Microlight Trike Edge-X 582

Hand Control Equipment & Modifications

The following information details the hand control equipment and other minor modifications that have been undertaken to allow a quadriplegic to independently and safely control an Airborne Microlight Trike aircraft in the air and on the ground. The new equipment items are not structural components and no additional boltholes or welding to the structure has been undertaken to the aircraft. All new equipment either utilises the existing bolting positions or uses appropriate clamps for fastening into position without damage to the members.

The main elements of the new hand control equipment include hand steering of the front nose wheel, a base bar adaptation (control bar) allowing the user to fasten their hands/wrists for control of the wing and throttle control via electric push button system. Other minor modifications include a moulded seat for additional support, the foot brake converted to a hand lever and the reorientation of the On/Off switches.

Hand Steering of the front nose wheel

The hand control for the front nose wheel utilises the same principal as the steering for the rear seat passenger via the use of a connection rod from the hand lever (in lieu of a rear steering bar), to the front fork. A push-pull action is used to rotate the wheel into the desired turn, push forward for left and pull back for a right turn.

During take-off and landing it is not necessary to continually steer as the trike tracks straight due to the castered steering design. This allows the pilots hand to be removed for the hand fork allowing both hands to be placed on the Control Bar.

The hand steering mechanism consists of three main components, these being the hand fork, steering lever and clamp, and steering connection rod.

The hand fork allows me to slide my hand in between the two posts, and by twisting my wrist to add pressure to the posts, it locks my hand in place allowing me to push and pull the lever. Once the pressure has been released the hand can be removed easily and quickly.

Figure 1 – Hand Steering Lever for Front Nose Wheel

Figure 2 – Hand Fork

The steering lever and clamp consists of two components, the clamp housing and lever arm. The lever arm is made from steel, with the bracket consisting of aluminium. The bracket clamps to the rear footrest with four bolts holding it in position.

Figure 3 – Hand Steering Lever and Clamp Arrangement

The steering rod is bolted to the bottom of the lever arm, running to the front forks and connects to the existing connection point for the original rear steering rod.

Figure 4 – Steering Rod & Fork Connection Point

A self-centring mechanism has been installed to assist with centring the front wheel. The spring in the mechanism is fairly light therefore it mainly provides centring of the wheel after take off ensuring the wheel is straight for landing. The mechanism connects to the existing connection rod position and the existing bolt for attachment of the rear steering bar. The existing steering dampener has not been removed and remains functional.

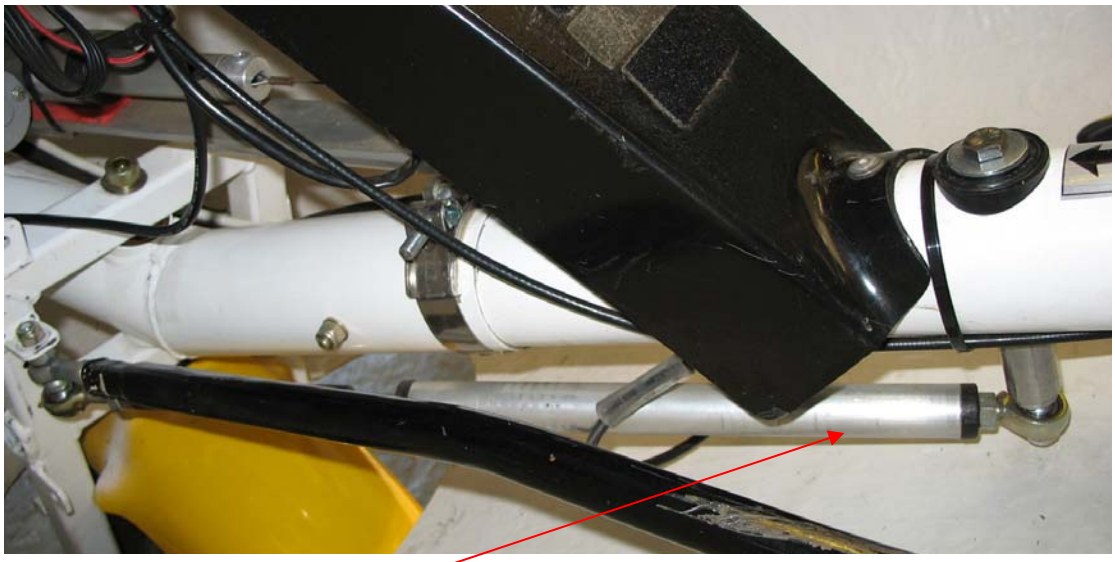

Figure 5 – Self Centring Mechanism

Control Bar Adaptation

Being quadriplegic with no finger function, the main issue is not being able to grip the base bar with my hands. An adaptation to allow the hands/wrists to be locked in place while being able to remove them easily and quickly was necessary for control of the wing in flight, this being the Control Bar.

Control Bar with hand in position

Figure 6 – Control Bar on Trike Base Bar

The Control Bar is constructed from aluminium, being 25x25mm square hollow section, 25mm diameter circular hollow section, 3mm plate and aluminium bar for the mounting clamps. All members have been fully welded.

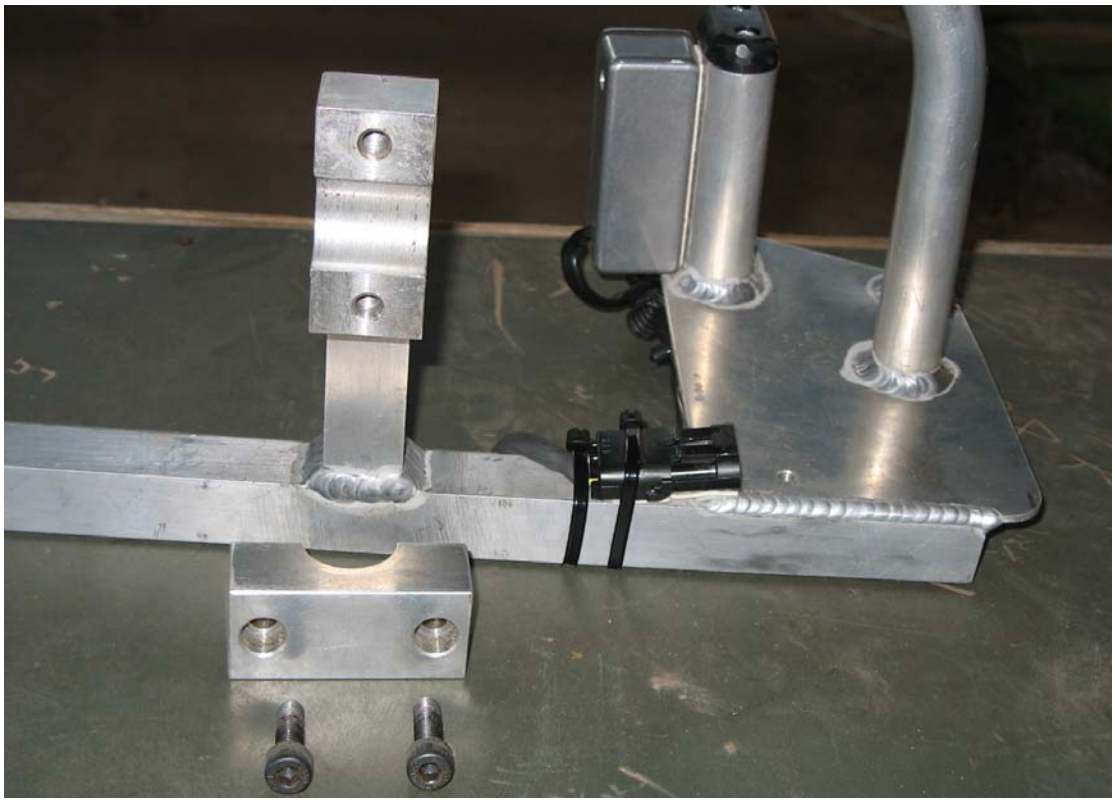

Figure 7 – Control Bar Clamp Arrangement

Figure 8 – Control Bar Clamp Arrangement

The Control Bar is clamped directly onto the base bar via the two clamps. Each clamp has been machined to precisely fit the diameter of the base bar tubing. Each clamp has two bolts, one top and bottom to secure it to the base bar.

Figure 9 – Control Bar Clamped to Base Bar

The hand supports consist of three upright posts. The wrist is supported between the two end posts with the hand and fingers wrapping around the long centre post. The wrist is then held in an extended position, which securely locks the hand in place. The hands can be removed easily and quickly by sliding them out.

Figure 10 – Control Bar Hand Supports

Throttle Control

The throttle control was an extremely important aspect of the modifications to ensure that the throttling could be achieved with ease, reliably and most importantly safely.

Following attempts to retain a mechanical throttling system to simulate the existing arrangement, it was not possible for me to operate a mechanical lever type throttle without taking one hand off the control bar, and being able to adjust it quickly and accurately was very difficult. Therefore for ease, reliability and safety I developed a motorised system with push buttons for throttle control, that would be extremely easy to use allowing quick adjustments of the throttle from small increments to large, and also allowing operation of the throttle while retaining both hands on the control bar.

In addition to the motorised arrangement the existing cruise throttle is retained as a backup, which I can use if necessary.

Operation

The operation of the new throttle utilises the same principal as the original arrangement, which is achieved by pulling and retracting the foot throttle cable. The motorised system only replaces the foot pedal arrangement.

An electric linear actuator has been mounted under the dash and clamped to the keel using two adjustable pipe clamps. The mounting bracket is constructed from aluminium angle with all components bolted.

The linear actuator has a stroke of 50mm, with a travel speed of 8mm/s. Although the throttling does not require the full 50mm stroke, to go from idle to full throttle is approximately 3 seconds.

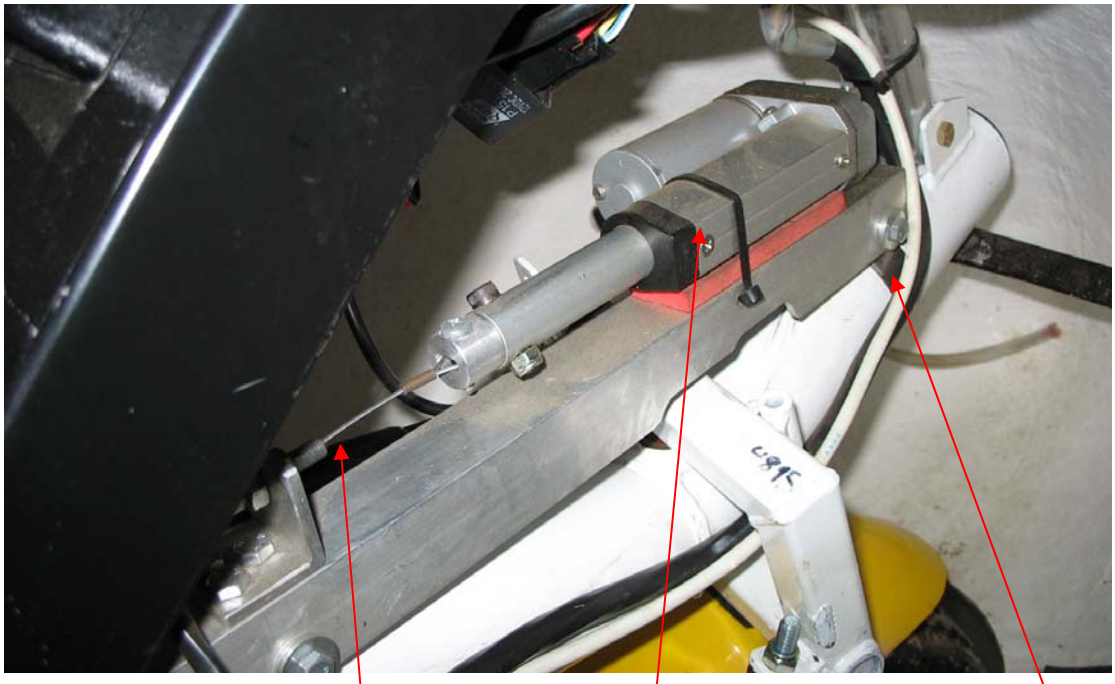

Figure 11 – Electric Linear Actuator Throttle Arrangement

The motorised system has been wired into the electrical system on the master switch side, therefore it will not operate if the master switch is not on.

The control of the throttle/actuator is achieved by the uses of two push buttons positioned on the control bar centre posts. The Red one on the left side throttles down and the Green one on the right throttles up the engine. The positioning of these push buttons allows me to keep my wrists and hands in position, while pressing the switches (throttling up and down), maintaining full control of the wing at all times. The switches are IP65 Rated therefore wet conditions are not an issue and they are suitable for extreme temperatures.

Small adjustments of the throttling can be achieved by quick clicks of the pushbuttons or depress it for longer greater throttle adjustment.

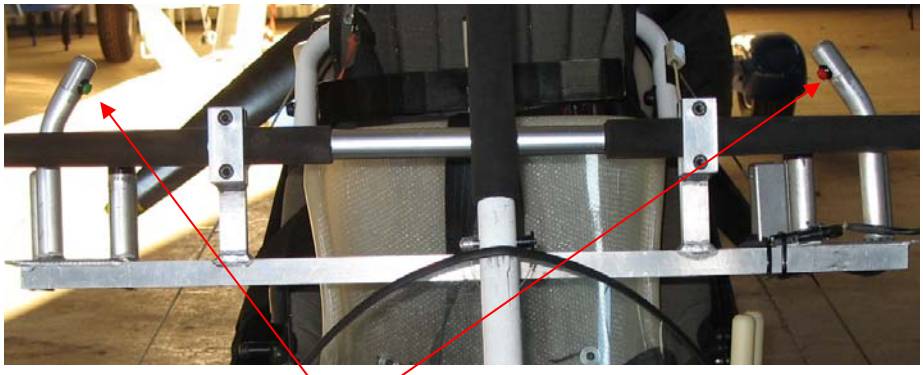

Figure 12 – Throttle Control Push Buttons

As a safety measure a secondary throttle control has been included in case one of the push buttons fails. The control is a joystick located on the left hand side of the Control Bar. It also provides an easily accessible throttling control while taxing on the ground.

Figure 13 – Secondary/Backup throttle Control

Operational Safety

As part of the pre-start-up checks the correct operation of the actuator is verified by testing the primary and secondary control.

Prior to starting the engine, confirmation that the actuator is in the throttled down position, as with the cruise throttle, is undertaken.

Similarly, as with the original foot throttle arrangement, if the actuator stopped working and was in a throttled up position (same as if the foot throttle jammed in the throttled up position) the same emergency shutdown procedures would be undertaken.

In addition, if the actuator stopped working (in the throttled down position), the existing cruise throttle can be used as a backup in flight.

Brake

The existing foot brake has been converted to a hand lever operated brake. The existing cable was extended to a lever mounted on the right hand side of the seat. The brake lever is constructed from steel and attached to the frame utilising the two existing bolts that support the hinge bracket and On/Off switch mounting plate. By pushing the lever forward the brake is operated.

Figure 14 – Brake

On/Off Switches

The existing On/Off switches were extremely difficult to use without finger function due to the switches being recessed inside a “U” bracket. The bracket was replaced with a mounting plate that was open on the side allowing clear access to operate the switches. The direction of the switches was reversed to allow easier operation for turning them off. To ensure that the switches could not be accidentally operated switch covers are installed.

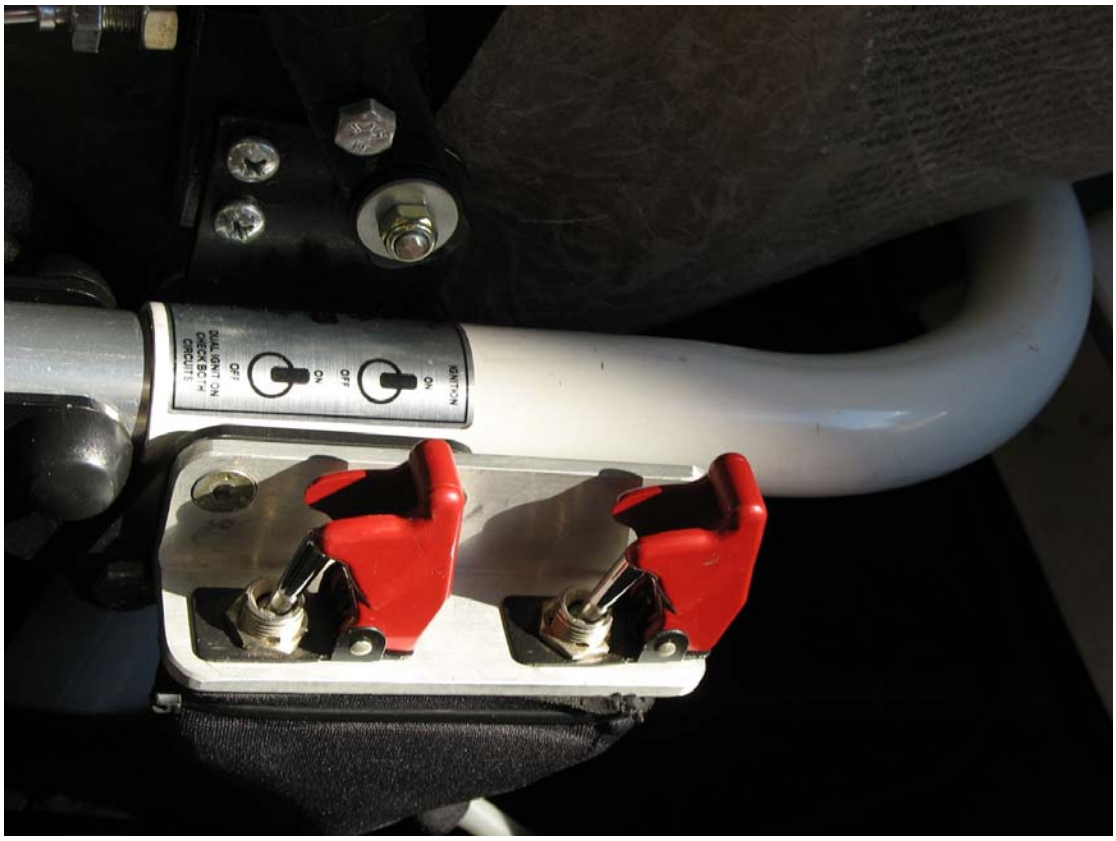

Figure 15 – On/Off Switches (shown in OFF position)

Front Seat

The existing front seat was replaced with a fibreglass racing go-cart seat for lateral stability. The seat attaches to the frame using plastic Stauff clamps, which provides rotation when folding the trike down to detach/attach the wing. The back of the seat clamps to the existing backrest support.

A four-point harness has also been fitted to provide better forward support.

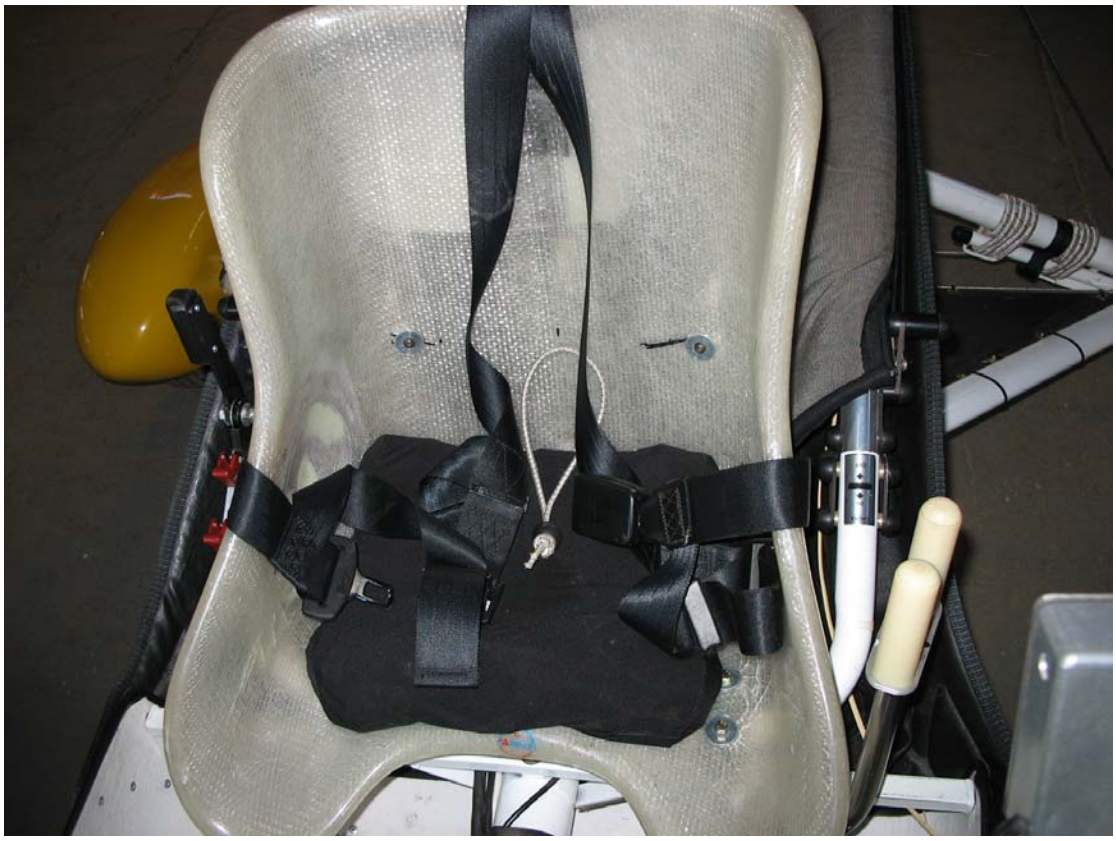

Figure 16 – Front Seat