# Puzzle Panel Itearation 1

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***Abstract*—This document reviews the purpose and creation of the first iteration of puzzle panels for the HackRover Autonomous Robotics Competition (HARC). Puzzle panels host puzzle elements that work together to constitute a puzzle. We designed 3D printable, electromechanicial puzzle elements that simple rovers can readily interact with. Control is accomplished via Arduino, and power is provided through a simple power distribution system (PDS). This paper explores design choices on various fronts throughout the development of iteration 1.**

## I. Introduction

Puzzle panels are competition 'props' which rovers can interact with to score points. Our early goals were to create something modular, quickly iterable, and electrically robust. We wanted to ensure unique puzzles could be created without too much down time. We also considered human and AI solvability such that present and future competitions could proceed in the event of person or computer-assisted competitors.

A modular puzzle panel would be easy to arrange electrically and mechanically and program in something like an Arduino IDE. A quickly iterable puzzle panel would be capable of displaying a distinct, unsolved puzzle in short time, related to concepts of physical/logical modularity. An electrically robust panel would ensure power is delivered to all devices in a clean and reliable fashion with low risk for failure.

## II. Related Works

### A. Portal Series

Inspiration was taken from Portal and Portal 2 game development principles. Portal is a series of puzzle games where the player must make their way through a robotics facility 'testing' the function of a portal gun through the completion of electromechanical puzzles. The puzzles in the game consist of distinct components which all interact with one another to constitute a larger puzzle. With about 20 distinct puzzle components/elements, game developers can create an infinity of puzzles which can be immediately attempted by anyone who has spent 15 minutes playing the game; this was our main point of inspiration. **INCLUDE IMAGE OF SIMPLE PORTAL 2 PUZZLE IDENTIFYING PARTS**

## III. Method

For the first iteration, efforts were sectioned into Mechanical, Electrical, and Software, with the mechanical role dictating most of the design parameters.

### A. Mechanical

The complete puzzle panel was designed in two parts: (1) physical panel and mounting, (2) the puzzle components.

*1) Puzzle Panel and Mounting:* There was a variety of early designs for mounting, but the obvious winner involved two part velcro. However the panel was to be constructed, it would host a sheet of tough velcro that would allow puzzle elements - fitted with soft velcro - to adhere and be removed easily.

Some spare plywood and 2x4's were found at Justin Heinzig's house, so he repurposed them to create the panel body. Two, perpendicular plywood faces, (18" square and 9" by 18") act as mounting surfaces for puzzle elements. Velcro is fitted to the vertical face in the form of 6x18, sticky backed strips. **INCLUDE IMAGE OF PUZZLE PANEL**

*2) Puzzle components:* As mentioned in the related works, puzzle elements were designed to be arranged in conjunction with one another to create a puzzle. The ideas for iteration one were a: button, potentiometer, ultrasound sensor, servo, and light strips. Each element recieved a housing which modified it to become velcro mountable and/or enhance it's function and interfacability with rovers. The first three elements are purely sensory, the fourth is actuative, and the fifth is visual aid. **INCLUDE IMAGE OF AN EXAMPLE PUZZLE COMPONENT**

### B. Electrial

The first iteration puzzle panel is powered by a rudimentary power distribution system (PDS); this was intended as practice in basic electronics for our electrical engineers. The purpose of the PDS was to recieve power from a wall wart, convert voltage to a meaningful value, and convey power in a controlled fashion to easily acccessible pins. **POSSIBLY INCLUDE IMAGE OF SCHEMATICS**

A port, buck modules, and female pin headers were all soldered to GikFun solderable bread boards. The port serves to convey power from the wall wart, through bread board traces, and to the buck modules. Buck modules are electronic devices capable of stepping down voltage from some higher value to a lower one. In our case, 5V was a pretty common voltage output. Current is also presumably limited in some fashion by the buck module. Finally, the female pin headers give students modular access to power for powering Arduino-compatible electromechanical devices. There is also an output port from the PDS which delivers clean, 5V power to the Arduino sitting atop. **INCLUDE IMAGE OF BREADBOARD**

All breadboards are mounted on racks in a plastic housing. **INCLUDE IMAGE OF HOUSING**

### C. Computer

**TO BE WRITTEN BY LONG PRESUMABLY**

## IV. Results

In like fashion to the methods, results will be presented according to discipline.

### A. Mechanical

Both the panel and elements were a success. Some improvements could be made in the woodframe panel design by considering construction procedure, as it was a bit difficult to affix everything together. The velcro operated nicely as intended.

The puzzle elements turned out nicely with regard to construction. Aesthetically they appeared dissimilar, so work could be done there.

### B. Electrical

**TALK ABOUT THE RESULTS AND PERFORMANCE OF THE PDS. Perhaps break things up according to tests. Have subsubsections that each represent a different test**

*1) Testing to ensure good current flow:*

*2) Testing to ensure desireably power output:*

### C. Computer

**To be written by Long**

## V. Conclusion

**TO BE WRITTEN AT A FUTURE TIME WHEN THE PROJECT IS CONCLUDED**

## VI. Future Work

Future improvements could be made to the design of the puzzle panels, either by making them larger (in 6" horizontal increments ideally), and/or by considering how they will be constructed. Little mind paid to how the different pieces would affix to one another led to dangerous construction positions.

## Acknowledgment

**TO BE WRITTEN AT A FUTURE TIME**