NEW PRODUCT DEVELOPMENT OF INNOVATIVE SHAVING RAZOR BY RAPID PROTOTYPING

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Abstract— An ergonomic design is provided to a shaving razor. The design concept is identified by the bench marking process on the existing product. The razor parts are designed using the SOLIDWORKS. The design files are converted into 'stl' format. The 'stl' file serves as the input of the Selective Laser Sintering machine. The ergonomic design is done by impressing a clay model with hand to form a pattern, which fits with the human hands. The shape and size of the pattern is retrieved by using the Reverse Engineering Technique. Selective laser sintering process is used to fabricate the parts. All the parts are assembled together manually. This innovative razor has ergonomics design on the handle and uses the standard blades for shaving. Thus, it will be economical and fits with the human beings who use them.

Index Terms— Razor, Ergonomic, Rapid Prototyping, Additive Manufacturing, Standard Blade.

I. INTRODUCTION

A. Rapid Prototyping Techniques

Rapid prototyping is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. Construction of the part or assembly is usually done using 3D-printing or additive layer manufacturing technology.

- *Selective Laser Sintering*

Selective laser sintering (SLS) is an additive manufacturing (AM) technique that uses a laser as the power source to sinter powdered material, aiming the laser automatically at points in space defined by a 3D model, binding the material together to create a solid structure. It is similar to direct metal laser sintering (DMLS). Selective laser melting (SLM) uses a comparable concept, but in SLM the material is fully melted rather than sintered, allowing different properties (crystal structure, porosity, and so on).

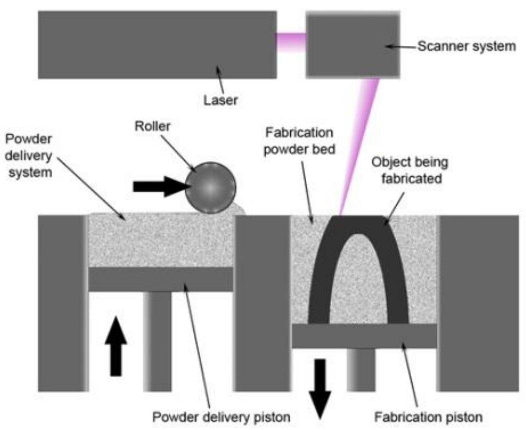

Figure 1: Selective Laser Sintering

An additive manufacturing layer technology, SLS involves the use of a high power laser (for example, a carbon dioxide laser) to fuse small particles of plastic, metal, ceramic, or glass powders into a mass that has a desired three- dimensional shape. The laser selectively fuses powdered material by scanning cross- sections generated from a 3- D digital description of the part (for example from a CAD file or scan data) on the surface of a powder bed. After each cross- section is scanned, the powder bed is lowered by one layer thickness, a new layer of material is applied on top, and the process is repeated until the part is completed. The Schematic diagram of SLS is as shown in Figure.1.

B. Razor

A Razor is a bladed tool primarily used in the removal of unwanted body hair through the act of shaving. Kinds of razors include straight razors, disposable razor, and electric razors.

C. Ergonomic Design

The word ergonomics comes from two Greek words

- ERGO: meaning work
- NOMOS: meaning laws

Ergonomics, also known as comfort design, functional design, and systems, is the practice of designing products, systems, or processes to take proper account of the interaction between them and the people who use them.

Ergonomics is a science focused on the study of human fit, and decreased fatigue and discomfort through product design. Ergonomics applied to office furniture design requires that we take into consideration how the products we design fit the people that are using them. At work, at school, or at home, when products fit the user, the result can be more comfort, higher productivity, and less stress. Ergonomics can be integral part of design, manufacturing, and use. The industrial design concept ideation on ergonomics is shown in Figure.2.

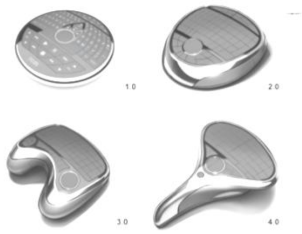

Figure 2: Industrial design concept ideation.

D. ATOS Compact Scan-3D scanner

We have measured the dimensions of a model (Razor Handle) by using the ATOS Compact scan for this project. A new class of scanner for 3D measurement and inspection. The ATOS Compact Scan defines a new class of scanner for 3D measurement and inspection. The lightweight, compact construction opens new application areas and ensures ultimate adaptability for 3-dimensional measuring of components such as casted and injection moulded parts, forms and models, interiors, prototypes & design models. The advanced hardware is combined with completely integrated, powerful software for scanning and inspection.

The ATOS Compact Scan Delivers

- Blue light technology
- Scan and probe
- The compact class and Portable measuring
- Complete measuring system
- Scan part ranging from a small coin to an aircraft

II. LITERATURE REVIEW

King C.Gillete (US775134) has invented certain new and useful improvements in Razors, of which the following is a specification. His invention is particularly applicable to razors of the safety type, the use of which as heretofore constructed involves a considerable amount of trouble, time, and expense on tile part of the user in keeping the blades. A main object of his invention is to provide a safety-razor in which the necessity of honing or stropping the blade is done away with, thus saving the annoyance and expense involved therein, and to this end. He secures this blade to a holder so constructed as to provide a rigid backing and support for the blade, as well as a handle.

Sharidan Stiles (US20040035003) has invented a personal shaving razor. A hand-held razor has single or multiple blades of a smaller dimension than is typical and features an ergonomically advantageous handle allow more detailed shaving and hair removal. Embodiments include a shaving head that is an integrated disposable razor or is part of a replaceable razor blade cartridge. A personal styling razor, comprising a handle portion having lower, middle and upper longitudinal portions; and a head portion having a razor blade and attached to said upper longitudinal portion; wherein said lower longitudinal portion extends along a first axis, said middle longitudinal portion extends along a second axis and said upper longitudinal portion extends along a third axis and wherein said first and third axes form a control angle that is less than ninety degrees and said razor blade has a width of less than or equal to one inch

III. METHODOLOGY

A. Ergonomic Design on Razor

From the different kinds of previous razors, they won’t have any ergonomic design except some cartridge razors. But the cartridge razor is costlier and it doesn’t use normal standard blades. Therefore, there is a need to replace the head assembly (cartridge) once it has been used.And also the other razors have used the normal standard blades; they don’t have any ergonomic design in handle. So, we have designed a new innovative razor, which has both ergonomic design as well as usage of standard blades.

B. Flow Chart

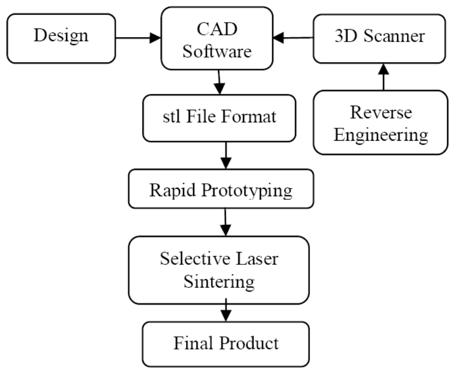

Figure 3: Flow chart

This project consists of step by step process that is mentioned in the above flow chart (Figure.3).

IV. DESIGN OF SHAVING RAZOR

The innovative razor consists of four different parts; they were modelled and assembled together using SOLIDWORKS 2016.

A. Bottom Part

The first part of innovative razor is the Bottom part as shown in Figure.4. It is sketched and modelled in the SOLIDWORKS. The part is designed by referring various razor that is current available. A blade profile is extruded on top face of the bottom part.

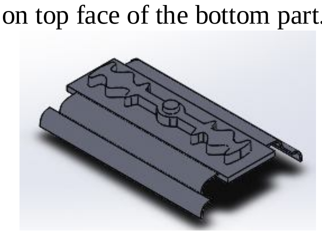

Figure 4: Isometric view of the bottom part

A ratchet profile is extruded on bottom face of the bottom part as shown in Figure.5. The ratchet arrangement helps to positioning the bottom part at the exact position. In order to allow the rotation and positioning of the bottom part, the ratchet is designed so that it has four numbers of teeth.

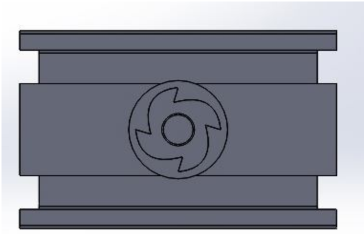

Figure 5: Ratchet wheel on the bottom part

B. Top Part

This is the second part of the innovative razor as shown in Figure.6. The top part serves to hold the blades over the bottom part. The cavity of the blade profile is provided on the bottom face of the top part. It is then mated with the bottom part.

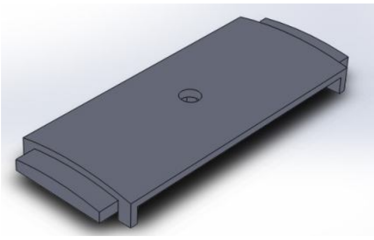

Figure 6: Isometric view of the top part

C. Neck Part

This is the third part of the innovative razor as shown in Figure.7. It is used to connect the two parts (Bottom Part and Handle). The neck part is modelled using the loft feature. In order to assemble the neck part with the bottom part and the handle, an extruded cut feature is provided on both the sides of the neck part. A pawl like arrangement is also provided in the neck part. The neck part is so designed such thatthebottom part is inclined at an angle of 30˚.

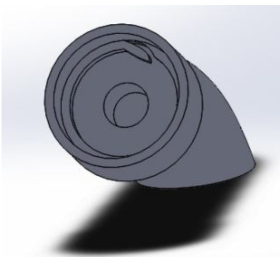

Figure 7: Isometric view of the neck part

D. Handle

This is the last part of the innovative razor. The main objective of the project is to provide an ergonomic design in the handle. So, a hand impression is made on the moulding clay. The shape of the clay mould is then converted into CAD Data by Reverse engineering.

F. 2-Dimensional views

1) Bottom part

The 2-Dimensional view of the bottom part is shown in the Figure.8.

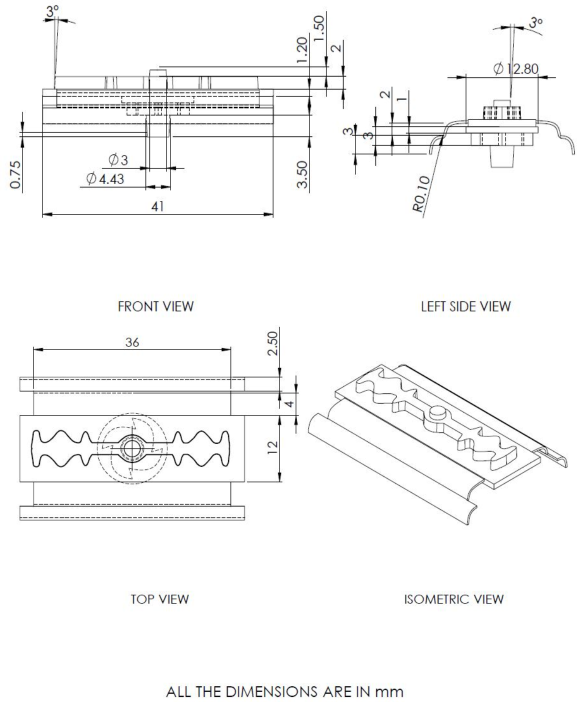

Figure 8: Isometric view of Bottom part

2) Top Part

The 2-Dimensional view of the top part is shown in the Figure.9.

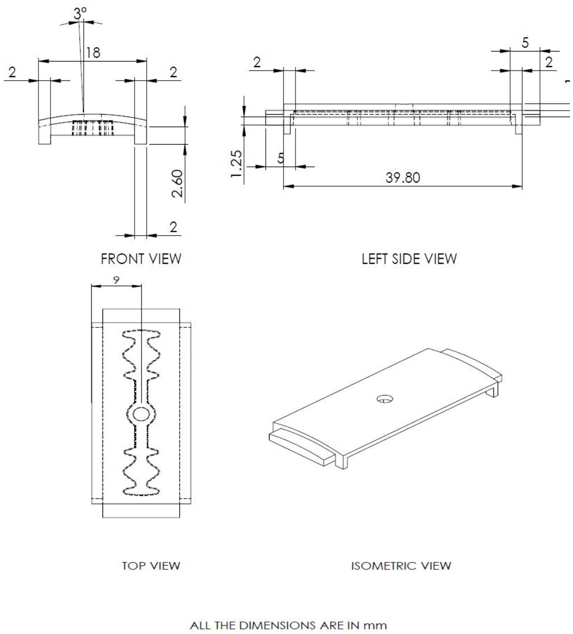

Figure 9:Isometric view of Top part

3) Neck Part

The 2-Dimensional view of the neck part is shown in the Figure.10.

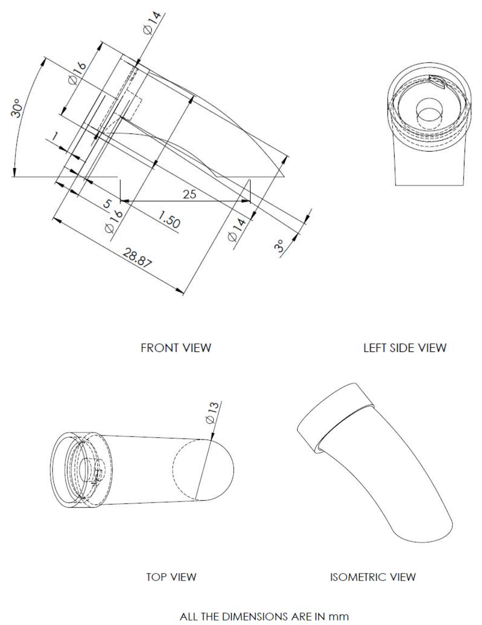

Figure 10: Isometric view of Neck part

G. Design Calculation of Ratchet

1) Calculation of Ratchet Wheel

- Number of Teeth on the Ratchet, $z = 4$(for 90˚)
- Tip circle diameter of ratchet, $D = 10mm$
- Module(m)

$m = \frac{D}{z}$ (1)

$m = \frac{10}{4}$ (2)

$m = 2.5$ (3)

- Face width of Ratchet(b)

$b = \Psi m$ (4)

$\Psi = 1.5$ to 3.0, Assume$\Psi = 2$ (5)

$b = 2 \times 2.5$ (6)

$b = 5mm$ (7)

2) Calculation of Ratchet Teeth

The tooth design of the ratchet wheel as shown in Figure.11.

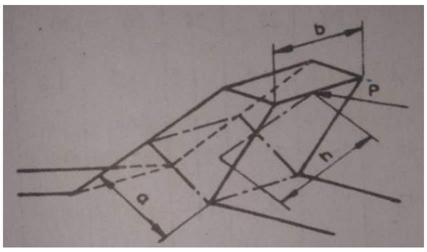

Figure11: Design of Ratchet teeth

$h = 0.75 \times m$ (8)

$h = 0.75 \times 2.5$ (9)

$h = 1.875mm$ (10)

- Area of critical section of the tooth $(a \times b)$

$a = m$ (11)

$a = 2.5mm$ (12)

$b = 5mm$ (13)

Φ=Ratchet tooth angle
μ=Coefficient of friction
ρ=Friction angle, tan-1μ

For best conditions of sliding, the ratchet tooth angle Φ>ρ

V. FABRICATION OF RAZOR

A. Basic Procedure

- The 3-D modelling of the parts are created using the CAD SOFTWARE (SOLIDWORKS 2016)
- The part file is then saved in the .stl format.
- Thus the 3D model is converted into number of nodes and elements.
- Now the CAD file (.stl) is imported to the SLS SINTERSTATION 2500+ machine.
- Choose the material (Durable polyamide nylon material) for making the required prototype.
- After setting the machining setup, the machine starts to produce the part layer by layer.
- Once the part is produced, it is taken out from the SLS machine.
- It is then cleaned and packed.

B. Fabrication Process

The handle consists of complicated surfaces and shapes; it is converted into CAD Data by a 3D Scanner.The modelled part is converted into .stl file format, which is the input file format for all the rapid prototype machines. The stl file is imported to the Selective laser sintering (SLS SINTERATION 2500+) Machine.

The machining time is mainly based on the orientation and slicing of the 3D-Model.SLS does not need a separate feeder for support material because the part being constructed is surrounded by unsintered powder at all times, this allows for the construction of previously impossible geometries.

A roller pushes the powdered material (Nylon 6) from the powder delivery system to the fabrication power bed. Then the laser was projected a 3D model by a single layer on the fabrication powder bed. The laser selectively fuses powdered material by scanning cross- sections generated from a 3- D digital description of the part. After each cross- section is scanned, the powder bed is lowered by one layer thickness, a new layer of material is applied on top, and the process is repeated until the part is completed. Finally, the 3D printed part is cleaned and assembled.

The Selective Laser Sintering has the following advantages.

- Best accuracy and smooth surface finish
- Consistent part characteristics
- Design to tool-less production runs in one step.

VI. COST ESTIMATION

This innovative shaving razor can be produced from the vacuum casting techniques for a required number of products.

PolyProplyene(PP) material is widely used for making the current shaving razor. So, Polyproplyene material is chosen for the production of this product.

For bulk production (say 10000 quantities), the cost of raw material is determined as below.

Here, the capital cost includes the cost of Rapid prototyping & Reverse engineering cost (Rs.8000) and Vacuum casting cost (Rs.3000).

- Capital cost $= Rs.8000 + Rs.3000$ (14)
  $= Rs.11000.$ (15)
- Production cost(PC)
  $PC = Mass\ (m) \times Cost\ of\ polypropylene$

Mass of material used

$$m = (1.58 + 1.31 + 3.31 + 17.30) \quad (16)$$
$$m = 23.5\ g \quad (17)$$

Cost of propylene material per kg $= Rs.150$

Production cost $= (23.5 \times 10^{-3}) \times 150$ (18)
$= Rs.35.25.$ (19)

- Total cost $= (1\%\ of\ capital\ cost) + (PC)$
  $= 11 + 35.25$ (20)
  $= Rs.46.25.$ (21)
- Final cost $= (Total\ cost + other\ expenses)$
  $= 46.25 + 24.75$ (22)
  $= Rs.70.$ (23)

VII. ADVANTAGES & LIMITATIONS

A. Advantages

- ✓ Solves discomfort associated with razor shaving.
- ✓ It will allow the user to use the Standard blades which is economical.
- ✓ Reduces stress in the hand.
- ✓ Ergo design form could also be adapted to other writing media.
- ✓ It is economical

B. Limitations

- o Only Single blade can be used
- o Used this razor for self shaving only

CONCLUSION

In day to life, we use the razor for shaving purpose every day. The ergonomics design on the razor will comfort or fit with the people. And it also allows the people to using the standard blade which is economical. It solves discomfort associated with razor shaving. It reduces stress in the hand.

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