

CLIENT EVALUATION HANDBOOK



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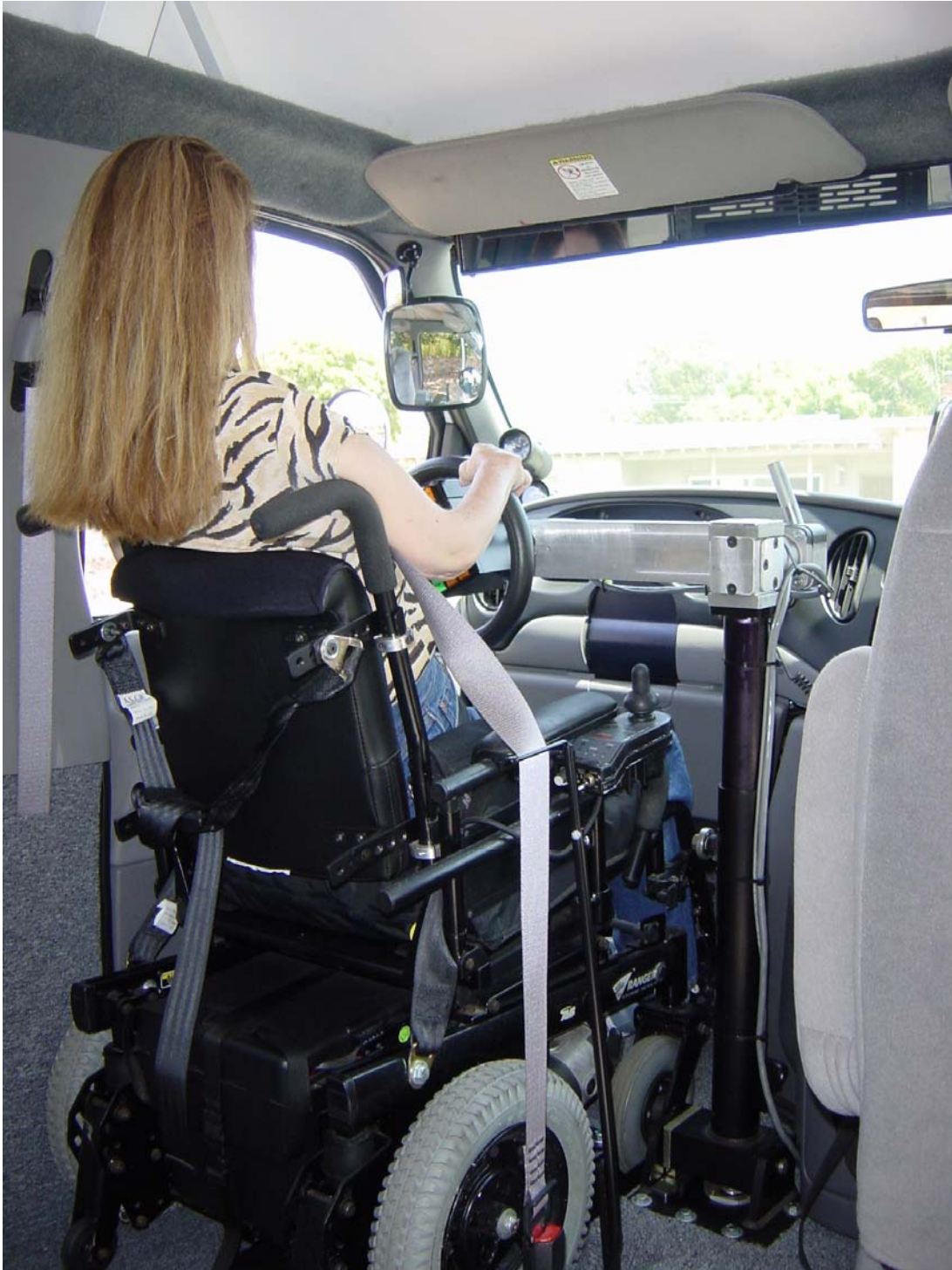
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1.0.0 Description of the Scott System

Description of Vehicle

The basic vehicle is a Ford E-150 Econoline Window Van (See Appendix A). A series of modifications are added to the basic automobile to enable a severely disabled person to independently enter the vehicle, drive to his or her destination, and leave while remaining in his powered wheel chair. All of these operations are accomplished without aid from others.

This is accomplished by the use of 3 basic systems.



Entry System

This system consists of electrically powered doors and a wheel chair lift, which will lift the driver and wheel chair from ground level to the interior level of the vehicle. Once in the vehicle, controls permit the folding of the lift and closing the entry doors. Reversing the operation permits the driver to leave the vehicle at his/her destination. Outside controls are provided to close and open the entry system. An optional remote radio control for the doors and lift is available.

Chair Hold Down System

This system is designed to permit the driver to enter the driving position and be safely secured in position for operation of the vehicle. The system consists of guide rails to properly position the wheel chair and an electro-mechanical system for locking the driving seat in place.

Steering and Control System

All essential driving controls are brought to a single vertical control column. Forward movement of the column opens the throttle providing control of power from the engine. Returning the control column to neutral returns the throttle to idle position. Movement of the column toward the rear applies the vehicle brakes in proportion to the pressure applied to the column.

At the top of the column is a cross arm with a mini steering wheel directly in front of the center of the driver. Rotation of the wheel left or right steers the vehicle. (See Insert #1).

All systems are amplified so that the power and range of motion required of the driver are reduced to a minimum. The system provides for a minimum of 6 ounces of force required in the fore and aft and lateral planes.

For persons who do not have finger dexterity or wrist function, such as high-level spinal cord injury, a tri-pin device mounted at the top of the vertical column with a parallel arm support provided.

Steering Control

The steering control is a closed loop servo mechanism. The loop is closed by mechanical linkage; the linkage is adjustable to provide two ratios. When the steering wheel is used 270 degrees of rotation is provided. When the tri-pin is used 180 degrees of rotation is provided.

Power Steering

Two hydraulic power systems are provided. The primary system is the engine driven pump. A separate secondary or emergency system using an electrically driven pump is also provided which will engage automatically if the primary system fails to provide adequate hydraulic flow, this provides continuous steering power. A manual override is also provided for the emergency system.

The Braking System

The braking system is vacuum boosted. Reduced pressure provided by the engine intake manifold is stored in a large tank with a check valve to assure retention of vacuum assist. The control column is mechanically connected to the normal power brake system. In addition, a separate actuator controlled by a vacuum servo valve in the mechanical link between the column and the primary system provides a backup booster system. Each system is independent of the other and either will provide adequate braking.

Electrical Controls

All of the engine and driving controls are brought to a special control box on which light pressure push button switches allow the driver full control of all electrical circuits including electrical shift actuator and front window controls. The column box can be placed anywhere convenient to the driver and any controls needed can be duplicated at any location. All electrical interface controls are located in one relay box generally located beneath the dash directly in front of the driver. Aircraft type manual and automatic circuit breakers are provided for all internal circuits. The fuse panel in the van (located on the fire wall directly ahead of the driver) protects the van circuits. All electrical systems & components are plug in modular units to make field service easier.



2.0.0 Disabilities

APPLICATION GUIDELINES FOR THE SCOTT DRIVING SYSTEM

Scott system drivers fall into two main groups. Those with finger dexterity and those without the ability to use their fingers, such as drivers with a high-level spinal cord injury. Taken as a group Scott system drivers are usually unable to drive any other type of control system for a number of reasons.

Drivers who are unable to accomplish throttle/brake and steering functions with both hands independently are logical candidates for the Scott system. Many spinal cord injury drivers lack the coordination to safely operate a two handed system. The Scott system can be configured for either a right hand or left hand dominant driver. Often a driver will use just one hand to operate throttle, brake and steering which allows the weaker hand to be used for secondary electrical controls such as turn signals, wipers, cruise control, head controls and mouthstick operation of secondary controls is also an option.

There are many individuals who are marginally able to drive two-handed systems because of strength and range of motion issues. The Scott system through intergration of functions and long experience in actually working with disabled clients in the course of individualizing vehicles provides answers to many of the dilemmas of high level driving controls.

TYPES OF disabilities among SCOTT SYSTEM drivers:

Quadriplegics to c4 -c5, Triplegia, Osteo genesis, osteo imperfecta. Post polio, rheumatoid arthritis, spina bifida, multiple sclerosis, muscular dystrophy and spinal muscular athrophy.

3.0.0 Review of Operations

Operation of the vehicle is reduced to primary and secondary controls. The primary controls are those which are used to control the motion of the vehicle. The secondary controls operate the functions of the vehicle used supplemental to driving the vehicle.

3.1.0 Primary Controls

The primary controls; Steering, Brake and Accelerator operate from the steering column, as follows:

3.1.1 Steering System Description

The Scott System steering control is a completely mechanical closed loop system. The mini wheel system starts with a chain drive with a chain tension adjustment. Rotational movement is carried through a 2 to 1 gearbox which is fully adjustable for gear lash and preload. A tube transfers this movement to a square shaft u-joint assembly. A gib allows vertical adjustment for changing column height. The u-joint bends at the point of bending of the forward / backward movement of the column. This eliminates the possible binding of the steering motion while braking or throttling. The u-joint is clamp bolted to a modified Saginaw steering gear valve. In a stock vehicle this valve is an integral part of the frame mounted steering gear assembly. In the Scott System the housing has been modified and a linkage arm has been added to the end of the valve stem. The rotary motion of the link arm becomes a linear front to back motion of a long link of alloy steel, ending at a bell crank mounted on the cross member under the engine. This bell crank also changes the ratio as well as changing the forward / backward motion to left / right. The lower arm of the bell crank has a short link with rod ends that connect to a drilled hole in the Ford pittman arm. This way, although the valve provides the control of the power assist, the follow-up linkage keeps a mechanical relationship with the road wheels true closed loop steering. The steering wheel control is 270° lock to lock while the 3 post, due to some minor differences in the follow-up linkage is 180° lock to lock.

3.1.2 Brake System Description and Function

The braking system of the Scott driving controls is a vacuum servo assist operating on the stock Ford brake controls. As the unilever column is pulled rearwards the lever arm below the floor moves forward, operating a servo valve. The servo valve is a balanced poppit design and ports full vacuum flow to the brake booster diaphragm. The servo valve is built into the linkage system making it a closed loop system. The first section of linkage contains the servo valve and a slider tube. The slider is to allow rearward column-movement without involving the brake linkage. The slider tube contains a compression spring. This spring absorbs the initial movement in the linkage, smoothing out the brake operation. This first valve and linkage segment is supported by an intermediate bell crank. Brake motion is transferred to a longer link and then to a firewall mounted bell crank. All linkage tubes are made from 4130-chrome moly steel and have permanently lubed rod ends. The firewall bell crank transfers forward motion to the brake pedal. The brake booster assembly pulls on the Ford pedal via the bell crank and pedal link. In this manner as the Ford pedal goes down, the pedal position is transferred to the brake valve, which in turn neutralizes the vacuum flow to the booster. The result is a smooth, responsive and predictable brake operation. Stock Ford brakes are retained from the stock pedal to the wheels. A slider on the brake booster shaft allows the use of the stock pedal by an able-bodied driver.

3.2.0 Secondary Controls

3.2.1 Electrical and Secondary Controls

Once the positioning and adjustments of the driver and steering column are complete, the next question for the evaluator involves secondary electrical controls. Many Scott system drivers are really one handed, have limited range of movement or no finger dexterity. Some electrical controls can be operated while stationary and others like the turn signals must be operable while driving.

The major control panel for the Scott system has 30 functions, not counting environmental controls and is usually mounted on the driver's door. It can however, with extended cables, be mounted on the right hand side of the driver or suspended from the dash. Although most of the controls on the main push button box are not used while driving, sometimes a small switch box is added with an extended toggle switch for turn signals or a 3 button box for cruise controls. An extension can be mounted on the horn switch for example to allow quick and easy operation. In most cases a box containing the environmental controls for both the front and rear heater /A/C units is mounted on the bottom of the main push button box. Once the position of the push button box has been established via the adjustment of the 2 vice bases and the 5/8" rod, two tubular brackets will be made to support the box properly. For evaluation usage however, the push button box is seldom mounted permanently for any one individual driver. The trainer/evaluator has driving function controls available on the passenger side of the engine cover. We have had good success using head control toggle switches for one-handed drivers. Up to 7 functions can be mounted on a head panel, with long switch extensions.

There seems to be two ways to deal with secondary controls during the evaluation process. Most evaluators concentrate on the techniques that relate to the operation of the primary controls rather than the operation of the secondary controls. Since evaluation vans have secondary controls that can be operated by the evaluator while driving, the push button box is mounted tight to the door, out of the way of the steering column movement. The push button box can be moved further from the door by using a longer mounting rod and placing it so the driver can easily test push button operation. Without the additional supporting brackets the push button box will vibrate and will not long maintain it's position. The brackets hold the box in its exact position during the fitting process.

In some cases evaluators will need to set the evaluation van up for an individual and take this driver all the way to license. This requires that the vehicle set-up, both primary and secondary controls be maintained throughout the training process. Push button box distance, height and angle must be maintained (or recreated) during the training.

Driving Systems has a variety of secondary control solutions for virtually every situation. Several secondary control options will be discussed later in this guide. The Scott System is very flexible and adaptable to modifications and we always welcome discussions and suggestions about unique applications.

3.3.0 Back – Up Systems

The Scott System has always included a full array of back-up features for the primary control systems. First a brief description of each primary system and the method of redundancy.

Steering Controls

The power steering system can be described as a remote valve controlled; full feedback mechanically actuated system. Stock Ford motor driven power steering pump pressure is used. There is no need for a higher capacity pump or higher steering pressures in the Scott system. A 12-volt power steering pump provides steering pressure should the stock pump fail. Stock pump failure is detected by the monitoring of steering line pressure by a pressure-sensing switch. A pressure drop of 30 P.S.I activates the back-up pump. Both the stock pump and back-up pump are feed from an aluminum tank with increased capacity over the stock Ford tank. Return flow passes through a filter and a cooler. Return flow is also baffled so that it doesn't interfere with the supply of power steering fluid to the suction side of the two pumps. Fluid capacity of the system is almost 5 quarts. Pressure side hoses are 2250-pound steel braided hoses. All fittings are military spec. Weatherhead items.

Brake System

There are two methods of brake back-up. First, brake vacuum is stored in a 1400 c.i. Tank protected by a check valve. The contents of this tank are monitored by a dash-mounted vacuum gauge. A low vacuum sensing switch and low vacuum warning buzzer also warn of low vacuum condition.

Additionally a ball drive actuator pulls on the parking brake cable providing both a parking brake, as well as emergency brake function. This brake is operated from a button on the push button box a spring softens the onset of the pull on the cable resulting in a smooth progressive brake application.

Throttle Operation

Although the throttle does not have a back-up system as such, a few features should be noted. First, the system using a vacuum valve to deliver vacuum to a diaphragm does not effect the stock Ford pedal/cable system. Part of the pedal is cut away but all stock return springs remain intact. Vacuum is drawn from the intake manifold directly not from the check valve protected brake vacuum reservoir. If there is a problem with the vacuum system, the stock throttle operation is not compromised.

4.0.0 Getting into the Van

Vehicle Checklist

Before Entering

1. Check all tires for visible damage and obvious under-inflation.
2. Observe ground beneath vehicle for signs of fresh leakage. If in doubt, have all coolant and lubricant levels checked.

Entering

1. Make sure clearance to rear of vehicle is adequate.
2. Insert key in lift control panel to right of rear door.
3. Activate door control switch. Allow both doors to open and lift to deploy to vehicle floor level. Lift will come to a complete stop

Caution- Make sure area between rear doors is clear before lowering ramp.

4. Move fold switch to unfold position, wait for platform to stop at floor level. Move ramp control switch to lower position. Hold until platform reaches ground.
5. Turn off outside key switch and remove key.
6. Move wheelchair onto ramp. Go forward far enough for rear wheels to clear safety flap.
7. Actuate lift switch, located on left, to UP position.

Caution – Watch feet during lift to make sure they clear the vehicle bumper and doorsill. If necessary back chair carefully against safety flap.

8. Lift will stop automatically at floor level.
9. Enter vehicle carefully. Watch head clearance
10. Move forward into cockpit area. Enter chair hold-down as straight as possible making sure right front caster enters guide track. Continue forward until latch is contacted.
11. Attempt to back chair to make sure chair is locked.
Turn off chair power and set brakes, if possible.

4.1.0 Wheelchair Lift, Outside Controls, Remote Controls

Driving Systems, Inc. has installed all types of wheelchair lifts over the years. We have been associated with Ricon lifts and continue to install Unilite lifts in the majority of our vans. Weight considerations such as those in a side installation make the Unilite a better selection in our opinion. We have also used Braun lifts and will continue to do so. To a large extent lift selection is left up to the driver. Elsewhere in this handbook there is a discussion of lift placement.

Outside Lift Controls

There are a variety of lift and door controls available. Outside toggles with a locking key switch have been used for years. They are a low-tech solution. Worries about breakage has been somewhat exaggerated. More recently, magnetic outside switches have been very popular. Hidden in the tail light lens, they are activated by a locking key switch. Very often an adapted handle is fabricated in order to make it easy to handle the magnet and key.

A very important and useful option is a remote lift and door control. Given the level of disability among Scott System drivers we install a remote control on almost every vehicle. Problems with strength, range of motion and bad weather make it a very practical item. D.S.I. has adapted many types of remote controls for client use. Remote controls should be easily removable for servicing without disrupting regular lift and outside switch function. There are a variety of hand held unit options available. The smallest is a key chain sized unit. We have found that smaller isn't always the best solution. Spinal cord injured driver's seem to do better with the larger unit which is about the size of a transistor radio. We often mount the remote on the wheelchair with Velcro or tether it to the wheelchair to prevent loss of the unit due to dropping it.

4.1.1 Lift Locations

It is probably a good idea to look at some of the factors involved in deciding whether to have a side or rear mounted lift. Since the primary reason for having a Scott System vehicle is independent transportation, any configuration that creates a problem for the wheelchair driver should be identified at the time of the order.

Here are some factors, which we have noted over time, which bear on the selection of a side or rear lift. First of all where will the person ordinarily park? This can be very important since a driver can't always count on being able to use a handicapped space. A side lift with a few exceptions can require almost a double space to allow the driver to enter and exit. A rear lift in a diagonal parking spot will almost never be blocked.

In terms of inside space, a side lift requires the wheelchair driver to back-up and make a 90-degree turn to enter the driving position. This is a greater problem for larger drivers. If a side lift is going to be selected, the type of lift is important. Some lifts restrict the passenger seat movement or tilt. Also should the lift be inoperable and a rear bench is mounted getting out through the back door is more difficult.

Selection of a rear lift also has its considerations. The door opening on the side and rear doors is the same that is 48 inches. The side door floor can be lowered allowing a 52-inch door opening without having to raise the top and extend the door. On the rear, the floor cannot be lowered due to the location of the gas tank. So in order to have an opening of more than 48 inches it will be necessary to raise the doors and install a fiberglass top. Rear entry also limits the selection of wheelchair lifts. D.S.I. ordinarily uses Ricon lifts in the rear. When a Ford rear tank kit is used a notch must be cut in the rear threshold so the Ricon lift will reach the ground.

On the positive side, a rear entry allows the driver to enter forward and drive their chair right to the drivers station. Rear entry allows the greatest amount of maneuvering room at the expense of extra seating for able-bodied passengers.

D.S.I. has worked with virtually all types of lifts and will continue to do so. A little planning can help to avert later problems. Most of our drivers have little experience in operating a vehicle independently prior to receiving the D.S.I. van conversion. Their new van is really a personal transportation vehicle. Any consideration for able bodied passengers, the use of the van for camping or the transportation of other wheelchair bound individual s should be used at in terms of the effects on the day to day use of the van by its primary user.

4.1.2 Lift Safety Alarm

The lift safety alarm was developed as an answer for the problem of lowering the lift to the ground and having the driver drive off the van floor to the ground. This happens most often in a rear lift situation when the driver is backing out onto the lift platform. Obviously this is not recommended but it has also happened because of other wheelchair or unloading luggage. In any case there is a safety feature which will reduce the chances of this happening.

D.S.I. installs a micro switch system that senses platform position. A pressure sensing mat under the carpeting sounds a warning buzzer should the wheelchair approach the open door way. It is a kind of open elevator shaft alarm. It has two circuits, two switches and two buzzers so that if one part is damaged there is a back-up alarm.

4.2.0 Positioning of Driver and Wheelchair

The Scott Driving System for spinal cord injured drivers consists of two major components; electrical controls and driving functions. The electrical controls consist of dash board and wheelchair lift functions that are operated from a central positioned box in the driver's station.

The driving functions of steering, throttle and braking are provided by a floor mounted control column, which is located to the right of the driver just behind the engine cover. The column pivots forward for throttle and backward for brake. Current Scott System vans has columns, which travel 3" for brake and throttle (6" of overall travel). Older vehicles have about 8" or more of total travel. Steering requires pronation and supination of the forearm. 180 degree of steering control movement provides full lock to lock steering on a full size Ford van.



There is no issue more central to the safe operation of a modified van of this type than the correct position of the spinal cord injured driver in the driver's station. To begin with, the driver should be as close to the steering column as possible. Often, the right front wheelchair tire is virtually touching the steering column base plate. This position allows the driver to reach the column without leaning over to the right.

The fore/aft position of the driver in relation to the 3-post device must take two factors into consideration. The driver must be able to apply force even at the extreme forward point of column travel. In terms of brake travel, the rear of the driver's upper arm should not be limited by the wheelchair backrest.

Generally the driver's upper arm should be slightly forward of his/her torso. The driver should be able to demonstrate an ability to perform all of the movements needed to complete all driving tasks. The most difficult being an extreme right turn with brake.

The steering column height plays a part in the ability of the spinal cord injured driver to drive smoothly. As viewed from the rear, the driver's shoulders should be level. Often, this places the 3-post/ armrest assembly level with the driver's wheelchair armrest.

The armrest of the 3 post assembly should be placed so that there is about ½" of space between the armrest and the driver's elbow. This is important because the distance between the 3-post the elbow rest decreases as the brake is applied.

Torso stability is an important issue effecting the road driving performance. Static adjustments have their place in the initial part of the fitting. But, the road testing truly tests the driver's responses when exposed to the inertial force inherent to high speed driving. In our experience, all spinal cord injured drivers experience some problems with torso stability. Wheelchair back height, posture, positioning belts, shoulder pads and passive restraints are often part of the solution. If the driver is not securely supported, the most sensitive, precise control cannot be obtained.

The wheelchair backrest height determines, to a certain extent, the forward push stability and the highest possible position for the upper positioning belt. Taller individuals tend to have backrests that are too low. An additional passive restraint belt, not attached to the wheelchair, can be used to contact the driver at the top of the left shoulder.

Side to side stability is an issue in high-speed turns. A properly placed left side shoulder pad limits movements to the left side while the right side armrest tends to limit movement to the right.

A couple of observations on common driving problems. As previously mentioned, the right turn/brake motion seems to be the most difficult for the new driver. Actually, it is a two-part movement. First, the forearm must be moved as far as possible toward the right turn. When the natural limit of movement is reached, the elbow should be straightened and extension of the shoulder should enable the driver to complete the turn. When the natural limit of movement is reached, the elbow should be straightened and extension of the shoulder should enable the driver to complete the turn. Once the elbow is straightened, it moves out of the armrest "pocket" toward the body.

The second most common problem involves the tendency to steer inadvertently when throttling or braking. Improper positioning or the control not being centered are most often the cause of steering while throttling. Generally, the 3-post system was conceived for those individuals who do not have full use of their upper arm muscles. Shoulder muscles are sufficient for normal operation of the controls. Some individuals tend to use their bicep muscles to push or pull on the control column. When an individual uses their biceps, the hand tends to rise and the elbow tends to go down. The palm guard device on the 3 post is intended to prevent the driver's hand from sliding up the nylon pins. Most of the force applied by the driver is wasted, as the hand and arm movements are not in the same linear movement pattern as the fore and aft movement of the column. The most effective right arm position is parallel to the floor in all positions involving throttle and brake. Under some situations, some shifting of the forearm is necessary, but more often, gross movements of the driver's body or arms indicate that force and motion are being wasted.... That is, NOT being applied to the actual driving tasks, but compensating for poor body position or technique.

The mini wheel driver is usually positioned as close to the wheel as possible, allowing for full brake travel. Typically the steering column will travel further back past where full braking is completed. It is not, strictly speaking, necessary to accommodate the entire brake travel with driver positioning. Drive

testing will confirm the proper distance between the driver and the wheel. Throttle operation is usually more difficult. Most drivers have a loss of strength as they push further away from their body.

One important factor for mini wheel drivers is hand position on the wheel. Most two-handed drivers use the standard 10 o'clock/ 2 o'clock position the wheel. The height of the column will also influence hand position. Most drivers seem to do best with the column set low enough to allow the drivers forearm and elbow to be stabilized on the wheel chair armrest. Generally the more contract that the forearm has with the armrest the greater stability that the driver has for steering. Some drivers use just the points of their elbows on the armrest. The armrests themselves can be modified to enhance arm placement, location and stability.

Most throttling and braking is done by wrist flexion and extension. Some drivers must use their entire arm and shoulder musculature to perform throttle and brake movements. In this case the drivers arms will tend to slide forward and backward on the armrests.

Many two handed drivers will have a dominant or stronger hand. It is possible to place the driver to slightly favor this dominant hand during a driver evaluation. Some drivers need to "walk the wheel" between their hands for steering while others keep a fixed grip on the wheel and rotate both wrist and forearm.

Steering wheel systems can be built with either 180-degree or 270-degree steering. Typically a one-handed driver would have a 180-degree steering ratio. The 270-degree system is less sensitive and is intended for those drivers with greater strength and the ability to move their hands on the wheel while parking.

The effort required to move the steering control can be varied to suit the drivers need. Demonstration vans have standard steering valve. The effort level of the steering can be raised or lowered to match the individuals abilities. If a driver tends to over control at high speeds, he or she may benefit from heavier steering effort. This observation should be included in the driver evaluation report.

4.2.1 Scott System Wheelchair Tie-down

The Scott System employs tie-down device by which a driver can independently lock his or her wheelchair in the drivers station and when the time comes smoothly exit the driver's position. There are two parts to the system. First is a base that mounts to the floor. It has an upright section that includes a hook locking device and a vacuum actuator for release. The second is a wheelchair mounted tie-down bar. It is important to explain each element for a successful tie-down and the reasons behind this crucial part of the fitting procedure.

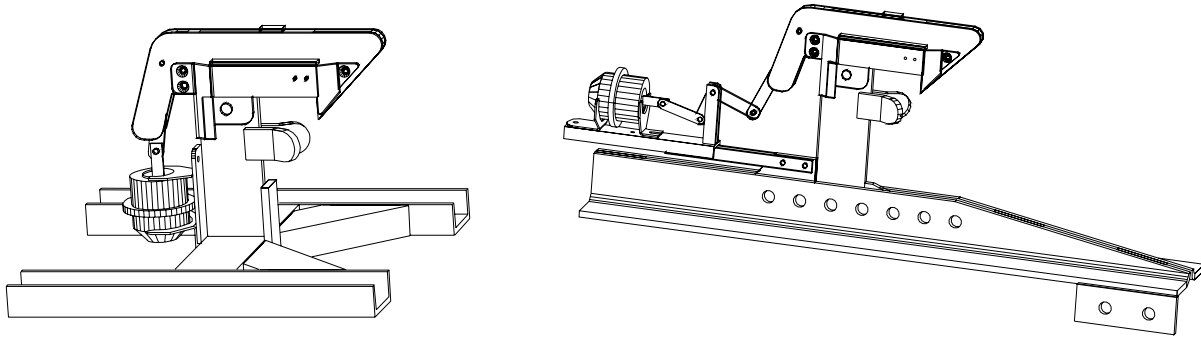


Figure B. H-Style and Deep Floor tie downs

In order to get a wheelchair into and out of the somewhat restricted drivers station we use a couple of devices to stop castor problems and to insure that the wheelchair locks into the same position each time. By trapping the right side front wheelchair tire in a channel just slightly wider than the tire, the wheelchair can be placed consistently in the correct relationship with the tie-down. The channel comes in two pieces and is pop riveted together about 1/8" wider than the tire. The longer track is kept to the inside or left side in order to prevent premature casting. In some cases, by tracking both front wheels, the tilt angle of the chair can be controlled to avoid obstacles or to compensate for a stock floor which tilts down towards the dash board. The left side front tire can be induced to castor first by placing it on a slanted plate. This caster plate should be located so that the tire castors out towards the door. Once the left tire has castored the right side tire stays trapped against the long axis of the track and will only castor when the wheelchair is out of the driver's area. The caster plate is tilted by placing washers under 1 side of the plate. It should be located under the tire in such a way as to maximize the distance the tire travels on the plate. The wheelchair driver can also induce casting by steering the joystick to the 5 o'clock position. In any case, every effort should be made to prevent both wheels from casting at the same time. Of course both of these items will raise the chair slightly so they should be in place, even if not bolted in, when measurements are made for the tie-down upright.

The floor mounted tie-down base comes in 2 basic styles, the "H" style tie-down and the deep floor tie-down. The "H" style was the original tie-down used in the time when most floor lowerings were less than 4 inches. As it's name implies the base is shaped like the letter "H". The method of mounting is 4 1/2"-20 X 4" B7 grade studs, one at each corner. The spacing of the "H", allows the studs to be mounted through the floor on either side of the Ford van frame. Although primarily used with a flat floor the "H" style can be used with a floor that has up to a 1" channel over the frame. For use with an old style round tube frame chair like the E&J Marathon. The stock tie-down height allows 1" between the tie-down and the floor. Using a jam nut arrangement, adjustment is very easy to accomplish without removing the tie-down or getting under the vehicle. Because of the need for forward and rearward adjustment the 1/2" studs are located in the center of a 3" slot. This way the driver can be positioned closer or further away from the controls as needed, without moving the tie-down stud location. Mounted to the rear of the upright in a vertical orientation is a vacuum motor, which both pulls on the hook for release and provides spring tension to keep the hook in the closed position. A more detailed description of this motor will come later.

The deep floor tie-down was developed because taller clients required deeper floor cuts in the driver's position. Rather than raise the body or cut the frame, it was decided to channel over the frame. In the deepest floor the channel can reach almost 3 inches in height. Since taller clients also have lower footrests, it was very difficult to use the "H" style tie-down as it would have to straddle the channel. As a result of this an alternative tie-down was needed. The long and narrow floor bracket is anchored on the body mount bolt on the floor channel. Adjustability is maintained by moving the hook upright forward and rearward. The vacuum motor is mounted horizontally and it operates the hook by means of a bell crank. Because the tie-down base is mounted on the raised channel the hook and upright is shorter. In fact each upright is built and fitted to each wheelchair individually. A small amount of vertical adjustment in the upright is achieved by over sizing or slotting the holes in the upright in order to compensate for wheelchair front tire wear

Because of the incredible variety of wheelchair frames, it has been necessary to develop a number of types of wheelchair tie-down bars. A chair bar for a late model chair like an Invacare or Quickie can be either bolted or clamped on the rectangular frame(see figure A). We make a slotted 1"x2" channel section that forms a chair bar section that is trapped by the tie-down hook. Since the new style chairs have frame sections that are 10" or so from the ground, we normally build a chair bar that is dropped 4 to 5 inches in the center so that the tie-down upright doesn't get too tall. It's a good idea to have the center section level with the tie-down hook in order to simplify adjustments. So it is important to take into account the angle of the floor when constructing the tie-down crossbar. It can also be that the center section can be moved forward or rearward in relation to where the bar is attached to the chair. The best attach point is toward the center of the chair and center of gravity. The hook needs 2" of rearward clearance to any chair-mounted obstacle (such as the battery box). Because the leverage involved in the drop section wheelchair crossbar, we brace the bar to some other strong part of the wheelchair frame. The braces are made from 1"x 1/4" cold rolled steel and can be attached from the bar to the frame or some other structural part of the wheelchair.

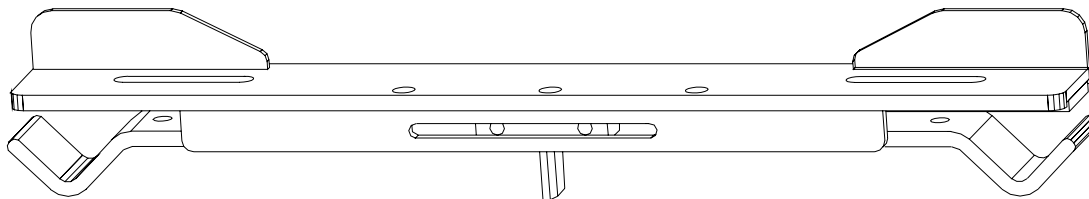


Figure A. Tie Down Bar

Various methods have been used to attach the chair bar to the wheelchair frame. On the "H" frame chairs we have through bolted into the center frame and the side frames. It is also possible to fabricate a clamp type mount for large diameter round tube frame chairs. Please check the illustrations for examples.

Some types of wheelchair have the batteries (and their weight) moved far to the rear of the frame. This weight imbalance introduces a tipping factor into wheelchair movement during hard braking of the vehicle. To stop the rear of the chair from coming off the floor, we install a passive tie-down at the rear of the chair. A bracket or bar at the rear of the chair pulls underneath a floor mounted bracket as the wheelchair enters the final lock down position. If the rear of the chair leaves the floor it contacts the floor bracket which limits the movement. No additional mechanism is required nor does the chair bracket even contact the limiting bracket.

Once the bracket is mounted on the chair and the client is in the driving position it is time to establish the height of the tie-down hook. It is only the deep floor tie-down that requires a custom-made hook assembly on every installation. But on occasion the "H" style tie-down upright must be modified as well.

For the most part we are establishing the height and angle of the upright as well as the location of the 4 mounting bolt holes. The material of the upright is 1/4" x 2" cold rolled steel. We add 2 sections to this part

once we have established the height needed to match the chair bar. These additional pieces are triangular and must be long enough to span 4 holes on the tie-down base. These holes are 1 ¼" on center in order to move the upright forward and backward easily. The rear "triangle" should be taller to provide a place for mounting screws for the vacuum release assembly. The upright should be parallel with the chair bar and actually touching the top of the bar. A slight amount of contact with chair bar reduces small movements in the chair, which makes driving easier. In addition, since the opening under the hook is 1 1/8" and the bar is 1", it allows the maximum time before tire wear requires tie-down adjustment. 2" of the upright can slide into the slot between the sides of the tie-down base. Mark the height and angle on the upright as well as the 4 mounting holes. Remove the upright and drill the holes to 9/16" or slot to allow up /down adjustment.

The final part of our discussion of the tie-down concerns the vacuum release mechanism. An electric vacuum valve allows push button control of vacuum flow to a Ford heater control diaphragm. The diaphragm pulls the hook up allowing the chair to move rearward out of the tie-down. An adjustable flow valve in the feed line to the vacuum motor controls the delay of the vacuum in the motor in order to allow the driver to turn the wheelchair on and back out. The delay is adjustable and should be about 7 – 10 seconds.

4.2.2 Belt Constraints

Aside from wheelchair mounted positioning belts there are other belt-related issues in using a Scott system evaluation van. We have found that the standard Ford shoulder belt with its airbag activated tensioner system work very well with both wheelchair drivers and able-bodied driver trainers. The upper adjustable mount seems to fit both tall and shorter drivers quite well. We mount the explosive tensioner on the floor next to the driver's position. On vehicles owned by an individual a support stanchion holds the belt up above the right hand wheelchair armrest so the driver can more easily enter the driving position. This stanchion is not needed for an evaluation vehicle.

It is possible to immobilize this shoulder belt by clamping the belt so the retractor will not allow more belt past the shoulder harness support ring. This simple clamp helps restrict the upper body movement. As the upper body moves forward only a small amount of belt will move with it. This can help deal with the front to back rocking inherent when braking and accelerating.

Although most if not all driver evaluators are familiar with belt type wheelchair tiedowns a few words regarding them is probably in order.

Mounting the slotted belt brackets in the driver's position can be difficult. One or both of the front brackets will probably interfere with the footrest plates of the wheelchair. It might be necessary to remove one of the footrests during evaluation in order to get a good strong pull on the wheelchair frame. In the rear it is a good idea to use the lap belt that goes over both the driver and the chair.

Belt tiedowns provide a strong flexible tiedown that fits many types of wheelchairs. We have noted the importance of having the belts very tight when evaluating a client in a Scott system van. Even a tight as possible belt will stretch and the wheelchair and driver move slightly. This effects every type of control accuracy. A good solid wheelchair tiedown will always result in better driver performance.

4.3.0 Changing Steering Columns On An Evaluation Van

Changing steering columns on a Scott System van is a simple, straightforward task. The bolt that holds the throttle linkage tube to the side of the lower column tube has a dog point end which locates the steering column by locking into a slot in the upper column tube. The column telescopes to adjust to various driving heights. Back the throttle bolt out and the column can be pulled up and out of the lower column tube. It will be slightly easier if the road wheels are straight. Both the wheel and 3 post columns will fit the straight-ahead position the same way.

The U joint assembly stays in the lower column tube and the upper column assemblies are matched for center. Because the U joint stays in the lower column tube, it is necessary to adjust the steering column gib while the replacement column is installed. A demonstration van is being constantly adjusted for column height and being switched from 3 post to wheel and back again.

These activities will progressively loosen the fit of the steering column gib. The gib is in fact a corner of a square hole that accepts the U joint shaft. Its purpose is to eliminate rotational play between the u-joint and still allow for the telescoping adjustability of steering column height. With a privately driven van this adjustment is done once and it needs to be done only infrequently thereafter. In this case it is performed with the steering column out of the van. In an evaluation van a small “window” is cut in the lower column tube so this adjustment can take place without removing the column and u-joint from the van.

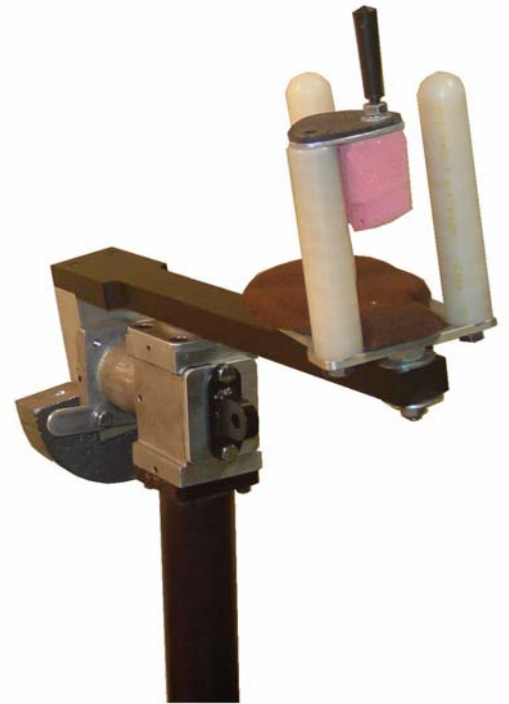
4.3.1 Types of Steering Columns

There are three basic types of Scott system steering columns. First is the steering wheel column. It consists of a lightweight aluminum casting attached to a two to one ratio gearbox. The steering wheel is deep-dish, 10 inch in diameter. It has a rim one-inch diameter foam covered rim. In the center of the wheel is a box, which has twelve push buttons that operate secondary driving controls. These are usually operated by the thumb or by the finger from the opposite hand of a two-handed driver. Operating the steering wheel rotates a sprocket and chain. The chain is tensioned with a left and right turnbuckle so that the chain will be neither too loose nor too tight. As with the other types of steering columns, we are aiming for maximum sensitivity and responsiveness with minimum effort and friction. The mini-wheel column can be used in either a 180-degree lock to lock ratio or a 270-degree ratio. Generally the limits of wrist movement will require a one –handed driver to use the 180-degree ratio but we have also used this quicker ratio with two-handed drivers with limited range of motion. Driver training control is accomplished by the manipulation of a handle that is attached directly to the gearbox end of the column. This handle provides immediate positive driver trainer control. There is no switch over time delay.



The most common of the spinal cord injury columns is the right hand 3-post. The 3- post device is mounted directly to the top of the steering column gearbox. The weight of the control and drivers hand is counter balanced by a semi circular lead weight attached below the 3-post arm.

This weight inertially counter balances against forces that would tend to bring the drivers hand and control out of a turn. It is possible to add some additional weight to one side in order to make it turn easier in that direction. Driver training access to throttle brake and steering is directly to the arm connecting the 3-post device to the gearbox. We can add a driver training post if it is desired. Attached to the right hand 3-post column is a parallel arm rest assembly. The armrest serves at least 3 purposes. First it provides a stable armrest which moves with the column. This enables the driver to make smooth, controlled steering movements, even when the column is pivoting on throttle or brake. Second, the armrest provides a place for the elbow to effect braking. Rearward movement of the forearm causes the elbow to push against the armrest to move the column backward for brake. Since a spinal cord driver has little or no grip, using the hand to brake is inadequate even if the wrist pins are reasonably tight. The third purpose is to provide right side torso stability. Most spinal cord injured drivers need additional upper body stability for good driving performance. The armrest provides stability to the driver during left turns when the driver's upper body leans left. A door post mounted torso pad limits upper body movement to the left.



The left hand 3-post is a blend of right-hand 3-post and the steering wheel column. As in the general population some spinal cord injured drivers are left hand dominant. In response to this, we mounted a 3-post control on an extended steering wheel crossarm casting. The crossarm extension brings the 3-post directly in front of the drivers left hand. The counter balance weight is mounted on the gearbox end of the crossarm casting. We have also had good experience using an additional right-hand 3-post so that a two-handed driver can use his or her right-hand to assist brake and throttle. The armrest for the left-hand cannot be built like the right hand post. There are several solutions possible. We have built stationary armrests on the door or door post. The stock armrest on the door can be modified. We have modified the wheelchair armrest. A wrist cuff can be used with two rings to slip over the wrist pins for braking.



4.3.2 Steering Column Balance

One of the considerations in the use of an evaluation van is steering column balance. The Scott system uses a large counter balance weight to offset inertial forces that act on the pivoting steering column. As the van slows down for example, the column will tend to move forward due to its own weight. This of course causes the driver to have to apply more force to maintain braking force. The same logic applies to a lesser extent to the inertial effects of hard acceleration. In the case of a privately owned van we balance the column once the final column height has been established. The column height ordinarily stays very close to this measurement through the life of the vehicle.

In an evaluation vehicle, however, not only is steering column height being frequently changed but the type of column used changes for different drivers (See Appendix C). There is a considerable difference in weight between the three different types of steering columns. The right-hand three-post is the lightest and the left-hand three post is the heaviest with the mini wheel in between. In addition much of the weight of the mini-wheel and left-hand three-post is forward of the column pivot point making these steering columns naturally throttle heavy.

In order to achieve good steering column balance in a demonstration van it will be necessary to add or subtract weight from the lead weight under the van. Two steel brackets with threaded inserts are attached to the large lead weight under the van. Usually the weight will be balanced for the lightest steering column without additional weights attached. So weights will be added when heavier columns are needed. In practice the principle of balancing is simple. When the throttle and brake linkage are unhooked, the column should be able to be placed either forward or backward and it should stay where placed. Since most of the column travel takes place within 3 inches, forward and rearward movement, we should be concerned mostly about this six-inch area. If the column falls forward toward the dash, the lead weight is too light. If the column snaps back toward the center of the travel the lead weight is too heavy. Either situation makes it more difficult to drive the van.

In the evaluation environment there are fewer variables to consider. The three-post column is the lightest steering column and it is also usually the shortest installed. Since the other two columns are throttle heavy, adding weight to the rear of the lead weight underneath will counter balance the throttle heavy tendencies to a large extent. Butterfly shaped weights of a little over one pound can be easily bolted to the steel bracket attached to the main weight. It is also not really important to disconnect the brake linkage, which must be done under the van, as the balance on the throttle side is much more important. The butterfly weights are attached with ¼-20 bolts and washers. No nuts are needed as nutserts are trapped to the mounting plate.

The chart that has been supplied is an attempt at providing an exhaustive chart to show what the weight might look like for every variation in column height and selection. It was compiled on a column jig. Variations in column height are at least partly based on floor lowering depth. Since the floor depth in any given van remains a constant, the differences in column heights are somewhat narrower.

Finally it is important to know what we are trying to achieve in balancing the steering column. The average Scott system driver can tolerate column imbalance. Understanding and adjusting the counter weight can be valuable in helping drivers who are having difficulty on steep hills and high speed panic braking. Correct counter balancing will maximize the driver's ability to throttle and brake effectively, regardless of road conditions and vehicle speed.

4.4.0 Driver Stability

Typically a Scott system driver should be carefully placed in the best location in relation to the unilever control before the tiedown location is finalized. Positioning should be first considered relative to the forward/rearward movement of the column for throttle/brake. As most drivers lose strength as they push away from their body, the driver should be positioned as far forward as can be accomplished without compromising full rear brake travel. In most newer vehicles brake travel is 3" to 4". In any case brake travel can be demonstrated with the van running. Mini wheel drivers can be positioned to favor a dominant hand but most of the time the wheel chair should be centered with the steering wheel. Steering wheel extensions can be made in cases where the wheelchair cannot go closer to the front of the driver's station. This is most often because of footrest interference with the engine cover or throttle link.

The crossarm assembly can be shortened or lengthened in order to place the steering wheel directly in front of a one handed driver. Doing this lessens the tendency of the driver inadvertently steering when braking and throttling. Driver stability using the mini wheel is greatly enhanced by proper use of the wheel chair armrest. The forearms should be well supported by the wheel chair armrest. Braking is accomplished most often by wrist flexion not by gross arm movements. Torso supports attached to the wheelchair can also limit body movements that have an adverse effect on steering accuracy.

The right hand 3-post system requires the driver to be close to the steering column as possible. Most often the right front tire of the wheelchair is directly next to the steering column baseplate. We often replace the front right wheel axle bolt with a countersink bolt in order to get the driver closer to the control. For the right hand 3-post driver the most difficult task is a full right turn with throttle. Careful attention to column height and 3-post position will remedy this problem. After the driver fully supinates the right arm, a small amount of shoulder extension will complete a full lock right turn. In the optimum position for the right arm 3 post driver is slightly forward of the torso, that is biased toward the throttle. This position insures that there is ample rearward movement for a complete braking stroke. If the upper arm is in line with the driver's torso it is likely that the back of the drivers upper arm will hit the wheelchair backrest before full braking will be accomplished. As with the steering wheel extension, the 3-post device can be mounted on a longer bar in order to bring it closer to the driver.

Any driving control system that requires low effect levels to perform driving function demands the stability of the driver and wheelchair. The sensitivity and accuracy of the controls are lost when even small movements of the driver or wheelchairs occur. Almost any kind of driving introduces the driver to a variety of vertical influences. Forward and rearward pitching resulting from throttle and brake activities, side to side rolling from vehicle body movement during steering are everyday occurrences. Every effort must be made to isolate the effects of these forces on the driver's performance. First and foremost in importance to driver stability are upper and lower torso belts. The upper belt should be anchored as high on the driver's torso as possible. One consideration comes into play here. Many drivers have wheelchair backrests that are too low. This is particularly true with many spinal cord injured drivers who "hook" their arms on the backrest handgrips. When the backrest is too low all driving tasks are compromised because the upper torso cannot be placed properly. Assuming correct backrest height, many types of upper torso belt can be used successfully. Automotive type belts, "D" ring Velcro belts and specially constructed double loop belts will all work. The double loop belt such as made by Imec of Chico, California, are especially useful in controlling side to side torso movements that occur during vehicle turns. One loop encircles the chair back while the other fits the driver's torso. Because the torso section is made to an individual measurement, the fit is accurate. This belt eliminates the gaps often seen on the sides of the drivers torso even when the belt is tight this type of belt has side stays that are adjustable and are able to partially correct for spinal curvature and posture problems. Lap belts, while not as important as the upper torso belt for driving stability are, none the less needed. A lap belt placed over the pelvis and mounted down and behind the driver will prevent the driver from slipping down and forward during braking. Another stabilizing feature that we have found useful is a driver's doorpost mounted shoulder pad to limit the drivers upper body movement. Spinal cord injured

drivers using the Scott System are stabilized to the right by the floor mounted armrest. On the left we mount a pad of approx. 6" x 6" wood and foam construction. It is mounted ½ to ¾ of an inch from the shoulder on the driver's door post. It is very effective in limiting leftward movement during right turns. In a few circumstances we have built a floor mounted "Tower" to provide right side support for a mini steering wheel driver.

4.5.0 Wheelchair Suitability and Modifications

We have become familiar with many kinds of wheelchairs in the 25 years we have been building the Scott driving system. It's probably a good idea to share some observations regarding wheelchairs, as they become an integral part of the driving controls.

The first thing about driving from a wheelchair is size. Is the wheelchair positioned correctly in relation to the controls and does it allow visibility to the left? Wheelchairs have been getting wider for sometime. Currently the Scott system can accommodate a chair width at the front tires of 26". A right hand 3-post driver must get as close to the steering column as possible, so it is much better to have front tires no bigger than 8". Ten inch tires and forks add 2 1/2" to each side of the wheelchair width. Front wheel drive wheelchairs can usually be brought close enough to the controls to work. The steering wheel and 3 post controls can be extended towards the driver should that be necessary.

Another area of concern is recliner back on wheelchairs. Any excessive movement in the chair back becomes a problem for smooth throttle and brake operation. The backrest height can also be a problem. Many potential drivers have chair backrests that are too low. Low backrests offer little support and provide poor location for anchoring an upper torso belt. Wheelchair mounted torso pads can be helpful in limiting torso movement during cornering. We have also fabricated backrest pads to fit persons with spinal curvature or posture problems.

Armrests are another part of the wheelchair that deserves some consideration. For the driver of a mini wheel van, armrest location and shape are critical to smooth driving. Armrests provide the stable platform on which the driver's hands and arms find support throughout the throttle and braking range. We have often widened the armrests, and changed upholstery material to discourage or encourage sliding, and even provided removable features such as lateral support that can be removed when it is not needed.

For the right hand 3- post driver we have developed a couple have right side armrest modifications that allow the wheelchair to mesh with driving activities without compromising either. Most drivers who use the right hand 3-post system have, as you might expect wheelchair controls on the right side. The idea of the right 3-post is to mimic the wheelchair armrest and control. The 3-post and armrest should be as close to the right side of the wheelchair as possible so the driver doesn't have to lean over to the right. The first problem is to relocate the control box so it is out of the way while driving. We have used a number of methods to relocate the wheelchair controller. Most commonly we mount the controller on a set of parallel arms so that it moves forward and down out of the way of the driving control mechanism. The control can also be dropped straight down mounted on bearings. A third method is to reverse a commonly used mechanism so that the controller swings to the left into the driver's lap rather than to the outside, which would interfere with the parallel armrest.

Another modification that is commonly made to a wheelchair is cutting about 1 ¼" from the inside edge of the foot rest plates to clear the Scott system tiedown. It may involve relocation of the inside heel loop.

The final wheelchair related issue is seat belts. For the most part, belts provided by wheelchair manufacturers are only held to the chair by small sheet metal screws. These are inadequate for even the limited body support over a long period of time. DSI prefers to replace these belts with automotive belts that are looped around the backrest tube, the loops can be either sewn or looped using an adjuster slide. The

lower belt should pull down across the pelvis while the upper belt should be mounted as high on the chair back as possible. The Ford supplied retractable seat belt is retained in the Scott system. It has an explosive retractor, which tensions the belt as part of the air bag system. This belt touches the left shoulder, is supported by a tubular stand on the right and is anchored on the floor. The stand is adjustable to allow the belt to clear the driver's knees and right side armrest while entering the driving station.

5.0.0 Driving the Van

5.1.0 Starting the Van

A stock Ford van requires the turning of a steering column mounted key through two positions the Scott system replaces this operation with a two push button sequence. When the green button marked, ING is pushed two things happen; first the ignition system is activated. The stock Ford dash and warning lights will come on. If there is a low vacuum condition a warning buzzer will sound. Secondly the sound of the back-up steering pump will be heard. If the ignition is on and the power steering pressure doesn't reach 30 psi. The back-up steering pump will be activated.

Pushing the start button either just below the ignition button or on the steering mounted auxiliary control box will complete the start sequence.

Fuel injected vehicles do not require pushing the throttle to prime the choke before a cold start. Cold start fuel mixtures are determined electrically by the engine management system.

5.2.0 Transmission Shift

While new Scott system vans require brake activation before the electric shift will operate, older vehicles will not. The electric motor that operates the shift mechanism will only work when the ignition is on. Two buttons, marked shift right and shift left, control a ball drive mechanism which moves the transmission lever through its full range from park to drive 1. These buttons are located toward the bottom on older vans and on the bottom left of late model push button boxes. Duplicate shift buttons are found on the steering wheel mounted auxiliary control box and the driver trainer control box on the right side of the engine cover.

While pulling back on the brake, push the shift right button and observe the shift indicator to select a transmission position. The buttons are momentary in function, release the button and the transmission gear is selected internally. Pre 1991 vans used a potentiometer-based meter to indicate gear position. Late model vans utilize the dash-mounted stock Ford indicator.

5.3.0 Gas/Brake Operation

One of the unique features of the Scott system is the push/pull operation of the throttle and brake mechanism. The entire steering column which is inertially counter balanced tilts forward for the throttle and backwards for the brake. There is a small neutral distance between the throttle and the brake. The action of both throttle and brake are servo in nature. That is the boosted mechanism is in addition and acts on the stock Ford mechanism rather than replaces it. For both brake and throttle, the initial movement opens a valve, which sends vacuum to a diaphragm, which pulls on either the brake pedal or throttle linkage.

Once the vehicle is running and still in park, gently try the throttle and brake to familiarize yourself with the feel of the column movement. Note the amount of movement needed in relation to engine speed and brake pedal movement. A little practice will smooth the transition between throttle and brake especially for able-bodied drivers. Most disabled drivers have no problem providing they are stabilized properly.

5.4.0 Steering Operation

The steering response of the Scott system is very similar to stock power steering, just lighter and with a faster ratio. The stock Ford van steering is about 4 turns lock to lock on a 15-inch diameter wheel. The Scott system mini wheel is 270 degrees lock to lock on a 10-inch diameter wheel. Stationary steering requires about 2-3 pounds of force. This effort drops as vehicle speed increases as it does with stock power steering. The 3- post steering control requires 180 degrees of rotation to steering from lock to lock.

A good way to teach a new driver is to go to a large parking lot and practice turns and figure eight's at low speed. In this way the driver can begin to relate steering wheel position with the steering response of the van. The "feel" of the van body movement is also evident and can be taught in relation to the amount of steering input.

The Scott system is a closed loop full feedback control. There is a solid mechanical connection between the control and road wheels. This means that road conditions like high crowns, traction conditions and the like are consistently reported back to the driver, not filtered through an artificial feed back mechanism or computer. This factor considerably reduces the time it takes to learn to be proficient in steering.

The stability of the forearm is very important. For the two handed driver the wheel is easily passed from hand to hand using minimal arm movement. Well-placed, properly shaped armrests provide a good platform. A one handed driver also needs a stable elbow rest and probably a 180 degree lock to lock ratio to avoid having to relocate their fingers when doing parking maneuvers.

5.5.0 Secondary Control Operations

Typically a Scott system van has most of the secondary controls located on the drivers door. This box has 30 buttons most of which are not necessary to operate while driving the van. It is possible to adjust the box for an individual who is being evaluated. The mounting method for the box are two rotating adjustable vise bases, separated by a 5/8 diameter rod with a 1/2 inch wrench and a selection of rod, the location and angle of the box is very widely adjustable. For the final placement in the driver's own van additional brackets will hold the push button box securely in the best position.

For the high-level spinal cord driver an important item on the push button box is an extended toggle switch that operates the turn signals. For a right hand 3- post driver the push button box is usually mounted at a shallow angle with the turn signal attached at the lower corner within the driver's easy reach. It is also a good idea to determine whether the proposed driver has a typing stick in order to operate the push buttons.

Single-handed spinal cord drivers and left hand 3-post drivers represent the greatest challenge for secondary controls. Since the left hand 3-post moves the control to the area of the left side of the drivers station usually occupied by the push button box we can move the box to where the client can reach it with an extended cable from the push button box. If the client has any right hand usage it is easy to do secondary controls from this type of arrangement.

For the one handed spinal cord injured driver we have had good success using roof mounted head control switching. A panel with 6 or 7 toggle switches can be mounted on the headliner or suspended from a raised top. Cruise control, wipers, turn signals and horn are among the functions usually accessed by head control switches. The toggles are extended using plastic extensions, which are bent in such a way as to always maintain the correct relationship to the driver's head.

Another low-tech solution to secondary control problems is to use a mouthstick. The mouthstick works very well for functions like shifting, where as a head control switch might be hazardous.

For those drivers with finger dexterity using a mini wheel conversion a number of switching options is possible with the wheel mounted auxiliary control box as a platform. Miniature toggle switches can be attached to the side of the box for turn signals. Small buttons can be mounted on top of the auxiliary box which can be operated by the drivers fingers over top of the steering wheel rim; the three button control box for the cruise control is often attached to the wheel mounted box, top side or bottom.

Since most drivers cannot reach the drivers door mounted door lock and mirror control, we extend the wires and move these controls where they can be reached in a small plastic box. Environmental controls are also stock Ford items remotely located, usually mounted on the bottom of the main push button box.

D.S.I. prefers the simplest solutions to problems relating to secondary controls. Automotive use is hard on overly sophisticated hardware. Voice controls and multiplexing are nice but we think that often more rugged less expensive answers work best in the long run.

6.0.0 Driver Prescription

Evaluation, Prescription and Quotation

The path to a successful driver leads from the evaluation, on the road testing to the equipment prescription and quotation. D.S.I. has a long history of working with individuals in the driver training field to find solutions to the most difficult issues facing severely disabled drivers. All parts of the evaluation experience must blend with the driver, vehicle and modifications to insure the best possible outcome. D.S.I. employees bring many years of experience and understanding to the field of high level disabled driving. We have worked one on one with drivers, vehicles and evaluators toward the best and safest outcome for our clients. The process is lengthy, detailed and complicated and there are no shortcuts. There will be and should be many back and forth phone calls between everyone involved. It may take a few days of driving to identify and appropriate candidate for driving The Scott System.

The potential driver should be checked out for everything from getting into the van, using the lift, seat belts and torso stability. Steering control, brake and throttle controls can only be assessed by actual on the road experience. The well-known driveway, "wobble the controls" evaluation has no place in the disabled driving quotation. Sales based assessments will always bring poor results. Too many vehicles have been built which can't be driven by the intended user. Too many drivers are marginally able to operate their vehicles. D.S.I. feels that these problems are the result of a breakdown in the partnership between evaluator dealer and manufacturer and are completely preventable.

A major factor in controlling all of the variables in a large complicated van conversion is experience. D.S.I. has been building all of its about 900 vehicles in house. In order to supply vehicles to markets outside of Southern California, care and attention to detail both in interpretation of evaluation information and in completeness of quotation is essential. When a vehicle is built and delivered to its final destination all of the details have to be correct because it is too late to change the major features. D.S.I. would like to share information regarding evaluation, quotation and fitting with any evaluators interested in using the Scott driving system. This handbook is intended as a guide through the evaluation process for a Scott driving system. We will be using two primary sources to provide a framework. First, we will look at a sample evaluation report. Then we will consider the D.S.I. quotation menu.

For purpose of illustration we will be looking at an example of an evaluation report used by the State of California Department of Rehabilitation. We feel that in terms of completeness and flexibility it covers every concern that D.S.I. has when preparing a quotation. This form is also used for documentation of all different kinds of driver evaluations for the Department of Rehabilitation, not just for the Scott driving system drivers.

6.1.0 Sample Evaluation Report

MODIFICATIONS

MATERIAL LABOR

_____ C. Tall raised roof (Insulation Required) (Rehabilitation Engineering consultation required for tall raised roof on single control van.)

_____ D. Other: _____

IV. **Floor Modifications** (All floors carpeted. See attached wheelchair measurements to determine exact modifications needed. If fuel tank is moved to rear, secure spare tire in rear interior of van.) _____

_____ A. Floor leveled

_____ B. Floor lowered _____ inches at driver's station with ramp for entry from rear door.

XX _____ C. Floor lowered _____ 3 _____ inches at driver's station, center area of van and to the side door.

_____ D. Floor lowered _____ inches driver's station with ramp for entry from rear door and in central area of van to the side door.

_____ E. Other floor modification _____

V. **Transfer Seat** - Transfer seat must rise to within 1" of wheelchair seat cushion height (wheelchair measurements attached) unless otherwise noted. _____

- A. Seat Base Type: Vendor Specify Brand and Model Bid _____
 - _____ 1. Forward/Reverse (Power)
 - _____ 2. Up/Down (Power)
 - _____ 3. Power Swivel motion
 - _____ 4. Other _____

- B. Special requirements
 - _____ 1. Transfer height of seat surface _____"
 - _____ 2. Special positioning _____

- C. Seat Specifications
 - _____ 1. Armrests
 - _____ 2. High Back
 - _____ 3. Other _____

_____ D. Other transfer needs _____

VI. **Wheelchair Securement Device** Vendor Specify Brand and Model Bid _____

XX _____ A. Powered/automatic securement device for driver **occupied** wheelchair at the **driver's station** (Including means to keep wheelchair ends from swiveling or raising during acceleration or deceleration. Also including a quick release seat for an able bodied driver).

- B. Automatic or semi automatic device which client can operate independently for **unoccupied** wheelchair at the **transfer position** located:
 - _____ 1. Between and behind transfer seat and passenger seat
 - _____ 2. Behind driver's seat against van wall
 - _____ 3. Other _____

_____ C. Other wheelchair securement: _____

MODIFICATIONS

MATERIAL **LABOR**

VII. Safety Belts and Chest Harnesses

A. Safety Belt

- _____ 1. Original equipment with buckle receiver on transfer seat base
- _____ 2. Separate lap and shoulder belts attached to van at driving position for driver in a wheelchair.
- _____ 3. Lap belt attached to client's wheelchair and shoulder belt attached to van at driving position.
- XX** _____ 4. Lap belt attached to client's wheelchair and shoulder belt (which remains in position for driver to drive wheelchair under) attached to van at driving position.
- _____ 5. Special Modifications to safety belts.
 - _____ a. Button on belt buckle modified for independent release by the client.
 - _____ b. Loops or other modifications to facilitate tightening by the client
 - _____ c). Holders for the seat belt receptacle so the client can reach and fasten the seat belt from the driver's seat.
- _____ 6 Other _____

B. Chest Harness/Trunk Positioning(for trunk stability while cornering)

- _____ 1. Chest harness attached to transfer seat.
- XX** _____ 2. Chest harness attached to client's wheelchair.
- _____ 3. Special Modifications
 - _____ a. Belt buckle button modified for independent release by client.
 - _____ b. Loops added for independent operation.
 - _____ c). Velcro® fastening
- XX** _____ 4. Support Pad on "B Pillar"
- _____ 5. Other _____

VIII. Wheelchair Modifications (Describe in space provided)

- _____ A. Armrests _____
- _____ B. Footrests _____
- _____ C. Seat _____
- _____ D. Back _____
- _____ E. Control box _____
- _____ F. Other/Describe _____

IX. Steering/Gas/Brake System (Checked only if a change is needed)

Vendor Specify Brand and Model Bid _____

A. Joystick Control System (*AEVIT J, formerly Digidrive for example*)

- _____ 1. Joystick Control Location _____
- _____ 2. Terminal Device _____
- _____ 3. Forearm Support _____
- _____ 4 Other _____

MODIFICATIONS

MATERIAL **LABOR**

B. DSI Unilever Power and Steering Control System (Includes Throttle Boost) _____

- XX 1. DSI Wheel. if not center, specify _____
Total Rotation 180 degrees.
- 2. DSI Tripin
 - _____ a. Right with Parallel Support
 - _____ b. Left
 - _____ c. Other
- _____ 3. Steering Device; specify _____
- XX 4. Servo # _____ Medium (see old van – 1990)
- _____ 5. Other _____

XX C. Instructor Control: Specify _____
(Vendor to include cost of removal, if not single attachment point.)

_____ D. Other _____

X. Electrical Control System

Electrical control system includes a control console consisting of micro switch push buttons or touch pads with appropriate actuators for all major secondary controls including shifting ,turn signals, windshield wipers (min. low, high and wash), power windows (driver and passenger), headlights on/off and dimmer, horn, ignition/start, hazard lights, hvac (heat, a/c etc.), parking brake, and cruise control. Console should also have switches for components bid elsewhere but needing control at driver's station such as lift, door openers and wheelchair securement

A. Primary Touchpad/Control Panel _____

- Vendor Specify Brand and Model Bid _____
- XX 1. Left Side
 - _____ 2. Right Side
 - _____ 3. Quick access switches on side of console
 - _____ a. Type of pads _____
 - _____ b. Location _____
 - _____ c. Functions _____
 - _____ 4. Other _____

B. Second Panel/Auxiliary Control Box _____

- Normally contains turn signals, dimmer, horn, shift and start for quick access without removal of hand(s) from primary control Vendor Specify Brand and Model Bid _____
- XX 1. Center of wheel (if DSI)
 - _____ 2. Touch pads
 - a. Type of pads _____
 - b. Location _____
 - c. Functions _____
 - _____ 3. Head switches
 - a. Type of switch _____
 - b. Location _____
 - _____ 1). Roof
 - _____ 2). Headrest (Not attached to van wall)
 - _____ 3). Other _____
 - c. Functions _____
 - XX 4. Other Buttons on top of Auxiliary Control Box for horn and dimmer.

Miscellaneous

Client's Name _____

MODIFICATIONS

MATERIAL LABOR

XI. Miscellaneous

A. Mirrors

XX 1. Convex mirrors both sides (located above standard mirrors, not on them. Minimum 18 square inches.) _____

XX 2. Other mirrors Segmented Mirror in front of OEM mirror (if one which meets his needs cannot be found, use the one on his van. _____

XX B. Transport the van from the vendor to client's home or other designated location. Location _____

XX C. Other –If the Ford E 250 being modified is an "Commercial Van" with windows, the following additional modifications will be needed to complete the conversion:

- a. The interior of the vehicle must be finished including covering the walls (with insulation and finished trim around the windows).
- b. The Commercial Van specified has front and rear air conditioning but not the ducting for the rear air conditioning. If rear air conditioning is specified in the evaluation, rear air conditioning ducting must be added as part of the conversion.
- c. The Commercial Van does not come with a rear bench seat. If one is needed it must be supplied and installed by the vehicle modifier (or a subcontractor). The rear bench seat installation must meet Federal Motor Vehicle Safety Standards (FMVSS) 207 (seat anchorage), 209 (seat belt anchorage) and 210 (seat belt assembly).
- d. The interior finishing materials and the upholstery of the rear bench seat should be the same as (or similar to) the OEM colors and of the same material quality. These interior materials must comply with FMVSS 302 (Flammability of Materials) as well as any other applicable Federal Motor Vehicle Safety Standards.

Subtotal _____

Total Cost (materials plus labor) _____

Vehicle Modifier Name _____ Telephone (____) _____

Vehicle Modifier Address _____

Vehicle Modifiers Warranty (in months) Parts _____ Labor _____

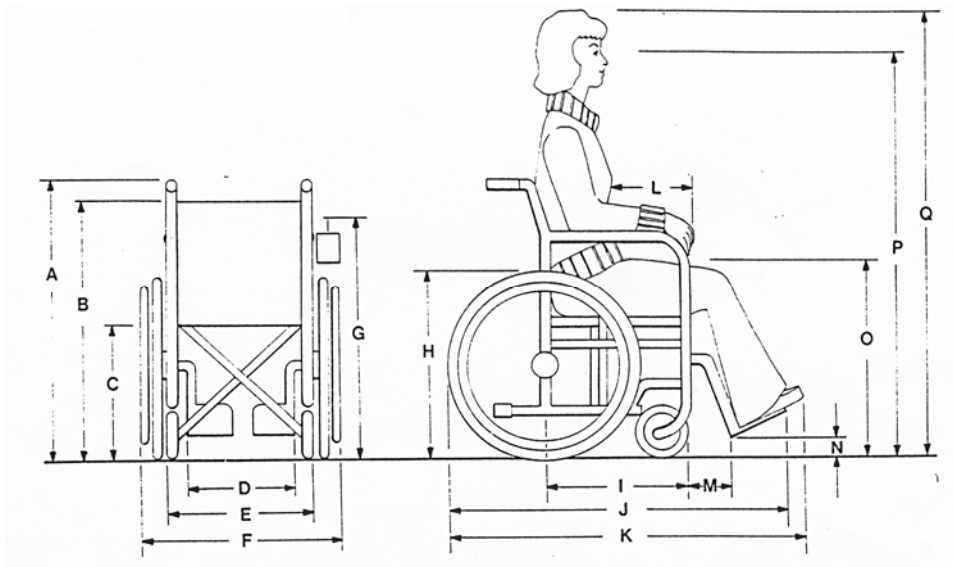
Weeks to completion after unmodified van delivered to your shop _____

Signature of Vehicle Modifier or Vehicle Modifier's Agent _____ Date _____

* **Note:** Items noted "bid but do not install" are to be bid above. but **not installed** until a final determination is made by the evaluator. These items were questionable during the evaluation but may **not** be needed in the client's own vehicle. The final decision about installation will be made by the **evaluator** during the follow-up at the vehicle modifier.

Client's Name _____

WHEELCHAIR MEASUREMENTS - VAN



Wheelchair Mfg. Invacare Model Ranger X Power on Left

Removable Armrests yes Removable Leg rests yes Cushion Thickness 3"

- 38 1/2" A. Overall wheelchair height Back - 16" wide X 18" high
- 36 1/2" B. Height of wheelchair back upholstery Seat - 16" wide X 18" deep
- 16 1/2" C. Height of seat (floor to top of fabric where it attaches to the wheelchair)
- 18" D. Maximum footrest width
- 20 1/2" E. Maximum caster width (including nuts)
- 25" F. Maximum width of drive wheels, including hand rims on manual (measure near ground)
- 28 1/2" G. Height of wheelchair control on power wheelchair
- 13" H. Diameter of drive wheels
- 20" I. Horizontal distance from front of swivel wheels to drive wheel axle
- 43" J. Length from rear-most part of wheelchair (from floor to 5" up) to front edge of footplate
- 46" K. Length from rear-most part of wheelchair (from floor to 5" up) to toes
- 7" L. Torso to front edge of chair seat (measured at waist)
- 7" M. Distance from rear of footrest to front of caster tire
- 4" N. Minimum footrest height
- 23 1/2" O. Top of thigh to ground
- 45 1/2" P. Eyes to ground
- 49 1/2" Q. Overall height from top of head to ground

NOT SHOWN ON DIAGRAM

- 25" R. Widest part of wheelchair and/or client and wheelchair. Where: drive wheels
- 43" S. Lowest height to which client can bend and still functionally operate his/her wheelchair
- na" T. Lowest height under which client can functionally transfer. Type of transfer dependent

January 1,2005

Attn.:

Preliminary Quotation:

Quotation:

Dear Mr./ Mrs. ,

We are pleased to submit our quotation covering the modifications to a 2004 or 2005 Ford E-250 or Ford E-350 van, to permit independent operation by _____ from his / her _
_____wheelchair.

We are pleased to submit our supplemental quotation covering the modifications to a Ford E-250 Ford E-350 Club-wagon van, to provide additional line item details in support of your Department of Rehabilitation solicitation for bid for _____

The purpose of this supplemental quotation is to provide additional line item details.

The systems and accessories proposed are in accordance with the recommendations of the Driver Evaluation Group at _____.

The systems and accessories proposed are based on the recommendations of the Driver Evaluation Group at _____.

The Following basic systems will be required:

Parts

Labor

Total

System

dsi-1005 Uni-lever power & steering control system:

Wheel (# 5 servo) +

Wheel (# 7 servo) +

Wheel (# 10 servo) +

Wheel (# 13 servo) +

Special long cross-arm

Tri-pin (# 5 servo)

Tri-pin (# 7 servo)

Tri-Pin (# 10 Servo)

Tri-pin (# 13 servo)

Left hand tri-pin (# 5 servo)

Left hand tri-pin (# 7 servo)

Left hand tri-pin (# 10 servo)

Left hand tri-pin (# 13 servo)

dsi Throttle booster assembly w/ low vacuum throttle assist
 dsi Throttle booster assembly
 dsi Low vacuum throttle assist assembly
 dsi Modify and enhance sensitivity of adaptive brake valve assy.
 dsi Secondary brake booster assist assy.
 dsi Brake / throttle assist for right hand
 dsi-113 Fitting charges: wheel
 dsi-113 Fitting charges: tri-pin
 dsi-113 Fitting charges: left hand tri-pin
 dsi Instruction lever
 Install and remove instructor brake
 dsi Install 3" steering wheel spacer
 dsi Install lock pin to block gas/ brake pivoting
 dsi-108 Parallel forearm & elbow support for tri-pin
 dsi-108a Custom elbow support for left arm
 Put original steering column into van for shipping
 Tri-Pin Steering with Little Driver Trainer Handle
 Left Hand Tri-Pin with Little Driver Trainer Handle
 dsi Short Crossbar (R.H.) Steering with Little D. T Handle

Electrical

dsi-2005 Electrical control system
 dsi-2005 Electrical control system (+) (relocate controls)
 dsi-2005 Electrical control system (crsnt) (relocate controls)
 dsi-2005 Electrical control system, with quad control
 dsi-2005 Electrical control system, with quad control (+)
 dsi Right hand side console box mount a.t.f
 dsi-102a Auxiliary control box
 dsi-102a Special auxiliary control box
 DSi Lift Interface Harness Assy. M
 dsi Relocate power controls
 dsi Relocate power mirror controls (if required) (a.t.f)
 dsi Relocate power door lock controls (if required) (a.t.f)
 dsi Relocate overdrive switch
 dsi-102b Auxiliary head control panel
 dsi-102c Wiring for auxiliary head control panel
 dsi Power headrest
 dsi Power headrest with custom head support pad
 dsi Special turn signal controls on aux-box

- dsi Special turnsignal & hi-lo controls on push button box
- dsi Horn & wiper control on the bottom of main control panel
- dsi Raised buttons on wipers
- dsi Non-standard wiper function on aux-box (low/wash)
- dsi Non-standard wiper function on aux-box (add: int., high & wash)
- dsi-206 Solar charger 34w, with regulator
- dsi-208 Automatic headlight dimmer
- dsi Remote start 552t
- dsi Dual battery system with diode isolation solenoid override
- dsi Cuff with poker for left hand
- dsi Mouth stick & holder
- dsi Back-up warning device (c-back)
- dsi102d Driver Trainer Control Box

Nor-Cal Floor

- dsi-103 Lowered floor at driver's station:
 - Special 4" driver- cargo dropped floor NC (no ramp)
 - Special 4" driver- cargo dropped floor NC with rear ramp
 - Special 6" driver- cargo dropped floor NC (no ramp)
 - Special 6" driver- cargo dropped floor NC with rear ramp
 - Special 8" driver- cargo dropped floor NC side entry only
 - 4 1/4" at driver includes frame modifications (no ramp)

DSI Floor

- dsi-103 Lowered floor at driver's station:
 - Model S-3 (rear entry)
 - Model S-4 (rear entry)
 - Model CS-2 (full width/ rear ramp)
 - Model CS-3 (full width/ rear ramp)
 - Model CS-4 (full width/ rear ramp)
 - Model CS-5 3/4 (full width/ rear ramp)
 - Model CS-6 (full width/ rear ramp) including 2" body raise
 - Model CS-8 (full width 8" at driver station,)
 - 4 1/4" at driver includes frame modifications

Floor Accessories

- dsi Custom servo housing (CS-5,CS-6, CS-7 & CS-8 only)
 - Floor preparation and carpeting
- dsi Floor modification for non-lowered floor & exhaust pipe
- dsi Modify floor to level wheelchair at driver station

- dsi Modify floor to level driver station
- dsi Triangular turn-around for model s-3 & s-4
- dsi Fill side door step plate
- dsi Floor 3"- & OEM floor filler plates
- dsi Modify and fill driver side step well and reroute wiring harness
- dsi Modify floor to except quick release seat (pockets)

Gas Tank

- dsi Rear tank conversion (Transfer Flo)
- dsi Rear tank conversion (Transfer Flo)

Raised Top

- dsi-104 Full size top, low profile 8", with front brace & side / rear door extension 7": with liner and two reinforcing bars, painted
- dsi-104a Full size top, low profile 8", with front brace & side / rear door extension 7" with steel cage and fabric headliner, including front roof section modification, painted to match.
- dsi Plexiglas roof window, front
- dsi-105 Rear door 3" eyebrow for clearance at door
- dsi-105 Custom rear door eyebrow for clearance at door
- dsi-105 Rear door 3" eyebrow for clearance at door (+)
- dsi-105 Rear spoiler top (raised rear roof & raised doors at rear of van)

Lift and accessories

- dsi-4005 Entry system with UL2806 (2940) & Int'l mount rear swing door openers RDO-2912
Int'l mount side swing door openers RDO-2909
- dsi-4005 Entry system with UL2808 (2944) & Int'l mount rear swing door openers RDO-2912
Int'l mount side swing door openers RDO-2909
- dsi-4005 Entry system with UL2810 (3240) & Int'l mount rear swing door openers RDO-2912
Int'l mount side swing door openers RDO-2909
- dsi-4005 Entry system with UL2812 (3244) & Int'l mount rear swing door openers RDO-2912
Int'l mount side swing door openers RDO-2909
- dsi-4005 Entry system with UL2808 (2944 Tall) & Int'l mount rear swing door openers RDO-2912

- Int'l mount side swing door openers RDO-2909
- dsi-4005 Entry system with UL2812 (3244 Tall) &
Int'l mount rear swing door openers RDO-2912
Int'l mount side swing door openers RDO-2909
- dsi-4005 Entry system with S-Series Clearway Lift
- dsi-4005 Entry system with Ricon S-1231, Split 3042,
& side entry with swing door openers RDO-2791
- dsi-4005 Entry system with Crowriver Vangater, w/dual
entry, manual fold-over platform lift
- dsi-4005 Entry System with CrowRiver Vangater II, w/dual
entry, automatic tri fold-over platform lift
& side entry with Crow River side swing door opener
- dsi-4005 Entry system with Braun "swing" lift L800X +
side door opener 18633A (ORDER W/ DOG LEG)
- dsi-4005 Entry system with Ricon Reliant S- Series Personal S1204 &
Int'l mount rear swing door openers RDO-2912
- dsi-4005 Entry system with Braun Millenium L955SE &
Braun rear swing door openers #62402-000
Braun side swing door openers #62400-000

Lift only

- dsi-4005 Entry system with UL2806 (2940)
- dsi-4005 Entry system with UL2808 (2944)
- dsi-4005 Entry system with UL2810 (3240)
- dsi-4005 Entry system with UL2812 (3244)
- dsi-4005 Entry system with UL2808 (2944 Tall)
- dsi-4005 Entry system with UL2812 (3244 Tall)

Door openers

- Side slider RDO 2501
- Rear entry swing door openers RDO -2706 external
- Side entry swing door openers RDO -2706 external
- Int'l mount side swing door openers RDO-2909
- Int'l mount rear swing door openers RDO-2912
- Int'l mount side swing door openers OEM latch RDO-3009
- Int'l mount rear swing door openers OEM latch RDO-3012
- Dash harness
- Outside harness
- DSi Interface
- dsi Dual entry platform

- dsi Dual switch arm
- dsi Dual switch arm (after market)
- dsi Extended switch arms
- dsi Modify threshold for lift clearance (rear only)
- dsi Rear bumper modifications
- dsi Remove & reinstall camper conversion package
- dsi-109a Remote lift and door control:
 - Circuitron MR-4 Unilite
 - Circuitron MR-4 Unilite with raised buttons
 - Circuitron MR-6 Unilite
 - Circuitron VR-6 R30B (Square/ Round Connector)
 - Circuitron VR-6 for Spirit Lift
 - Braun remote 15608A
 - Circuitron remote (for Vangator II)
- dsi-109b Remote lift & door control for R30B (round plug) VRG
- dsi-110 Telescoping wheelchair ramps, 5' to 8'
- dsi Uni-lite interface wiring
- dsi-111a Lift safety alarm
- dsi-111b Lift safety alarm (Not Installed)
- dsi-204 Magnetic outside switches, with key switch
- dsi-204a Magnetic outside switches, without key switch
- dsi-211 Recessed box for outside lift-switches
- dsi Courtesy light for entry area
- dsi Courtesy light for entry area with int. light
on/off switch on lift door
- dsi Install interior light ON-OFF switch on side swing door

Wheelchair

- dsi-3005 Wheelchair tie-down assembly
- dsi-3005a Wheelchair tie-down assembly including stabilizer
 - Install EZ-Lock tie-down assembly
- dsi Guard for tie-down release
- dsi Wheelchair securement for scooter (Amigo if required)
- dsi Stabilize Permobil wheelchair: install manufactures
seat stabilizing kit.
Client needs to have Permobil front wheel width narrowed
to 24 inches by manufacturer
- dsi Modify engine compartment for wheelchair footrest clearance
- dsi-114 Parallel swivel for wheelchair control box
- dsi-114 Move wheelchair control to left side

- dsi Custom wheelchair armrests on both sides (2")
- dsi Modify right wheelchair armrest (detachable)
- dsi Modify left / right wheelchair foot rest
- dsi Custom back support cushion with loops (upholstered)
- dsi Custom back support cushion (upholstered 2")
- dsi Relocate wheelchair recliner mechanism
- dsi Install ON/OFF switch for recliner mechanism
- dsi Wheelchair cross bar
- dsi Wheelchair rear bar and stabilizer
- dsi Left custom armrest for transfer seat

Restraint Belts

- dsi Passive restraint for upper torso
- dsi Passive restraint for upper torso (including door post modification)
- dsi Modify seat belt assy. with special holders
- dsi Passive rear tie-down assembly with lap belt
- dsi-112 Kinedyne belt tie-down, installed
- dsi-112 Kinedyne belt tie-down, installed, with lap and shoulder belt
- dsi Grandmar seat belt restraint
- dsi Grandmar or custom velcro upper torso restraint
Attached to clients wheelchair
- dsi Custom chest harness with modified buckle
- dsi Custom chest harness attached to clients wheelchair
- dsi Custom chest harness with modified buckle and loops for
Independent operation attached to clients wheelchair
- dsi Support pad on pillar
- dsi Chest harness, velcro fastening with d-ring
- dsi Lap belt, with loops
- dsi Lap belt with clips, incl. custom release button and loops

Seat base

- dsi Install 6-way power seat base with _____” travel
- dsi Install 6-way power seat base with ___” travel Ricon-dSi modify)
- dsi Stabilize 6-way power seat base
- dsi-107 Quick release seat base assembly
- dsi Install wiring & base for power passenger seat
- dsi Custom transfer seat arm rests, left and right
- dsi Custom 4 point stabilizer base for lowered floor

Heating & A/C

- dsi Service and recharge a/c & modify heater lines front only
- dsi Rework/ replumb rear heater & lines + front air
- dsi Rework/ replumb front & rear heat & ac lines
(NO FLOOR & SIDE LIFT) (1,250.00)
- dsi-201 Heat & cooling system control
- dsi-201a Heat & cooling system including blower controls
- dsi-201b Heat & cooling system control (cresent) incl. blower
Control (front only)
- dsi-201c Heat & cooling system control (cresent)(front and rear)
- dsi-202 Rear heater blower control
- dsi-209a Rear heat/air conditioning:
Side unit 4”
Over head unit
Under sofa unit
- dsi-209b Modify and recharge factory front & rear heat & a/c
with overhead output
- dsi-209c Install / modify and recharge factory front heat & a/c
& install rear unit
- dsi-209d Install / modify and recharge factory rear heat & a/c
with overhead output
- dsi-209e Modify and recharge factory front heat & a/c and
remove rear unit and lines.
- dsi-209f Modify and recharge factory front heat & a/c
- dsi-209g Modify and recharge factory rear heat & a/c
with overhead output
Install rear A/C unit
- dsi209c Install A/C rear unit
- dsi-209e Modify and recharge factory front heat & a/c

Delivery

- dsi-115 Delivery charges for transportation of van from Van Nuys, CA
to.
- dsi-115 Final check and test drive, follow up evaluation with
client, includes minor adjustments and delivery of van from
Van Nuys, CA to
Vehicle Delivery from Nor Cal to DSI

Mirrors

- dsi-205 Power mirrors
- dsi-213a Convex mirror assemblies (1999+)

- dsi-213a Convex mirror assemblies (1999+) round 6"
- dsi-213b Convex mirror for center windshield for view left/right
- dsi-213c Inside top mirror for view to left on console (a.t.f)
- dsi-213d Installed convex mirror above left front fender
- dsi-213e Relocate right OEM mirror assembly forward to fender
- dsi-213f Large convex mirror for center windshield rearview (lcii)
- dsi-213g 8" convex mirror on left fender to check cross traffic to right. (a.t.f)
- dsi Mirror, 9" or 10" round convex passenger side front fender
- dsi Install Lane Changer II prismatic rear view mirror
- dsi Rear view prism
- dsi Front view prism
- dsi Segmented mirror

Phone & Radio Accessories

- dsi-203 Remote radio tuning control or relocate remote box
- dsi-210 CB radio & antenna, installed
- dsi-210a Motorola hand held cellular telephone,
handsfree & removable, installed in van
- dsi-210b Motorola hand held cellular telephone,
voice actuated, handsfree, installed in van
- dsi-210c Motorola handheld cellular telephone,
handsfree, installed in van
- dsi VA credit towards cellular telephone
- dsi Install hands free cradle for client's cellular telephone
- dsi Install cellular telephone (labor only), max
- dsi Power radio antenna MX-3, semi automatic
- dsi Transfer cell phone from old van to new van
- dsi Install Sony remote am/fm/cas/10cd changer w/ acc. Tech. RB-1

Interior

- dsi Inside spare tire rack, side mount, with cover
- dsi Fold -A- Way rear dual bench seat including belts
- dsi Remount rear seat bench or sofaed in back of van
Including OEM standard seat belt restraints
- dsi Sofa bed with 3 seat belts, Concours 5000 (If Available)
- dsi Electric adjustable sofa bed with 3 seat belts, Concours 5000 (if available)
- dsi-212 Fire extinguisher, installed
- dsi Interior paneling insulation package, 1998
- dsi Interior paneling wood: walls, doors, head-liner,
Insulation & 5 interior lights

- Interior paneling fabric: walls, doors, head-liner,
with oak trim, insulation & 5 interior lights
- dsi High back captain seat, reclining, with swivel
base & folding armrests, concours
- dsi Adjustable lumbar (for captain seat)
- dsi Bay window 28" x 48" with shrouds & blinds each
- dsi Bay window 28" x 40" with shrouds & blinds each
- dsi Privacy glass window tinting:
Rear side window, non-opening, each.
Center side window, opening, each.
Center side window, non-opening, each.
Swing door window, opening, each.
Swing door window, non-opening, each.
Cleaning supply kit
- dsi Magazine holder, driver's side
- dsi Snack tray Ford (1991 & earlier models)
- dsi Interior Package
- dsi Removal and reinstall of existing interior

Exterior Accessories

- dsi Inside or outside spare tire rack, rear door, with cover
- dsi Outside spare tire rack, rear door, with hard cover
- dsi Fiberglass running boards, painted, pair
(1991 & earlier models)
- dsi Fiberglass running boards, painted, pair
(1992 & later models)

Estimated Total Charges -----

for Modifications & Accessories

*** Items with remaining questions**

Important: Please supply dSi with an evaluation report including the customer's wheelchair measurements so we are able to verify the lift and floor options quoted above.

If a E-250 van is selected note there is no interior. An additional cost of approx. \$4,000.00 to \$7,500.00 will be needed to complete the modifications.

If a E-350 van is selected note there is an additional cost of approx. \$1,800.00 for removing and replacing interior so floor modifications can be performed.

All prices are F.O.B our plant in Van Nuys, California and are good for **forty five (45) days**.

Client was advised to use Lap belt and passive restraint!

Due to the extensive nature of the modifications to the vehicle additional costs may arise during the final fitting procedures.

We require a **33% deposit** to start with the work process. The remaining balance is due upon delivery of the vehicle.

Warranty covered by Driving Systems Inc. is "WARRANTY IS ONE YEAR PARTS AND LABOR".

The time required to complete the work is estimated to be 14 - 16 weeks, following receipt of the official authorization and the vehicle, and further depends on the backlog of production. Please be advised that our production line is based on a "first come - first serve" basis.

The fitting procedures will take approx. 4-5 **days** and require the client's presence at our plant.

Important: Before ordering the Van from your Ford Dealer please make sure it will come with a **8 cylinder 5.4 Liter engine**, as we will **not** be able to install the system in vehicles with other engines. Please order according to our Basic Vehicle Specification List.

Please fill out DSI conversion references sheet for column height & other data and fax back to 818-782-6485

If we can be of any further help please feel free to contact us.

Sincerely,

Rudolf Schinz

President

William C. Butt

Vice President

Enclosures:

- Basic Vehicle Specification List
- Wheelchair Measurement Worksheets: (to be filled out...)
- dSi Column height & push button location sheet (to be filled out...)

Ps. We need Wheelchair Measurements Worksheets

General Service Recommendations

Routine preventative maintenance procedures are the least expensive and most effective insurance against unexpected mechanical failures available.

Follow faithfully the manufacturers service recommendations as outlined in the booklet provided with each vehicle.

We recommend two exceptions as follows:

Oil change and Lubrication

Most of the Scott systems vehicles are operated on basically shorter runs, which tends to shorten the life of the lubricants. Therefore, we suggest that the engine oil and filter should be changed at 3,000 to 3,500 mile intervals. Always have the chassis lubricated at the time of the oil change, especially in wet weather.

Mobility system

There is very little in the way of routine servicing required by the driving controls. The level of type III automatic transmission fluid in the large aluminum power steering reservoir should be checked regularly. Rubber parts of the brake booster system should be replaced periodically. We have established a 5 year replacement cycle for the diaphragm of the brake booster. The rubber quad rings in the brake servo valve also require replacement and re-lubrication every 3 or 4 years. All of the other bearings and rod ends used in the mechanical assemblies are permanently lubricated and sealed. Complete maintenance information can be found in the workshop manual.

The power steering reservoir is located under the hood at the front of the van. It is to the right of center facing the front of the van.

Appendix B

September 3, 2004

BASIC VEHICLE SPECIFICATION LIST

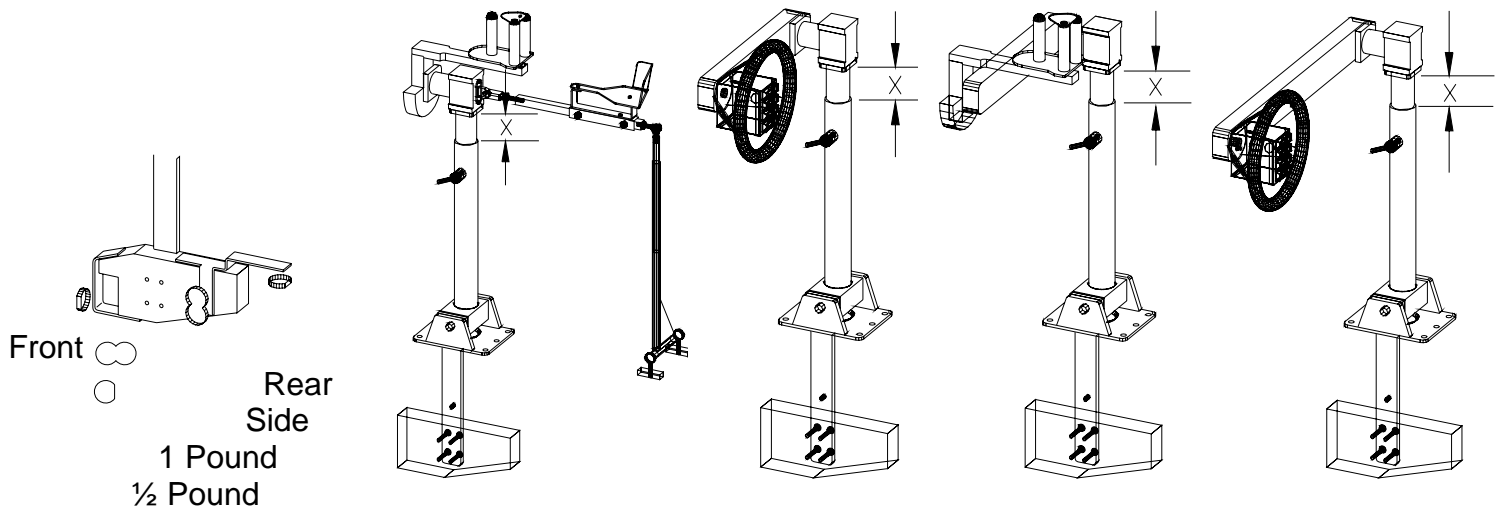
- 2000 or later Ford Econoline E-250 Rv Converter or E-350 Wagon (XLT 8-passanger preferred)
- Gross Vehicle Weight: 7900 Lbs. Minimum
- 5.4 Liter EFI V-8 engine only
- Heavy Duty Cooling System
- Steel Belted Radial Tires P235/75R x 15 XL
- Automatic Transmission, Overdrive OK
- Heavy Duty Suspension: Shocks and Springs, Front Stabilizer Bar
- Heavy Duty Alternator
- No Auxiliary Battery
- Power Steering
- Power Brakes
- Power Windows
- Power Door Locks
- Cruise Control
- No Camper Conversion Package before installation of dSi Equipment
- Ford Rear Heater/AC is OK, if floor lowering is required & lift in rear
- Fuel Tank will be relocated to rear, if floor lowering is required
- Hinged Side Cargo Doors preferred with side W/C entry (Slide Door with rotary lift)
- Limited Slip Rear Axle
- Privacy Glass

Please call if you have any questions.

Appendix C

Column Balance Chart Scott System Van Driving Systems Incorporated

Placement of extra weight to balance column



Column Offset X	Weight Placement	Right Hand Three Post	Right Hand Wheel	Wheel	Left Hand Three Post
2"	Front		1/2	0	2
	Side	No Extra Weight	0	0	4 1/2
	Rear		0	1/2	5
4"	Front		1/2	1/2	3 1/2
	Side	No Extra Weight	0	1/2	6
	Rear		0	1/2	5 1/2
6"	Front	1 1/2	1 1/2	1	5 1/2
	Side	1/2	0	1 1/2	8
	Rear	0	0	1 1/2	6
8"	Front	2 1/2	2 1/2	4	
	Side	1 1/2	0	2 1/2	N/A
	Rear	1/2	1	2	

Appendix D

Vacuum Valve Function

The Scott system brake servo valve is a balanced popit vacuum valve used to supply vacuum to an additional brake booster resulting in reduced effort braking. The original design was used to control hydraulic power for the control surfaces on a P-38 fighter plane the design and operation of this valve is simple and elegant. A mushroom shaped popit is in one half of the valve body with an equal amount of area behind and in front. This balance of surface area allows the popit to rapidly respond to both physical forces and vacuum flow very quickly and consistently.

Lets look at how the valve is constructed and trace step by step how it works.

The valve housing is a two piece aluminum cylinder. One half is smaller and contains the mushroom shaped stainless steel popit. The bore that the popit fits in should be smooth and polished.

At the bottom of this bore is a vent hole. If this hole is plugged or in any way restricted the air behind the popit quad ring cannot be displaced properly, restricting the free movement of the popit. The popit itself has a groove in which a quad ring is retained as well as a rubber sealing surface on it's top. Smooth brake response is dependent on the smooth, light operation of the popit in its bore. The rubber sealing face has two functions. Most importantly it seals stored brake vacuum from escaping from the storage tank. The rubber seals against a knife edged sealing surface on the other valve body half. This way vacuum for potential braking is held ready for use behind the popit seal.

A light compression spring holds the popit against the sealing surface when the valve is operating. All brake servo valves have been tested for sealing integrity after assembly. It is possible to use the vacuum gauge in the vehicle to test the sealing of the valve. Vacuum should be retained after engine shut down. Dirt or grease on the popit surface can cause leaks.

The larger valve body half contains the piston and a linear bearing. The piston is a heat-treated stainless steel shaft with a pressed on aluminum disc/collar.

The shaft travels about .060 inches from off to full open. It moves through a six row linear bearing that is split to allow precise adjustment with minimum friction. In the narrow section of the body half there is a quad ring, which seals and supports the piston shaft in the area closer to the center of the valve. The piston shaft is also mirroring polished for smooth operation. Two small compression springs operate against the aluminum collar casing the piston to retract against the snap ring at the end of the valve.

Valve Operation

As the driver pulls back on the steering column, the lower arm of the column moves forward, beginning the movement of the piston. After approximately .025 inches of movement, the piston pushes the popit off of the sealing edge and vacuum begins to flow out of the hose fitting on the bearing half of the valve. The full piston travel is about .060 inches.

Until the popit is moved by the piston there is no vacuum in the brake booster, the hose to the booster or the bearing half of the brake servo valve.

When vacuum reaches the booster it collapses pulling both the pedal and the linkage forward. This neutralizes the valve position, interrupting the flow of vacuum to the booster unless the column is pulled further back moving the piston again. This is a closed loop braking system. The brake valve

is built into the brake linkage making it responsible to the position of the Ford brake pedal.

As soon as the popit returns to its sealing position and the piston is retracted from its sealing position against the popit face, atmospheric air flows from a vent hole, through the center of the piston replacing the vacuum in the valve, hose and booster.

Repair and Maintenance

There are two mechanisms involved in the adapted brake system. The servo valve has 2 moving parts, both are stainless steel, and requires periodic replacement of quad rings and relubrication. The brake booster itself is just a rubber diaphragm and spring mounted inside a metal housing. Time, heat and air pollution all work toward the deterioration of rubber parts so we recommend replacement of the brake booster every five years. The brake booster slider should be greased once a year.

Trouble Shooting

Trouble shooting the braking system is relatively easy. Since the add-on equipment is vacuum, a problem with the D.S.I. brakes system result in short, high effort travel of the steering column. Brake valve maintenance is required when the column travel is rough, sticky or not smooth. Most any problem felt through the operation of the steering column is likely to be the brake valve. Brake booster integrity can be tested using the stored brake vacuum in the reserve storage tank. Run the engine to accumulate vacuum in the tank. Note the level on the gauge. Shut the engine off. Pull back on the brakes and hold. The vacuum level should drop about 2 inches and stop if there is no leak in the brake booster or feed hose.

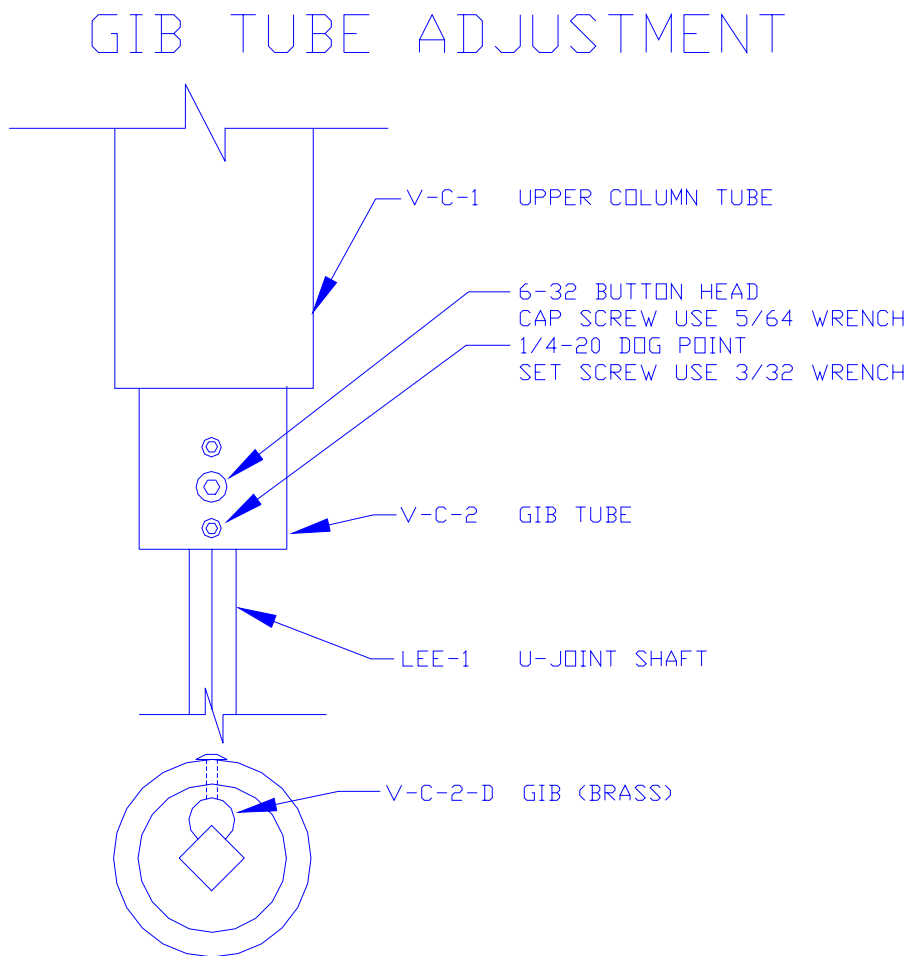
Generally, stock Ford brake problems result in long brake travel, both from the column and the foot pedal, and no effort or braking. The stock Ford pedal should start moving down as soon as the steering column moves backwards.

Appendix E

Steering Column Gib Adjustment

The steering column gib is a brass corner piece attached to part V-C-2 the steering column gib tube. The purpose of the gib is to allow the telescoping of the column to adjust its height while controlling rotational play in the steering column. For the van owned by an individual, the steering column height is adjusted only occasionally, usually because of the changing of a wheelchair or cushion. An evaluation vehicle will require constant changing of the columns and adjustment of column height. These actions lead to loosening of the gib and require attention for the most accurate steering.

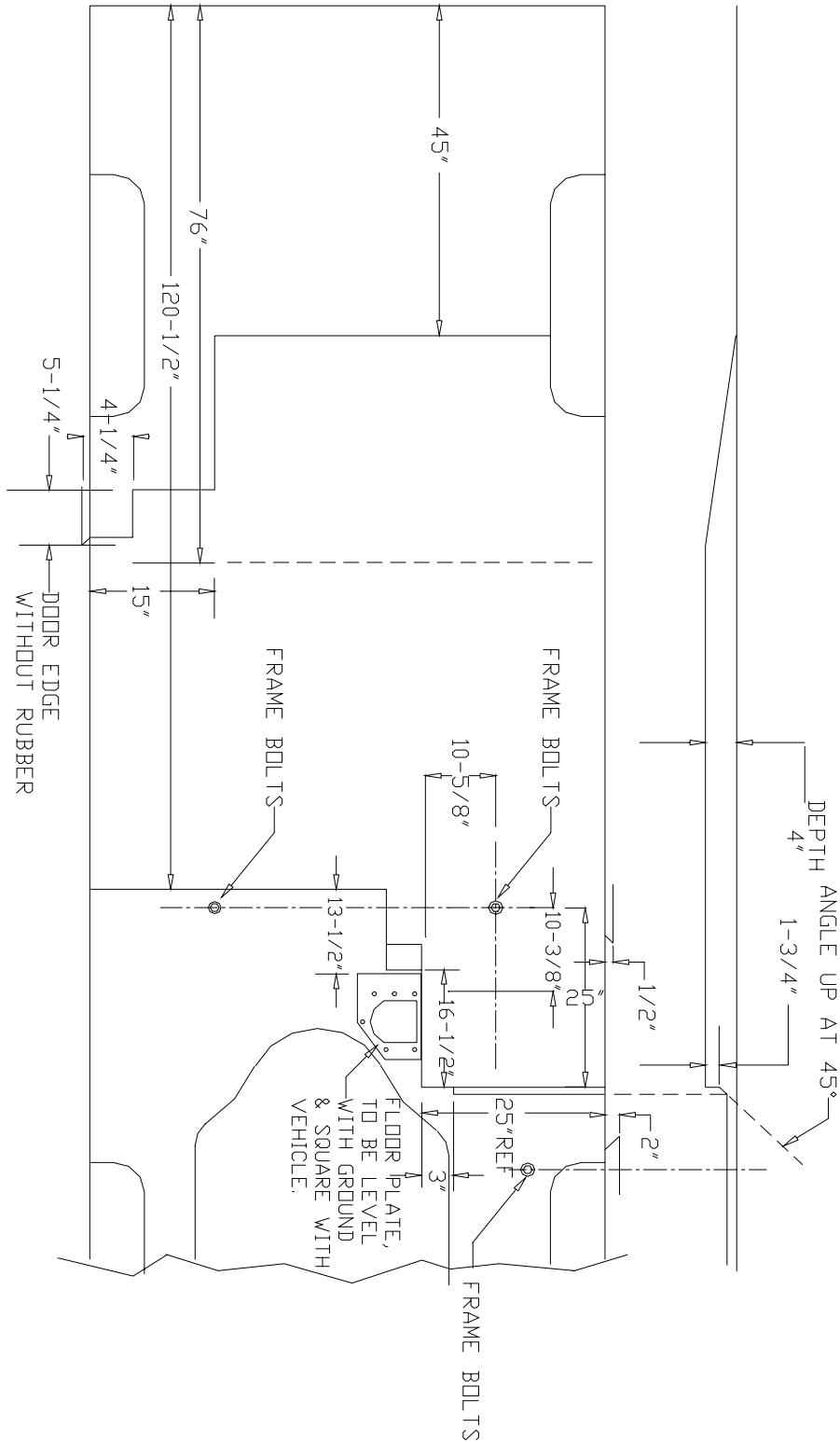
The U-joint shaft should be greased to allow ease of sliding. The center machine screw retains the gib in its correct position. The two outside socket set screws have dog point ends, which fit into recesses in the brass gib. The center screw should be loosened slightly and the outside screws should be tightened evenly to bring the gib closer to the corner of the 7/16 u-joint shaft. The tightness of this slip fit should be tested for rotational play and the ease of linear slide. If the situation doesn't require further adjustment, tighten the gib until it barely moves. When the desired fit is achieved, tighten the center screw and recheck adjustment. It may be necessary to repeat this procedure a few times to get the correct fit.



Appendix F

Floor Layout

FLOOR LAYOUT MODEL NDR-CAL
2005 & LATER VANS 4" FLOOR



- NOTES:
- 1) REFER TO DRAWING LAYOUT FOR DIMENSIONS
 - 2) UNDERCOST IN ALL AREAS EXCEPT: 6" AROUND FLOOR PLATE
 - 3) NO SHARP EDGES UNDER FLOOR OR EXCESS MATERIAL ON JOINED SURFACES
 - 4) POSITION BASE PLATE AS SHOWN FROM FRAME BOLTS, LEVEL TO GROUND AND SQUARE TO THE BODY OF THE VEHICLE
 - 5) LEFT THRESHOLD OF SIDE DOOR TO BE OPEN FOR W/C LIFT AND MODIFIES (FILLED) WHEN VANGATOR LIFT SPECIFIED.

Appendix G

Push Button Box Layout



Driving Systems Floor & Lift Chart

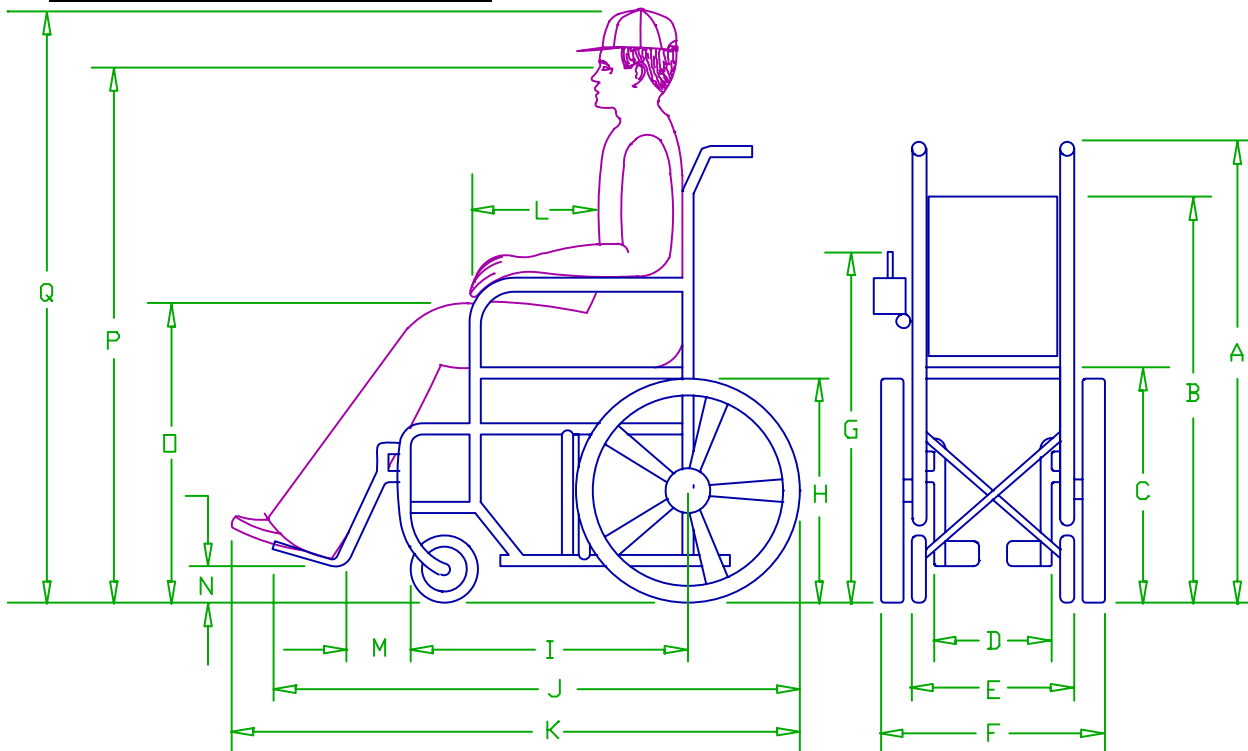
Head Height	Eye Height	Floor Mod.	Lift Height*	Raised Roof
57	53	-6	Tall	Yes
56	52	-6	Tall	Yes
55	51	-6	Tall	Yes
54	50	-6	Tall	Yes
53	49	-6	Tall	Yes
52	48	-4	Std	Yes/No
51	47	-4	Std	Yes/No
50	46	-2	Std	Yes/No
49	45	-2	Std	Yes/No
48	44	0	Std	Yes/No
47	43	0	Std	No
46	42	0	Std	No
45	41	0	Std	No
44	40	0	Std	No
43	39	+2	Std	No
42	38	+2	Std	No
41	37	+2	Std	No

*depends on raised roof

WHEELCHAIR MEASUREMENT SHEET

Client Name _____
 Evaluator Name _____
 Date _____

Wheelchair measurements-van



Wheelchair Mfg. _____ Model _____ Serial # _____
 Removable armrests _____ Removable leg rests _____ Power Recliner _____ Power Foot Rest _____
 Cushion thickness _____ Other _____

- _____ A. Overall wheelchair height
- _____ B. Height of wheelchair back upholstery
- _____ C. Height of seat (floor to top of fabric where it attaches to the wheelchair)
- _____ D. Maximum footrest width
- _____ E. Maximum caster width (including nuts)
- _____ F. Maximum width of rear wheels, including hand rims (measured near ground)
- _____ G. Height of wheelchair control on power wheelchair
- _____ H. Diameter of rear tire
- _____ I. Horizontal distance from front of caster to rear wheel axle
- _____ J. Overall horizontal length from rear edge of rear tire to front edge of foot plate
- _____ K. Overall horizontal length from rear edge of rear tire to toes
- _____ L. Torso to front edge of chair seat (measured at waist)
- _____ M. Distance from rear of footrest to front of caster tire
- _____ N. Minimum footrest height
- _____ O. Top of thigh to ground
- _____ P. Eyes to ground
- _____ Q. Overall height from top of head to ground
(Not shown on diagram)
- _____ R. Widest part of wheelchair and/or client and wheelchair. Where: _____
- _____ S. Lowest height to which client can bend and still functionally operate his/her wheelchair
- _____ T. Lowest height under which client can functionally transfer. Type of transfer _____

Scott System Fitting Procedures

It is best not to under estimate the importance of the van fitting procedure with regards to the safe and successful operation of a Scott Driving System van. There are many complex and interrelated factors that must be considered and dealt with in a certain order so that shop time is effectively used and the severely disabled driver can safely drive for many years without having to return for adjustments.

Driving Systems Inc. has always followed a principle of single site building of Scott Driving System vans. We build our conversions in Van Nuys California and ship completed units all over the country. While some clients come to California for the final fitting procedure, we have also developed a policy of shipping vans to other shops in order to perform the fitting close to the driver's home. Initially we will come to the shop and work with our client and the employee's of the shop to do the fitting. This provides hands on experience for our new associates and a quality, experienced fitting for our client's. Further vans can then be shipped and the shop can do the fitting on their own. Many shops in the disabled mobility business have limited experience with high level driving controls for quadriplegics. Learning by making mistakes can have serious consequences. The relative rarity of high level driving controls works against the accumulation of experience based on repetition. This is the major reason that D.S.I. wants to continue building the Scott System, not ship the parts in a box and hope everything works out.

The fitting, given proper planning, detailed evaluation, and the benefit of D.S.I. experience can be accomplished by most mobility equipment shops. This essay is meant to document the fitting procedure both in detail and in the correct sequence in which these details should be carried out. A check list will be provided to be a work in progress guide while the explanation of the check list items are contained in this essay.

The basic the Scott Driving System is the floor mounted push pull steering column. Scott System drivers cannot use the standard steering wheel because of strength and range of motion issues. In addition it was also a difficult task to get the typical electric wheelchair close enough to the steering column. Charlie Scott had the idea to bring the steering column back to the place where the severely disabled driver could easily reach it. The push – pull throttle - brake idea came from aircraft controls.

Have the client approach the driver's area. If the van is equipped with the mini wheel the driver should be centered with the wheel. The steering column height is adjustable by the $\frac{3}{4}$ " throttle pivot bolt. A $\frac{1}{4}$ " hole will later be drilled to locate the column's permanent position using a column drilling bolt. Temporarily, the column can be held in place by finger tightening the bolt. Generally people do better with the column lower. The mini wheel should just clear the driver's knees. The key to good control by the driver is the best use of the wheelchair armrests. The mini wheel driver will usually use wrist flexion and extension for throttle and brake. Stability while steering is greatly aided by most of the driver's forearm on the armrests. We have often widened or modified armrests for better driving performance. Don't be afraid to start the van to test brake, Throttle and steering performance. Most people have more trouble with throttle than braking. Keep in mind that the column will travel farther than the brake pedal when stopped. This factor can result in the placement of the driver too far from the wheel. If initial testing is done in a static mode a spacer can be placed behind the steering wheel in order to make smaller forward/backwards adjustments. This is sometimes important where the wheelchair can't be moved any farther forward. Right handed 3 post drivers should be as close to the steering column as possible. We often countersink the right hand castor wheel axle bolt on the wheelchair to get it closer to the column. The column height should be about the same height as the wheelchair armrest. The most difficult movement for a right hand 3 post driver is a hard right with throttle. Sometimes changing the column height will help. We have also used longer mount bars on the 3 post assembly which moves the 3 post hand piece closer to

the drivers. In any case, small changes in positioning and column height can make significant improvements in driving performance, particularly with spinal cord drivers.

While the client is still in the driving position it's a good time to look at the secondary electrical controls. The general location of the main push button box is controlled by the length a 5/8" diameter rod that supports the box between two vise bases. The vice bases swivel and rotate allowing the box to be positioned in many different ways. Two smaller brackets will be added later to stabilize the finalized push button box location.

For spinal cord injured drivers the door mounted push button box can also become a mount for switches that will be need to be operated while the vehicle is being driven. Some drivers have or can use a splint or typing stick of orthotic device with which they can push the buttons. A separate box with an extended toggle switch for turn signals is often used. For S.C.I. drivers, mounting the push button box at a shallow flat angle with the turn signal within easy reach at the lower edge of the box. This also works well with the horn and cruise control.

Mini wheel drivers have a steering wheel mounted auxiliary control box for access to driving related secondary electrical control functions. These functions are duplicates of the ones on the main box. Ordinarily they would operate by the driver's thumb. Miniature toggle switches can be added to the sides of the box. Many of these types of details can only be determined at the time of fitting through observation of the client's abilities.

Once these tasks are identified and the client is in the correct location, it's time to consider the positioning and installation of the tie-down. D.S.I. uses two types of tie-downs. A tie-down manufactured by D.S.I., which is available only on Scott Driving System conversions, and the widely available E-Z Lock tie-down.

First the discussion should probably focus on those tie-down related items that both tie-down systems have in common. Two items bear on the tie-down issue that we have solutions for. We have for years fabricated tracks that trap the front right wheelchair wheel insuring that the wheelchair is locked in the same spot every time. Given the narrowed floor lowering in the driver's station and the importance of consistent driver location, this is critical. The track is two sided only in the front 13". The left side of the track is 27" long. Going into the driver's area the right side front tire can contact this longer track section aiding the client in entering the driver's area straight. The left side front tire rests on a castor plate tilted slightly to the outside of the van. As the driver exits the tie-down, by steering consistently towards the 5 o'clock position the left front wheel aided by the tilted castor plate, castors first while the right front tire stays trapped against the track. This technique prevents both tires from castering at the same time and trapping the wheelchair in the lowered floor area.

The E-Z Lock tie-down is the most widely used power tie-down in use by independent wheelchair drivers. It is a very flexible system that due to it's many chair mounted bars, fits a wide number of different wheelchairs. The floor mounted locking unit is standard while each chair has a different style of bar. There are only two different short comings we have encountered with a deeper channeled floor, common on Scott System vans, it must be mounted on the channel and can therefor presents a barrier to the wheelchair with low ground clearance. Secondly the E-Z Lock has a small amount of play when the chair is locked in. This play has an effect on driving performance on a very tight sensitive system. The effect of this fore and aft movement is to make throttle and braking less smooth, although it can be compensated for to a certain extent.

The Scott System Tie-down that we have been using for many years is a hook mechanism that traps a wheelchair mounted bar. Almost every installation of this hook tie-down is to some extent, custom. Once built, installed and adjusted, it is a very flexible, strong and reliable system.

Given the huge variety of wheelchair configurations, it's not that surprising that the tie-down can become an important issue. As far as the base unit is concerned there are two types of floor mounts. The "H" style has four 1/2" studs bolted through he floor holding the tie-down. It is used on floors that are 4" or less in depth, or when footrest clearance is not a problem. The "H" style tie-down has an advantage in that the studs are placed in the center of the slot, 1 1/2" forward or rearward making adjustment possible. In addition the stud system allows up and down adjustment to compensate for wheelchair tire ware (or new tires) without crawling under the van or removing the

tie-down. The overall height of the "H" style tie-down can also be modified by cutting the upright and making it either longer or shorter. This a welding process.

Deeper channeled floors that are needed for taller individuals cause problems with the "H" style tie-down. Low footrests would interfere with the tie-down when the front tires go through the lower part of the floor. The deep floor tie-down considerably narrows the floor profile for much better footrest clearance. As with our usual practice we always narrow the footrests by cutting about 1 ¼" from the inside (between) of both footrests to provide more space to clear the tie-down upright. The upright hook assembly in the deep floor tie-down is a separate part, which allows front to back adjustment. The shear bolts that hold the upright to the base are evenly spaced at 1 ¼" increments. The holes in the upright are oversized and slotted allowing a small amount of up and down adjustment.

Most of the burden of the increase in wheelchair frame variety has fallen on the fabrication of the Scott System wheelchair tie-down bar. Originally, we used a simple straight bar that clamped on the lower bar of a typical E&J wheelchair. The height of the "H" style is based on this type of frame. New wheelchair frames are usually higher from the ground, are not parallel to the ground and don't usually lend themselves to a simple clamp on attachment method. We have been building chair bars that are u-shaped, dropping the center locking section of the bar about 6" from the floor. The 1" x 2" locking portion of the chair bar works best when it is parallel to the floor and tie-down hook. So when fabricating to a frame that isn't parallel to the floor, we can compensate for that.

Attaching the chair bar is something that has been a continuing challenge. On some chairs with rounded or round tubing we can still use our original clamp method. On large steel rectangular frames like Invacare Ranger, we drill and bolt through horizontally. On smaller rectangular frames we clamp over the frame. The usual materials for wheelchair cross bar construction are 1" X 2" hot rolled channel and ¼" x 2" cold rolled bar stock. Many applications also have side braces to stiffen the dropped center chair bar against another part of the frame. When the bar must be located far forward of the center of gravity of the wheelchair, we install a passive bar or hook system to hold the rear of the chair from leaving the floor. Over all our goal is to remove as much of the movement between floor, tie-down and the wheelchair as possible. Even wheelchairs with active spring shock absorbing suspensions can be held securely so that suspension movement does not effect the ability of the driver to control the van in a smooth fashion.

The final topic in this discussion of van fitting procedures is modifications to the wheelchair itself. There are a few common changes that we routinely make in order that the wheelchair doesn't interfere with the driving controls and vice versa.

Lap and torso restraint belts are always added to the wheelchair. Most belts supplied with wheelchairs are poorly mounted with a single sheet metal screw. We use either professionally sewn loops that slip over the backrest tubes or retain the steel belt ends bolted to the chair. Upper belts are very important to driving tasks, particularly for spinal cord drivers. Spinal cord injury drivers often have seat backs that are too low to provide good torso stability. The torso belt should be mounted as high as possible. Specially made upper belts made by IMEC can greatly improve driving performance by limiting side to side torso movement during turns. A effective upper torso belt along with the right side armrest and left side door post pad will work very well to stabilize a spinal cord injured driver.

Right hand 3 post drivers often need to have modifications made to the right side of their wheelchair. Left turn/brake movements cause the driving control to interfere with the wheelchair control box and armrest. D.S.I. does a combination modification to the control box armrest. We have a device that allows the control box to be moved forward and down out of the path of the steering control. Together with a notch offsetting the armrest pad to the rear, the modification is complete.

One fact involving a fitting is that every step made in the shop must be verified on the road. There is no way to simulate what happens while driving in the shop. Once the driver is secured we often go on multiple test drives in order to check each change as it is made. Positioning, column adjustment, upper body stability, driver sight lines, mirror positioning, panic braking are the most important items that are resolved through the test drive process.

The last part of the fitting procedure involves checking through the detailed check list. Balancing the steering column can be done at this time as well as drilling the 3 post and wheel for center. D.S.I. is very experienced in preparing vehicles from prescriptions and shipping them to remote locations for fitting. We are interested in making the fitting procedure as simple and comprehensive as possible for the local mobility provider. The more information that can be provided by us, the easier servicing the Scott System van will be.