Electrifying the High School Student Pipeline

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• What do you love about power electronics?
  – Do high school students know this?
• Why is power electronics cool?
  – Do high school students know this?
• What is power electronics?
  – Has a high school student ever heard of it?
• Has a high school student heard of
  – Billions and billions of transistors on a chip?
  – A single giant transistor that can pass thousands of amps of current?
• We have a problem…..
Importance of tackling skills gap

• Identified as one of the top risks to the U.S. transportation supply chain and modernization of the electric grid [1,2].
• Designing from a systems-perspective is a key skill requested by industry [3]
• Problem: High school students don’t go into engineering.
  – High school students don’t go into electrical engineering. (You can’t take it apart…)
  • High school students have never heard of power electronics…
    – This is bad…..

Introducing power electronics and system-thinking to address future need

• Goal 1: Making high school students aware of power electronics
  – Power electronics makes thing happen! This is not an mp3 player!
  – Things move, sometimes fast. Sometimes really, really fast….
  – Exciting things happen. Sometimes very, very exciting…
  – This is not your parent’s transistor radio…

• Goal 2: Physics & energy modeling (“balance of plant”) for battery charging and discharging
  – Increased number of sensors and processors become siphons for energy from the battery for autonomous electric vehicles

Introducing power electronics and system-thinking to address future need

• Goal 3: Introduce students to soldering/debugging and circuit waveforms for car-side and track-side power electronics for in-motion wireless charging
  – Ability to charge while driving or facilitate fast-charging will require compact, lightweight on-board power electronics [1-4]

• Goal 4: Getting young people/high school students interested in power electronics.
  – It is not very often a high school student can participate in a project that shows them that they could be the people to make it happen in the future.
  – It does not exist now... It will exist... Someone has to do it... They will be the ones to make it happen...
  – This is not making a better toaster!

Working to Meet Goals with High School Autonomous Vehicle Challenge

- Linescan Camera
- Servo motor steering
- Power Electronics
- Independent rear motors
- Microcontroller and power board
History

- Over the last five years over 500 students from 24 different schools have participated.
- Program a 1/18th scale vehicle to follow a random track autonomously as fast as possible.
- Wouldn’t it be cool if those 500 students knew what power electronics existed!

• High School Autonomous Vehicle Challenge
• Micro Mouse Competition at APEC
What Students Learn

• Graphs? What do graphs have to do with the real world?
• Visualization – How do we follow a line given this information?

- $y = mx + b$
- Slope
- Y-Intercept
- Who really cares!?
What Students Learn

• Proportional Feedback

• High school students introduced to proportional feedback and control: The good, the bad, and the ugly.
What Students Learn

• Application of Algebra/Graphs/Visualization

This method links the subjects of math and physics to solve to a contemporary problem. Students know autonomous and electric vehicles are the future.
The Present Competition

• What Teams Get (Free)
  – Car Kit
  – Laptop with Software Installed (MATLAB and Simulink)
  – Oval Practice Track
  – Technical Support from Rose-Hulman

• What Teams Must Do (Work)
  – Program in Simulink
  – Optimize cars for the following tracks:
    • Long Oval, Clover, Random
What Students Learn

• Proportional Feedback Control
• Rear-wheel Differential Steering
• Slowing Down in a Curve
  – (Counter intuitive to a high schooler….)
• Accelerate out of a curve
• Memory Lock for Tight Curve
• Image Analysis and Processing
• Real-time programming
2018 Random Track
2019 Random Track

- One square = 3 Feet.
Impact

<table>
<thead>
<tr>
<th>Year</th>
<th># Schools</th>
<th># Teams</th>
<th># Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>3</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>2017</td>
<td>11</td>
<td>25</td>
<td>91</td>
</tr>
<tr>
<td>2018</td>
<td>17</td>
<td>47</td>
<td>210</td>
</tr>
<tr>
<td>2019</td>
<td>16</td>
<td>35</td>
<td>115</td>
</tr>
</tbody>
</table>

Teams from 7 states have participated

30% female participants

• Students are successful.
• We have yet to have a team that did not complete at least one event successfully.
The Future

• We have created a model that:
  – Is Inexpensive for schools to adopt
  – Is easy for teachers to incorporate into existing classes
  – Allows self learning by students
  – Can be expanded nationally and technically

• Expand the Scope of the Competition
  – Advanced manufacturing learning outcomes with 3-D printed chassis and accessories
  – Image recognition and deep learning modules
  – Power electronics learning outcomes with charging and solar powered vehicle activities
The Future

3-D Model of Vehicle
Equivalent to The Vehicle Now but Modular
Allows Expansion of Competition in Multiple Directions

Electrical
- Heathkit Type Modules
- New Sensors
- Lights
- Sound/Audio Amplifier
- Battery Charger
- Off-Line Charger
- Energy Monitor
- PV Panels

Control
- 2/4 wheel steering
- Create new 3-D parts
- Crash Avoidance
- Auto Stop
- Right Turn/Left Turn
- Vehicle Following

Physics
- Energy Storage
- Coast Down
- Friction
- Vehicle Model
- Solar Power
- Cap Energy Storage
- Inductive Charging
- Water Thrust Motor

Computer
- Image Recognition
- Deep Learning

Mechanical Engineering
- Modify Components in the Vehicle
- Create new 3-D parts
- 2-Wheel Steering
- 4-Wheel Steering
- Center of Gravity
- Weighting
- Vehicle Floatation Device

Autonomous Vehicle Challenge
Thank You!

Questions?

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