1103 Project Deliverable G

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Mackenzie Gillis, Jacob Hepburn, Randina Amarakoon

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Abstract

This prototype is a physical focused version on our prototype. We have created a subsystem of our overall system and will be using it to complete prototype III. We used a variety of skills, some freshly learned and some based on prior knowledge brought into this course. Having access to the labs at uOttawa and some basic training skills made this possible. Some of the key things taken away from this prototype was the fact that prototypes take a large sum of time to get the materials and build. As well as a limited budget makes it very difficult to not only get the pieces for the prototype but to also put the prototype together as adhesives are very expensive. This prototype took several hours due to the complexity and the structure of the frame. However, we are very happy with the result and believe it will be a great addition to our final prototype and with a few adjustments should work on design day. This prototype is essentially a glorified conveyer belt but specifically designed for the boards. The measurements of the conveyor belt and the frame were crafted in such a way that the board would fit perfectly to slide through the rails, with a little bit of room. The reason why this is like this is because we wanted it to fit an actual board and be life sized. This gives us a better understanding of the actual requirements of the board and what the clients really need. We figured that making this design actual sized would help not only from a focused point of view but from a comprehensive point of view as well. This prototype is being used in our third prototype as this is our loading system and the only other system that we have to add to the design is the pressurized water system. Once this is added then both major systems of our prototype will be complete.

Client Feedback II

In client meeting III, although it was a short meeting, there were many things that were to be considered based on the feedback we had received as well as other groups. When speaking about direct feedback we had received in the allocated 1-minute time slot for the client's feedback, they had talked about optimizing angles with the water pressure. It was mentioned how the farther away the water pressure is from the boards, the less pressure it would produce. However, what comes with that is the closer we put the nozzles to the boards, the less surface area of the board would be covered. To overcome this issue and fix our design, we have decided to put more than 2 pressure washer nozzles on the top and the bottom cleaning portion of the board and put the nozzles closer to the board. This would fix the issue of losing pressure due to height away from the board. And by putting more nozzles to the pressure washer system, the issue of the water not contacting all the surfaces of the body will be overcome. Speaking more globally about the client's feedback, it seemed to be a common recurrence when the clients talked about level of automation and simplicity to other groups. This showed our group that one of the client's main concerns was the ability of the design to be easily troubleshooted as well as less labour oriented. To ensure that this criterion was met, we made the amount of effort to get the machine going and the amount of labour involved to a minimum. In technical terms the only labour that would be required is loading up all the boards and turning on the machine by plugging it in. This also improved the simplicity and would make it much easier to troubleshoot as everything that is involved in this design is off the counter and finding out how to fix it would very simple.

Prototype Analysis

This Prototype is what feeds the board through our pressurized water system. The instructions of this system would be to place a stack of boards on the loading portion and just flip the light switch to start the conveyor belt. The conveyer belt has paddles on it that push the boards through one by one. To prevent the other board from going in there will be a bar that stops the board above from going in the system too. Thus, the rest of the boards will stay in place. After one board is pushed through gravity will drop down the other boards and repeat the process until all the boards have been pushed through the system. The motor that is moving the conveyor belt is a 12 V motor powered by AA batteries. This motor is not the greatest for the torque and resistance we need, however it does the job. For an actual design we would have a more powerful motor, ours was just based on the materials and limited amount of money we had available. The belt portion of the conveyor belt is made up of a loop of duct tape taped together at the right tension so it can rotate in a circle, but not to much tension that it cannot move at all. The belt it moved by PVC pipes that freely rotate. There are 2 PVC pipes in the design. They are both on the horizontal axis in such a way that they are perpendicular to the belt that wraps around it. The one that is the furthest from the water system would be the one that is connected to the motor and spins with the help of the motor. This was achieved by 3D printing gears. One gear wraps around the PVC pipe while the other is attached to the motor. These two gears interlock creating a gear ratio that gives the system as a whole to be able to bear more resistance. The PVC pipes are connected to the frame of the system through holes that were drilled into the legs. The PVC pipe that has the motor is attached via screws and metal chain. This gives it the ability to rotate freely while being connected to the motor. The other PVC pipe that is at the end of the conveyer belt and closest to the pressurized water system would be the freely rotating pipe. This pipe is attached via cord that run from end to end of the frame through the hollow pipe. This cord allows the pipe to freely rotate. It is freely rotated as the first pipe moved with the motor, moving the belt, which is attached to the second pipe thus moving it too. There are 2 light switches that are attached to the frame of the system. One of these light switches controls the turning on and off of the conveyer belt, while the other will be used in our final prototype and be used to turn on and off our

pressure washer. We made the first light switch work by attached part of it to AA batteries that all connected together to make 12V of power to power our motor. The switches and batteries are enclosed in a carboard box and there are a few wires that connect everything together. This “control panel” is duct tapped to the frame of the system. The frame of the system is made from hot rolled steel which makes it nice and easy to weld. There are 4 legs on the system each being 2 feet tall and being 1” x 1” square tubing. There are various holes drilled in at precise measurements to connect other aspects of our prototype to the frame. Attached to the legs are the rails which are 1” x 1” angled steel that will bear the weight of the board while the conveyer belt pushes the boards through the system. To connect the two rails and the legs there is a 0.5” x 0.5” angles steel that runs in the middle of the system on the horizontal axis. All of this metal for the frame is connected through welding. The legs are welded from all sides of the square to the angled steel, while the 2 sets of angles steel are welded to the 0.5” x 0.5” steel that runs horizontally. This structure is very sound and can bear a lot of weight. All of these components come together to create the loading portion of our conveyer belt or our board loading and pushing system. This system only requires whoever is operating it to just load the boards on and flip a switch. This reduces labour and time greatly as they can just leave and do another task while the machine is running. This is a metric that we decided as a group that was important and was one of our main goals. Even though it seems like there is a lot of automation going on in this project, it is actually very simple mechanisms making it extremely easy to trouble shoot. There are not many parts that are involved in this system that could affect the functionality of the system. Everything in the system is also relatively cheap so it would not be to costly if anything was to break down or deteriorate. Overall this system needs a bit of work before prototype III is created, however this prototype helped us learn how many things work and what will not work in the final version of our project.

Prototype Development

This prototype was developed using a variety of methods. For this specific prototype there were many sketches that attributed to understanding what we were really going to do for this prototype. Although we have a very simple design, when building it the measurements and the overall system had to be precise for it to preform in the way we wanted it to. There were many sketches of each individual component of the system in order to achieve this preciseness. We started off by gathering all the materials that we needed in order to make the prototype. We went to Home Depot to get some items, makerspace, and Bransfield centre. After getting the metal we needed from the Bransfield centre, we cut it all to the desired lengths that were carefully and well thought our based on the sizes of the board and what would work best for our system. After getting the metal we welded the metal together to make a strong stable frame for our system. After having the frame, we drilled holes with a drill press to make sure there were parts that the other parts of our system could attach to. After building our frame we were able to attach the PVC pipes to it to start our conveyor belt system. We attached the batteries to the light switch as well as the motor so that by simply flipping the switch the conveyor belt will turn on and it can also be turned off. The motor was attached to the frame via duct tape, as well as many things that we needed to attach to the frame of the system. Everything was placed and secured in a particular way such that our next prototypes components would fit nicely and would preform its proper function. This planning ahead made so that it would be much easier to complete future prototypes without changing to many things that worked well from past prototypes, thus saving us work to do on more important aspects of our design. The development of this prototype was very fun but at the same time quite difficult specially to work in the time constraints that we have been put through. We developed it is a week which was difficult due to the time constraint but helped us understand and plan for future prototypes and make us realize that there are certain aspects in our project work that need to be changed and refined. Our time management skills need to be improved upon as well as our ability to do work in a short amount of time.

In summation:

What are we doing for this prototype: We are focusing on the loading system of the design to see if we can effectively load the board through our pressurized water system 1 by 1

Why: This prototype was made for the purpose of understanding what is required and what needs to be changed to make sure that the loading portion and automation aspect of our design makes sense and will work effectively

When: This prototype is for the first part of our design and will be used for the remainder of our prototype and be used to build off of.

Test Plan

Question: Will the conveyor belt convey when weight or large objects are put on it?

Why: To see if the conveyor belt will be able to convey the boards if they were to be put on the belt.

Focus: Physical Testing

Testing Method: Physically focused on the conveyer system that dispenses the boards.

Testing Protocol:

Test #1: The first test was to see if the size of the board would work well with our rails and the overall size of the system. For this we used a carboard cut out which was the exact same size ad has the same dimensions as the boards that we have been asked to clean.

1. Cut carboard in such a way that the length of the cardboard is 36” and the width is 24”
2. Place this cardboard on the conveyor belt in between the two metal rails
3. Flip the switch on the conveyer belt
4. Watch to see if the carboard moves down the conveyor belt.

Test #2: The second test was preformed to see if the structure and conveyer belt could support a load wile still functioning properly. To do this, textbooks and the cardboard from the first test was used.

1. Take the carboard with the dimensions from the first test and put it back on the conveyor belt in between the two pieces of angled steel.
2. Take one textbook and place it on top of the cardboard.
3. Flip the switch to turn on the conveyor belt.
4. Observe to see if the conveyor belt still moves the cardboard through the system.
5. Repeat steps 1-4 to see how much weight the system can support while still functioning to a high degree of effectiveness.

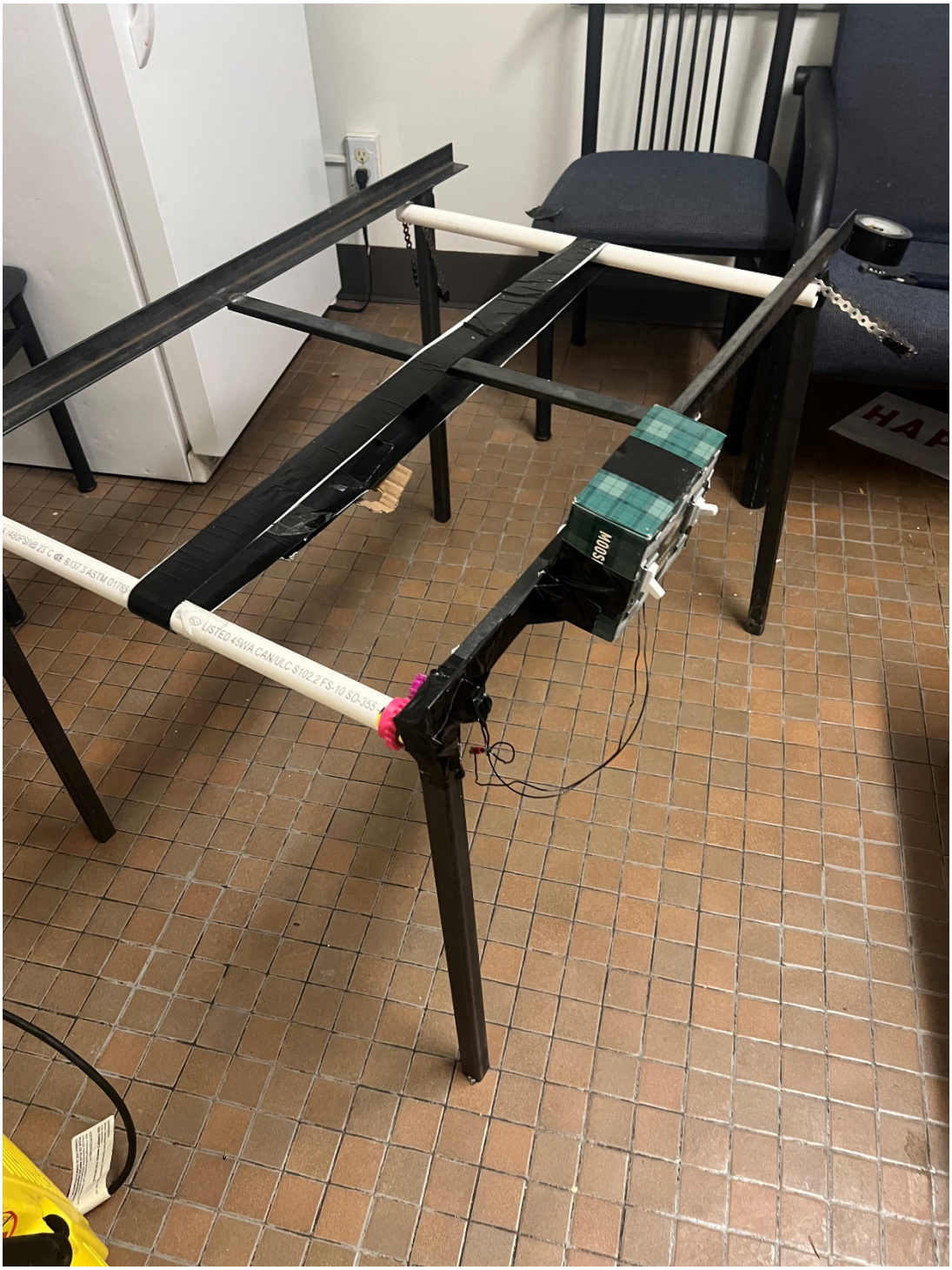
Other Feedback II

When this design was showed to other people coming from a variety of backgrounds, there was some concern on which how the board would be fed through the system only one board at a time. We reassured this person and explained to them that there are a variety of measurements put in place to ensure that this does not happen. The first measurement that was put in place for this would be with the bar that is placed strategically around 1.70” above the flat part of the conveyor belt. This bar is around 2” thick and is placed in such a way that it would only be possible for 1 board to pass through at a time. This bar will be holding the second board back which in terms will prevent all the other boards above from going through the pressurized water system all at once. Having the boards go through the system one by one will give the best possible cleaning experience for the boards and will give the most time to cover the whole surface area. Another measurement that we had put in place to prevent the same thing from happening would be paddles on the belt portion of the conveyer belt. These paddles are attached to the duct tape belt via more duct tape and are 1.25” in height. The height of these represents the height of one board making it so that it only pushes on board through at a time. There are 2 paddles that are equidistance apart so that the conveyor belt does not have to do a whole loop before pushing the next board through instead it can push boards one after the other. Thus, saving time and energy in the batteries. Another concern that was raised by someone other than a marking figure or the client was with the bar that connects the two halves of the frame of the structure. Their concern was with the fact that the bar that connects the two halves in the middle would get in the way of our conveyor belt making it unable to move. This was a very reasonable point to bring up and we fortunately never ran into this issue with in the testing stages of our prototype. So, at the moment it does not present itself as a problem because it is aligned pretty flush with the rails of the system. If we are to encounter an issue with this in further prototypes then we will have to take a deeper look at the frame, but for now it doesn’t seem like an issue we are going to take priority on to deal with. Lots of great feedback was given along with different perspectives on our design which was very helpful for now and future prototyping.

Bill of Materials

Material	Cost (CAD $)	Place Purchased
1” x 1” HRS Square Tubing	0	Brunsfeild Centre
1” x 1” HRS Angled Steel	0	Brunsfeild Centre
0.5” x 0.5” HRS Angles Steel	0	Brunsfeild Centre
Duct Tape	5.97	Home Depot
Batteries	2.64	Home Depot
¾” PVC Pipe (51”)	6.97	Home Depot
String	0	Already Had
Motor	4	Maker Store
Gears	0	Maker store 3D printing
Wire	1	Maker store
Cardboard	0	Had Already
Light Switch	1.27	Home Depot
Metal Wire	4.00	Home Depot
Total	28.85	

Actual Prototype



Conclusion

In summation, this prototype was very helpful in not only our comprehension of our design but will help in our future designs. There were problems that we ran into while building this prototype. Some of them including that the first set of gears that we 3D printed did not interlock properly which make the conveyor belt skip and not move as efficiently. To solve this problem, we 3D printed a new larger gear, on that interlocked much better with our smaller gear that was attached to our motor. This made it so that the gear went on the PVC pipe very nicely while also spinning as it is connected to the gear that is connected to the motor. This was a good learning experience in the fact that not everything works out and that you must be very precise in your measurements when using a 3D printer. Another thing that we had learned in this prototype is that adhesives and knowing how a design will all be put together is a very important aspect of a design. We found it very difficult to put everything together as we only have limited adhesives, the limiting adhesives being duct tape. Knowing what you are going to use to put things together will not only make it easier when building the design but also attributes to the overall strength and stability of the structure. These two attributes can also contribute to the overall performance of the design as if the structure is not stable then the whole design will deteriorate and cause poor performance overall. There are also things that we had learned that are not related to the actual physical part of the prototype. We learned that we must break up the actual building of the prototype into smaller sections of work. When you work for to long you get tired very fast which makes it more difficult to think straight and that is when not so smart decisions get made. When this happens, mistakes get made and tensions get high and the overall productivity decreases. So as a group we had decided that it would be more efficient to just split our work into smaller increments that would allow us to be more productive in a shorter period without getting burnt out. This prototype will be very good for our third prototype as we are using this prototype and building on our pressurized water system to make prototype III. Only some fine adjustments need to be made to this prototype to make this possible. In summation, this prototype was a very good process that will help us greatly throughout this course and for our final prototype.