

GNG2101

Design Project User and Product Manual

Adaptable Fitness Equipment

Submitted by:

AdaptAble Rowing (Group A2.2)

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List of Acronyms and Glossary

Table 1. Acronyms

| Acronym | Definition |
|----------------|------------------------------|
| UPM | User and Product Manual |
| WRA | Wheelchair Rowing Attachment |

1 Introduction

This User and Product Manual (UPM) provides the information necessary for owners of the Concept2 Rower to effectively use the Wheelchair Rowing Attachment (WRA) and for prototype documentation.

This product was designed for the Concept2 Rowing machine and should only be used with the proper equipment. Using the product with other machines could lead to injury. If you are unsure of how to operate the WRA, consult this UPM.

2 Overview

The WRA was designed to tackle the problem of offering a solution for those with limited motor control in their lower body to use a rowing machine. Without it, potential users of this machine must lift themselves from their wheelchairs or other seating and place themselves on the Concept2 Rowing machine. The WRA is an easily attachable/detachable solution which allows users to simply roll up to the machine and begin using it without leaving their chair. It offers adjustable knee and foot braces that can be removed and reattached perpendicular to their normal attachment, allowing the WRA to become thin and easily storable in a small space when not in use.



Figure 1: The Wheelchair Rowing Attachment

The system was constructed by attaching aluminum metal tubing with brackets and rivets. Telescopic aluminum tubing is used to allow adjustment of the knee stopper (fitted with padding) and the wheel stopper (aluminum). The product attaches to the Concept2 Rowing machine using a custom latching mechanism from the Concept2 website.

2.1 Cautions & Warnings

The WRA was designed for use with the Concept2 Rower, if used on other machines the product may not function properly and could potentially be dangerous. Do not use this product for any other purpose than attaching to the Concept2 Rower and using the equipment as intended. This UPM was written under the assumption that users understand how to properly operate the Concept2 Rower, if the user does not know how to operate the machinery they should review the Concept2 Model E user manual.

3 Getting started

The WRA has three main subsystems that the user must take into account when using the product: The latch, knee stopper, and wheel stopper. When attaching the product to a Concept2 Model E rowing machine, it is important to make sure the stoppers are secured by the pins so as to not let them slide out. It is recommended that the setup of the product be done by two people. Once attached to the machine, the WRA is ready to be used. To remove the product, simply unlatch the product while once again making sure the stoppers are secured.

3.1 Configuration Considerations

This product was designed to function as an attachment to the Concept2 Model E Rowing machine. It requires the user to already have access to that equipment. There are no other tools necessary in the set up of the WRA.

3.2 User Access Considerations

For users with limited motor functionality, the attachment may be difficult to set up. To ensure the WRA can be attached and set up safely without harm, complete the set-up procedure with another person.

3.3 Accessing/setting up the System

To attach and use the WRA, first detach the seat from the Concept2 Rower and set it aside. To detach the seat, lift the plastic clip where it attaches and pull the seat out.



Figure 2: Removing Original Latch

Then grab the WRA and set it next to the rowing machine, latch the Concept2 Rower onto the WRA by lifting the clip and setting the latching mechanism into place.



Figure 3: Attaching WRA to the Concept2 Rower

Then adjust the length of the knee/wheel stoppers until they fit comfortably against the user while they are rolled up to the WRA. This can be done by lifting the pins and sliding the foot/knee rests until they are at the desired length.

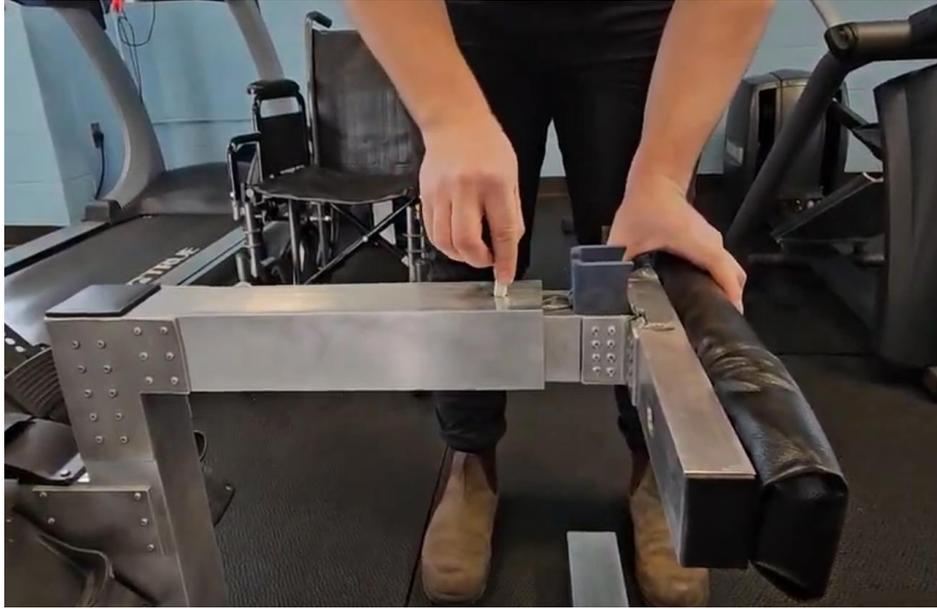


Figure 4: Attaching WRA to the Concept2 Rower

3.4 System Organization & Navigation

The WRA can be organized into the latch mechanism, the main frame, the knee stopper, and the wheel stopper. The latch mechanism can be found on the back of the WRA, it is made out of plastic and allows the attachment to click into place on the Concept2 Rower.



Figure 5: Latch

The main frame of the WRA includes the aluminum metal connecting the latch, the knee stopper, and the wheel stopper. It is made from 3 tubes of aluminium and brackets to hold them together.

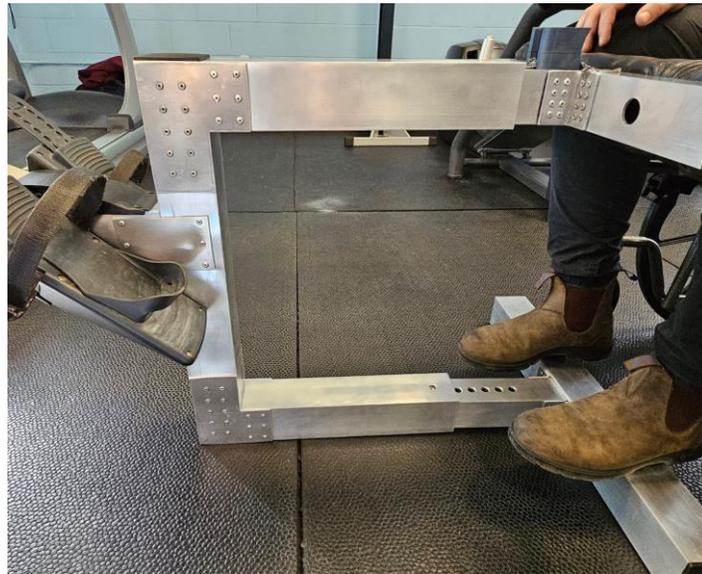


Figure 6: Main Frame

The knee stopper includes the telescopic tubing, which connects to the main frame using a pin and has leather upholstery and padding to protect the knees of the user.



Figure 7: Knee Stopper

The wheel stopper includes the telescopic tubing which connects to the main frame using a pin and is made out of aluminum.



Figure 8: Wheel Stopper

The handle holder gives the user easier access to the handle by holding it closer to the user so they do not have to reach. It is made of plastic.



Figure 9: Concept2 Rower handle holder ¹

¹ <https://shop.concept2.com/parts/98-handle-hook.html>

3.5 Exiting the System

To remove and store the system, disconnect the latching mechanism of the WRA. Then remove both the knee stopper and wheel stopper by taking out the pins and taking out the telescoping tubes and reattaching them vertically, allowing the WRA to be in storage mode.



Figure 10: WRA in storage

4 Using the System

The following subsections provide detailed, step-by-step instructions on how to use the various functions or features of the Wheelchair Rowing Attachment.

4.1 Wheel Stopper

The wheel stopper is an integral subsystem of the WRA which is required for the use of the product. The wheel stopper can be found at the bottom of the product. It is a long horizontal tube connected to a telescoping tube. When using the WRA, simply move the wheelchair to the attachment until either the knees or the castor wheels are in contact with their respective stopper.

If the knees get in contact before the wheels (See section 4.2), simply lift the pin out of the wheel stopper's tube, pull it forward until the stopper is in contact with the wheels, and insert the pin back into place.



Figure 11: Front wheels in contact with wheel stopper. Also visible, extended tube.

4.2 Knee stopper

The knee stopper is a subsystem of the WRA which can be found at the top of the attachment. It is recognisable by the telescoping tube it is attached to and the black padding at the front of it. The goal of the stopper is to have a comfortable and secure stopper for the user. It resists the user from moving forward when using the rower. To use the stopper, simply wheel the wheelchair to the attachment. If the castor wheels get in contact with their respective stopper first (See section 4.1), simply remove the top pin from the tube and pull forward the knee stopper until the padding is in contact with the knees or shins of the user. Re-insert the pin.



Figure 12: Knee stopper in contact with knees of user

4.2.1 Handle holder

The handle holder is located on the knee stopper subsystem, on the top surface between the telescoping tube and the padding. To use it, make sure the knee stopper is in place (Section 4.2). With the help of another person, or by one's self, pull forward the handle and set it in the holder.



Figure 13: Rowing handle seated in the holder

4.3 Latch

The latch is located on the opposite side of the device relative to the stoppers. It is used to connect the WRA to the Concept2 Model E rower. To install the WRA, remove the monorail from the Concept2 rower. Information on how to remove the rail can be found here, at the Concept2 website: <https://www.concept2.com/service/indoor-rowers/model-e/manuals-and-schematics>. After the rail and seat assembly have been removed, bring forward the WRA with the latch facing the rower. Lift the plastic clip and drop the latch into place. If done correctly the clip should rest flush on the top latch piece.

The latch is removable in the same way as the rail and seat assembly



Figure 14: The latch being lined up with the machine

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

The plastic handle holder may be subjected to accumulated stress over time from the rowing machine's handle being repeatedly placed into the holder roughly. Since it is weaker than the aluminum frame and is handled by users, it is more prone to breakage than other areas. Breakage may result in the handle breaking out of place and hurting the user from the recoil. Users are encouraged to put the handle carefully back into place when not in use. Breakage or extensive fractures may result in part replacement being necessary.

The plastic link connecting the device to the rowing machine base may break from expected forces over time. Breakage may result in the device being misaligned with the rowing machine base and extra strain on the user. Users are encouraged to clip and unclip the device carefully with an assistant.

The telescoping adjustment mechanism is a subsystem that is frequently in contact with the user and may be subject to significantly wear over time than other components. The pins that hold the tubing in place absorb the force of the user's legs and may wear down or even break from repeated use. Customers must routinely check the state of the pins at their discretion based on the volume of users in order to prevent breakage and any harm that may result. Customers are encouraged to replace the pins before complete breakage.

5.2 Special Considerations

In the event that the latching mechanism or handle holder breaks during operation of the machine, replacement parts can be ordered on the Concept2 website.

5.3 Maintenance

The upholstery of the equipment pad must be replaced when worn out and ripped in order to avoid harm to the user by exposing their skin to the sharp edges of the device. The padding should also be wiped down between uses to avoid accumulation of bacteria in the fabric that may lead to early material breakdown.

The rivets keeping the bars together should be checked occasionally for breaks or loosening and replaced if missing. Failure to maintain the rivets may result in the device breakage and user injury.

5.4 Support

Notification of damage inflicted on the plastic connection point or handle holder may be directed to the toll free Concept2 customer service account at info@concept2.com. This includes cracks, breakage, and replacement support for the plastic components of the device under the two year warranty provided by Concept2 [https://www.concept2.com/service/product-warranties?gad_source=1&gclid=CjwKCAiAmZGrBhAnEiwAo9qHid2Ih0-ZuW9x2sz80ytVzDq51B1j94YhpenMHIO_u8Rxovnep0bVYBoC2HIQAvD_BwE].

Notification about damage sustained to the overall frame of the device or production can be sent to Abdullah Ramadan at arama014@uottawa.ca for support. Identified problems that do not fall under the Concept2 support should be emailed to Mr. Ramadan with the product name and the main location of failure as the subject.

6 Product Documentation

6.1 Main Frame

5.4.1 BOM (Bill of Materials)

Table 2. BOM for the main frame

| Item Name | Description | Units | Quantity | Cost (\$) | Link |
|-----------------|-------------|-------|----------|-----------|---|
| Aluminum Tubing | 3"x3" | ft | 3 | 120.24 | https://www.mcmaster.com/4931T157/ |
| End Caps | 3"x3" | Units | 2 | 16.84 | https://www.amazon.ca/Square-Tubing-Black-Plastic-Protector/dp/B08T69HJVG/ref=sr_1_13?crid=N6OCJ7D1UMAC&keywords=square+aluminum+tubing+3x3&qid=1696707697&sprefix=square+aluminum+tubing+3x3%2Caps%2C92&sr=8-13 |

5.4.2 Equipment list

- Any saw for cutting metal
- Rivet tool

- Milling machine or drill press

5.4.3 Instructions

To build the main frame, 3 pieces of 3x3 tubing are needed: the two telescoping tubes and the back piece. These pieces will need to be of specific length within tolerance. The vertical (back) tube has to be 24 inches in length, with a tolerance of 0.050". The two outer tubes are 15 inches in length each with the same tolerance

5.5 Latching Mechanism

5.5.1 BOM (Bill of Materials)

Table 3. BOM for the latching mechanism

| Item Name | Description | Units | Quantity | Cost (\$) | Link |
|-----------------|-------------|--------|----------|-----------|---|
| Aluminum Tubing | 3"x4" x 8" | Inches | 0.5 | 58.72 | https://www.mcmaster.com/6546k66/ |
| PN 1251 | Latch part | Units | 2 | 0.40 | https://shop.concept2.com/parts/379-polydrive-rivet.html?search_query=1251&results=1 |
| PN 1038 | Latch part | Units | 1 | 1.40 | https://shop.concept2.com/parts/480-upper-hangerupdated-model-d-e.html |
| PN 1204 | Latch part | Units | 2 | 1.60 | https://shop.concept2.com/parts/365-monorail-hanger-bolt-38-16-x-5-12.html?search_query=1204&results=1 |
| PN 1153 | Latch part | Units | 1 | 2.40 | https://shop.concept2.com/parts/485-upper-die-cast-hangerupdated-model-d-e.html?search_query=1153&results=1 |
| PN 1062 | Latch part | Units | 1 | 2.10 | https://shop.concept2.com/parts/483-monorail-bolt-supportupdated-model-d-e.html?search_query=1062&results=1 |

| | | | | | |
|---------|------------|-------|---|------|---|
| PN 1039 | Latch part | Units | 1 | 0.95 | https://shop.concept2.com/parts/481-lower-hangerupdated-model-d-e.html?search_query=1039&results=1 |
| PN 1154 | Latch part | Units | 1 | 2.55 | https://shop.concept2.com/parts/486-lower-die-cast-hangerupdated-model-d-e.html?search_query=1154&results=1 |
| PN 1244 | Latch part | Units | 2 | 0.20 | https://shop.concept2.com/parts/375-nut-38-16-nylock.html?search_query=1244&results=1 |

5.5.2 Equipment list

- Wrench for bolts
- Saw for cutting metal
- Mill
- Rivet gun

5.5.3 Instructions

To build the latching mechanism, use a piece of aluminum tubing with 3x4 inches in height and width. Mill holes into the aluminum piece for the plastic latch pieces to align to. Attach the top, middle, and bottom pieces of the latch to the edge of the aluminum piece with the through bolts. This latch piece can then be attached to the mainframe using brackets and rivets.



Figure 15: Completed Latch

5.6 Knee/Wheel Stoppers

5.6.1 BOM (Bill of Materials)

Table 4. BOM for the knee and wheel stoppers

| Item Name | Description | Units | Quantity | Cost (\$) | Link |
|-----------------|---------------------|--------|----------|-----------|---|
| Aluminum Tubing | 2.5"x2.5" | Inches | 3 | 67.00 | |
| Thread Inserts | For bolts | Units | 2 | 13.56 | https://www.mcmaster.com/90975A313/ |
| End Caps | 1.5"x2.5" | Units | 2 | 14.25 | https://www.amazon.ca/Square-Tubing-Black-Plastic-Protector/dp/B08T69HJVG/ref=sr_1_13?crid=N6OCJ7DIUMAC&keywords=square+aluminum+tubing+3x3&qid=1696707697&prefix=square+aluminum+tubing+3x3%2Caps%2C92&sr=8-13 |
| Felt Pads | To protect flooring | sq/in | 3 | 16.85 | https://shop.concept2.com/search?controller=search&orderby=position&orderway=desc&search_query=1244&submit_search= |
| PN 1754 | To hold handle | Units | 1 | 22.42 | https://shop.concept2.com/parts/98-handle-hook.html?search_query=1754& |

| | | | | | |
|--|--|--|--|--|---------------------------|
| | | | | | results=2 |
|--|--|--|--|--|---------------------------|

5.6.2 Equipment list

- Mill
- Rivet gun
- Saw for cutting metal
- 3D printer
- Lathe

5.6.3 Instructions

Once all the materials have been acquired, the aluminum can be cut to size (specifications can be seen in our 3D model), the holes in the outer aluminum and telescopic tubing can be cut using a mill/drill press, and the pieces can then be attached together using rivets as seen below. The knee and wheel stopper are connected to the inner telescoping tube with a corner bracket (as seen below) with 16 rivets. A minimum of 8 are required for safe assembly. This is repeated on the other side of the tube. To connect the outer telescoping tubes to the main frame, install them as seen below with 16 rivets. The horizontal piece is the outer telescoping tube.



Figure 16: Rivets and brackets

5.7 Testing & Validation

Multiple aspects of the WRA and its subsystems were tested to ensure manufacturing was done properly and that the system would function without issue for a long period of time.

The tensile strength and the durability of the main frame was tested to ensure it would sustain any force applied to it during regular use. Further testing was also done to ensure each riveted connection between pieces of metal was secure enough to last for as long as necessary.

The latching mechanism was tested on multiple different Concept2 Model E rowing machines to ensure it would fit on all Model E machines.

The pins in the telescopic tubing were tested to ensure they would withstand the weight of the tubing hanging when wall mounted and would not fall out over time.

Recommendations for sustained usage over a long period of time include only using the product as it has been described within this user manual. Do not attempt to use the product on other machines or for unintended activities. Check all parts of the machine upon each set up and use, if there is any damage to the product refer to the Support section of this document.

6 Conclusions and Recommendations for Future Work

Through the development of this prototype we have learned the importance of designing with the user in mind and adding multiple points of functionality, ease of use, and durability to your product. Our product was designed with all these aspects in mind.

For future work, the riveted and bracketed connections between aluminum on our product can be welded to reduce weight and improve the overall aesthetics of the WRA. To continue reducing weight, dimensions of the metal beams could be adjusted and potentially reduced, including the thickness of the aluminum itself.

Further work could be done on the pins to improve their fit in the telescopic tubing, making them smoother to insert/remove

The height of the latching mechanism can also be made adjustable so the attachment can fit the Concept2 Model D rower as well as the Model E, recommendations to accomplish this include a similar pin mechanism to the telescopic tubing or removable bolts.

Much of this work to improve the overall product could be done if given a few more months to improve upon it. We have had a great semester working with the client on this product and we hope that this document helps anyone else in the future wishing to recreate or take inspiration from our design.

7 Bibliography

https://www.concept2.com/service/product-warranties?gad_source=1&gclid=CjwKCAiAmZGrBhAnEiwAo9qHid2Ih0-ZuW9x2sz80ytVzDq51B1j94YhpenMHIO_u8Rxovnep0bVYBoC2HIQAvD_BwE

APPENDICES

8 APPENDIX I: Design Files

<https://makerepo.com/RemiThomasRichard/1858.adapted-fitness-equipment-team-adaptable-rowing-gng2021-a22>