

Center for International Rehabilitation

Chapter 2 Tools and Shop Facilities

This chapter includes descriptions and prices of the tools, machinery, and shop equipment that you will need to manufacture the ATI-Hotchkiss Torbellino wheelchair. It also includes information on how to set up a safe, efficient, and accessible shop.

The Torbellino (Whirlwind) wheelchair has been designed so that it can be built using low cost tools and machinery, most of which can be purchased locally. While the tools available locally will vary from one country to the next, there are some tools that have been consistently difficult to find.

A Basic Tool Kit is available from Appropriate Technology International which includes the hand tools that are often difficult to purchase locally plus two different tubing benders, a sample fender, brake, and footrest (wheelchair parts that can be difficult to bend accurately), and a complete set of the jigs that we have found to be most useful. The Basic Tool Kit can be purchased for approximately \$1000 (U.S.) from Appropriate Technology International. A detailed list of the contents of the Basic Tool Kit, prices, and ordering instructions can be found later in this chapter.

TOOLS AND MACHINERY

All the tools and machinery needed to equip a shop are listed below accompanied by pictures and descriptions. Items that are included in the Basic Tool Kit are identified with an asterisk (*). When we suspect that it may be difficult to find a certain tool locally, we have included the name and address of a company that sells it (in case you would prefer to order directly from the manufacturer).

MACHINERY

1) Tubing, Rod, and Bar Bender*

Bending steel tubing, rod, and bar accurately and smoothly are some of the most important tasks of a wheelchair maker. Building the Torbellino wheelchair involves making many bends with a small radius. Only a good bender with well formed dies can make these bends without wrinkling the tubing.

The best type of bender we know of for local wheelchair manufacture is one made by the Hossfeld Company in Winona, Minnesota, U.S.A. This bender makes a tighter and stronger bend than most benders of comparable cost.

The Hossfeld bender has two basic parts, the bending frame and the die sets. One arm of the frame is mounted on the work bench while the other arm pivots inside it, pulling the tubing, bar, or rod around the form die.

It is possible to make a bender frame that works as well as the Hossfeld frame for a fraction of the cost. Directions and diagrams for making a bender frame that can be used with Hossfeld dies and bending parts can be found in Appendix A at the end of this book. This frame can also be purchased as part of the Basic Tool Kit. Since the dies must be very precisely made in order to bend tubing without wrinkling it, we recommend that you buy the Hossfeld dies and bending parts. The Hossfeld dies and bending parts used in manufacturing the ATI-Hotchkiss chair are included in the Basic Tool Kit. If you prefer to order the dies and bending parts directly from Hossfeld, use the list of parts in the Basic Tool Kit found later in this chapter to help you order.

Hossfeld Manufacturing Co.
Box 557
Winona, Minnesota 55987
U.S.A.

2) Wooden Tubing Bender and Dies*

This bender has been designed to form the large radius bends used in making the fenders and handrims. Instructions for making this bender can be found in Appendix A.

3) Welding Equipment

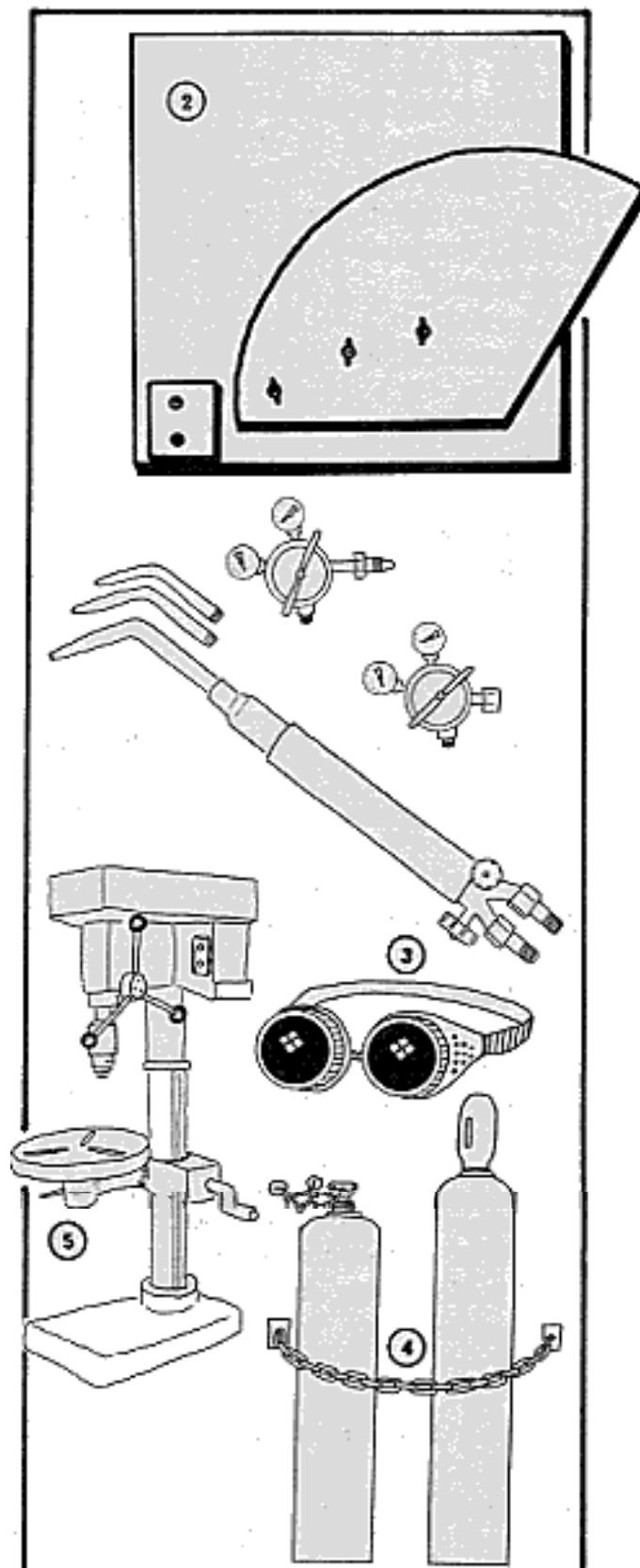
We have chosen to use the oxygen-acetylene torch because it is the only low cost welder that is well suited to all the welds on a lightweight steel wheelchair. You will need a complete set of oxyacetylene welding tools including regulators, hoses, torch, tips, a striker, a mask, and goggles.

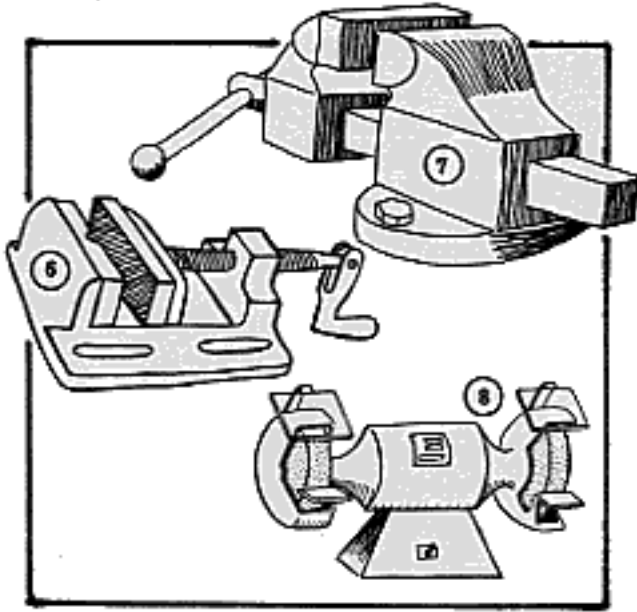
Electric arc welding can also be useful for the heavier weld such as on the caster fork. It is not recommended for lightweight steel tubing; electric welds are more likely to crack under heavy use.

4) Gas Tanks (Acetylene and Oxygen)

5) Drill Press

Use a bench height drill press. By setting it on a low table, it will be the right height for a worker who rides a wheelchair. The drill press should be either 1/2 or 3/4 horse power. It should have a rotating table which can be raised or lowered with a hand crank. In many countries, some of the least expensive drill presses are of excellent quality; nevertheless, we have often needed to replace the chuck (the part that holds the drill bit).





6) Drill Press Vise

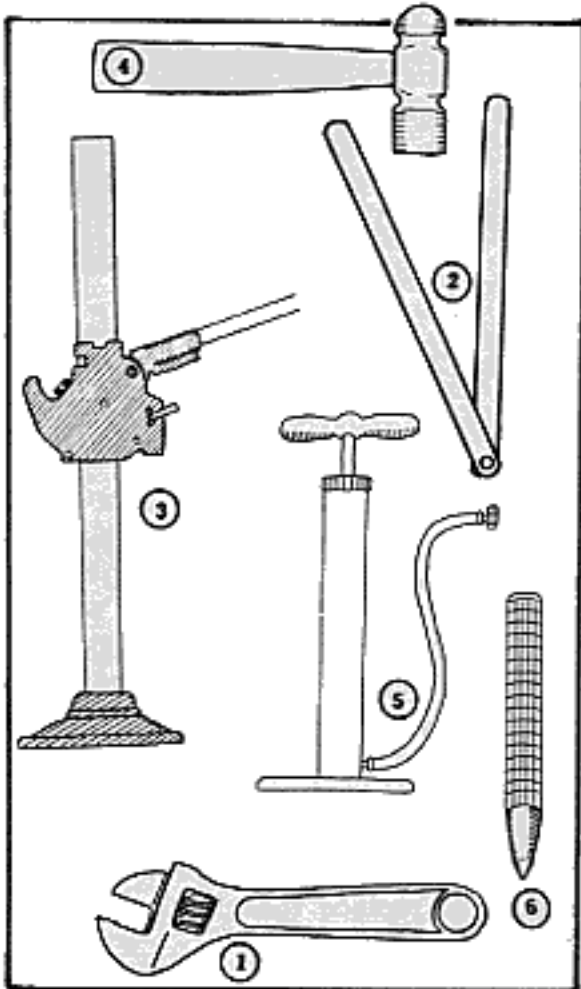
Without a drill press vise, you are likely to break off a lot of drill bits. If your tool dealer doesn't carry this type of vises, ask him to order some. They are sold by the same manufacturers that sell drill presses.

7) Bench Visers

These should have a jaw width of from 3" (75 mm) to 5" (125 mm).

8) Grinder

8" (200 mm) wheel, 3250 rpm



HAND TOOLS

1) 8" (200 mm) Adjustable Wrench

2) Angle Measuring Tool

Make this simple tool yourself (see Chapter 6 and Appendix B).

3) Auto Jack

Use a ratchet jack (the kind that would come with any large American car). This jack is used to help bend the larger tubing (7/8"). To attach it to your tubing bender, drill a 1/2" (13 mm) hole in the bottom end.

Descriptions of how to attach it to your bender and how to bend tubing using this method are found in Chapter 6.

4) Ball Peen Hammer

5) Bicycle Pump

6) Center Punch

7) C-Clamps 3" (75 mm), 4" (100 mm), and 6" (150 mm)

8) Electric Hand Drills

9) Extension Cords with Adapters

10) Hacksaws

11) Hold Down Clamp

If you have trouble finding one, you can make your own by cutting a C-clamp in half and welding a plate on the bottom so that the clamp can be bolted to a table.

12) Knife

13) Leather Gloves (for welding)

14) Leather Punch (for 3/16" [5 mm] hole)

15) Leather Tool Aprons

16) Monkey Wrench

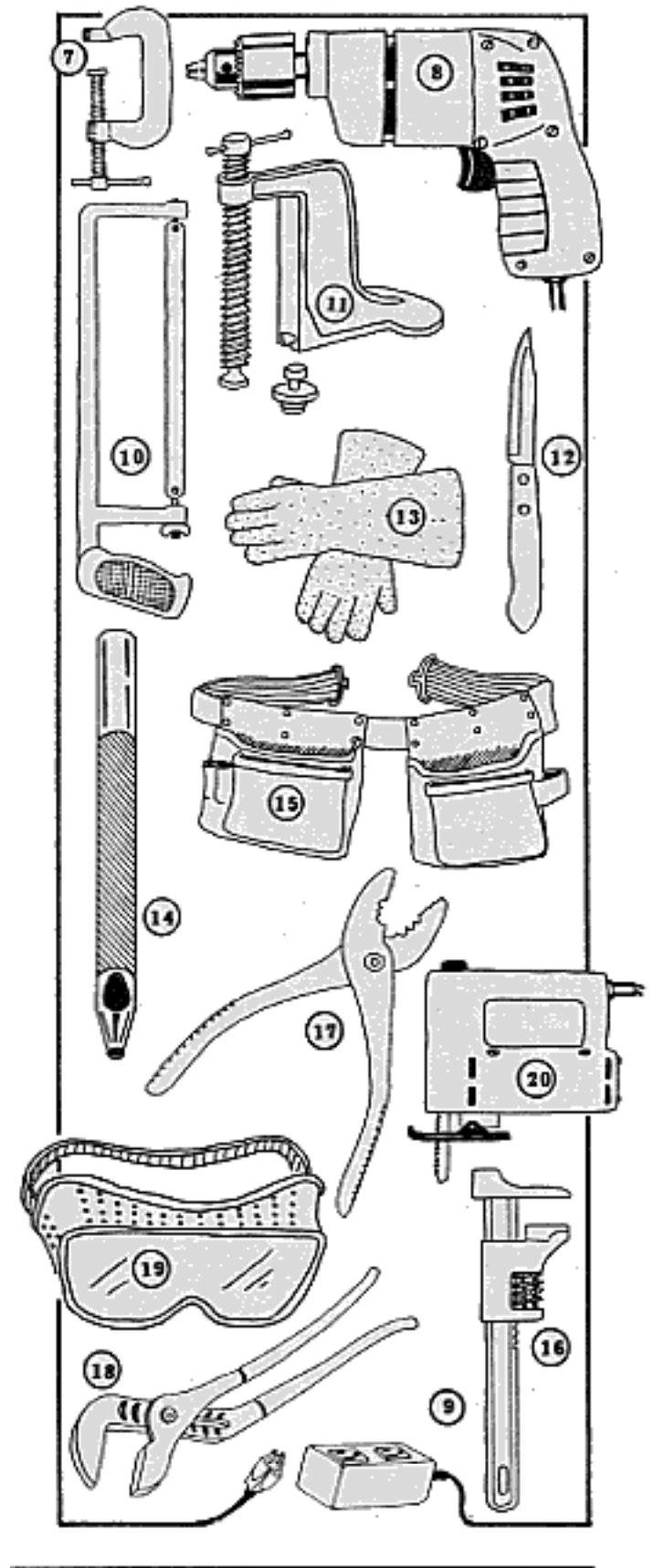
17) Pliers

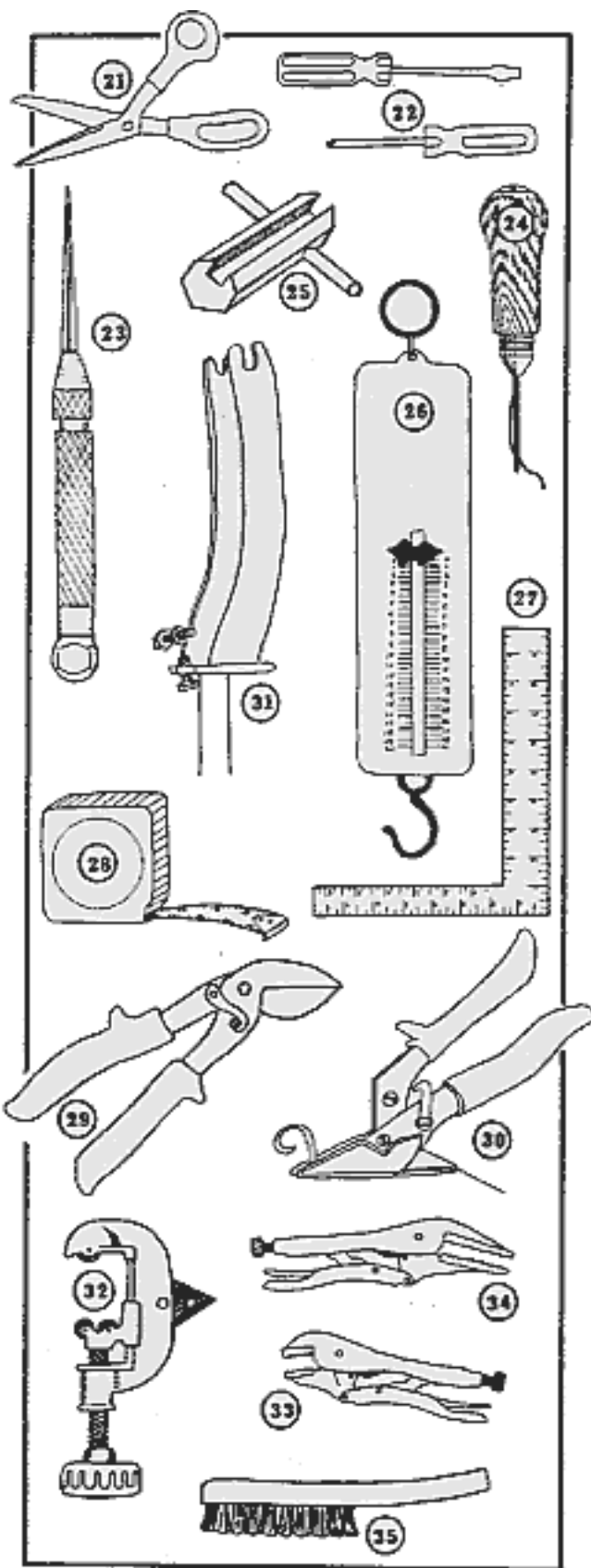
18) Channel Lock Pliers

19) Safety Glasses or Goggles

Safety glasses or goggles are **ABSOLUTELY NECESSARY** whenever a worker is using the grinding wheel, drill, or any other tool that shoots out metal particles.

20) Saber Saw with Blades





21) Scissors

22) Screwdrivers (slotted and Phillips)

23) Scribes (for marking steel)

24) Sewing Awl

Use a hand awl with an industrial sewing machine needle in it.

25) Spoke Keys

26) Spring Scale (0-40 lbs [0-20 kg])

27) Squares

28) Tapemeasures

29) Tinsnips (offset)

30) Tinsnips (slitting)

31) Truing Stand

Use an old bicycle fork with nuts welded to it. Insert bolts through the nuts and adjust them to the desired length. They will serve as guides to sight against when truing the wheel.

32) Tubing Cutter

33) Vise Grips

34) Vise Grips (long nose)

35) Wire Brush

Use the brush to clean surfaces before and after welding.

HAND TOOLS THAT MAY BE HARD TO FIND

1) Angle Level*

This is a combination of a level and a protractor. A protractor alone will serve, but the angle level can measure angles more easily. One company that makes and sells this tool is:

Mayes Brothers Tools
Johnson City, Tennessee 37601
U.S.A.

2) Circle Cutter* (for cutting circles out of wood)

3) Protractors* (used for measuring angles)

4) Reamers* 1/8" (3 mm) - 1/2" (13 mm) range.
These are used to enlarge and smooth holes in metal.

5) Vernier Calipers* (Metric/English) These should be capable of accurately measuring the inside and outside diameter of tubing and the depth of holes. The circle cutter, protractor, reamer, vernier calipers can be ordered from:

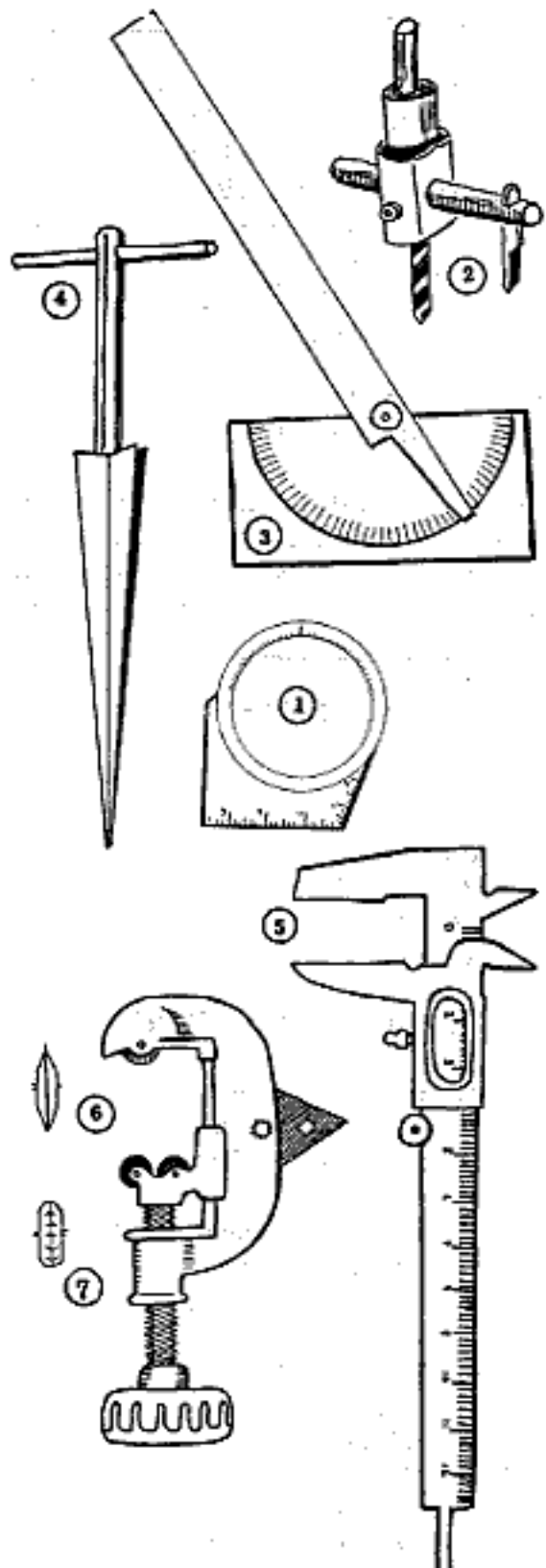
General Hardware Mfg. Co., Inc.
80 White St.
New York, New York 10013

6) Tubing Cutter*

Model #20 made by: Ridge Tools
400 Clark St.
Elyria, Ohio 44036
U.S.A.

7) Indenting Wheel*

Made by local machinist.



CONTENTS OF THE BASIC TOOL KIT

The Basic Tool Kit can be purchased through A.T. International. The price is currently \$1000 U.S. with shipping to most countries. This price is subject to change if costs or the contents of the tool kit change. The Basic Tool Kit is made up of four separate tool sets: the hand tools, the commercial bending tools, the ATI bending tools, and the jigs and sample parts. It is possible to purchase one or more of these tool sets separately. Unfortunately, we are not yet capable of breaking up these sets to sell tools or jigs individually. We have listed the individual prices of the hand tools to allow you to compare prices.

To order the Basic Tool Kit or one or more of its four tool sets, write to:

AT International, 1331 H Street, Washington D.C. 20005, U.S.A.

The Basic Tool Kit from Appropriate Technology International includes the following items. It is possible to make most of the jigs and some of the bending tools locally. In Appendix A and B we have included instructions for making the jigs and tools on this list that have been marked with an asterisk (*).

1) HAND TOOLS:	\$90.00
Angle Level	\$8
Circle Cutter	11
Protractor	8
Reamer	8
Tubing Cutter with Indenting Wheel	45
Vernier Calipers	10

2) COMMERCIAL BENDING TOOLS	\$200.00
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- Hossfeld Tubing Bending Die Sets
 - 3/4" Outside Diameter, 1-7/8" Center Line Radius
 - 7/8" Outside Diameter, 2" Center Line Radius
- Hossfeld Miscellaneous Bar and Rod Bending Parts
 - Flat Head Pin
 - Center Pin for 1/2", 5/8" and 3/4" eyes
 - Eye Pin
 - "U" Shaped Pin with lug for small eyes
 - Bending Dog
 - "U" Pin Roller
 - Thumb Nut
 - "U" Pin Support Plate

Center Pin Support Plate

3) ATI BENDING TOOLS (use with Hossfeld dies) \$100.00

*Bender Frame

*Caster Fork Die (2 3/8" O.D. x 3/4" I.D.)

4) JIGS, WOODEN BENDER, AND SAMPLE PARTS \$550.00

Sample Parts: Fender, Brake, and Folding Footrest

*Wooden Tubing Bender with Fender and Handrim Dies

*A Complete Set of Jigs (18)

(See Chapter 3 for a complete discussion and list of jigs.)

TOTAL COST OF BASIC TOOL KIT \$940.00

(All of the prices listed above are subject to change and do not include shipping fees.)

PRICE LISTS

The following price lists were based on the quantities of tools, machinery, and shop equipment that would be needed to equip a wheelchair manufacturing business employing four people, three of whom are mechanics. The prices listed are approximate and are based on 1985 U.S. dollars.

As the tools and machinery that can be purchased as part of the Basic Tool Kit have already been listed above, they are not included in the following lists.

MACHINERY	Quantity	\$/Unit	Total \$
Bench Vises	2	55	110
Drill Press	1	350	350
Drill Press Vises	2	12	24
Gas Tank, Acetylene	1	80	80
Gas Tank, Oxygen	1	120	120
Grinder	1	120	120
Welding Equipment	1	240	240
MACHINERY TOTAL			\$1,044

HAND TOOLS	Quantity	\$/Unit	Total \$
Adjustable Wrenches (8" [200 mm])	4	8	32
Angle Measuring Tool	1	0	0
Auto Jack (for tubing bender)	1	25	25
Ball Peen Hammer	3	7	21
Bicycle Pump	1	6	6
C-Clamps 3" (75 mm), 4" (100 mm) and 6" (150 mm)	16	5	80
Drills, Electric hand	2	80	160
Extension cords w/adapters	2	5	10
Hack Saw	2	6	12
Hold-down Clamp	1	8	8
Knife	1	10	10
Leather Gloves	1	6	6
Leather Punch (3/16" [5 mm])	2	7	14
Leather Tool Aprons	3	6	18
Monkey Wrench	1	14	14
Pliers	3	6	18
Pliers, Channel type	1	11	11
Saber Saw w/blades	1	26	26
Safety Glasses	3	6	18
Scissors	1	8	8
Screwdrivers (slotted)	8	8	8
Scribes	3	3	3
Sewing Awl	1	6	6
Spoke Keys	1	3	3
Spring Scales (0-40 lbs [0-20 kg])	1	60	60
Squares	3	7	21
Tape Measures	3	5	15
Tinsnips (Slitting and Offset)	2	16	32
Truing Stand	1	0	0
Tubing Cutter	2	45	90
Vise Grips (regular)	2	10	20

Vise Grips (needle nose)	1	10	10
HAND TOOLS TOTAL			\$765

SHOP FACILITIES AND EQUIPMENT

SHOP EQUIPMENT	Quantity	\$/Unit	Total \$
Cardboard Boxes for Parts	30	0	0
Chairs	2	10	20
Fans (1 large, 1 small)	2	70	140
Fire Extinguishers (ABC)	2	50	100
First-Aid Kit	1	50	50
Janitorial Equipment (brooms and metal garbage cans with lids)	1	50	50
Office Furniture (Used)	1	80	80
Shelving	1	20	20
Steel Rack	1	50	50
Work Benches, 3 wood and 1 steel	4	140	560
EQUIPMENT TOTAL			\$1,070

A good shop is one that is safe, well organized, and accessible to both disabled and non-disabled workers. Every shop needs a fire extinguisher. The dry powder type (ABC) will put out electrical, wood, and grease fires. To help prevent fires, be sure to use metal garbage cans *with lids* for greasy rags and other flammable refuse. Your shop will also need adequate ventilation. Welding is best done outdoors; a couple of fans may also be necessary to draw fresh air in and blow the fumes and hot air out.

A list follows of what your first aid kit should contain. Keep it well stocked and within easy reach at all times.

FIRST-AID KIT CONTENTS

- Sterile gauze pads
- Assortment of finger sized bandages
- 1, 2, and 3" gauze bandage rolls
- Clean cotton
- Adhesive tape (1" wide roll)
- Disinfectant soap
- 70% alcohol

Hydrogen peroxide
Petroleum jelly (Vaseline)
Scissors
Needle
Tweezers with pointed ends
Aspirin
Triangular bandage

ORGANIZATION

It is easy to waste a lot of time searching for the part, bolt, or tool that you need. We recommend that you use separate, labeled cardboard or wooden boxes to store each individual part and a wooden rack to store and organize the tubing. Once the shop is well established, different size wheelchair components can be made in large quantities and stored for custom assembly.

WHEELCHAIR ACCESSIBILITY

Work benches should be constructed so that a wheelchair rider can work at them comfortably. Each work bench should be no more than 30" (74 cm) high with at least 26" (64 cm) of clearance on one side, allowing a wheelchair rider to pull up and under one side of the table. Since the work bench will be too low for some non-disabled workers to use comfortably while standing up, be sure to provide chairs for them to use. The benches should also be very heavy. The tubing bender will be mounted on one of the wooden work benches; therefore, this work bench should be heavy enough not to move when you are bending tubing.

Be sure to allot some money in your budget for modifications that may be necessary to make your shop fully wheelchair accessible (ramps, widened doors, access to the bathroom, etc.). Depending on the shop space you have chosen, accessibility modifications could cost more or less than the \$50.00 we have included in the budget.

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