

# **Residential & Workplace Accommodations - and Assistive Technology for Quadriplegics**

## **PART-2 ASSISTIVE TECHNOLOGY** (updated to October 2002)

The National Institute for Rehabilitation Engineering (NIRE) is a non-profit organization which operated clinics to design, dispense and fit customized assistive equipment with user training, from 1967 through 1996. Working with disabled people's own doctors and therapists, these NIRE clinics assisted *hundreds* of people having severe and permanent motor impairments. *The N.I.R.E. pioneered the development and use of personalized quadriplegic self-care and mobility aids; appliance controllers; communications aids; adapted computers and office equipment; power wheelchairs (steered and controlled with inertial guidance systems or with breath controls, by people unable to use hand controls); and adapted road vehicles.*

Although the NIRE no longer operates these clinics, it is still active in dispensing "Accommodation" and "Assistive Technology" information, advice and referrals. *PERMISSION is granted for the free copying and distribution of these © papers, provided all copies are complete and unaltered.*

### **Part-2, this part, discusses "Assistive Technology" and "Adapted Vehicles".**

A separate **Part-1** discusses "Residential & Workplace Accommodations"

**THIS PAPER** is intended for people who have partial to total paralysis of both arms, both hands, both legs, and both feet. They may be either "Quadriplegics" or "Quadriparetics." (1) Some Quads can freely move and support their heads; others cannot. (2) Some Quads can position and move their hands but not use the fingers. Some of these can use a tool attached to one or both hands to typewrite or to press buttons, one at a time. (3) Other Quads cannot use their hands or arms at all. (4) Some Quads have useful finger dexterity in one or both hands.

**Assistive Devices** (discussed in this paper, Part-2) are non-medical tools which relate to and assist with mobility, transportation, communication, activities of daily living, and performance of job related activities. (NOTE: Implanted medical devices such as pacers or muscle stimulators are not considered "Assistive Technology." They fit in the realm of "Bio-Medical Engineering.")

### **NOTES:**

***(1) This paper is for quads who have adequate to normal speech, hearing and eyesight. Quads who also have impaired speech, hearing or eyesight should contact the N.I.R.E. and request papers dealing with their added disabilities.***

***(2) This paper is written primarily for the newly disabled person. Experienced quads will already be familiar with many of the fundamentals discussed herein.***

***(3) This information is to help the reader to understand his needs and to better search for appropriate products. We usually do not recommend specific commercial products.***

## **ASSISTIVE TECHNOLOGY AIDS ...Typically Needed by Quads**

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**\*NOTE: Categories marked with an\* should be the subjects of in-hospital trial fittings, evaluations and training before discharge. These are good reasons for the new quad to be sent home from a rehabilitation hospital, not from a general hospital.**

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1. \*Personal Mobility Aids ... for indoor and outdoor use. May include wheelchairs, power wheelchairs and/or power scooters.
2. \*Transfer Aids ... for indoor or outdoor use. May include simple mechanical devices such as sliding board ... or manual hydraulic lift machine on wheels, a bathtub lift, or a ceiling-mounted overhead lift device or system.
3. \*Personal Self-Care Aids for bedroom, bathroom, dining room, etc.
4. Stair Climbing Aids ... for indoor or outdoor use. May include portable ramps or permanently installed ramps, stairway seat transporters or elevators.
5. Desk or Work Table ... for home or workplace and wheelchair compatible. This is for comfortable reading, writing, and using a desktop personal computer.
6. Reading Aids ... may include book and magazine holders, hand tools, page turning machines, electric actuators, lights, eyeglasses and/or page magnifiers.
7. Telephone Equipment ... which vocal quads can use alone and unaided. Depending on lifestyle needs, these may include any one or more: (1) desktop telephone, (2) bedside telephone, or (3) wheelchair-mounted, wireless telephone.
8. Appliance Controllers ... to enable the quad to selectively switch ON or OFF specific appliances such as computer, room lights, TV, etc. Such controllers might be at the bed, on the desk or on the wheelchair – depending on the person's lifestyle needs.
9. Personal Computers ... for use by the quad for word processing, bookkeeping, email and internet access, online banking and bill paying, controlling appliances, etc. and for personal use. Also, as a work tool for those who are employed or self employed.
10. \*Kitchen Aids ... for, quads to facilitate their eating ... and for quads desiring to be able to prepare and serve meals.
11. Highway Transportation Vehicles ... that are wheelchair compatible, such as adapted automobiles or vans. Some vehicles are adapted to transport the quad as a passenger. Others may be adapted so that the quad can drive.

**CAUTION:** These adapted devices must all be compatible with the user's disabilities, with his w/c and with each other. This takes a great deal of technical detail, planning, time, and money. Costs for the typical quad can vary from a low of \$18,000 to a high of

\$600,000. Do not rush to buy all of these assistive devices or systems too quickly. Buy the medically necessary and essential ones first (primary wheelchair, transfer aids and access ramps), with insurance, Medicaid or other assistance, if possible. Take time to design the overall system, to obtain more financial aid, and to have work done by responsible contractors or suppliers – always with inspections, guidance, and approvals by a qualified rehabilitation technologist or an experienced occupational therapist.

## **MORE DETAILED INFORMATION - by category**

**Category -1. \*Personal Mobility Aids** ... such as wheelchairs or scooters are always needed by quads and will require customized controllers for quads unable to safely and reliably operate the standard joystick controller that is present on most electrically powered wheelchairs ...or the mechanical steering on scooters. The rehabilitated quad will usually need two or more wheelchairs to meet varied needs:

**Primary Wheelchairs – are best used Indoors ... or Outdoors on City Sidewalks but not on grass or soil.** Typically, these include: (1) a foldable manual wheelchair, and (2) a compact, foldable power wheelchair. **These wheelchairs, usually with two small wheels (or casters) in front, and two large wheels in the rear, facilitate close maneuvering within congested spaces** but are inefficient and dangerous on grass or soil. Often, these wheelchairs have removable “desk” armrests that are recessed for closer seating at a table. Depending on needs of the user, the wheelchairs may or may not have: (a) a reclining back; (b) a headrest; and/or (c) elevating leg rests. Because these wheelchairs are compact and light weight, the reclining back and elevating leg rest features are not self-operable by the quad and must be manually set by another person.

\*MANUAL WHEELCHAIRS: Many quads are not able to self-propel the manual wheelchair so that mobility is dependent on another person. This chair is convenient for auto and air transportation, for emergency transportation and for other purposes. With a manual w/c, only, some quads can never be left alone and need a constant companion.

\*POWER WHEELCHAIR: A power wheelchair gives the quad self-controlled mobility which reduces the need for a care giver from full-time to intermittent. Most funding programs recognize the need for both and often pay for both manual and power wheelchairs.

\*NOTES: The quad will need trial fittings, training and wheelchair prescriptions for these basic wheelchairs while still in the hospital. Typically, the Occupational Therapy Department at a Rehabilitation Hospital holds “wheelchair clinics” where the quad is trial-fitted, evaluated and trained in appropriate wheelchair configurations. Sometimes, the quad is given a prescription and written specifications with which to order the wheelchair(s) from a vendor near his home; other times, vendors are present at the w/c clinic and one or another is selected to provide the equipment. With appropriate prescriptions and statements of “Medical Necessity” from the doctor, most vendors will know how to get paid – whether from health insurance, Medicaid, Medicare or Vocational Rehabilitation. These basic wheelchairs are most often fundable.

**Power Wheelchair Controller selection is of life and death importance.** If a particular quad has marginal control of the joystick - whether by hand, chin or mouth - then extreme care must be exercised, even indoors. If, for example, the front wheels or casters strike furniture or a threshold unevenly, the w/c may lurch causing the user to lose control and get hurt. Use of such a wheelchair outdoors is even more dangerous because of unexpected cracks in the sidewalk, or uneven or raised slabs, or sideways-tilted slabs. We recommend that, for quads, qualified technicians (the hospital's or the vendor's) always provide and set up a personalized control device for each quad that will be entirely safe. For people unable to safely use the standard, or a modified joystick, there are breath (puff and sip) controllers – and other type controllers.

**Secondary Wheelchairs** – may be for Special-Purpose Indoor Use or for Outdoor Use. Usually these chairs must be customized and can be very expensive, costing from \$3,800 to \$29,000 each. Funding for such wheelchairs sometimes is provided by insurance payments, especially if the quadriplegia was the result of an accident. In some situations where employment is a rehabilitation goal, a necessary secondary wheelchair may be paid for by the federal-state Vocational Rehabilitation program.

One type of Secondary Wheelchair is an INDOOR power chair that can seat or stand the user, at the user's will. Most paraplegics, but only some quads, can use such chairs. They can be useful for reaching shelves in the kitchen or in closets, for example. In some case, patient-standing wheelchairs are prescribed for physical therapy purposes and may be medically necessary. Few are used, but there are “STAIR CLIMBING” power wheelchairs. They are expensive, potentially very dangerous to use, and they generally perform poorly as wheelchairs because of their bulk and complexity. *Another, smaller device is a manually propelled “shower chair.” This is discussed under “Personal Self-Care Aids.”*

Other Secondary Wheelchairs are most suitable for outdoor use, and indoors, in public buildings. They tend, however, to be too large for use in the small, congested spaces of residential apartments and houses. Many different makes and models are available. The new quad should NEVER even consider buying an outdoor power chair by mail. **ALWAYS try before you buy!** First, try to see and test drive a variety of these chairs in one place – such as a wheelchair clinic at a rehabilitation hospital ... or at an “Assistive Technology Center.” (Note: Some Cerebral Palsy centers have such technology centers.) Some wheelchair dealers stock a variety of power wheelchair models. Only after comparing and trying outdoor power wheelchairs in group settings should you consider telephoning specific manufacturers (whose ads you see in magazines) to send a representative to visit you. The problem is a visiting salesperson may try to close a sale at that one visit and balk at giving the quad more time to try competitors' products.

**SAFETY NOTES:** Wheelchairs intended for outdoor use should have large, powered wheels in front, not free-wheeling casters, and not even powered wheels that are small diameter. While this makes them safer outdoors, it also renders them less maneuverable in tight spaces, indoors. Also, because of unexpected bumps and jolts, a power w/c used outdoors MUST have a very stable control device – and most certainly not rely on barely marginal ability to manually or orally operate a joystick control.

**“POWER SCOOTERS”** are also available as alternatives to powered Secondary Wheelchairs. Scooters usually cost less (typically \$1800 - \$3600), are lighter and more easily transported in a car, ship or airplane. However, they are better suited for paraplegics than for quads. Many scooters have three wheels – not four. They may have two wheels in the rear and one in front ... or they may have two wheels in front and one in the rear. Most scooters are steered manually with the user holding and moving a handlebar or tiller. A few scooters are available with electrical or electronic controls. Most scooters are unsafe on grass or soil, and are best suited for indoor use, or sidewalk use, or in hotels, supermarkets, or public building. FOR A QUAD, a scooter would have to feature a full seat with back support and armrests ... a saddle or small seat would not suffice. Also, a 3-wheel scooter would pose a danger of falling over during transfers, or outdoors where the sidewalk or ground may be inclined or hilly. We do not recommend any 3-wheel scooter for use by a quad.

**Category -2 \*Transfer Aids** ... are used to facilitate a quad’s transfer between wheelchair and bed, w/c and toilet, w/c and bathtub, w/c and car seat, etc. Some quads can learn to transfer themselves, unaided, using appropriate assistive devices. For other quads, the transfer aids are operated by a spouse, caregiver or aide. The newly rehabilitated quad - along with spouse or caregiver – should be evaluated and trained in transferring while still in the rehabilitation hospital, by physical or occupational therapists. Ideally, therapists will have visited the quad’s residence and thus be able to trial-fit, train in the use of assistive devices that will work efficiently and safely with the quad’s wheelchair, car seat and home fixtures (bed, toilet, bathtub).

**\*Basic TRANSFER AIDS** might include: (1) Primary Wheelchair with detachable armrests; (2) a Sliding Board (for w/c to car seat transfers); (3) a Hoyer rolling hydraulic lift with appropriate type sling seat; and (4) a bathtub transfer lift (preferably non-electric, for safety). *All of these devices are available from “surgical supply” or “medical equipment” dealers. All are essential and should be paid for by third party payers such as insurance, Medicaid, Medicare, or Vocational Rehabilitation to permit residential living rather than requiring expensive nursing home care.* All of these devices should be trial-fitted, with user training, at the rehabilitation hospital before discharge. They should then be prescribed as appliances that are medically necessary for the quad to be discharged to a residential environment. *NOTE: These aids are not self-operable by most quads. They almost always require the quad to have assistance from a spouse, caregiver or aide.* Some people consider ramps, from street to entrance, to be basic and necessary transfer aids.

**Advanced TRANSFER AIDS** are very much more costly and may not qualify for public funding. However, these more costly systems may still qualify for funding from private insurance companies, particularly when quadriplegia is due to an accident – or by Vocational Rehabilitation when needed to facilitate employment. Equipment in this category is generally sought by partial quads with some arm and hand use, who desire the ability to transfer themselves with little or no assistance. Included in this category are: (1) Indoor Ceiling-Track Electric Lift, Travel & Transfer Systems – often in bedroom and bathroom; (2) Outdoor Vertical Power Wheelchair Lift – from street to porch level; (3) Indoor Seat-Type Stair Climbers such as the “Stair Glide” can be installed on a stairway.

Typically, this device has a chair seat that requires transfers in and out. These are generally unsuitable for quads and are better suited for paraplegics. A very few offer a w/c transport platform but these require the staircase to be wider than most; (4) Indoor Powered (Wheelchair) Vertical Lift or Elevator – from floor to floor (*Note: these require an architect's plans and municipal approvals and are very expensive*); and (5) Power Lift & Transfer System - in or on car or van, for w/c to vehicle transfers.

Advanced Transfer Aids should never be ordered quickly because, by doing so, one is likely to overlook important limitations and details, thereby spending enormous amounts of money while obtaining poor or even dangerous results. These types of aids should be carefully considered and researched months after returning home from the rehabilitation hospital, when the quad's daily routines are established (using Basic Transfer Aids), when the quad knows which wheelchair(s) he desires for which functions and in which environments, and exactly what his ongoing transfer needs will be as well as how much he desires to perform unaided, and how much he can safely do unaided.

To pursue the goal of achieving partial-to-complete transfer independence, the quad should rely, first of all, on his Physical and Occupational Therapists. They can help the quad test and learn to safely use the various devices that are available. They can recommend specific makes, models and vendors. And they can provide, along with the vendor or contractor, the information that a licensed architect might need to provide plans that a building inspector would approve. (This is necessary for structural safety reasons when **lift & transfer tracks are to be attached to the ceiling of a residence**). Typically, the tracks, lifts, motors, sling seats, etc. are purchased from a manufacturing company. They are then installed by a local contractor – under the guidance of the therapist (who trains the quad to use the equipment) and the architect (who assures structural safety in the house).

**Category -3 \*Personal Self-Care Aids** ... for bedroom, bathroom, etc. are best explored while in the rehabilitation hospital with the help of therapists who have various devices on hand for testing , training and trial use. **\*Basic Personal Self-Care Aids** are usually fundable by insurance, Medicaid, etc. as medical necessities. These aids, for dental hygiene, washing, shaving, etc. may require use by a caregiver or aide, or may be usable by the quad without assistance depending on how much head movement, arm and hand dexterity the quad may retain. **Advanced Personal Self-Care Aids** are more complex and more costly. They should be considered later, after the quad is settled in his permanent residence and determines additional needs or desires. Again, these types of aids (usually for bathroom or kitchen) should be gotten on the advice of an experienced therapist after one or more at-home evaluations.

**Category -4 Stair Climbing Aids** ... may be for indoor or outdoor use. These may include portable ramps or permanently installed ramps, stairway seat transporters or platform/car type elevators.

**RAMPS** may be portable or permanent. **Portable Ramps** are advertised in disability catalogs and magazines. They are usually made of aluminum or magnesium to be light weight. They may be full-width or they may simply be two separate channels (for the left and right wheels, respectively). They may be foldable or non-foldable. Typically, they

rest on a step and on the ground without being fastened. They can slip and slide and are potentially dangerous each time used. Therefore, an attendant should be assisting the quad every time a portable ramp is used, for SAFETY!

**Permanent Ramps** are far safer and can often be used by a quad who is alone, in his power chair. It is important for the ramp to be long enough so that the incline is less than 10% (less than 1 foot rise for every 10 feet of length). Some experts recommend 10% for attendant use but less for unattended travel – say 8% or 6% rise – for every 10 feet of length. A ramp should have, along its entire length, side-barriers on each side which prevent the wheels from rolling off the edge of the ramp ... plus handrails on both sides at a height that is useful to an aide walking behind the w/c as well as for the occupant. **Construction** can be (1) permanent, e.g. poured concrete with metal posts and handrails; (2) semi-permanent, e.g. cement block structure topped with metal or treated wood surfaces; or (3) removable, e.g. a ramp fabricated of metal and/or treated wood, with posts set in the ground in cement. One's choice of construction must depend on whether one owns or rents, and on whether the property will be more salable with the ramp removed, at some future time. **CAUTION: When wood is used outdoors, it should always be wood that was "treated" for wet weather exposure. Even so, it must be carefully inspected for rot at least twice a years with professional repairs when needed and periodic re-treatments to prevent rot.**

**STAIRWAY TRANSPORTERS** are sold commercially by companies such as "Stair-Glide." To fit most existing stairways, one must use a "**folding-seat** on a track" type transporter. Many paraplegics are able to keep two wheelchairs – one at the top and another at the bottom – and to transfer at each end of the ride. These transporters are unsuitable for most quads, however. There is also limited availability of a "**w/c platform** on a track" transporter. These can only be used on abnormally wide stairways which rarely exist and then, for only one stairway section. This is usually not a practical solution for quads!

**VERTICAL ELEVATORS** are available commercially and can transport wheelchairs and standing people. These are available from commercial elevator companies or contractors and are very expensive (from \$8,000 to \$75,000 installed in a private home). The services of a licensed architect are required, at extra cost, to ensure structural safety and for obtaining the necessary construction permits. *When a multi-story residence has such an elevator installed, its presence usually increases the property value.*

**Category -5**    **Desk or Work Table** ... for home or workplace, that is wheelchair compatible. This is to facilitate reading, writing, and using a desktop personal computer. These can be purchased from regular stores that serve the public – in which case some modifications may need to be made to have the correct surface height and necessary armrest and footrest clearances. It can be custom-made by a carpenter, or it can be purchased from one or another disability equipment catalog. These are the most important factors to consider, and you may want help from an occupational therapist:  
(1) work surface height from floor; (2) no obstruction of access by armrests or footrests; (3) eyes-to-work surface distance compatible with glasses for good eyesight; (4) sufficient available work area on work surface, to accommodate all objects to be on the

desk or work surface, now and in the foreseeable future; and (5) expandability for future needs – such as adding another surface on one side (for an L desk) or on both sides. *(The room-size must be adequate for present and future modules, and there must be sufficient maneuvering space in the room for entry, use and egress.)*

**Category -6 Reading Aids** ... may include book and magazine holders, hand tools, page turning machines, electric actuator, lights, eyeglasses and/or page magnifiers. ***Simple Page-Turning Tools:*** An occupational therapist can almost always help the quad who has partial use of at least one arm, to find a hand-tool attachment and suitable book or magazine holders. A quad able to use his arm, with the tool attached to his hand, to turn pages will not need a page turning machine. Likewise, some quads with no arm movement can use a mouthstick to turn pages when books and magazines are in holders at the correct distance, height and angle. For quads unable to use these simple tools adequately, an ***Electric Page Turning Machine*** may be needed. Good machines for this purpose have been available for over 30 years from: “Touch Turner,” reachable by telephone at (360) 651-1962 in Arlington, WA. This machine can be on a desk or table for w/c use - or on an over-the-bed table for in-bed use. Some over-the-bed tables have a height adjustment so that the same table and machine can be used in bed, or in a wheelchair, alternately. Always get the two-way page turner – never the one-way model. This ensures pages can be turned forward or backward. The machine’s ACTUATOR is of great importance. Standard is a switch that must be touched by a finger, a hand or an arm ... or by the chin. For many quads, this is adequate. But, for other quads, the best choice is a PUFF and SIP breath-control actuator. This is usually on a fixed adjustable gooseneck with the air tube near the lips. It can be used sitting or reclining. ***Eyes-to-Page Distance*** is important for good reading eyesight. Lighting of the page should be optimal for the user and he should have reading glasses appropriate for his Rx, if any, and the actual reading distance used.

**Category -7 Telephone Equipment** ... which vocal quads can use, alone and unaided. Depending on lifestyle needs, this may include any one or more: (1) desktop telephone, (2) bedside telephone, or (3) wheelchair-mounted, wireless telephone. ***In bed***, a quad can use a speakerphone or he can wear a headset – whichever is preferred. A voice actuated telephone is probably preferred so that an aide is not needed for switching it on or off, or for dialing. ***At a Desk*** in a w/c, it is better to have no wires between the w/c and the desk so as to preserve mobility. This gives the quad a choice: (a) he can have a phone on the desk which he can use without wires when he is at the desk ... or (b) he can have a wireless phone on the w/c which he can use while in the w/c whether or not at the desk. The latter is more complex and more costly. In any of these situations, the phone should be voice-actuated for ON-OFF switching and dialing. Such phones, for desk or bedside use, are available commercially. When buying, make certain it is intended for a quad and that ALL functions are voice actuated. (Avoid models for non-disabled which have voice dialing but manual on-off switching.) ***NOTE: Quads having impaired speech or using respirators may be unable to use a voice operated telephone. Alternatives are manually switched on-off phones with auto-dialing to get an operator who places calls; or to use a telephone in conjunction with a computer. A Wireless Telephone on the Wheelchair*** can be either (a) a short-range cordless telephone for use only within a particular house, or (b) a regular cell phone that can be used anywhere.

***The cell phone (b) is the better alternative for convenience, safety and cost reasons.***

Cell phones can be gotten for almost any area, that dial numbers chosen by speaking a name (voice operation). However, many of these phones do not have voice On-Off switching. Either buy one that does, or else have a manual (head-movement activated) switch installed on the w/c that will switch the cell phone on and off. Also, have a charging cable connect, thru a noise filter, between the cell phone and the power chair's battery. This will keep the cell phone's battery charged at all times. ***You will probably need a local technician to install and set up the cell phone, on the w/c.*** To facilitate this, it may be most convenient to obtain the cell phone from a local seller or service supplier on condition that he installs it (at a one-time extra cost to yourself).

**Communications Aids & Telephones for Non-Vocal or Speech-Impaired Quads** are costly and complex because they cannot use speech input. Quads with enough hand, arm or mouthstick movement can use a personal computer with speech output ...for in-person and over-the-telephone communications, although slowly. Those not able to use keyboard input can use eye-movements for inputting data to a PC. (Some MS and some ALS patients are totally paralyzed and unable to speak.) A company in Virginia (tel. 1-800-EyeGaze) provides on-site service, equipment and training using a dedicated computer system. It costs approximately \$20,000 and is for speech output, message typing and, sometimes, appliance control. It does not run all ordinary PC applications. Other companies sell eye-movement sensing and control kits, at low cost, with software and hardware that work with the user's conventional PC. Most users need the on-site services of a local computer technician to set-up and maintain such systems. Computer speech-out systems can be configured for use over telephone lines but this must be done on-site by a local technician.

**Category -8 Appliance Controllers** ... can enable a quad to selectively switch ON or OFF specific appliances such as computer, room lights, TV, etc. Such controllers might be at the bed, on the desk or on the wheelchair – depending on the person's lifestyle needs. In past years, such controllers were sold as stand-alone machines. Nowadays, most are switching boxes that are connected to a standard personal computer (PC) which has special software installed. These controllers are listed in many disabled equipment catalogs and can be found on the internet. In buying such a controller, be certain that it is designed to control the types of appliances you have or plan to obtain. Some appliances are simple to connect: you merely plug in an ac cord. But other appliances (such as TVs, DVD players, cable boxes, VCRs, etc.) may require customized programming. Even room air conditioners are available which come with cordless remote controls. *You may need to pay a technician to wire and program these devices with your controller and PC.*

**Category -9 Personal Computers** ...for use by quads for word processing, bookkeeping, email and internet access, online banking and bill paying, controlling appliances, etc. for personal use. Also, as a work tool for those who are employed or self-employed. (Note: special prescription eyeglasses may be needed.) ***In general, a PC (IBM compatible Personal Computer) is preferable to a Macintosh*** because more application programs and more disability utilities are available for the PC – and because equipment, software and accessories are usually less costly. However, a quad whose

business requires him to provide document disk files in Macintosh format (as for use in the printing and publishing industries) may need to use a suitably adapted Macintosh. ***The Quad's Necessary Data Entry Method*** is the first and foremost consideration in acquiring a PC. Can the user move one or both arms enough to use the keyboard and mouse, with tools attached to his hand or hands? If yes, then it may be preferable to use ***keyboard entry***. This is practical if the user can sustain character entry rates of 15 characters per minute, or better. Some quads can use both the keyboard and the mouse. Others can use the keyboard but not the mouse. (Late versions of MS Windows have a utility built in that allows keyboard mouse emulation so that use of the real mouse is not necessary). *If feasible, keyboard use is preferred because it avoids application software incompatibilities, error correcting difficulties, slowness, and other disadvantages of voice activation & speech input systems.* Disability Technology Centers usually have equipment, software and staff for evaluating a particular quad to determine if he can best use the keyboard and mouse; the keyboard, alone; or speech-input. ***Speech Input*** is an option for quads having normal speech and not using ventilators or respirators. One well known brand is "Dragon Dictate Naturally Speaking" but there are also other brands. All these companies make speech input software for non-disabled such as lawyers, physicians, etc. which enter text but do not perform computer control functions. These functions are still performed via the keyboard and mouse.

***ALWAYS specify, when ordering speech input software, that you are a quad and require "All-Functions" speech input software for "xyz operating system" and it must work with all applications and recognize commands for, and perform ALL computer control functions.***

Speech-Input, Operating System, and Application Compatibility problems are so frequent, so difficult to resolve and so annoying that they need to be prevented from the start of any PC procurement. We recommend these procedures, to be specified BEFORE the procurement is even begun:

Step 1: Prepare a list of desired software applications. It should include BOTH those Applications you plan to install immediately AND specific applications you might conceivably want to install in the future. Some basic items to be sure to list: (a) the PC operating system; (b) anti-virus software; (c) web browser; (d) e-mail program; (e) Word Processing – Spreadsheet-Office Suite (such as MS Office Professional XP); (f) Image Processing Software ( i.e. Adobe PhotoShop 7.0); (g) universal document reader (i.e. Adobe Acrobat Reader 4.2); (h) Fax-Send Software; (i) modem driver software (i.e. for telephone, DSL or cable TV connection); (j) specific printer drivers; (k) CD-R/CR-RW writing software; etc. ***AVOID duplicate applications, i.e. plan on MS Word or COREL WordPerfect Suite but not both. Plan on using Internet Explorer or Netscape or AOL but NOT more than one. Use Outlook Express or Pegasus for mail but not both.***

Step 2: Contact the manager of a local computer store near you - but make certain they service what they sell. Tell him you plan to buy a complete computer system from him if he will visit you at your residence and help plan the system. ***Obtain a written proposal that lists, describes, details and prices all equipment, software, accessories, delivery,***

***set-up, and on-site user training services.*** Be sure to include a modem, a scanner and a printer. The PC should have at least a 60-Gb hard drive and it should have 3 extra drives built-in, to: (1) read/write floppy disks; (2) read CD-ROMs and DVDs; (3) read/write CD-R and CR-RW disks. ***BACK UPS:*** Be sure the vendor makes and keeps a full image backup of your system's hard drive once he has installed all the accessories and programs. This will enable him to quickly and fully restore the entire system, should it become necessary. You will, yourself, regularly, back up your folder: "My Documents" to CD-RW disks that you will retain. (Typically, 2 are used, alternately). ***You will need the written proposal to seek insurance or Vocational Rehabilitation funding for the costs – and to ensure that actually receive all proposed materials, training and services.*** Make it the vendor's responsibility to guarantee full functionality and 100% compatibility of all software and hardware. The vendor has to agree to this in return for you to agree to never buy or obtain software or equipment elsewhere and to never have anyone other than the vendor service the system or attempt any installations.

**CAUTION:** Once speech-input software has been installed, **do not** do as your friends do – **do not** buy, receive or download software. Have the vendor provide it and install it, always. This is the only way you can prevent errant or incompatible applications from damaging or disabling your system thru inadvertent corruption of the registry or the hard disk. Do not let well meaning friends make adjustments to your PC.

**Category -10** **\*Kitchen Aids** ... ***for quads, to facilitate self feeding:*** (1) For quads having sufficient movement of one or both arms, personalized gripping, grasping and self-feeding tools are available. These are best tested and evaluated, with user training, and then recommended for home use by occupational therapists at the patient's rehabilitation hospital. *Complete quadriplegics (and partials with insufficient movements) will have to be fed by someone else, a spouse or caregiver. This caregiver will need to use appropriate tools and appliances. ...* and (2) ***for quads desiring to be able to prepare and serve meals.*** As an example, a quad may live alone with drop-in, part-time help rather than full-time help. A quad living this way might want and need to be able to prepare his or her own meals and be able to wash dishes, dispose of waste, etc. Obviously, complete quads cannot do this - but some partial quads can. In-hospital occupational therapy evaluations can predict the feasibility of this for a given patient. However, at-home visits will be necessary, by an occupational therapist, to facilitate the successful establishment of such capabilities.

**Category -11** **Highway Transportation Vehicles** ... that are wheelchair compatible include adapted automobiles or vans. ***Paraplegics***, better able to transfer without assistance, often choose sedans. They need to transfer themselves between w/c and car seat – and they need to be able to fold, load, unload and unfold the w/c. Paraplegics most often drive themselves although some ride as passengers. Generally, this is not feasible for quads – hence the quad's preference for wheelchair vans. *Some paraplegics prefer a wheelchair van.*

**Quadriplegics** most often choose to use a wheelchair van, mostly for passenger transportation – or, rarely, for driving with special driving controls. Commercial products are not available to facilitate driving by substantial or complete quads. It is possible for some partial quads to drive, with personalized assistive devices, training and

licensing – but *the majority of quads ride in vans, in their wheelchairs as passengers* (driven by a non-handicapped driver). This paper deals with quad passenger transportation – not with quadriplegic driving.

**Note:** Typically, quads are individually classified as: “static”, “potentially progressive”, or as “progressive”. People with spinal cord injuries or cerebral palsy are mostly “static” while those with MS or ALS may be “progressive”. Because adapted cars and vans are so costly, people who are potentially or actively “progressive” should plan appropriately for “worst case”.

### **ADAPTED VANS - Features and Options**

**Van Sources:** Wheelchair van sources vary - with a small range of choices, including:

(1) Regular auto dealers who sell minivans often work with nearby, independent business firms which modify the vans to transport wheelchair users. Thus, one can buy Ford, Chrysler or GM vans from local dealers who will assist by coordinating the sales with the modification vendor. The major advantage of purchasing this way is that the dealers can often arrange special purchase credits (possibly \$1500 or more) from the manufacturer toward the modification costs.

(2) **A Nearby Van Modification firm** which buys the same model van again and again from the same manufacturer, and uses the same modification parts on most or all of their vans. Typically, they raise the roof, install a wheelchair elevator, install wheelchair lockdowns, and install special safety and communications equipment. Typically, these firms obtain lower purchase prices and are able, through their dealer, to help buyers obtain manufacturer’s purchase & modification payments or credits. ***We prefer and recommend these types of vendors because they generally provide better, safer equipment plus better training and better maintenance service.***

(3) Out-Of-Town Van Modification firm which advertises “conversion vans” in disability magazines and catalogs. They buy their own vans, modify them and resell the “converted vans” to people all over the country, to whom the vans are shipped. While mass production and volume sales may lower unit costs for such vehicles, there often are major “after purchase” problems. **First problem: SAFETY** - because the distant vendor did not custom-build lockdowns for the buyer’s own wheelchair. Generic lockdowns often do not work well with many wheelchairs and many quads have died, unnecessarily in even minor auto accidents because of this. **Second problem:** Vehicle warranty repairs, locally and without difficulties, because the user was not the vehicle’s buyer. **Third problem:** prompt and effective repairs to special equipment by the vendor (warranty or not) because the vendor’s shop is too far away to bring the vehicle to, conveniently. **We recommend that adapted vans NOT be bought this way!**

**Van Size and Configuration** is a primary consideration and will vary depending on a number of factors, for each buyer. **Question: which van configuration is best for the van-user? SIDE ENTRY or REAR ENTRY for the wheelchair and occupant?**

Answers: For the city dweller, side-entry is generally best ... for curbside loading and unloading. Country dwellers: rear-entry is generally best. For the suburban dweller – or

for the frequent traveler to different neighborhoods – one usually must choose either side- or rear- entry. (A very few buy large vans and have both side- and rear- entry lifts.)

**Question: which van size is best for the van-user?** Answers: Most quads choose to have a full-size “minivan” with raised roof (for necessary headroom clearance). These vans typically have side-door and rear doors allowing the built-in wheelchair lift to be set up for either side- or rear- loading. ***Small vehicles not recommended:*** Some quads, especially if not too tall, elect to buy and use a station wagon type vehicle that has had its roof raised. These smaller vehicles are easier to drive and park. However, they can be equipped only for rear-entry (no side-entry) and are considered less safe to ride in (in case of accident). They are especially poor for city use because they are not high enough, above curb or sidewalk level. *Some van vendors offer these smaller vehicles but we do not recommend them.*

**Immediate SAFETY issues** ... that should be addressed before, and while buying a van:

W/C Lift - (a) side or rear door lift? (b) electric or hydraulic lift? (c) safety platform?  
(d) self-operable? (e) manual operation on power failure?

Lockdowns - (a) will you have a custom set for each and every w/c you may use?  
(b) will the vendor test you for security with each w/c, to prove the lockdowns will hold in case of accident? And that the waist and shoulder belts that you will wear to hold you in the w/c, will hold in case of accident?

Fire Safety - (a) will the van have sufficient fire extinguishers in front & rear?  
(b) is the van one whose fuel tank is not vulnerable to rear end collision?  
(c) will the van contain a smoke detector?

Exiting - If the quad is a large, heavy man – and the driver a slight woman or a small person – then, is there provision for rapid emergency removal in case of accident or fire? If so, what provisions?

Telephone - Will the van have a built-in, always-present, cellular phone? This assumes the van will always be in good cellphone coverage areas. Will it also have a CB, maritime or other means for communication?

Local Service Who will provide necessary “emergency” plus “scheduled” and “preventive” maintenance, locally, to:

(a) the van? ..... and (b) the special equipment in the van?

**Life Support backups for emergency situations.** When being driven in or through deserted rural areas, it is possible to be stranded in the event of fuel exhaustion, multiple flat tires or engine failure. If this occurs in extreme weather (i.e. hot summer or cold winter weather), the

quad's life may be in more danger than the driver's. Quads being driven under these conditions should consider the feasibility of having their vans equipped with (a) space heater not dependent on engine running, (b) backup two-way radio system (or carmaker's emergency satellite communications system such as "On-Star"), (c) gasoline powered electric generator which can power respirator (if used) and other equipment, and/or (d) emergency food, water, cooler, etc.

**Spare Fuel** can be carried safely – with special planning. *Most important is not running out of fuel. This is accomplished by the driver watching the fuel gauge and always filling up when it reaches the half-tank mark.* Extra protection can be attained in either of these ways:

(1) Carry a rigidly mounted safety can of fuel on or in the van. The can may be of 2, 4, or 6 gallon size. It should be rigidly mounted, preferably outside of the van so that fumes cannot reach people inside. However, it should be mounted in a place that is not likely to be struck in case of a collision or rollover. Instead of keeping the can filled with volatile gasoline, one should consider using a "less volatile "gasoline substitute" emergency fuel that is sold for this purpose. Or ...

(2) Arrange for the van to have a second fuel tank (with dashboard fuel gauge) to be permanently installed under the chassis, much like the original fuel tank. This auxiliary tank may hold as many as 15 to 30 gallons of gasoline, which is in addition to the capacity of the original fuel tank. A valve inside the van allows the driver to select the main tank or the auxiliary tank. Just be sure the auxiliary tank is installed in a location such that it is protected from being damaged in a collision or rollover.

**Flat Tire problems** can be minimized by having the van equipped on all four wheels with special tires that do not go flat. These tires, sold commercially, have steel liners and internal supports which allow the vehicle to continue to be driven even though one or more tires may be punctured and partially flat. *Some vans have, at standard or at extra cost, full-time air pressure monitoring of all tires which give early warning of air loss. Ask if this feature is available before you buy a particular van!*

**Engine Failure problems** can be lessened but not prevented. These measures may help: (1) Have a second battery installed in the van, which is always being charged, but which can be discharged (for normal use in place of the primary battery) only after the driver operates a battery selector switch. (2) A second backup electronic ignition unit can be installed. Some types are connected in parallel with the primary device and take over without manual switching. Other units must be manually selected using a switch. (3) For use in case of engine overheating in an isolated area, carry in the van at all times, at least one gallon of engine coolant fluid plus at least 2 gallons of water – in permanently mounted or well secured containers.

**Long-Term SAFETY Issues** – that should also be addressed when buying a van:

#1 - RUSTING: Limiting or preventing chassis and floorboard rusting from constant exposure to rain, moisture, salt-melting chemicals, etc. is essential. Rusting of these outside surfaces is insidious, constant and not visible to driver or owner. If not prevented

or controlled - then, in as few as 2 to 4 years, the vehicle can become unsafe and unsaleable. (This is a major reason we recommend against buying a used van.) The seller of a new van should be asked to certify, in writing: (a) that the chassis, floorboards and under- surfaces are or will be rust-protected; and (b) the vehicle has a manufacturer's full rust-protection warranty, good for a stated number of years. *Heated, indoor vehicle storage greatly lessens rusting – especially in cold or wet climates – garaging helps.*

#2 - NEW VEHICLE WARRANTY ... bumper-to-bumper by the manufacturer for 3- or 5- years. This covers (as when one buys a new car) all repairs for 3 years or 36,000 miles (or 5 years or 60,000 miles) except for auto accident body damage, brake linings, oil changes, air and oil filters, etc. The vehicle manufacturer would not warranty the special equipment which should be separately warranted by the seller(s) or manufacturers.

#3 – RELIABLE LOCAL VEHICLE SERVICE is a must because factory service every three thousand miles, or every 3 months, helps to ensure continuing safety and to prolong the life of the vehicle. We recommend that the van owner make friends with the service manager at a nearby dealer (Ford, GM or Chrysler dealer – whichever is the van's make) and then continue to use that dealer's service shop all the time, without exception. One should NOT save money by having routine oil changes, or other services, provided by other than the authorized dealer. To do this may save a few dollars but it can create excuses, later, for the dealer and/or manufacturer to refuse major warranty repairs on the basis of alleged neglect, inadequate or damaging services by unauthorized personnel.

**A Fully Equipped Quadriplegic Wheelchair Transport Van is a major investment** that may cost between \$35,000 and \$65,000 to buy. Operating and maintenance costs (and driver wages, if paid) will add to the purchase cost. Depending on how it is cared for, the van may have a safe service life of as little as 3 years, or as long as 10 to 12 years. How often will you use a van? If often, it may be worth owning. If not often, it may be better to use van-for-hire taxi services, and to rent a van for vacation or business travel. (Always be sure the lockdowns are safe for your w/c when riding in someone else's van.)

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