International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Process Selection on the Basis of Time Cost and Quality for Development Components of Aluminium Bracket

Piyush Shukla

Engineer, Student

Abstract

Development of various new processes has reduced the development of tooling while Designing of Aluminium Component before going to mass production by Dies. The selection of the Process to manufacture Proto quality of Aluminium is not significant. In present research is an attempt to prove that Die Casting Die in soft condition die is also recommended process for commissioning quantity of aluminium component because for prototyping one or two quantity are sufficient. Proto DCD process is also Compared with Time, Cost & quality parameters on this basis process can be selected only for maximum one thousand quantity requirement

1. INTRODUCTION

1.1 DEVELOPMENT PROCESS SELECTION

at the case of new product development manufacturing process selection for a assembly part for checking feasibility or trial commissioning of assembly of product play an important role for some mechanical engineers, process selection is the last thing they think about during the design process. The best approach is to keep manufacturing concerns in mind throughout the entire design process. This will result in a design that is easier and less costly to produce.

here are hundreds of manufacturing processes. You are likely to already be familiar with the most common, e.g. casting and machining.

For any given product, there will be multiple manufacturing processes that you'll need to select from. The process you choose will depend on many factors called the process selection drivers. These process selection drivers include the following:

• **Quality** of the product • **Cost** for tooling, manufacturing machines and equipment • **Time** required for processing • Level of skilled labor required • Process supervision • Energy consumption • Availability of material and cost of material	• Capabilities required to processes material • Product dimensions and size • Surface finish required • Design tolerances • Waste produced by the process • Maintenance costs • Other costs

An experienced manufacturer will have a good idea of all the process selection drivers mentioned above. Depending on the product design and manufacturing considerations, a good manufacturer will be able to guide you through the selection process.
Follow the simple procedure below to select the appropriate manufacturing process for a product:

1.2 PART DEVELOPMENT OLD PROCESS

Mass production, also known as flow production or continuous production, is the production of large amounts of standardized products, including and especially on assembly lines. Together with job production and batch production, it is one of the three main production methods.
Before starting the Mass Production, it is necessary to freeze part requirements by assembly checks and tryouts
For Mass Production by Die Casting dies it will be easy but what process to select for tryout parts this is called as part development process in this case of producing aluminium alternator cover for starter motor for Automotive
In addition to changes in volume, product development may affect productivity through changes in design, and product designs may have an important effect on yields and costs in production. Number of parts, the ease of assembly and hence the cost of the product. In-addition, the ability to exploit the potential for automation in-process-often depends on the design of the product.
The impact of new products on costs, productivity, and customer choice suggests that Product development may have important competitive implications. Yet, if product designs could be changed instantaneously at low cost, the competitive impact of a new product would be sharply reduced. Thus what gives product development the power to affect competition is the long life of the designs. Depending on the product, changing from one design to another entails significant adjustment costs and time. Moreover, the organisational capabilities that determine the time and costs required-the engineering know-how, the procedures and information systems are even longer-lived assets with significant costs of adjustment. In an industry such as automobile manufacturing the life of a given design is measured in years while the life of a development organisation may be measured in decades.
Here we are studying one process investment casting and doing practical of two (3D-printing and VMC machining and Porto-tooling) different process of manufacturing the developed part so that the part can proceed for Assembly and tryouts by the best method for the next time.

1.3 INVESTMENT CASTING

Investment casting is an industrial process based on lost-wax casting, one of the oldest known metal-forming techniques. The term "lost-wax casting" can also refer to modern investment casting processes
Investment casting has been used in various forms for the last 5,000 years. In its earliest forms, beeswax was used to form patterns necessary for the casting process. Today, more advanced waxes, refractory materials and specialist alloys are typically used for making patterns. Investment casting is valued for its ability to produce components with accuracy, repeatability, versatility and integrity in a variety of metals and high-performance alloys.
The fragile wax patterns must withstand forces encountered during the mold making. Much of the wax used in investment casting can be reclaimed and reused. Lost-foam casting is a modern form of investment casting that eliminates certain steps in the process.

Investment casting derives its name from the pattern being invested (surrounded) with a refractory material. Many materials are suitable for investment casting; examples are stainless steel alloys, brass, aluminium, carbon steel and glass. The material is poured into a cavity in a refractory material that is an exact duplicate of the desired part. Due to the hardness of refractory materials used, investment casting can produce products with exceptional surface qualities, which can reduce the need for secondary machine processes.

Produce a master pattern: An artist or mould-maker creates an original pattern from wax, clay, wood, plastic, or another material. In recent years the production of patterns using 3D printing has become popular using either standard PLA filament or custom made 'casting wax' filament,

Create a mould: A mould, known as the master die, is made to fit the master pattern. If the master pattern was made from steel, the master die can be cast directly from the pattern using metal with a lower melting point. Rubber moulds can also be cast directly from the master pattern. Alternatively, a master die can be machined independently—without creating a master pattern

2. OBJECTIVE

1. On the basis of Selection parameters say; time, cost and quality of the part. Which manufacturing process is suitable for more than one prototype quantity, compared with Proto die casting (soft core cavity) instead of hardened.
2. To obtain single time process for proto commissioning and final tooled up sample. With less change and less cost.

Selection of process on the basis of following parameter:

- Time : process time for manufacturing proto 20 component
- Cost : comparetive cost
- Quality: material quality & dimentional quality with all three processes.

Quantity is also a parameter, study is only specific for commissioning trial part quantity which required minimum 20 component.

3.1 RESEARCH GAP

After the deep literature study it is found that there is lot of investigations carried out by different researchers to optimize the different manufacturing processes but comparison on the particular basis i.e time, cost and quality not done by any researcher. Comparison of processes done by very few researcher and specifically comparison with 3d printing Machining and soft Die casting die not fount. Only some researcher who had done study on process development and comparison of these manufacturing processes with proto die casting

4.1 COMPONENT SPACIFICATION

Material:	Aluminum, AlSi10Mg,
Dimension:	According to the drawing or sample
Standard:	DIN GB ISO JIS BA ANSI
Casting equipment:	80T/160T/250T/300T/500Tcasting machine,Sand blasting machine,5T electri stove,Metallographicnt mould manufacturing

Production Process:	Polish/Sand Blast / EDM / Milling / Texture / Grind / Pre-Treatment / Quenching / Lathe/ Wire Cut / Annealing/Temper etc.
Equipment of Casting:	1. Die casting machining:125T/180T/250T/280T/500T/800T/1250T 2. Gravity casting machine: 5 production lines 3. Low pressure die casting machining: 1 production line 4. Degassing equipment and opportunities to refine the material 5. Machining: 5Sets CNC Machines;3 sets Milling machines;3 setsTurning machines;10 sets drill

Table 1.1 component specification

4.2.1 3D PRINTING PROCESS

3D printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together (such as liquid molecules or powder grains being fused together). 3D printing is used in both rapid prototyping and additive manufacturing (AM). Objects can be of almost any shape or geometry and typically are produced using digital model data from a 3D model or another electronic data source such as an Additive Manufacturing File (AMF) file (usually in sequential layers). There are many different technologies, like stereo lithography (STL) or fused deposit modeling (FDM). Thus, unlike material removed from a stock in the conventional machining process, 3D printing or AM builds a three-dimensional object from computer-aided design (CAD) model or AMF file, usually by successively adding material layer by layer. The term "3D printing" originally referred to a process that deposits a binder material onto a powder bed with inkjet printer heads layer by layer. More recently, the term is being used in popular vernacular to encompass a wider variety of additive manufacturing techniques. United States and global technical standards use the official term additive manufacturing for this broader sense.

- Fused deposition modeling (FDM)
- Stereo lithography (SLA)
- DLP 3D printing
- Photopolymer Phase Change Inkjets (PolyJet)
- Selective laser sintering (SLS) – Direct metal laser sintering (DMLS)
- Plaster-based 3D printing (PP) – Powder bed and inkjet head 3D printing
- Thermal Phase Change Inkjets
- Laminated object manufacturing (LOM)

Direct metal laser sintering (DMLS) process used for the experiment.

4.2.2 3D PRINTING TIME CALCULATION

Figure 1.3 part build structure 1.4 time calculation

- The building time calculation is done on the software called MAGIC-20.0
- The model shows the completion time of 6 hours and 21 minutes.
- Build time shows the time required to complete a job.

3D PRINTING TIME LINES		
Sr.No	**TOTAL JOB TIME CALCULATION**	**Time calculation**
1	MATERIAL MIXING AND BUILD PREPARATION	6 Hrs
2	DESIGNING AND PLANNING	5 Hrs
3	DMLSCYCLE TIME	7 Hrs
4	POST PROCESSING	8 Hrs
5	SHOT BLASTING AND BENCH WORK	5 Hrs
6	CMM INSPECTION	4 Hrs
7	Approx. time for 1 pair	35 Hrs
8	**Approx. time for 10 pair**	**350 hours 15 days**

Table 1.2 3D printing time calculation

4.2.3 3D PRINTING COSTING

1.5 Volume of part = 154087.25 mm3

3D PRINTING COSTING				
Sr.No	**Description for one pair (2 qty)**	**Per/Hrs/kgs**	**Rate/Rs**	
1	Material Cost (including support weight)	**3.3 kg**	**6000**	**20000**
2	3D Printing Cost	**154 cc**	**150**	**46200/-**
3	Support removal Cost	**1 plate**	**1000**	**1000/-**
4	Post processing Vmc machining Cost	**6 Hrs**	**800**	**4800/-**
5	Turning and grooving operation Cost	**2 Hrs**	**300**	**600/-**
6	Shot blasting bench work Cost	**4 Hrs**	**500**	**2000/-**
7	Cmm inspection Cost	**4 Hrs**	**1000**	**4000/-**
8	**Total Cost**			84,600/-
9	**Total Cost for 10 pairs**			**8,46,000/-**

4.3.1 MILLING OF PART

In Milling is the process of machining using rotary cutters to remove material by advancing a cutter into a work piece. This may be done varying direction on one or several axes, cutter head speed, and pressure. Milling covers a wide variety of different operations and machines, on scales from small individual parts to large, heavy-duty gang milling operations. It is one of the most commonly used processes for machining custom parts to precise tolerances. Milling is a cutting process that uses a milling cutter to remove material from the surface of a work piece. The milling cutter is a rotary cutting tool, often with multiple cutting points. As opposed to drilling, where the tool is advanced along its rotation axis, the cutter in milling is usually moved perpendicular to its axis so that cutting occurs on the circumference of the cutter. As the milling cutter enters the work piece, the cutting edges (flutes or teeth) of the tool repeatedly cut into and exit from the material, shaving off chips from the work piece with each pass. The cutting action is shear deformation; material is pushed off the work piece in tiny clumps that hang together to a greater or lesser extent (depending on the material) to form chips. This makes metal cutting somewhat different (in its mechanics) from slicing softer materials with a blade.

The milling process removes material by performing many separate, small cuts. This is accomplished by using a cutter with many teeth, spinning the cutter at high speed, or advancing the material through the cutter slowly; most often it is some combination of these three approaches. The speeds and feeds used are varied to suit a combination of variables. The speed at which the piece advances through the cutter is called feed rate, or just feed; it is most often measured in length of material per full revolution of the cutter.

There are two major classes of milling process:

In face milling, the cutting action occurs primarily at the end corners of the milling cutter. Face milling is used to cut flat surfaces (faces) into the workpiece, or to cut flat-bottomed cavities.In peripheral milling, the cutting action occurs primarily along the circumference of the cutter, so that the cross section of the milled surface ends up receiving the shape of the cutter. In this case the blades of the cutter can be seen as scooping out material from the work piece. Peripheral milling is well suited to the cutting of deep slots, threads, and gear teeth.

4.3.2 VMC MILLING PROCESS FOR BRACKET

Methods of Holding the Work piece on milling

- Holding the work between centers
- Chuck on a fixture plate

Face Milling- Cutter overhangs work on both sides End Milling- Cutter diameter is less than work width, so a slot is cut into part Profile Milling- Form of end milling in which the outside periphery of a flat part is cut Pocket Milling- Another form of end milling used to mill shallow pockets into flat parts Finishing operation- same operation with different types of cutters like ball nose cutter. Drilling- Creates a round hole in a workpart, Cutting tool called a drill or drill bit Reaming- Used to slightly enlarge a hole, provide better tolerance on diameter, and improve surface finish Tapping- Used to provide internal screw threads on an existing hole Tool called a tap Methods of Holding the Work piece on Lathe

- Holding the work between centers
- On a fixture plate
- A single point cutting tool removes material from a rotating workpiece to generate a cylindrical shape Performed on a machine tool called a lathe •Variations of turning that are performed on a lathe:
- Facing- Tool is fed radially inward

Contour turning- Instead of feeding the tool parallel to the axis of rotation, tool follows a contour that is other than straight, thus creating a contoured form

Chamfering- Cutting edge cuts an angle

Grooving- The size of the cut depends on the width of a cutting tool.

4.3.3 VMC MILLING PROCESS COST AND TIME SCHEDULE

COST WITH VMC MACHINING				
Sr.No	**Description for one pair (2 qty)**	**Per/Hrs/kgs**	**Rate/Rs**	**Total Price in Rs**
1	Material Cost (block size 170X170X95mm)	14.8 kg	350	5180/-
2	Programming and planning charges (one time)	1	5000	5000/-
3	Tooling fixture charges	1	8000	8000/-
4	Vmc machining Cost	24 Hrs	800	19200/-
5	Finish machining 5-axis charges	8 Hrs	1200	9600/-
6	Turning and grooving operation Cost	2 Hrs	300	600/-
7	Banch work tapping	1	150	150/-
8	Cmm inspection Cost	4 Hrs	1000	4000/-
9	Total Cost 38730 + 11000 (one time cost)			49730/-
10	**Total Cost for 10 pairs (**3,87,300 + 11000)			**3,98,300/-**

Table 1.4 Macining Cost

3D MACHINING TIME LINES		
Sr.No	**TOTAL JOB TIME CALCULATION**	**TIME CALCULATION**
1	VMC ROUGH MACHINING	24 Hrs
2	FINISHING VMC &. LATH	10 Hrs
3	BENCH WORK AND POLISHING	2 Hrs
4	CMM INSPECTION	4 Hrs
7	Approx. time for 1 pair	40 Hrs
8	**Approx. time for 10 pair**	**400 hours 17 days**

Table 1.5 Machining time calculation

Approx. time for 1 pair 40 hrs (neglected programming time & fixturing)
Approx. time for 10 pair 400 hours 17 days (minus rotation cycle time 8 hrs)

4.4.1 INTRODUCTION TO DIE CASTING DIES

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 aluminum or zinc, is melted in the furnace and then injected into the dies in the die casting machine. There are two main types of die casting machines - hot chamber machines (used for alloys with low melting temperatures, such as zinc) and cold chamber machines (used for alloys with high melting temperatures, such as aluminum). The differences between these machines will be detailed in the sections on equipment and tooling. However, in both machines, after the molten metal is injected into the dies, it rapidly cools and solidifies into the final part, called the casting. The steps in this process are described in greater detail in the next section.

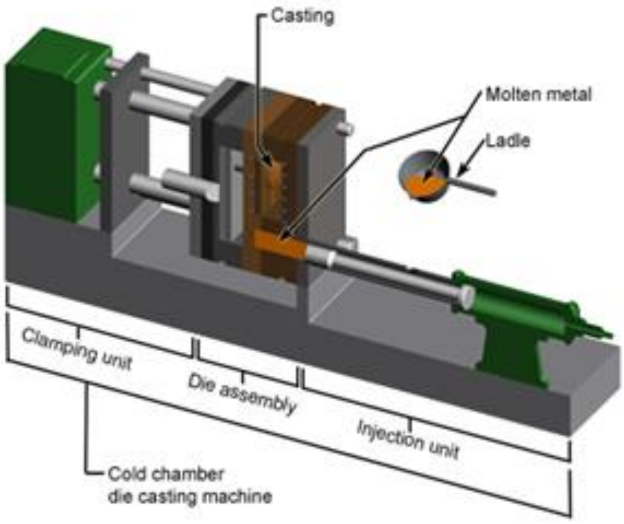


Figure 2.2 Die casting machine

Causes:	Defects
• Injection pressure too high.	Flash
• Clamp force too low.	
• Insufficient shot volume	Unfilled sections
• Slow injection	
• Low pouring temperature	
• Injection temperature too high	Bubbles
• Non-uniform cooling rate	
• Non-uniform cooling rate	Hot tearing
• Cooling time too short	Ejector marks
• Ejection force too high	

4.4.2 FEASIBLITY STUDY OF PART WITH DIE CASTING DIES.

	Typical	Feasible
Shapes:	Thin-walled: Complex	Flat
	Solid: Cylindrical	Thin-walled: Cylindrical
	Solid: Cubic	Thin-walled: Cubic
	Solid: Complex	

Part size:	Weight: 0.5 oz - 500 lb	
Materials:	Metals	Copper
	Aluminum% 85 to 90	
	Lead	
	Magnesium	
	Tin	
	Zinc	
Surface finish	Visual finish coat can be done	
Tolerance:	± 0.01 mm.	
Max wall thickness:	0.05 - 0.5 in.	0.015 - 1.5 in.
Quantity:	10 - 10000	10 - 1000
Lead time:	1 Months max	1 Weeks minimum
Advantages:	Can produce large parts	
	Can form complex shapes	
	High strength parts	
	Very good surface finish and accuracy	
	High production rate	
	Low labor cost	
	Scrap can be recycled	
Disadvantages:	Trimming is required	
	High tooling and equipment cost	
	Limited die life	
	Long lead time	
Applications:	Engine components, pump components, appliance housing	

Table 1.6 feasibility specifications of Die castings

Material cost
The material cost is determined by the weight of material that is required and the unit price of that material. The weight of material is clearly a result of the part volume and material density; however, the part's maximum wall thickness can also play a role. The weight of material that is required includes the material that fills the channels of the die. A part with thinner walls will require a larger system of channels to ensure that the entire part fills quickly and evenly, and therefore will increase the amount of required material. However, this additional material is typically less than the amount of material saved from the reduction in part volume, a result of thinner walls. Therefore, despite the larger channels, using thinner walls will typically lower the material cost.

Tooling cost
The 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 (equal to the projected area of the part and projected holes) and its depth. Any other elements that will require additional machining time will add to the cost, including the feature count, parting surface, side-cores, tolerance, and surface roughness.
The quantity of parts and material used will affect the tooling life and therefore impact the cost. Materials with high casting temperatures, such as copper, will cause a short tooling life. Zinc, which can be cast at lower temperatures, allows for a much longer tooling life. This effect becomes more cost prohibitive with higher production quantities.
One final consideration is the number of side-action directions, which can indirectly affect the cost. The additional cost for side-cores is determined by how many are used. However, the number of directions can restrict the number of cavities that can be included in the die. For example, the die for a part which requires 3 side-core directions can only contain 2 cavities. There is no direct cost added, but it is possible that the use of more cavities could provide further savings.
Other benefits include:

- Variable wall thicknesses
- Tighter tolerances
- Fewer steps from raw material to finished part

Fast production cycle times
Reduction in material scrap

- Long tool life, especially for zinc and magnesium

4.4.3 PROTO TOOLING DIE CASTING PROCESS
Concept of proto tool is also known as soft tooling because it contains die elements like core and cavity in soft condition instead heat treated. In die casting dies generally die core and cavity has to done heat treatment surface coating and hard machining which improve die life to obtain more no of shots says one laces component usually a die casting die can produce But in the case of soft tool as it is a proto part requirement and ECR engineering change request in the dimensions of component and feature addition in part die modification of hardened material is cost consuming and lengthy process to save cost time and same structure of die final can die casting tool like Die set structure, Child parts, Standard part (bolt

dowels), Guiding elements These are the basic element for the die casting to assembly in any type of die made or in the same case of proto tool, main parts to be modified at the time of hardened tool after fulfilling the requirement of proto parts after production line testing and trials Core insert, Cavity insert, Core and cavity pins

TOOL DETAILS **TOOL SIZE [IN MM]**
Type of tool PDC Die LENGTH
No of Cavities1 **Machine tonnage** 135 T WIDTH
Die Life Guarantee SHUT HEIGHT

MATERIAL COST

Materials & Treatments: **Matl** **RM SIZE IN MM** **QTY** **WEIGHT** **RATE / Kg**
Cost in Lacs
L **W** **D** **kg** **Rs**
MOLD BASE
BOTTOM PLATE EN-8 510 455 50 1 100.32 90 0.1
EJECTOR PLATE 320 455 30 1 37.77 90 0.03
EJECTOR BACK PATE 320 455 30 1 37.77 90 0.03
SPACER BLOCK1 455 75 205 1 60.48 90 0.1
SPACER BLOCK2 455 75 205 1 60.48 90 0.1
OTHER MOULD BASE STD ITEMS 100.00
0.00
TOTAL MATERIAL COST 396.82 **0.27**
Die base cost @Rs 180 kg 396.8 120 **0.48**
Total Mould Base Cost è
0.48
FD Insert P20 510 455 115 1 230.72 250 0.58
MD Insert 510 455 190 1 381.20 250 0.95
HOLDER PLATE-1 0 0.00 380 0.00
HOLDER PLATE-2 0 0.00 380 0.00
Total OS MATERIAL **611.92** **1.53**
SPRUE BUSH H13 120 115 1 10.22 380 0.04
DIFFUSER 85 115 1 5.13 380 0.02
SIDE CORE-1
SIDE CORE-2
Total DAC MATERIAL **15.34** **0.06**
SIDE CORE HOLDER-1 OHNS 0.00
GUIDE RAIL -1 0.00
GUIDE RAIL -2 0.00
GUIDE RAIL -3 0.00
CORNER COLUMN 0.00
WEDGE BLOCK 0.00

International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

TOTAL HDS MATERIAL **627.27**
1.59

OTHER MATERIALS **SPECIFICATIONS** QUANTITY
RATE AMOUNT
Electrode material LOCAL ACCESSORIES GRAPHITE
0.00 1100 0.00
Chillvent - Path 0.00 15000 0.00
Hydraulic Cylinder-1 0.00
50000 0.00
Hydraulic Cylinder-2 0.00
40000 0.00
Hydraulic connectors 0.00 800 0.00
Limit switches 0.00 1500 0.00
Cu pipes 0.00 100 0.00
Quick couplers with Needle valves 6P 0.00
1070 0.00
Cooling Manifold 0.00 2000 0.00
Bubblers 0.00 600 0.00
Water JACKET MOVING 0.00 550 0.00
ball valve 0.00 140 0.00
Elbow 0.00 150 0.00
Brass nipple 0.00 150 0.00
Hose clips 0.00 80 0.00
Baffle 0.00 850 0.00
spiral cooling insert 0.00 25000 0.00
Brass plug 0.00 35 0.00
Springs 0.00 250 0.00
Dowels 0.00 200 0.00
spring washers 0.00 3 0.00
Aluminium samples 0 0.00 260 0.00
MELTING LOSS 0 0.00 150 0.00
Misc Hardware (baffles+hoses+nipples) 0.00
10000 0.00
Packing Box 0.00 10000 0.00
Aesthetic requirement - Outer side finish cut/Painting
0.00 1000 0.00
TOTAL OF LOCAL ACCESSORIES
0.00
Hydraulic Cylinder OTHER ACCESSORIES 0.00
25000 0.00

LIMIT SWITCH WLD2 0.00 3500 0.00
STELL BRAIDED FLEXIBLE HOSE 0.00
8000 0.00
STRAIGHT CONNECTORS 0.00 500 0.00
ELBOW 0.00 400 0.00
MISUMI EJECTOR PINS 0.00 2800 0.00
COOLING PIPES 0.00 850 0.00

TOTAL OF STD ACCESSORIES
0.00
TOTAL MATERIAL COST (A) è 2.07

HEAT TREATMENT
Coating

NOT REQUIRED FOR PROTO TOOLING 0 0.00 850 0.00
Vacuum heat treatment- INDIA 0 0 150 0.00
salt bah heat treatment in India 0 0 60 0.00
Nitriding liquid 0 0 50 0.00
Nitriding plasma 0 0.00
Stress relieving 0 0 50 0.00
H/T & Trial cost (B) è **0.00**
Core pins 0.00 400 **0.00**
Cavity pins 0.00 400 **0.00**
Ejector pins 0.00 500 **0.00**
Die polishing 8.00 250 **0.02**
Spares (core pin+ejector pin +loose pieces +ejector rod+4EYE BOLT+THERMOREGULATION+SHOT SLEEVE)
0.50
outsourcing cost C **0.52**
TOTAL MATERIAL COST D=A+B+C 2.59
CONVERSION COST

PROCESS HOURS RATE AMOUNT
Simulation 8.00 800 0.06
Design 8.00 800 0.06
Engg cost (E) TOTAL NO OF HOURS **0.13**
Electrode designing 6.00 400 0.02
CNC Programming 10.00 450 0.05
Plano milling 0.00 300 0.00
Conventional machining - 2D Milling ,Drilling etc 12.00 350 0.04
Grinding JIG GRINDING-350 10.00 300 0.03

CNC Machining ROUGH-700, FINISH-1200, 5AXIS-2500, C62-3200 12.00 **500**
0.06
Electrode CNC 12.00 500 0.06
EDM 8.00 500 0.04
Wire cutting 8.00 600 0.05
Spotting 6.00 300 0.02
CMM 8.00 1000 0.08
Inspection 6.00 300 0.02
Assembly 8.00 400 0.03
Mfg cost F TOTAL NO OF HOURS 106.00 **0.50**
DIE TRIALS No of trials
Trial 0 0.00 8000 0.00
Aluminium samples **20 Nos** 0 1.00 200 0.00
MELTING LOSS 0 1.00 350 0.00
PRICE / CASTING 0 0.00
EXCISE DUTY FOR @18% GST .
0.00
Trial cost Gè **0.63**
Manufacturing cost H= (E+F+G)
0.63
Overheads 8% on operation cost(I) 0.00
Transport (J) 0.00
Total Conversion Cost K=(H+I+J) **0.63**
Total Cost L=D+K 3.21
Profit M 0.00
Total cost (N)= [L+M] 3.21
Other costs
Drawing set 0.00
Miscellaneous expenses (Visit cost) 1 1000.00
0.01
Total Other cost **0.01**
Total Cut off price Put "1" if applicable
3.22
Risk Factor (if to be considered put "1" in the cell indicated)
0.01 1 0.03
Rework cost due to rejection 0.01 0.00
PTC and die proving cost 0.00 0.00
Warranty cost 0.01 0.00
TOTAL COST è 3.26

Table 1.7 Detailed BOM and costing

4.4.4 PROTO TOOL COSTING SUMMARY AND TIME SCHEDULE

PART COST BY PROTO TOOL COST				
Sr.No	**Description for one pair for 10 qty**	**Per/Hrs/kgs**	**Rate/Rs**	**Total Price in Rs**
1	Casting casting component price	2.88	300	840/-
2	5-axis Finish machining (tolerance Dimension)	2Hrs	1200	2400/-
3	Lathe charges	2 Hra	300	600/-
4	Bench work	1 Hra	150	150/-
5	CMM charges	1 Hrs	1000	1000/-
6	Total machining and processing cost:			4990/-
7	Total Processing Cost for 10 pairs			49900/-
8	Total Cost (tool + casting + machining) : 326000+ 8400+41500			**3,75,900/-**

Table 1.8 Proto Dcd Costing

PROTO TOOL TIME SCHEDULE		
Sr.No	**TOTAL JOB TIME CALCULATION**	**Time calculation**
1	Die Designing	2 days
2	Soft Machining (without HT, Coating & hard machining)	10 days
3	Die assembly	1 days
4	Die rework& correction:	2 days
7	Die Trail	1 days
8	Machining & Cmm	1 days
9	**Approx. time for 10 pair**	**400 hours 17 days**

Table 1.9 Proto Dcd time calculations

Proto Tooling cost Rs: 3,26,000
Aluminium Alloy Rates = 300 Rs/Kg (including menting cost of ingot 8%)
Part weight including runner gate: 1.4 kg (actual wt 1.2 kg)

5. RESULT AND DISCUSSION

There is a wide range of aluminum parts around the world for different type of usages. For the alternator bracket Selection of process plays an important role for better quality good cost and minimum time mainly for end part where it is going to assembled after proto typing in 3d printing and machining process is only good for prototype of one or two quantity which is generally use for fitment and branding purpose but for line trail and end product testing with alternator assembly minimum ten parts are required which takes lot of time and cost to manufacture but also difference in material which is resulted in this research . The alternator assembly makes the project special and unique. The experiment has done on proto tool to separate result of different manufacturing processes of aluminum bracket on the basis of time cost and quality. The main achievement through this project will be to implement a low cost better quality and less time manufacturing process, to existing conveying methods for aluminium brackt which is also moderated and not freeze some companies as going with 3D printing some are using machining but soft die casting prototype was not used before as surveyed in literature review. The main challenge will be to manufacture proto parts with in one week

Constrain with proto tool process as the requirement on trail and commissioning quantities if more than ten then only proto tooling can preferred otherwise it will be a costly process

To manufacture the aluminium cover of automotive industries in prototyping specialy in commissioning try-out of aluminium parts

Processes:

- Die casting dies + Proto DCD,
- 3D printing
- VMC machining

5.1 GEOMETRICAL DIMENTION COMPARISION.

While comparing all three processes out put on CMM research found no difference in geometrical tolerances all the values are under tolerance, below table shows the achieved dimensions hence the aluminum bracket is could be manufacture through DCD soft tool.

Plan Name	Incremental Part Number	January 28, 2020	11:17:25 pm		CMM	Page From
FRONT BRACKET	-1	ACTRUAL DIMENTION			C32Bit	1.0000
Name	**ID**	**DCD**	**3D PRINT**	**VMC**	**Nominal**	**pos Tol**
YV alue_Circle3:- 01	Y	61.0411	61.0341	61.0326	61.0000	±0.1
Diameter_Circle3:- 03	D	32.9647	32.9672	32.9561	33.0000	0.025 -0.05
Diameter_Circle3:- 07	D	43.0272	43.0195	43.0568	43.0000	0.15 -0.05
Diameter_Circle3:- 12	D	57.3266	57.3242	57.3592	57.3000	±0.1
Diameter_Circle3:- 13	D	60.0698	60.0591	60.0872	60.0000	0.12 -0.02
Concentricity1:- 14	GDT Con	0.0513	0.0451	0.0054	0.0000	±0.1

Diameter_Circle3:- 26-1	D	12.5228	12.4998	12.489	12.5000	0.2700
LengthOf Axis_Perpend:- 31	Ax Length	68.0009	68.0056	68.0039	68.0000	±0.1
TruePosition2:- 50-2	GDT Po2d	0.1081	0.1018	0.0827	0.0000	0.3000
Distance1:- 51_3d	Dist	72.4302	72.3076	72.3437	72.5000	±0.2
	QCD.FO. 03					

Table 2.0 Comparison of Dimensions

Hence Dimensional result found same in all three processes as the measurement done of machined surface proto tool samples also found under tolerance part accuracy level is not critical minimum tolerance is 0.02mm which is very ease to achieve in machining die casting sample.

5.2 MATERIAL COMPARISION.

Process	**VMC**	**3D Printing**	**DCD Proto**
Alloy group	Al6061	AlSi10mg	Actual
Si %	0.698	9 - 11.0	9.36
Fe%	0.595	0-0.055	0.324
Cu%	0.726	0-0.1	0.0233
Mn%	0.326	0-0.45	0.0245
Mg%	1.657	0.20-0.45	0.425
Cr%	0.145		
Ni%	0.035	0-0.05	0.00248
Zn%	2.237	0-0.10	0.0233
Ag%	0.025		
Pb%		0-0.05	0.0031
Sn%		0-0.05	0.00625
Ti%		0-0.15	0.128
Al%	93.38	87.545	87.545
Hardness HB	81	121	97

Tensile strength	255.55	300 Mpa	340.0 Mpa
Yield strength	234.3	394 Mpa	321.9 Mpa
Elongation% Min	13%	5.56%	5.68%

Table 2.1 Comparison of Material properties.

5.3 Result on time cost and quality.

End result of the testing and comparison found Die casting sample has good mechanical as well as chemical properties which match with an aluminum part, hardness test on brinell hardness test which is result hardness of Alsi 10 mg 3D printed part is higher side range and Al6060 at lower side of range but for proto tool hardness range found perfect in range 95 to 100 HB.

PROCESS	**TIME**	**COST**	**QUALITY** (Material Geometrical)	
DIE CASTING (Proto)	17 days	3,75,900 INR	Hardness 97 HB	With in tolerance
3D PRINTING	15 days	8,50,000 INR	Hardness 121 HB	With in tolerance
VMC MACHINING	17 days	3,98,300 INR	Hardness 81 HB	With in tolerance

Table 2.2 Result values.

6. CONCLUSION AND FUTURE SCOPE

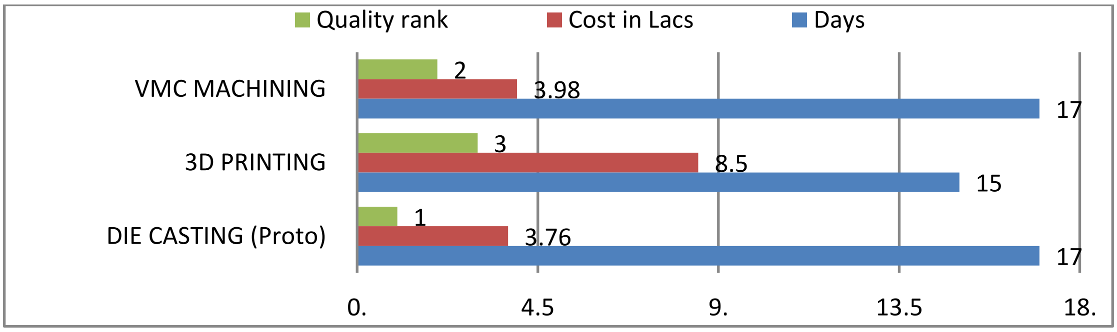
6.1 CONCLUSION:

Experimental Work lead to following Conclusions:-

Implementation of 3D printing was the suitable process which was fulfilling the purpose of this experiment in proto type and only for one or two component as the result better time saving process. But in comparison with Casting VMC and Proto die casting, 3D printing is found very Costly.

With VMC machining process material composition did not matched with the required material composition. When tried with Proto Die casting (Soft die) Tool cost of ten samples found less than all three process.

Final process of mass production is also Die casting Die so more cost and time saving reported by this experimental research.



Graph 1.3 Result chart.

6.2 FUTURE SCOPE

More modification ECR can be done and modification on the same proto dies After fulfilling requirement of five thousand components hard inserts can be replaced and the die can be treated as regular die casting with 1 lac shots. More cost reduction in final tooling.

As already proven practice 3D printing and machining should be preferred for prototyping but for low cost 5-axismilling is better than 3D printing depending upon program time and programming skills.

In the case of hardness requirement of component as per AlSi requirement Al6061 can be used but limitations will be material compositions.

7. REFERENCES

1. International Conference on Mechanical Engineering Research 2011 (ICMER2011) IOP Publishing IOP Conf. Series: Optimization of Process Parameters of CNC
2. Characteristic Behaviour of Aluminium Metal Matrix Composites:A Review 2018 Prasanna Nagasai Bellamkonda1, Srikanth Sudabathula2Mr. NISHANTH PATEL GM1, Dr. K G SATISH2b © 2020, IRJET | Impact Factor value: 7.34 | ISO 9001:2008 Certified Journal
3. https://www.researchgate.net/publication/307446249_Thermal_Fatigue_of_Die-Casting_Dies_An_Overview
4. https://www.researchgate.net/publication/257707301 Mechanical Properties of AlSi10Mg Produced by Selective Laser Melting Article in Physics Procedia · December 2012
5. Experimental investigation into characterization and machining of Al + SiCp nano-composites using coated carbide tool https://ui.adsabs.harvard.edu/abs/2020MeInd..21 307S /abstract
6. Pradyut Kumar Swain1,*, Kasinath Das Mohapatra1, Ratnakar Das2, Ashok Kumar Sahoo3, and Amlana Panda3 February 2020
7. https://ui.adsabs.harvard.edu/abs/2020MeInd..21..307S
8. https://www.researchgate.net/publication/266863408 Quality Improvement Model At The Manufacturing Process Preparation Level Article in International Journal for Quality Research · December 2009
9. https://www.researchgate.net/publication/342349012 Application of die casting: Article · January 2018
10. Manufacturing Engineering and materials processing A Series of Reference Books and Textbooks Copyright © 2002 by Marcel Dekker, Inc.
11. Mass Production Definition – Investopedia https://www.investopedia.com
12. https://www.villageplastics.com/3d-printing processes,additive manufacturing(AM).
13. 3D Printing - Keene Village Plastics
14. https://www.bartleby.com/questions-and-answers/milling-is-the-process-of-machining-using-rotary-cutters-to-remove-material-by-advancing-a-cutter-in/9570b70c-47df-4e5f-a80d-0e51fa920073
15. https://www.custompartnet.com/wu/die-casting
16. Experimental investigation into characterization and machining of Al + SiCp nano-composites using coated carbide tool
17. A Study on Wear and Microstructure Properties of AA7075 Reinforced with SiC MMC by Powder Metallurgy Technique © 2020, IRJET | Impact Factor value: 7.34
18. Comparative study of Al6061 and AlSi10Mg produced by Selective Laser Melting Process

19. Quality Improvement Model At The Manufacturing Process Preperation Level, Dusko pavletic, Mirko Sokovic during December 2009
20. Investment casting (IC) has benefited numerous industries as an economical means for mass producing quality near net shape metal parts with high geometric complexity and acceptable tolerances
21. International Conference on Mechanical Engineering Research 2011 (ICMER2011) IOP Publishing IOP Conf. Series: Materials Science and Engineering 36 (2012)
22. International Conference on Multi disciplinar yResearch & Practice
23. Optimization of Process Parameters of CNC Milling for Aluminium Metal Matrix Composite
24. Application of Die casting: A review paper of AKASH TIWARY, HARSIMRAN SINGH SODHI January 2018
25. EOS material certificate material composition and properties.
26. 3D prining images Google photos
27. Hand book notes indo german tool room aurangabad, Die casting dies.
28. Rate matrix india marts for compairing of material rates and costing.
29. https://www.123rf.com/photo_153959915_the-multi-axis-cmm-machine-measuring-the-aluminium-casting-parts-by-touching-probe-the-quality-contr.html
30. https://www.genfoundry.com/capabilities/quality
31. https://www.mmsonline.com/products/methods-optimizes-three-axis-mv-1600h-for-large-workpieces
32. Die casting process https://www.dynacast.com/en/specialty-die-casting/die-cast-process