Mechanical Shredder

By
Ryon Baloo, Kendall Meyer, Mohammed Molani,
and Sultan Al Shahrani
Team 10

Midpoint Review
Document

Submitted towards partial fulfillment of the requirements for
Mechanical Engineering Design II – Spring 2015

Department of Mechanical Engineering
Northern Arizona University
Flagstaff, AZ 86011

Table of Contents

Introduction

Team 10 has been assigned the task to retrofit an electronic paper shredder to be operated manually by a hand crank design. The mechanical shredder has to operate as efficiently as an averaged market paper shredder and to stay under the $100 budget. Multiple designs were considered, but the team decided on a final design of attaching a hand crank directly to the main shaft in the shredder mechanism.

Unfortunately, there were consequences to selecting this design. The team did not assume that the hand crank would remove itself from the mechanism while it was being operated. Team 10 is dedicated to solve this problem while meeting all same the requirements earlier in the semester.

Assembly Drawing

Team 10 simply assembled a hand crank that will be screwed tightly into the arbor shaft. The opposite side of the arbor shaft will slide over the main cylindrical shaft. It will have two set screws to tighten itself to the main shaft, preventing it from sliding off. The two set screw holes are located on top of the arbor shaft. This will allow the hand crank to rotate the whole system as shown in Figure 1.

Figure 1: Hand Crank Assembly with Arbor Shaft

Crank Handle Issue

The arbor shaft bolt is threaded in the right direction. When the crank handle rotates clockwise, the mechanism operates in reverse. When the handle rotates counter clockwise, the system operates correctly. However, the handle tends to unscrew itself from the arbor shaft bolt at a half rotation. The team has to find another solution to rotate the handle without untightening itself from the bolt. The main idea is to disassemble the mechanism easily without using a permanent solution such as welding or any type of adhesive.

There are two possible solutions that the group came up with for the hand crank issue. The first is a flange solution that is followed by the set screw method. All solutions will be discussed in the following paragraphs with figures shown.

Flange Solution

Shown in figure 2 is a method of attaching the hand crank with the arbor shaft by placing a flange between the two. The flange is to be attached to the face of the crank shaft that has the threaded opening, and the threading of the flange would be to help secure the handle onto the arbor shaft and lock it in to place.

The issues that arose with this method were that the flange actually wouldn't lock in the handle and would instead act as an extension to the threading and still come loose when being turned in a reverse motion. The second issue arose with the size of the flanges that are commonly available, which most market brand flanges do not have a threaded diameter of a ½ inch that is required to fit over the arbor shaft. The diameter of the entire flange is 3 inches which is double the size of the wall that we would want to attach it to which leads the group to needing a custom flange, or heavily machining the part, and because the outer diameter is too big, this is not a reasonable option as we would have to reduce the size of the diameter and add threading.

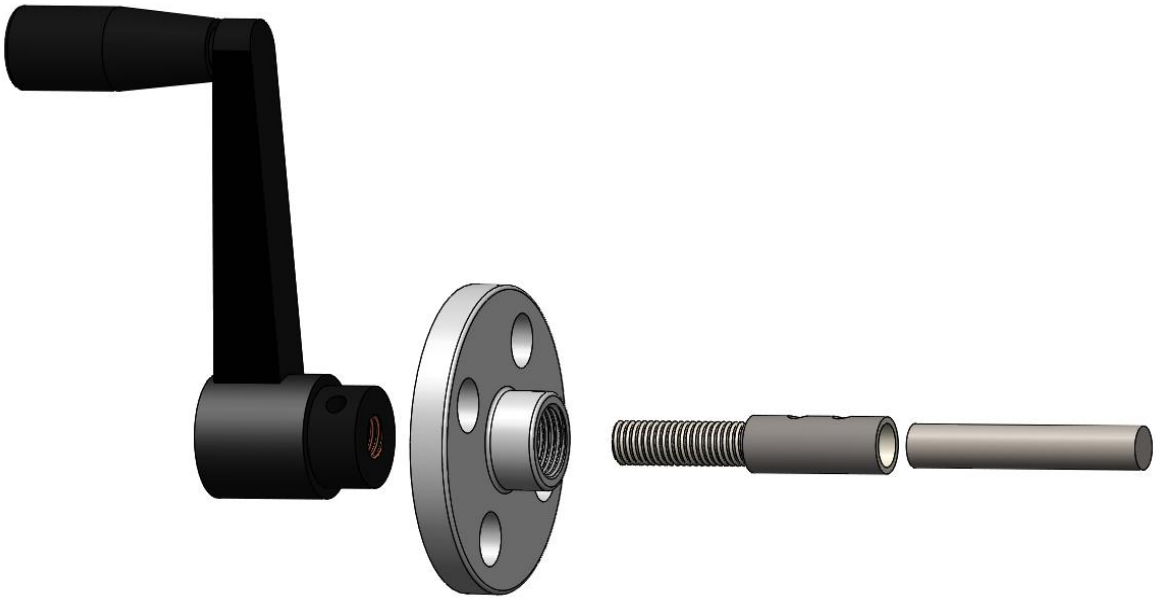

Figure 2: Assembly with Flange Implemented

Set Screw Solution

Figure 3 depicts the location of where we would want to drill holes to insert set screws. This a simple option that involves drilling into the threading of the handle and adding a set screw through the hole to grasp onto the arbor shaft. ¼ inch diameter set screws would be used because of the small surface of the handle. The main concern with this method is that we are unsure of what material the threading inside the crank handle is, and if it is too brittle or weak of a metal, we risk permanently damaging it. Further solutions are being considered as to not have to drill into the handle and taking such a risk, but this is the number one consideration incase no other methods work.

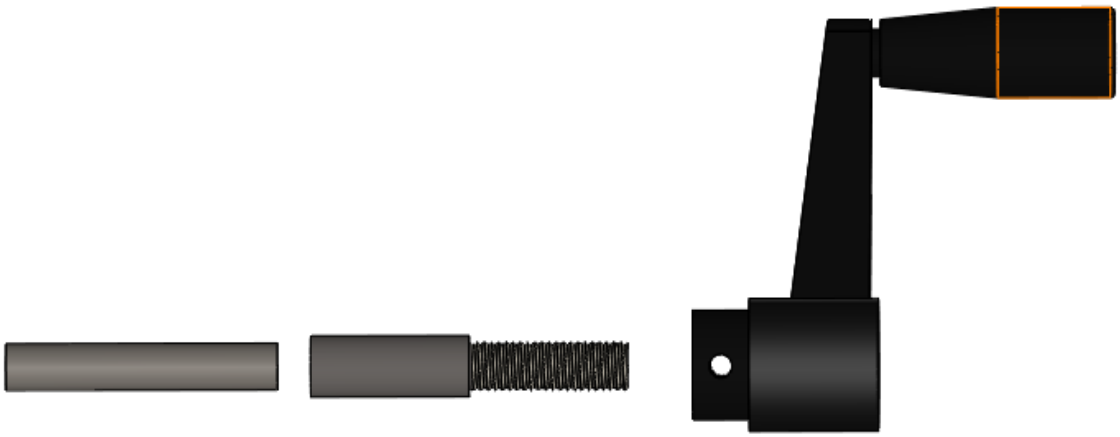

Figure 3: Assembly with Set Screws Implemented

Bill of Materials

Tables 1 and 2 show the different price outcomes depending on the two considered methods. The set screw, while being the considered solution at the moment, also comes in as the cheapest method due to the cheap pricing of set screws. The flange puts us to the edge of our $100 budget and would require a lot of outside work to complete which could possibly require unexpected prices.

Table 1: Cost of Set Screw Method

Parts	Price
AmazonBasics 12-Sheet Cross-Cut Paper, CD, and Credit Card Shredder [3]	$54.99
½" Arbor Attachments for Electric Motors [1]	$6.06
Crank Handle with Revolving Handle [2]	$29.21
10" Bolt	$1.50
Set Screws [2]	$5.50
	Total: $97.26

Table 2: Cost of Flange Method

Parts	Price
AmazonBasics 12-Sheet Cross-Cut Paper, CD, and Credit Card Shredder [3]	$54.99
½" Arbor Attachments for Electric Motors [1]	$6.06
Crank Handle with Revolving Handle [2]	$29.21
10" Bolt	$1.50
Flange [2]	$7.56
	Total: $99.32

Conclusion

Group 10 is nearing completion with the paper shredder, but only one issue remains with the rotation of the hand crank. When tightening the handle onto the arbor shaft, the rotation of the shredder is very smooth and efficient, but turning the handle in the tightened direction instead produces a reverse motion of the shredder. When the handle is rotated in the opposite direction the threading becomes loosened and the handle starts to become removed from the arbor shaft

Two methods are being considered to attach the handle to the arbor shaft without attaching the handle permanently with welding. We want to be able to repair the shredder in case any pieces malfunction, and welding the handle to the shaft would need too many parts replaced and increase the cost of repair and maintenance significantly. The flange, in theory, will attach directly the handle and help maintain its position on the arbor shaft, but many issues are occurring in the size and method of the solution. The set screw is the second option being considered as it is a common solution in machining, but the threading could possibly break which is something we are trying to avoid and do not want to risk.

The set screw method for now is the best option in both practicality and cost, but other methods will be looked into for keeping the handle on the shaft when rotated in both directions.

After this issue is solved, the paper shredder prototype will be complete and be ready for all testing.

References

[1] Amazon. *Amazon Basics 12 Sheet Cross Cut Credit Shredder* [Online]. Available: http://www.amazon.com/AmazonBasics-12-Sheet-Cross-Cut-Credit-Shredder/dp/B005QAQFFS

[2] McMaster. *McMaster-Carr* [Online]. Available: http://www.mcmaster.com

[3] MSC Industrial Supply Co. [Online]. Available: http://www.mscdirect.com