# CHAPTER 18
# UTAH STATE UNIVERSITY

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# AUTOMATIC ROCKING BENCH SWING

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## INTRODUCTION

This project was designed for a young woman with autism who had a history of engaging in self-injurious or aggressive behavior when she was tired, bored, or frustrated. Her parents reported one of the few things that calm her during such episodes was to rock her for long periods of time, either in a rocking chair or on an outdoor porch swing.

This led to the development of an inexpensive automatic bench-type swing, in which the young woman was able to rock herself independently. Making the automatic swing mechanism safe and easy to use for the consumer was an important consideration. Because she could use it independently, she was able to engage in an enjoyable, self-selected leisure activity. Her use of the swing provided the additional benefit of some much-needed respite for her primary caregivers.

## SUMMARY OF IMPACT

This automatic swing was developed to meet the needs of one consumer and her family. However, the swing is appropriate for use by children (age 3+) or adults with a range of disabling conditions, who may benefit from the sensory stimulation and relaxation the swing can provide. Safety features include an adjustable seatbelt, a padded seat, an adjustable umbrella to limit sun exposure, a weather-safe motor enclosure, and an easily accessible switch for the caregiver.

## TECHNICAL DESCRIPTION

The swing structure was made of 1.5" galvanized pipe for long lasting outdoor use. The framing dimensions were made to hold a five-foot bench with room bilaterally to eliminate the possibility of pinching hazards. The base is 4' x 7' with 8"x 8" steel pads used for supporting the swing in a level manner.

16” steel drive rods were used to give the swing added support in the desired location in the front lawn of the consumer’s house. The height of the frame structure is 6' 4" to accommodate the height needed for the free-moving swing.

The swing attachment is made from a 5/8" swivel with an internal bearing allowing free movement. The 5' wooden bench seat is attached to the 1.25”metal pipe swing frame. The motor is a ½ hp 110-volt AC gear motor with 30 RPM. The motor attaches to the swing frame directly underneath the center of the bench. The motor also attaches to a steel base stemming from the lower steel frame work and is positioned in a vertical position allowing the actuating arm to have unlimited lateral motion. The motor frame and bench frame are attached by an actuating arm with swivel couplers on both ends. The motor and actuating arm are encased in a protective cover to ensure safe operation.

Figure 18.1. Automatic Rocking Bench Swing.

# TRAILER-MOUNTED LIFT SYSTEM FOR HORSEBACK RIDING

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## INTRODUCTION

Lifting a person from a wheelchair to a horse is no easy task and the risk of injury to caregivers and consumers is considerable. The purpose of this project was to design an affordable lift system that would make the transfer from wheelchair to saddle easier and safer, thus making horseback riding a more accessible recreational option for persons with disabilities.

## SUMMARY OF IMPACT

There are many equestrian organizations for people with disabilities in the United States. Few use lifts. A local organization that provides recreational activities to its consumers with disabilities needed a lift system that was mobile and inexpensive. After several meetings with the recreational department of this organization, design criteria established were that the lift system:

- Provide a safe and easy means of lifting a person from a wheelchair on a trailer bed to above the horse's back;
- Be adjustable and have lifting range of up to 5 feet;
- Easily pivot from the wheelchair position to the horse mounting position; and
- Be simple and cost-effective.

## TECHNICAL DESCRIPTION

This project incorporated three major components, including a trailer, a wheelchair ramp, and the lift system. The trailer was 8' x 10' and had a height of 20" on its deck. Four adjustable stands were added at each corner to ensure stability and to provide for a flat surface when on uneven terrain. A wheelchair ramp was added, providing easy access to the trailer bed, easy removal, and storage on the trailer when transporting to a different site. The trailer and ramp were available on the market at reasonable prices.

The lift system was built to provide the recreational team a transfer method with substantial range and a quiet, smooth transfer.

The lift system was built on a 2' square base made from a 1/4" steel plate. A 44" x 2 1/4" steel pipe extended from the base, with three gussets providing the rigid stand.

The lift mechanism was 6 feet tall and built from 1 3/4" steel pipe with a rounded plug at the bottom, providing a smooth pivoting point.

The lift arm was built from a solid 1 1/4" shaft with a 20-degree bend to keep the angle of motion in a more fixed position during lifting. The adjustable arm was inserted into the 1 1/2" pipe connected to the upright standing frame. The hydraulic cylinder was a standard piece of durable medical equipment, therefore meeting safety standards.

Figure 18.2. Trailer Mounted Personal Lift Transfer System.

# REMOTE-CONTROLLED MOTORIZED TOY VEHICLE

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## INTRODUCTION

An inexpensive simple kit was developed to modify a toy vehicle to be operated by remote control. It was designed for a child with cerebral palsy. Toy vehicles on the market need major modifications both for the safety of the child and the addition of the remote control. The main modified components of this project are as follows:

- New safety harness
- Better roll bar
- Motor to control steering
- Motor to control speed
- Relay to control stop / start

The modified toy in shown in Figure 18.3.

## SUMMARY OF IMPACT

The major goals included the following:

- Safety for the child
- Easy and inexpensive modifications for parents
- Parent control of vehicle
- Enjoyable interface for the child

A kit was designed to utilize a remote control to operate servomotors similar to a remote-controlled airplane. A safety harness and larger roll bar were added to the vehicle. An additional modification was made to enable the child to use the steering wheel without interfering with control of the car.

The kit includes complete instructions and all necessary parts to accomplish the modification or information on where to obtain parts.

## TECHNICAL DESCRIPTION

The modification involved converting a remote signal to enable the parent to steer, start / stop, and change speeds on the toy vehicle. Most remote devices (and the one chosen for this project) come with two small servomotors. Using mechanical switching, the gas pedal and the gears are operated by one or both of these servomotors.

Through preliminary tests, the torque required to turn the car was determined to be 250-ounce-inches. The size of the servomotor and its connection to the vehicle were designed accordingly. Utilizing a four bar linkage, the rotation of the servomotor was transferred to the steering column.

For safety, the degrees of freedom on the steering column were limited to plus and minus 30 degrees. This provided a large enough mechanical advantage to overcome this high torque with a smaller servomotor.

To meet the needs of the child with limited motor control, a larger and more secure roll bar was added along with a safety harness to provide the child with needed support.

The final cost of the kit was approximately $270.

Figure 18.3. Remote-Controlled Motorized Toy Vehicle.

# THE SIGHTSEER: ADAPTED OFF-ROAD VEHICLE

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## INTRODUCTION

All-terrain vehicles (ATVs) are not designed for persons with disabilities to use safely. A prototype was developed to allow an individual with limited use of his limbs to operate safely an off-road vehicle.

## SUMMARY OF IMPACT

The Sightseer is an off-road vehicle designed to be operated by a person with a disability or any individual who would prefer a 4-wheel drive ATV with additional safety features such as a four-way seatbelt harness system, roll cage, and safe return steering. The Sightseer vehicle is fully controllable by a person with limited use of one hand. Further testing is needed to determine whether a person with quadriplegia would be able to operate the steering controls if a joystick controller were provided.

## TECHNICAL DESCRIPTION

Design criteria were that the Sightseer be:

- Be accessible for entry of a person in a wheelchair;
- Be safe and durable, with restraints and a roll bar to protect the driver;
- Be reliable, reducing the possibility of breakdown so that the user would be stranded;
- Have four-wheel drive;
- Have simple controls and few complicated parts.
- Have a top speed between 10 and 15 mph for safety; and
- Be designed to climb a 30-degree incline.

A 10 hp Briggs and Stratton gas engine was used to power the Sightseer. Two hydraulic motors were used to provide variable torque output and skid steer. The steering was designed so that if the hand control is released or centered, the vehicle will come to a stop. The vehicle has an electric start and is run by two levers, which fit in one hand.

The vehicle is equipped with a harness over both shoulders and a lap belt to hold the user in a comfortable, safe position. The seat is padded and has a high back for upper trunk support. Four chains were utilized for the power and the steering, thereby enabling the operator to return for assistance if one chain were to break. Standard-sized ATV tires were used for easy replacement. The chains and all other moving parts are protected from accidental contact for safety.

A safety training session was planned and offered to the user.

Figure 18.4. Off-Road Vehicle for a Person with a Disability.

# CHILD'S JOYSTICK-CONTROLLED GO-CART

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## INTRODUCTION

Many children with physical disabilities cannot easily operate standard motorized vehicles. Motorized vehicles adapted for use with a joystick control cost up to twenty times more than standard models.

The purpose of this project was to design a safe inexpensive joystick-controlled motorized go-cart for a 6-year-old boy with motor impairment due to spina bifida. The child had a cart that had been adapted from a standard type vehicle, but it was difficult for him to operate, and the cart would not operate on the lawn area around his house. Furthermore, the seating system on his cart did not provide him optimal support and its long wheelbase resulted in poor maneuverability.

## SUMMARY OF IMPACT

Many youths with a range of cognitive or motor impairments could utilize an affordable, attractive form of independent mobility. There are several benefits from using this type of device, including the development of visual and motor skills, increased social activity, and outdoor recreational opportunities from which children with disabilities are often excluded.

The go-cart fabricated for this project incorporated many important safety features including a seat belt system, a foam wrapped roll-bar, a free floating front axle, and a low center of gravity.

## TECHNICAL DESCRIPTION

The main objective of this project was to enable anyone, including persons with limited mechanical skills, to construct a high quality, low cost, joystick-controlled go-cart using recycled equipment. Most of the basic components of the go-cart were taken from motorized wheelchairs that had been discarded or outgrown by their operators. Design requirements included a short wheelbase for good maneuverability, a low center of gravity to compensate for the short wheelbase, and a seating system that would provide the operator with total support for his torso and legs.

The front wheels were extended 5", enabling the seat to be positioned in a safe operable position. Chrome rectangular tubing (3/4" x 1 1/2") was welded from the lower battery frame to the front axle. A solid shaft was fitted into the original frame pivot point and covered with a chrome pipe for aesthetic value.

A child-carrier seat from a bicycle was adapted to provide added support to the user's torso and legs. Half-inch closed cell foam padding was used to cover the seat, back, leg, and footrest areas.

The seat angle was set as the child sat in the cart while accurate measurements were taken. A front bumper was then added to give additional protection to the child and the go-cart framework.

Because this go-cart may be constructed from parts obtained from older motorized wheelchairs, which are often available at a low cost, the total cost of a similar project may range from only $200 to $500.

Figure 18.5. Child's Joystick-Controlled Go-Cart

# WHEELCHAIR DYNAMIC SEATING SYSTEM

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## INTRODUCTION

Over two million Americans suffer from a debilitating condition known as decubitus ulcers or pressure sores. The sores occur as a result of prolonged pressure in the seating area. Individuals who use wheelchairs are susceptible to them, especially if they are unable to make natural, manual shifts of their own weight.

The goal of this project was to create a dynamic seating cushion to prevent pressure sores by alternating the air pressure in the cushion. The seat is designed to assist the natural shift of an individual, thus reducing pressure between the individual's buttocks and seating area, and facilitating blood flow through a pulsing action of high versus low pressure. This theoretically alleviates the problems of constant pressure experienced by individuals with limited movement utilizing wheelchairs. The completed prototype will provide a platform for further investigation of the project's efficacy.

## SUMMARY OF IMPACT

In the sitting behavior of persons without a disability, there is frequent weight shifting from side to side and from front to back, which occurs unconsciously. This dynamic seating system would help one with a significant motor impairment to simulate this natural weight-shifting pattern. Automatically controlling airflow throughout the cushion provides constant changes in the seating position for the individual. The programmable flow of air throughout the cushion acts as a natural shifting process, which helps alleviate constant pressure on certain points on the buttocks most vulnerable to the development of pressure sores.

## TECHNICAL DESCRIPTION

To obtain a suitable design for this project, a dynamic cushion, designed by Roho, Inc., that provides an individual with the lowest pressure differential between the cushion and the posterior of the user was studies. Design specifications were then given to Roho employees, who produced the prototype. The new cushion has 90 separate air compartments in 9 different rows, divided in the middle of the cushion, resulting in 18 different controlled rows.

A diagram showing the pneumatic plumbing of the cushion is presented in Figure 18.6. A 12-volt pump provides the air pressure needed. A micro-controller controls the mechanical and electrical system.

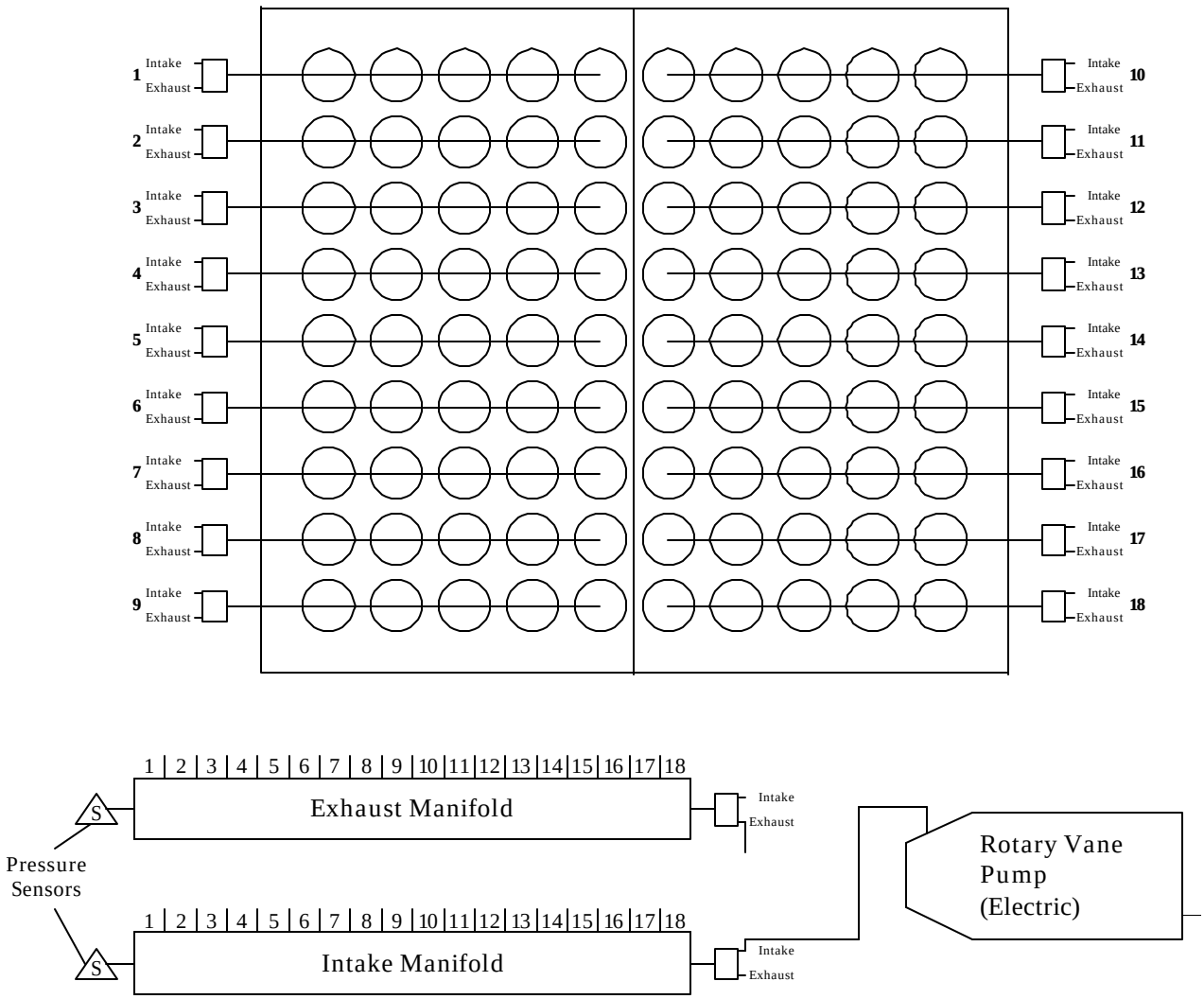


Figure 18.6. Mechanical Diagram.

# THREE-WHEELED HAND POWERED CYCLE

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## INTRODUCTION

A three-wheeled hand-powered cycle was designed to provide riders who have motor impairments with an affordable cycle that requires only the use of the upper body.

## SUMMARY OF IMPACT

Adapted cycles are typically unattractive, heavy, and overprotective. A cycle was designed to be easy to use, lightweight and fun. The design provides safe, affordable recreational exercise to individuals with paraplegia or other lower extremity disabilities.

## TECHNICAL DESCRIPTION

The cycle utilizes a standard tricycle configuration, is hand powered (cranked) with an internally geared, chain-driven mechanism connected to the front wheel and mounted directly in front of the rider. Steering is controlled using the same crank mechanism that powers the cycle. Braking is accomplished via front wheel reverse cranking.

The frame consists of a triangular main section and a rear suspension wishbone made of 6061 aluminum. The frame is designed to support a rider weighing up to 300 pounds under normal riding conditions. Notable frame components include a full seat in the recumbent position, standard bicycle headset, ergonomically correct hand cranks, and a rear shock absorber. Other designs are available on the market, but

Figure 18.7. Three-Wheeled Hand Powered Cycle.

are prohibitively expensive and do not include a suspension system.

To ensure safety, a chain guard was placed over the drive system. This cranking system is designed to collapse under the weight of the rider in the event of a severe collision. A leg cross brace was provided for maintaining leg positioning.

The down tube has padding to protect the rider from leg bruises. The cycle also has reflectors. The use of a helmet is strongly recommended for all users. A diagram of the design is shown in Figure 18.8.

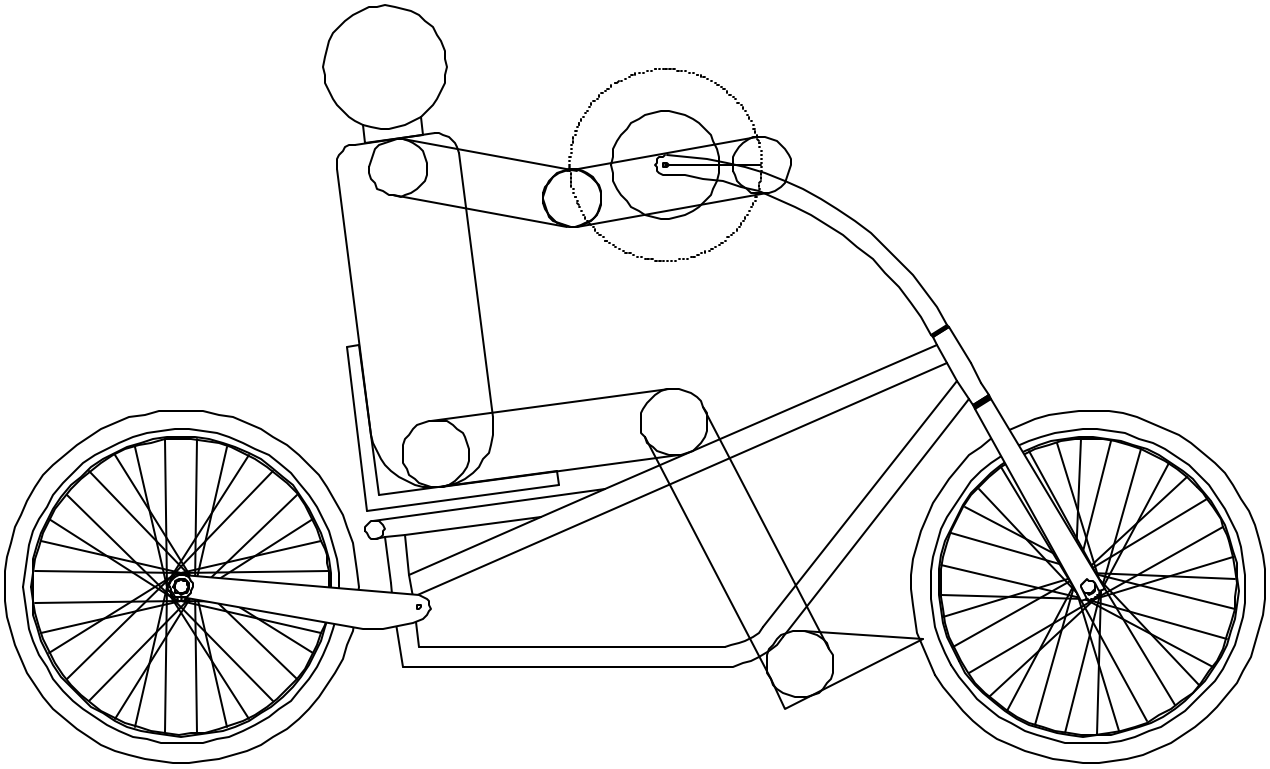

Figure 18.8. Three-Wheeled Hand Powered Cycle.

# DUAL ADAPTIVE RECUMBENT TRICYCLE

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## INTRODUCTION

The Dual Adaptive Recumbent Tricycle (DART), a three-wheeled tandem bike, was designed to provide stable riding for two. The rear rider cranks with his or her arms while the front rider steers and pedals.

## SUMMARY OF IMPACT

The DART is a tricycle that allows two riders to travel together. The rear rider may have any level of ability. He or she may crank with his or her arms or just ride along; he or she is not required to balance or control the cycle.

## TECHNICAL DESCRIPTION

This tricycle was built in a tadpole configuration, with two front wheels providing the steering, and the rear wheel providing the power. It was designed to be recumbent, with full seats to support the riders and provide greater comfort.

The frame and seat of the cycle were assembled from 6061-T6 aluminum with an expected life of 20 years. To ensure continued usability, the cycle was constructed using as many standard bicycle components as possible, including such items as brakes, wheels, derailleurs, and cranks.

To ensure safety, guidelines from the American Society of Mechanical Engineers Human Power Vehicle competition were followed, with exception of rollover protection. This was considered to be unnecessary because of the recreational, low-speed nature of the project.

Figure 18.9. Dual Adaptive Recumbent Tricycle.

There are similar recumbent designs on the market. However, their costs are prohibitive for the average consumer. Also, current designs on the market do not provide the person in the rear position the capability of cranking with his or her arms.

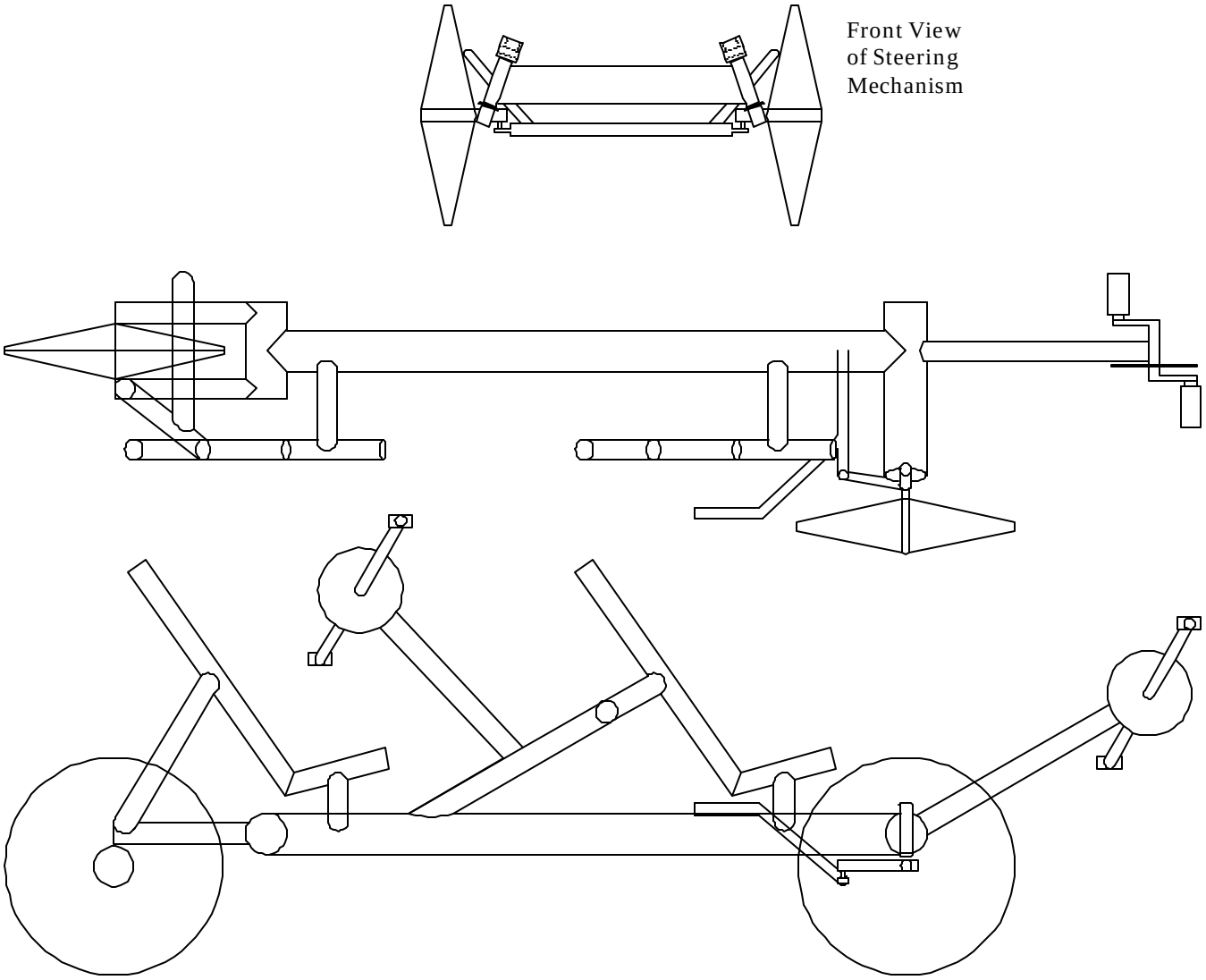


Figure 18.10. Dual Adaptive Recumbent Tricycle