Mechanical Paper Shredder

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Team 10

Concept Design and Generation
Document

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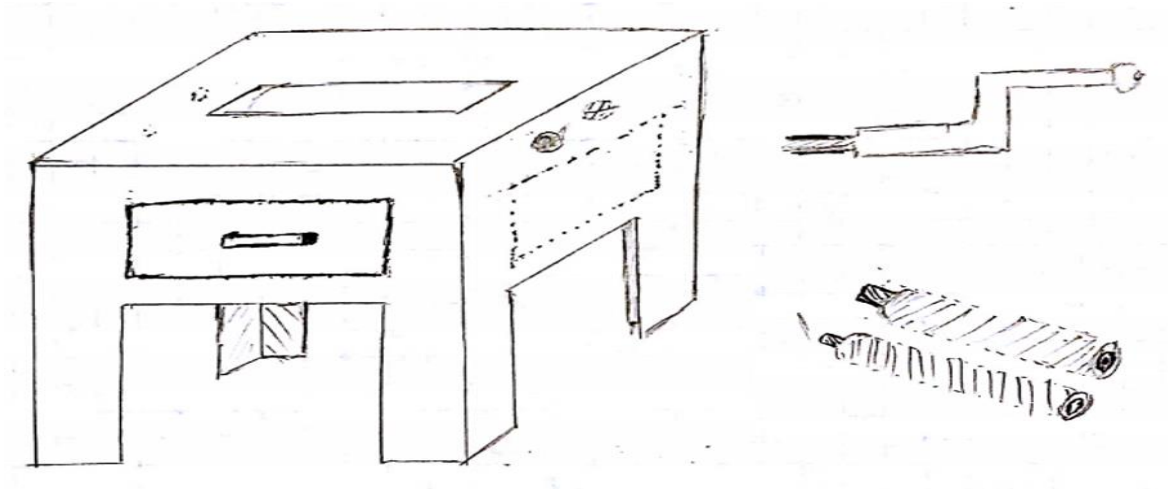
Introduction

The mechanical shredder capstone team designed two concept drawings each and together, assessed each design. After further evaluation, the team decided to list our weighted averages of our criteria, based off the House of Quality (HOQ) and Quality Function Deployment (QFD) requirements. Each member took the weighted averages and scored the outcome on a team decision matrix graded on a scale from 1-10. Furthermore, the team averaged the scores and inserted them on a group decision matrix to select the two final designs that will be a part of our next engineering analysis phase.

Design Concepts Introduction

To begin our design concept and generation stage, each team member was assigned to create two design concepts of their own for our mechanical paper shredder. We set no restrictions, other than that it had to be a process that was completely mechanical. The team members had to come up with a full system for their designs. This would include: a paper shredding mechanism/system, a bin/storage system, and some way to dispense of the paper shreds when the system became full. Together, we came up with eight designs for the mechanical paper shredder system.

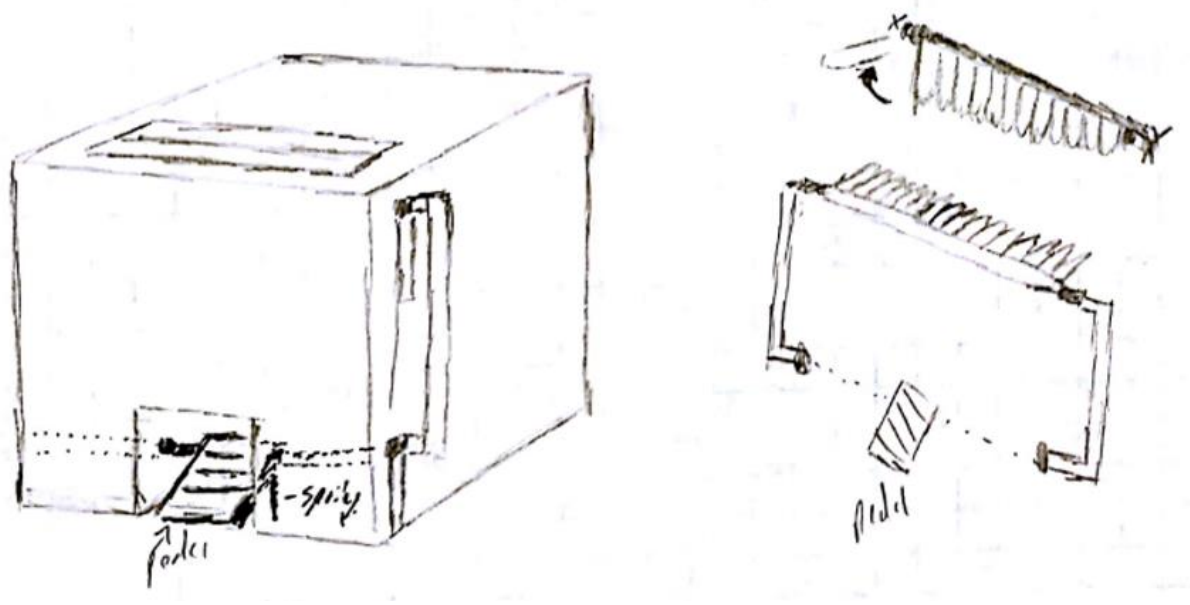
Design 1



Design 1: Coffee Table Paper Shredder

This design concept is based off of the night stand. There are two gearing systems that rotate and shred the recommended materials. While one gear is stationary and the other is being rotated by a hand crank, the paper is inserted from the top of the design. On the front side of the design, there is a drawer to dispense wasted material. This allows the users easy access to determine what is causing the mechanical shredder to jam. This design is very portable and can be moved around an office space so as not to get in the way of the user. However, when operating the shredder, it may jam due to the stationary gear that is set in place.

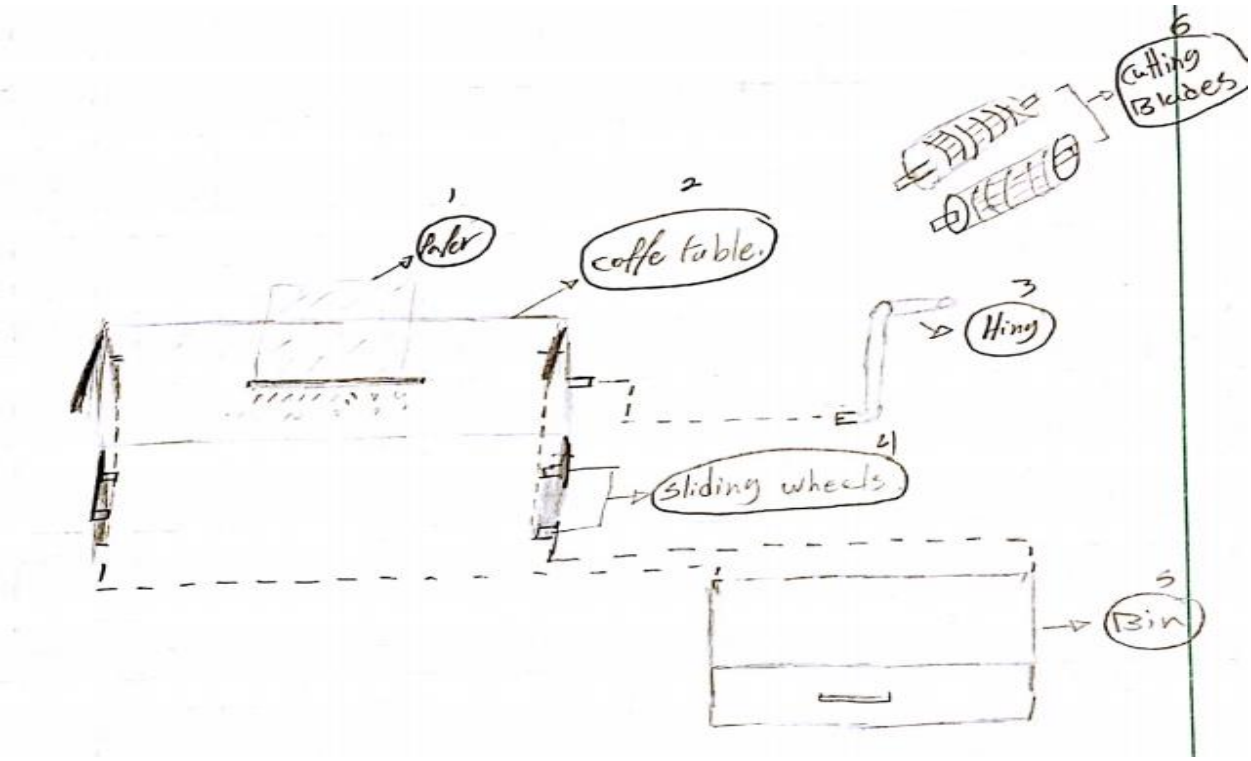
Design 2



Design 2: Foot Operated Shear Shredder

The following design is operated similar to a shear system, however used with a foot pedal. Once the user pushes down on the foot lever; the shears disengage and cuts the recommended material that is inserted through the top of the mechanical box. There are a couple of shears that will operate this mechanism. One is positioned to the container while the other operates. The springs that are placed underneath the foot pedal will recoil the shears to its original position once the user removes their foot. This design will most likely jam depending on what the user is trying to shred. The user can remove the shredded material by opening the backside and taking out the bin container

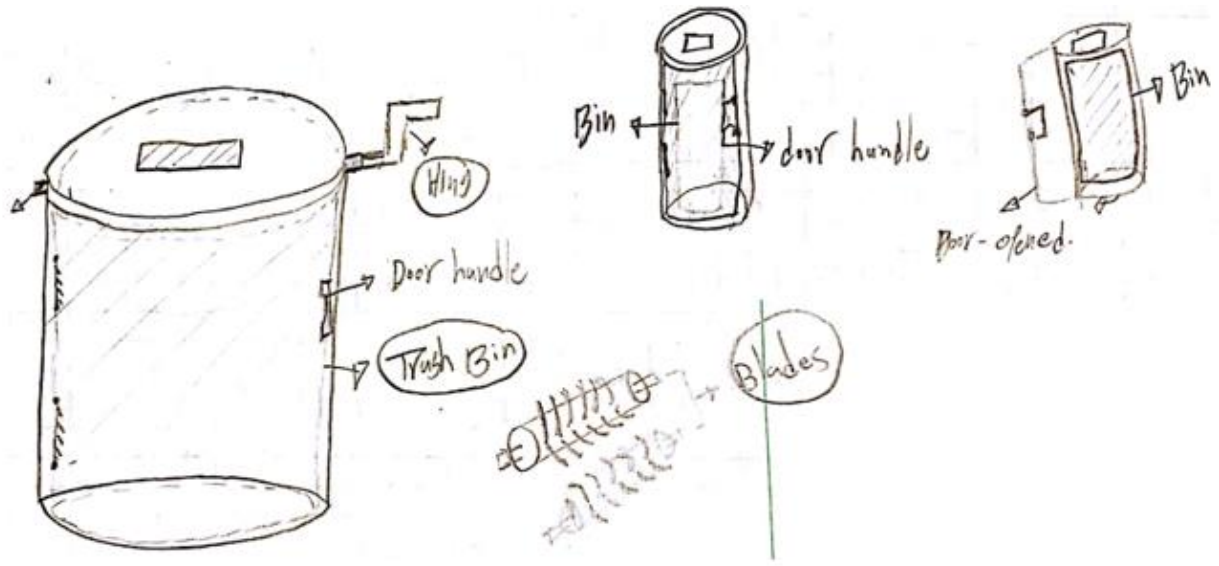
Design 3



Design 3: Coffee Table Shredder with Drawer

This design is a combination of a coffee table and a paper shredder. The system is a multi-directional cross bladed shredder that can allow a multiple sheets of paper to be shredded per feed. It has a big bin size that can carry a large amount of shredded items. The bin is easily disposed of because it is a drawer system that pulls out of the main body, so the waste can be disposed of quickly and efficiently. When shredding items, the system remains stable and silent to maintain a quite working environment through the use of the hand-crank mechanism. The table also fits into an office environment and can be used to keep drinks on, and even decorate.

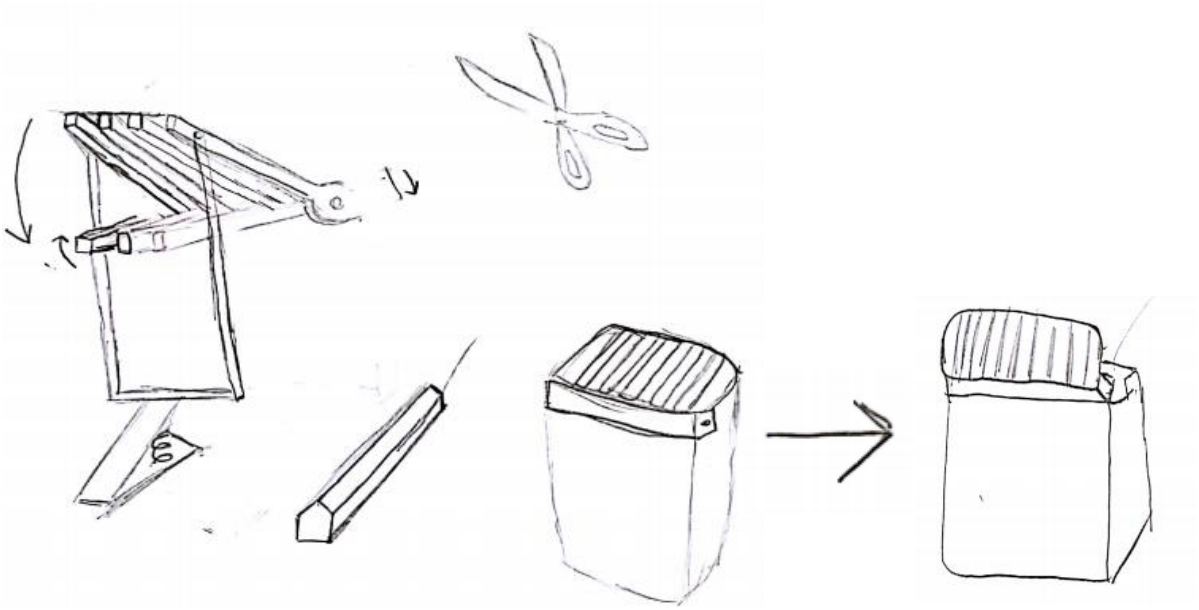
Design 4



Design 4: Paper Shredder Trashcan

The design is based on a simple trashcan. Almost the entirety of the container can be used to store waste, with the exception of the space the shredding mechanism takes up at the top of the system. The bin can be emptied by taking off the top, so a garbage bag can be removed or the system can be directly tipped over and disposed of, or a side door can be attached to the system, so no lifting of the entire mechanism is entirely necessary. The system is designed to be durable and light-weight, so it might be unstable when using the hand-crank to rotate the shredding mechanism.

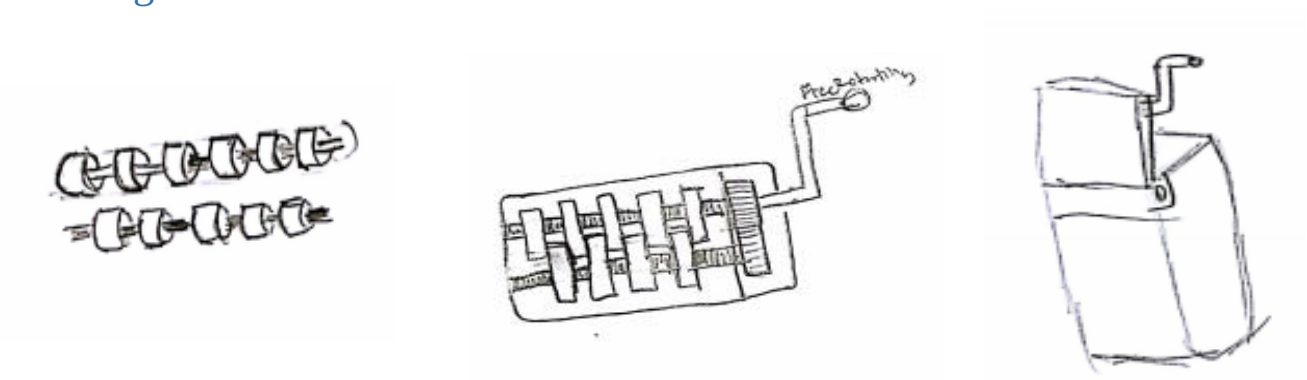
Design 5



Design 5: Foot Pedal Shear (Mechanism attached to top)

This design derives from a simple scissor-shear design. The shear mechanism is attached to a foot-pedal that brings that top half of the system down, essentially cutting the paper into strips like multiple scissors would. When the foot-pedal is let go, the top row half of the system comes back up for more paper to be placed. The system is designed to fit on top of a bin, while the mechanism attached to the foot-pedal rests along the inside wall of the bin. The system would be locked onto the top of the bin, and when needed to be empty, it would need to be unlocked through a latch, and the other side of the mechanism would be attached to a hinge, so the system could be lifted from one side and be emptied out, or a trash bag could be lifted from the bin and easily replaced.

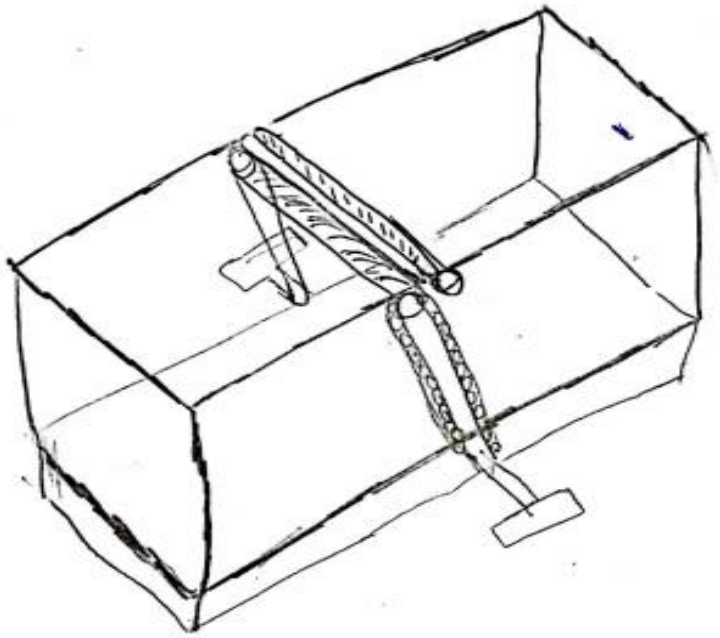
Design 6



Design 6: Simple Gear System
Shredder (Attached to top of bin)

This design is inspired by the common paper shredder mechanism. There are two rows of gears that are parallel to each other and the gears align side-by-side to the parallel row so they can shear and tear the paper. A hand-crank is attached to one row of gears that is connected to a gear that rotates the parallel row of gears. This simple gear system lets both gears rotate inwards to bring paper down to grind it, and if a jam occurs, rotating the hand-crank in an opposite direction will allow the system to reverse the paper flow and fix up jams that occur. Similar to design 5, this system will be attached to the top of a bin that is attached to a hinge on one side, and has a locking mechanism on the opposite side so the system can be opened easily to rid of waste, and easily be put back together. A trash bag can be put into the system to collect waste, and just emptied out and replaced, so the system does not need to actually be lifted.

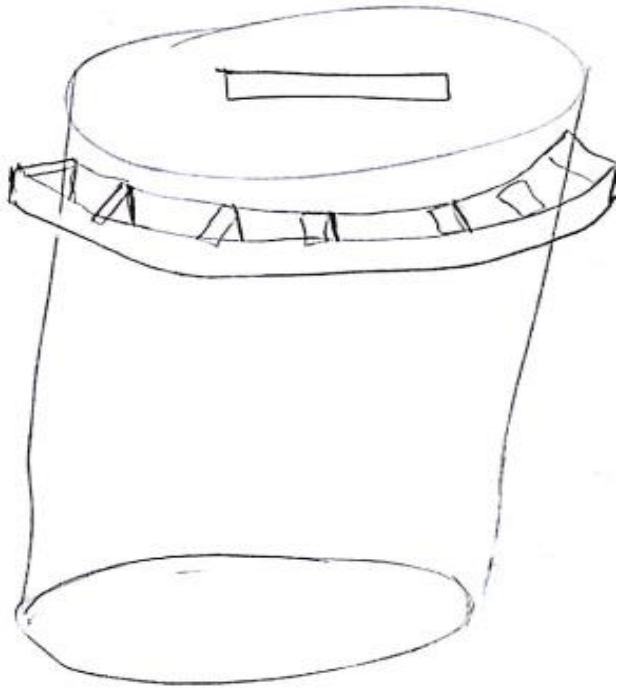
Design 7



Design 7: Bike Pedal Operated Shredder

This designed is based off of a bicycle, in that it has a bike pedal on each side that you use to rotate the gears that shred the paper at the top. Each pedal is attached to a chain and gear system that convert power from the pedals to the shredding mechanism. The idea of the shredder is that it can be portable, but won't take up office room because it would be used in the commonly empty space between a person's legs while sitting in an office chair. The rectangular shape of the system allows it to fit between someone's legs while sitting in a chair and will not be uncomfortable or feeling as if it is in the way and inconvenient. The system will be composed of two rows of gears for shredding paper, attached to two gears, two chains, and finally two bike pedals for transmitting power. The paper can be disposed of with a drawer on one of the smaller faces of the system.

Design 8



Design 8: Coffee Grinder Style Paper Shredder

Design 8 is based off of the idea of a coffee blender. The container will be cylindrical and have the appearance of a metal trash can. A wheel will installed around the outer perimeter of the container that when rotated, will shred the paper that is inserted within it. The wheel will rotate gears inside the system that will shred and grind the paper into small pieces.

Decision Matrix Criteria.

From looking at our QFD and HOQ, we found common trends in both the dimensions of our system, and the reliability of the system. We pulled criteria from our customer and engineering requirements and used those as the basis of our decision matrix. Then we used the common trends that were found to rank our criteria in an order of priority. We reached the rank and dispersed the weights in an order that we felt fitting to the priorities we arranged and managed to create the final criteria for the decision matrix, as seen in **Table 1**.

Table 1: Decision Matrix Criteria with Weights

Criteria	Weight
Reliability	15%
Cost Effective	13%
Materials (Strength of System)	13%
System Operation	11%
Volume	9%
Speed	8%
Ease of Use	7%
Stability	6%
Bin Size	5%
Shred Width	5%
Noise Level	4%
Portable	4%

We ranked reliability as the highest because we defined it as how the system operates and if it meets the requirements without maintenance. If the system cannot do its job, then we do not consider it to be a successful project overall. We ranked criteria that dealt with system operation rather high because they determine if the system works or not. Next, were the dimensions of the product, which we ranked around the middle of our criteria because we felt as long as we fit within the restrictions given to us in those areas, we would be satisfied with the system. Shred width and noise level ranked low because we are comparing those measurements to those of an electrical shredder, which we assumed to be a non-difficult task to accomplish, given that we are

designing a mechanical system with no motors. Finally, a portable design was the lowest on our criteria because we imagine this product to be used mainly within a single office space. Since, moving the mechanical system from room to room on a daily basis, is not an aspect that we are considering.

Averaged Group Decision Matrix

Each group member went home after we presented our concepts to one another and graded each concept in our decision matrix, in which we used a grading scale of 1-10. After each member finished their copy of the decision matrix, a final group average decision matrix was put together, and designs 1 and 6 were our top concepts, as seen in **Table 2**.

Table 2: Averaged Group Decision Matrix

Group Decision Matrix Average								
	Design 1	Design 2	Design 3	Design 4	Design 5	Design 6	Design 7	Design 8
Reliability (15%)	1.2	0.975	1.0875	1.0875	1.0125	1.1625	1.0125	1.0125
Cost Effective (13%)	0.9425	0.8775	0.8775	0.9425	1.0075	1.04	0.8775	0.91
Materials (Shredded material+10 Pages) (13%)	1.0075	0.845	0.8775	0.8125	0.845	0.975	1.04	0.715
System Operation (11%)	0.88	0.825	0.825	0.825	0.825	0.88	0.825	0.6875
Volume (9%)	0.54	0.7425	0.5625	0.54	0.72	0.6975	0.5175	0.72
Speed (8%)	0.54	0.56	0.52	0.52	0.54	0.56	0.68	0.44
Ease of Use (7%)	0.6125	0.6125	0.5775	0.5775	0.6125	0.595	0.525	0.4725
Stability (6%)	0.51	0.465	0.465	0.405	0.465	0.45	0.435	0.3
Bin Size (5%)	0.2625	0.375	0.3375	0.325	0.4	0.3875	0.325	0.4
Shred Width (5%)	0.375	0.3625	0.375	0.35	0.3375	0.3625	0.4	0.35
Noise Level (4%)	0.28	0.29	0.27	0.26	0.29	0.27	0.26	0.24
Portable (4%)	0.26	0.26	0.24	0.31	0.35	0.34	0.24	0.34
Total:	7.41	7.19	7.015	6.955	7.405	7.72	7.1375	6.5875

Common trends we found in the outcome of the decision matrix were in the reliability score, because it is the highest weighing criteria. Materials was another section where these designs excelled, and helped their total scores extend beyond the other designs. Design 5 came at a very close 3rd, which is one of the few foot pedal designs, and we will also take a look into how plausible and efficient the system can be for us, and look into it along with our main two designs.

Conclusion

The first task was to have each team member to go home and design two concept drawings for a full paper shredder system that they found appropriate for our project. We then came together to create a decision matrix which we created using trends and elements from our QFD and HOQ in our previous deliverable and ranked, then weighed each criteria to make a decision matrix. After presenting all of our ideas, we went home and filled out a decision matrix for all team member's concept designs, and then created an averaged decision matrix of all team members.

We came up with two designs from the average decision matrix, and they were both hand-crank operated designs that we have decided to bring into our engineering analysis stage. Our third highest score was a foot-pedal design, and to add diversity to our project, we decided we would look at the foot-pedal design as well, since it has been requested by the client to at least look at one hand-operated and one foot-operated system.