

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

GNG 2101- Introduction to Product Development and Management for
Engineers

Faculty of Engineering - University of Ottawa

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Introduction:

Wheelchair-accessible fitness equipment have been recently developed in order to accommodate disabled people with limited physical capabilities. One example of a piece of fitness equipment is the rowing machine. Regular rowing machines cannot be used by people in wheelchairs because they cannot sit on the machine and strap their feet into the foot pads. The design team is building an adapter that can be attached to the machine, making the rowing machine wheelchair-accessible and, hence, allowing people with disabilities to exercise their upper bodies and use the machine comfortably. The main idea is for the adapter to be designed in a way that these people can use the machine independently. Also, it has to remain secure and stable at all times during exercise. The product that the team is designing is differentiated and unique. Not only will it be produced to make the rowing machine wheelchair-accessible, but the team also plans to create an innovative way in which users can reach the handlebar on the machine easily to accommodate people who have limited upper-body mobility. The team thoroughly describes the engineering design process and the problem definition process that had to be followed in order to appropriately understand the problem and ensure that the right problem is being solved. Client statements are listed, translated and prioritized into need statements. A problem statement is then developed and a benchmarking analysis is performed. Finally, metrics and target specifications are listed with appropriate reasons.

1. Client Statements/Observations Obtained From Client Interviews

Client Statements:

- 1) The users can have a staff member helping them set up the machine, but they are on their own after that.
- 2) The product adapts the rowing machine so that it can be used by people in different types of wheelchairs.
- 3) "It would just be sitting as a docking station to be used." The staff can install it and detach it at any time without any difficulties.
- 4) The design needs "something going against the chair so when the users pull, they are not travelling all over the place."
- 5) It can be used by all people that are able to move their upper bodies to some extent.
- 6) With the docking station installed, the adapted rowing machine can be a bit bigger than the original machine, but not by a significant amount.
- 7) "It could be a whole week goes by without it being used but it could be used like four times in one day. We don't know, but we're not going to dedicate this to that."
- 8) It can be repaired, without difficulties, if needed.
- 9) When the adapter is not being used, it has to be stored appropriately and safely.
- 10) The budget is \$100.

- 11) It has to be easy to carry and mount.
- 12) It is as safe as the other fitness equipment.
- 13) The adapter will be replicated to make more rowing machines wheelchair-accessible.

Observations:

- The design team observed that the client was energetic, passionate, and highly interested about the product to be designed.
- He explained his desires clearly and answered the team's questions thoroughly.
- The client engaged himself in the process and showed the team how the rowing machine works by using it himself.

2. Translated and Prioritized Customer Needs

Table 1. Need Statements.

Client Statement Number	Need	Importance
1	The design is easily and independently used.	5
2	The design is compatible with different sizes, weights and types of wheelchairs.	4
3	The design is easily and quickly installed/detached.	3
4	The design remains secure, rigid and stable for the user throughout the exercise.	5
5	The design allows use by people with different ranges of disabilities.	4
6	The design has a reasonable size.	2
7	The design lasts a long time.	3
8	The design can be easily accessed for maintenance.	3
9	Compact storage of design.	2
10	It is a cost-effective design.	5
11	The design is lightweight and maneuverable.	3

12	The design is safe to use.	5
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3. Problem Statement

Convert a rowing machine, using a detachable adapter, to make it wheelchair-accessible for people who suffer primarily from lower-body disabilities.

4. Benchmarking of Similar Products

Product 1: Adapt2Row

Description:

A lightweight rowing machine adapter that can be easily installed and used by people in wheelchairs.



Figure 1. Adapt2Row Adapter.

Product 2: Keiser Cardio M Series M7i Wheelchair-Accessible Total Body Trainer

Description:

A total body trainer that can be used with any mobility device or wheelchair.



Figure 2. Keiser Cardio Total Body Trainer.

Product 3: SciFit PRO1 - Upper Body

Description:

An upper body trainer that can be used while people are seated or standing. It has a wheelchair platform and a removable seat.



Figure 3. SciFit PRO1 - Upper Body Trainer.

Table 2. Benchmarking Products.

Metric Number	Need Number	Metric	Importance	Unit	Product 1	Product 2	Product 3
1	11	Total mass	3	kg	15	38.56	110
2	3,8	Time to assemble/ dismantle	3	s	60	0	Not Known
3	10	Unit manufacturing cost	5	\$	761.25	3395	Not Known
4	1	Actions that need to be performed by a staff member	5	list	-Secure the adapter to a regular rowing machine	-Secure straps to the arms and wrist -Place the loop over the M7i handle	-Remove the seat and clamp the wheelchair into the machine
5	2,5	Size of wheelchair that can be accommodated	4	cm	70	any	76
6	7	Expected functioning duration	3	yr	Not Known	Not Known	3
7	6,9	Space taken up in storage	2	m ³	0.0851	0.0742	2.079
8	4,12	Safety features	5	list	Not Known	-Wrist stability straps to hold the wheelchair in place if	-Iso - Strength safe -Straight hand grips (optional

						the user feels unstable -Velcro fastener -Foot stability straps to keep legs in place -Leg stabilizers to ensure proper leg alignment and position	accessory) -Assist gloves (optional accessory)
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5. Metrics

Table 3. Metrics.

Metric Number	Need Number	Metric	Importance	Unit
1	11	Total mass	3	kg
2	3,8	Time to assemble/dismantle	3	s
3	10	Unit manufacturing cost	5	\$
4	1	Actions that need to be performed by a staff member	5	list
5	2,5	Size of wheelchair that can be accommodated	4	cm
6	7	Expected functioning duration	3	yr
7	6,9	Space taken up in storage	2	m ³
8	4,12	Safety features	5	list

6. Target Specifications

Table 4. Target Specifications.

Number	Metric	Unit	Marginal Value	Ideal Value	Reasons
1	Total mass	kg	<20	<15	This ideal value is chosen since the competitive Product 1 has the lowest mass (15 kg). The marginal value is <20 kg because the team's design is more complex than Product 1 and can therefore weigh more.
2	Time to assemble/dismantle	s	<30	0	The ideal value is 0 s since Product 2 does not require assembling and dismantling. The marginal value, however, is less than 30 s because the team's design requires assembling and dismantling. This value was chosen to remain competitive with Product 1 (60 s).
3	Unit manufacturing cost	\$	<100	<761.25	The ideal value is <761.25 dollars because that is the lowest cost between the benchmarking products (Product 1). However, the marginal value is <100 dollars since that is a budget constraint in the team's design.
4	Actions that need to be performed by a staff member	list	<3	None	The ideal number of actions is 0 because the benchmarking products

					all have 1 or 2 actions. To remain competitive with them, 0 actions would be ideal. The marginal value is <2 because, realistically, a staff member will have to perform at least 2 actions to assemble the equipment for the user since the design is detachable.
5	Size of wheelchair that can be accommodated	cm	>70	any	To be competitive with Product 2, the design will have to accommodate any wheelchair size (ideally). The marginal value is >70 cm because there is a limit to the amount of space that the adapter can occupy. To accommodate bigger sizes of wheelchairs, a much bigger adapter would be needed.
6	Expected functioning duration	yr	>1	>3	The ideal value is more than 3 years. This is chosen to compete with Product 3. The marginal value, however, is more than 1 year since there are certain constraints for the team's design (such as budget constraints) that could lead to a lower functioning duration.
7	Space taken up in storage	m^3	<0.100	<0.0742	The ideal value is chosen as $<0.0742 \text{ m}^3$ since that is the least space taken up between the 3

					benchmarking products (Product 2). The marginal value, though, is $<0.1 \text{ m}^3$ because, in order to develop an adapter suitable for many wheelchair sizes, a slightly bigger adapter that takes up more space is needed.
8	Safety features	list	>2 features	>4 features	The ideal value is more than 4 features since Product 2 has 4 safety features. However, the marginal value is >2 features since, in order to add more features, a greater budget is needed.

7. Client Meeting Reflection

During the client meeting, the design team had the opportunity to empathize and better understand the needs of the client and, hence, the users. This helped in the process of listing, translating, and prioritizing customer needs accurately. The client also thoroughly explained how he expects the adapted machine to function and showed the team good examples of other fitness equipment in the market that have already been adapted for people with certain disabilities. The client further demonstrated the limitations of these adapted machines and the difficulties that users have while exercising with them. These explanations and limitations helped the team in performing the benchmarking process and developing the appropriate metrics and target specifications for the product.

Conclusion:

The seven steps of the problem definition process were successfully performed. Client statements were translated and prioritized into need statements using the appropriate strategies. A problem statement was clearly defined and a benchmarking of similar products was performed. Finally, metrics and target specifications were listed. The client interview certainly helped the team in completing these steps. The team was able to empathize with the customer

and truly understand the problem. Further steps will include a conceptual design and feasibility study to lead the team into the actual design of the product.