ECOR 1010 – INTRODUCTION TO ENGINEERING

REVERSE ENGINEERING PROJECT

Carleton University, Department of Engineering

To: Borna Monazzah Moghaddam

By: Youssef Ibrahim, Alexandros Pietrobon, Anthony Zgheib

Lab Section: L8

Project Group Number: L16

Date: November 30th, 2018

TABLE OF CONTENT

ABSTRACT

The objective of this activity was to reverse engineer a product/part, then using what you learned redesign the part to improve it in some way. Reverse engineering is the process of understanding the technical aspects that are used in pre-existing products, and how the impact the product. The part that was reverse engineered was a double open-ended wrench. After reverse engineering it became apparent that all of the aspects of the wrench promoted withstanding as much torque as possible and being as sturdy as possible. Redesigning a part is the process of changing a pre-existing part to increase its functionality, improve its effectiveness or increase its lifespan. When redesigning the wrench, the focus was shifted away from the maximum torque, and became increasing the number of uses the wrench had. The main feature added was the addition of a level in the centre of the wrench. It was decided that this was best, in order to replace multiple tools that would take up extra space. This new tool is named a double open-ended level wrench.

In order to properly reverse engineer the part, an in depth understanding must be created. An example of the original product was purchased, studied, and measured in order to fully understand what it's functions are. The notes created on the original part were then cross referenced with the potential changes that could be made, only picking the changes that would best work with the type of part chosen. CREO was used to create the redesign. CREO is a computer aided design program that allows you to create virtual prototypes, instead of having them manufactured, greatly reducing the price and time required.

While redesigning the wrench a change of material into a more foreign tool material was considered, but it was quickly determined that this would be counterproductive, and the cons would heavily out way the pros. After much research it was determined that the most effective material for our purpose would be chromium-vanadium alloy steel. This is because it provides an exceptional amount of hardness, while also giving some elasticity and protection against wear. The production of the part involved having the steel be formed into a rough shape, then refining that shape and tempering the metal. Finally ends with the part being chrome plated. The final part is 8 inches long, 2.25 inches wide, and 0.25 inches tall.

After completing the redesign, it was compared to the original to determine if the improvements made were actual improvements. While the improvements have come with their own set of issues, they also solve issues present in the original. The new part has an area with less material than previously, giving this area a larger change of being overwhelmed by the tension and failing. The new design also adds multiple uses to the part and improves its portability and longevity. There was a trade-off, the part slightly lost effectiveness, but also gained more functions, is lighter and generally more portable and will last longer if exposed to the elements.

Overall, the reverse engineer, then redesign of the double open-ended wrench was successful, and many things were learned throughout the experience. The objective was reached, granted there were some issues along the way, but that was expected. The new wrench is more portable than the old, can accomplish more tasks and has an increased lifespan. The only downside is that the part cannot handle as much strain as the previous.

INTRODUCTION

Reverse engineering is the process of understanding the technological features used in existing products, and the effect they have on the product. The part that was reverse engineered was a double open-ended wrench. After reverse engineering the part, a redesign was made. A redesign is the process of modifying an existing part to add more uses, increase longevity, improve performance, and/or lower its cost. The double open-ended wrench was improved by increasing its number of uses, as well as increasing its longevity and portability. The redesigned part was designed to replace multiple open-ended wrenches, as well as a level. It has 2 aspects that improve lifespan, chrome plating and chromium alloy. The part is called a double open-ended level wrench and was designed as a multi-tool of sorts to do the job of 3-4 individual tools while maintaining a minimal size.

METHOD

In order to properly understand the part, a variation of the part was purchased in order to investigate the shape, size and material used. Extensive measurements were collected, then modified to better fit, not only the part, but the size requirements of the 3D print. After the part was morphed the extra holes were positioned and inserted on paper. After a rough sketch of the modified part was created, along with the measurements, CREO was used to use these measurements to create an accurate 3D model of the wrench. After this, a version of the part needed to be scaled down to be 3D printed, and an engineering drawing was created. Finally, a 3D render was created.

RESULTS

Throughout the creation of our redesigned part there were many different materials considered. The first material we considered had the perfect properties to make our part but was extremely expensive making it very unrealistic. After understanding that it is not possible to get a perfect material at a reasonable cost it became much simpler to find a material that would suffice. The manufacturing process, unlike the choice of material, was simple to establish since our part is a variation of a normal open-end wrench. The part ended up being approximately 8 inches in length, 0.25 inches high and 2.25 inches wide.

Manufacturing Material:

The material chosen to manufacture the double open-ended level wrench is a chromium-vanadium alloy steel. This material was chosen after extensive research, into different tool steels, and what many brands of wrench are actually made of. The steel may be on the more expensive end of the spectrum, but when you look to purchase a tool you never want to buy a tool that is made cheap or cheaply made. Considering that our part has a large hexagonal hole on one end, a stronger steel was chosen to counteract the lack of material. Also the chromium in the steel assists in resisting abrasion, oxidation and corrosion which, paired with the chrome plating, will increase its longevity.

Manufacturing Process:

The manufacturing starts with steel rods which are cut into smaller sized billets that are easier to work with. These billets are then heated, one by one, using an induction heater so they are malleable and can be forged into the shape needed. The steel is then quickly brought to a forging press witch, using multiple different dies of various complexity. This wrench is then air cooled and the trim line (line formed where excess metal is trimmed off to give final shape) is grinded off. The open ends of the wrench are then broached to give it its final size, as well as the other holes on the wrench. The wrenches are then tempered to harden/strengthen them, then plated in chrome to prevent corrosion. Finally, a small, pre-constructed level vial is glued into the rectangular hole.

DISCUSSION

The redesigned open-ended level wrench is a successful redesign. It improves upon the original design by increasing the uses, increasing the lifespan, and maintaining portability. This is not to say that the redesigned part is perfect, it has its fair share of issues or "failure modes", but objectively it is an improved version of the original.

Failure Mode:

The rectangular hole, as well as the hexagonal one will definitely have an impact on the strength of the wrench. This will create thinner parts to the wrench that cannot withstand as great a degree of stress as a wrench without holes. If a nut or bolt was extremely stuck and required an intense amount of torque, there is a high possibility that the wrench will snap under the pressure at one of these holes and be unusable.

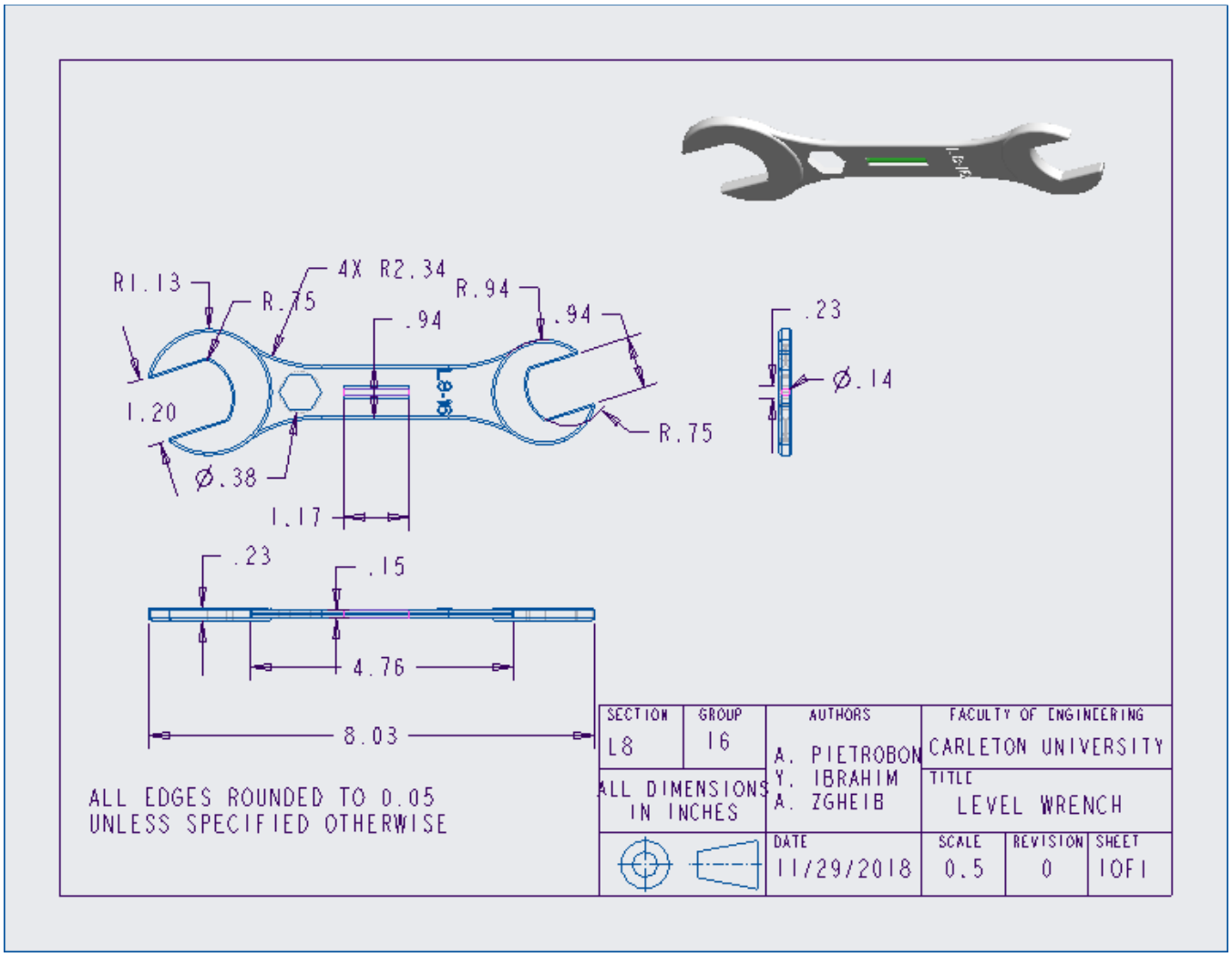
Benefits of Redesign:

The redesign allows the user to manipulate 3 different sizes of bolt or nut and gives them the added function of a level. When designed this tool was not intended for construction where it will be used to the max almost every day. It was designed to be a multi-tool to replace multiple tools in a household toolbox. Of course, having the wrench do one thing extremely well would be better in certain situations, but if every tool was designed with this in mind you would need an endless amount. A level is not something usually included in household toolboxes, and we wanted to change that. This tool offers a single tool to replace multiple tools in a home toolbox. The part created may be weaker than the original, but it has many more uses and looks quite aesthetically pleasing. The part is rounded on most edges giving it a very sleek look and is quite flat allowing it to fit in even the tightest of places.

CONCLUSION

The double open-ended level wrench was a successful redesign. This was achieved by thoroughly understanding the original double open-ended wrench during the reverse engineering phase. The new part does an excellent job of improving what were deemed to be the more important aspects of the part, but unfortunately requires that the part be lacking in other areas. The decreased strength of the wrench is not as important when used as a household tool and not in heavy duty construction, while the increased functionality, portability and longevity will be much more important.

CAD DRAWING


R1.13
R.75
4X R2.34
.94
R.94
.94
1.20
Ø.38
1.17
R.75
.23
Ø.14
.23
.15
4.76
8.03
ALL EDGES ROUNDED TO 0.05
UNLESS SPECIFIED OTHERWISE
SECTION
L8
GROUP
16
AUTHORS
A. PIETROBON
Y. IBRAHIM
A. ZGHEIB
FACULTY OF ENGINEERING
CARLETON UNIVERSITY
ALL DIMENSIONS IN INCHES
TITLE
LEVEL WRENCH
DATE
11/29/2018
SCALE
0.5
REVISION
0
SHEET
1OF1

SOLID MODEL