

**Deliverable B:**  
*Needs, Problem Statement, Metrics,  
Benchmarking and Target Specifications*

**Submitted by  
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# Abstract

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The following document details progress made by the design team B31 in their “Wheelchair Arm Gaps” term project. It begins by detailing the collection of client statements following an interview, and the subsequent use of these statements to formulate a set of client needs. It continues by establishing the problem statement which will direct the team’s future efforts, and from there, it proceeds to the formulation of design criteria and their associated metrics. Finally, it details a benchmark comparison of several similar products in order to demonstrate the need for a new, all-original product.

In conclusion, the team was able to determine that the client requires a set of rigid panels, which will be used to close the gaps in the arms of a wheelchair, alleviating the client’s many issues that result from their usual presence, namely physical discomfort from pressure sores, friction, and a generally unflattering look. The team was also able to determine the exact necessary traits that these panels will need to have (rigidity, ease of installation, a certain look, etc.) as well as the metrics by which these traits will be measured in the final product. Finally, the team’s benchmarking shows that very few products currently exist which actually deal with this issue in the manner requested by the client.

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# 1. Introduction

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The wheelchair-bound are a minority for whom there is always room for improvement in specialty products. Wheelchairs themselves come in countless shapes and sizes, behind all of which lies an extensive engineering process. In spite of this, problems will continue to arise. Sometimes these problems will be rather niche, requiring equally specialized solutions. Such is the case with this project's client, who has had significant difficulties with their chair because of a problem for which they have yet found no solution: the problem of gaps in the armrest. According to this client, these gaps are both a source of discomfort and embarrassment.

As such, they have decided to call upon the engineering team B31, of the University of Ottawa's Engineering faculty, to design for them a suitable solution. The following report outlines the first steps in the process this team will be using to create their product and ensure that it will fulfill the exact set of needs specified by the client. As such, it will discuss the results of the first client interview, followed by the formulation of needs and problem statements, then the design criteria and quantifiable metrics, and finally the comparative benchmarking of similar products.

## 2. Engineering Design Process

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The problem explored in this project requires an in-depth and emotional understanding of the client's problems and consequent desires. While it is only somewhat specialized, it requires that a lot of thought be put into empathizing with the client, creating numerous prototypes and maintaining regular and consistent rapport with the client, in order to reach a solution that provides optimal satisfaction.

Thus, the project team has opted for the "Iterative Engineering Design Process" model, in order to best meet the needs for client-designer empathy and iterative prototyping. This document outlines the first of the three major steps in this process: the "Problem Definition Process" section.

## 3. Needs Identification and Product Specifications

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### 3.1 Client Statements

On the 19th of September, the team conducted their first meeting with the designated client for this project. This meeting took the form of a short interview, in which the client answered a set of questions formulated to assist the engineering design team in figuring out the exact form and scope of their upcoming project. The following are notes the team compiled during the interview. They will be used to guide the project in its appropriate direction.

- The client expressed that they desired “rigid” panel-like objects for their wheelchair, such that no part of their legs or posterior protrude through the side gaps, which is typically the case.
- They very specifically requested that the panels be “stiff” and flat, offering no flex or curvature.
- The user specified that the panels should not narrow the width of the wheelchair to avoid pressure sores.
- They also asked that the panels leave no gaps at all, if possible.
- They specified that, because they spend a majority of time in the chair, including for activities like gardening, that the panels should be resistant to the weather, and must not make the chair any wider.
- When asked, the client requested that they be made as easy as possible to install.
- They also mentioned that side accessories are a bad idea because of the concerns with total width.
- Finally, it was mentioned, not too strictly, that the panels should match the chair’s style.

### 3.2 Needs Identification

Based on the client statements compiled above, the team was able to formulate a table of interpreted needs, with varying degrees of importance.

In the following table, specific statements are used to generate need statements, which are then given an importance rating ranging from 1 to 5, with 5 being reserved for the more mandatory/important needs, and lower scores symbolizing features which, in the case of a dilemma, may be tweaked within a certain margin of flexibility in design.

Table 1. *Client Statements and Interpreted Needs*

#	Client Statement	Interpreted Need	Importance*
1	I want the gaps to be covered	The panels fully close the side gaps.	5
2	The panels should be “stiff”	The panels are rigid.	5
3	The panel must not interfere with the wheel	The panels are flat.	4
4	The panels should not make the chair any wider.	The panels face inward. The panels are thin.	5
5	The panels should be as easy as possible to install.	The panels are easy to install for a lone user	4
6	The panels should match the rest of the chair.	The panels are black.	1
7	The panels need to resist the weather (Gardening).	The panels are waterproof. The arm gap panels need to withstand shock.	4
8	The arm rest should still be able to flip back.	The arm gap panels need to move with the armrests	3

*\*importance rating 1-5; 5 being most important, 1 being least important.*

### 3.3 Problem Statement

From the statements of “need” above, we were able to formulate the following formal problem statement:

***Wheelchairs are uncomfortable for larger users because part of the user’s legs or posterior will often protrude through the gaps in the armrest. They need to be provided with rigid panels that will close the side gaps and offer a comfortable, affordable and easy to install experience.***

### 3.4 Design Criteria and Metrics

Following the determination of the problem, as well as the general form that the solution will take, the team has devised the following design metrics, which will be used to evaluate whether or not their final product will meet the conditions set out by the client.

Table 2. Metrics

Metric #	Need #	Metric	Functional/Non Functional	Importance	Units
1	6	Aesthetics	Non Functional	3	Subj
2	3, 4	Flatness	Functional	5	Yes/No (Binary)
3	5	Ease to install	Non Functional	5	Subj
4	7	Comfortability	Functional	5	Subj
5	7	Waterproof	Functional	3	Yes/No (Binary)
6	4	Thickness	Functional	4	in
7	7	Durability	Functional	4	Years
8	N/A	Cost	Non Functional	1	\$CDN
9	2	Rigidity	Functional	5	Subj

*\*importance rating 1-5; 5 being most important, 1 being least important.*

### 3.5 Benchmarking with Similar Products

The team conducted research to determine whether there exist alternative products that already fulfill the design conditions, at least partially. The products found all, to an extent, provide the user with lateral support, in most cases closing the gaps as a side-feature of their operation. The products are all cushioned and not flat, and thus none fully manage to meet the needs of the client. The Skil-Care and NYOrtho products both do not have any rigidity, but the Physical Therapy Supplies Product has a rigid insert. All of the products were reviewed as comfortable and easy to install. Only Skil-Care provided a water-proof option for under \$50.00. The products also sit on the seat of the chair making it narrower, which is not ideal for larger wheelchair users. See figures 1, 2, and 3 in appendix A for images of the products.

Table 3. *Benchmarking*

Metric #	Need #	Metric	Imp *	Units	Skil-Care Wheelchair Snug Support	NYOrtho Wheelchair Lateral Support	Physical Therapy Supplies - Lateral Support Arm Trough
1	6	Aesthetics	3	Sub	Yes	No	No
2	3, 4	Flatness	5	Binary	No	No	No
3	5	Ease to install	5	Sub	Yes	Yes	Yes
4	7	Comfortability	5	Sub	Yes	Yes	Yes
5	7	Water resistance	3	Binary	Yes	No	No
6	4	Thickness	4	in	1.5	1.75	6.5
7	7	Durability	4	years	Unknown	Unknown	Unknown
8	N/A	Cost	2	\$CDN	30.00	85.99	142.92 (each)
9	2	Rigidity	5	Subj	No	No	Yes

*\*importance rating 1-5; 5 being most important, 1 being least important.*

All in all, the team concluded that the closest existing item to their product is the “Skil-Care Wheelchair snug support”, which offers the most of the important features, whilst also being significantly more affordable than its competitors. However, rigidity is an important aspect of the final product which will definitely differentiate the final product from the Skil-Care.

### 3.6 Target Specifications

The target specifications summarized in Table 4 were determined based on the interpreted needs of the client (see Table 1). The client is more focused on the functionality of the product but would prefer if the panels match their black wheelchair. The flatness of the panels is important because the client specified that grooves or bumps would be uncomfortable against their legs. The product has to be easy for the user to install and remove independently. Water resistance is important for the product to be functional in the client’s everyday life. Ideally the panels will be less than  $\frac{7}{8}$  of an inch thick, so they are not wider than the frame of the wheelchair. The budget for this project is \$50.00 but providing a solution at a lower cost would be ideal.

Table 4. 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

## 4. Conclusion

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The gaps in the arms of wheelchairs are a big problem for the client, and possibly many other wheelchair-bound. Although this problem seems like a very typical issue, a solution attuned to the client seems not to currently exist. Deliverable B of this project has been completed to properly analyze the answers obtained during the client interview, and to allow for the making of a proper and efficient solution for the client's issues.

The client meeting, which took place on the 19th of September, has allowed the team to analyze the problem further and make sure that the solution being created is properly attuned to the real problem. Through the findings from the client interview, the needs of the client were properly defined which also further allowed the creation of the metrics of the solution, benchmarking of similar pre-existing solutions, and the target specifications the team would like the final product to meet.

All of the analysis done after the interview has led team B31 to understand the scope of the solution. Now that the problem has been appropriately defined, the team will be able to move on to the "ideation stage", wherein they will come up with their preliminary designs and initiate the selection of their definitive design.

## 5. Bibliography

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### Benchmarking Products:

- [https://www.amazon.com/Physical-Therapy-Supplies-081159540-Lateral/dp/B07BKLKMSS/ref=ex\\_alt\\_wg\\_d?encoding=UTF8&pd\\_rd\\_i=B07BKLKMSS&psc=1&pd\\_rd\\_w=rtHKw&pf\\_rd\\_p=4e1b46a8-daf9-4433-b97e-d6df97cf3699&pf\\_rd\\_r=HKRE2PZBYEPNPG0QWW1S&pd\\_rd\\_wg=WVbPU&pd\\_rd\\_r=ae07e0dd-095b-468f-8ede-449fca345bf0&content-id=amzn1.sym.4e1b46a8-daf9-4433-b97e-d6df97cf3699](https://www.amazon.com/Physical-Therapy-Supplies-081159540-Lateral/dp/B07BKLKMSS/ref=ex_alt_wg_d?encoding=UTF8&pd_rd_i=B07BKLKMSS&psc=1&pd_rd_w=rtHKw&pf_rd_p=4e1b46a8-daf9-4433-b97e-d6df97cf3699&pf_rd_r=HKRE2PZBYEPNPG0QWW1S&pd_rd_wg=WVbPU&pd_rd_r=ae07e0dd-095b-468f-8ede-449fca345bf0&content-id=amzn1.sym.4e1b46a8-daf9-4433-b97e-d6df97cf3699)
- <https://www.amazon.com/NYOrtho-L-Shape-Lateral-Support-Wheelchair/dp/B08NXSNX2M?th=1>
- [https://www.amazon.com/Skil-Care-Wheelchair-Support-Vinyl-706309/dp/B00EPGYFM4/ref=sr\\_1\\_11?crid=12MWUS2VNZBW7&keywords=wheelchair+armrest+gap+cover&qid=1663614824&srefix=wheelchair+armrest+gap+cov%2Caps%2C112&sr=8-11](https://www.amazon.com/Skil-Care-Wheelchair-Support-Vinyl-706309/dp/B00EPGYFM4/ref=sr_1_11?crid=12MWUS2VNZBW7&keywords=wheelchair+armrest+gap+cover&qid=1663614824&srefix=wheelchair+armrest+gap+cov%2Caps%2C112&sr=8-11)

# APPENDICES

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## Appendix A: Figures



*Figure 1. NYOrtho Wheelchair Lateral Support*



*Figure 2. Physical Therapy Supplies Lateral Support Arm Trough*



*Figure 3. Skil-Care Wheelchair Snug Support*