

**GNG2101 - Lab Section B03**

**Deliverable F:**  
*Prototype 2*

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# Abstract

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The following document outlines the result of the *Second Prototype* produced by team B31 in order to confirm some concept decisions from the last prototype constructed.

In this deliverable, the team created the second prototype based on the previous results obtained during the testing of the low-fidelity prototype. As a means of improving on them, a **medium-high fidelity physical prototype** was selected in order to verify assumptions, confirm concept decisions and refine the team's solution to the problem. The process of the making of the second prototype after the third client meeting was documented with the prototype stage level to its design and finally the overall testing of prototype 2.

**The second prototype proved to be a success** in the functionalities the team was unable to test in its predecessor, due to the materials used. The team is confident that it will be able to complete the set of the wheelchair arm panels, with the results obtained in this deliverable allowing them to supplement new features, such as comfortability.

# Table of Contents

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<b>Abstract</b>	<b>2</b>
<b>Table of Contents</b>	<b>3</b>
<b>List of Figures</b>	<b>4</b>
<b>List of Tables</b>	<b>4</b>
<b>List of Graphs</b>	<b>4</b>
<b>1. Introduction</b>	<b>5</b>
<b>2. Engineering Design Process</b>	<b>5</b>
<b>3. Detailed Design</b>	<b>5</b>
3.1 Client Statements	5
3.2 Physical Prototype II	6
3.3 Prototype Sketches	7
<b>4. Testing</b>	<b>8</b>
4.1 Test 1: Rigidity/Durability	8
4.2 Test 2: Flatness	9
4.3 Test 3: Water Resistance	9
4.4 Test 4: Shape	9
4.5 Test Results Summarized	10
<b>5. Conclusion</b>	<b>10</b>

# List of Figures

---

[Figure 1: Schematic & Inkscape sketch](#)

[Figure 2: Shape Testing](#)

# List of Tables

---

[Table 1: Target Specifications](#)

[Table 2: Test Results](#)

# List of Graphs

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[Graph 1: Type of Prototype](#)

# 1. Introduction

There are many different facets in the process of creating a product. One, very important among them, is prototyping. Prototyping is a central part of the product creation process and serves many purposes. For one, it allows for “proof-of-concept”, which gives a design team the ability to start properly testing the validity of the ideas that they have brainstormed. Furthermore, it allows them to begin fleshing out the more subtle intricacies of the product they are creating. A physical prototype also gives them the opportunity to give the client a glimpse into what the final product might be like.

Having created and evaluated a first prototype, in their Deliverable D, the team has now moved forward and created their 2nd prototype, with the intention of testing for **more focused metrics** which could not be tested before. As such, the prototype displayed in this report can be described as one of *medium-high fidelity*, and uses higher quality materials to evaluate for traits crucial to the final product.

Following the sections which detail the creation process for this prototype, a section will be dedicated to presenting the results of the various tests the product has been put through. The conclusions drawn from this will be used to further improve the panel, and understand the changes necessary for the upcoming **final prototype**.

## 2. Engineering Design Process

A common stage in most engineering design process models is the prototype and testing stage. This stands true for the team’s chosen model, the *Iterative Engineering Design Process*, as well.

In such an iterative process, it must be understood that prototyping happens on multiple occasions, where the feedback from the previous units is used to improve their successors. With respect to this particular project, the following document discusses the second of three prototypes, as is required by the chosen process model.

## 3. Detailed Design

### 3.1 Client Statements

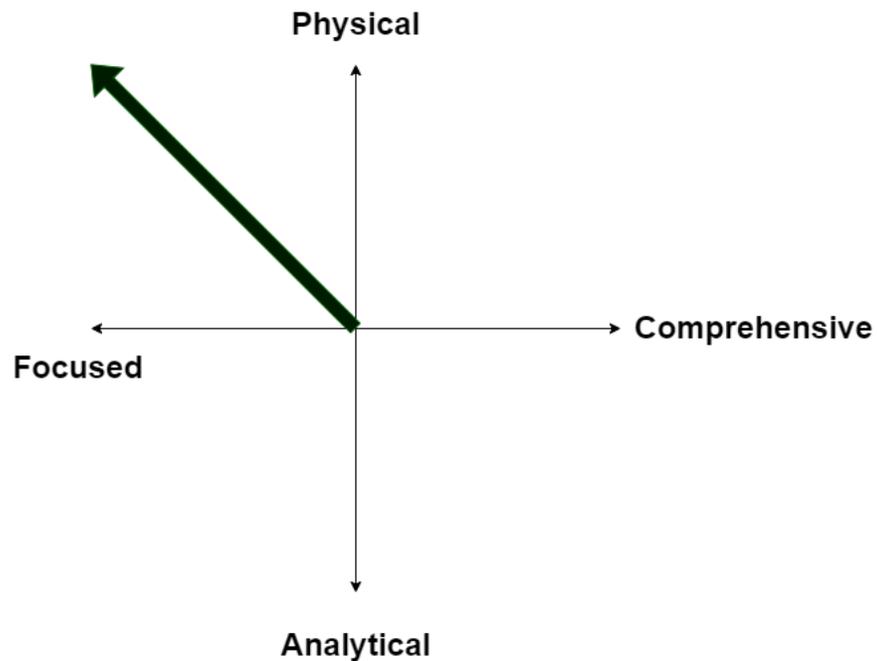
On the 31st of October, the team conducted their third meeting with the designated client for the project. This meeting involved a showcase the low-fidelity prototype created in Deliverable D and presenting the testing results obtained with it. The client was also informed about the team’s plans for future prototyping and testing. The following are notes the team compiled during the interview:

- The client is satisfied with the design of the prototype and now more clearly understands what the intent of the design team.
- The client was able to envision themselves using the product in their everyday life.

## 3.2 Physical Prototype II

In this deliverable, the team built a functional medium-high fidelity prototype. The prototype was made out of 1/4" of acrylic sheet and its shape was laser cut using the Epilog Laser Mini machine. Similar to prototype 1, prototype 2 is a focused, physical prototype meant to test mainly the sub-function of rigidity of the product.

Graph 1: Type of Prototype



Upgrading our prototype stage from low to medium-high, the team improved the material of Prototype 1, from cardboard to acrylic sheet. Thus, the rigidity and durability of the prototype will be the main focus of the testing. Alongside those tests, the chosen material will also be tested for its flatness, water resistance as well as its shape.

### 3.3 Prototype Sketches

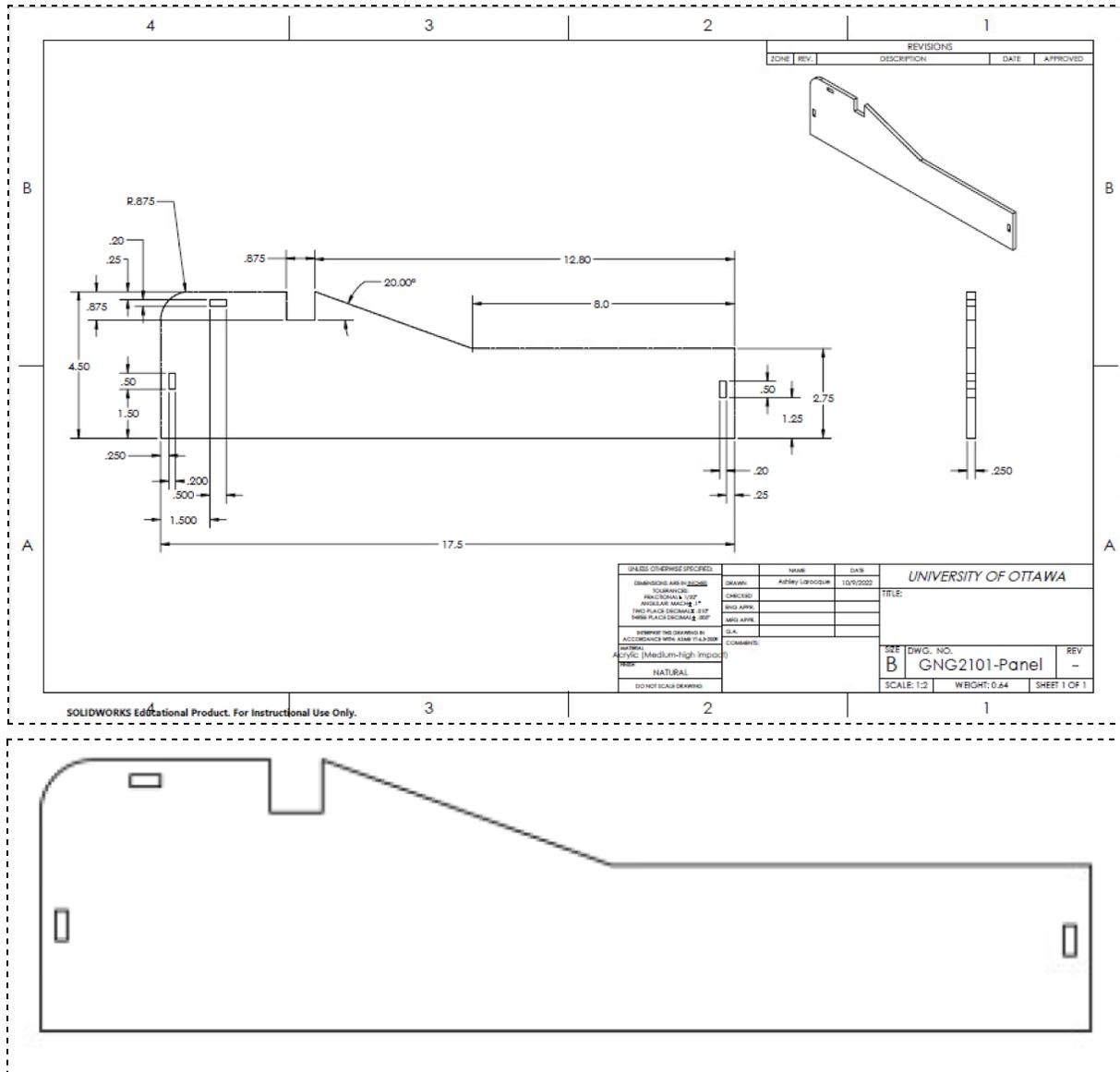


Figure 1: Schematic & Inkscape sketch

An inkscape sketch was created by importing the scaled technical drawing created in SolidWorks. This sketch was necessary to laser cut the second prototype. The line size required for laser cutting the sketch was 0.001 inches so it was edited in the above image for visibility. The required speed was 12%, the power was 150% at a frequency of 5000 Hz.

## 4. Testing

The testing conducted on prototype II is based on the target specification outlined in *Table 1*. The main focus of this prototype was to test the rigidity of the material chosen. The shape of the prototype was also tested, along with water resistance, flatness, and thickness. Only one panel was cut to reduce the risk of going over budget in case of mistakes in laser cutting. As with previous exercises, the team is guided by the following specifications:

Table 1: Target Specifications

Metric #	Metric	Unit	Marginal Value	Ideal Value
1	Aesthetics	Subj	Any color	Black
2	Flatness	Binary	Yes	Yes
3	Ease to install	Subj	Moderate ease	With ease
4	Comfortability	Subj	Comfortable	Very Comfortable
5	Water resistance	Binary	No	Yes
6	Thickness	in	< 1.5	< 7/8
7	Durability	years	>3	>5
8	Cost	\$CDN	<50	<30
9	Rigidity	Subj	A bit of flex	No flex at all
10	Mobility	Subj	Requires some adjustment when returned to down position	Requires no adjustment when returned to down position

### 4.1 Test 1: Rigidity/Durability

To test the rigidity, the panel was subjected to small loads to see if it can withstand daily use. A drop test was also conducted to see if it could withstand shock. The panel was dropped from standard counter height, which is slightly higher than the height of a wheelchair to ensure it would resist the shock in the case that the client drops the panel.

From these tests it was found that:

- The panel meets the marginal value for rigidity.
- The panel has minimal flex which is desirable for the client.
- The panel can also endure shock without breaking, which is necessary for the prolonged lifespan of the product.

## 4.2 Test 2: Flatness

The material was chosen for its flat nature which makes testing rather simple. The ¼ “ acrylic sheet is flat which meets the client’s needs. This test was conducted by observation.

## 4.3 Test 3: Water Resistance

To test the water resistance of the panel, water was poured on it. The acrylic sheet is not porous which makes it waterproof. This quality is important for the lifespan of the product as it needs to be usable through the clients daily activities, such as gardening. From this test it was found that the panel meets the clients needs in terms of water resistance.

## 4.4 Test 4: Shape

The shape of the prototype was tested by using a similar wheelchair available in one of the labs. It was found that the panel fits as well as prototype 1 did. *This specification cannot be tested with full certainty* since we do not have access to the clients actual wheelchair. However, the shape was created using the dimensions obtained from the manufacturer of their wheelchair, such that it will fit the shape of their armrests.



*Figure 2: Shape Testing*

## 4.5 Test Results Summarized

Table 2: Test Results

Test no.	Test Name	Target Specification	Functional or Non-Functional	Units	Marginal Value	Ideal Value	Result
1	Rigidity /Durability	1/7	Functional	Subj	A bit of flex	No flex at all	A bit of flex
2	Shape	N/A	Functional	Subj	Fits with some room	Fits well	4
3	Water Resistance	10	Functional	Binary	No	Yes	Yes
4	Thickness	6	Functional	Inches	<1.5	< 7/8	1/4
5	Flatness	2	Functional	Binary	Yes	Yes	Yes

Overall, the testing of this prototype was highly successful. Each specification tested meets or exceeds the clients minimum standards. In further testing, the aesthetics, mobility, and ease of installation will be tested further before the delivery of the final product.

## 5. Conclusion

This report summarized the process of creating the second prototype. The focused, high-fidelity prototype was lasercut using 1/4 " acrylic. This was done using the Inkscape vector graphics software, and the Epilog Laser Mini machine.

The purpose of this prototype was to test the rigidity, durability, shape, water resistance, thickness, and flatness of the panel. The team concluded, after testing this prototype, that their design continues to show promise. Each specification tested was able to meet the client's needs, outlined in *Table 1*. These test results were summarized in *Table 2*. Further testing will be conducted on the remaining specifications and repeated to ensure the final prototype meets all of the client's needs. These test results enable further development of the second panel now that it is confirmed that the panel meets the needs of the client.

In the weeks to follow, a business and economics report will be created for this project. Further testing will be conducted on the final prototype, and the team will prepare for their final presentations on Design Day.