

**CHAPTER 16**  
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# A WHEELCHAIR LIFT FOR ADULTS WORKING AT GONE FOR GOOD™

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## INTRODUCTION

LINCPoint is an affiliate of United Cerebral Palsy of Greater Birmingham, which provides employment services for adults with special needs. One program is called Gone for Good, which employs these adults to sort paper on a conveyor belt for shredding. Many potential employees are restricted by a wheelchair and cannot access the conveyor line, which is too high for them to reach. The client is requesting a wheelchair lift that permits wheelchair bound users to reach the work area, allowing them to do their daily duties. A prototype was completed last year with NSF RAPD support; however, the device was extremely heavy and cumbersome, rendering it unusable. The goal of this project is to modify the existing wheelchair lift, to reduce weight and footprint, and to improve mobility and functionality in the working environment. The device needs to support the weight of the heaviest wheelchair and the user, which is approximately 400 lbs. In order for this device to be useful, it must lift a user of average height 8 in. Each user is allowed to work a maximum of 2.5 hours each day, thus the device must maintain constant elevation throughout their shift. Additionally, the device must fit within the standards of the work environment.

## SUMMARY OF IMPACT

This device provides the workers with ample height to reach the conveyor line. The device has not yet been delivered. However, we anticipate a very positive impact on the LINCPoint facility, allowing new users to participate in the Gone for Good program activities. We hope the system proves to be durable and provides years of safe use for the staff and workers at LINCPoint.

## TECHNICAL DESCRIPTION

The final design (Fig. 16.1) consists of a base that supports the platform and lift mechanism. The base is constructed of tube steel (A36, 2.5 in. x 2.5 in.) and is able to withstand the weight that the actuators push against it and has a “pull handle” for easy transportation. The aluminum platform (Al 6061, 32 in. wide and 40 in. long) holds the user and wheelchair, lifting 500 lbs. with negligible deflection. An aluminum ramp allows the user access to the platform for loading/unloading, and lifts up and locks into place as a rear toe board. The ramp complies with ADA standards that for every one inch of rise, there must be one foot of run. A gate latch keeps the ramp locked in place. Toe boards are also installed (2 in. tall, ADA Standard A.8.7).

The lifting mechanism involves two linear actuators, which attach to the platform via two aluminum “z-brackets”. The linear actuators (Linak LP 2.1) are salvaged from the original design. They are rated to lift 585 lbs each and stabilize moments of 6200 lb-in on the platform. The initial height of the platform from the ground is roughly one-half inch. Therefore, the z-brackets attach to the top of the actuators and bottom of the platform. Spring loaded casters are used for easy transport of the wheelchair lift. The design of the wheelchair lift is made such that with the load of the lift, the platform will have one-half inch of clearance from the ground. When the weight of the user and wheelchair are applied, the springs collapse the remainder of the distance to the ground. This inhibits the movement of the wheelchair lift when it is loaded under the weight of a user. To further limit movement, there is a rubber strip connected to the ramp that creates friction against the floor.

The total cost of this device is \$734.

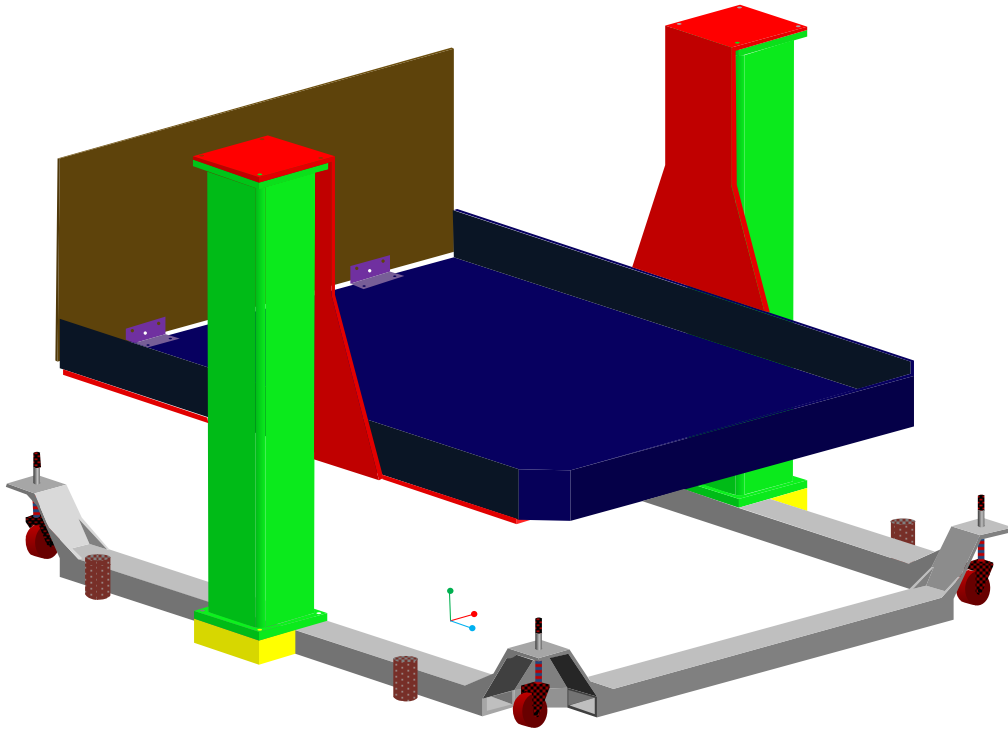


Fig. 16.1. CAD drawings of Wheelchair Lift.

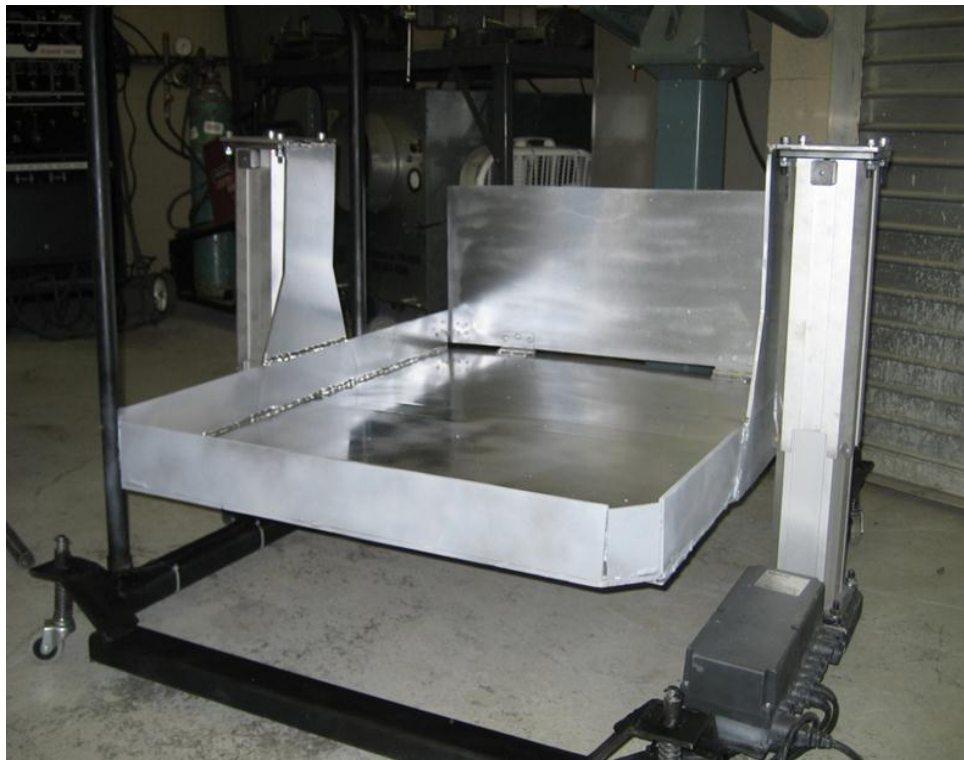


Fig. 16.2. Completed Prototype of Wheelchair Lift.

# THE EASY EATER: AN ASSISTIVE DINING DEVICE FOR A GIRL WITH ARTHROGRYPOSIS

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## INTRODUCTION

Arthrogryposis Multiplex Congenita (AMC) is a congenital disease which severely impairs the movement of joints. The most common cause is fetal crowding and/or immobility. Rigorous intervention immediately follows birth, often requiring physical/occupational therapy or surgery. The purpose of the present design is to develop a no-hands spoon feeder for a three year old girl with AMC and limited use of her arms. The goal is to provide a mechanical alternative that utilizes movement of her torso (flexion/extension) to help her effectively dine with minimal assistance. This aim requires the development of an efficient mechanism for power transmittance from torso to spoon shaft. Safety and ergonomics are heavily considered, and all materials used are to be FDA approved. The device is also to be portable, simple to setup and essentially maintenance-free.

## SUMMARY OF IMPACT

At the time of this document, the finishing touches are needed to improve alignment and ensure smooth mechanical motion and no seizing of gears. We anticipate that, if successful, the impact will be major. The little girl will be able to eat by herself, creating a new level of independence. Her parents will also enjoy new freedom, eliminating the need to spoon feed their daughter at each meal.

## TECHNICAL DESCRIPTION

The final design was dubbed the "Easy Eater" (Fig. 16.3) and consists of two main parts: the push mechanism and the feeder unit. The main feeder unit is responsible for transforming mechanical cable pull into precise spoon turn and controlled extension. With only user-provided mechanical power, the design effectively cycles through its gear

mechanisms with great efficiency, so as not to discomfort the user. The prototype's unique bowl, spoon, and serving motion are adapted from an existing commercial device, the Mealtime Partner™. Our device is essentially a mechanically powered analog that allows our client to take a more active role in eating.

The main role of the push mechanism is to effectively deliver power from the user leaning forward to the main feeder unit's linear guide block. Depression of the push mechanism's chest pad, by the user's forward lean, pulls the cable end 4 in. Cable pull is transferred via a flexible housing to the main unit where it pulls the linear guide block and the lever actuator/gear rack. The first 2.75 in. of block travel causes the lever actuator to turn the lever, miter gears, and turning gear 90 degrees, which in turn rotates the spoon 180 degrees through the bowl, scooping food. The next 1.25 in. of block travel does not turn the lever as it rides on top of the actuator without impeding further displacement.

During this segment, the extension rack contacts the extension pinion, turning the extension cogs and extending the spoon approximately 3.5 in. Spring return mechanisms built into the turning lever and sliding linear guide block reverse the motion after each bite and keep the cable taut. The device is easy to setup and only requires that a table vice be tightened by hand. The forward lean required to operate the push mechanism also puts the user in a natural position to receive a serving of their meal from the extended spoon. The full four-inch range of motion is ensured to be comfortable with a variable selection of light return springs and a custom manufactured chest pad.

The total cost of this device is \$938.

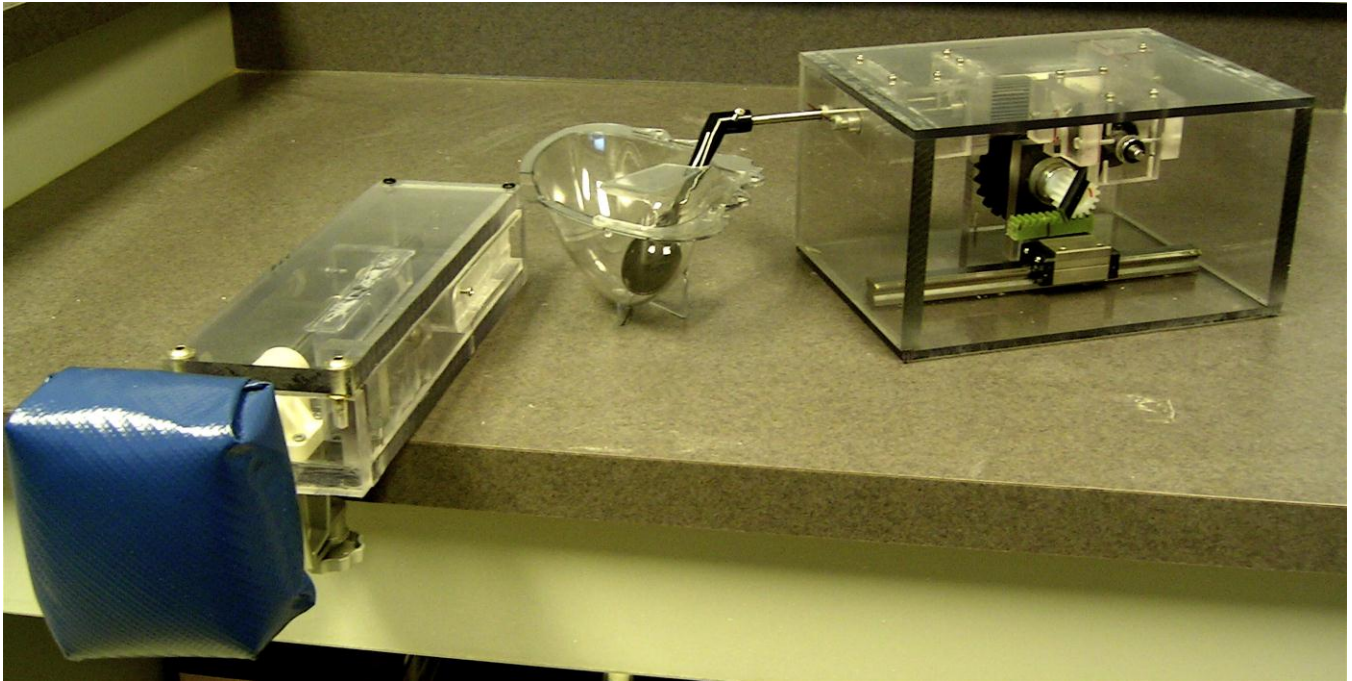


Fig. 16.3. The Easy Eater finished prototype.

## NO-HANDS SPOON FEEDER

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### INTRODUCTION

The goal of this project is to design a second no-hands spoon feeder for our shared client, the little girl with Arthrogryposis, described previously. In this case, the design has switches and motors to drive the spoon scooping mechanism. Additional requirements of the device are that it should be portable, easy to install, and able to attach to a dining room table.

### SUMMARY OF IMPACT

At the time of this document, the student team was still working on the connector arm and switching system. If successful, this device will provide the little girl with Arthrogryposis another feeding device option, in this case a battery-operated one that works with the press of two buttons. Again, this will create a new level of independence for our client and freedom to her parents during mealtime.

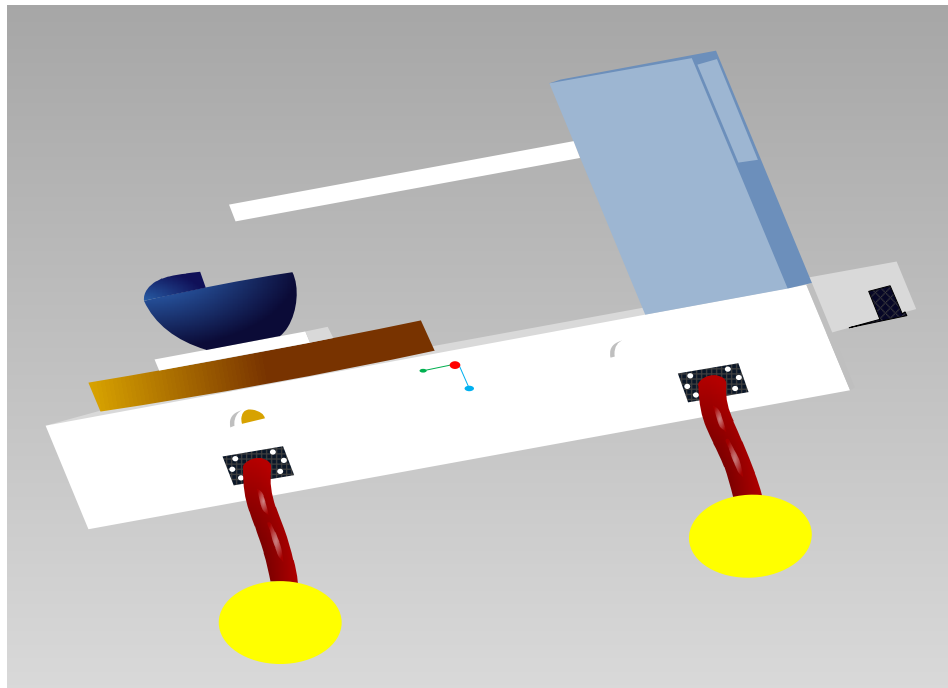


Fig. 16.4. CAD Design of the No-hands Spoon Feeder.



## TECHNICAL DESCRIPTION

Fig. 16.5 illustrates the final design at the time this report was written, still under construction and without the connecting arm attaching the spoon to the motor. A slab of polypropylene is machined to create the base, the body and arm of the no-hands spoon feeder. The base of the design is 16" long, 12 3/4" wide, and 1.50" thick. The bottom of the base is hollowed out to reduce weight. The base is hollowed out at 0.50 inches from the edge of the base, leaving a 6" diameter circle for the location of the turntable and a rectangle with 3.625" wide and 6.375" long for the location of the battery.

A 12 V DC gear motor with 40 in-lb of torque at 8 rpm creates motion in a 5 in. diameter circular path for a 7 1/4 in. long, 1 in. height, and 1 in. width attached arm. The spoon attaches to the arm with a

90 degree angle at the tip of the handle, and radius of 2 in. at the scooping location of the spoon. There are three bowls that can be placed on the turning plate. A turntable is utilized to rotate the plate for different locations of food, which has a 7 in. diameter and a height of 2 1/2 in. The spoon and turntable are controlled by switches attached to goose necks. A Genesis battery (12 V, 2 Amp-hr) is used to supply power to the motors. Two goose necks (15 inch long arm type C) are large enough to fit the wire going to the control system and are mounted onto the base of the feeder using a rectangular plate or universal plate. The switches control the spoon (right) and turntable (left), and are extended from the base for easier access for the individual.

The total cost of this device is \$537.76.

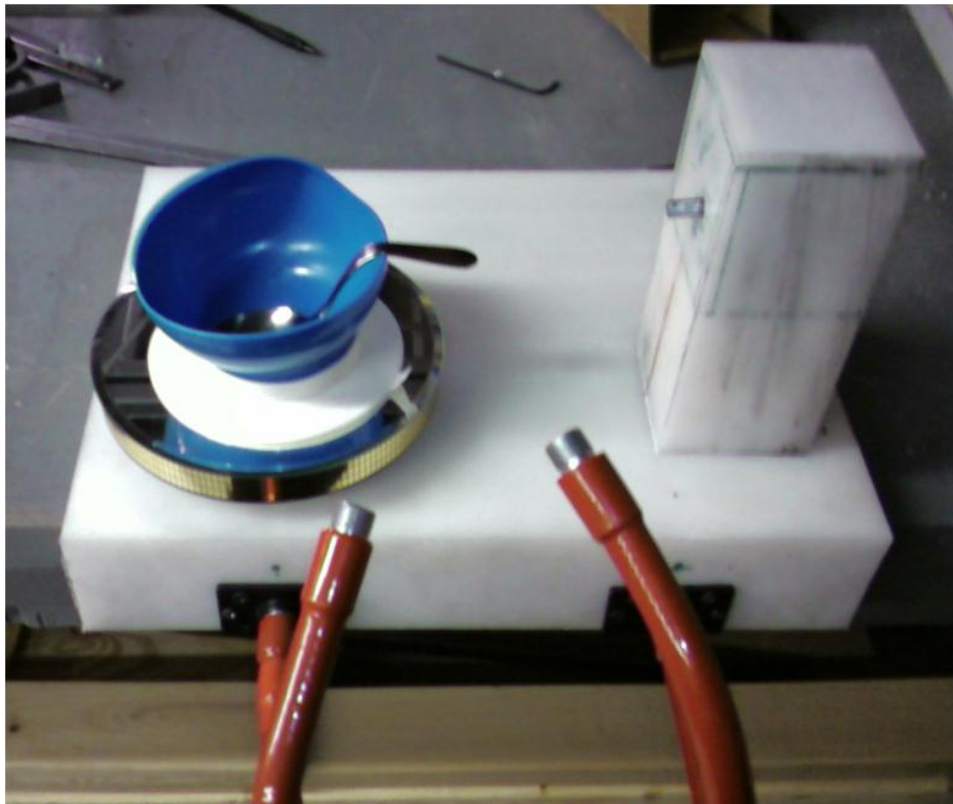


Fig. 16.5. No-hands spoon feeder device under construction.

# WALL CLIMBER FOR SPECIAL NEEDS CHILDREN AT THE BELL CENTER

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## INTRODUCTION

This project involves the design and construction of a wall climber for The Bell Center, which provides day-care services for special needs children ranging from ages one to three. The first and most important concern is safety. The total weight and portability of the climber are important, since the climber will be moved frequently in and out of storage. The different abilities of the children using the wall climber are also taken into consideration since the children have a wide range of mobility. Size and ease of storage is also an important factor in this design. The staff at the Bell Center has limited space to store the climber, so it also needs to break down and take up a minimal amount of space.

## SUMMARY OF IMPACT

Although device construction has not been completed, successful delivery and implementation of the wall climber will impact the Bell Center children and staff. Children who previously were unable to access existing climbers will have the opportunity to play and develop motor skills using the new climber. The device is intended to function with only one supervisor needed to ensure the safety of the children. This may free up other staff to supervise additional children who wish to participate in other activities.

## TECHNICAL DESCRIPTION

The final design (Fig. 16.6) features a platform that is enclosed on two sides, thus reducing the number of supervisors needed to one. The climbing ramps are designed to accommodate children with both normal and reduced mobility. The ramp for the children with low mobility is oriented with a gradual slope (approximately 30 degrees), and instead of climbing pegs, the surface is a soft rubber

mat to allow for maximum grip. The other ramp is similar to a traditional climbing wall. It has the standard climbing grips, but is inclined at a 45 degree angle to reduce difficulty. Both of the ramps are lined with 10 in. barriers on either side to prevent children from slipping and falling off the ramps. At the top of the platform, there are interactive components such as a mirror and a steering wheel that act as an incentive for the children to climb to the top of the platform. On the other open side, there is a slide to allow children to get off of the platform in a safe and entertaining manner.

The enclosing walls at the top of the platform and the hand rails are designed to fold down. The ramps and slide are detachable and can be stored inside the base, which is made to dimensions of 3 ft x 3 ft. x 5 ft. The base has wheels on one side that can fold out to allow for easier transport to the storage area. The device conforms to ASTM standards for play equipment, F-2373 and F-1487, which apply to children 6-23 months, and 2 -12 years old, respectively.

Construction of this device is underway. The box platform will be constructed with FRP channels. The frame will be covered with thin sections of a polypropylene fiber/polypropylene matrix panel, which goes by the trade name of CurvTM. The climbers will be a composite construction with Honeycomb and Curv. Adhesion between the Curv and honeycomb structure will be created using a specialty 3M tape. The guardrails will be constructed using PVC and then covered by soft foam. The box platform frame will be built with fiber-reinforced plastic (FRP) channels and tubes from Bedford Plastics.

The total cost of this project is \$850.



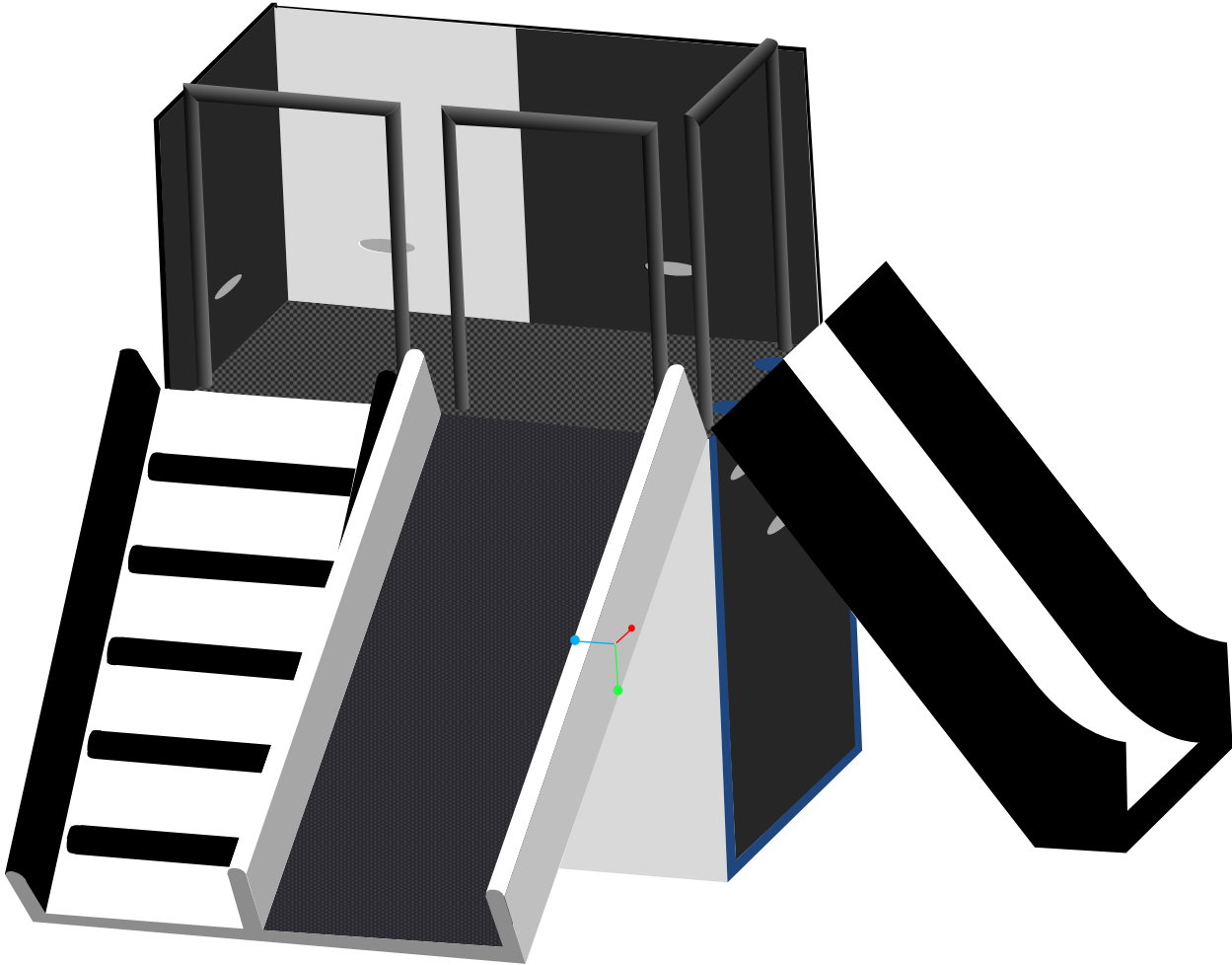


Fig. 16.6. Schematic of the climbing wall to be constructed for the Bell Center.

