity could be modified by providing CAD designs or even pre-manufactured moulds. This activity assumes prior knowledge of CAD drawing two dimensional designs to accurate dimensions.  **Introduction**  If available, examples of cast products could be provided for learners to handle. The merits and limitations of manufacturing these using casting could be discussed.  **Designing and CAD drawing**  Learners should be given a size for the MDF mould based on the available facilities in school. For example, if the casting process is carried out using a crucible there is more flexibility of size than if the process is carried out within a self-contained casting unit (although the self-contained unit can significantly reduce risks due to health and safety issues).  Learners could include acrylic shapes in their medal as ‘jewels’. These shapes could either be random, drawn using CAD, or downloaded images. The examples in the presentation use downloaded images of the World Cup trophy and a football. Depending on the available facilities, the drawing could also include etched features or lettering, although unless these are very clear they may be removed by subsequent finishing.  **Laser cutting and casting**  ⚠These stages could be completed by a staff or technician dependent on the school’s risk assessments and policies.  The melting point of adhesive tape is higher than 175 oC, so it should not degrade if it does not come into direct contact with the pewter.  Casting could be carried out using either a crucible, with pewter melted by a flame or a hot air gun, or using a self-contained casting unit. In either case it is important to ensure that the mould is fully dry – if possible, this should be pre-heated to remove moisture. All health and safety precautions specified in the school’s risk assessment, such as, for example, wearing a full-face mask and gauntlets for casting using a crucible, must be followed.  **Finishing**  There is the opportunity to demonstrate several finishing techniques with associated learning and discussion about uses and merits of each. This could involve use of machinery such as milling machine if available, but also how this can be achieved by hand. |
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| **Differentiation** |  | |  |
| **Basic** |  | | **Extension** |
| * Provide learners with pre-started templates of the CAD drawing. * Provide learners with pre-manufactured templates. * Produce simple designs that do not include encapsulated acrylic. |  | | * Produce designs including multiple encapsulated acrylic parts. * Add more decorative techniques to the finished design. |
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| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * Computer with 2D CAD drawing software. * MDF blanks (one for the insert and two for side panels). * Acrylic for insert. * Laser cutter. * Pewter. * Pewter casting facilities (for example, ladle and heat source such as a hot air gun or flame, or a self-contained casting unit). * Appropriate PPE. |  | | icon-ppt Design and create a pewter cast medal presentation  icon-doc Design and create a pewter cast medal handout |
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| **Additional websites** | | | |
| * **FIFA – World cup 2022:** Official website for the FIFA men’s world cup 2022 in Qatar. <https://www.fifa.com/tournaments/mens/worldcup/qatar2022> * **Designer of World Cup trophy** https://en.wikipedia.org/wiki/Silvio\_Gazzaniga * **History of trophy** https://olympics.com/en/news/fifa-world-cup-trophy-jules-rimet-history * **Pewter casting process** https://www.youtube.com/watch?v=vcxt9PlgMec * **World cup soundtrack** https://www.youtube.com/watch?v=vyDjFVZgJoo | | | |
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| **Related activities (to build a full lesson)** |  | |  |
| **Starters** (options)   * Use a handling collection of cast items (vice, toy cars, statues). Analyse similarities and common features – complexity, surface finish etc.- and discuss the benefits and limitations of using casting to make them. | | **Plenary**   * Learners to identify three things they like about their manufactured medal and one thing that could have been improved. * Learners to discuss what other ways of manufacturing could have been used, such as how else they could have made their moulds (without a laser). | |
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| **The Engineering Context** | | | |
| * Many everyday products are made using the casting process. These range from car door handles and golf clubs to bells and pump housings. | | | |

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| **Curriculum links** | |
| **England: National Curriculum**  Design and Technology KS3   * Select from and use specialist tools, techniques, processes, equipment and machinery precisely, including computer-aided manufacture. | **Northern Ireland Curriculum**  Technology and Design KS3   * Selecting and using materials fit for purpose; safe use of a range of tools and processes appropriate to materials, demonstrating accuracy and quality of outcome. |
| **Scotland: Curriculum for Excellence**  Technologies   * I can apply my knowledge and understanding of engineering disciplines and can develop/build solutions to given tasks. * TCH 3-12a. | **Wales: National Curriculum**  Design and Technology KS3   * Combine and process materials in order to create enhanced properties and desired aesthetic characteristics. |

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| **Assessment opportunities** |
| * Informal teacher assessment of practical skills through observation of learners. * Formal teacher assessment of the completed medal. * Self/peer assessment of the completed medal. |