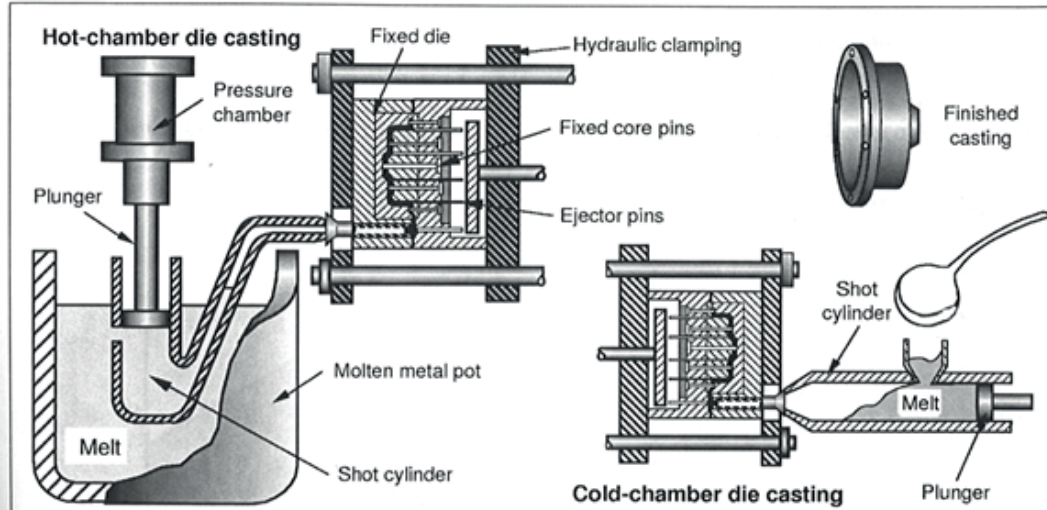


DIE CASTING



POST PROCESSING:

During cooling, the material in the channels of the die will solidify attached to the casting. This excess material must be trimmed from the casting either manually via cutting or sawing, or using a trimming press. The time required to trim the excess material can be estimated from the size of the casting's envelope. The scrap material that results from this trimming is either discarded or can be reused in the die casting process. Recycled material may need to be reconditioned to the proper chemical composition before it can be reused.

VOLUME AND COST:

The die casting process is suited to high volumes of production. Compared to most other casting processes, the casting equipment, dies and related components are very costly. Therefore, to make die casting an economic process, a large production volume is needed.

Production costs vary greatly depending on material, size, volume, tolerance, complexity and product finish, making individual part costing a difficult process that is often unique to the part being manufactured.

SPEED (CYCLE TIME):

The total cycle time of the die casting process is very short, typically between 2 seconds and 1 minute. The process cycle consists of five main stages;

- Clamping
- Injection
- Cooling
- Ejection
- Trimming

DESIGN APPLICATIONS:

- Transmission cases
- Machine and engine parts
- Pump components
- Electrical boxes
- Domestic appliance components
- Toy bodies
- Pump and impeller parts
- Furniture
- Consumer electronics
- Lighting
- Jewellery

PRODUCTION PROCESS EXPLAINED:

Die casting is a manufacturing process that can produce geometrically complex metal parts through the use of reusable molds, called dies. The die casting process involves the use of a furnace, metal, die casting machine, and die. The metal, typically a non-ferrous alloy such as aluminium or zinc, is melted in the furnace and then injected into the dies in the die casting machine. After the molten metal is injected into the dies, it rapidly cools and solidifies into the final part, which is called the casting.

Typically, the die is created with hardened steel that has been machined to the shape of the parts they are producing. The process allows products to be made with a high degree of accuracy, with the ability to produce fine details such as textured surfaces without the need for further processing.

MATERIALS:

Die casting typically makes use of non-ferrous alloys. The four most common alloys are Aluminium, Copper, Magnesium and Zinc. Their physical properties and performance characteristics can be tabled as follows;

The die casting process can be divided into two main categories:

- Hot Chamber
- Cold Chamber

Materials	Physical Properties and Performance Characteristics
Aluminium Alloys	• Low density • Good corrosion resistance • High thermal and electrical conductivity • High dimensional stability • Relatively easy to cast • Requires use of a cold chamber machine
Copper Alloys	• High strength and toughness • High corrosion and wear resistance • High dimensional stability • Highest cost • Low die life due to high melting temperature • Requires use of a cold chamber machine
Magnesium Alloys	• Very low density • High strength-to-weight ratio • Excellent machinability after casting • Use of both hot and cold chamber machines
Zinc Alloys	• High density • High ductility • Good impact strength • Surface smoothness allowing for painting or plating • Susceptibility to corrosion if not protected • Easiest to cast • Can form very thin walls • Long die life due to low melting point • Use of a hot chamber machine

SUPPLIERS:

IOTA SIGMA

Newtown Industrial Estate
Crosskeys
NP11 7PZ

01495 270060

DYNACAST

1 Fisher Road
Offa's Dyke Business Park
Welshpool
SY21 8JF

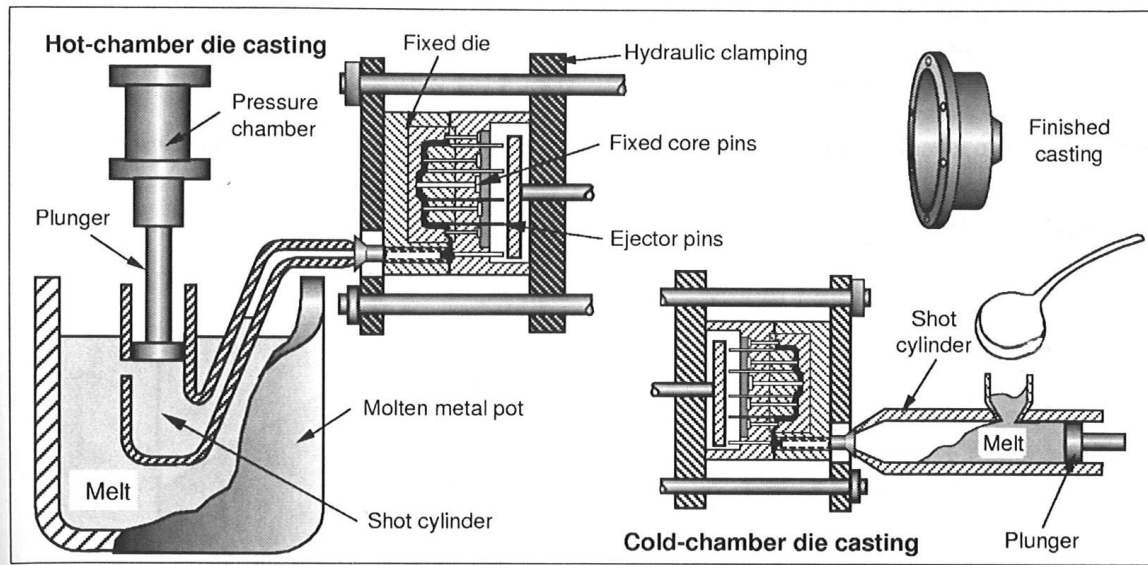
01938 557185

CASTALUM

Buttington Cross
Enterprise Park
Welshpool
SY21 8SL

01938 557557

Die Casting



Production Process Explanation:

Die casting is a manufacturing process that can produce geometrically complex metal parts through the use of reusable molds, called dies. The die casting process involves the use of a furnace, metal, die casting machine, and die. The metal, typically a non-ferrous alloy such as aluminium or zinc, is melted in the furnace and then injected into the dies in the die casting machine. After the molten metal is injected into the dies, it rapidly cools and solidifies into the final part, which is called the casting. Typically, the die is created with hardened steel that has been machined to the shape of the parts they are producing. The process allows products to be made with a high degree of accuracy, with the ability to produce fine details such as textured surfaces without the need for further processing. The die casting process can be divided into two main categories:

- Hot Chamber Die Casting
- Cold Chamber Die Casting

Hot chamber die casting relies upon a pool of molten metal to feed the die. At the beginning of the cycle the piston of the machine is retracted, which allows the molten metal to fill the 'gooseneck'. The pneumatic or hydraulic powered piston then forces this metal out of the gooseneck into the die. Alternatively, cold chamber die casting is used when the casting alloy cannot be used in hot chamber machines. The process for these machines start with melting the metal in a separate furnace. Then, a precise amount of molten metal is transported to the cold chamber machine where it is fed into an unheated shot chamber. This shot is then driven into the die by a hydraulic or mechanical piston.

Post Processing:

During cooling, the material in the channels of the die will solidify attached to the casting. This excess material, along with any flash that has occurred, must be trimmed from the casting either manually via cutting or sawing, or using a trimming press. The time required to trim the excess material can be estimated from the size of the casting's envelope. The scrap material that results from this trimming is either discarded or can be reused in the die casting process. Recycled material

may need to be reconditioned to the proper chemical composition before it can be combined with non-recycled metal and reused in the die casting process.

Relevant Manufacturing Companies:

Relevant Manufacturing Companies			
Name	Iota Sigma	Dynacast	CastAlum
Address	Newtown Industrial Estate Crosskeys Newport South Wales NP11 7PZ	1 Fisher Road Offa's Dyke Business Park Welshpool Powys SY21 8JF	Buttington Cross Enterprise Park Buttington Welshpool Powys SY21 8SL
Contact	01495 270060	01938 557185	01938 557557
Website	www.iotasigma.co.uk	www.dynacast.co.uk	www.castalum.com
Services	Ultra-light weight, tough and attractive extrusions, pretty enough to use as a show face	Design solutions for a variety of industries including consumer electronics, automotive, healthcare, and more	CastAlum has 7 fully-automated high pressure die casting cells in the range of 1,000 – 1,600 tonne locking-force

Volumes of Production:

The die casting process is suited to high volumes of production. Compared to most other casting processes, the casting equipment, dies and related components are very costly. Therefore, to make die casting an economic process, a large production volume is needed.

Materials Used in Process:

Die casting typically makes use of non-ferrous alloys. The four most common alloys that are die cast are tabled below;

Materials	Physical Properties and Performance Characteristics	Design Applications
Aluminium Alloys	- Low density - Good corrosion resistance - High thermal and electrical conductivity - High dimensional stability - Relatively easy to cast - Requires use of a cold chamber machine	- Transmission cases - Machine and engine parts - Pump components - Electrical boxes - Domestic appliance components - Toy bodies - Pump and impeller parts - Furniture - Consumer electronics - Lighting - Jewellery
Copper Alloys	- High strength and toughness - High corrosion and wear resistance - High dimensional stability - Highest cost - Low die life due to high melting temperature - Requires use of a cold chamber machine	
Magnesium Alloys	- Very low density - High strength-to-weight ratio - Excellent machinability after casting - Use of both hot and cold chamber machines	
Zinc Alloys	- High density - High ductility - Good impact strength - Surface smoothness allowing for painting or plating - Susceptibility to corrosion if not protected - Easiest to cast - Can form very thin walls - Long die life due to low melting point - Use of a hot chamber machine	

Costs:

The die casting process represents large capital and subsequent running costs, which tend to limit the process to high-volume production. Production costs also vary greatly depending on material, size, volume, tolerance, complexity and required finish of the product, making individual part costing a difficult process that is often unique to the part being manufactured. However, the costing process can be split into three main categories;

- **Material Cost:** Determined by the weight of material that is required and the unit price of that material
- **Production Cost:** Primarily calculated from the hourly rate and the cycle time
- **Tooling Cost:** Has two main components - the die set and the machining of the cavities. The cost of the die set is primarily controlled by the size of the part's envelope. A larger part requires a larger, more expensive die set. The cost of machining the cavities is affected by nearly every aspect of the part's geometry. The primary cost driver is the size of the cavity that must be machined, measured by the projected area of the cavity and its depth. Any other elements that require additional machining time will add to the cost, including the feature count, parting surface, side-cores, tolerance and surface roughness

Time:

The total cycle time of the die casting process is very short, typically between 2 seconds and 1 minute. The process cycle consists of five main stages;

- Clamping
- Injection
- Cooling
- Ejection
- Trimming

Design Considerations:

In the die casting design process, metal flow is one of the most important considerations. If the mold does not fill correctly, it can result in defects such as visible surface flowlines and air pockets that create internal porosity in the part. The following design rules should also be taken into consideration;

Design Considerations	
Maximum Wall Thickness	Decrease the maximum wall thickness of a part to shorten the cycle time and reduce the part volume
	Uniform wall thickness will ensure uniform cooling and reduce defects
Corners	Round corners to reduce stress concentrations and fracture
	Inner radius should be at least the thickness of the walls
Draft	Apply a draft angle to all walls parallel to the parting direction to facilitate removing the part from the die - Aluminium: 1° for walls, 2° for inside cores - Magnesium: 0.75° for walls, 1.5° for inside cores - Zinc: 0.5° for walls, 1° for inside cores

Undercuts	Minimize the number of external undercuts - External undercuts require side-cores which add to the tooling cost - Some simple external undercuts can be cast by relocating the parting line - Redesigning a feature can remove an external undercut
	Remove all internal undercuts that require lifters - Jamming of these devices often occurs in die casting - Designing an opening in the side of a part can allow a side-core to form an internal undercut - Redesigning a part can remove an internal undercut
	Minimize number of side-action directions - Additional side-action directions will limit the number of possible cavities in the die

Samples / Product Examples:

Note: I attempted contacting several UK based Die Casting companies, including those tabled above. A number said they were unable to help, whilst the others gave me email addresses to contact – all of which were dead ends with no reply.

Reference List;

Swift, K.G. and Booker, J.D. (2003) *Process Selection – From Design to Manufacture* (2nd ed.). Oxford, UK: Elsevier Ltd. : 45 - 47

Lefteri, C. (2007) *Making It – Manufacturing Techniques for Product Design*. London, UK: Laurence King Publishing Ltd. : 195 - 197

Thompson, R. (2011) *The Manufacturing Guides – Product and Furniture Design*. New York, USA: Thames & Hudson Inc. : 62 - 65

Die Casting. Retrieved from https://en.wikipedia.org/wiki/Die_casting

What is Die Casting? Retrieved from <http://www.paceind.com/die-casting-101/die-casting-faqs/what-is-die-casting/>

Die Casting. Retrieved from <http://www.custompartnet.com/wu/die-casting>

What is Die Casting? Retrieved from <http://www.cast-rite.com/engineering/die-casting/>

Die Casting. Retrieved from http://www.engineerstudent.co.uk/die_casting.html

ASSIGNMENT SPECIFICATION

Student name:		Student P number:	
Programme:	MDes[Hons] BA[Hons] Product Design MDes[Hons] BSc[Hons] Product Design & Technology	Faculty/School:	FAD/SD&AA
Module:	Materials & Manufacturing	Module Level (4, 5, 6, 7):	4
Module code:	M4X01231	Contribution to Overall Module Assessment (%):	A1: 50% A2: 50%
Lecturer:	I Williams M Bellis M Archer	Internal Verifier:	SDJ
Assignment Title:	A1: A2:	Assignment No (x of x):	1/2 of 2

Hand Out Date:	A1: 17.10.17 A2: 29.01.18	Submission Date:	A1: 08.01.18 A2: 04.05.18	Feedback Date:	A1: 22.01.17 A2: 29.05.18
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Referencing:	Written coursework submissions: In the main body of your submission you must give credit to authors on whose research your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have read or quoted in order to complete this assignment (e.g. for books: surname of author and initials, year of publication, title of book, edition, publisher: place of publication). Harvard or APA referencing systems is accepted. Practical coursework submissions: You must give credit to designers or artists whose work you have used to inspire your own. Where specific designs or images have been used in your development work you must indicate the name of the 'author' and details of the source of the work (e.g. book, journal, website etc.).		
Disclosure:	I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people. All references have been duly cited.		
Student's Signature:	<i>Assignments will not be accepted without a signature here and date ></i> 	Date of submission:	8/1/18
Turnitin: Lecturer to tick to indicate if an electronic version of the assignment must be submitted to Turnitin. If both electronic and hard copy submissions are required then both versions MUST be submitted by the same deadline. No marks will be released until both submissions are received. Note: the Turnitin version is the primary submission and acts as a proof of receipt for the student. A paper receipt must be completed for hard copy submissions, including portfolios and other design work.		YES	☒ A1 A2
		NO	☐

Penalties for late submission: Up to ONE week late, maximum mark of 40% for first attempt.
Work cannot be accepted after ONE week and will be recorded as a non-submission, 0%.

- The Assignment Specification Form **MUST** be at the front of all assignment submission. Assignments will not be accepted without this form, as it is a requirement that you sign the disclosure regarding referencing conventions.
- DO NOT** include this form in your Turnitin submission or it will match many similarities with other students' submissions.

This form must be signed and submitted with your assignment

ASSIGNMENT DESCRIPTION

Learning Outcomes

Module Learning Outcomes being Assessed:

1. Demonstrate a basic knowledge and understanding of material properties and their selection, application, advantages and limitations;
2. Demonstrate a basic knowledge and understanding of manufacturing processes and their selection, application, advantages and limitations;
3. Effectively integrate this knowledge within a design project.

Task

Lectures will introduce students to fundamental manufacturing processes and material selection and understanding. Demonstrations, product break downs and 'how to' exercises will be used to develop practical skills to enable students to implement their knowledge, understanding and skills to produce graphical template of manufacturing processes and material selection.

Assignment 1 (A1) – 50%

Research a given manufacturing process; identify companies that provide this service, identify the range of appropriate materials listing their physical properties, performance characteristics and provide examples of specific design applications and (where possible) source a range of material/component samples, design guides and data sheets. Using an agreed template, produce a PDF 'design guide' from the research material collected for inclusion in a shared studio/moodle reference resource for all students.

The PDF is to be A3 size with key content including:

- Production process explanation
- Post processing
- Relevant Manufacturing companies
- Volumes of production
- Materials used in process
- Costs
- Time
- Design considerations
- Samples/ product examples

Think about the layout of each area of information and the design guide as a whole

The Design Guide needs to be clear and easy to read.

Assessment Criteria:

The storyboard will be assessed in relation to the specified deliverables as follows:

- LO1 & 2 using the common assessment & marking criteria 3, 5, 6: coursework (research folder)
(All criteria are weighted equally).

Submission: 5.00pm A1 - 08.01.18; A2- 04.05.18

Feedback: During the week beginning: A1 - 22.01.17; A2 – 22.05.18