Rubik's Puzzle Timer

Concept Proposal

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Revision History

Date	Comments
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1. Introduction

1.1. *Document Scope*. This document conceptually outlines a prospective project for the design and manufacture of a puzzle timer suitable for officially timing solutions to hand-held puzzles such as the Rubik's cube.

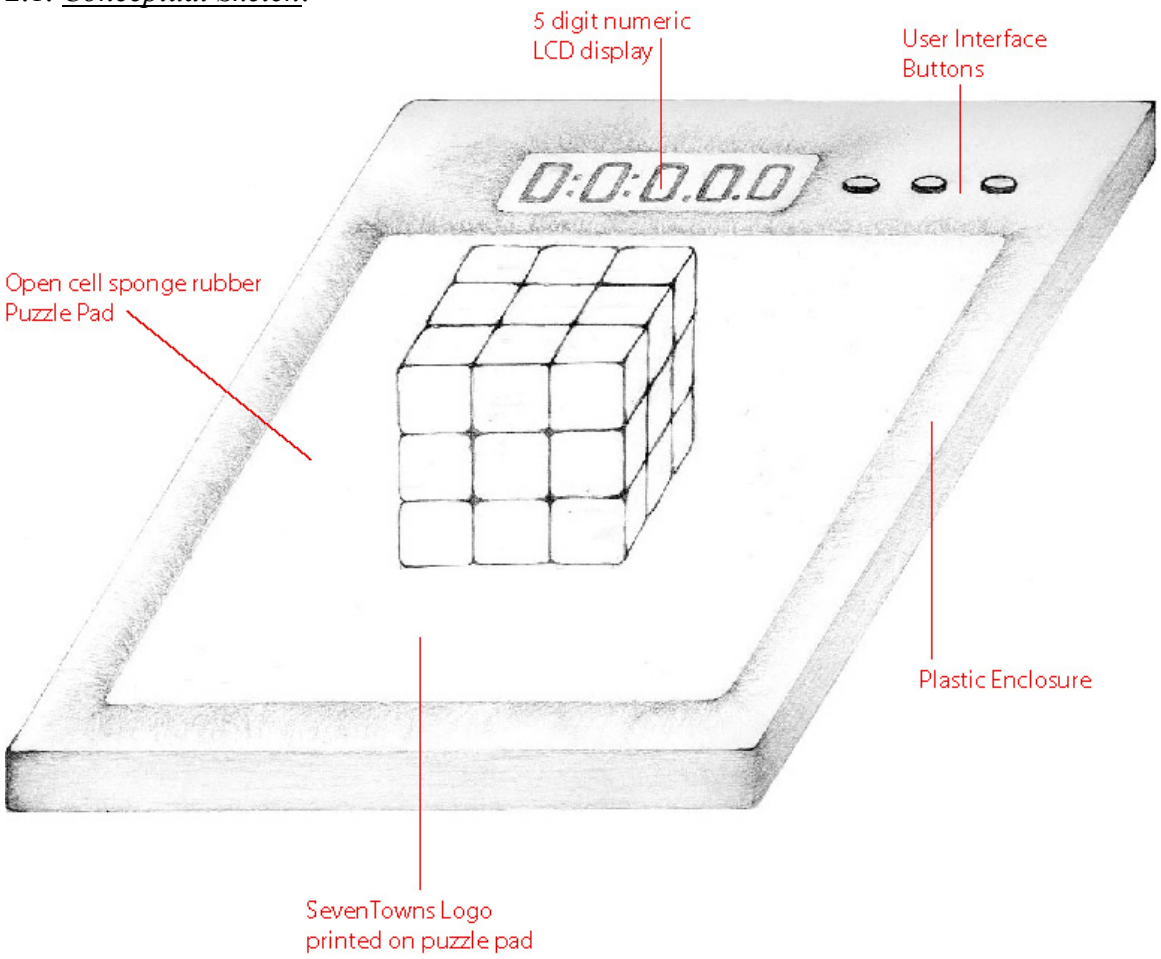
1.2. *Project Background*.

The puzzle timer is being proposed by Mission Designs, a sole proprietorship based in New Hampshire, owned by Eric Johanson. Eric is an avid speed-puzzler himself and recently competed in the 2003 Rubik's world championships.

At the recent world championships, the SpeedStacks timer was used for timing solutions. While the timer worked adequately, everyone agrees that this was a compromise because nothing better exists. It is the intent of this project to design and build something specifically suited to the task of timing solutions to hand-held puzzles.

2. Technical

2.1. *Conceptual Sketch*.



- Artist sketch is not to scale; it is only to show concept
- Puzzle timer measures perhaps 6” x 8” and is perhaps ½” high
- Puzzle pad area is approximately 5” x 5”
- Puzzle pad has a hole in center (not shown), under which photocell is mounted in the plastic enclosure
- Not shown in sketch is communications port, DC power connector, on-off switch; all are probably located on the far side of the timer

2.2. *Basic Principal of Operation*. The puzzle timer times the solution to hand-held puzzles for use in sanctioned competitions or for practice. It does this by presenting the solver with a pliable but firm pad with a small circular hole in the center, beneath which a photocell is mounted.

The solver places the scrambled puzzle on the puzzle pad, covering the photocell, and then resets the timer via a user-interface button. When the solver picks up the puzzle, ambient light triggers the photocell and timing begins on the built-in LCD display. When the solver has finished, he places the puzzle back on the pad and timing ends. The solver can then view his solving time on the LCD display. These basic principles for timing (photocell trigger) were used successfully in the early 1980's in sanctioned Rubik's cube competitions (sanctioned by Ideal Toy Corporation).

Since the puzzle timer is controlled by a small microprocessor, it will be possible to include numerous additional timing features, limited only by imagination. More sophisticated features would include averages of 10 (or any number of) solves, discarding a time due to puzzle dismemberment (pop), perhaps a long-term average (stored in the microprocessors built-in flash memory), etc.

2.3. *Conceptual Feature List*.

2.3.1. *Single Solve Times*. This is the most basic mode of operation. The solver executes a single solution to a puzzle and the time is displayed

2.3.2. *Average-of-N Times*. It is widely accepted in the speed-puzzling community that a single solution is not a good indicator of skill. Rather, an average of 5 or 10 solves is taken to make the resulting time more statistically relevant. The puzzle timer would allow the solver to start an average, and before each solve, it will indicate to the solver in the LCD panel which attempt he was about to begin. At the end of all attempts, the puzzle timer will indicate that the average has been completed and display the average in the LCD panel.

2.3.3. *Pop / Discard*. When speed-solving a hand-held puzzle such as the Rubik's cube, the fast motion occasionally causes the puzzle to "explode" or "pop" a puzzle piece. A button will be provided to allow the solver to indicate to the timer that the current solution was invalidated by such an event. The puzzle timer will then ignore the time for purposes of averaging.

2.3.4. *Setup Parameters*. Numerous parameters will be available in "setup" mode. This will allow the solver to set averaging and other long-term parameters. These parameters are saved in the microprocessor's flash memory even when the unit is powered off. Parameters might include:

- Default number of attempts per average
- Auto-discard fastest & slowest in averages
- Photocell sensitivity

2.3.5. *External Communications Port*. A small port on the side of the enclosure will enable the puzzle timer to be connected to external equipment. This

port will use the standard RS-232 communications protocol. This will allow the puzzle timer to communicate with a personal computer or a large tournament display.

The puzzle timer's communications port will allow the timer to communicate with a large tournament display for use in large tournaments. Mission Designs has contacted SpeedStacks Inc, the manufacturer of a large tournament display, and they have supplied the necessary technical information for the puzzle timer to communicate with their tournament display. The SpeedStacks tournament display can be seen at http://www.speedstacks.com/store/products/403.htm. This tournament display was used at the recent 2003 Rubik's world championships. The communications port will allow the puzzle timer to communicate with this tournament display.

The puzzle timer's communications port will also allow the timer to communicate with nearly all personal computers that have a serial port (and nearly all do). This capability allows for infinite flexibility in managing solve times for multiple puzzles to an extent that is not possible with the built-in buttons and small LCD display. Mission Designs will write a database application for the Microsoft Windows operating system for long-term storage and management of solve times for multiple puzzles. The features of such an application would be outlined later.

2.4. *Electronics*.

2.4.1. *Power Supply*. All electronics will operate at a level of 3 volts. Two replaceable standard AA batteries will be located inside the unit for powering the electronics. An optional external DC power supply connection will also be provided on the side of the enclosure.

2.4.2. *LCD Display*. A prospective LCD display has been sourced which contains 5 numeric digits and colons and decimal-points in appropriate locations. The display is suitable for displaying times with an accuracy of one-hundredth of a second (0.01) for all times ranging from 0 to just under 10 minutes. Beyond 10 minutes, accuracy is reduced to one-tenth of a second (0.1).

2.4.3. *PCB Board*. Mission Designs will design the electronic schematic, and a small PCB (printed circuit board) will be spun at a local electronics manufacturing plant. The PCB board will be the mounting location for the power switch, external display port, external power supply jack, user buttons, micro-processor, LCD display, and other supporting circuitry.

2.4.4. *Microprocessor*. A cost-effective 3 volt microprocessor has been sourced from Zilog to execute the firmware to operate the timer. The microprocessor contains built-in discrete and analog I/O, built-in flash memory to store the firmware, built-in RAM, built-in RS-232 interface (for the external communications port), and built-in I2C interface (for operating the LCD display).

2.4.5. *Photocell Sensor*. It will be necessary to source a simple photocell sensor, probably a simple cadmium sulfide cell. Numerous other trigger mechanisms have been considered, including a weight-sensing mechanical switch, capacitive proximity switch, convergent reflective photoelectric sensor, and others. It could be argued that these other options are more desirable. However, Mission Designs has thus far determined that the only cost-effective sensor is the simple cadmium sulfide cell, although investigation is ongoing.

The cadmium sulfide photocell is also a known and proven technology for timing puzzle solutions, since it was used in custom timers from the early 1980's for Rubik's cube tournaments sanctioned by Ideal Toy Corporation.

2.4.6. The remaining required supporting circuit components are easily sourced and this will be done when the project is launched.

2.5. *Enclosure and Mechanical*.

2.5.1. *Plastic Enclosure*. Since the puzzle timer will be produced in low quantity (200 or less per run), it does not make financial sense to pay for the tooling necessary for plastic injection molding. Instead Mission Designs has sourced a company to produce low-quantity plastic enclosures that do not use expensive tooling, although each enclosure will have a higher cost than with injection molding.

The enclosure will be manufactured in two halves and will be screwed together. It will contain standoffs for mounting the internal PCB board, a battery holder, and cutouts for the various user-accessible parts. The enclosure will likely be a colored plastic solid in color.

2.5.2. *Puzzle Pad*. The puzzle pad is the surface on which the puzzle rests before solving begins, and is the surface to which the user returns the puzzle after it is solved. It will be constructed of a custom-cut "open cell sponge rubber" (commonly known as a mouse-pad). This pliable but firm surface is perfect for this application because it will not itself be damaged by a puzzle being slammed onto it, nor will it damage a puzzle that is placed on the pad by a solver going at top speed.

Mission Designs has sourced several companies which will custom-cut open cell sponge rubber to custom shapes. The visible surface of the pad can contain any number of custom graphic designs. Mission Designs hopes to yield the design of the graphics on the puzzle pad to SevenTowns, in exchange for an endorsement of the puzzle timer as the "official" Rubik's timing device.

3. Commercial

3.1. *Financial*.

3.1.1. *Non-recurring Engineering Design*. One time initial design costs fall into the following categories:

- Electronic schematic design (Mission Designs)
- PCB design and tooling (Outsourced to a local PCB manufacturer)
- Tooling fee for the custom cut open cell sponge rubber
- Plastic enclosure design and tooling (Outsourced to selected supplier)
- Materials cost to build a single prototype timer for evaluation

3.1.2. *Recurring Production Costs*. Production costs fall into the following categories:

- Electronic components materials cost
- Open cell sponge rubber materials cost
- PCB manufacture
- Plastic enclosure manufacture
- Final assembly
- Packaging for shipment

3.1.3. *Sale Price*. The puzzle timer will clearly be produced in low-quantity runs (200 or less per run), and this has an impact on price. Based on the rough pricing obtained from initial sourcing of components, Mission designs hopes to sell the timer for around $80. An exact sale price will be set as the project develops. Mission Designs seeks to sell the timer at a small profit, to insure that the puzzle timer project is sustainable over time.

3.2. *Design Ownership*. Mission Designs will own the electronic and mechanical design of the puzzle timer as intellectual property.

3.3. *Endorsements*. For the puzzle timer to gain support in the puzzling community, it will be necessary for it to be endorsed as the "official" timing device for one or more puzzles. Mission Designs is first and foremost interested in the puzzle timer being declared the "official" timer for the Rubik's cube puzzle. It will be highly desirable for SevenTowns, the current owner of the Rubik's trademark, to endorse this product as the "official" Rubik's timer. This would be conveyed on the graphics design on the puzzle pad.