Project Deliverable D: Conceptual Design

GNG 1103

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1. Introduction

Canadian Nuclear Laboratories explores various aspects of nuclear science and technology in Canada. They study a variety of materials to help improve design features, however using new material comes with uncertainty and potential challenges. The goal of this project is to help alleviate some of this uncertainty in materials testing by creating a device that can be used to test the degree to which erosion parameters affect a given material/part. This device will be used by Canadian Nuclear Laboratory scientists to determine whether and how long a given material will be suitable for a predetermined application. This report details the development of ideas for the design of the final product.

2. Problem Statement

Canadian Nuclear Laboratories needs a safe and cost-effective accelerated erosion testing device that produces measurable results after a short runtime to test different parameters causing erosion on various materials.

3. Concept of Subsystem

To begin developing ideas for the final product, we began by first dividing the device into three distinct subsystems: the motor, the loading apparatus, and the container. The container can be defined by the system that holds the fluid which the part is getting tested in. The motor is defined as both the arduino and motor that is responsible for the rotation of the part. The loading apparatus is defined as the apparatus used to hold the part while the device is running. These three definitions will be the basis of the product designing process.

Summary:

The gathered data below can be summarised into this table:

	Michael. A	Aldrich.N	Aksayan.J	Joe.T
Motor	- DC 775 Motor 12V-24V 6000-12000RPM 775 Electric Motor Double Ball Bearing High Torque Large Power Low Noise DC Motor ($27) **[7]**	- 60RPM Reducer Motor Dual Bearing Synchronous Gear AC Motor CW/CCW Control 115V 60Hz 10W ($37)**[5]**	- GE Dishwasher Circulation Pump Wash Motor WD26X10022 - 115V 3150 RPM ($35) **[2]**	- CONQUERALL 775 DC Motor DC 12V / 24V 6000-12000 RPM ($24) **[4]**
Container	- Metal cylindrical container (12in x 12in)	- Cube glass tank (20X20X20cm) ($74) **[6]**	- Horizontal cylindrical model - Radius: 10cm, height 20cm ($41)	- Build your own, tin bucket or dollar store cheap item ($5)
Loading	- 3D printed modified rod.	- Aluminium bars	- Stainless Steel ($12)	- Can be placed on a shelf while the motor can be attached to the top with 3d printed

	Michael. A	Aldrich.N	Aksayan.J	Joe.T
				brackets and spin the test material ($0)

3. 1. Motor

- Idea 1 (Michael):
  We would need a motor that is capable of providing a consistent speed for a given sample. This motor should be robust and be able to provide rotation of a sample from a long time. It also needs to be relatively cheap. The DC motor from Amazon provides all of the requirements. **[7]**

- Idea 2 (Aldrich):
  Low RPM but high power motor, capable of strong fluid current. Using 115V AC so there's no need for an adapter. **[5]**

- Idea 3 (Aksayan):
  Utilizing materials at hand is a convenient way of saving money; and so I recommended the reuse of an old dishwasher water pump motor that was available for free. With high enough rpms and a reasonable energy supply, and so, I recommend the GE Dishwasher Circulation Pump Wash Motor. **[2]**

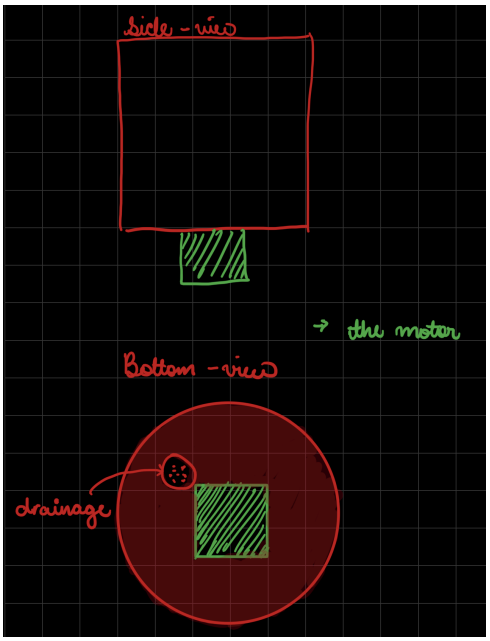
- Idea 4 (Joe):

3. 1. 1. Analysis of Motor Ideas

	Pros	**Cons**
Idea 1	- Consistent RPM range - Relatively inexpensive	- Low voltage means the device will be prone to overheating
Idea 2	- High power - No adapter required	- Low RPM - Unchangeable RPM
Idea 3	- Free	- Relatively high voltage usage
Idea 4		

3. 2. Container

- Idea 1 (Michael):
  After speaking with the client, we knew that we needed to be able to test a cylindrical part. This means that a cylindrical container would result in the least amount of fluid needed for even testing. The cylindrical shape would also be an advantage for the rotation of the cylindrical part. The container will also have a drainage at the bottom to remove the fluid once the testing is done. The container will be made of a durable metal.
  Dimension: 12in x 12in



- Idea 2 (Aldrich):
  Glass containers could resist rust, corrosion, and chemical reactions. Thick glass walls can resist strong forces. However, it needs special handling to prevent damage and for safety of users. **[6]**

- Idea 3 (Aksayan):
  A unique solution for the clients needs is using a stone tumbler system. It uses larger abrasives but is not limited to them (i.e. the use of fine granite/sand). A tumbler container system will allow for erosion testing to take place longer; meaning instead of the full weight of the motor being on the top of the cylinder, the full surface area will be used, and hence leading to a more stable situation for testing. It can also be left unsupervised safely. Dimensions: 10cm radius, 20cm height - Material: aluminum **[8]**

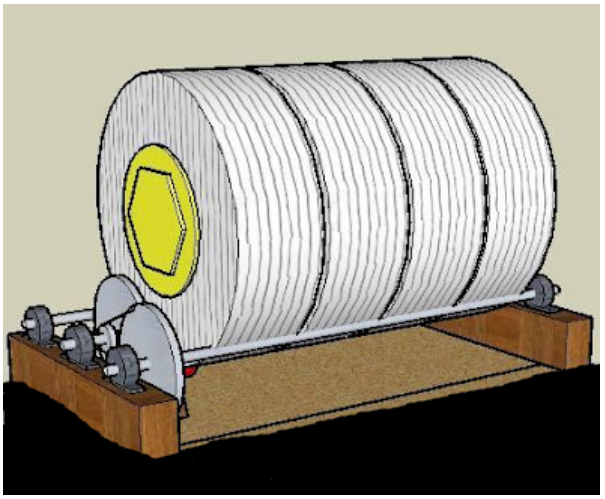


Image is from http://www.schoolofhardrocks.org/rocktumblers/modelb1a1.html

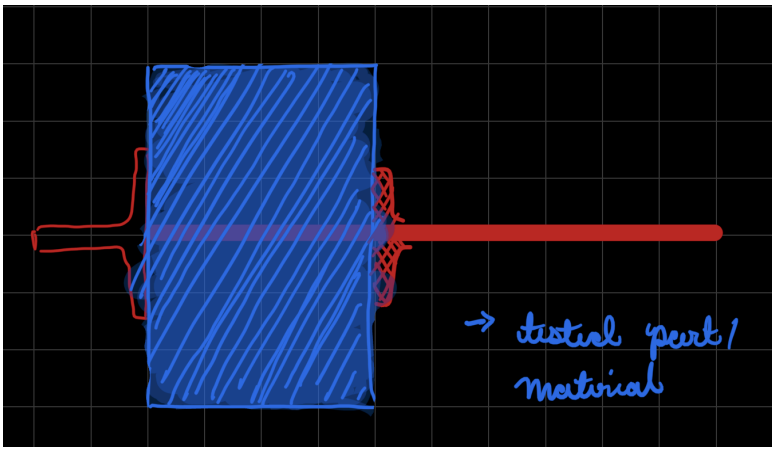
- Idea 4 (Joe):

3. 2. 1. Analysis of Container Ideas

	Pros	Cons
Idea 1	- The metal will be a durable material for the container - The cylindrical container means it has the most efficient design in terms of amount of fluid for a rotating object.	- Since it is made of metal, it will be hard to add any customization once the container is bought.
Idea 2	- Resistant to corrosion	- Needs careful handling
Idea 3	- Cheap - Durable - Cylindrical housing	- No means of shaping aluminum sheets
Idea 4		

3. 3. Loading Apparatus

- Idea 1 (Michael):
  From the client meeting, we know that the device needs to be versatile and needs to be able to test various materials/parts. This means that the loading apparatus should be able to hold a variety of sizes. The design shown in the drawing shows a modified rod for loading. The rod is fitted with the motor and the rod is put through the object and fastened with another tool. This device will be cheap and easily made since it can be 3D printed.



- Idea 2 (Aldrich):
  Aluminium bars/rods can be used to secure the motor above the container and to connect the motor with the testing sample. Aluminium is strong while remaining light and cheap.

- Idea 3 (Aksayan):
  A loading system is a standard among group ideas; basically a shaft connected to the motor, which in turn is housing the sample we wish to erode. In this case I suggest using stainless steel for its durability and versatile strength. Due to its properties being able to test different samples should not be a problem for the client.

Image is from https://www.istockphoto.com/photos/stainless-steel-rod

- Idea 4 (Joe):

3. 3. 1. Analysis of Loading Ideas

	Pros	**Cons**
Idea 1	- This is a versatile loading apparatus - Holds what is getting tested firmly	- It requires a hole in the middle of the part/material.
Idea 2	- Lightweight - Resistant to rust - Inexpensive	- Need special equipments to cut or bend into shape
Idea 3	- Resistant against erosion	- Heavy
Idea 4		

4. Refined Subsystem

Motor

The standards for choosing a motor for this new concept were; cost, energy intake, and rotations per minute. Hence resulting in our choosing of Joe's motor: CONQUERALL 775 DC Motor DC. Its resulting alternating 12V- 24V allows for easy access controlling the speed and rotations per minute, which is 6000-12000 RPM, of the motor. It was also the cheapest choice to performance ratio.

Container/Housing

A crucial element of the erosion testing device is its housing, and hence careful considerations must be taken before choosing it. These considerations include; durability, strength and price. With all these elements taken into consideration group 11 has opted for a metal housing, preferably being aluminium. It is also to be noted that being able to purchase the cylindraical shape is the key to success, as currently we have no means of bending the aluminum.

Loading Apparatus

We believe the loading/shaft is still up to debate. As there are many pros and cons for each subsystem, collectively decisions must be made with specification matters at mind. And hence the decision of what material to utilise for the erosion testing device will be subject to the budget and careful consideration over the period of the production of our device.

5. Selection of Final Concept

5. 1. Selection Matrix

Specifications	Concept 1	Concept 2	Concept 3
RPM	60	3150	3500 - 9000
Controllable RPM	No	Yes	Yes
Container's size (cm)	20 x 20 x 20	Radius 10cm, Height 20cm	33 x 33 x 27
Container's material	Glass **[6]**	Plastic or Aluminum **[8]**	Plastic or Metal
Loading	Aluminium bars	Stainless Steel	3D printed brackets
Costs ($)	~$100	~$80	~$30

5. 2. Analysis of Chosen Global Concept

Although the glass used to create the container results in an inert container compared to other concepts, concept 1 is the not very realistic since it would use up the budget on one Prototype. Concept 2 and 3 are very similar and the only main difference is the material that the loading apparatus is made of; the stainless steel is more robust than the 3D printed brackets. However, the cost of concept 2 would result in over 80% of our budget being used, so concept 3 is better.

6. Conclusion

Canadian Nuclear Laboratories are constantly exploring ways to push the boundaries of different products and materials. To aid this exploration, they need to understand the extent to which various erosion causes erode a given material. The device that we design will produce replicable scientific data on a given erosion parameter in a short time; this device must be safe and versatile.

Concept 3 is a safe, robust, and cheap option for the product; therefore it is the concept we will be moving forward with.

7. References

[1] “Plastic Bucket - Case of 14“, https://www.dollarama.com/en-CA/p-plastic-bucket/3029893

[2] “GE Dishwasher Circulation Pump Wash Motor WD26X10022 , WD26X10033, WD26X10027”, https://www.ebay.ca/itm/126155327692

[3] https://www.amazon.ca/Supplying-Demand-WD26X10051

[4] https://www.amazon.ca/CONQUERALL-6000-12000RPM-Electronic-Component-Electric

[5] “60RPM Reducer Motor Dual Bearing Synchronous Gear AC Motor CW/CCW Control 115V 60Hz 10W 60KTYZ”, https://a.co/d/09iX0j9

[6] “HIRO Aquatics Cubic Rimless Frameless All Glass Aquarium, Low Iron Rimless Glass Tank, White Leveling Mat Included (20X20X20cm)”, https://a.co/d/fnG8Fjk

[7] “DC 775 Motor 12V-24V 6000-12000RPM 775 Electric Motor Double Ball Bearing High Torque Large Power Low Noise DC Motor with Bracket DIY for Mini Angle Grinder Table Saw Drill Electrical Tools”, DC 775 Motor 12V-24V 6000-12000RPM 775 Electric Motor Double Ball Bearing High Torque Large Power Low Noise DC Motor with Bracket DIY for Mini Angle Grinder Table Saw Drill Electrical Tools : Amazon.ca

[8] “5pcs Aluminum Sheet Metal, 10cm×10cm 20cm×20cm Golden Anodized Anodising Aluminum Plate Decorative Metal Sheet Color Laser Marking Engraving Thin Aluminum Plate Architectural Model (Size : 100X100X0)”, https://www.amazon.ca/10cm%C3%9710cm-20cm%C3%9720cm-Anodising-Decorative-Architectural/dp/B0C53HSCN4?th=1

https://www.amazon.ca/Connector-BetterJonny-Stainless-38mmx30mm-Brackets/dp/B096X1BV9S/ref=sr_1_9?keywords=stainless+steel+brackets&qid=1707696940&sr=8-9