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Innovative Die Component Manufacturing by Using Lost Wax Casting and 3D Printing Processes

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Abstract: The project focuses on crafting a casting die for designing the micro jet nozzle of an aircraft engine. The manufacturing of the casting die involves various steps outlined in the procedure. Regular stone material, categorized under ceramic parts, is utilized for constructing the casting die. The primary objective of this project is to integrate additive manufacturing into the production of automobile parts and the construction of mechanical components. We are going to fabricate d casting die by using different material other than regular casting material which is more accurate. This project involves 3Dprinting technology and SLA printing technologies.
Keywords: Lost wax casting, 3D printing, additive manufacturing, Resin, SLA(stereolithography), Micro Jet Nozzle, Automobile parts.

I. INTRODUCTION

Additive manufacturing is the process of creating an object by building it one layer at a time. It is the opposite of subtractive manufacturing, in which an object is created by cutting away at a solid block of material until the final product is complete.

Technically, additive manufacturing can refer to any process where a product is created by building something up, such as moulding, but it typically refers to 3-D printing.

Additive manufacturing was first used to develop prototypes in the 1980s — these objects were not usually functional. This process was known as rapid prototyping because it allowed people to create a scale model of the final object quickly, without the typical setup process and costs involved in creating a prototype. As additive manufacturing improved, its uses expanded to rapid tooling, which was used to create moulds for final products. By the early 2000s, additive manufacturing was being used to create functional products. More recently, companies like Boeing and General Electric have begun using additive manufacturing as integral parts of their business processes.

II. LITERATURE REVIEW

Kang, Jw.et.al[1]. 3D printing is such a magical technology that it extends into almost every sector relating to manufacturing, not to mention casting production.

In this paper, the past, present and future of 3D printing in the foundry sector are profoundly reviewed. 3D printing has the potential to supplement or partially replace the casting method. Today, some castings can be directly printed by metal powders, for example, titanium alloys, nickel alloys and steel parts. Meanwhile, 3D printing has found an unique position in other casting aspects as well, such as printing the wax pattern, ceramic shell, sand core, sand mold, etc. Most importantly, 3D printing is not just a manufacturing method, it will also revolutionize the design of products, assemblies and parts, such as castings, patterns, cores, molds and shells in casting production. The solid structure of castings and molds will be redesigned in future into truss or spatially open and skeleton structures.

Meet Upadhyay et.al[2]3D printing of sand molds enables new manufacturing strategies which significantly reduce the CO2 emissions associated with metallic component production via casting. The application of this technology for the production of sand molds for shape casting optimizes the consumption of materials through design optimization of both part and mold/core, and hence this reduces the energy consumption and the use of metal. This metal saving results in at least 2/3 of the CO2 emission.

III. MICRO JET NOZZLE

A nozzle is a crucial component in the propulsion system of small jet engines, missiles, and other aerospace applications. Its primary function is to control the flow of exhaust gases expelled from the engine, converting thermal energy into kinetic energy to generate thrust. Nozzles play a pivotal role in determining the efficiency, performance, and maneuver ability of these propulsion systems.

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In the context of small jet engines, nozzles are typically designed to accelerate the exhaust gases to high velocities as they exit the engine. This acceleration is achieved through carefully engineered convergent-divergent (CD) nozzle geometries, which utilize the principles of fluid dynamics to increase the exhaust velocity and maximize thrust output. The shape and dimensions of the nozzle are critical in optimizing the exhaust flow and ensuring efficient propulsion.

Figure 4.4: Convergent-divergent nozzle design: CD Nozzle

In missile systems, nozzles serve a similar purpose but may have additional requirements such as thrust vectoring capability for precise control and maneuverability. Thrust vectoring nozzles allow the direction of the exhaust flow to be altered, enabling the missile to change its flight trajectory rapidly and accurately. This feature enhances the missile's agility, responsiveness, and targeting accuracy, making it more effective in combat scenarios.

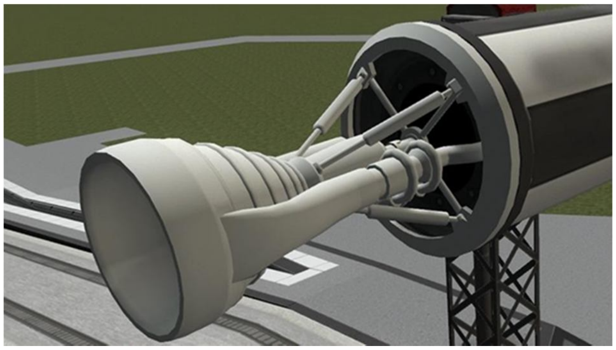

Figure 4.5: Thrust vectoring nozzle:

These images illustrate different types of nozzles used in aerospace applications, showcasing their diverse designs and functionalities in small jet engines, missiles, and related systems.

A. Modelling

1) Step 1

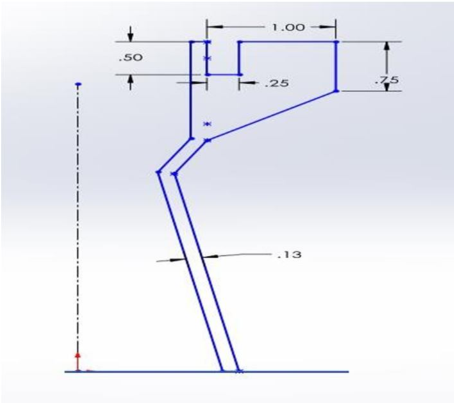

Figure :5.6 Draw cross section Profile in a plain

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2) Step 2

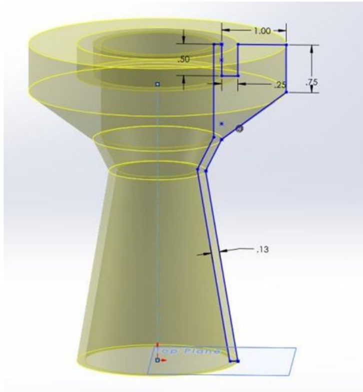

Figure 5.7 Revolve 360 degrees to 3D

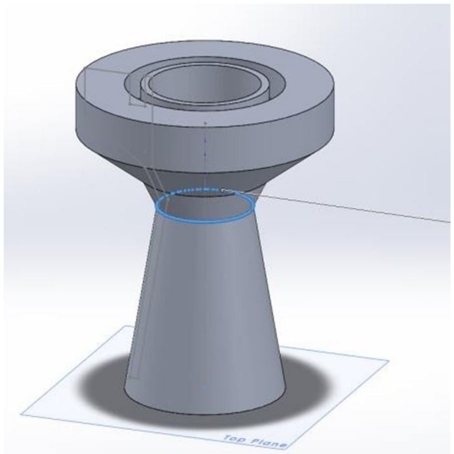

Figure 5.8 Isometric view of micro jet nozzle

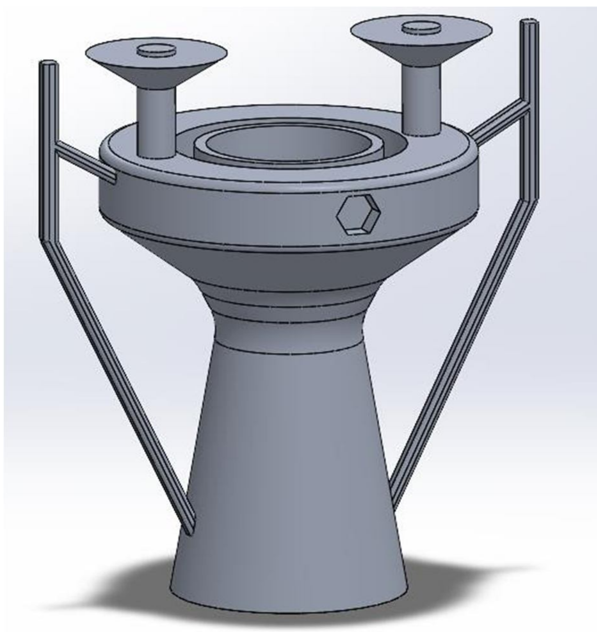

Figure 5.9 Isometric view of micro jet nozzle with runner, riser, and vents.

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B. Slicing

All the files designed in solid works are saved in the form of. STL files.These files are post processed in Chitbox for slicing. Import Stl files to be printed.

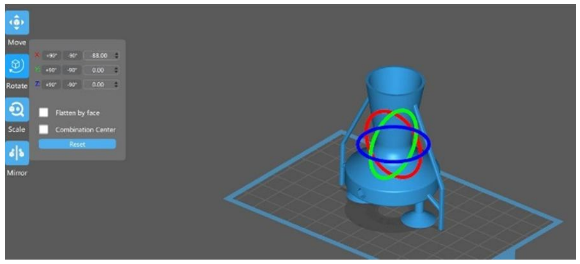

Figure 5.27 Set orientation

Orientation has to be set based on the geometry and to accommodate more number of models

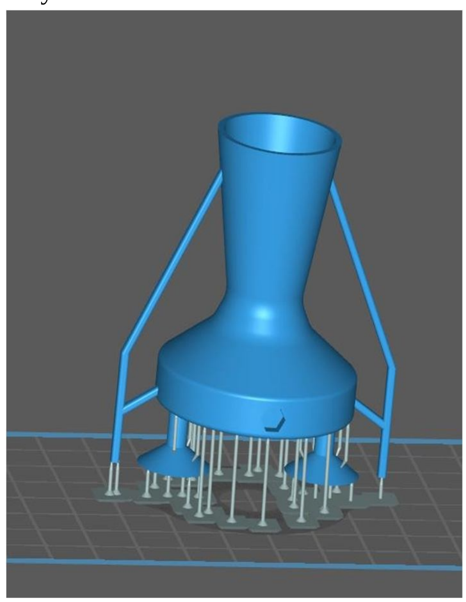

Figure 5.28: Supports are arranged to these models as they are not flat bottomed and regularshapes

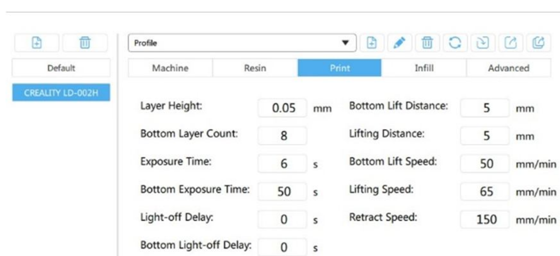

Figure 5.29: Slicer print settings

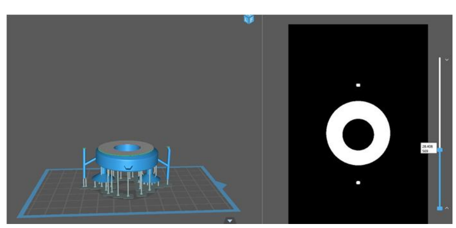

Figure 5.30: Post slicing

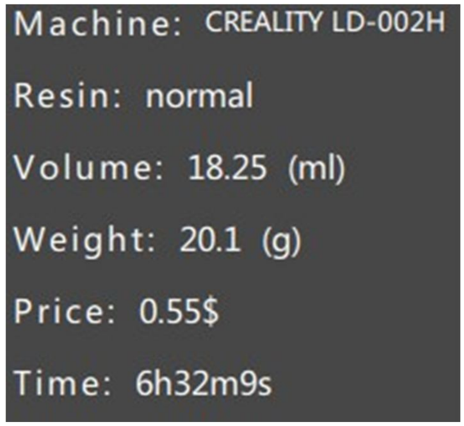

Figure 5.31: Print detail

IV. CONCLUSION

In this work we Fabricated a convergent divergent jet nozzle used in small rockets/missiles, the design is done in solid works and are sliced using Chit box Slicer, fabrication is done on aCreality LD002H SLA resign printer, the models are cured and finished to use for making investment casting moulds, these moulds can be further used for casing the parts in required metal, the observations made during this work are discussed below

Figure 6.1: Cured and finished parts,

Figure 6.2: Vat with Resign and build plate immersed in Resign.

Figure 6.3: Finished parts in the curing machine

Figure 6.4: Casting arrangement

V. FUTURE SCOPE

This project can be modified in the future by changing the working material andcalculating its properties.
By applications of the mechanical components this project can be applicable formanufacturing of different components
In precision point of view this project attracts every mechanical manufacturing industryin future.

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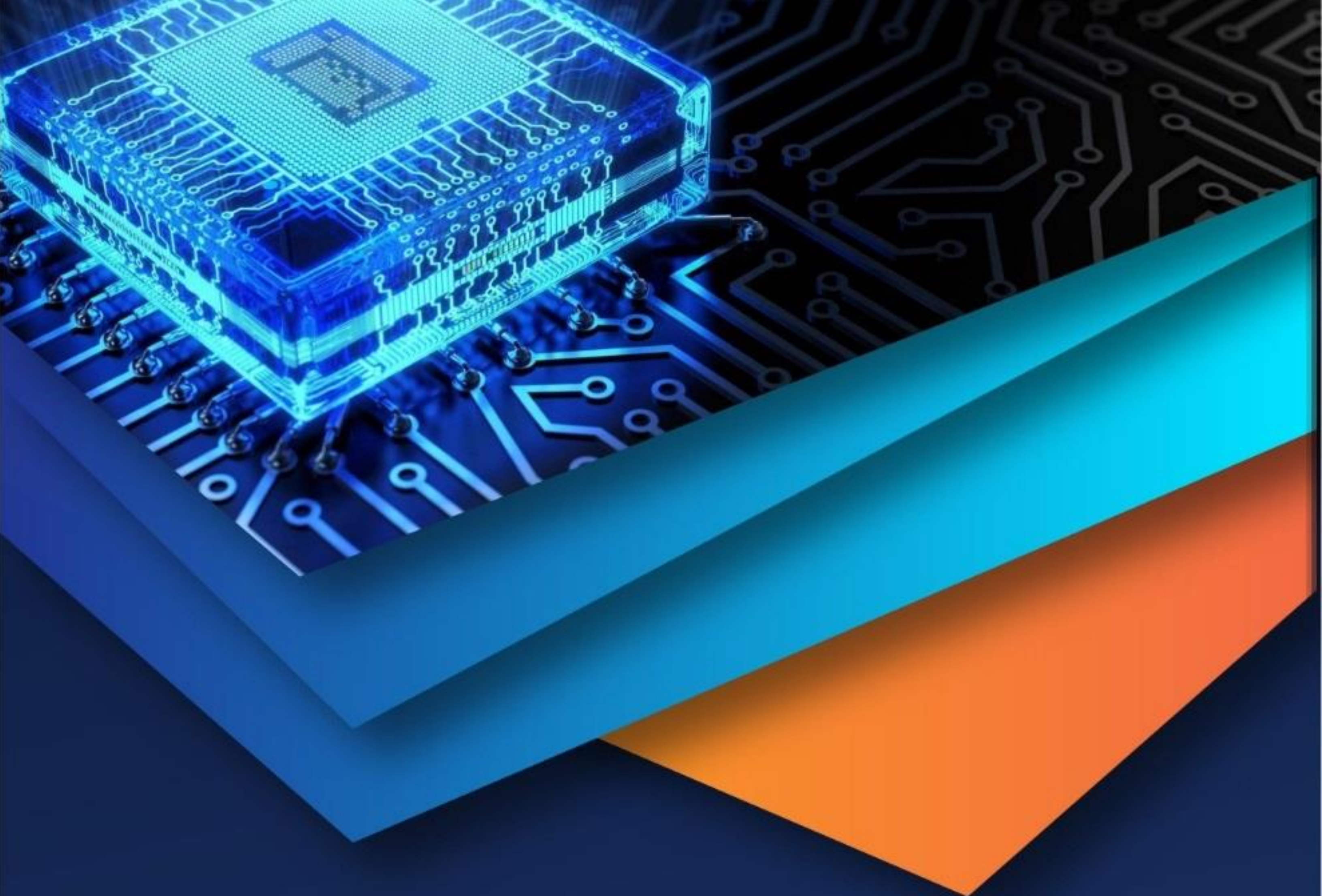

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