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Teaching concepts in STEM to two generations through senior capstone projects

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Session XXXX

Teaching Concepts in STEM to Two Generations through Senior Capstone Projects

Abstract

Senior capstone programs at US universities offer an excellent opportunity to teach engineering concepts to not only the engineering seniors in the capstone program, but also to the next generation of students currently in K-12. To achieve this, engineering students are given the challenge to create an exhibit in Science, Technology, Engineering, and Mathematics (STEM) that, in a fun way, conveys fundamental concepts to K-12 students.

An example of this is a recently concluded senior capstone project in Mechanical Engineering at Texas A&M University called Electrocycle. Using a standard bicycle and a small generator, the exhibit effectively conveys concepts of energy generation, conversion and storage, as well as basic principles in mechanical and electrical engineering. In one mode of operation, 8-12 year-old students at the Boys and Girls Club of Brazos Valley [1], in Bryan TX, are able to light up and vary the intensity of incandescent and LED bulbs using purely their cycling output. In another mode, they can charge a LiFEPO4 storage battery, which in turn is used to charge computers, phones, and rechargeable AA batteries. This device provides a clever way to incentivize the students at the Club to perform physical activity on the bike to receive charged AA batteries that they can use to play video games. The seniors also created engaging videos using Lightboard that further reinforced the lessons imparted by the exerciser.

One of the significant findings of this project was the community-oriented nature of the project and its long-term utility was a key factor to motivate the seniors to perform their best. Not only did they work longer hours than those on other projects, but they also made extra efforts to ensure safety and craftsmanship. The other key finding was that the seniors learned the concepts much more thoroughly than usual, understanding their responsibility to properly teach K-12 students.

1: Introduction

Like most other engineering schools across the nation, the J. Mike Walker ’66 Department of Mechanical Engineering (MEEN) at Texas A&M University has a senior capstone requirement for students graduating from the department. In their final year, students working in teams of 5 or 6, spend two semesters undertaking a design project that is a culmination of their undergraduate engineering education. The department has an extremely robust senior capstone program, 54/79 annual projects being financially sponsored by our industry partners such as Shell, Dell, Fluor, Siemens Energy, Trane Technologies, etc., and from government agencies like Los Alamos National Laboratory, Sandia National Laboratory, Army Research Laboratory, Office of Naval Research, etc. The remaining projects are sponsored by TAMU faculty as well as directly by the MEEN department.

The project described in this paper is one such example. A team of 6 students was challenged to build a Science, Technology, Engineering and Mathematics (STEM) exhibit for use by 8-12 year olds at the Boys and Girls Club of Brazos Valley (BGCBV) [1] in Bryan, TX. The Club offers safe and curated after-school recreation and companionship programs to youngsters from underserved communities. The objectives provided to the students were quite broad-based and open-ended, such as that the final exhibit shall be:

- based on kinematics principles,
- capable of being used in a hands-on manner by 8-12 year-olds at BGCBV, and,
- clearly convey/teach basic STEM concepts in a fun way

The students responded to the challenge by designing and building the Electrocycle [2] that is shown in Figure 1.

Figure 1. Electrocycle Kinematics STEM Exhibit as installed at BGCBV

2: Project Planning

Projects like these provide the Faculty Advisor and Studio Instructor a golden opportunity to teach STEM concepts in a two-fold manner. Firstly, the engineering seniors need to brush up on their engineering fundamentals from their coursework and ensure that they have a solid grasp of the concepts. Secondly, they should also be coached to extend, harness, and refine that knowledge to disseminate those basic principles in a fun, innovative way to the 8-12-year-olds aiming to be the next generation of prospective engineers.

The team interviewed both students and leadership at BGCBV to determine customer needs and priorities, based on which they developed a simple set of needs and relative priorities as shown in Table 1.

Table 1: Project top priorities based on Customer Needs

#	Customer Need	Relative Priority
1	Teach kinematics concepts to students aged 8-12 year-olds	5
2	Safe for students	5
3	Withstand constant wear and tear	4

4	Simple to operate	4
5	Engaging to students	4

The students then utilized various concept generation and refinement techniques such as the 6-3-5 and mind map methods to develop preliminary ideas for the exhibit, keeping in mind their research on visits to local STEM museums. Of these, the 6-3-5 method proved most effective [3]. From this method, the team narrowed down to a shortlist of ideas, eventually deciding upon an exhibit centered around students pedaling a bicycle to generate electricity to power light bulbs, called the Electrocycle. Once the basic concept was decided, the customer (BGCBV) provided additional scope for the exhibit. For example, they requested that in addition to the bulb display, that AA batteries be also charged using the physical output of the exerciser. The motivation behind this was to incentivize the 8-12 year-olds to perform physical activity in earn charged batteries that they could then use to play video games.

In the next step, the seniors created a list of kinematics and STEM concepts that they wished to teach the BGCBV students, and examined the Electrocycle concept to ensure that they were all covered. For example, Power, Energy, Torque, and Energy conversion were all addressed. In addition, the team realized that electrical concepts such as Current, Voltage, Resistance, Ohm's Law, incandescent vs. LED lighting, battery capacity, etc., could also be conveyed through the exhibit effectively.

3: Design Development

3.1: TAMU/MEEN Background

In the first semester, seniors at the MEEN department at TAMU spend the bulk of the time developing the design for their project, and in the second semester, they build the proof of concept and complete the verification and validation testing phases. In the second semester, the students finalize the Embodiment design, perform Fault tree and Reliability/Risk evaluations, focusing on Failure Modes and Effects Criticality Analysis (FMECA) for their specific projects. By the end of the first month of the second semester, the students would have ordered most of the materials required for their proof-of-concept, usually a combination of "make" and "buy" components, based on their budget and ease of manufacture. The students then spend the rest of the semester building the prototype and testing it, supported by lectures on Embodiment Design, Prototyping, Design for Manufacture and Assembly (DFMA), Engineering Standards, Engineering Ethics, Project Management, Lifecycle Design, etc.

3.2: Electrocycle Design

The underlying design philosophy for the energy generation/conversion part of the project is quite straight-forward with several similar manifestations already reported in the open literature [4, 5, 6]. At its root, the principle is that the user pedals a stationary bicycle, and the rear wheel is connected by a V-belt to the driven pulley of a small permanent magnet generator that produces a voltage and current depending on the electrical load (bulbs, battery, etc.) which then needs to be properly harnessed to produce the desired electrical effect(s).

Based on this, the team decomposed their design into a Structural/Mechanical and Electrical subsystem, with parallel sub-teams primarily focused on each subsystem. The mechanical subsystem includes structural design, bicycle integration, motor/belt assembly, and safety shroud. The electrical subsystem includes wiring, power distribution, lightbulb circuitry, battery charging system and electrical safety.

3.2.1: Mechanical subsystem

Using virtual simulations and other analytical calculations, the mechanical sub-team designed the following parts:

- A horizontal sturdy base made primarily from a pine wood 2x4 board structure that is covered by a ¾" sheet of plywood (Figure 2), including a box structure to serve as the front mount of the stationary bike. The stationary bike, safety shroud (Figure 3) and generator are attached to this horizontal base.

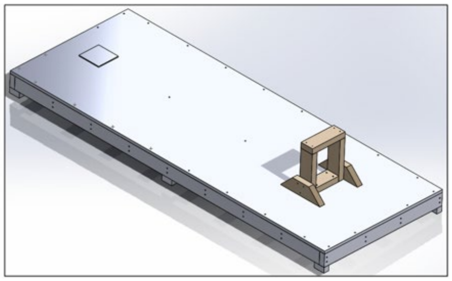


Figure 2: Design of Wooden base and Front Mount

- A safety shroud (Figure 3) has been designed to cover the rear wheel, belt and the generator to prevent users from getting potentially tangled with the spokes and other moving parts.

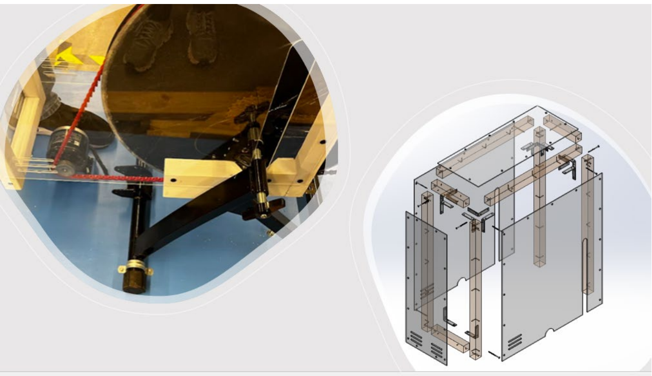


Figure 3: Safety shroud for rear wheel and generator

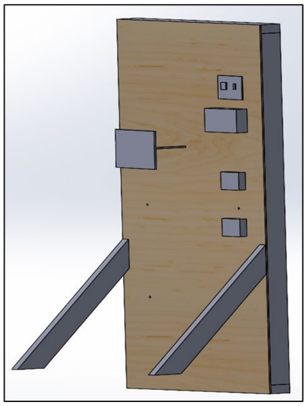


Figure 4: Design of the front wall

- A front vertical wall built again with 2x4 boards and ¾" plywood (Figure 4). This vertical wall contains the tablet with educational videos, a switch panel, other displays and charging stations.
- On the top of the front wall is the Lightbox (Figure 5), designed to house the incandescent

and LED lights. A tinted acrylic sheet was attached to the front of the lightbox to protect the user's eyes when pedaling on the exhibit.

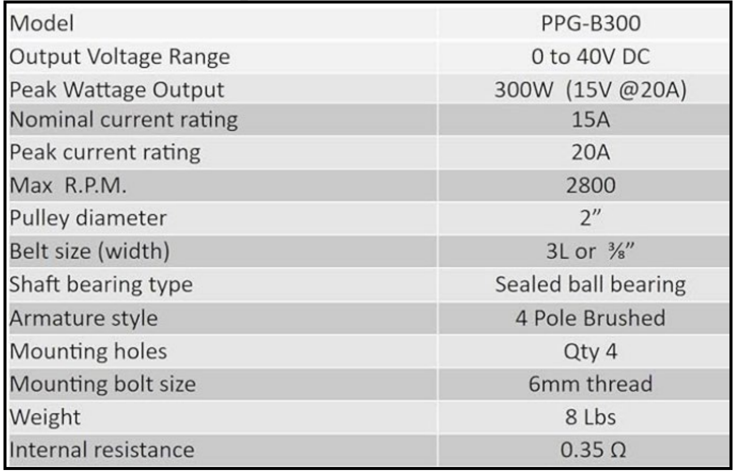
Figure 5: Design of the Lightbox

3.2.2: Electrical subsystem

Based on the intended lessons to be imparted to the 8-12 year-olds (energy conversion to light energy and charged batteries), the basic skeleton of the electrical subsystem was designed and described below, although the actual working of the system required significant learning and experimentation that will be discussed in the next section

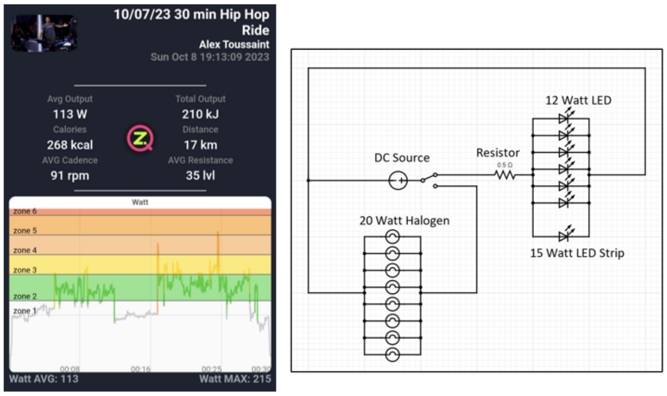
- An off-the-shelf generator (Specifications in Table 2) was selected for use.

Table 2: Specifications of DC Generator



Model	PPG-B300
Output Voltage Range	0 to 40V DC
Peak Wattage Output	300W (15V @20A)
Nominal current rating	15A
Peak current rating	20A
Max R.P.M.	2800
Pulley diameter	2”
Belt size (width)	3L or ⅜”
Shaft bearing type	Sealed ball bearing
Armature style	4 Pole Brushed
Mounting holes	Qty 4
Mounting bolt size	6mm thread
Weight	8 Lbs
Internal resistance	0.35 Ω

- For the lights to be used, the team decided to use 12V incandescent bulbs and LEDs, since the typical voltage produced by the generator was in the 12-15V range, and 12V bulbs are available in large varieties from the automotive market. How many to use was dependent on human power output. After considerable research [7,8] and experimentation with stationary gym exerciser outputs (Figure 6), eight 20W incandescent lights in parallel were used in the Incandescent switch position, and six 15W bulbs plus a 15W color LED strip were used in parallel in the LED switch position.


10/07/23 30 min Hip Hop Ride
Alex Toussaint
Sun Oct 8 19:13:09 2023

Avg Output 113 W
Total Output 210 kJ
Calories 268 kcal
Distance 17 km
AVG Cadence 91 rpm
AVG Resistance 35 lvl

Watt AVG: 113
Watt MAX: 215

Figure 6: Example of typical human output (left), Light circuit (Right)

It may be noted here from the circuit in Figure 6 that the switch ensures that either the incandescent bulbs OR the LEDs will turn on, not both.

- For the Battery charging circuit, the design includes a Charge controller which is required to charge a Lithium storage battery at a steady stable voltage slightly higher than the battery voltage. Solar charge controllers are ideal for this purpose, with a backflow preventer and a battery overcharge prevention system. The one selected for this application also has 4 built-in USB2.0 outputs (5V/2A) that can be used to charge the AA batteries (Figure 7).
- The battery charging circuit is shown in Figure 8 consisting of the generator output being used to charge a 12.8V/20Ah (256Wh) LiFePo4 battery, which in turn is used to provide USB2.0 and USB QuickCharge 3.0 (5V/3.6A) outputs for charging computers, phones, batteries, etc.

Figure 7: Charge Controller

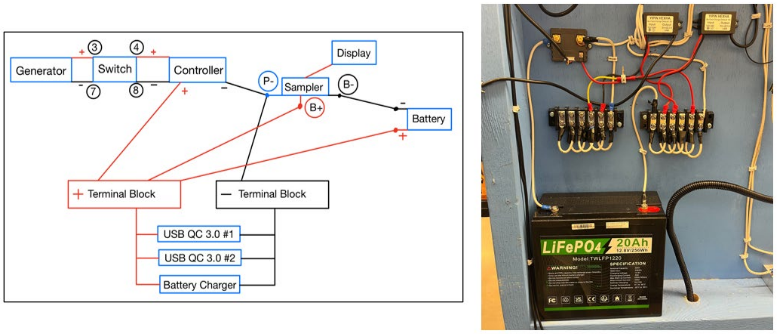


Figure 8: Battery Charging Circuit

4: Prototype Build: Lessons Imparted

Even with a robust starting design, the team quickly discovered that during the manufacture/build phase, as in most other capstone designs, the devil is in the details. The biggest challenges came from the electrical side of the project, for several reasons. On the electrical side, they needed much more learning and guidance. The key challenges were in characterizing the generator, sizing the bulbs and storage battery, and whether to include buck/boost stabilizers, etc. Typically, MEEN students do have a reasonable physical handle on what one volt is, but not so much on what one watt, ohm, and ampere are. How much energy is in one AA cell? At what rate does it get charged?

To make things more complicated, the concept of resistance (physical vs electrical) is quite intricate in this project. To *increase* the biker's physical resistance, one needs to *reduce* the electrical resistance attached to the generator. This is a counter-intuitive concept that the students had to grasp before continuing to subsystem prototyping and development.

4.1: Electrical subsystem prototyping

There was a tendency in the team to want to wait and validate at the full system level, rather than each subsystem separately. The electrical sub-team was waiting for the cycle and generator to be fully functional before embarking on sizing and finalizing the electrical parts required. This is quite commonly observed in capstone design. It has been reported in prior studies [9], that *both novice and expert designers* still fail to fully leverage prototypes throughout design. In this study, it has been mentioned that prototyping heuristics can be easily implemented in design processes to improve design outcomes (Figure 9), specifically in subsystem prototyping. Several reasons have been cited for this behavior, the two most significant being fear of failure, lack of knowledge of prototyping tools/mindsets, and lack of prototyping culture.

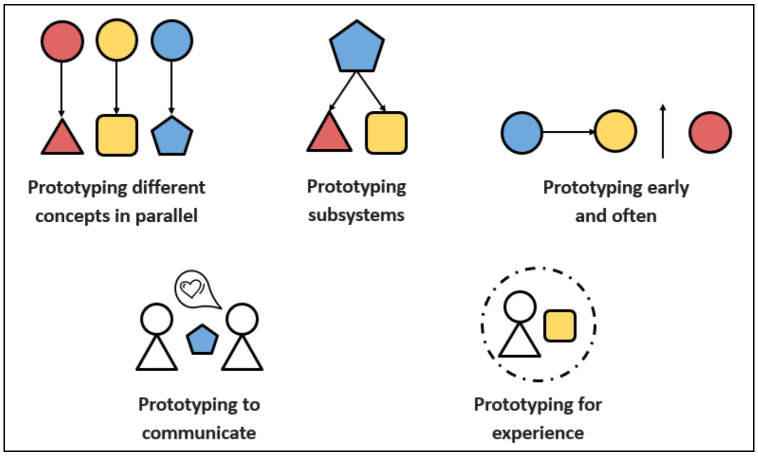


Figure 9: Implementation of Prototyping heuristics in Design process [8]

With proper guidance, the team pivoted to using surrogate prototyping on the electrical side. For example, they needed determine the number and size of the bulbs as well as their lumen output as the power was gradually increased. In the absence the mechanical subsystem, the student used electrical power supplies to mimic the generator output. Knowing the approximate wattage expected from the human bikers (Figure 6-Left), they used constant voltage (CV) or constant current (CC) power supplies as appropriate to observe the performance both in the lighting and battery charging circuits. This exercise was highly effective in understanding how the Charge controller worked to charge the Lithium storage battery well before the mechanical sub-system was ready to provide human power to the generator.

Another example was to characterize the generator, that is, to determine the voltage vs rpm characteristics of the generator for different currents (electrical loads). The lower the electrical resistance, the higher the electrical load (current); this drops the voltage output of the generator for the same pedal rpm and higher is the physical resistance experienced by the biker. To develop these curves, the team created a heat sink with different resistances attached (Figure 10, left). Using these resistances, the students were able to achieve values all the way from 0.75 ohms to 6 ohms. Using a tachometer, voltmeters and steady pedaling cadence (30-90 RPM), the team created the generator characteristic curves shown in Figure 10, right. It may be noted here that the figure shows generator pulley rpm which is much higher due to the belt and gear ratios; for example, in the highest gear of the 21-speed bike, the bicycle gear ratio was 3.07, multiplied by the belt ratio (rear wheel to generator pulley) of 10.4, for a total ratio of about 32. A pedal rpm of 90 in the highest gear translates to 2873 rpm at the generator. The characterization curves helped in sizing the bulbs and in determining the voltage spec of the storage battery. For example, for an electrical resistance of 0.75 ohms, the generator can produce 140 W (12.5A @ 11.2V), which they already knew was in the capability range of human output. This helped determine the number of bulbs to be added in parallel to obtain the right system electrical resistance. Similarly, with knowledge of the voltages produced at steady pedaling rates, the students selected a 12.8V storage battery for the battery charging circuit.

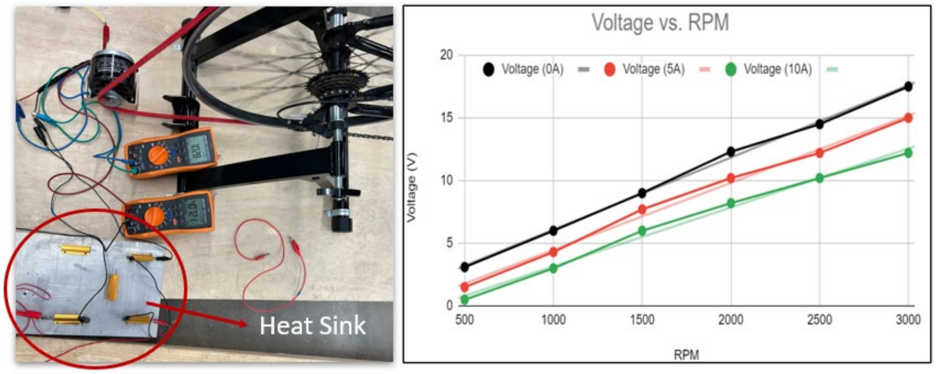
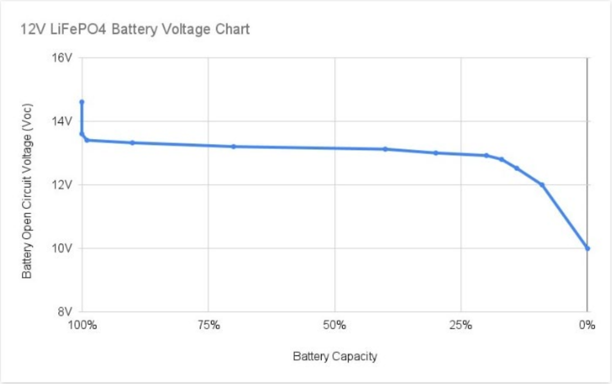


Figure 10: Heat sink with various electrical resistances (left) for Generator Characterization (right)

Even seemingly obvious matters would turn out to be deceptive. Why is a storage battery even needed? Why cannot the human generator output be directly used to charge the batteries and other devices? The students quickly realized that there was a mismatch between the output rate (75-150W) and the charging rate of the devices (10W-30W), which is a much slower rate requiring longer charging times. A large storage battery nicely provides the interface to collect all the energy output at the higher rate (with the help of the Charge Controller), and then charge the devices at a slower rate, thereby avoiding any losses in transmission.

Another example of extended learning was in the selection of the Battery meter. The state of charge (SoC) of the storage battery is of specific importance. This is because, being in parallel to the battery terminals, it only measures the voltage state and then uses a chart of SoC vs. voltage. This yields unreliable SoC estimates for two reasons: the chart used is often generic and not specific to the battery, and secondly, even small errors in the measured open circuit voltage can cause large errors in SoC due to the nature of the curve [10] (Figure 11). In this case, the solution is to use a more sophisticated battery meter that includes a sampler (Figure 12) through which all the current in the entire system passes.



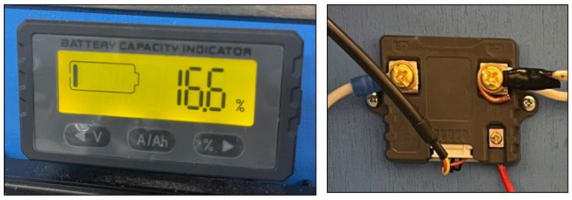


Figure 11: Battery Capacity (SoC) vs. Voltage Figure 12: Battery Capacity Meter with Sampler

4.2: Safety Considerations

From the very onset, the team was made cognizant of the project's safety requirements, given the age of the end users of the STEM exhibit. To this end, some examples are provided in this section:

- Regular usage of fault tree and FMECA risk analysis and mitigation action plans for potential modes of failure.
- Limiting the system to low voltage DC (Direct Current), nominally in the 12-18V range.
- The electrical system incorporates a 15A circuit breaker and large 12-gage wires, which can accommodate up to 20A. There were no exposed wires due to the use of proper wire connectors (Figure 13).

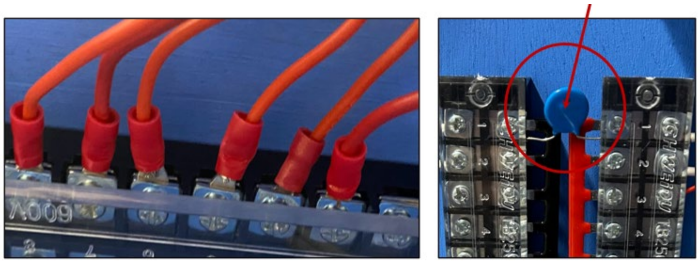


Figure 13: Enclosed wire connectors (left), and MOV (right)

- The Lightbox shown in Figure 5 is fully ventilated with 22 large 2" holes on the top to release heat generated by the halogen incandescent lights.

4.3: Craftsmanship

The faculty provided guidance the team that the exhibit should exhibit a high level of craftsmanship in how it was put together. This team took this guidance to heart and produced some of the cleanest-looking wiring setups (Figure 14), taking advantage for instance, of terminal blocks to connect several components in parallel, and labeling all wires for easy future maintenance. Most wires are also cleverly hidden from the user, so out of any possible contact and safety issues.

Figure 15 provides another example of the care taken by the team to produce a well-crafted product, both from ergonomics and an aesthetic point of view. The overall look has been executed to be simple, aesthetic and efficient.

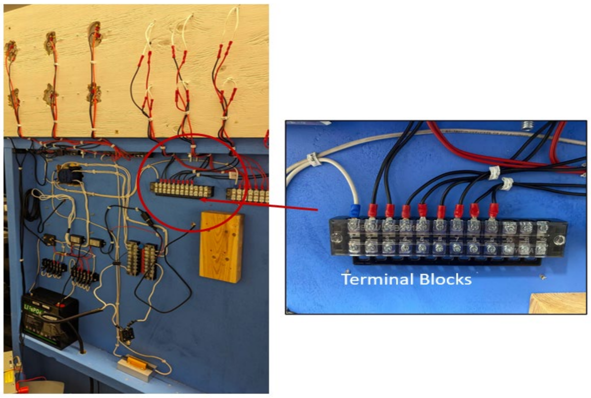


Figure 14: Wiring on back of Front Wall

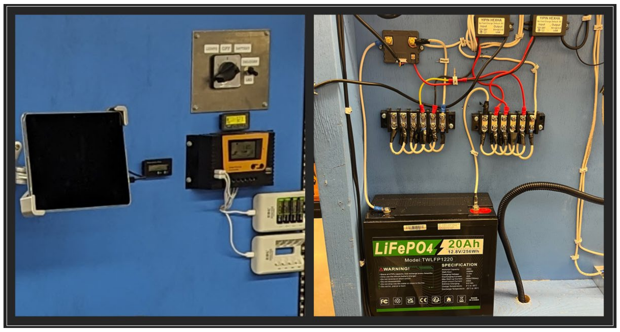


Figure 15: Wiring for Battery Charging, front vertical wall (left), rear of wall (right)

4.2: Professionalism

The team provided a product to the Club that they strived hard to make as professional as possible, so intuitive to use and maintain. In addition to producing a safe product executed with a strong sense of workmanship, the students added the following special touches:

- Regular touchpoints with all stakeholders, particularly BGCBV leadership, providing regular feedback and soliciting continuous feedback.
- Completed exhibit delivered and installed as promised during the last week of the semester. Indeed, the project's final presentation was held at the Club and provided in the presence of MEEN faculty and BGCBV leaders, with demonstrations of the exhibit.
- Supplied an Operating Manual like what customers get with commercial products (Figure 16). This useful document includes Operating instructions (How to Use), General Maintenance information (for example, on how to check for belt tension, remove shroud, remove/replace belt), and Troubleshooting FAQ (for commonly encountered issues), etc.

OPERATING MANUAL

Switching Between Lights and Battery:

This exhibit comes with the option to also charge a dedicated battery behind the exhibit. This battery can be used with any USB cable to charge a variety of devices, such as the video screen. To switch between the two modes, follow these steps:

1) Ensure the bicycle is stationary and no one is pedaling.
2) Turn the large rotary switch to Position-1 on the control panel to engage the light system.

HOW TO USE:

1) Conduct a walkaround to ensure there are no loose parts.
   a) Ensure the bike is stable.
   b) Ensure the belt is not loose, refer to the Belt System section.
   c) Ensure that the lightbulbs are installed properly.
2) Carefully climb on the bike.
   a) Use a step stool if needed.
3) Select the settings on the control panel that you would like to use (do not pedal while the rotary switch is in the "OFF" position).
   a) For example: to light up the halogen light bulbs, the rotary switch needs to be in Position-1 and put the switch to its right in the UP position.
4) Begin pedaling. Start slowly, then build up speed.
5) Adjust front and rear gears as necessary to achieve a comfortable effort and speed output.
6) When finished, carefully dismount from the bike.

GENERAL MAINTENANCE

Safety Shroud

The safety shroud was specially designed to safeguard students from the belt and generator during the operation of the exhibit. The safety shroud will need to be removed in order to gain access to the belt and generator. To remove the safety shroud, please adhere to the following procedures below (it may be easier to do do with 2nd person):

1. Locate the four lock nuts at the base of the safety shroud.
2. Loosen the four nuts in a counter-clockwise direction. Use a socket wrench if needed.

Figure 16: Operating Manual for Electrocycle

- Box of spares (bulbs, belt, extra AA batteries, etc.), and Replacement Parts Order list with links to purchase them.

- Educational Videos for the 8-12 year-olds at BGCBV, which can be viewed on the exerciser on the onboard display tablet and available on YouTube for learning experiences off the bike, on other computers and devices. These videos [11-16] cover various topics in STEM and engineering, which will be discussed in more detail in the next session.

5: STEM Lessons for 8-12 year-olds

It was not enough for the MEEN senior students to have detailed knowledge of the engineering principles behind the Electrocycle. They also had the added responsibility of conveying key STEM concepts to 8-12-year-olds who are still in their formative years of learning. This involved simplifying the concepts to smaller chunks of easily digestible material for these youngsters at an age-appropriate and personal ability-based level.

This knowledge transfer happens in two broad avenues:

1) *Access to the exhibit*: Most of it occurs by simply interacting with the physical Electrocycle. Some of the broad lessons that can readily be experientially learned are as follows:
    a. Direct proof that their human energy output can be converted to electrical energy to turn on the lights and charge other devices. Higher the effort, the brighter the bulbs glow, establishing a direct connection between effort and results.
    b. Specifically in the hard (incandescent mode), it takes a lot of effort to produce light (since heat is also being generated), whereas in the "easy" mode, the LEDs produce 3 times as much light even when the incandescent bulbs are at their brightest (160W of effort), though they need only half the effort by the rider (87W of effort). This lesson is dramatically evident to the student and is a striking visual demonstration of why LEDs are the present and future of efficient lighting around the world.
    c. In the battery charging mode, students will wonder why the battery starts charging (indicated by an increase in battery meter percentage as well as moving charging arrows in the charge controller) only at a certain minimal effort, below which there is no charging. They will learn that this is because they need to produce a generator voltage that is higher than the voltage of the battery, at which time the charging current produces the electrical load to make the effort visibly harder.
    d. The exhibit serves as a reminder of the ability of humans to generate useful amounts of energy, albeit somewhat inefficiently, for charging small electrical devices. It takes hard work to generate useful energy, and this can be used to reinforce energy savings concepts in the students.

2) *Educational Videos*: To supplement the direct learning above, the students created a set of 3-5 minute fun videos using the Lightboard technology (Figure 17) on various STEM topics such as:
    a. Introduction to Engineering [11]
    b. Basics of Mechanical Engineering [12]
    c. Electricity Unplugged: Basics of Electricity [13]
    d. Electricity Unplugged: Intro to Ohm's Law [14]
    e. Conversion Between Mechanical and Electrical Energy [15]
    f. Electrocycle Product Showcase Video [16]

Figure 17: Short Educational Videos using Lightboard

These videos address a multitude of introductory STEM topics as suggested by the titles above, including Power, Energy, Torque, Energy conversion, electrical concepts such as Current, Voltage, Resistance, Ohm's Law, incandescent vs. LED lighting, battery capacity, and several other useful materials. In addition, they also created an Youtube playlist[16] of already existing videos on similar topics to augment the learning experience of the engineers of tomorrow. All of this material is also available on classroom computers, not just the display on the bike, so the younsters are able to review the material prior, during or after the biking experience. As mentioned earlier, the BGCBV staff can also add other videos to this playlist to cater to the students' individual abilities, and their full-time STEM coordinator is always available on hand to offer more personalized teaching to those students who are not too visually inclined. Between this personal contact, the experiential hands-on learning and the videos, the team believes that they have developed an effective medium for instruction of STEM concepts on simple concepts of energy generation and transfer to a range of student abilities and knowledge bases.

6: Conclusions

TAMU MEEN engineering seniors have developed a remarkable STEM kinematics exhibit (Electrocycle) for use by 8-12 year-old students at BGCBV. One of the significant findings of this project was its community-oriented nature and its long-term utility potentially was a key factor in motivating the seniors to perform their best. The needs of the project beyond traditional mechanical knowledge required extra guidance from the faculty, and the students amply repaid these efforts. Not only did they work longer hours than those on other projects, but they also made extra attempts to ensure safety, craftsmanship and professionalism. The other key finding was that the seniors learned all the concepts much more thoroughly than usual, understanding their responsibility to properly convey key STEM concepts to K-12 students, fulfilling the adage by Seneca, the Roman philosopher, *While we teach, we learn.*

In their Final Report [2], the MEEN students best summarized their project's impacts as they saw it, which is quite perceptive. *The broader impacts of this project for the customer can be surmised in three main categories: educational enrichment, boosting confidence, and inclusivity in STEAM. The primary objective of the exhibit is to teach kids engineering and physics concepts. This exhibit does that in a fun and interactive way. It also fosters interest in wanting to learn more about day-to-day concepts. Knowing how things that are seen and used in everyday life, such as light bulbs, is the first step in enabling creativity in an engineering sense. The students will be able to look at other things* *and want to figure out how they work as well. Additionally, by knowing how these things work, students will develop confidence in themselves and their knowledge. This confidence will allow them to feel good in figuring out and tackling tough concepts. Additionally, STEAM is a field in which gender and cultural inequality is high in terms of representation. Exhibits such as these that are catered toward underrepresented groups are essential in bridging the gap in professions like engineering.*

References

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GLOSSARY

A, Amp	Ampere
ABS	Acrylonitrile Butadiene Styrene (thermoplastic material)
ASEE	American Society of Engineering Education
BGCBV	Boys and Girls Club of Brazos Valley (Bryan, TX)
DFMA	Design for Manufacturing and Assembly
FAQ	Frequently asked Questions
FMECA	Failure Modes and Effects Criticality Analysis
K-12	Kindergarten to 12th grade
LED	Light Emitting Diode
LiFePO4	Lithium Iron Phosphate (Battery)
MEEN	J. Mike Walker ’66 Department of Mechanical Engineering, TAMU
MOV	Metal Oxide Varistor
RPM	Rotations per minute
SoC	State of Charge (of battery)
STEM	Science, Technology, Engineering and Mathematics
STEAM	Science, Technology, Engineering, Art and Mathematics
TAMU	Texas A&M University
V	Volt
W	Watt