Designs for 6 Basic Wheelchairs

CHAPTER **66**

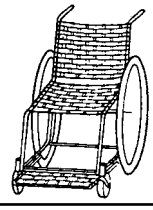
There are dozens of designs for low-cost, appropriate technology wheelchairs. Some are lower cost and more generally useful than others. In PROJIMO, we have built many different wheelchairs. In this chapter we give designs for 6 of the ones that we have found most useful. Each has advantages and disadvantages.

Healthlink wood wheelchair made from a child's chair, bicycle wheels and axles at front, one rear caster

Advantages: The simplest and one of the cheapest chairs to make; easy to modify or adapt; very little welding needed; can be built in one day by someone with some carpentry skill; low cost.

Disadvantages: Single, small rear wheel makes it difficult for either the child or helper to push over rough ground or up curbs. Fixed footrest makes it hard for child to climb in and out without tipping chair forward when weight is on footrest. Sideboard makes transfers to side and lifting child from behind difficult.

Re-bar and woven plastic wheelchair steel construction rod frame with woven plastic seat, back, and footrest

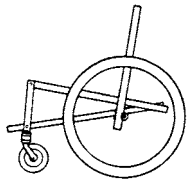


Advantages: Simple design; fairly low-cost re-bar is easy to bend; plastic woven seat is comfortable and easy to clean; slide-away footrest makes getting in and out easier.

Disadvantages: Builder needs welding skills; relatively heavy and not as strong as tubing chairs. Big bumps may bend the chair out of shape.

Square metal tube wheelchair

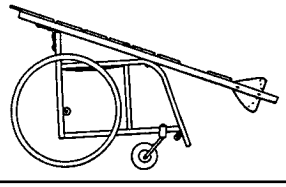
frame bolted together



Advantages: Strong, stable metal chair that can be built with nuts and bolts (welding needed only to attach front wheels). Flat surfaces make it easier to put on wood adaptations; fairly low cost.

Disadvantages: More work and skill needed than for above chairs; design more complex; slightly higher cost than wood chairs.

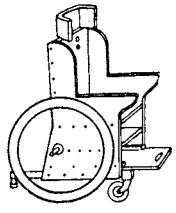
Wheelchair with lying board made of steel tubing, with removable wood lying board



Advantages: Useful for active child who must lie face down to heal sores or stretch contractures. When board is removed, it is regular wheelchair; low cost; very adaptable.

Disadvantages: Requires welding (but a simpler model can be made of wood); does not fold; board takes up a lot of space; stiff ride.

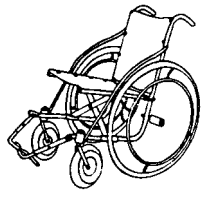
Plywood frame wheelchair with 20 inch bicycle wheels and axles, and 2 front casters



Advantages: Attractive; lightweight; low cost, easy to make and adapt. Caster wheels in front (not in back) make it easier to go over rough ground and curbs. Adjustable push-away footrest makes positioning and getting in and out easy.

Disadvantages: Plywood and double casters increase cost (although it is still a cheap chair). Plywood (if not marine grade) may come apart in wet weather. Bicycle axles may bend or break with a heavy child or rough use.

Metal tube folding wheelchair made from thin-wall steel tubing; strong axles with machinery bearings



Advantages: Chair folds for transporting or storage; very tough; flexible design good for uneven surfaces; good for side transfers; a very high-quality chair if well-made.

Disadvantages: Needs more skill (tube bending, welding, wheel spoking, etc.) to build; relatively costly; hard to adapt.

Tools needed for making wheelchairs

Ideas for setting up a workshop for workers with disabilities are discussed in Chapter 57 and p. 603 of Chapter 64. How you equip your workshop for making wheelchairs will depend on (1) how much money you have (or can borrow) to do it, (2) the kinds of chairs you hope to build (metal or wood), (3) the skills, physical and mental abilities, learning potential, and responsibility (regarding safety) of the workers, (4) the availability of electricity and power tools, (5) how many persons will be working, and (6) how many chairs you hope to produce.

Here we list the basic equipment you will need for making the 6 wheelchairs described in this chapter. Many choices are possible. More specialized parts of the work can be done by outside craftspersons. For example, in a wheelchair production center in Belize, axles must be machine tooled on a metal lathe. Local machine shops cooperate by doing this free.

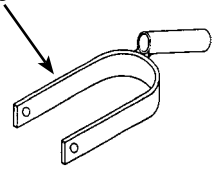
CODE **AN** – Absolutely necessary **N** – A big help, but you might do without it **(N)** – Necessary only for axles **?** – Depends on model	**TYPE OF CHAIR**					
	wood chair	re-bar and woven plastic	square metal tubes with wood seat and back	wheelchair with lying board	plywood	round metal tube
TOOLS REQUIRED bench vise	N	AN	N	AN	(N)	AN
tubing bender				AN		AN
welding (brazing) equipment	(N)	AN	N	AN	(N)	AN
metal saw	(N)	AN	AN	AN	(N)	AN
wood saw	AN			AN	AN	
hammer	AN	AN	AN	AN	AN	AN
wrench (set or adjustable)	N	N	AN	AN	N	AN
metal file and/or grinder	(N)	AN	AN	AN	(N)	AN
screwdriver	AN	AN	AN	AN	AN	AN
sewing equipment (hand or machine)			?	N?		N?
drill (hand or electric)	N	?	AN	AN	N	AN
drill bits for metal			AN	AN		AN
drill bits for wood	AN		AN		AN	
spoke wrench	?	?	N	N	?	N
bicycle pump	?	?	?	?	?	?
center punch	N	N	N	N	N	N
tape measure	N	N	N	N	N	N
carpenter's square	N	N	N	N	N	N

Terms for metal tube or bar used to build wheelchairs

- *Thin-wall* refers to thin steel tubing often used for electrical wiring work and sometimes for lightweight metal furniture.
- *Thick-wall* refers to heavy weight pipe such as the one used in plumbing.
- *Re-bar* refers to solid metal rod, usually used to reinforce cement.

Jigs or guides for more exact welding

For making the metal tube chairs and the welded wheel mounts and handrims of any of the chairs, your work will be easier and more exact if you make or purchase certain "jigs" or guides to hold parts in the right place while you weld them. For example, to weld the front caster fork you can make a jig like this. Details on jigs and other techniques for making different wheelchair parts are well described in Ralf Hotchkiss's book ***Independence Through Mobility*** (see reference on p. 604). We strongly recommend it to any group planning to make wheelchairs.



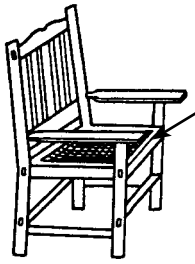
Notes on measurements
For some of the wheelchair designs in this chapter, we give the measurements for a standard child's or adult's model. Be sure to adapt the measurements to the size and needs of the particular child.

In many countries inches (") are used for measurements of certain things, and centimeters (cm.) for others. We therefore also use both. Centimeters is abbreviated cm. and inches is abbreviated ". Two inches is written 2". 1" equals 2.54 cm. You can use the scale on the edge of this page (and on the inside back cover) to change inches to cm.

HEALTHLINK WOOD WHEELCHAIR

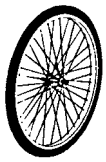
(Modified from *Personal Transport for Disabled People—Design and Manufacture*, see p. 604)

The Healthlink wheelchair is built onto an ordinary **child's wood chair.** Measurements should be adjusted to the child's needs.



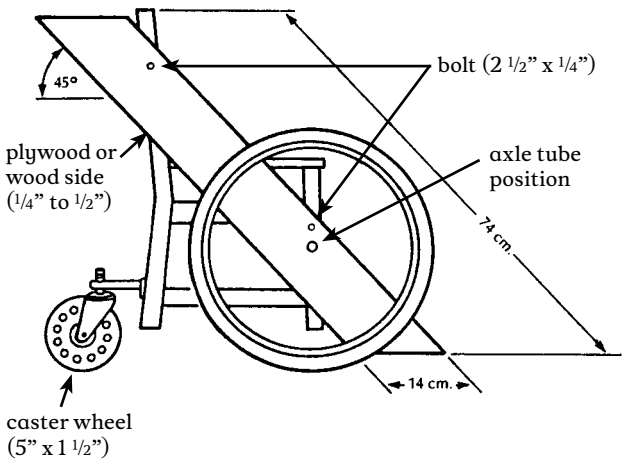
A webbed plastic seat lets air move through it and can be easily cleaned.

It uses standard 20" x 1 3/4" bicycle wheels and axles.

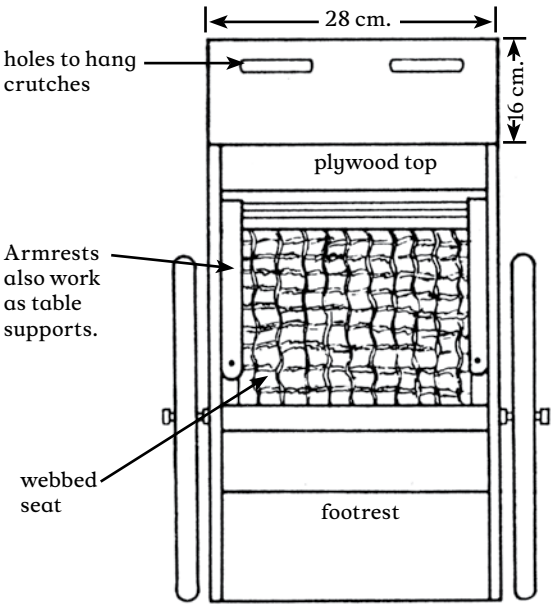


Basic carpentry tools are needed to build this wheelchair. It can be made in one day by someone with basic carpentry skills. The local blacksmith may be able to help weld together the wheel supports if you cannot. It is easy to add positioning aids or make other adaptations.

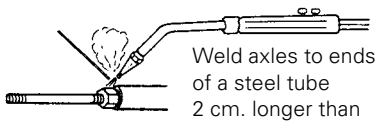
SIDE VIEW



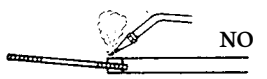
TOP VIEW

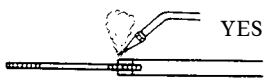


AXLES

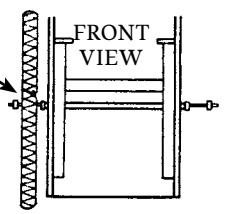


Weld axles to ends of a steel tube 2 cm. longer than the chair is wide.



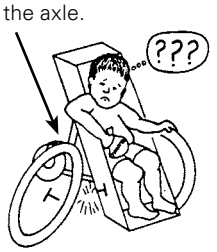


Weld axle perfectly straight.

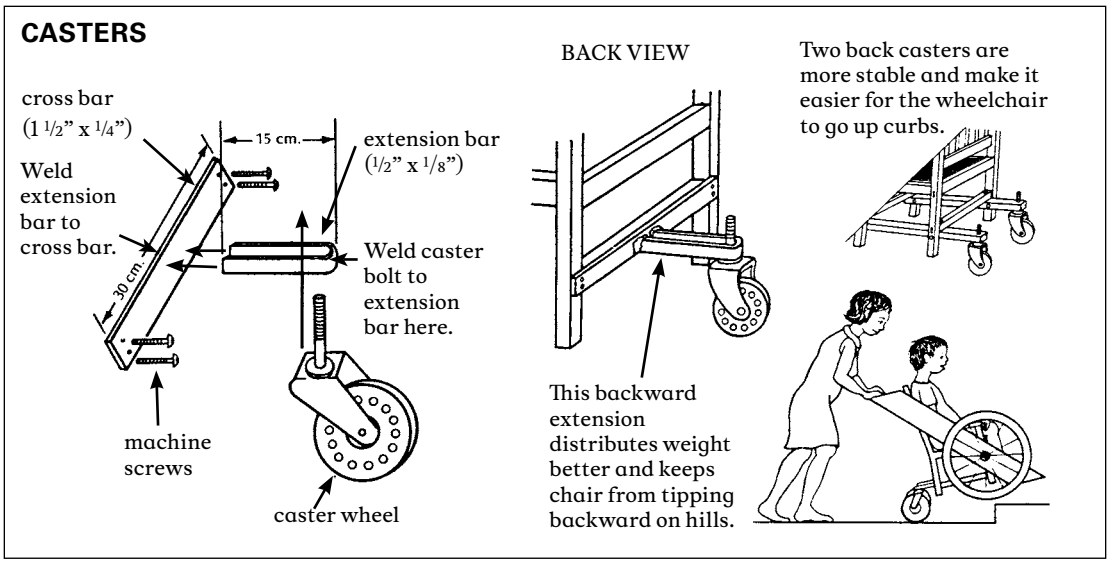


Pass axle tube through holes drilled through sideboards and front chair legs.

WARNING: Use standard bicycle axles this way only for children under 20 kg (50 lbs). A heavier child, or rough use, will bend or break the axle.

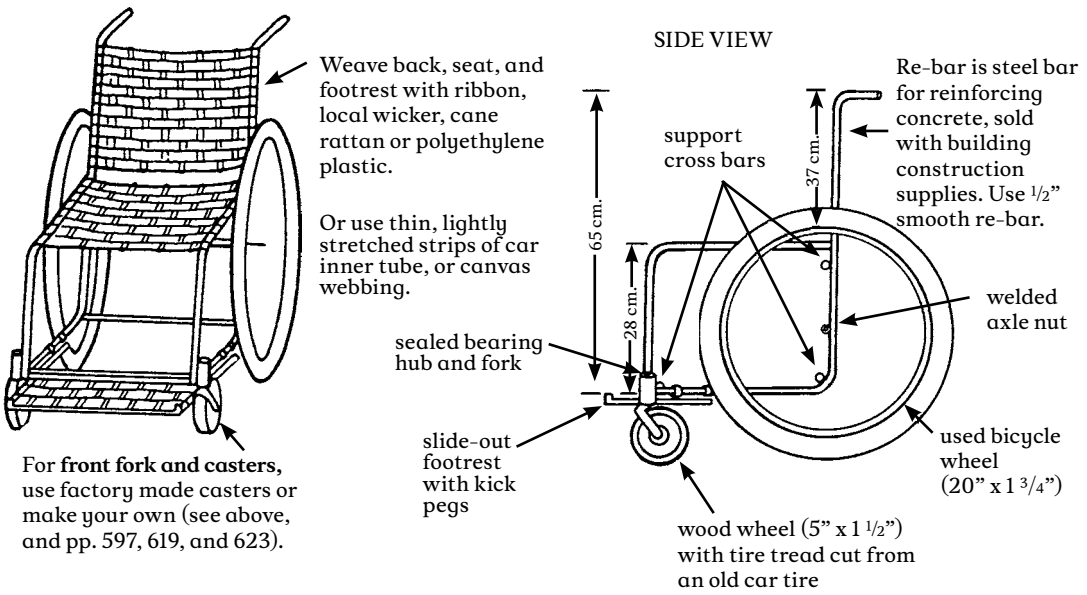


For children over 20 kg, use a stronger axle (see p. 623). Or support the bicycle axle from both sides (see p. 598).

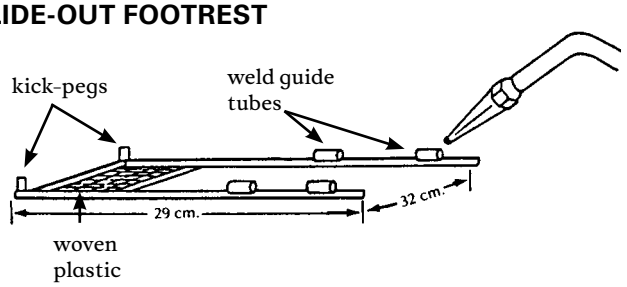


For **brake designs**, see pp. 601 and 623. For other pictures and models of the Healthlink wheelchair, see pp. 526, 592, 600, 601, 604, and 624.

RE-BAR AND WOVEN PLASTIC WHEELCHAIR



SLIDE-OUT FOOTREST



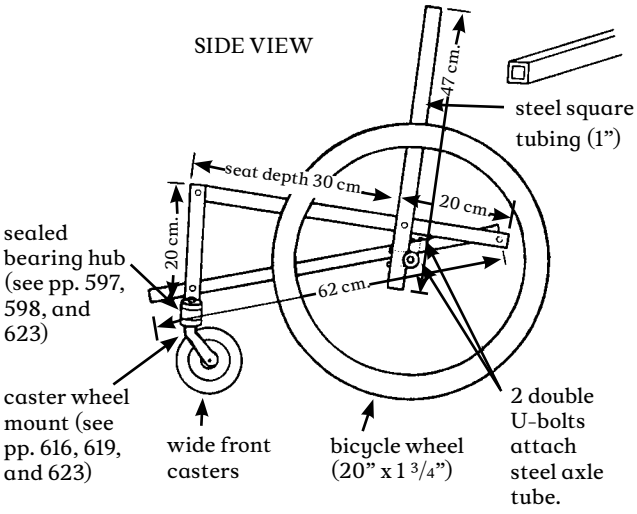
MATERIALS NEEDED

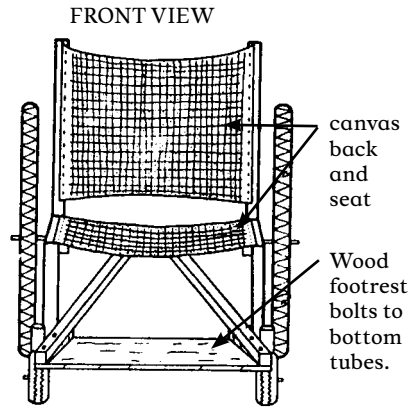
- ½" re-bar (4 ½ meters)
- inner tube strips
- bicycle wheels (2)
- front casters (2)
- webbing for seat

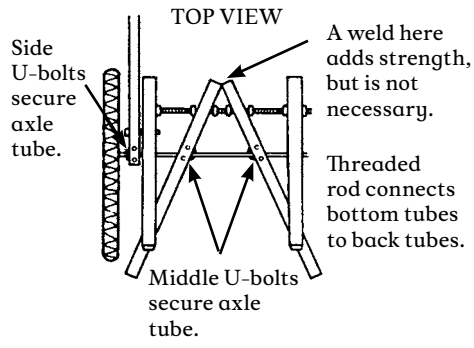
For **axle designs** see pp. 597, 598, 615, and 623.

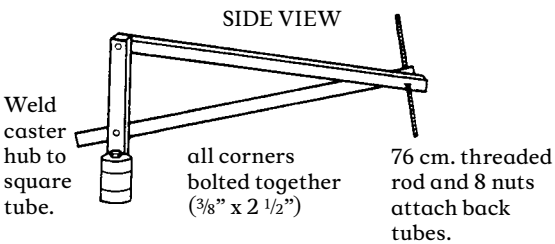
SQUARE TUBE WHEELCHAIR

This wheelchair, like other steel tube chairs, should use only thin-wall tubing. To keep costs down, check with various sources of materials and ask at small fix-it shops for advice and possibly even some free scrap material. Metal scrap heaps are great for materials.







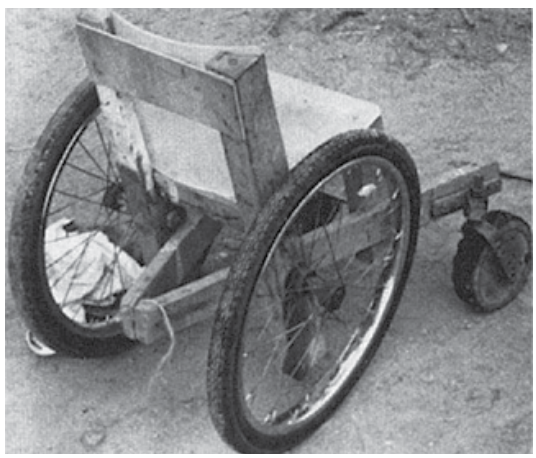


MATERIALS NEEDED

- thin-wall square tubing (1" x 3.64 meters)
- thick canvas cloth (1 square meter)
- galvanized steel tube (½" x 66 cm.)
- bicycle wheels (2) (20" x 1.75")
- caster wheels (2) (wood or rubber)
- threaded rod (⅜" x 38") (Use extra 20" to bend 4 U-bolts.)
- 2 front casters
- 21 ⅜" nuts and 12 screws for seat and back supports

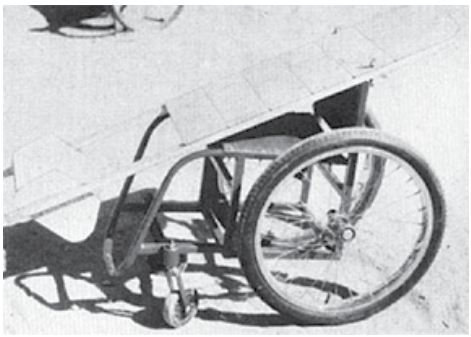
HOW TO MAKE YOUR CHAIR

1. Review drawings. Adjust measurements to fit child.
2. Cut all sections of square tubing. Make sure that matching tubes are equal in length.
3. Drill holes in bottom tubes and pass the threaded rod through them. Adjust nuts until a "V" is formed. (Weld tip of "V" for extra strength.)
4. Drill all holes in seat tubes. Pass threaded bolt through seat holes.
5. Drill holes in back support tubes and front caster tubes. Bolt to frame.
6. Weld axle nuts to ends of axle tube. Drill holes for U-bolts and bolt axle tube to frame.
7. Weld front caster forks to front tubes.
8. Sew cloth back and seat supports. Screw into place.
9. Cut out and bolt wood footrest to frame. (Use wedges to get the angle right.)
10. Attach axle tube with U-bolts and put on the wheels.
11. Paint frame to help keep tubes from rusting (if not galvanized).



The same design can be made of wood.

WHEELCHAIR WITH LYING BOARD



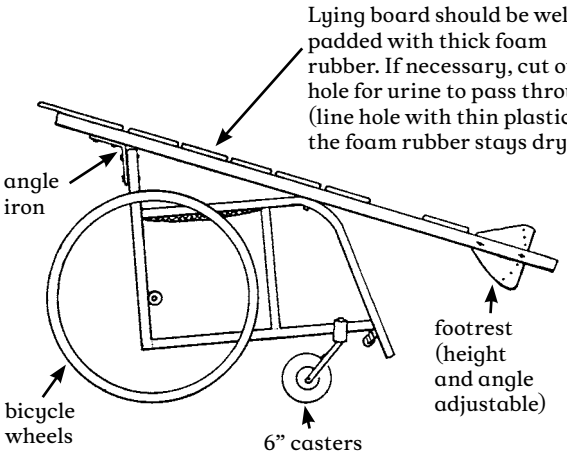
This is useful for an active child who must lie face down to heal pressure sores or to stretch hip and knee contractures.

The board is sloped so that the child can play, look ahead, and move about more easily. If necessary, you can make the lying board adjustable so that the child can rest lying flat. This helps to improve circulation and to prevent swelling of the feet.

After the pressure sores heal, the lying board can be removed and the frame is easily adapted to form a lightweight wheelchair.

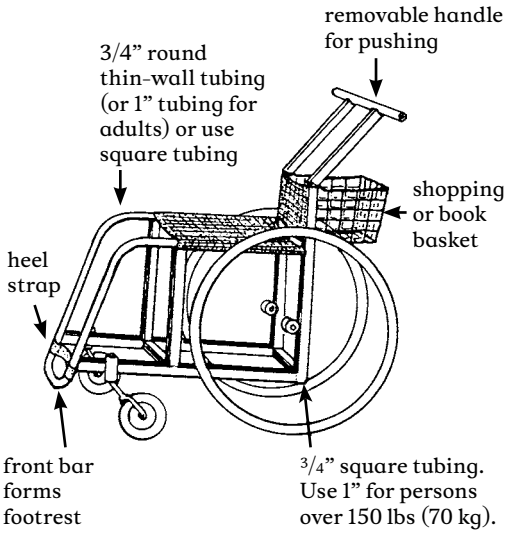
The design we show uses a simple, non-folding steel tube wheelchair frame with a wooden lying board mounted on top. However, many other designs are possible. (See, for example, the photo of a lying and standing wood wheelchair on p. 190.)

WITH LYING BOARD



For tall persons, place the casters farther from the big wheels to help prevent tipping.

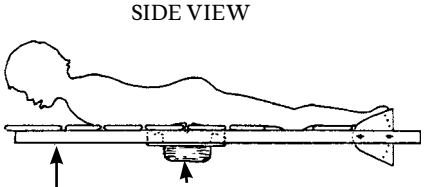
WITHOUT LYING BOARD
and with other additions



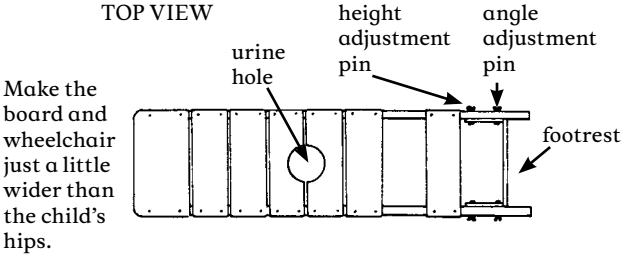
THE LYING BOARD

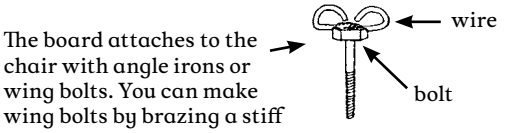
Attach thin wood or plywood boards with small screws so that they can be easily adjusted to leave open spaces under bony parts or sores.

SIDE VIEW



TOP VIEW

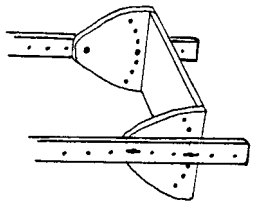




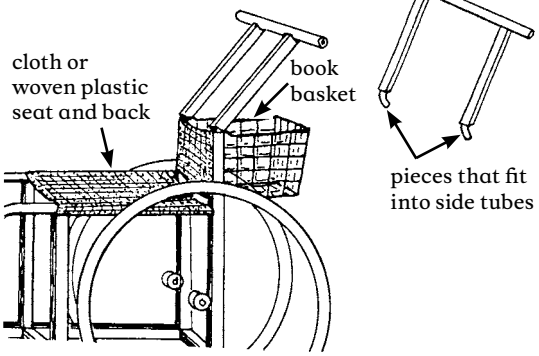
The board attaches to the chair with angle irons or wing bolts. You can make wing bolts by brazing a stiff bent wire to a bolt.

FOOTREST

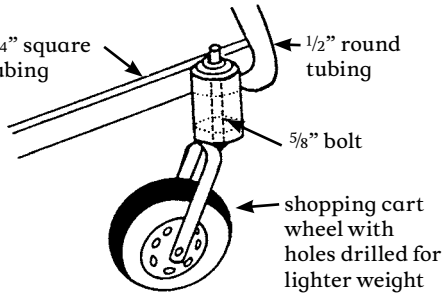
Use thin wood or plywood. (Pad sides and bottom well to prevent sores. Examine feet daily.)



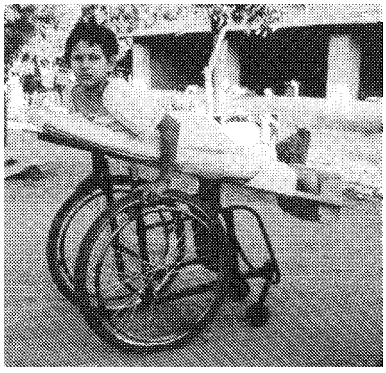
REMOVABLE HANDLE



FRONT CASTER WHEEL

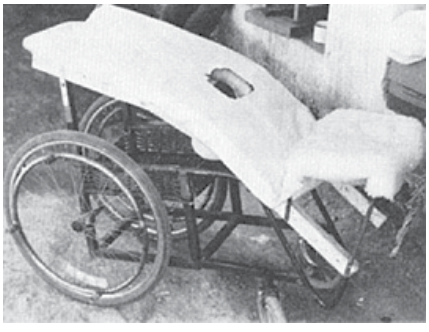


You should now have enough information to make a wheelchair with a lying board without step-by-step instructions. Adapt it, and make it the size to fit the child that needs it.



Wheelchair with lying board. A wide strap holds the child in place (but take care it does not press on sores).

Wheelchair without lying board.



A variation of the wheelchair with lying board (p. 618) adapted for a child with paraplegia with both contractures and pressure sores of his hips and knees. Urine is collected in a plastic container. The wheelchair seat has been converted into a basket.

CAUTION: Remember that a child who has some pressure sores can easily get new ones. Be sure the child lies and sits so that there is little or no pressure over bony places. **Examine her whole body at least once a day and try to keep her dry.**

PLYWOOD FRAME WHEELCHAIR

CP

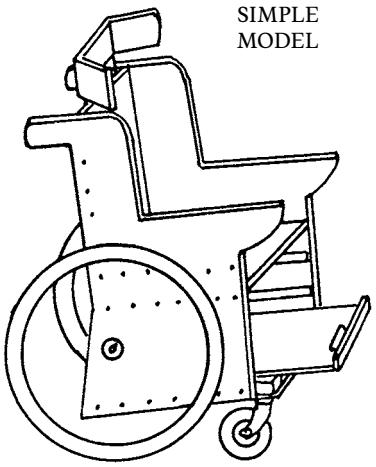
This can be easily built by someone with basic carpentry and welding skills. Positioning aids (head rest, hip pads, etc.) can be easily added. The chair can be designed to meet a child's particular needs. For example, if the child sits well without extra support, the tops of the side pieces can be removed to allow more freedom of movement.

A plywood frame is a low-cost alternative to metal. However, if not made well, or if left out in the rain, the chair may weaken and the plywood can split. As with any wheelchair, it must be protected from misuse, periodically examined for weaknesses, and promptly repaired.

See model on p. 621 ⟶

For active children the wheelchair can be strengthened by reinforcing all joints and by adding strong hubs and axles (see p. 623).

SIMPLE MODEL

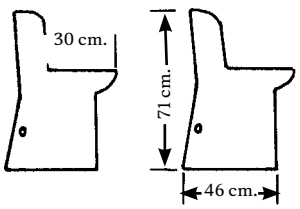


HOW TO MAKE YOUR CHAIR

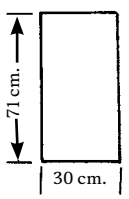
1. Review drawings of chair and adaptive equipment.
2. Cut out the two side pieces to the same shape; sand with sandpaper.
3. Cut out back support, seat, and bottom piece of chair; sand with sandpaper.
4. Screw or nail seat and bottom piece to back piece.
5. Screw or nail side pieces to seat, bottom, and back.
6. Check that all pieces are lined up straight. Then add glue and more screws or nails for strength.
7. Cut out footrest and guide brackets for footrest.
8. Screw or nail guide brackets to side pieces under seat.
9. Bolt front casters to chair and assemble rear axle tube.
10. Drill holes in side pieces for axle tube; mount tube and rear wheel.
11. Let glue dry 1 to 2 days; check for strength of all wood joints.

MATERIALS NEEDED

- ⅜" plywood (1 sheet)
- 20" bicycle wheels (2)
- small caster wheels (2)
- ½" steel tube (66 cm. long)
- wood glue
- sandpaper
- screws
- nails
- ½" by ¼" wood strips (6 x 46 cm. long)

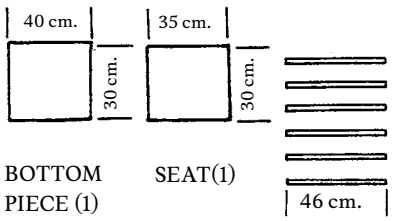


SIDE PIECES (2)



BACK SUPPORT (1)

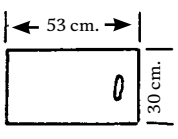
These measurements are for a 4 to 8-year-old child.



BOTTOM PIECE (1)

SEAT(1)

FOOTREST BRACKETS (6) (¼" to ½")

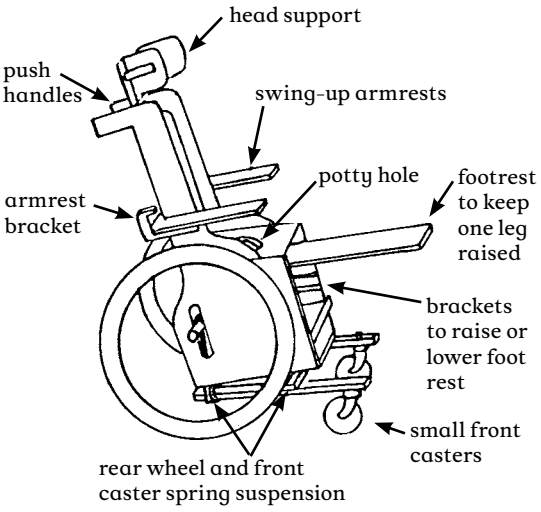


FOOTREST (1)

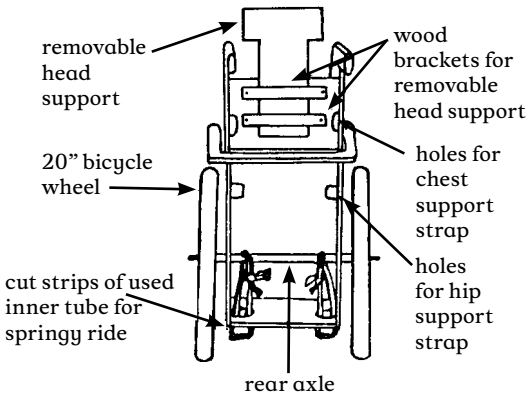
A plywood wheelchair with many adaptations

This wheelchair has a variety of additions sometimes needed for a small child who has poor body control, head control, and urine or bowel control. The head support and armrests fit into wooden holders and can be easily removed. A lap table can be easily added. Holes can be cut out for chest and hip straps for extra support.

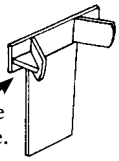
SIDE VIEW



BACK VIEW



head positioner

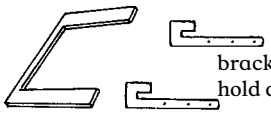


Important: Pad it well.

Wedge adjusts angle of head piece.

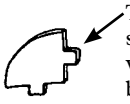
Bottom slides into slot on rear of chair.

swing-up armrests

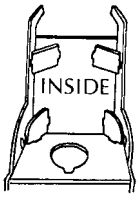


brackets to hold armrests

padded hip and shoulder positioners

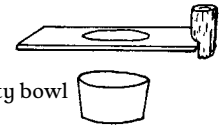


Tabs fit into slots in the wheelchair back and seat.



potty bowl holder with leg separator

Pull out to empty potty.

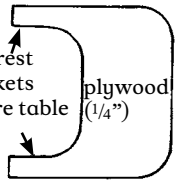


Tree branch holds stiff legs apart.

potty bowl

lap table

The lap table should be cut to fit closely around the wheelchair sides. The same wooden brackets for the armrests keep this table in place. If the table wobbles, you can use small slats to strengthen the table. If the knee separator is made a bit higher, the table can rest on top of it and prevent any dips.

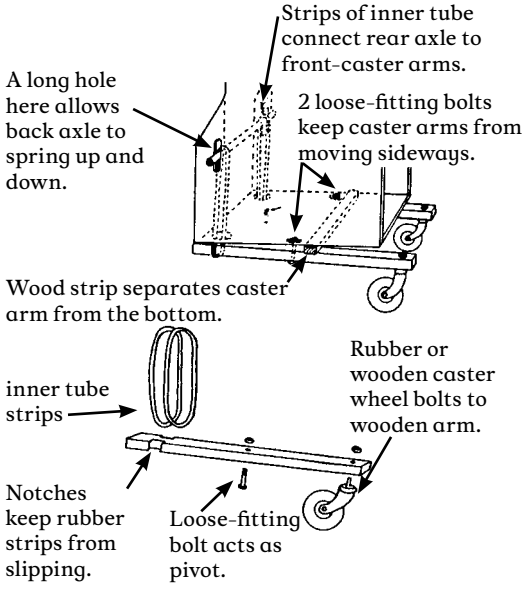


SPRINGS FOR ALL 4 WHEELS

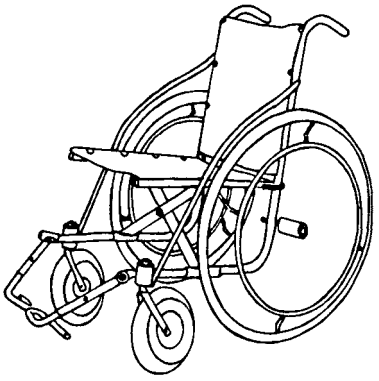
This plywood wheelchair has a springy ride. Old inner tube rubber strips connect the rear wheel axle to the wood strips holding the front caster wheels. These wooden strips should be strong enough to withstand the springy motion of the front casters.

Cut-away slots allow the rear axle to move up and down freely. Other cut-away slots in the bottom of the wheelchair allow for the inner tube strips to be wrapped around the wooden caster strips. The tighter the inner tube strips are wrapped, the less bouncy the ride becomes.

To build your own strong rear hub and axle, see p. 623. If you want to use hubs from bicycle wheels, see p. 597.



WHIRLWIND AND ROUGHRIDER STEEL TUBE WHEELCHAIRS



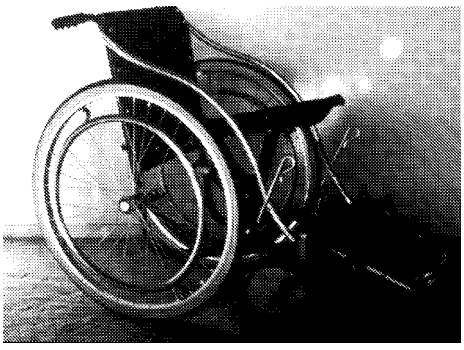
The Whirlwind (ATI-Hotchkiss) and RoughRider wheelchairs are very strong lightweight folding chairs. On rough ground, each rides more easily and lasts longer than more costly factory-made chairs. If it breaks, it can be fixed by the neighborhood metalworker. It is narrow and helps the rider to move about crowded rooms.

The frame of this chair is made of thin-wall steel tubing that is easy to shape by someone with basic mechanical and welding skills. It can be built in about 4 days in a small metalworking shop. More than 10 groups of mechanics with disabilities throughout Latin America are building this wheelchair—often at less than a quarter the cost of imported wheelchairs.

Most materials for this chair can be obtained locally. It uses standard 24" (or 26") bicycle wheels. The extra strong hubs (see p. 623) use standard small machinery bearings (which can often be obtained used for free or at low cost from electric machinery repair shops). The axles are 5/8" (1.6 cm.) steel bolts. Seating is canvas (heavy cloth). If the small front wheels are not available, you can make them out of wood (see p. 597 and 616).

The curved fender bar that follows the shape of the tire makes transfers easier. The lightweight folding footrests are narrow at the front, for moving more easily in crowded spaces.

Plans for making hubs, casters, and brakes are on the next page. Complete plans for making this wheelchair are in the book *Independence Through Mobility* (see p. 604). The book is essential for anyone planning to build this chair.

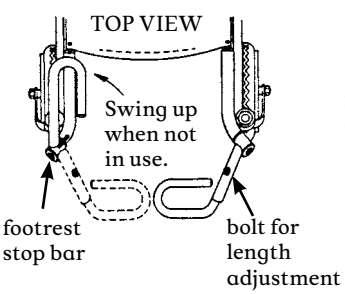


Model with wooden front wheels

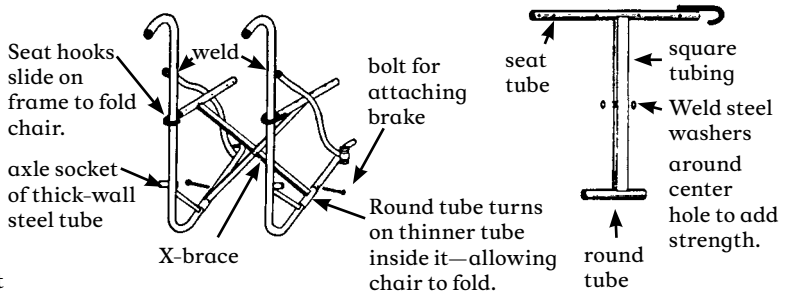
MATERIALS NEEDED

- thin-wall tubing (from ½" to 1 ¼")
- thick-wall tubing (⅝" inside diameter)
- thick canvas or nylon cloth (2 meters)
- square tubing (thin-wall)
- bicycle rims and spokes (24" or 26" diameter)
- caster wheels (2)
- used sealed bearings (8)
- re-bar steel (⅜" round)
- flat bar steel (1/16" x ⅜")
- axle bolts (4) (⅝" x 5")
- washers (4) (1" diameter, 16 upholstery)
- screws (8 upholstery)
- machine screws (8) (¼" x 1 ½")
- paint or chroming chemicals
- bronze welding rod, flux
- bicycle tires and inner tubes (24")

FOLDING FOOTREST



X-BRACE

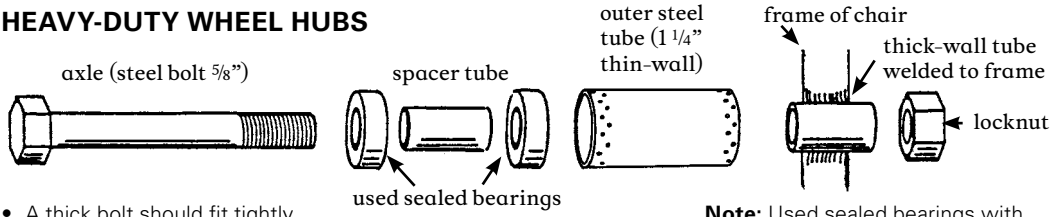


For a photo of this chair, see p. 536.

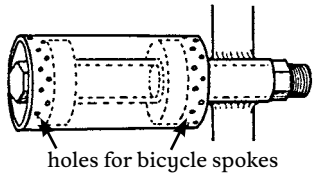
DETAILS OF HOW TO MAKE WHEELCHAIR PARTS

(can be used with many wheelchair designs)

HEAVY-DUTY WHEEL HUBS



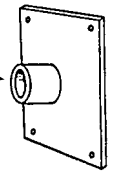
- A thick bolt should fit tightly inside bearing.
- Bearings should fit tightly inside outer steel tube.
- Carefully mark and drill the outer steel tube for spoke holes.
- Spacer tube fits over axle bolt and holds bearings against spoke heads.

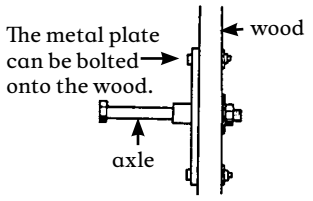


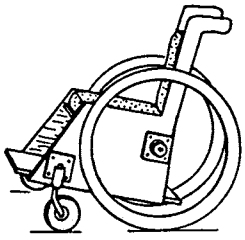
Note: Used sealed bearings with a 5/8" inner diameter can often be obtained free or at low cost from electrical tool and appliance repair shops. These used bearings often last longer than standard wheelchair bearings.

To attach the heavy-duty hub to a wood chair, you can weld the thick-wall tube to a metal plate.

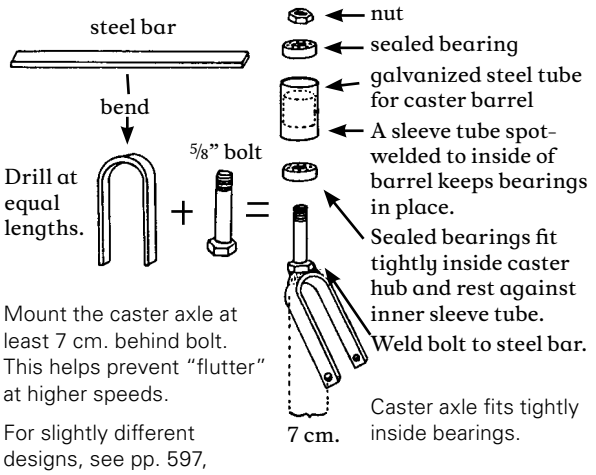
The bigger the plate is the stronger the mount.







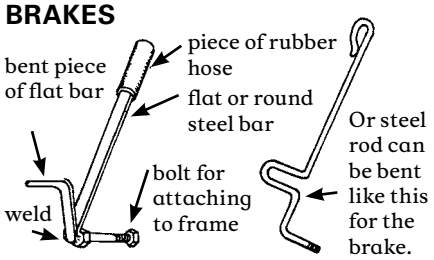
CASTER FORK AND HUBS

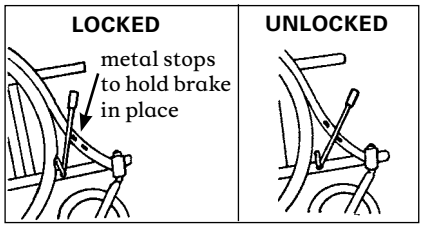


Mount the caster axle at least 7 cm. behind bolt. This helps prevent "flutter" at higher speeds.

For slightly different designs, see pp. 597, 616, and 619.

BRAKES

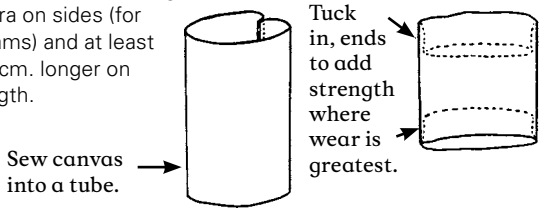


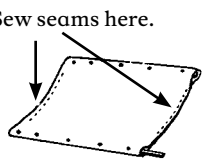


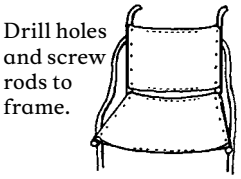
For other brake designs, see p. 601.

SEAT AND BACK MADE OF CANVAS (strong cloth)

Cut canvas twice as wide as seat or back, allowing 4 cm. extra on sides (for seams) and at least 20 cm. longer on length.





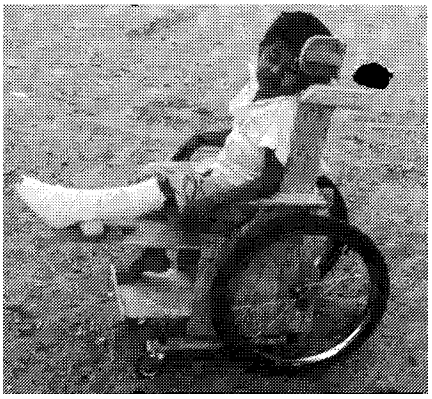


CAUTION: Measure carefully. On a folding chair, the width of the seat and back control the width of the chair.

For designs of other wheelchair parts, see the following pages:

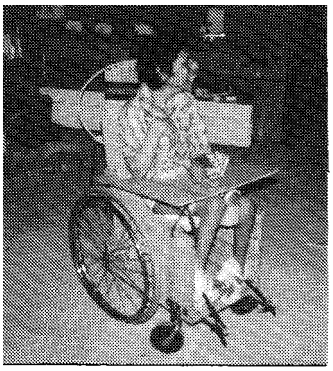
wheels: 594, 596, 597, 616, 619
seats and backs: 595, 615, 616, 617, 619, 620
tires: 596
armrests: 599, 621
footrests: 600, 616, 619, 621, 622
axle mounts: 597, 598, 615
handrims: 601 cushions: 200, 609

Examples of locally made wheelchairs



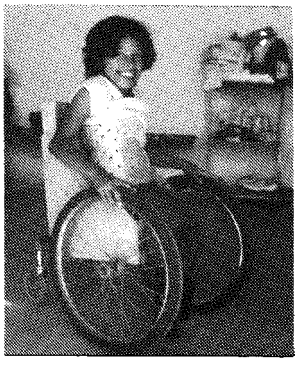
CP

The plywood wheelchair on p. 620, with the armrest in place (left) and swung back (right).

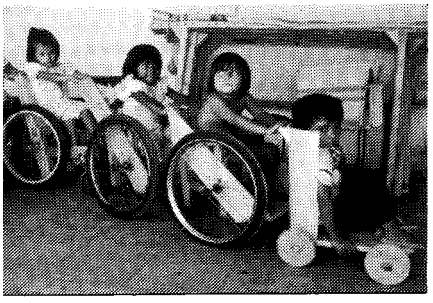


A plywood wheelchair for a child with cerebral palsy with inner tube stretching aids to gently pull his feet and straighten his severe knee contractures.

A bamboo hand-powered tricycle made at Viklang Kendra (People's Village), Allahabad, India.

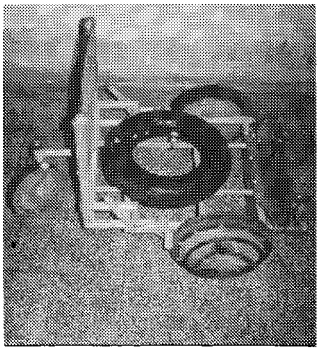


A wheelchair made completely of paper, including the wheels. Paper is glued together using rice flour in water (Zimbabwe).

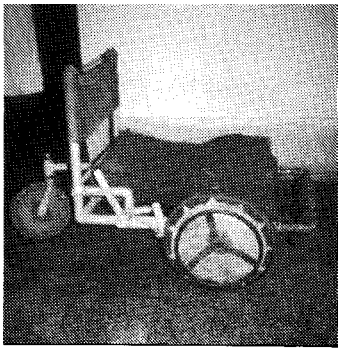


A wood design of the wheelchair on p. 617, two Healthlink wheelchairs, and a trolley made from half of a plastic bucket and wood wheels.

A wood wheelchair in Thailand. The bicycle wheel axles are supported on both sides to keep them from bending.



A metal frame, wood wheel trolley in Bangladesh (see p. 572). The rubber tube serves as a cushion and also as a toilet seat.



This trolley, also from Bangladesh, uses a cushion made of coconut fiber covered with rubber (see p. 199).

For more examples of wheelchair designs, see pp. 65, 86, 98, 189, 190, 229, 288, 343, 430, 441, and 526.