

APPENDIX

Types of Wheelchairs

Reprinted from *Wheelchairs: A Prescription Guide*, by A. Bennett Wilson, Jr. and Samuel R. McFarland. Charlottesville, VA: Rehabilitation Press, 6-18, 44-46, 1986.

THE BASIC WHEELCHAIR

The configuration and dimensions of the adult basic chair are shown in **Figure 10**. The dimensions and components that must be specified in a prescription of a wheelchair are:

Seat: Dimensions, type
Back: Dimensions, type
Arms: Type, dimensions, in some cases
Footrest: Type
Legrest: Type
Wheels and Tires: Type and size of wheel, type and size of tire, type of driving rim
Casters: Type and size

Other considerations are weight, amount and type of use expected, upholstery material and color, and seating inserts.

Seat Width and Depth

Chairs are regularly available in widths ranging from 10 inches to 22 inches in 2-inch increments.* Chairs with seats 24 inches wide are available but they do not fold. Wider chairs can be obtained by special order. The seat depth and height from the

*Dimensions given here for seat width and depth relate to space available to the occupant and are not overall dimensions for the chair or its components.

floor vary with the width approximately as shown in **Table 1**.

Selection of the proper seat width is important to comfort and stability. A seat too narrow is not only uncomfortable, but access to the chair is made difficult. Furthermore, the chances of pressure sores developing is increased. A seat that is too wide encourages the user to lean toward one side, thus promoting scoliosis and increased pressure over the buttocks on one side. In addition, a seat wider than is necessary makes propulsion more difficult.

A seat that is too shallow reduces the area in contact with the seat and causes more pressure on the soft tissues in contact with the seat than is necessary. Furthermore, the footrests do not support the feet and legs properly, and balance of the user is affected.

A seat that is too deep, or longer than it should be, can restrict circulation in the legs, and causes the patient either to sit with his legs extended or to slide forward in the chair.

Seat Height

The height of the seat above the ground of the basic adult chair is 19 1/2 - 20 1/2 inches. The tall person will require a seat that is higher and deeper; a shorter person will require a seat that is lower. Usually these requirements can be met by a stock chair; if not, properly dimensioned units can be had

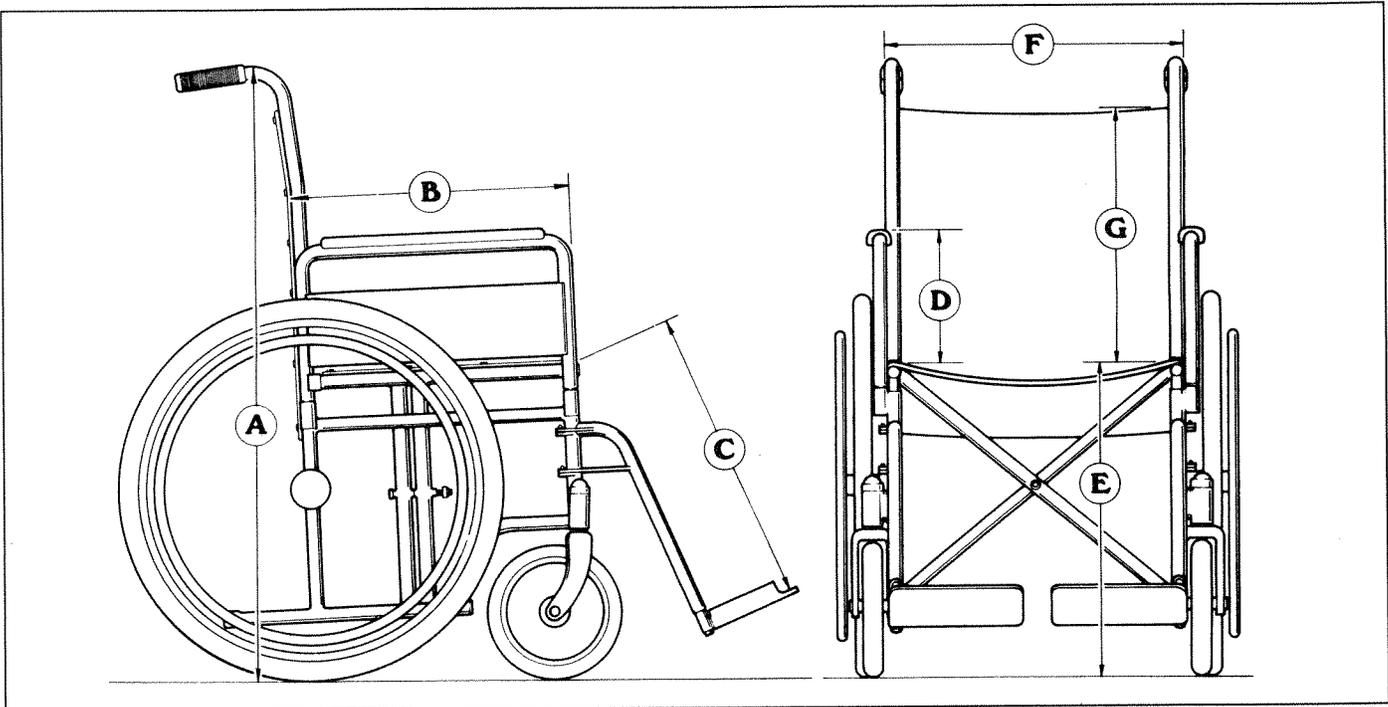


Figure 10. Dimension ranges for the basic adult wheelchairs from major U.S. manufacturers. a) Overall height: 36 - 37"; b) Seat depth: 16 - 17"; c) Footrest support (adjustment range): 16 1/2 - 22"; d) Armrest height from seat rail (adjustment range): 5 - 12"; e) Seat height from floor: 19 1/2 - 20 1/2"; f) Seat and back width: 14 - 22"; g) Back height from seat rail: essentially as required.

on special order. Obviously, the cushion or seating system to be used will affect the end result.

Seat Type

Seat types available from wheelchair manufacturers are sling, or hammock, made of a flexible material, and solid seats which are generally removable (Figure 11).

The sling seats are by far the type used most. A solid seat installed so that folding is still possible is

available, or a removable solid wooden seat may be purchased or made, when such a seat is indicated for posture control or some other reason.

For many patients, especially those with lack of sensation in the buttocks and legs, special cushions or inserts are required.

Cushions and inserts should not be considered as "add-ons" but as an important part of an overall mobility system. While cushions and inserts are used to obtain the lowest pressures possible over the soft

Table 1.

Height from floor	Width	Depth	Designation
19½	10	8	pre-school or tiny tot
19½	12	10-11½	child's or tot's, high
16½	12	10-11½	child's or tot's, low
21	14-14½	11½	growing chair
17½-20½	14-16	11-13	growing chair
18½	16 ¹	14	junior or slim adult
19½	16-16½	16-17	narrow adult
19½-20½	18 ²	16	adult
		17	tall adult
19½-20½	20-22	16	wide adult

¹ at least one manufacturer supplies 14 and 15 in. as well. ² at least one manufacturer supplies 14, 15, 16, and 17 in. as well.

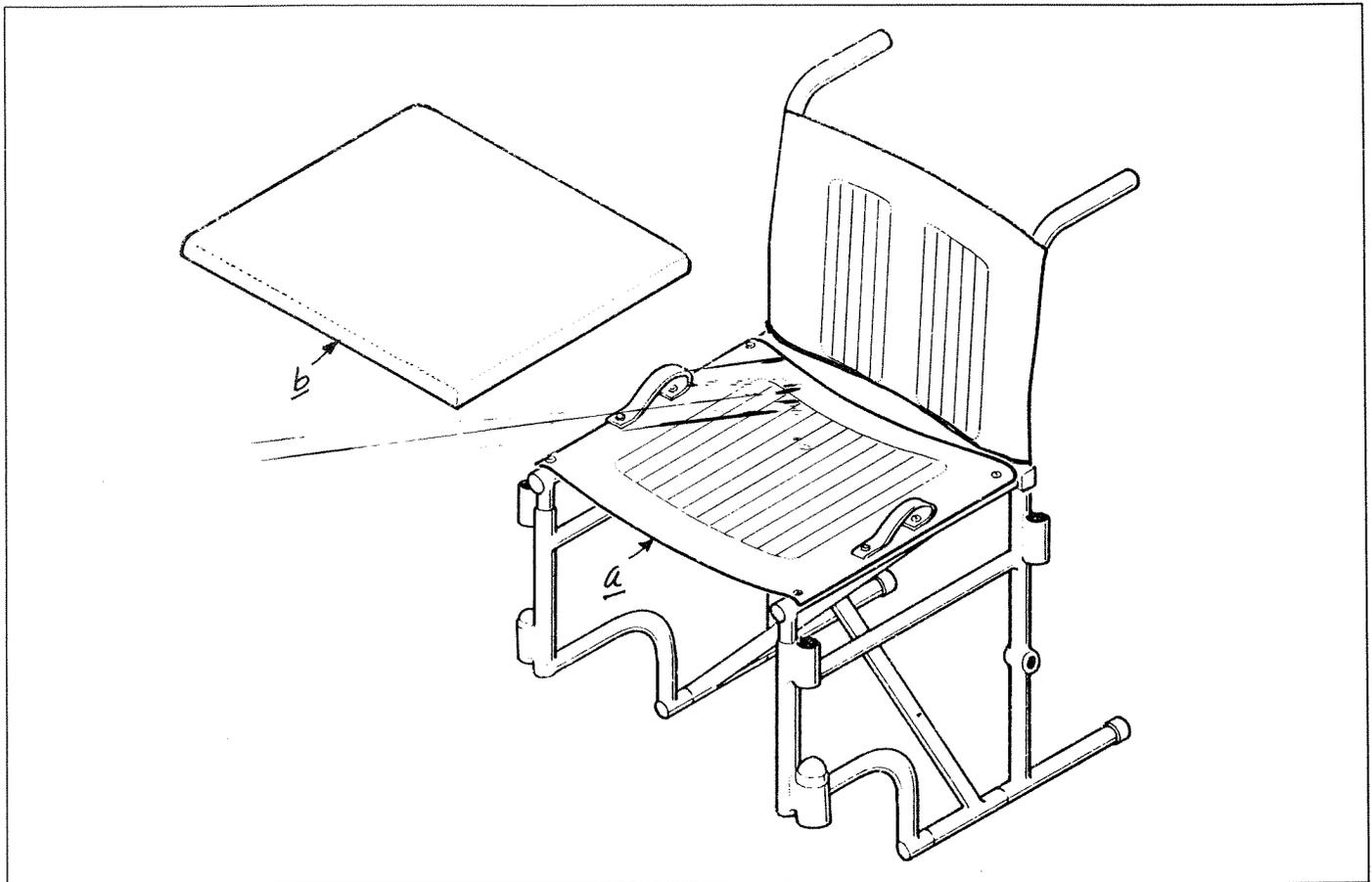


Figure 11.
Seat types: a) Hammock or sling; b) Solid.

tissues in contact with the seat to reduce the chance of pressure sores, they can also be used to great advantage to place the user in the best position for operation of the wheelchair or for simply maintaining the user in the best position for other functions.

Cushions and inserts are covered in more detail in a separate chapter.

Backrest

The backrest of the basic chair is made of a flexible material stretched between the two side frames which are fixed with respect to the seat. The height of the backrest of the adult chair from the seat is 16 - 16 1/2 inches. Shorter heights can be ordered. Backs of different heights which are interchangeable are available for some models. The backrest should be high enough to provide support without inhibiting motion, and not so low that the scapulae can hang over the back of the chair and cause discomfort.

For patients that have to enter the chair from the rear, backrests with a vertical zipper or snap fasteners for easy opening are available (**Figure 12**).

Solid inserts are available for the backrest when that type of support is required, usually for people with cerebral palsy. Also available are cushions that support the lumbar area. In the prescription process, it must be remembered that both solid backs and lumbar supports move the patient forward with respect to the other parts of the wheelchair.

Patients who cannot sit fully erect or otherwise need to be able to adjust the attitude of the back can be provided with a semi-reclining back that can be adjusted to 30 degrees with the vertical (**Figure 13**). For those patients that require respirators, a backrest that can be reclined to 90 degrees with the vertical is necessary. The fully reclining feature has slight additional advantage in that the patient can be transferred between bed and wheelchair somewhat easier, although the upper part of the wheel presents

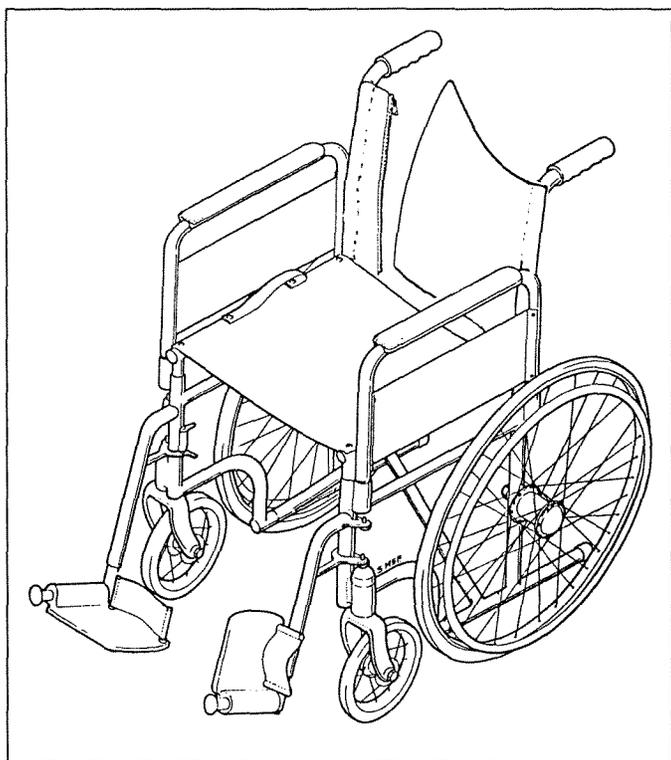


Figure 12.
Backrest: zippered opening.

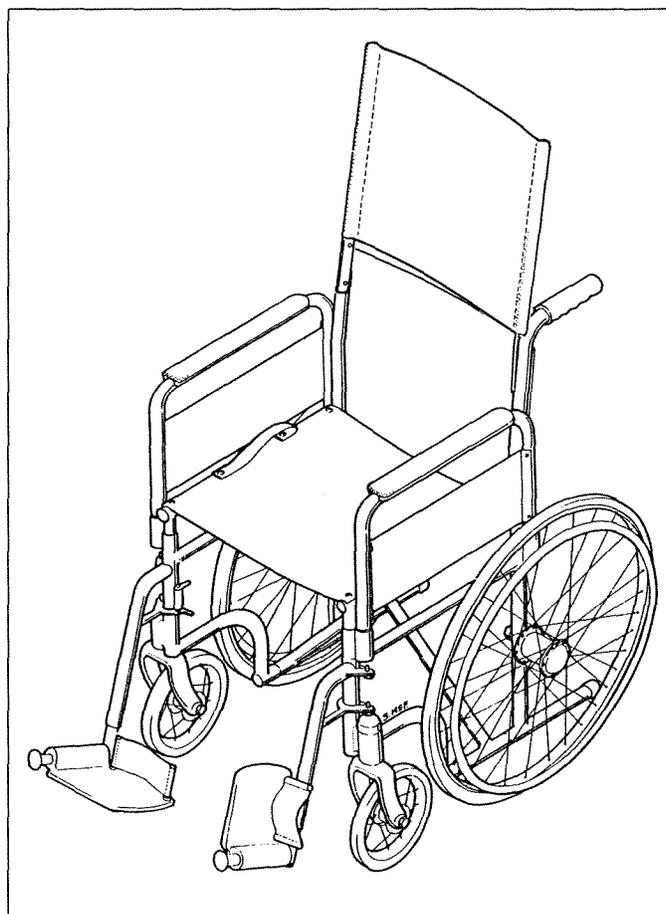


Figure 14.
Backrest or "headrest" extension.

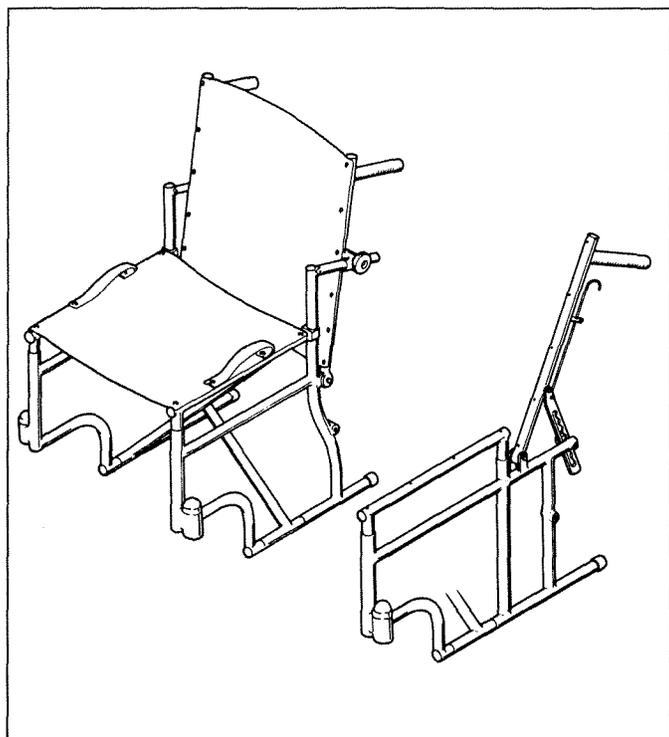


Figure 13.
Reclining backrests: a) Partial; b) Full.

an obstacle. A longer wheelbase is necessary for maintenance of adequate stability when the backrest is in the fully reclined position. One design accomplishes this by coupling the reclining mechanisms with the driving-wheel mounts so that the wheelbase is lengthened as the seat is reclined. Thus, maneuverability is not sacrificed when the back is in the upright position.

The backrest on the reclining chairs is lengthened usually by an extension (**Figure 14**), which is removed when the chair is to be folded.

Arms

The lightest chairs have fixed arms (or none at all), but an overriding factor in wheelchair prescription is transfer into and from the wheelchair, especially when the patient is unable to stand for a brief period. For this reason, most patients require arms that can be removed easily.

Chair arms not only provide support for the patient's arms in a resting attitude, but also provide lateral support and a reaction point for the hands when the asensitive patient elevates his body at regular intervals to prevent restriction of circulation and thus pressure sores.

Both removable and fixed arms are available in full-length and desk models; both of these styles are available with the height either fixed or adjustable (**Figure 15**). The height of the arms above the seat of the basic adult chair is usually 9 inches. Many models can be had with higher arms at 1-inch intervals on order. The thickness of any seat cushion to be used must be taken into account when specifying the height of arms.

The desk models are foreshortened to permit the user to get closer to a desk or table top. The removable desk arm is by far the most popular type. The full length models are indicated when the forepart is needed to support the arms of the user in rising from the chair or when lordosis, obesity, or some other physical factor makes it necessary to use the front part of the arm for support while the patient is in the sitting position.

The standard removable desk model can be reversed to provide this feature.

Adjustable removable arms have an adjustment range between 5 and 12 inches above the seat.

The simplest type of removable arm design adds nearly 2 inches to the overall width of the basic chair. When this is a disadvantage the wrap-around, or space-saver, arm is used. The single functional disadvantage in the wrap-around design is that the desk model arm cannot be reversed.

The armrests are cushioned and upholstered in nearly every instance and custom features are available on the more expensive models.

Front Rigging

Front rigging is the collective term for footrest and legrests (**Figure 16**). Footrests consist of a support bracket with swing-away mechanism, and pivot-and-slide-tube to which the footplates are attached. Legrests consist of an elevating support bracket with swing-away mechanism, pivot-and-slide-tube with foot-plate, and calf pad to support the back of the leg when elevated.

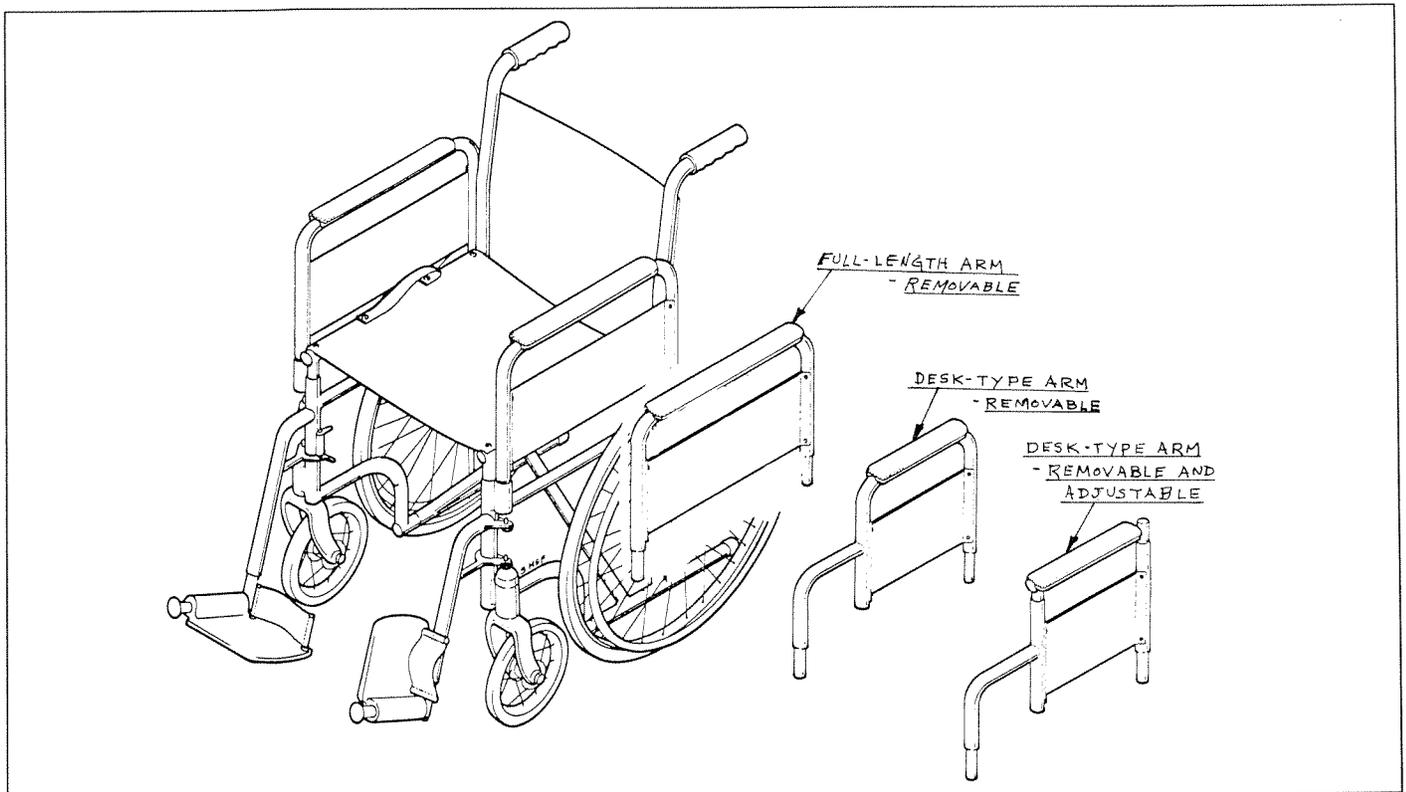


Figure 15.

The basic wheelchair and the most popular types of arms: a) Removable full-length; b) Removable desk-type; c) Removable, adjustable desk-type.

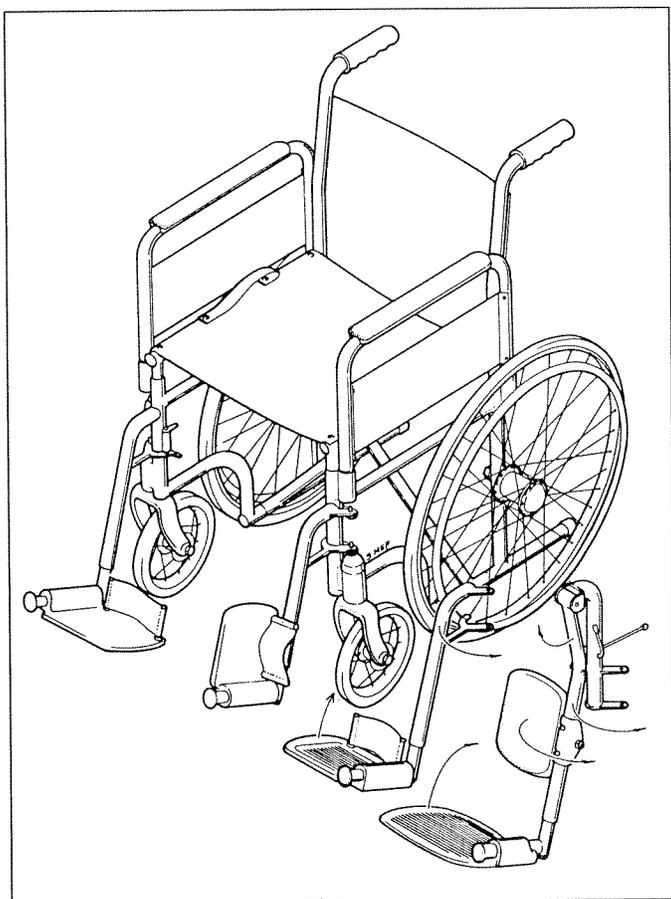


Figure 16.

The basic wheelchair with some variations of footrests and legrests. Shown is the detachable type that can be pivoted away from the center line of the chair to afford better entry and exit and to permit the chair and occupant to get closer to a desk or counter. Also shown is the legrest for support for the leg when elevated. The distance between footplate and chair is adjustable.

The obvious function of the footrests is to keep the feet off the floor. Not so obvious is that footrests hold the posterior aspect of the distal thighs of paralyzed patients at a height above the front edge of the seat so as not to restrict circulation.

Footrests can be fixed or can be detached from the wheelchair for those occasions when their presence is restrictive, such as maneuvering in a small bathroom.

Detachable footrests and front rigging that can be pivoted about the vertical axis to aid entry and exit and to permit the chair and occupant to get closer to a desk or counter are available.

The distance between the footplate and the front edge of the seat can be adjusted. This

adjustment is critical with respect to the distribution of the loads over the thighs and buttocks. The foot-plates can be swung up 90 degrees so that they are vertical to the floor to permit easy access to the chair by patients who can stand.

Elevating front riggings consisting of adjustable footrests and legrests are available for those patients with conditions, such as edema, arthrodesed knee, and leg in a cast, that require that one or both legs be elevated. Legrests also provide better support for persons with long legs.

Wheels and Tires

The basic chair has two 24-inch diameter rear wheels and two 8-inch diameter caster wheels in the front (**Figure 17**). Overall length without the front rigging varies between 30 5/8 and 32 inches, depending upon model and manufacturer.

The standard rear wheel for many years has been a wire spoke wheel, but wheels of cast metal alloy and wheels of cast plastic have been made available recently to overcome the maintenance problems inherent in the wire wheel design, yet not weigh any more.

Three types of tires are available in several widths and tread types as shown in **Table 2**.

Pneumatic tires provide a more cushioned ride and the shock absorber action tends to prolong the life of a wheelchair when kept inflated properly.

Handrims

Handrims are attached to the driving wheels of wheelchairs to permit control without soiling the hands. The standard handrim is a circular steel tube. For users who have problems gripping the smooth surface of a metal ring, there are available vinyl coated rings and a variety of knobs and projections that can be added to the ring (**Figure 22**).

Casters

Casters make steering possible and are available in two diameters: 8 inches and 5 inches. Pneumatic, semi-pneumatic, and solid tires are available (**Figure 18**). The 8-inch diameter wheel with solid rubber tires is standard on the basic chair, and is suitable for use on smooth surfaces and indoors. The semi-pneumatic and pneumatic tires provide shock absorption, and, thus, are more suitable for rough surfaces and outdoor use. The 5-inch model is available only with solid tires, and is used on

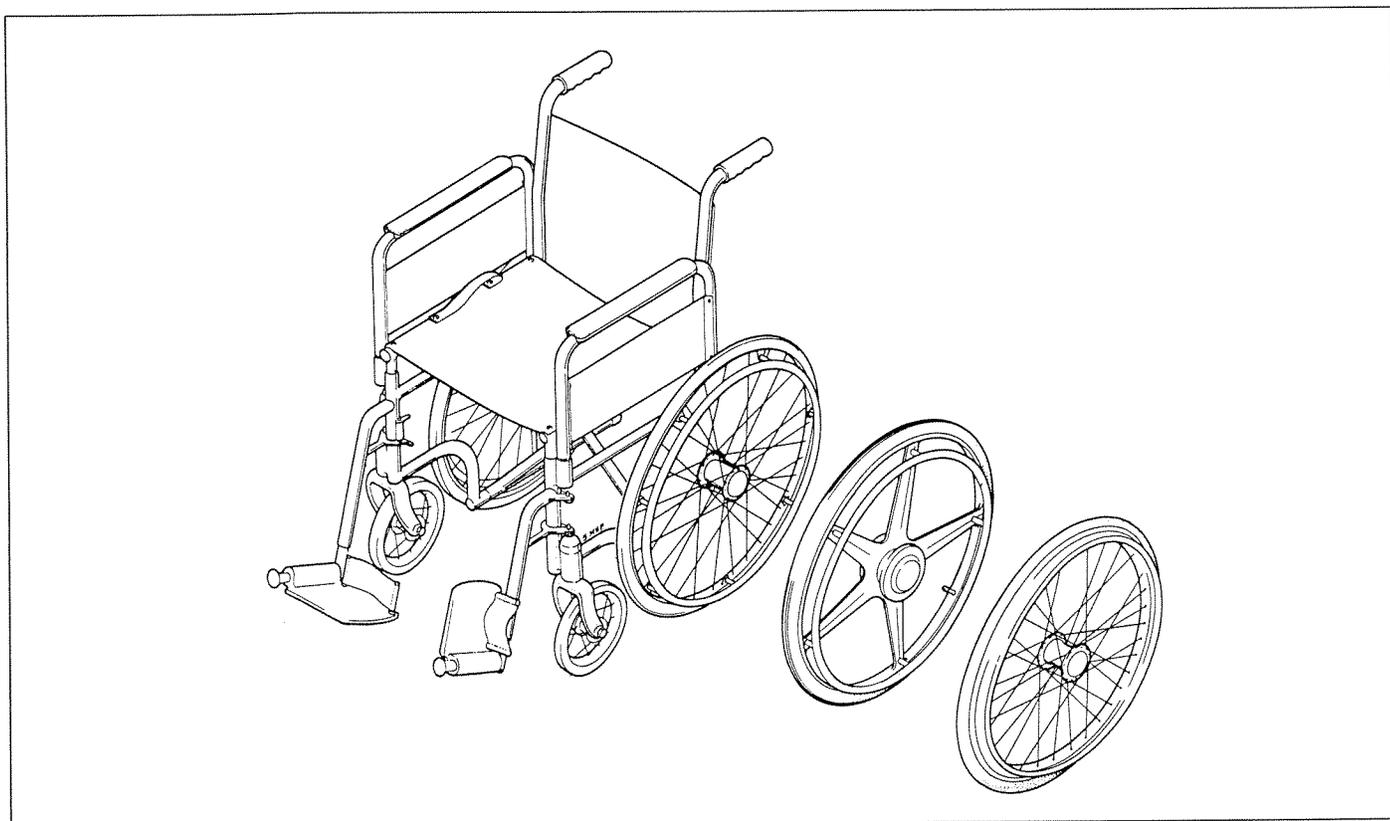


Figure 17.

Basic wheelchair with standard 24-inch diameter wire-spoke wheel and 2 options: a) The cast magnesium wheel; b) A wheel with special built in handrim.

children's chairs and in special circumstances on adult chairs and basketball chairs, when more maneuverability is desired.

Parking Locks

Most users need some means of securing one or more wheels to keep the chair from rolling down inclines or to provide stability during transfer to and from the chair. Two types of parking locks are available for the large wheel (**Figure 19**): toggle and lever. Selection depends upon user preference which is usually based on the residual function of the upper limb and hand. These devices are designed

strictly as locks to hold the chair in place and should never be used to slow down a chair because the abrupt stop that would be provided can cause the chair to overturn.

Pin type locks are available for retaining a caster in the trail position and to prevent swiveling during lateral transfer. Extensions are available so that users with limited function can operate the locks.

Amputee Chair (Figure 20)

Because the center of gravity of a bilateral amputee in the seated position, even with artificial

Table 2.

Type	Width	Spoke Size	Tread Type	Purpose
Pneumatic	1 ¼"	.105	smooth	general purpose
	1 ¼"	mag. wheel	smooth	general purpose
	1 ¼"	.105	treaded	for soft, sandy, or rough terrain
Semi-Pneumatic Solid	¾"	.080	smooth	indoor use
	¾"	mag. wheel	smooth	sturdier, less maintenance

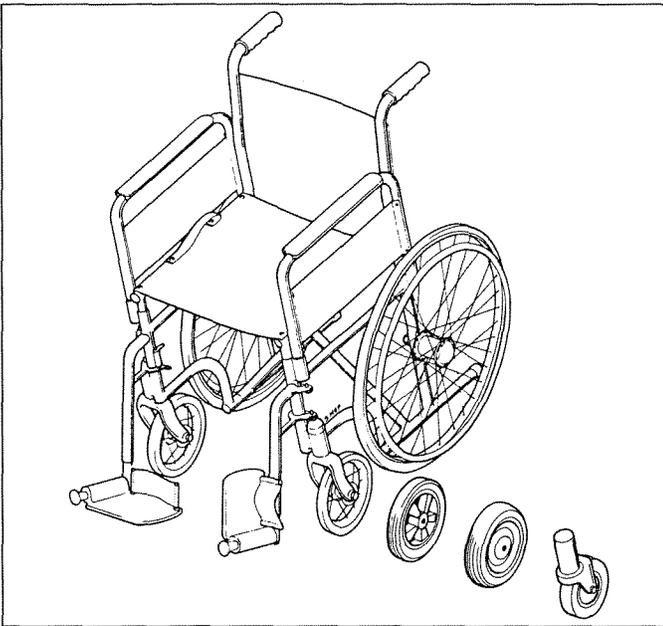


Figure 18.

Basic wheelchair and optional casters available. Shown on the chair is the standard 8-inch diameter wheel with solid rubber tire. Next in order are: the 8-inch wheel with semi-pneumatic tire; the 8-inch wheel with pneumatic tire; a 5-inch diameter wheel with solid rubber tire.

legs, is at least an inch further to the rear than is the case with most other patients, it is wise to provide a chair in which the rear wheels are moved

toward the rear if the proper degree of stability is to be attained. The distance used in most chairs is 2 inches. As a result, the turning radius is increased slightly, but this is offset when the front rigging is removed for amputees not wearing artificial legs.

Footdrive Chair (Figure 20)

For those patients who have good use of at least one leg, such as hemiplegics, the so-called footdrive, or hemiplegic chair, where the seat is about 2 inches lower than standard and specially adapted front riggings are used, is available to permit efficient use of the leg.

The use of 22-inch diameter wheels will effectively lower the seat 1 inch.

Indoor Chair (Figure 20)

When the large driving wheels are placed at the front and the casters are placed at the rear, the overall length of the wheelchair can be reduced and the feet can be placed parallel to the floor. Known as the indoor chair, this configuration is seldom prescribed because the disadvantages almost always outweigh the advantages. Although it can be maneuvered in smaller areas than the basic chair, it is more difficult to propel and to negotiate curbs and steps, and is generally not as handy.

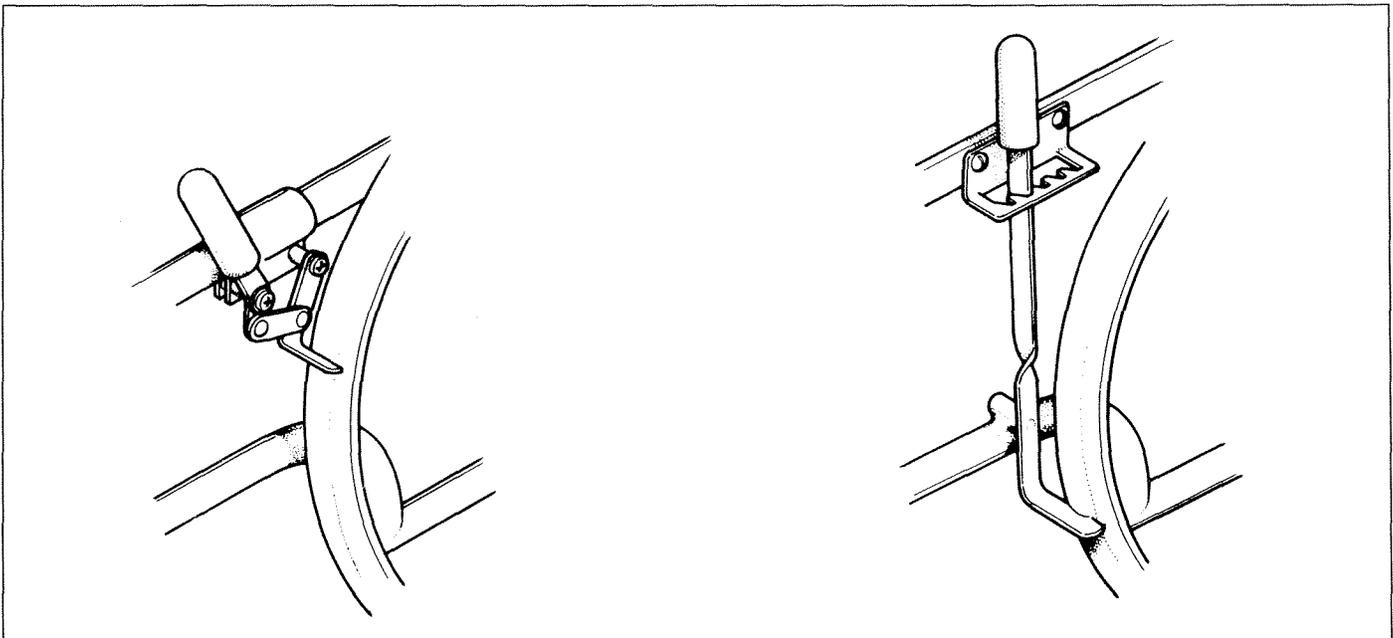


Figure 19.

Two types of parking brakes: left, toggle type; right, lever type. Variations of these 2 types of brakes are available.

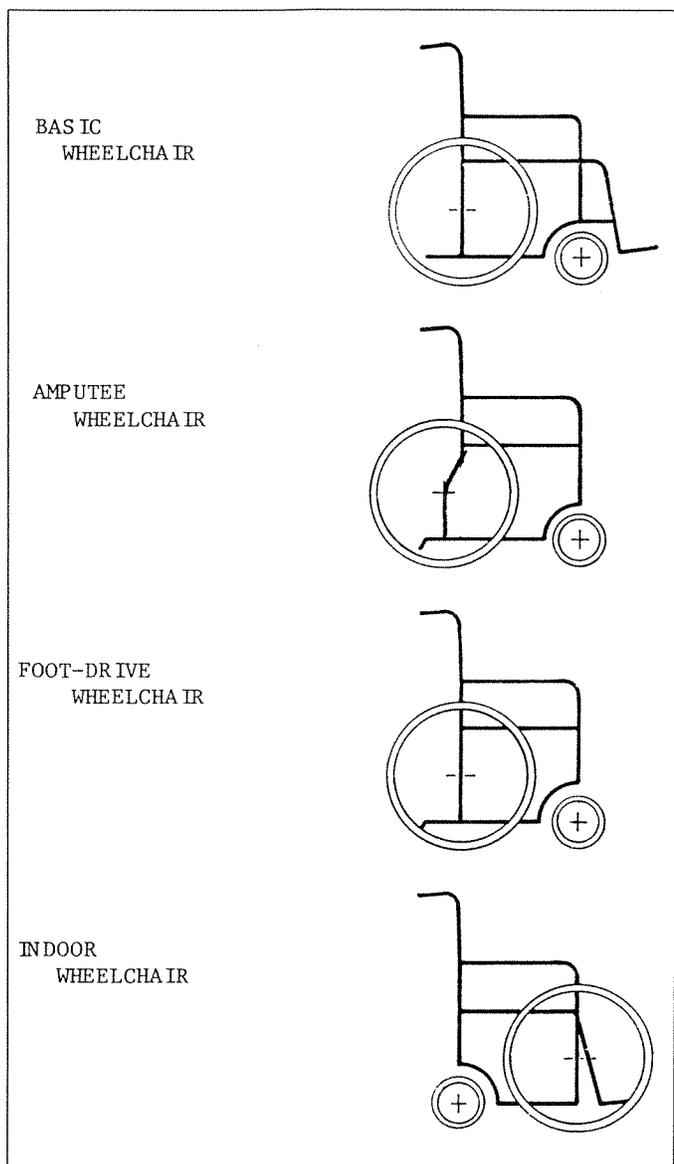


Figure 20. Sideview schematic showing differences between: a) Basic chair; b) Amputee chair; c) Foot-drive chair; d) Indoor chair.

One-Hand Drive Chair (Figure 21)

For people who have use of only one arm, such as hemiplegics and unilateral arm amputees, the wheelchair can be equipped with a system that permits operation from one side. The driving wheels are interconnected so that either or both can be controlled from one side through a dual set of handrims. When one handrim is moved independently of the other, only one wheel is driven; when both rims are grasped in the hand and moved together, both wheels are driven.

Lever drives are also available for one-hand operation, but in present designs the lever can be restrictive in certain situations.

ACCESSORIES

A great number of accessories are available to meet special needs. Some are available from the manufacturers of wheelchairs, while some ingenious devices are available from other sources. Some of the accessories available and used most frequently are described below.

Special Handrims (Figure 22)

Handrims can be provided with projections of various designs to make it easier for patients with hand deformities to propel the driving wheels. Special handrims for replacement on the original equipment to provide more function are also available.

Trays and Desks (Figure 23)

A variety of trays and desks are available for eating and working. Some are made of plywood,

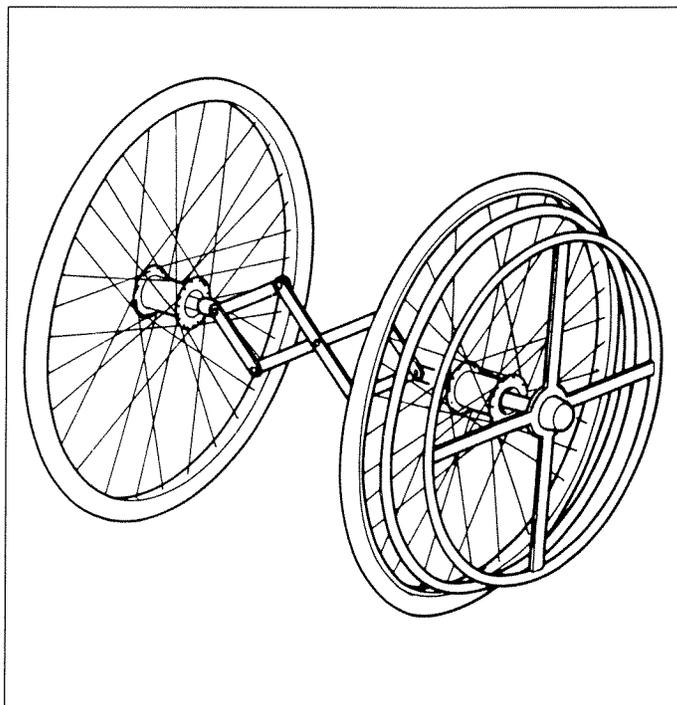


Figure 21. Mechanism for a 1-hand drive chair.

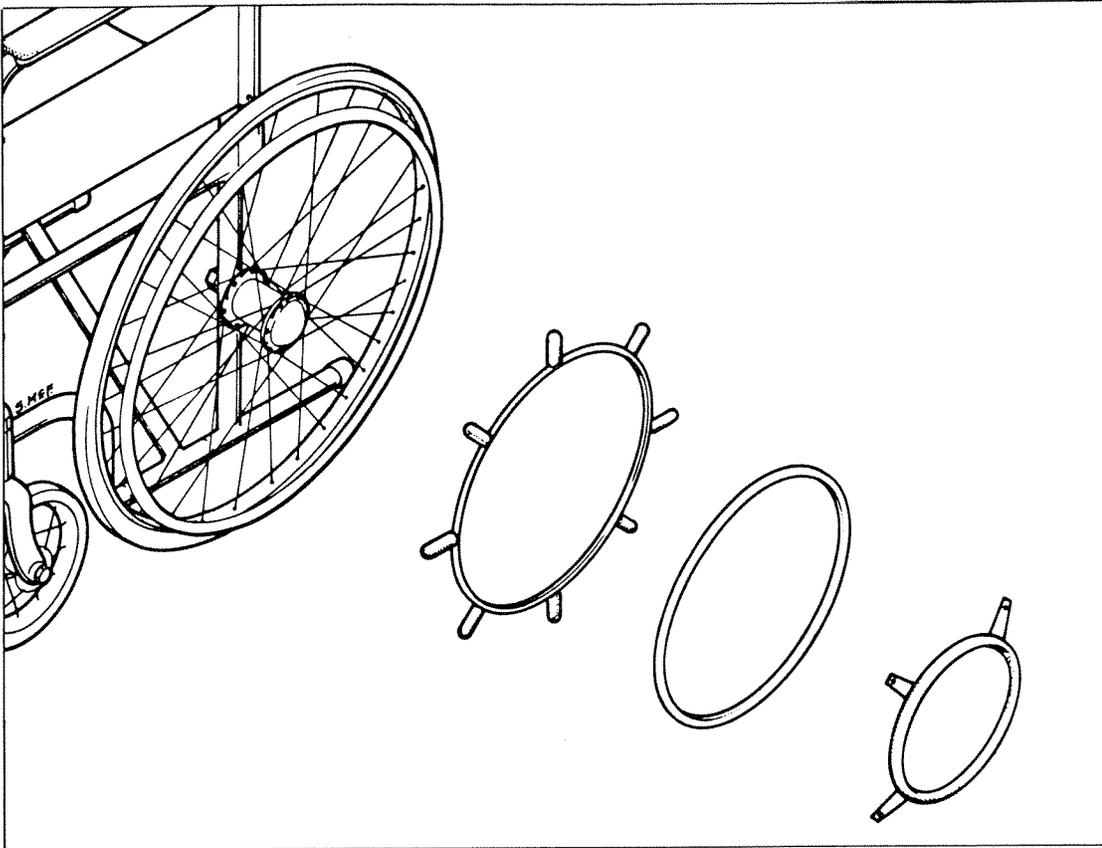


Figure 22.
Several types of
handrims.

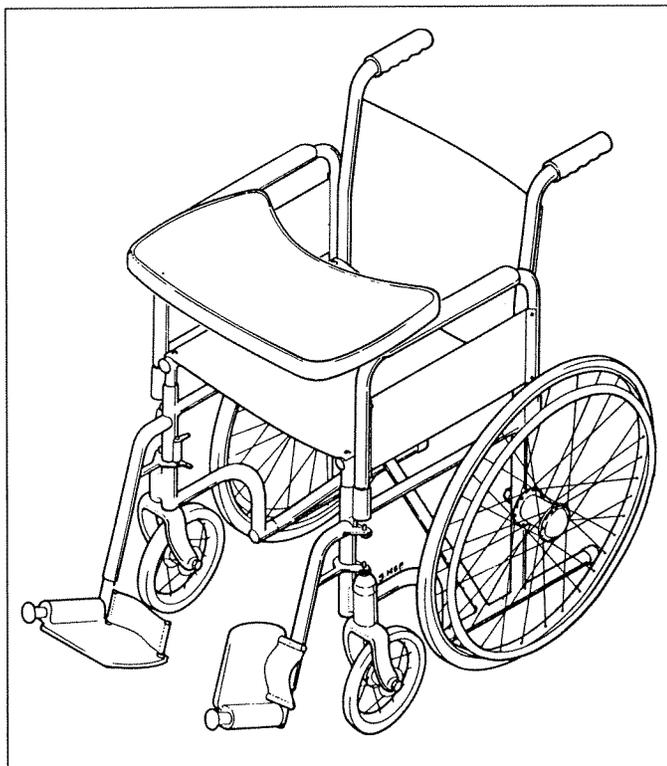


Figure 23.
Typical tray in place on wheelchair.

others of plastic, transparent and opaque; some are adjustable in several ways; some are designed for special purposes.

Restraining and Positioning Systems (Figure 24)

A number of belts and pads are available for holding severely disabled patients in proper position in the wheelchair.

Anti-Tipping Devices (Figure 25)

Detachable extensions for the lower rail of the wheelchair can be used to prevent the chair from tipping backward. One design uses wheels at the end that will come in contact with the floor upon tipping, thus avoiding a sudden deceleration.

Anti-tipping devices are also available for attachment to the front rigging to prevent tipping forward.

Narrowing Device (Figure 26)

A device is available that permits a wheelchair to be made narrower temporarily by a few inches by applying through a crank and gear mechanism the

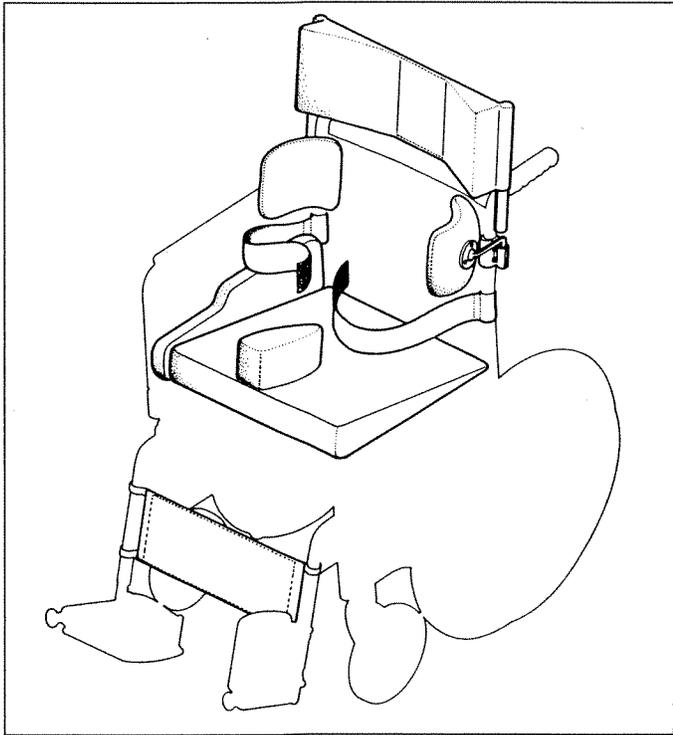


Figure 24.
One type of restraining and positioning device.

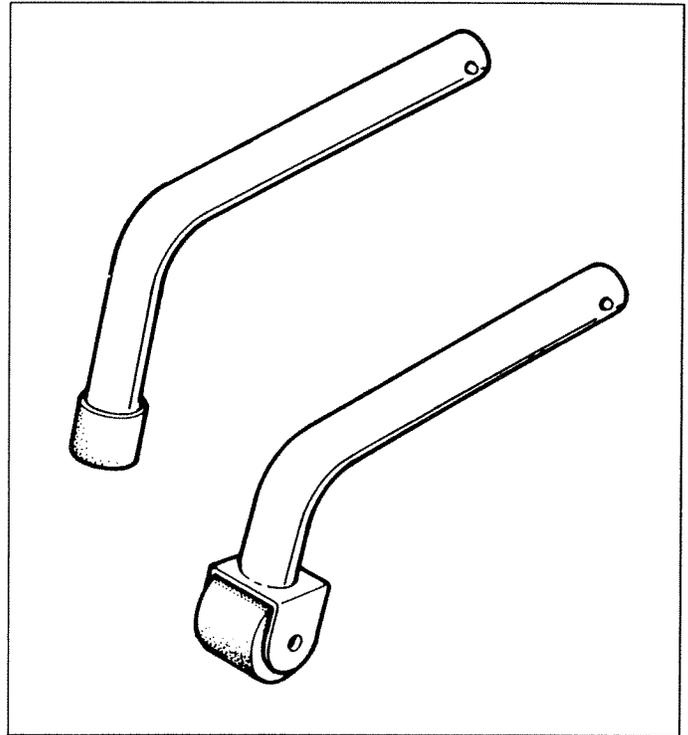


Figure 25.
Two anti-tipping devices that fit over end of lower rail of the frame. The model shown in the lower part contains a wheel that prevents scraping.

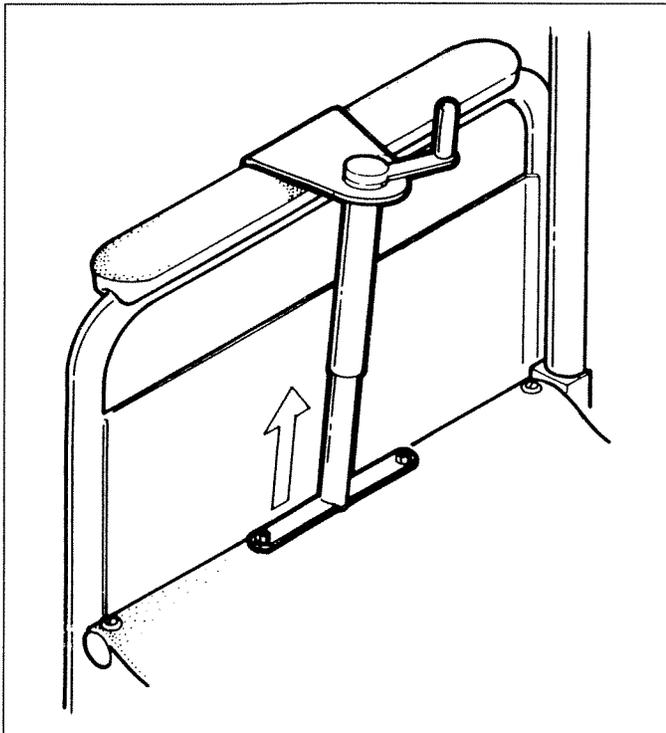


Figure 26.
View of narrowing device. The wheelchair is made narrow by turning the crank which causes the chair to start the folding action.

force necessary to begin the folding process. The narrowing device is generally left in place, but the crank handle is removable for storage.

New accessories and refinements of present designs are continuously being introduced for general use. Advertisements and announcements of new commercially available chairs and accessories are published in one or more of the following periodicals:

Accent on Living
P.O. Box 700
Bloomington, IL 61702

Paraplegia News
5201 N. 18th Ave.
Suite 111
Phoenix, AZ 85015

Sports 'n Spokes
5201 N. 18th Ave.
Suite 111
Phoenix, AZ 85015

SPORTS CHAIRS

Since the introduction of wheelchair basketball shortly after World War II a constant stream of modifications and refinements have been made to the basic wheelchair to meet the need of the so-called wheelchair athletes. Development of the lightweight, high-performance, sports chair (**Figure 39**) has led to racing among wheelchair users and has made tennis from wheelchairs practical and enjoyable. These chairs have also been found useful in non-competitive recreation such as camping and mountain climbing. Some of the lessons learned in developing and using sports chairs have resulted in improved performance and quality of prescription wheelchairs just as automobile racing has led to improvements in the family car. At the same time

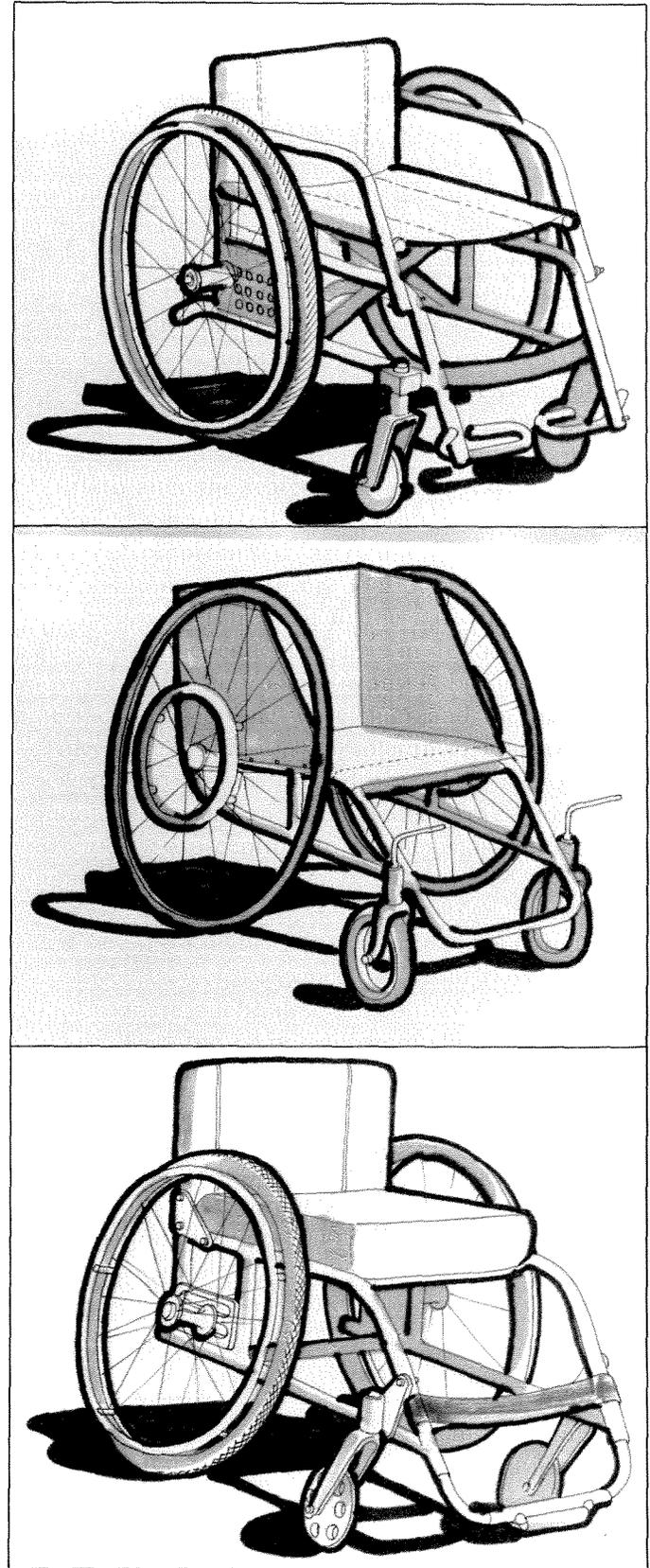


Figure 39.
Three designs of sports chairs.

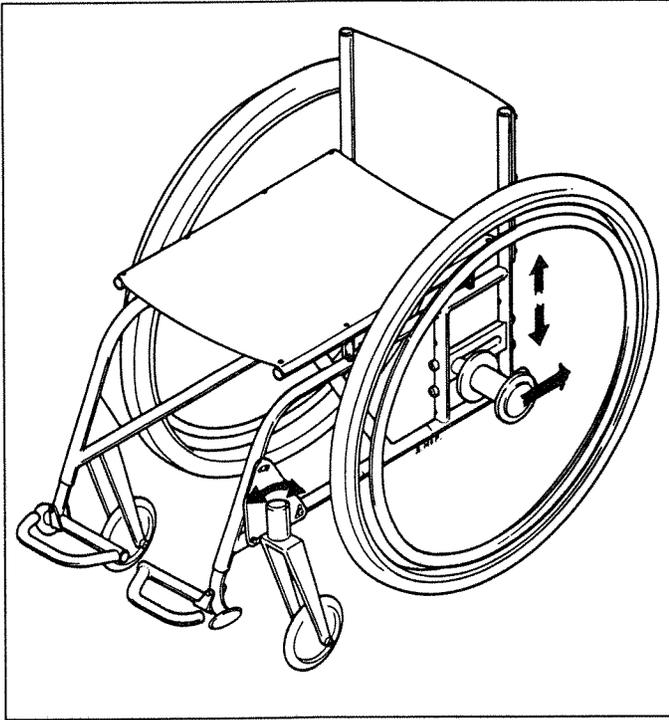


Figure 40. Schematic showing adjustability often found in sports chairs that permit an optimum relationship between position of the user and the wheels.

many of the people who have been using conventional wheelchairs are now using the so-called sports chairs full time.

Like the basic prescription wheelchair, the sports chair has evolved through a series of refinements to where the general configuration of the

most used chairs is strikingly similar. At least 14 manufacturers at this time offer 1 or more models. Most use 24-inch diameter wheels; some use 27-inch wheels. Weight varies from 16 to 38 pounds due mainly to material selection and whether the chair can be folded or not. A number of designs incorporate provisions for folding. The others use wheels that can be disconnected (and connected) quickly without tools to make transportation easier.

Nearly all use 5-inch diameter front casters except one manufacturer that uses 4-inch wheels. Two make 8-inch casters available as an option. All have a feature that permits a choice of rear wheel axle position with respect to the frame. Only a very few offer armrests.

Many active wheelchair users prefer to use a sports type chair all the time, and in many instances options that make regular use practical are offered. Many models have adjustable features, and most manufacturers will provide a chair with dimensions to suit a given individual. Most manufacturers offer one or more types of arms.

A feature found on most sports chairs, but not on other types is the easy adjustability of wheelbase and seat height afforded by the positioning plate for the rear wheels. In many models the position of the caster wheels can also be adjusted (**Figure 40**). Such adjustability, of course, permits the user to be seated in a position which puts the muscles in the upper limbs and shoulders in the optimum arrangements for maximum biomechanical efficiency.