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| **Why Cast it?** |
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| Understanding the reasons why casting is used to make parts |
| **Subjects:** Engineering**Approx. time:** 45 - 60 minutes |  | **Key words / Topics*** 3D parts
* Casting
* Machining
* Manufacturing cost
* Pressure die casting
* Sand casting
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| **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 reasons why parts are made using casting rather than conventional machining processes.
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| **Introduction** |  |  |
| This is one of a set of resources produced in conjunction with the engineering company Arconic. The resources are designed to support teaching of key engineering concepts at both key stage 3 and key stage 4, including the new GCSE in Engineering. This resource focusses on the understanding of the reasons why casting is used to make products. |
| **Purpose of this activity**In this activity, on outline is given of the casting process and the reasons why it is used to make products. Learners then carry out a practical activity to reinforce their understanding of why casting is used to manufacture some products rather than subtractive (wasting processes). This activity involves the use of moulding materials to simulate manufacture using two process types, for comparison: a moulding/casting process and manual wasting.This could be used as a one-off main lesson activity or as an introductory lesson to a wider unit of work involving a casting activity. |
| **Activity**  |  | **Teacher notes** |
| **1. Overview of casting (15-20 mins)**Teacher to outline:* what is casting
* types of casting – this could be linked to other alternatives and the types of products typically cast
* an explanation of sand casting – extending the detail of the types, for illustrative purposes
* reasons for casting.
 |  | The overview of casting could be supported by practical demonstration (for example, of pewter casting) or the use of video clips (see additional websites below). When using the presentation for the overview:* What is casting - the numbers of the first image indicate the liquid, typically molten, material (1) is poured into the sprue, a channel which allows the material to flow into the mould (3); (2) are the shapes being cast, (4) is the material that the mould is made from, and (5) is the casing for the mould.
* Types of casting – the explanation of slide could be extended to inform learners of other casting
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| **2. Practical activity: making parts (25-35 mins)**The practical activity involves making two versions of the same product by alternative routes, to illustrate the difference between the routes. This activity could be carried out individually or in small teams.Learners are provided with modelling material, moulds and modelling tools. Firstly, they make the shape using the mould provided, recording how long this takes.They then manufacture the same shape by hand using the modelling tools, recording how long this takes.**3. Review (5 mins)**Class discussion of the two process routes followed: * How do the manufacturing times compare?
* Which of the processes had the opportunity to make the most mistakes?
* Which process gave the highest quality of manufactured part?
 |  | processes and to cover injection moulding of plastics, which is a process with many features similar to pressure die casting (reusable metal mould, liquid material injected under pressure). The relative economics of single use versus reusable moulds could also be introduced.* Sand casting – this slide is provided to develop understanding of what is involved in one type of casting process. The sequence of operations runs left to right, then from top to bottom. The gating system is made at the same time as the mould. There is normally a sprue to allow the liquid material to be poured in, and frequently a ‘runner’ to allow air to escape from the mould as it is filled. These have to be removed/cut off the part after it has solidified.
* Reasons for using casting – learners could be asked to indicate which process could be used to manufacture the items shown in the images, providing a justification for their choice.

For the practical activity:* The product to be manufactured should be three dimensional: when developing this activity shaped ice cube moulds were found to be very effective, and could be cut into individual moulds for pupils to use. These are readily available from most large supermarkets or online. Alternatively, the mould could be made by vacuum forming over a simple shape, such as a small toy car.
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|  |  | * The moulding material could be clay – subject to negotiation, this may be available from the schools art department, who will typically also have a range of modelling tools. Alternatively, this could be a proprietary product such as the different types of putty-like modelling material used by small children. It should be pointed out that this is more difficult to shape/mould than a liquid, although it has the advantage of a much lower operating temperature!

The use of modelling tools should be associated with traditional subtractive machining processes. During the second (subtractive) modelling activity, learners could also be instructed that no material can be added – i.e., if they remove too much material they have to restart, to increase similarity to traditional subtractive manufacturing processes. |
| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| Use a relatively simple shape for the making activities; demonstration of the making activities, rather than being carried out individually/in teams. |  | Learners could calculate the cost of manufacture of a specified part made using casting and conventional machining processes This could include:* material cost by weight;
* cost of making the mould;
* cost of casting and finishing operations per part;
* machining times for different operations and associated costs (for example, as a rough estimate these could be presented as cost per unit mass or volume removed).
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Projector/Whiteboard
* Moulding material (see above – could be clay, plasticine or similar)
* Moulds (see above – for example, shaped ice cube moulds)
* Tools for use of moulding materials
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| **Additional websites** |  |  |
| The following websites can be used for additional background information or to aid with the activity: * **BBC Bitesize – How die casting works:** video explaining the process. https://www.bbc.co.uk/programmes/p067871t
* **BBC Bitesize – die casting and sand casting:** short video overview of the two casting processes. <https://www.bbc.co.uk/programmes/p010wnkq>, <https://www.bbc.com/education/clips/z3dygk7> or
* **Technology Student:** scroll down to the foundry section(http://www.technologystudent.com/equip1/equipex1.htm) for several links on casting, ranging from pictorial representations on how to make moulds (<http://www.technologystudent.com/equip1/found1.htm>) to casting projects to videos of the process (<https://www.youtube.com/watch?v=jRxZsW405nw>)
* In addition to the above, there are a very large number of clips of casting activities on youtube.
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| **Related activities (to build a full lesson)** |  |  |
| **Starter*** Product analysis – show one or more metal products and ask what processes would be used to make them, and why these processes were used.

**Main*** ACTIVITY: Why cast it
 | **Plenary*** Review of the manufactured parts: How long did each take to make? Which of the processes had the opportunity to make the most mistakes? Which process gave the highest quality of manufactured part?
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| **The Engineering Context** film |
| Casting is required learning as part of the GCSE Engineering 9-1 course and is also included within GCSE Design & Technology.This process is very widely used in industry, with uses ranging from high performance aerospace components and car engine blocks to statues, ornaments, door handles and metal casings. |

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| **Curriculum links**  |
| **England: National Curriculum**KS3 Design & Technology* 2a
 | **Scotland: Curriculum for Excellence**Technologies* TCH 3-05a, TCH3-07a, TCH3-12a, TCH 4-05a
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| **Northern Ireland: Curriculum**Technology and design* Objective 2: Developing pupils as contributors to society / explore technical inventions and designs that have met a social need cost-effectively
* Objective 3: explore issues related to economic awareness.
 | **Wales: National Curriculum**KS3 Design and technology* Skills / making / 2. use hand and machine tools/ utensils, and a range of equipment and processes, to mix, shape, form and join materials and ingredients
* Range / activities in which they investigate, analyse and evaluate products in order to acquire technological and health and safety knowledge and understanding that can be applied in their designing and making
* Resistant materials and textiles / consider issues of sustainability when choosing and using materials
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| **GCSE Design & Technology**AQA Engineering* 3.2.8 Specialist techniques and processes:
	+ tools, equipment and processes / deforming and reforming / casting
	+ commercial processes / metal based material (milling and casting)
 | **GCSE Engineering**AQA Engineering* 3.2.4 Casting and moulding
* 3.6 Practical engineering skills / select and use appropriate processes
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| **Assessment opportunities** |
| Peer review of the produced shapes and responses to questions about the activity. |
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| **Personal, learning & thinking skills (PLTS)** |
| * Self-manager
* Effective participator
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