Levitation Clock P13321

Final Project Review – MSD II

- *Trong Duong – Electrical Engineer*
- *Kevin Fronczak – Electrical Engineer*
- *Holden Sandlar – Electrical Engineer*

Project Description

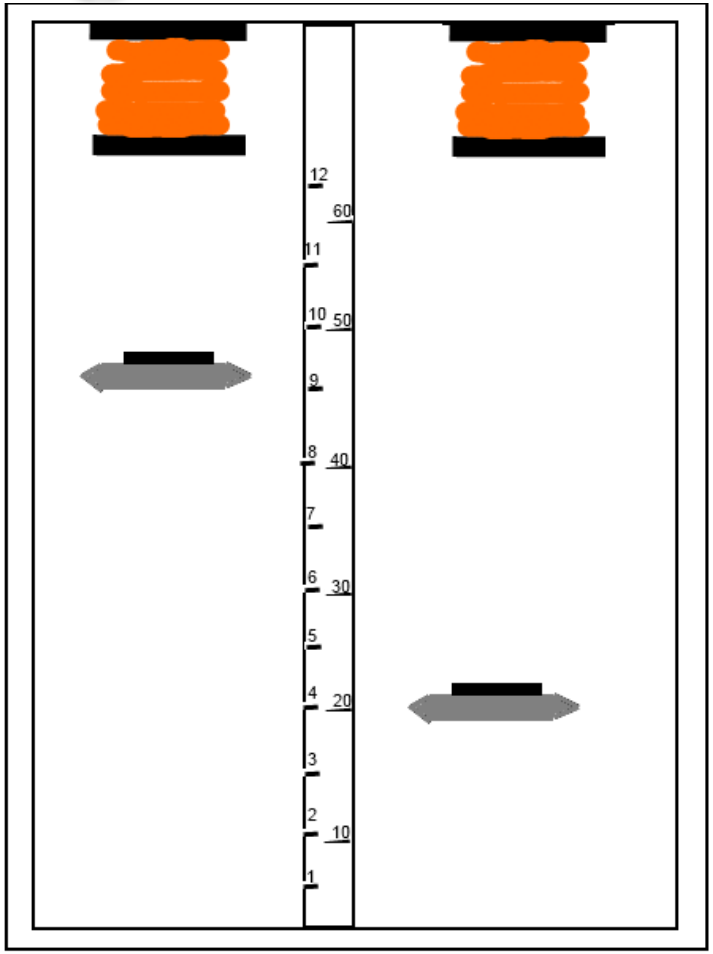
- A clock that uses levitation to tell time.
- Appear “magical” to the observer
- Design a clock that would look cool and aesthetically pleasing as a display unit

Customer needs and Engineering Specifications

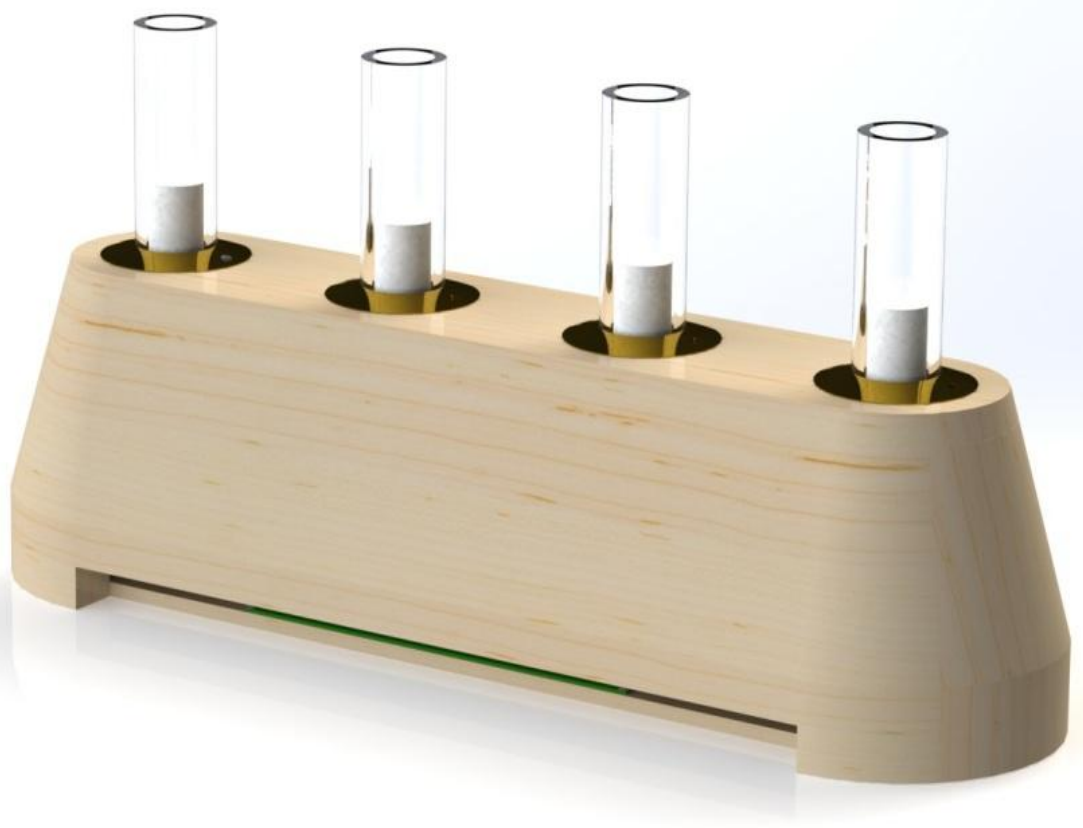
Customer Need #	Importance	Description	Comments/Status
CN1	2	Autonomous start/stop	Start/Stop levitating without user assistance even if power fails
CN2	1	Visibility from decent distance	Clock size and environmental lighting
CN3	1	Adjustable time set point	Easy user input for time set point and user feedback(LCD) to show set point
CN4	2	Standard wall outlet power	US Standard
CN5	2	On/Off Indication	Clock On/Off indicator
CN6	1	Indoor Operation	Room temperature and humidity
CN7	3	Outdoor Operation	Northeast US climate
CN8	1	Hour accuracy	Minutes do not need to be perfectly accurate
CN9	3	Night time visibility	Environmental lighting
CN10	1	Appear Magical	Want it to seem like magic

Spec. #	Importance	Source	Function	Specification (metric)	Unit of Measure	Ideal Value	Marginal Value	Comments/Status
S1	2	CN1, CN5	No user interaction required for operation	Start/Stop levitation when power is applied or removed	seconds	1	5	Clock will autonomously operate within 0-5 seconds from power event
S2	1	CN2	Aesthetics	Visibility from at least 8 feet	feet	15	8	
S3	1	CN3	User Feedback	Easy user interface and feedback system for time adjustment	seconds	10	60	Units are how long it takes user to change time
S4	2	CN4	Power	Current Draw	A	1	5	
S5	2	CN5	User Feedback	Power On Indicator	Binary		Pass	
S6	1	CN6	Control and Stabilization	Proper sizing for indoor use. Interference rejection for indoor use.	inches	12	18	Value may change after concept analysis
S7	1	CN8	Time telling	Hour indicator must be larger than minute indicator. Hours must be clearly displayed on clock. Must be accurate within ± 30 minutes	minutes	10	60	Accurate to 60 minutes
S8	2	CN2	Time telling	Viewing angle	degrees	360	30	Minimum ±15 degree viewing angle from straight-on

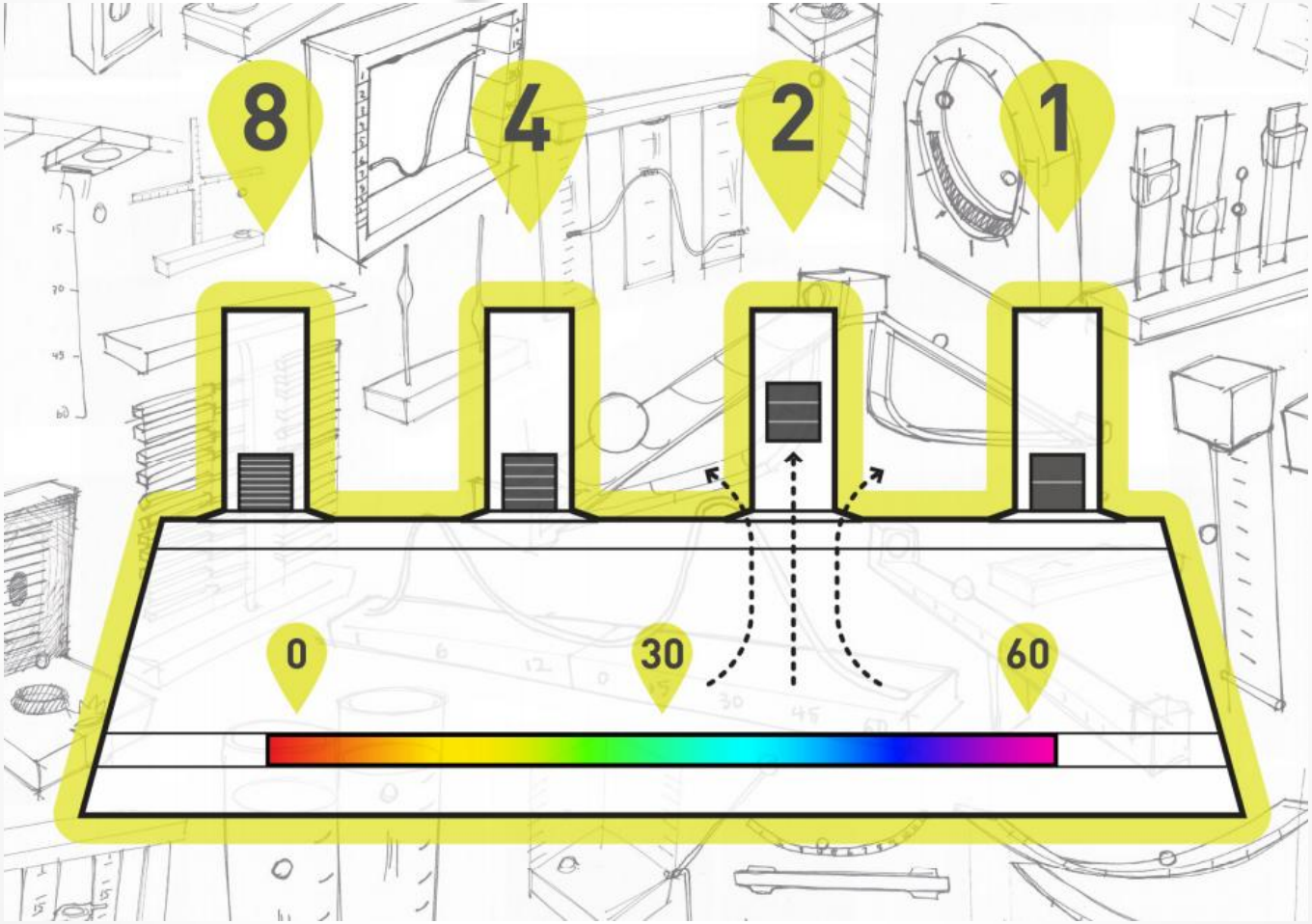
Original Concept



Final Design Concept



Operation



Build Process

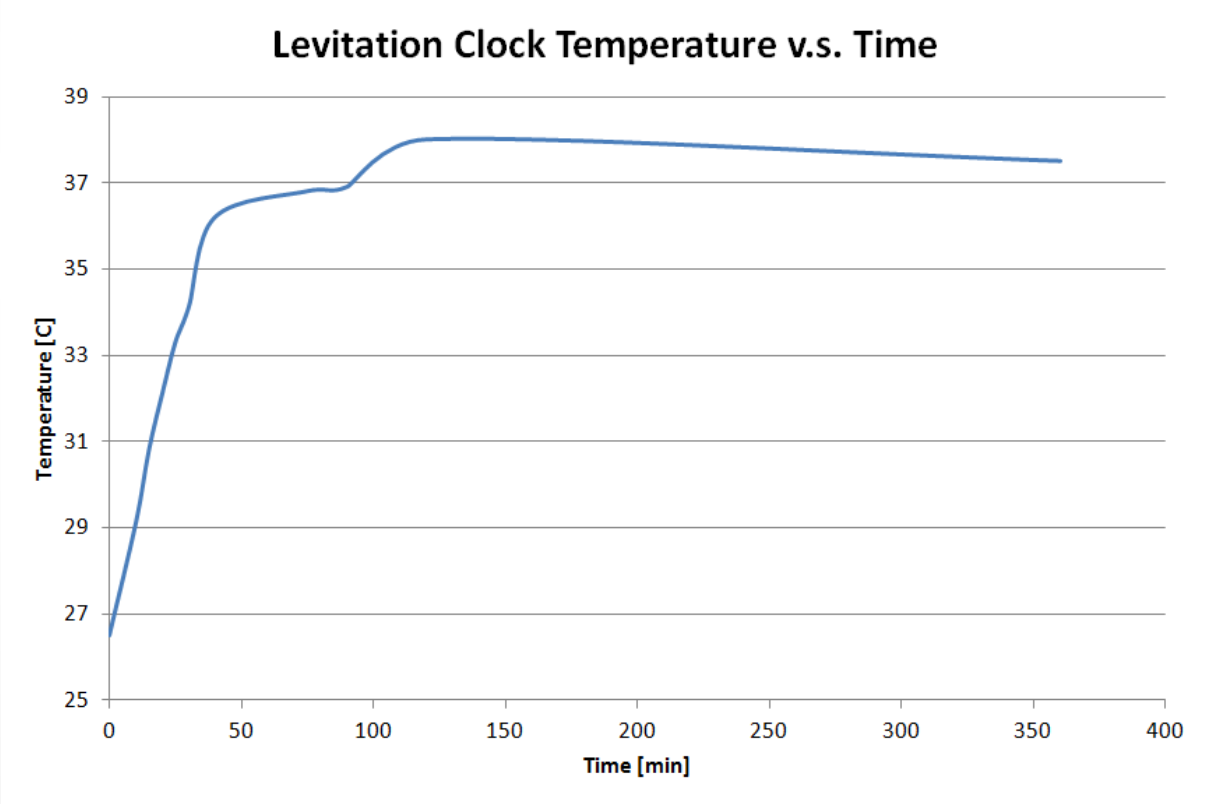
- PCBs fabricated and ordered via OSHPark
- Wood Frame built by Byron Conn
- Glass Tubes purchased. Cut, rounded, and annealed by Tom Zogas
- Tube Support Rings 3D printed by Vince Burolla
- Levitating Objects cut from high-density foam

Test Process

- Verify User Interface Operation
- Verify Main Controller Signal Routing
- Verify RTC Functionality
- Tune Solenoid Lift Height
- System Integration Testing

Temperature Test

- Ran clock in "Test Mode" at Imagine RIT
  - 7 hours



Lessons Learned

- Temperature/Heat dissipation big concern
- Molex KK connectors should NEVER BE USED
  - They were manufactured by Satan himself
- Hand-winding coils imprecise and tedious
- If something looks like it COULD be touched, someone will ALWAYS TOUCH IT
- Triple-check BOM entries after design changes
  - Ordering incorrect package size or wrong regulator very easy to do
- Quadruple check PCB layout
  - Helps avoid rework
  - Missing standoffs on main board