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Design of Rotary Knob Assembly

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Abstract— Hand-related apparatus needs ergonomic designs failing which may leads to hand-related musculoskeletal disorders. There have been several studies on hand-related apparatus like gearshift knobs, door knobs, gas valve knobs, butterfly nuts and screw knobs are common knobs used for daily living activities. Other knobs like the convex, knurled, spherical, cone-shaped and ridged knob are often used for industrial-related applications. The ergonomics considerations identified in knobs include aesthetic look, position, torque requirement and shape-coding. The main function of this Rotary knob is to control the blower speed of Air Conditioner (AC) in a car. So without this part AC is stuck with same settings all the time because there is no other means to change settings. To operate this component often it must be made of durable materials to keep it away from deteriorating quickly. The aim of this project is to design a Rotary knob with its detailed components and assembling the knob on to encoder according to the specifications given in encoder drawing using CATIA and also to check all the possible interferences in between the parts to prevent clashes.

Keywords— Ergonomics, Rotary Knob, Air conditioner, Encoder, CATIA, Interferences.

I. INTRODUCTION

CATIA is one of the world's leading software modeling tool in CAD/CAM/CAE packages developed by Dassault Systèmes. It serves the basic design tasks by providing different workbenches. The basic workbenches are Part Design workbench, Surface Design and Wireframe workbench, Assembly workbench, and Drafting workbench. The drawing views that can be generated include orthographic, section, auxiliary, isometric, and detail views. The main concern of this project is to use CATIA V5 to explore and optimize the different features and functions. To achieve this task, transition between workbenches inside the mechanical design section was assured to attain the most feasible shape. The purpose of snap fit is to joining two different components. So one component has a protrusion (Hook or Stud or Bead or bump) and another component has a depression (latch or undercut).

The joint may be separable depending on the shape of undercut. The force required to separate components varies according to the design. Snap-fits are the simplest, quickest and most cost effective method of assembling two parts. When designed properly, parts with snap-fits can be assembled and disassembled numerous times without any adverse effect on the assembly. Snap-fits are also the most environmentally friendly form of assembly because of their ease of disassembly, making components of different materials easy to recycle.

Although snap-fits can be designed with many materials, the ideal material is thermoplastic because of its high flexibility and its ability to be easily and inexpensively molded into complex geometries. Other advantages include its relatively high elongation, low coefficient of friction, and sufficient strength and rigidity to meet the requirements of most applications.

II. LITERATURE SURVEY

Most engineering material applications with snap-fits use the cantilever design (see Figure 1) and, thus, this manual will focus on that design. The cylindrical design can be employed when an unfilled thermoplastic material with higher elongation will be used (a typical application is an aspirin bottle/cap assembly).

When designing a cantilever snap, it is not unusual for the designer to go through several iterations (changing length, thickness, deflection dimensions, etc.) to design a snap-fit with a lower allowable strain for a given material. Other types of snap-fits, which can be used, are the U or L shaped cantilever snaps. These are used when the strain of the straight cantilever snap cannot be designed below the allowable strain for the given material.

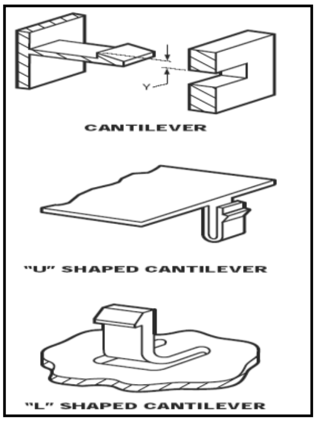

Figure 1: Cantilever Types

A design engineer's job is to find a balance between integrity of the assembly and strength of the cantilever beam. While a cantilever beam with a deep overhang can make the unit secure, it also puts more strain on the beam during assembly and disassembly. This chapter explains how this balance is achieved. A typical snap-fit assembly consists of a cantilever beam with an overhang at the end of the beam (see Figure 2).

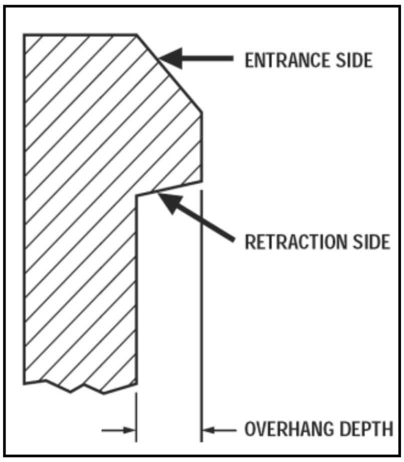

Figure 2: Overhang at the End of Beam

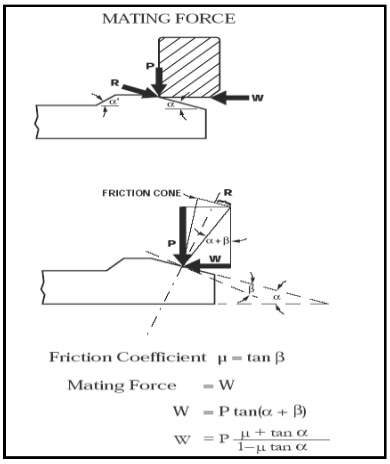

Figure 3: Mating Force

The overhang typically has a gentle ramp on the entrance side and a sharper angle on the retraction side. The small angle at the entrance side (α) (see Figure 3) helps to reduce the assembly effort, while the sharp angle at the retraction side (α') makes disassembly very difficult or impossible depending on the intended function. Both the assembly and disassembly force can be optimized by modifying the angles mentioned above.

In a typical snap-fit, the strength of a beam is dependent on its geometry and maximum deflection during assembly. The force to assemble and disassemble snap-fit assemblies is highly dependent on the overhang entrance and retraction angles.

III. PROPOSED SYSTEM

In proposed system, novel design of the rotary knob assembly is introduced and consists of 4 parts as follows:

Part Number	Description of Part Number
1	Mounting clip
2	Outer Knob
3	Gripper
4	Rotary Knob Cap

Table 1: List of designed parts

The following diagram depicts the four parts of Rotary Knob Assembly:

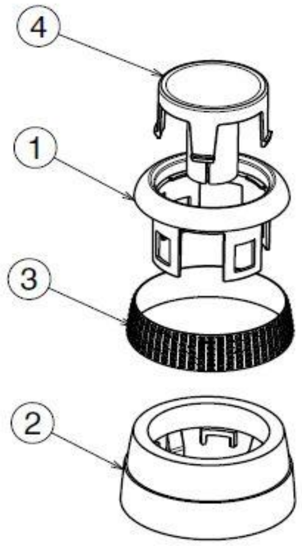

Figure 4: Part Models Designed for Rotary Knob Assembly

1. Mounting Clip

The basic Function of Mounting clip is aesthetic part and it holds on to the Rotary Knob. ABS is the material used to manufacture this part under injection moulding process in a single shot. A Straight mould can be possible by creating the side holes off the parting line and 4 sliders which are mainly connected to the forming core, with the angle pin lead for core pulling.

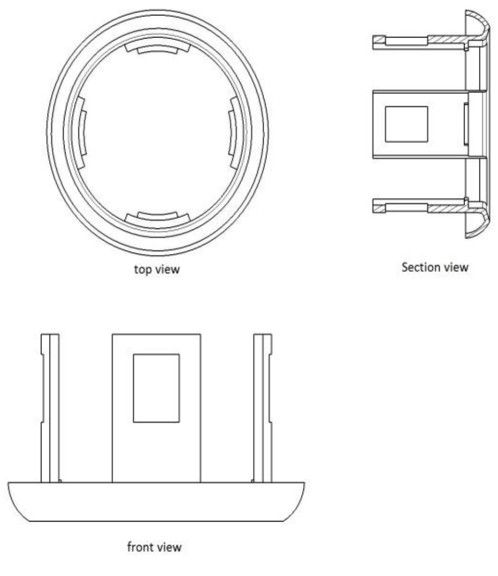

Figure 5: Mounting Clip

2. Outer Knob

The outer knob is the core or main part of the Knob. It consists of both protrusion and depression to facilitate the fittings made in harmony with the Mounting clip and knob holder.

The basic function of outer knob is to hold the Rotary knob cap and Mounting clip and the Outer knob is assembled with encoder to control the speed of AC in a car and this outer knob is ergonomically designed for ease of use and for ease of accessibility which holds Gripper, Mounting clip and Rotary knob cap. The ergonomics considerations identified in knobs include aesthetic look, position, torque requirement and shape-coding.

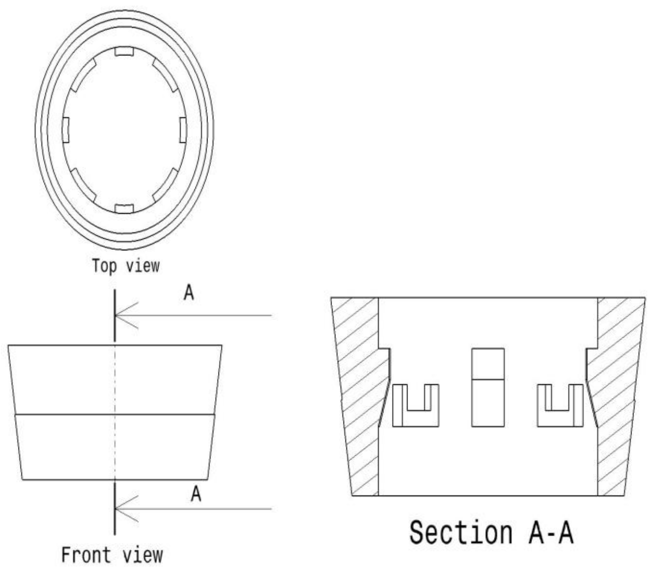

Figure 6: Outer Knob

3. Gripper

The basic function of gripper is gripping that is generally used to grasp and hold an object firmly to perform the required action. The coefficient of friction µ between the work surface and gripper fingers can vary depending on the material used and surface finish.

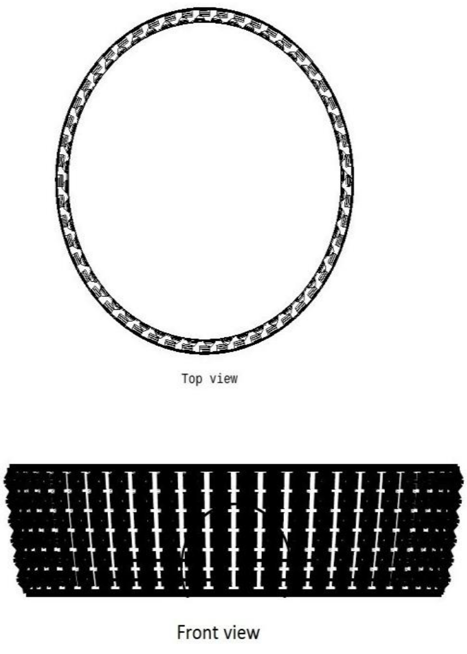

Figure 7: Gripper

Installing a gripper on to the Rotary knob depends on the elastic tension of the rubber. If elastic tension is more for a material then the gripper engages very tightly to the Rotary knob otherwise it is loosely fitted.

4. Rotary Knob Cap

The basic function of Rotary cap is holding both Encoder shaft and Mounting clip. This part is very close to the human so the manufacturer must take care to avoid sharp corners. ABS is the material used to manufacture this part under injection moulding process in a single shot. A Straight mould can be possible by creating the side holes off the parting line and no other tooling methods required (Sliders and Lifters). The finishing of the Rotary cap can be made with Spray painting Black.

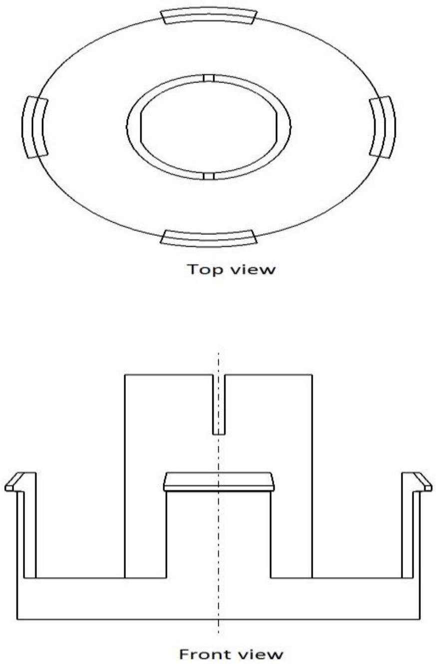

Figure 8: Rotary Knob Cap

IV. CONCLUSION

While carrying out this project, many challenges were faced and surmounted. Varied functions are applied to the different workbenches, such as part design and wireframe surface design. However, the main issue in the design was finding the interferences exist in between the parts with the help of Tolerance Stack up Analysis in the Assembly workbench. The Rotary Knob has been designed using CATIA v5. Dismantling Force, Diametrical Interference and Allowable Deflection has been calculated.

V. ACKNOWLEDGEMENT

I have taken my efforts to complete this paper. I have referred many sites and books related to Product Design. I would like to thank all given citations in the following section that I have acquired knowledge from their papers and books. Also I would like to acknowledge that, some of the images and original definitions are directly written in this paper from the following citations.

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