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Student Responses to the Ethical Twist

The project involved building a machine that can lift a 1-kilogram mass at least 7 inches vertically. It was the culminating project for students to show that they understand how to design and calculate mechanical advantage in a useful machine. Their task was not only to implement five simple machines in their design, but also to have the mechanical advantage of the machine be between 5 and 15 after accounting for all the mechanisms.

Student groups of four brainstormed and selected an initial design to pursue. During the first day of their build, they were asked to draw one Ethical Twist card. Similar to a "twist" in a cooking show on the Food Network, this card required them to modify their design to accommodate a special circumstance posed by nature or their end user.

The following are reflections from students regarding their group's approach:

> Our ethical twist was that we had to make sure we had little to no environmental impact while building our machine and the materials we used for it. To address this we used steel in our simple machines, which we bought from the SSAB America's EcoSmart project where they make recyclable steel from scrap metal. This steel production results in 66% fewer Co2 emissions, and an overall 25% less energy consumption. Additionally, we used plastic in our pulleys and gears from the Hemp Plastic Company which makes it their mission to mass produce plastic using alternative energy resources. This results in an estimated 75% drop in carbon footprint. Lastly, we used Eco Friendly rubber to tighten everything up, made from recycled materials. This reduces CO2 emissions by 323 pounds.

> Our ethical twist was "visual impairment." The twist card told us to make our machine more friendly for those hard of sight / blind. In order to address this issue, we added lots of signage to our design. The physical design itself was relatively compact with dividers throughout, making the simple machine separation points obvious. The convenient location at the back of the base plate also allowed us to put text + braille on the front of the plate for those who are potentially blind but still want to learn about our machine. To finish our approach to our ethical twist, our input was a simple, isolated wheel which was very obviously marked as our input by a bright red arrow pointing to its location. This separation from the rest of our machine made it stand out much more, making it a lot easier to spot and understand its purpose.

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Our ethical twist was that we were building our machine in the Texan Gulf Coast, which was prone to many types of hurricanes or storms. We solved the problem of fast wind and rain impacting our design by making it very flexible, but also strong. We made it flexible, and not rigid so it could move a little in response to the severe winds, and we held the individual parts together with many screws. In short, the parts could move around, but their range of motion is limited by the screws making sure that they don't move too far (to the point at which they will fly off.)

Our team's Ethical Twist was that a wheelchair bound person would be operating our machine, we addressed this by lowering our crank from the mid section of our back C-channel, to the bottom closer to the metal plate, this way the wheelchair operator would be able to reach the crank and operate the Machine with no problem.

Our team's ethical twist was that the person had limited vision. We addressed it by having a large wheel to turn the pulley, compared to something small like a metal axle that might be hard to find at the start. We also included a bright green label that indicates when the load has reached the required height, so that they know when to stop working the machine. Lastly, we added signs in braille that read out the steps to use the machine if needed as well.

Our teams Ethical Twist was that we had to make it safe for children, we addressed it multiple ways. First, we went from a flat, unstable, sharp ramp to a ramp with guard rails attached to it. We also added a sign to make sure that kids don't touch the machine. We made the machine in a way that you have to turn it slow and it falls relatively slow in case. We also added many reinforcements to the structure to make the entire machine much more stable. These improvements helped keep the children safe around the machine, we changed our gears from sharp gears to more dull gears, using sprockets and chains. We then also added less flat and sharp objects but more objects with rails. Lastly we made it taller so the lever isn't where kids can accidentally touch it.

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The ethical twist that we had for our project was that we had our machine set up in the forest where we would have to take environmental factors into our machine. The things that we did to handle this is that we made it so that our machine could be constructed and deconstructed quickly, and so that it fit only within our borders so that we did not encroach on the environment.

Our ethical twist was that the area often experiences severe and flash flooding. With this info, we made sure to raise everything higher to ensure nothing could get water damaged from flooding. Additionally we added a cage on one side to protect whatever it is we are lifting from the elements and the water damage. Finally we added floats filled with buoyant foam so if the flooding was severe enough, our machine would be able to keep above water and away from damage.

Our team's ethical twist was that we had to use environmentally safe materials instead of plastic because it could hurt farmers and animals. We made sure to choose parts that were safe and wouldn't cause harm to nature. For example, we looked for materials that were reusable or made from safe substances instead of plastic. This helped our project be better for the environment and everyone involved.

Our teams ethical twist was the construction workers that were using our machine had small kids on the site and our challenge was how we were able to make our machine child safe. We first replaced our flat ramp with a ramp with railings so if the weight moves there is a guard protecting it from falling on the kids. We also made a sign and hung it onto our machine that warned kids not to go near it for there safety. Incase the children were too young to read the sign we added pictures to help them understand. We also added extra screws and tools to ensure that our machine was stable and doesn't pose any harm.

Our groups ethical twist was having our machine being able to survival and support itself through a hurricane. To address this issue we first haded multiple and much more stronger pillars (holding our machines together) which we connecting with multiple tighten brackets on the baseplate. Then we added supports from our gear box to the lever so that our whole machine was connected and everything was strongly connected. Finally we raised the baseplate so that our machine could better absorb shock and any movement it may encounter.

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Our team's ethical twist was that a small child would have to be able to use our machine safely. We addressed this by designing it with a simple hand crank that was easy to turn without needing much strength. For example, we made sure the crank was at a height a child could reach and kept the motion smooth so it wouldn't be tiring. We also made sure the machine had no sharp edges or dangerous parts that could hurt someone. By focusing on safety and simplicity, we created a design that a child could use without problems.