Teachers Without Borders Design Proposal

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WHY DO WE CARE ABOUT THIS PROJECT?

We want to revolutionize the education system by bringing the classroom to life and create a world where learning knows no bounds! Because of this, we are teaming up with Teachers Without Borders in order to provide a way to make education easily accessible. By helping with this project, it allows us as students to help solve the ongoing problem with education in remote parts of the world. It also allows us to showcase our education and portrays the amount of effort that has been put in to bring us to this point.

Licensed Vimeo Picture

01

02

03

DEFINITION AND REQUIREMENTS

PROBLEM STATEMENT:

- Create an innovative mobile classroom vehicle for the Teachers Without Borders to use when traveling to different communities safely to allow them to educate students in an active learning space.

DESIGN REQUIREMENTS:

- Maximum budget of $80 million dollars
- Operate at a speed limit of 0.8 ft/s
- Avoid objects through stop automation
- Transport 3 adults and 2 kids at any given time
- Functional vehicle and classroom space that holds 10 kids
- Fulfill the end users needs

DESIGN CRITERIA:

- **Creativity** - showcase innovation and unique ideas
- **Interactivity** - interactive learning environment
- **Comfort** - comfortable both when learning in the classroom and in transportation
- **Safety** - safety of both the teachers and students to be of the utmost importance
- **Storage** - enough storage to successfully accommodate all the educational needs
- **Convertibility** - effectively utilize its space and transform from vehicle to classroom

IMPORTANT FEATURES

- Double-decker bus exterior.
- Stairs within the design to make the 2nd level easily accessible.
- Two yellow LED lights that function similarly to night lights with the use of a photoresistor.
- 3D printing and laser cutting were used to cut wood and produce filament pieces to exact measurements to create curvature and open windows as well as a specially designed storage and seats.
- Stop and start automated so that it won't hit any obstacles and once an obstacle is moved the vehicle will automatically start on its own again.

DESIGN DESCRIPTION

CHANGES IN DESIGN

- The motor was changed from a 12V 5900 RPM to a 10500 RPM
- The gear ratio was changed 3 different times
- The sensitivity for the ultrasonic sensor was reduced
- Some minor changes of cuts and drillings were created in the laser cutting
- Position of solar panels and change of solar panel to 165 mm by 135 mm

VALUE FOR STAKEHOLDERS

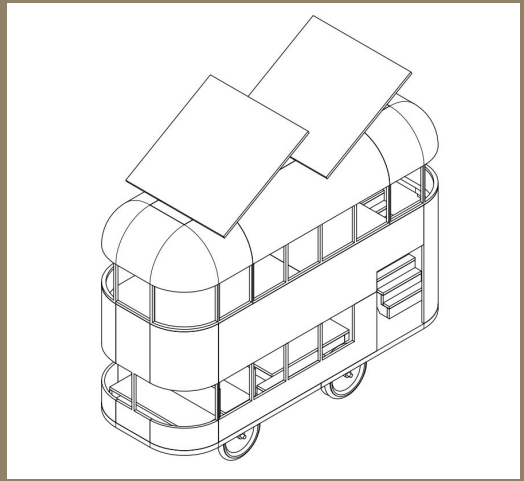
- Unique environment
- Transports the students and teachers efficiently and safely with style
- Integrates STEM within the design for active learning
- Incorporates safety features
- Showcases innovation in the design
- Utilizes renewable energy sources

VEHICLE DETAILS

EXTERIOR DESIGN

REASONING BEHIND DESIGN:

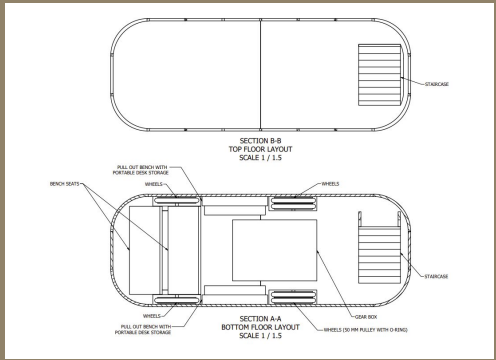
- Creative take on a traditional school related vehicle such as the school bus
- Two stories allow for ample amount of space (170 sq. inches total)
- Open windows made it easier to build by allowing access to both bottom and top floors and a beautiful view



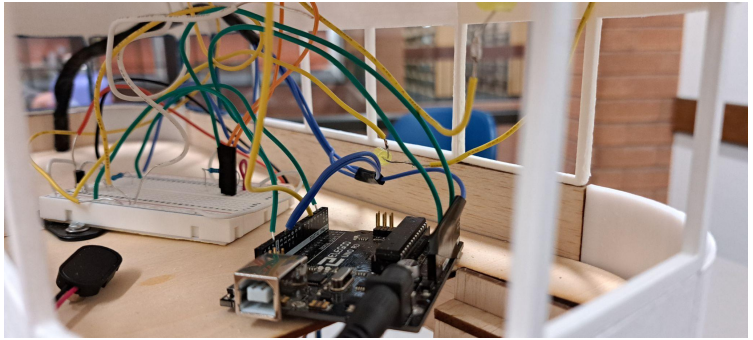
VEHICLE DETAILS

REASONING BEHIND DESIGN:

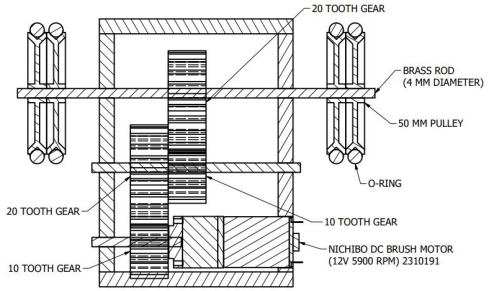
- First Floor Features:
  - A seat that can be used by students as a place to rest and learn in
  - Also acts as a cabinet for storage
- Second Floor Features:
  - An open space that will encourage participatory learning and enable a variety of classroom arrangements
  - Contains the circuit board



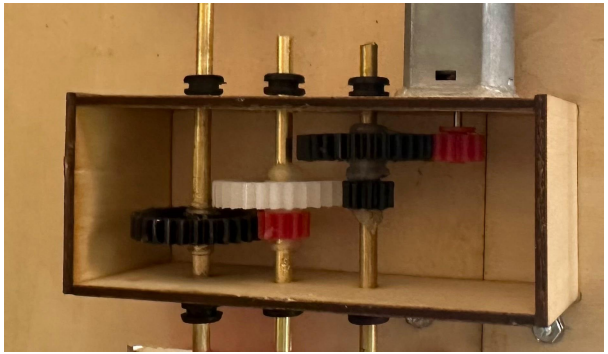
INTERIOR DESIGN



GEAR TRAIN DESIGN



SECTION A-A
GEAR TRAIN RATIO
SCALE 1 : 1



REASONING BEHIND DESIGN:

- Our calculations were off and original 9/1 gear ratio and 5900 RPM motor didn't work
- We then changed the gear ratio to 1/9, but there was not enough torque to power the vehicle
- We changed it out for a 10800 RPM so it would rotate faster and 1/27 because the larger gear was unable to rotate the smaller gear due to weight
- Chose double wheels so that the wheels were more sturdy and controlled

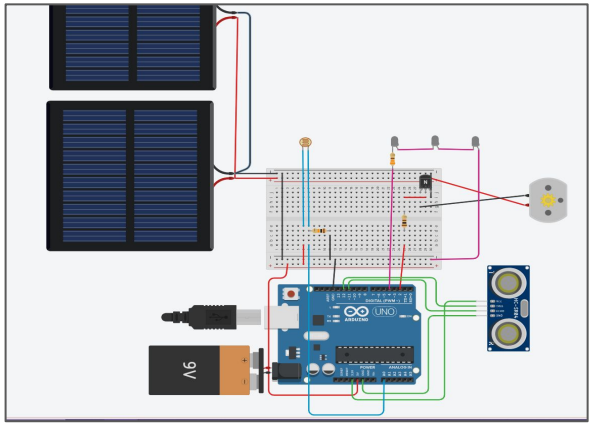
VEHICLE DETAILS

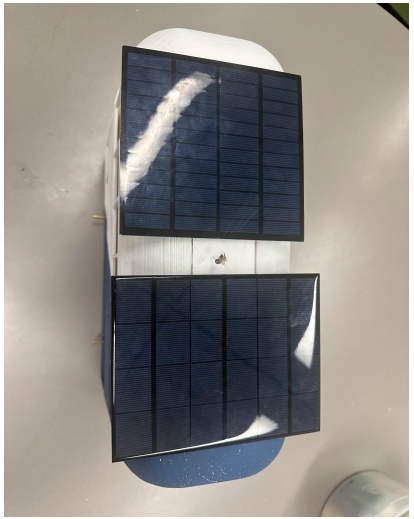
VEHICLE DETAILS

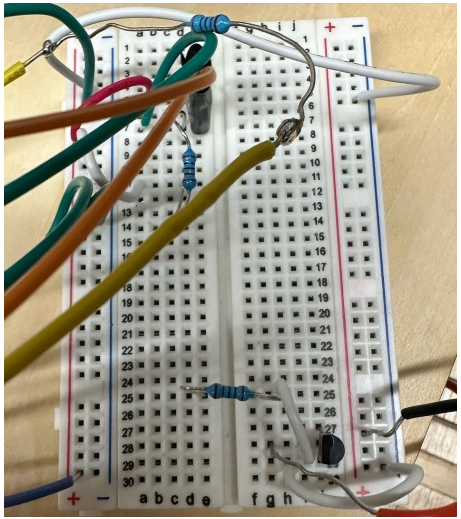
REASONING BEHIND DESIGN:

- Two solar panels
  - 145x145 and 135x165
  - Connected in parallel
  - Prioritize the amps
  - Maximize the torque output
- Automated system (lights)
  - Runs through an analog system
  - Reads the light via a photoresistor
- Automated system (motor)
  - Runs through the digital side of the Arduino board
  - Reads whether something is a certain distance
  - Decides whether to stop the car or not.

SOLAR PANEL CONFIGURATION







FINANCIAL ANALYSIS

Item Description	Price per unit	Quantity	Total Cost
Pulley 50mm	$0.60	6	$3.60
O-Ring	$0.25	6	$1.50
Big Flat Bracket	$1.00	4	$4.00
1/8" Plywood	$0.60	2	$1.20
1/8" Balsa Wood	$1.75	5	$8.75
Solar Panel	$10.00	2	$10.00
Grommet	$0.10	6	$0.60
10 Tooth Gear	$0.10	3	$0.30
30 Tooth Gear	$0.30	3	$0.90
Brass Rod	$2.50	2	$5.00
Colored LED	$0.10	2	$0.20
Mini Breadboard	$0.50	1	$0.50
Ultrasonic Sensor	$5.00	1	$5.00
Arduino	$20.00	1	$20.00
Nichibo DC Brush Motor (12 V 10500 RPM)	$3.00	1	$3.00
Photoresistor	$1.50	1	$1.50
3D Prints (measured per gram)	$0.02	342	$6.84
Gear Attachment	$0.10	1	$0.10
		Total	**$72.99**

BENEFIT FOR STAKEHOLDER AND FINANCIAL ANALYSIS

- Allows the students to learn in a unique environment
- Creative and adaptable in order for the bus to function as both a school and vehicle
- Example: storage desk, lights
- Ample amount of space with the two stories
- Space themed design allows for an interactive learning environment that relates to the STEM subjects that are being taught

- Number of People Helped Per Year: 21,900
- Total Yearly Cost: $20,885,622
- Cost Per Person Helped: $944
- Social Impact: $2,190,000
- Quality of Life/Environmental Impact: $18,000,000
- Total Combined Impact: $20,190,000
- Social Return on Investment (SROI): 96.67%

DESIGN DESCRIPTION

PROJECTED WEIGHT

- Mass of plywood: 247.1108 g
- Mass of balsa wood: 54.2187 g
- Mass of 3D prints: 342 g
- Additional mass: 308 g

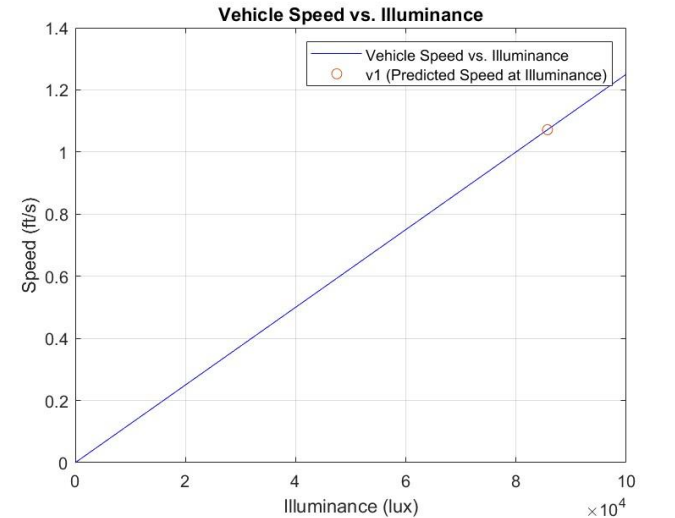
- **Total mass: 0.947 kilograms**

- **Final Total Weight: 1.106 kilograms**

MATLAB SCRIPT

Below is a summary of how the linear speed is calculated through illuminance:

- Illuminance ⟶ Input Power
- Motor Efficiency ⟶ Output Power
- Torque ⟶ Rotational Speed
- Gear Ratio ⟶ Output Rotational Speed
- Wheel Radius ⟶ Linear Feet Per Second



PROJECTED SPEED

- Illuminance: 85700 lumens
- Additional mass: 3 kilograms

- **Projected Speed: 1.0718 ft/s (translates to 107.18 mph)**

- **Final Speed ≈ 0.63 ft/s**

DISCUSSION ON FAILURE ANALYSIS

REFLECTION

01

WHAT WAS TESTED?

- Interaction between motor and gears
- Stop and start automation
- LED light automation

02

WHAT WENT WRONG?

- Gear ratios were incorrect
- Vehicle moved with a battery, but not a solar panel
- Issues with the code

03

WHAT WAS IMPLEMENTED TO PREVENT FAILURES?

- Gear ratio was modified from 9:1 to 1:27
- Motor was changed from 5900 RPM to 10500 RPM
- Two solar panels were used in parallel
- Yellow LEDs were used in place of other colors due to necessary voltage

REFLECTION

LESSONS LEARNED

- Manage time more efficiently
- Not procrastinate
- Testing and troubleshooting more
- Working on communication
- To thoroughly look over one's work and others work to eliminate mistakes

WHAT WOULD WE DO DIFFERENTLY?

- Start by building the prototype and design sooner
- Create parts that were easily interchangeable before having to permanently position them
- Test our design sooner so that we aren't worried about it not working properly up to the last day
- Find an alternative material to balsa wood because it is so fragile

SUMMARY

- ‘Classroom 2GO is a part of the ‘Without Borders’ fleet dedicated to the transport of teachers and their equipment to rural locations.
- The Double Decker design of the Vehicle allows the the teachers more usable classroom space. Combined with it’s automated night light systems and safe-stop technology, the Classroom 2GO is the ultimate mobile learning facility.

OUR DESIGN IS THE BEST DESIGN BECAUSE

- It’s unique setup allows students the ability to learn in multiple classroom configurations.
- The bus is well equipped for lecture, group work and even seminar and space..

CONCLUSION

THANK YOU FOR MAKING IT POSSIBLE FOR THE WHEELS ON THE BUS TO GO ROUND AND ROUND!

REFERENCES

Russell, J. (2017, February 28). *Intel Sets High Bar with Workforce Diversity Program Results*. HPCwire. https://www.hpcwire.com/2017/02/28/intel-sets-high-bar-workforce-diversity-program-results/ (Picture on Second Slide)

Special thanks to Tyler Santos and Lee Sorensen