A NEW TECHNIQUE FOR MARIN PROPELLER ENGINEERING

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Abstract: Sandia National Laboratories has developed a new technology to fabricate three-dimensional metallic components directly from CAD solid models. This process, called Laser Engineered Net Shaping (LENS), exhibits enormous potential to revolutionize the way in which metal parts, such as complex prototypes, tooling, and small-lot production items, are produced. Laser Engineering Net Shaping (LENS) is one of the rapid prototyping manufacturing processes for producing metal parts directly from Computer Aided Design (CAD) files. In this approach to fabricate the ship propeller by layer additive methods. The LENS process is unique since it goes from raw material directly to metal parts without any secondary operations. It can produce parts in a wide range of alloys, including titanium, stainless steel, aluminum, and Inconel. Primary applications for LENS technology include Repair & Overhaul, Rapid Prototyping, Low-Volume Manufacturing, and Product Development for Aerospace, Defense, and Medical markets.
Keywords: LENS, propeller manufacturing, RPT,CAD

I. INTRODUCTION

The LENS® technology is unique in that fully dense metal components are fabricated directly from raw materials, bypassing initial forming operations such as casting, forging, and rough machining. LENS® offers the opportunity to dramatically reduce the time and cost required to realize functional metal parts. As a material additive process, additional cost savings will be realized through increased material utilization as compared to bulk removal processes. LENS® can also be used to modify or repair existing hardware. Parts have been fabricated from stainless steel alloys, nickel-based alloys, tool steel alloys, titanium alloys, and other specialty materials; as well as composite and functionally graded material deposition[2].

The LENS technology is unique in that fully dense metal components with material properties that are similar to that of wrought materials can be fabricated. The LENS process has the potential to dramatically reduce the time and cost required realizing functional metal parts. In addition, the process can fabricate complex internal features not possible using existing manufacturing processes.

II. COMPONENT OF MARIN PROPELLER

Propeller:-

A propeller is a type of fan that transmits power by converting rotational motion into thrust. A pressure difference is produced between the forward and rear surface of the airfoil-shaped blade, and a fluid (such as air or water) is accelerated behind the blade. A propeller is the most common propulsion inducer on marine vessel; imparting momentum to a fluid which causes a force to act on the ship there by the ship will start sailing. Till now RPT technique is usually used to prototyping of new products, this paper proposes the LENS technology for the manufacturing of marine propellers.

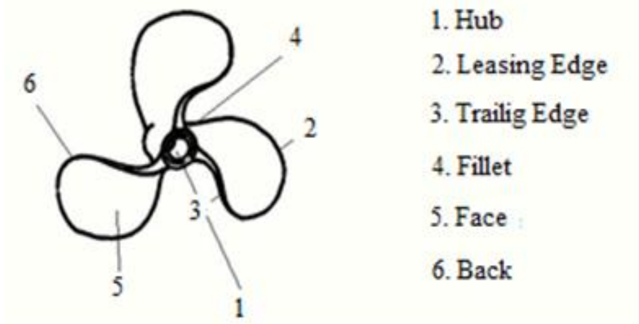

Figure 1:- Propeller Parts

Manufacturing of Propeller

The manufacturing process of marine propeller has remained virtually unchanged in the last 50 years. As the boat designs evolve, the shape and style of the propellers have changed, but they are still made the same way they were in the 1950.

The propeller is manufactured by sand casting technology. Sand casting is the common process to manufacture many components. In that pattern making, forming the mold cavity, metal pouring and finishing are the main steps. But particularly in propeller manufacturing the pattern making technique is different and tedious. Advantages in that, many metals can be molded in different sizes, shapes and cheaper in cost. But it has poor finish and tolerance. Engine blocks, cylinder heads are some example part to be made[1]

III. TECHNIUES OF MARIN PROPELLER

Rapid Prototyping

Rapid Prototyping (RP) is a term most commonly used to describe a variety of processes, which are aimed at quickly creating three-dimensional physical parts from virtual 3D computer models using automated machines. The parts are 'built' directly from the 3D CAD model and can match that model very closely (within the precision limits of the chosen process). Rapid prototyping is different from traditional fabrication in that it is only possible through the use of computers, both to generate the 3D CAD model data, as well as to control the mechanical systems of the machines that build the parts. Virtually all RP processes are "additive". Parts are built up by adding, depositing, or solidifying one or more materials in a horizontal layer-wise process. The part is built up layer by layer until done. This is similar to the result one would get if one made a topographical map of the object, with the contour lines representing the layer thickness of the process[1].

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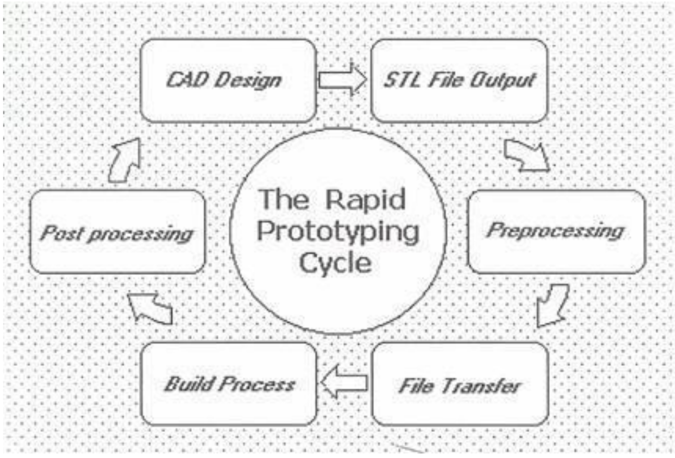

Figure 2: RAPID prototype process

Laser Engineering Net Shaping (LENS)

A technology that is gaining in importance and in early stages of commercialization and it is designed for aerospace industry especially to produce titanium parts. A high power laser (1400W) is used to melt metal power supplied coaxially to the focus of the laser beam through a deposition head that is deposited onto the table. The head is moved up vertically as each layer is completed. Metal powders are delivered and distributed around the circumference of the head either by gravity, or by using a pressurized carrier gas. Inert gas is used to shield the metal from atmospheric gases and repeat process till build is complete. Object fabricated are near net shape, but generally will require finish machining. Normally the material using for the propeller manufacturing are kinds of stainless steel. The LENS technology also most suitable for complicated shape parts with stainless steel.[1]

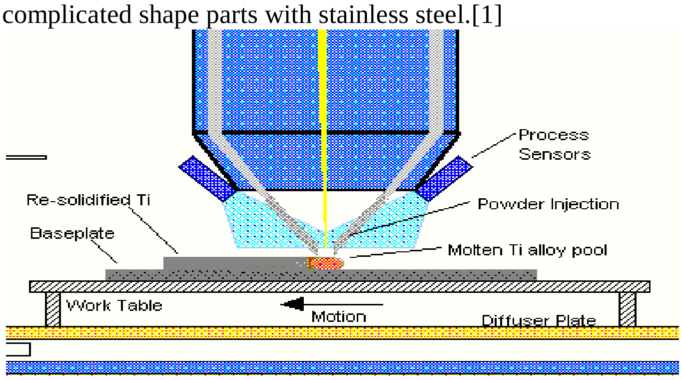

Figure 3: LENS Technology

Materials composition can be changed dynamically and continuously, leading to objects with properties that might be mutually exclusive using classical fabrication methods. Has the ability to fabricate fully-dense metal parts with good metallurgical properties at reasonable speeds; so it is suitable for alloying to add the properties for parts producing by this technology.

IV. METHODOLOGY FOR MAKING PROPELLERS

The major steps involved in manufacturing marine propellers by sand casting method[1].

(1)Layout:- The layout is done first and most important part of the job. It shows cross sections of the blades at chosen points. This includes the angle, rake, thickness machining allowance; length and shrinkage allowance for the metal casting process. After the general layout is complete, material requirement calculation made for the construction of the propeller. It is important that the wood be clear of knots, as a lot of carving is involved in the shaping process. For these propellers, nineteen layers were used for each. A separate layout is then generated off the original layout to determine shape of the individual cants. Once both layouts have been completed and checked, then checked again, construction can being.

(2)Pattern:- The wood is planed down and shaped according to the layout. The layers are cut on a band saw. In order to guarantee the layers line up properly, a center hole is drilled in each layer. This center hole represents the center of the hub. Using the layout, an offset is determined enabling the correct pitch of the blade. The layers are then marked and prepared for gluing. The layers are glued together using the offset. We use screws to hold the layers together because it is difficult to use clamps. It is now starting to look like a propeller blade.

(3)Shaping:- The steps in the shaping the wood need to be taken down to make a smooth surface. Tools are used in order of precision; it can typically go as follows: Axe-Draw Knife-Power Plane-Angle Grinder-Spoke Shave-Block Plane-Sand Paper. According to thickness the back is taken down in the same fashion as the face. Once the blade is finished, the hub can be built up. The off cuts from the cants are already kept to build up the hub. Hubs can be different depending on the foundry's needs, and the specifications of the vessel the support will use for. Typically a machining allowance is added on the diameter, as well as an addition in length on the forward end. The extra length allows for the work holding a lathe's chuck for machining. Once the hub meets the blade. The fillet is created using composite filler. It can also be carved into the wood.

(4)Finishing:- All the small holes, scratches and minor defect are filled with wood filler. The entire blade is sanded down with at least 80 grit sand papers. The scratches left by the 80 grit paper will be filled with paint. Special pattern paint is used to finish the propeller. It can be sprayed, rolled, or brushed on. The paint will fill small scratches and become extremely hard once dry. After painting, the pattern is now ready for molding in the foundry.

•The pattern is made with one blade for a number of reasons. The first being strength. If the pattern were to be made (in wood) with more than one blade, the hub would actually only be connected to one blade and the others would have to be attached after the fact. The second reason is continuity. The pattern is made with one blade to ensure that when molded, all the blades are the same. The third reason is price. Most of the price of the pattern is in the blade shaping. If a 5 blade pattern is needed, it would cost 5 times what a normal pattern would.

•Because of the way the pattern is molded, less than half the hub surface is used at a time. So a full hub is not necessary. A flat back on the hub also allows for easier pattern storage.

•The color of the pattern usually indicates the type of metal being used. However a foundry may have their own reason for color.

•It's actually quite common to re-pitch old patterns, update

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the blade shape, or build up the hub diameter. As we said earlier, propeller patterns are always built per vessel. They have to take into account the boat size, engine specs, region, etc. So if an old pattern was built for an engine with less horse power than a new one, the pattern may have to be modified to allow for a stronger propeller.

(5).Material

Over the years there has been advancements made in steel materials and alloys used for marine propeller. Long gone are the days of using stainless steel and others the most commonly used material is stainless steel. To avoid all the above manufacturing difficulties said in section1 and 2, increase the productivity and material compatibility the authors propose the following latest, waste eliminating technology called RPT (Rapid Prototyping Technology).

(6). RPT

A virtually geometry model is cut into slices for layer wise production. RP technologies are able to create one-piece part geometries which would be difficult if not create by machining, including overhangs, undercuts and enclosed spaces. To create these types of structures, RP technologies often really on a support material, this is used alongside the model material. These automatically generated support the part being built. The material which are available for RP use will depend on the process chosen and are still relatively limited, but the variety is growing. There are a number of plastics and resins commonly used, as well as some process that can use things like starch, plaster, wax and metal. The word “Rapid” in RP is a relative term, as most of these processes are actually quite slow. The rapid actually refers to the reduced time from initial design to the production of the final part. This is due to the elimination of extensive amounts of hand and machine work involved in making prototypes with traditional methods, as well as the ability to quickly iterate and test a design through various stages. Also, as contrasted with more complicated CAM programming and CNC machining, RP software and machines are generally simple and quick to use, resulting in significantly reduced “human time” needed to produce prototype parts. RP processes are generally quiet, non-dangerous processes which can run in an office environment (noise, dust, liquids) and has a number of safety issues (including personal injury or the possible destruction of the machine if things are not done properly).

➢ Sequence of RPT
- CAD solid model
- STL’ file
- Slicing the file
- Final build file
- Fabrication of part
- Post Processing
- STL format
- All commercial CAD systems can convert 3D models – STL
- User specifies accuracy: Higher accuracy- many, small triangle- large files

➢ Rapid Prototyping Technologies
- Stereo Lithography (SL)
- Laminated Object Manufacturing (LOM)
- Selective Laser Sintering (SLS)
- Fused Deposition Modeling (FDM)
- Solid Ground Curing (SGC)
- 3D Printing (3DP)
- Laser Engineering Net Shaping (LENS)

The authors approaches LENS technology is most appropriate to manufacturing of propeller for marine vessel, because it has ability to create parts with different material compositions.

Materials composition can be changed dynamically and continuously, leading to objects with properties that might be mutually exclusive using classical fabrication methods. Has the ability to fabricate fully-dense metal parts with good metallurgical properties at reasonable speeds; so it is suitable for alloying to add the properties for parts producing by this technology.

➢ Advantages of LENS
- Can be used to repair parts as well as fabricate new ones
- Has a very good granular structure
- Powder forming methods have few material limitations
- The properties of the material are similar or better than the properties of the natural materials
- Comparatively good surface finish than sand casting because not require secondary finishing operations

➢ Disadvantages of LENS
- Some post processing involved
- The part must be cut from the build substrate
- Has a rough surface finish, may require polishing

➢ LENS Initial Applications
- Fabrication and repair of injection molding tools
- Fabrication of large titanium and other exotic metal parts for aerospace applications

➢ LENS Capabilities
- Ability to build fully dense shapes
- Closed loop control of process for accurate part fabrication
- Ability to tailored deposition parameters to feature size for speed, accuracy, and property control
- Composite and functionally graded material deposition
- Three- and four-axis systems for complex part fabrication [6]

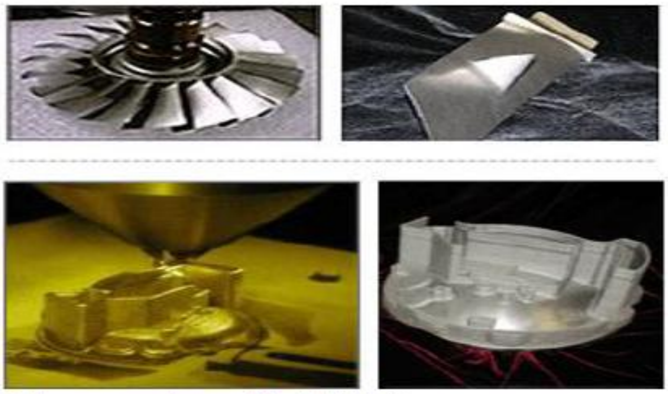

Figure 4: Parts manufactured by LENS

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V. CONCLUSION

The authors concluded that, in propeller manufacturing the LENS technology can be adopted toproduce the propeller to reduce the time, cost and increase the mechanical property, quality and productivity. The LENS process is unique since it goes from raw material directly to metal parts without any secondary operations LENS will be the appropriate production technology in future to produce marine propellers because it has own flexibility in sizes and materials.

REFERENCES

[1] YonasMitikuDegu, K. Sridhar,”Marine Propeller Manufacturing – A New Approach”American Journal of Engineering Research (AJER) Volume-03, Issue-05, pp-207-211
[2] Wikipedia, the free encyclopedia.htm
[3] info@industrialshapeandform.com
[4] http://www. PWMarine Blog.htm
[5] Prof H.Gugger, Assistant R.Loveridge ,LAPA Digital Technology Seminar Workshop 1: Mai 10 & 11200/ Version 1.1
[6] www.mfge.atilim.edu.tr/kaftanoglu, Prof. Dr. Bilgin KAFTANOĞLU, Manufacturing Engineering
[7] www.home.att.net/~castleisland/len_int.htm
[8] www.tms.org/pubs/journals/JOM/9907

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