Operator’s Manual

Single Hand Manual
Drive Wheelchair

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Important Safety Instructions

It is important for the operator to be aware of the hazards associated with the One Arm Drive Manual wheelchair. Though risk of injury is very low, it is necessary to be aware of these risks that may be presented.

Always be aware of your surroundings when using the One Arm Drive wheelchair. Always fasten safety straps when using the wheelchair. This will secure the operator in place so they don’t fall out. Always apply the wheel lock before getting in/out of the wheelchair. Do not have any loose articles of clothing that might get caught in the drive mechanism or wheels of the device. One should never stand on the wheelchair to access something out of reach. Always push the wheelchair from behind when the operator is not using the one arm drive system. Always leave the wheelchair in a place that is out of the way of others walking past. It is not recommended to use the wheelchair on inclined surfaces or near places that risk injury (staircases, etc.).

Inclined surfaces can be especially dangerous for the One Arm Drive wheelchair because it’s very difficult to maintain control. If the operator should ever get into a situation where they are moving down an incline and cannot control the wheelchair, they should apply the brakes by pulling back on the lever arm.

Any other use of the manual drive wheelchair beyond its intended use is not recommended.
Parts and Accessories

The following is a list of parts and accessories that are included with the One Arm Drive Wheelchair:

Wheelchair Frame

Lever Drive System

Headrest

Headrest Bracket
Large Rear Wheels

Footrest with Foot Straps

Soft Handles

Backrest bracket

Front Caster Wheel
Disengaging Mechanism

Rear Support Wheels

Armrest

Restraint Harness

Backrest with Headrest Attached
Wheel lock

Padded Seat Cushion
Features

The One Arm Drive Wheelchair has many different features, including mobility, ease of braking, wheel locks, restraint system, and the ability to disengage drive system. The following sections highlight these features in greater detail.

Mobility

The most important feature of this device is that it provides the operator with the ability to move the wheelchair in forward or reverse directions with simply one hand. The operator does not need to use two hands to operate the wheelchair. This device makes moving a wheelchair easier for those who lack certain motor control.

The way the system functions is that it incorporates a lever arm that must be pumped in a forward motion to allow the wheelchair to move. The lever is attached to a transmission drive system, which is attached to the axle of the rear wheels. The client can control what direction they would like their chair to move—forward or reverse—by simply switching the gear in the transmission. Movement of the wheelchair can be stopped by pulling the lever arm back to prevent movement of the wheels. Further description of each of the components will be discussed further on.

Wheel Braking

Safety of the one arm drive wheelchair is a very important concern. The team took into account a braking mechanism that allows the client to easily stop the wheelchair on command. The final product allows the operator to stop simply using their right hand.

Some of the alternative designs discussed ideas about disc brakes and hand brakes for the one arm manual drive wheelchair. However, the CLD system incorporates its own braking mechanism within the design. In order to apply the brakes, the operator simply pulls back on the lever arm. This motion can even be performed when the chair is in forward or reverse gears.

Ability to Disengage Drive System

One of the best features of this wheelchair is the ability to disengage the gears. This is really beneficial if the operator decides they do not want to control the wheelchair by themselves. This feature allows the ability for someone to disengage the gears so that they can manually push the wheelchair from behind.

Wheel Lock

Another important feature is the ability to lock the rear wheels in place. This is useful if the operator wants to prevent movement of the wheelchair if they are getting in or out. This is an important safety feature because if the wheelchair moves while the client is sitting down or standing up then it may cause the client to slip and get injured.
Restraint System

The team attached a restraint system to the wheelchair to ensure that the client is secured while operating the device. This is essentially a seat buckle that should be secured before the operator uses the wheelchair. It functions to keep the operator in the wheelchair so that they do not get injured during use.
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1 Introduction

The single hand manual drive wheelchair was built so that the operator is able to control the wheelchair solely by the right hand. The purpose of the project is to allow the client to have more freedom of movement in a lightweight, portable wheelchair, even though she cannot control movement in her left hand. The team made modifications to an existing manual wheelchair in order to incorporate a single hand mechanical drive device.

A lever one arm drive (OAD) system consists of a lever mounted to the front caster area of the wheelchair with linkages back to the rear wheel of the chair. The lever drive has a forward, neutral, and reverse setting and when the lever is pushed forward, the wheelchair will move. The neutral setting is used when the wheelchair is being pushed by a caregiver.

There is also a brake mechanism that is built into the one arm drive system. This brake system consists of a piece that rests against the right wheel to prevent movement when engaged. The method to engage the brake is to pull all the way back on the lever arm until it rests against the wheel. This will prevent the chair from moving. This brake part also functions as a wheel lock system.

The headrest piece is fixed to the wheelchair using an aluminum bracket. This headrest part is vertically adjustable so that it can provide a better fit to the client. There is also a seat cushion that has the capability of being removed from the wheelchair. It is fixed in place using two strips of Velcro. This cushion was enhanced with additional foam padding for a better client fit.

The footrest piece rests on the left side of the wheelchair and swings out when the wheelchair is in use. The purpose of this part is that it functions as a place for the operator to rest their feet when using the wheelchair. This ensures that the operator’s feet don’t drag on the ground while the chair is moving. There are a set of straps that are located on the footrest, which function to hold the operator’s feet in place while in use. These straps are made out of Velcro and can be adjusted to fit a wide range of foot sizes. One other important thing to mention is that it’s possible to remove the footrest from the left side of the wheelchair.

The backrest part is a piece that supports the client while they are using the One Arm Drive Wheelchair. This part essentially can be removed from the wheelchair in order to allow the wheelchair to collapse. This backrest is adjustable to different angles. It is recommended to keep the backrest positioned in the holes as shown in Figure below.

The large wheels contain hand rails that allow the operator to move the wheelchair using both hands, if they so choose. The right wheel is connected to the one arm drive system and rotates as the lever arm is pumped.
There are two armrests that function to support the client’s weight, should they decide to rest their arms there. They are padded and serve more for comfort purposes than for support.

The two handles that stick out of the back of the wheelchair function as handles for a caregiver to push the wheelchair from behind. These handles have a soft grip covering that makes it more comfortable for someone to grip.

1.1 Wheelchair Specifics

The wheelchair is a folding type that easily collapses and sets up in a matter of seconds. This guide will provide a step by step instruction on how to operate the device, starting when the wheelchair is in collapsed position, with the backrest, footrest, and seat cushion detached. All three of these parts must be removed in order to fold the wheelchair properly. The method of detaching these components is discussed at the end of this section. Figure 1 shows all components of the one arm drive wheelchair, which include the chair, backrest, headrest, seat cushion, and footrest.

![Figure 1: All components of one arm drive wheelchair](image)

Start by opening the one arm drive wheelchair by separating the large wheels so that they are as far apart as possible. The seat will bridge the gap between the two wheels. The wheelchair should be placed upright on a level surface when setting up. Figure 2 represents the wheelchair in the folded and unfolded positions.
Figure 2: Folded and unfolded positions

Next, set the backrest into place by putting the pins sticking out of the backrest into the bracket shown in Figure 3 below. The pin piece of the backrest must be looped through the hole and turned to lock into place. This ensures that the pin will not come out when the operator is using the wheelchair.

The footrest part must be put in place as well. The footrest bracket arm contains two holes that rest on the left side of the wheelchair, as seen in Figure 4 below. The left side of the wheelchair contains two pins that allow the footrest bracket to rest in place. The footrest itself contains a folding aluminum sheet that is able to fold away so that it’s not in the way. This aluminum plate can fold out so that it can be used for the operator to rest their feet.

The footrest part should be placed onto the two pins on the left side of the wheelchair as shown in Figure 5.
Lastly, the seat cushion should be put in place to provide comfortable support padding for the client. There are two strips of Velcro that hold the seat in the proper position. The part of the seat cushion with the large lump in the center should be facing closest to the front of the wheelchair. It is important to recognize this orientation so that the operator has the proper support for their body. Figure 6 shows the seat cushion.

![Figure 6: Seat cushion for one arm drive wheelchair](image)

Before the client gets into the wheelchair, the wheel lock should be engaged. This is done by pulling the lever arm all the way back so that it locks in place against the wheel. This will prevent the wheelchair from moving while the client gets in and out. Figure 7 shows the wheel lock piece.

![Figure 7: Wheel lock piece](image)
The wheelchair is made to function similar to any other standard wheelchair, except it has a one arm drive feature that allows the operator to control their movement easier. The device is operational simply by moving the lever arm system shown in Figure 8 below.

Figure 8: One arm drive system

The operator must select which direction they would like to move—forward, neutral, or reverse—which are controlled via a transmission lever. Once direction is selected, the operator pumps the lever arm forward, which will cause the wheelchair to move in the direction specified. The three phases of the transmission (forward, neutral, and reverse) are shown in Figure 9 below.

Figure 9: Three phases of transmission
The wheelchair can be collapsed by removing the seat cushion, backrest, and footrest. The footrest is removed by pulling the black lever that holds the part to the left side of the wheelchair. Figure 10 represents this piece that can be released in order to remove the footrest plate.

Figure 10: Removal of footrest

2 Maintenance

2.1 Mechanical

There are a couple things that can be done for preventative maintenance to ensure the wheelchair’s lifespan is maximized. It’s important to take into consideration these pieces of advice to ensure that the tray is less likely to break over time.

Every six months, it’s necessary to double check the bolts in the wheelchair to make sure they are tightened securely. It is especially important to check the nuts and bolts associated with the One Arm Drive lever arm system. This is one of the most important parts of the wheelchair and is necessary for the system to function properly.

It is also important to apply grease or oil to the moving parts of the lever arm should they become very difficult to move. The team applied a simple lubricating spray, WD-40, to the system before turning the final product over to the client.

The cleanliness of the wheelchair is another thing that is necessary to increasing the lifespan of the device. The wheelchair should be cleaned periodically to ensure that it does not collect dust, which can hinder movement of the mechanical components. Cleaning the wheelchair every couple months will ensure it is free of bacteria and will provide a healthier setting for those using the chair.

2.2 Electrical

There are no electrical components associated with this device.
3 Technical Description

3.1 Drive Arm Assembly

The CLD system is broken down into many different components, each serving a purpose in the overall functionality of the wheelchair. The first major component is the arm assembly and Fig. 11 below shows a diagram of the basic setup. Basically, there is a two foot long handle that attaches to the fork of the front right wheel to control the steering and forward and reverse movements of the wheelchair. The drive arm functions as the main method of control for the client. The arm is moved back in forth in a pumping action in order to propel the wheelchair forward. With each pump, the lever system moves a set of gears attached to the axle, and this provides movement to the rear wheels.

The arm is attached to the front wheel via a rotating mechanism, which allows the client to steer the direction of the wheelchair by turning the lever arm left or right. The client will also be able to adjust the height of the lever arm by simply unscrewing a nut that holds it in position. The lever arm will be able to slide up and down to the client’s desired height and can be securely tightened in place. This will allow the client to setup the arm assembly in a comfortable position in order to minimize discomfort while the wheelchair is in use.

![Figure 11: CLD Drive Arm Assembly](image)

3.2 Fork and Steering Assembly

The second major component is the fork and steering mechanism. Figure 12 below shows a diagram of the basic fork and steering assembly. These components are responsible for holding together the drive arm and the front right wheel. The fork is a common part that attaches wheels because it has two prongs that go on each side of the wheel with an axle holding it together in the middle.
This piece is made of aluminum or stainless steel and must be strong enough to support the weight of the wheelchair without falling apart. At the base of the drive arm (and the top of the fork assembly) there is a rotating fork stem and caster headtube that are essential for the 360 degree rotation of the wheel. The fork stem is placed within the caster headtube and the hex nut prevents the fork stem from being removed. The fork stem is free to rotate within the caster headtube with very little friction. This fork assembly is attached to the lever arm component and this entire assembly makes the wheelchair able to turn in any direction by applying simple movement to the lever arm.

Figure 12: CLD Fork and Steering Assembly

3.3 Rear Wheel and Axle

The third set of components of the one arm drive system are the rear wheels and axle. Figure 13 below shows a diagram representing how these components function as the lever arm is pumped. When the operator of the wheelchair desires to move forward, they will pump the lever arm and this will move the transmission assembly and transmission rear hub. The motion of these parts will essentially spin the rear wheel hub spokes and axle, which will ultimately spin the right and left wheels. The rear wheels are connected to the same rotating axle, so both wheels will rotate together at the same speed.

Figure 13: CLD Rear Wheel and Axle Assembly
3.4 Transmission

The transmission component of the wheelchair design is responsible for allowing the operator to change gears between forward, neutral, and reverse movement. This piece comes with the CLD system and is part of the lower portion of the lever arm. It basically attaches to the wheelchair side frame via a set of screws and this is what ultimately holds the control arm in place.

The transmission functions using a small lever that protrudes out the top. This lever is accessible to the client on the right side of the wheelchair. There are three different gears as mentioned before—forward, neutral, and reverse. When the client desires to move in the forward direction, they will engage the gear using the small lever. The same process is necessary for moving in the reverse direction as well. Figure 15 below demonstrates the basic setup of the transmission system.

One thing that is important to take into consideration is how difficult it is for the client to be able to switch gears. The shifting arm is a very simple setup and should not require a lot of energy to move. The pumping action of the control arm on the wheelchair is also another concern because it requires that the client make several pumping motions back and forth to move the wheelchair in any direction. The group has worked closely with the client to ensure that they are able to operate the wheelchair with ease and that it does not require a high degree of physical strain to use.

![Figure 15: CLD Transmission and Gear Lever Assembly](image)

3.5 Braking System

An image representing the braking system and brake pads is shown in Fig. 16 below. When the operator pulls back on the lever arm, it presses the brake pad against the rubber tire, which hinders movement of the wheels. The advantage of using this system is that there are very little mechanical pieces or wires sticking out.
3.6 Wheelchair Locking Mechanism

The wheelchair locking mechanism is shown in Fig. 17 below. The functionality of this design allows a lever to be turned that presses a brake pad against the tires to prevent movement. This lever operates with a simple turn and can lock the wheel in place. There are two wheel locks--one for each side of the wheelchair to attach to the large rear wheels. The small front wheels do not have locking mechanisms.
3.7 Disengaging Mechanism

The disengaging mechanism is something that functions using a spring and pin. The bottom of the lever arm contains a piece that attaches to the front wheels like what is shown in Fig. 18 below. The pin can simply be removed from its holder on the front wheel to allow the wheelchair to be disengaged from the control arm setup.

Figure 18: Ability to disengage CLD system
4 Troubleshooting

This section discusses some tips that might be useful should something go wrong with the One Arm Drive wheelchair. This section covers issues like foam padding coming unglued, headrest and/or footrest not being at proper height, and foot straps not fitting properly.

The first topic that will be covered is foam seat cushioning coming loose.

Another issue with the one arm drive wheelchair might be that the headrest is not set at the proper height for the client. The team created a custom headrest bracket shown in Figure 19 that holds this headrest to the back of the wheelchair. The design of this bracket allows for a screw to be loosened so that the headrest can be adjusted up and down at the preference of the client.

![Headrest bracket](image19.png)

Figure 19: Headrest bracket

Similarly, the footrest can also be adjusted to the proper height. There is a screw that is located on the footrest that allows the height to be moved up or down, according to the operator’s desired position.

There are a set of adjustable foot straps that are attached to the footrest. These foot straps can be loosened or tightened depending on the preference of the client. These straps are made of a long strip of Velcro for easy adjustment. Figure 20 below demonstrates the adjustable foot straps on the footrest.

![Foot straps](image20.png)
The height of the one arm drive can also be adjusted. If the lever arm is too high for the client, it can be lowered by removing a screw from the side of the system and adjusting the arm to the proper height. Figure 21 below shows the screw that can be removed from the lever arm in order to adjust its height.

The backrest can be easily removed from the wheelchair to allow the system to collapse for portability purposes. Figure 22 represents the bracket that holds the backrest in the proper position. This backrest is adjustable to different angles. There is a set of pins on the back of the backrest that lock the backrest into place within the bracket. Figure 23 represents this locking mechanism that holds the backrest. Locking the backrest in different positions will provide different support for the client. The backrest can be angled at the client’s desire.
The team purchased additional foam padding and foam glue to enhance the seating in the One Arm Drive wheelchair. Should this padding come loose, it can simply be glued back together using any standard foam glue. The team used a special type of spray adhesive in the assembly of this project. It is possible for the seat cover to unzip to expose the underlying foam padding. This seat cover can also be cleaned by washing it in a washing machine. Figure 24 below shows the seat cushion used in the wheelchair.
5 Related Links

The following are related links that show more information about the Invacare CLD mechanism:

- Invacare CLD Product information:
  http://www.phc-online.com/vvspfiles/docs/CLD-lever.pdf

- Invacare CLD Product Manual:

- Video demonstrating use of CLD system:
  http://www.youtube.com/watch?v=eGkV5apxcvs

- Local Invacare vendors:
  http://www.invacare.com/cgi-bin/imhqprd/inv_dealer/dealer_results.jsp?s=0

- Invacare CLD system for sale online:
  http://www.phc-online.com/CLD_LEVER_DRIVE_LH_6_INSTALL_p/inv-ldr96li.htm