**Optimal Design Project: Adaptive Skiing Device**

**Introduction**

The main purpose of this device is to provide support and enjoyment for children with difficulty coordinating movement and supporting their own bodies. The device allows the user to enjoy and experience the feeling of skiing, and at the same time, being secured when standing on the ski. This device does not target handicapped people since it still require the users to stand and hold on to the devices for minimum support. The device includes a back support, arm-resting part, and a full-body safety harness that provide support.

Aluminum will be used to create the frame for the back support. Different sized aluminum tubes will be welded together to create the back support with a cushion added for comfort. Arm rests will be added with aluminum tubing between the arm rests and the back support. To connect the tubes of the structure to the ski, the pivot mounting feet will be used for better connectivity; one side connects to the tubes and the other connects to the ski.

The optimal design was chosen from our alternative design two since it matches the client’s expectations of being simply and not bulky.
3.1 Components

Three major components are going to be added to this device; the back support, arm rest and mounting feet. These components will be explained and they are also pictured below.

![Figure 3.2: A) Back Support. B) Arm Rests. C) Mounting Feet](image)

3.1.1 Back Support

The back support consists of several horizontal bars that provides nearly flat surface. Cushion can be attached and tied onto the horizontal bars for better comfort. The safety harness can also be attached to the horizontal bars for security. As for the material used for the back support, we found that aluminum is easy to weld and strong while still being light weight.

![Figure 3.3: Close up look at the back support](image)
3.1.2 Arm Rests

The arm rests are essential for the skiing device because they provide support and balance to Elysa. The arm rests are shown in figures 4 and 5. While riding on the device, Elysa can put her arm comfortably in the U-shaped arm rests that are inserted with comfort foam. This way, Elysa can easily balance herself on the ski. Rubber grips or grip tape will be wrapped around the handle bar in order for her to have a better grasp. There will be two aluminum tubes welded to the bottom of the arm rest, and will be adjusted to Elysa’s arms position. Also, between the tubes of the arm rests and side bars of the back support, a horizontal bar will be welded to connect each arm rest tube and side bar for better stability of the whole structure.

Figure 3.4: Illustration of one of the arm rests.

Figure 3.5: The actual arm rest that will be used for our design
3.1.3 Mounting feet

In order to connect the ski and the aluminum steel tubes, perforated base studs (Figure 6) and tube adapters (Figure 7) are needed. Tube adapters have threaded holes, which can be screwed onto the perforated base studs that consists of threaded rods and connect the tubes and ski together. Tube adapters with the suitable size can be inserted to one end of the hollow tube. The perforated base studs can be fixed on the ski by using screws and adhesive. Four perforated base studs and tube adapters will be needed.

Figure 3.6: Perforated base stud    Figure 3.7: Tube adapter (round)

3.1.4 Harness

The model we will use for a harness is the Trango Junior Kids Rock Climbing Full Body Harness. The harness will be attached to the back cushion and back support. The harness will be adjusted to her appropriate height and keeps her steady in standing position.

Figure 3.8: Trango Junior Kids Rock Climbing Full Body Harness
3.2 Realistic Constraints

Since we are designing skiing devices for people with disabilities, there are many constraints that have to be addressed in order for them to operate the device properly and safely under any circumstances.

The skiing device must be made to be as simple as possible and not bulky, the device should not have any unnecessary parts to it. The device should be light-weighted and easily portable. The arm rests design and the cushion for back support should be ergonomically that can properly position Elysa’s stance when using the device.

The design itself should be affordable to anyone. There are many commercial products in the markets but they are all pretty expensive. Our goal is to design the similar device compared to the commercial products but more specific for Elysa’s situation, while the price is low enough that if other family with the similar situation can also afford to buy it.

Sustainability is important since we want the design to be used by Elysa frequently until she is able to voluntarily control her movement. Therefore, it is important to decide which material should be used for the design. We are using 4130 chrome moly steel, which exhibits high wear resistance, high mechanical strength, light weight, water and cold resistance, and high weldability. 4130 chrome moly steel has been used for an assistive skiing device made by Freedom Factory, thus it is also suitable for our design. With this material, the sustainability of the device can be greatly increased.

Since the design is built specifically for Elysa, it can only be used by her or people that are her size. The device is not suitable for adults. Another constraint is that the device is designed to operate on only small inclination because Elysa’s parents want her to step outside and have fun in the snow. Since she cannot control her movement, she is not able control the regular ski with her legs. Therefore her parents will be side by side with her when she is on the device. After using the device for a fair amount of time, she should be able to stand with the proper stance and her leg muscle should be more strengthen.

3.3 Safety Issues

The material, 4130 chrome moly steel, shows great mechanical properties and thermal properties, and therefore it is suitable for our assistive skiing device. Since our design will be operated in winter on the snow, material with good corrosion resistance and wear resistance are important, so the device will not be worn out or collapsed if it is properly operated. To avoid Elysa from falling off the skiing device, the full body safety harness will have to be fully secured and able to tightly keep her in place while the skiing is moving.