03-04-2022
Engineering Project Report

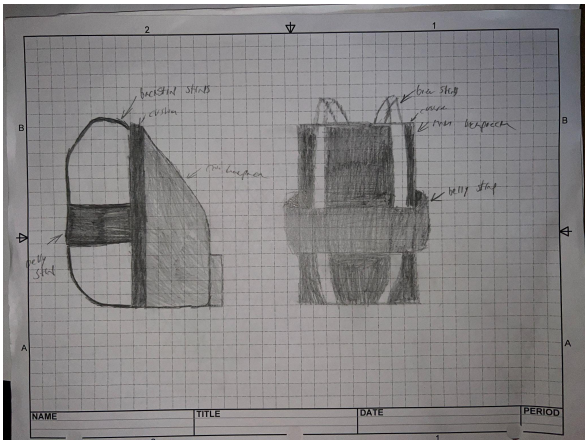
Abstract + Problem statement:

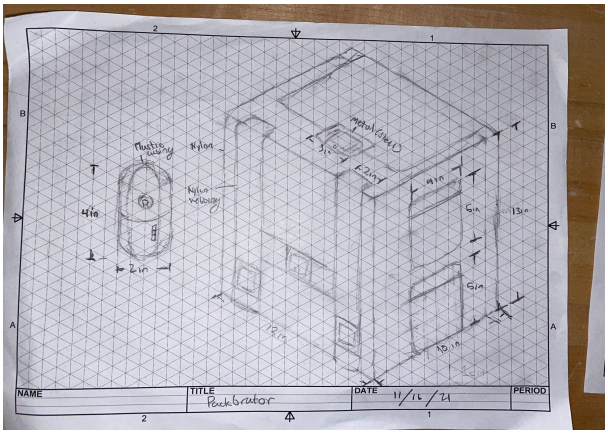
According to a study published by Midline in 2017 adolescents between the ages of 12 and 18 in the United States of America experienced back pain with many attributing the pain (midline.org). to the weight of their backpacks. They experience higher levels of overall lower back pain, which the study notes can result in decrease of determination and stamina for school.

Possible Solutions:

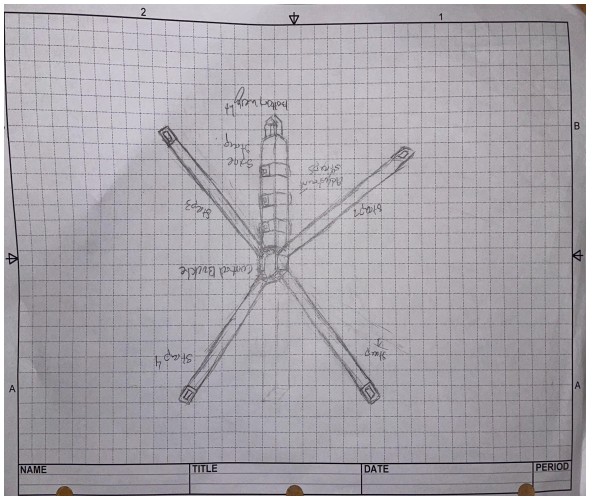
To solve the problem it was decided to create something that would be simple and require the least amount of effort or discomfort to the user, easy to apply and take off. After researching back alignment devices it was observed most solutions fall in the line of surgery, braces and massages. For our inspiration we mainly took note of the bag and massages.

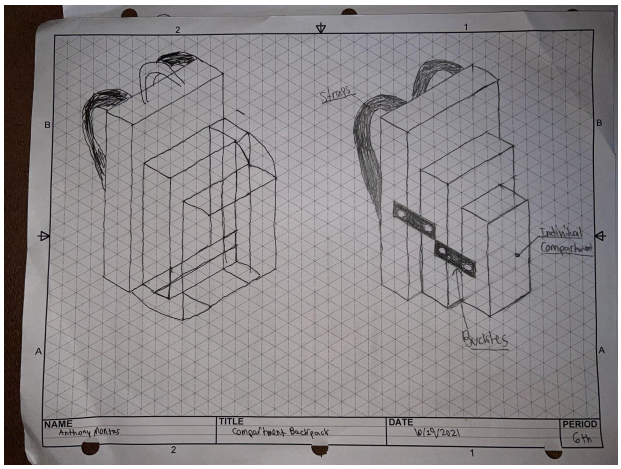
We considered that back braces that were common for tasks such as back straightening could take the place of backpack straps. This could keep the back straight and reduce the drag of the bag. Massaging components could be built into the bag to relieve already existing pain as well. You could also make multiple bag components that could attach or detach to allow the user to alleviate weight by allowing the user to shift the weight and carry parts. Lastly the positioning that the backpack was carried was taken into consideration.





A backpack with added strap support and back padding is diagrammed on the right. The straps would allow a more snug hold to the user and reduce the heavy weight on the shoulder by distributing weight throughout the torso. Another variation depicts a square design to the bag but with a massaging addition instead of padding. The device giving out a massage would provide a hastened relief once pain was present.





Attention was also given to considering a separate back support device that would run along the spine and forcefully keep it aligned. While a more simple idea was to prioritize customization of the bag through the use of compartments.

It was decided to adapt the common backpack into something that feels light under heavy weight, can be customized by the user and reduce muscle tension in the shoulders and back. So we combined the multiple attached compartments design to a base that would act as a massager as our final project.

Procedure:

Our procedure consists of separate tests on our criteria, these being carrying capacity, maximum weight, and vibrational functionality tests. The tests were conducted in three trials each on both experimental modified bag, as well as a non-modified commercial control bag. The experimental odified bag was crafted from a discarded commercial bag, reassembled to feature internal detachable “mini-bags”. A separate vibrational “pill” was also constructed as another back support feature, to be stored in a separate compartment in the bag. These features were included in theory that they would help aid back support for students. The comparable control bag possesses none of these features.

As stated earlier, the tests correspond to the criteria, being, maximum weight, carrying capacity and vibrational functionality. The first test, weight, was conducted by putting various size weights totaling 30 lbs into the main and “mini-bags” separately. The bag was then held 3 feet in the air and checked for any seam breaking or other abnormalities. This test duration was 3 minutes and was repeated 6 times, 3 for the experimental and 3 for the control. The experiment bag would “pass” the trial if it could hold the weight for the total of 3 minutes with no seam breakage or other anomalies.

The second test, carrying capacity, was conducted by filling the bag with various large objects, not necessarily ones that are heavy, but large in volume. The bag was then held in the air and checked for any seam breakage. The test duration was three minutes and was repeated 6 times, 3 for experimental, 3 for control. The experiment bag would “pass” if the bag could hold the volume with no seam breakage for the entire duration of the three minutes.

The third and final test, vibrational functionality, was conducted by putting the built vibrational massaging device into the built-in holder in the experimental bag and turning the device on. The bag would then be closed and the vibrational device would be tested for a visible and physical sense of vibration through observation and physical touch. This test will occur for 5 minutes and repeat 6 times, 3 for both the experiment and control bag. The experiment bag would “pass” if the vibrations can be physically seen and felt through the bag fabric without turning off for the entire 5 minute duration.

Materials:

Below are the materials used to create the backpack and vibrator prototype.

- Buckles
- Control bag (Unmodified)
- Electrical motors
- Fabric for creation and repair of modified bags
- Plastic casing
- Testing dummy
- Weights (30lbs worth)
- Wires
- Pool Noodle

Results:

Trial 1		
	Modified Bag	**Control Bag**
Carrying Capacity	Main bag: 16 lbs Mini Bag 1: 16 lbs Mini Bag 2: 12 lbs	Was able to hold at least 30 lbs
Sturdiness	None of the bags were able to hold 30 lbs	Was able to hold at least 30 pounds without breaking
Functionality	Successful (Visible and and physically felt shaking for 5 minutes)	Successful (Visible and and physically felt shaking for 5 minutes)

Trial 2		
	Modified Bag	**Control Bag**
Carrying Capacity	Main bag(1 strap)= 18lbs before stress snap	N/A
Sturdiness	Main bag was not able to hold 30 lbs	N/A
Functionality	Successful (Visible and and physically felt shaking for 5 minutes)	N/A

Trial 3		
	Modified Bag	**Control Bag**
Carrying Capacity	Main bag was not able to hold 30 lbs	N/A
Sturdiness	Main bag was not able to hold at least 30 lbs	N/A
Functionality	Successful (Visible and and physically felt shaking for 5 minutes)	N/A

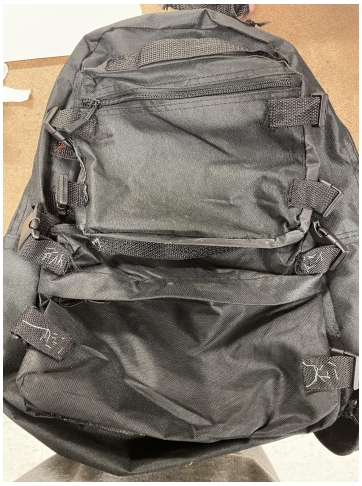
Photos:

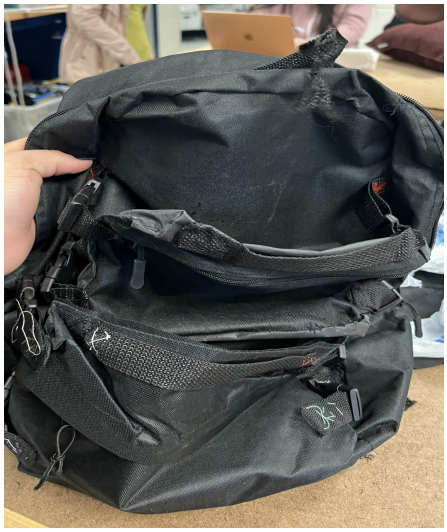
Below are images of the bag as it endured the process of being created. After approximately 5 weeks of sewing and hot glue we were finally complete with our finalized backpack. We also created the vibrational component with a pool noodle, motor, and wiring and completed that within a week. The images are in chronological order going from the first pouches being created all the way to the final creation.

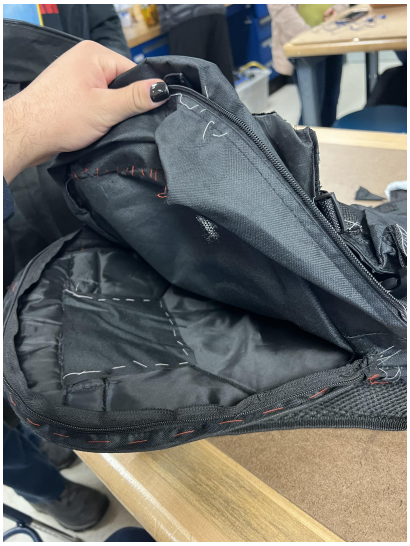
Figure 1: Front view

Figure 2: Inside view

Figure 3: Side pouches







Conclusion:

Our results were somewhat mixed in the assessment of our experimental bag design. Out of the three criteria, functionality, weight, and carrying capacity, our only bag consistently passed one, which was vibrational functionality. It was only able to partially withstand the 30lb weight that was required and was met by our control bag. Additionally, the experimental bag failed to withstand the carrying capacity requirement of 6 standard size textbooks, which again, the control bag also met. A way in which we could have done our experimentation better would have been using a better means for calculating and obtaining wait samples than using textbooks. Another thing that could have been done differently that could have possibly improved our results would have been to do a tad bit more stitching to ensure the components were as tightly attached as possible. If we were to continue this experiment in the future one thing we would most likely do is create another vibrational component, just so we could have more than one vibrator.

Works Cited

"Back Pain." MedlinePlus, U.S. National Library of Medicine, 15 Mar. 2022, https://medlineplus.gov/backpain.html.