CAT'S CONUNDRUM:
A Remote Control Vehicle Terrain Navigation Challenge

Multidisciplinary Design: Electrical and Computer Engineering Component

Challenge:

You will need to design, purchase, and implement the electrical system for your team's remote controlled vehicle. If your team has one, you will need to work closely with your CS who will be required to design a control interface for controlling the vehicle. You will need to work closely with your ME/T to ensure the system you design interfaces effectively with the chassis and that all wiring is secure, safe, and sturdy. Finally, your IE will help you determine the organization of the obstacle course and the need to balance speed vs. difficulty. This will likely influence your power and motor needs.

Final Design Constraints:

- Commercially available parts designed for the RC market are NOT allowed (electronic speed control, transmitter, or receiver).
- Vehicle must be remotely controlled. Touching the vehicle during the course demo will result in lost points.
- The vehicle must be able to complete the course without changing power source (battery, other).
- Central microcontroller must be programmable.

Grading:

Your final prototype design will be graded on its performance on the Cat's Conundrum course and depends on demonstrating that your vehicle has adequate electrical functionality (power, battery life, steering control and capability to complete the specified obstacles). In addition, you will be evaluated on the quality, aesthetics, safety (i.e., protection from track elements such as water), and integration of your system into the RC vehicle. Finally, the smaller the form factor of your final product and the less you rely on off-the-shelf parts, the higher the level of difficulty and thus the higher your grade. For example, there are many prepackaged boards available for driving motors or servos, etc. These are excellent for prototyping and much of it will likely show up in your final design. However, often these boards have more functionality than is necessary for our design. In a final product this means extra expense and an unnecessarily large form factor. With each successive prototype your goal is to minimize these excesses. For example, could you use only the ATmega328/P chip and required peripherals from an Arduino board and eliminate the unnecessary components?

General Guidelines for Judging Your Own Final Design: While you are not explicitly graded against the following rubric, students whose final design falls into the High Score category generally get an A in the class.

	Low Score	**<-----------------**	**----------------- >**	**High Score**
Level of Difficulty	Failed to integrate parts. Missing functionality. Used commercial RC car components. Electronics programmable.	Minimal time commitment. Minimal creativity. Little change between prototype iterations. Possibly a breadboard circuit.	Compact form factor. Minimal excess capability. Iterations show improvement.	Extensive time commitment. Utilizes unique, creative, custom built circuits that necessitate multiple iteration. Consistently minimized form factor and excess capability with each prototype. Possibly custom printed circuit board.
Quality of Build	Design requires frequent maintenance to function. Parts fail under track use and fixes difficult. Could not withstand use by 10 year old. Possibly uses a breadboard, no or minimal soldering, unorganized.	Design fails on track more than twice. Some connections not soldered. Shorts or other problems difficult to identify. Wiring not organized. Excess wire length. Poor wire color-coding.	Design is nearly maintenance free. Failed parts quickly repaired. Joints soldered but not clean. Wiring organized. Could not withstand use by 10 year old	Design is maintenance free and parts do not fail under track use. Easily repaired. All connections secured. Shorts unlikely. Solder joints clean and professional. Plugs easy to use and robust. Could withstand

				use by 10 year old. Remains functional after track use.
Aesthetics of Build	Easily recognizable as a DIY project. Poor artisanship apparent due to visible glue or tape, hastily cut wires, lack of finish work, etc.	Wires hidden in project box, but opening box reveals disorganization. Wires too long, boards not secured, etc.	Clearly organized with minimal glue, tape, or other joining material present. Looks professional.	Close to marketable product. Difficult to discern from a commercial product. Artisanship apparent in thoughtful details. Wires hidden unless it enhances the look of the vehicle. Circuitry and wiring or neat and clean.
Quality of System Integration	Electronics not integrated into vehicle (evidenced by kluged parts, wires broken, or form factor for electronics that does not align); performance degraded.	Some planning evident in connection of electronics to vehicle but some aspect still failed. Some kluged parts. Does not affect performance.	Electronics housed away from damage. Electronics well suited for stated obstacle objectives. Evidence of planning clear in connection of electronics to vehicle.	Incorporation of electronics enhances mechanical design (improves center of balance, etc.). Electronics housed away from damage. Electronics well suited for stated obstacle objectives.

				Electrical design allows for optimal course speed vs. difficulty.
Functionality	Inadequate power or battery life for course. Oversized components compromise performance. Difficult to control. Not remotely controlled.	Vehicle complete course but might need to change battery or skip obstacles due to insufficient power or battery life. Controls difficult to use, inconsistent and not suited for 10 year old.	Vehicle has adequate power and battery life for the course. Throttle and steering control adequate but perhaps not easy, intuitive or consistent.	Vehicle has more than enough power and battery life for the course without sacrificing weight or size needs. Sensitive, accurate, easy to use steering and throttle control. Intuitive to use for 10 year old.

Suggested Resources;

- https://www.adafruit.com/
- https://www.sparkfun.com/
- https://www.arduino.cc/
- http://fritzing.org/home/
- https://circuits.io/users/0

- Many, many, DIY videos on how to communicate wirelessly, drive motors, etc.

How to go above and beyond:

- Order a printed circuit board of final design
- Make your own printed circuit board. (It might not look as good at a commercially bought board, but it will get you more points.)
- Data log (or real-time display) vehicle tilt or position. Use an accelerometer (probably one with 9 degrees of freedom) to create a dead reckoning program that calculates the total distance your vehicle traveled while on course (see CompSci challenge).
- Make your own microcontroller board