	PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5	PHASE 6
GOALS	Market Research Understand motor options Assess risk of success/failure Determine throwing motor options Understand effective throwing wheel spacing	Settle on wheel material, design, dimenions Complete design of motor mounts Complete design of ball ramp Design Outer frame Design elevation mechanics Identify potentiometers to be used Solder & wire potentiometers Program PWM signals for DC motors	CAD model of control box Test fit potentiometer and button holes on control panel Establish pin assignments for motors, buttons, potentiometers, switches, motors, sensors Program feed motor stepper motor CAD model of feed rotor Select stepper motor for feed mechanism Select gear ratio for feed stepper motor CAD Model of feed stepper gear Wire feed stepper motor and driver	Design ball funnel and folding walls Plan/Research various oscilation mechanical options. Research stable oscilation bearings Select optimal pulley ratio for oscilation stepper Select oscilation stepper motor Design oscilation motor mount 3D print control box Assemble control panel	Oscilation completion RF Remote Completion	Stress test all features Real world tests and user feedback Make minor mechanical, electrical, and coding tweaks Ideate potential V2 improvements
RESEARCH	Assess market viability Competitor Feature Table Demo competitor ball machines Evaluate competitor materials and mechanics Assess potential for improvement over competition					Custom PCB Design Rotary Encoder Implementation LCD Display to replace control panel
FEATURES	Prototype ball ramp Prototype belt drive and direct drive DC Prototype pulse width modulation control	Motorized elevation implementation Aluminum Frame Permanent Motor Mounts Fixed Ball Ramp	Feed rotor implementation Control panel design Chip pin assignments	Complete feed design element Plan Oscilation implementation Assemble control panel Plan RF Remote	Oscilation Build RF Remote implementation	All feature fixes as needed Ideate V2 improvements
DESIGN		Settle on wheel material, design, dimenions Complete design of ball ramp Design/Build Outer frame	CAD model of control box Test fit potentiometer and button holes on control panel CAD model of feed rotor	Design ball funnel and folding walls Design oscilation motor mount 3D print control box Assemble control panel Install control panel onto aluminum frame	Build oscilation baseplate 3D print oscilation pulleys	Ideate V2 improvements
CODING		Program PWM signals for DC motors Program stepper pulses for elevation stepper	Establish pin assignments for motors, buttons, potentiometers, switches, motors, sensors Program feed motor stepper motor	Implement pin assignments into code Compile previous coded features into single program	Program RF Remote Program oscilation controls Adjust potentiometer range values	Fix any bugs coding tweaks based on testing Ideate V2 improvements Program drills
MECHANICS	Research/Assess motor choices Evaluate belt driven vs direct drive DC Evaluate wheel material choices Evaluate durability, build complexity CAD model of ball ramp CAD model of wheel spacing and fit of motor options 3D print ball ramp and related parts Assemble aluminum motor frame	Settle on wheel material, design, dimenions Complete design of motor mounts Complete design of ball ramp Design elevation mechanics Select stepper motor for elevation control	CAD model of control box (mechanical input) CAD model of feed rotor (mechanical input) Select stepper motor for feed mechanism Select gear ratio for feed stepper motor	Plan/Research various oscilation mechanical options. Research stable oscilation bearings Select optimal pulley ratio for oscilation stepper Select oscilation stepper motor Design oscilation motor mount Assess oscilation pulley pitch/length	Install oscilation stepper, pulleys, bearings	Minor mechancial tweaks as needed Ideate V2 improvements
ELECTRICAL	Evaluate battery chemistry Evaluate cost/weight/capacity	Identify potentiometers to be used Solder & wire potentiometers Select battery Plan/Design voltage conversion Plan power distribution Wire stepper driver Select elevation buttons Solder & wire elevation buttons	CAD model of control box (electrical input) Establish pin assignments for motors, buttons, potentiometers, switches, motors, sensors Wire feed stepper and driver Solder and wire feed potentiometer Provide component schematics to design for control panel	Wire and provide guidance for components for control box assembly Select RF Remote/Receiver	Wire oscilation stepper/driver Wire RF Remote	Minor electrical tweaks as needed Ideate V2 improvements
TESTING	Test competitors products Test belt drive wheel launch distance and velocity Test direct driven wheel launch distance and velocity Test EVA foam wheel and Neoprene densities Test various wheel diameters Measure maximum wheel RPM potential	Test stability of elevation adjustment Test Ball Ramp Arc Spacing Test optimal elevation stepper speed	Test hole sizing and spacing for control panel and planned components Test rotor performance for collecting balls Test rotor speed Test rotor potentiometer	Test Control Panel Test feed speeds and reliability Test control sensitivity, assess ranges	Assess oscilation range and speed Test RF Remote	Stress test all features Test in various conditions Get user feedback Measure final specs Velocity, Spin, Feed, Ball Capacity, Battery life, Oscilation speed, weight, Remote distance
METRICS	MCS - Maximum 50 MPH Velocity MCS - At least 44 feet throwing distance MCS - Consistent velocity and trajectory MCS - Maximum 15 inch variance for dinks MCS - Maximum 30 inch variance for launches longer than 20 feet (wind speed under 8 mph).	MCS - Rigid aluminum frame with adjustable motor mount MCS - Ball ramp has functional incline between line drives and lobs MCS - Working velocity potentiometer MCS - Working elevation up/down buttons	MSC - Control panel (on/off switch 24v, start/stop button, velocity pot, spin pot, feed pot, elevation up/down buttons, oscilation on/off switch, oscillation range/speed pots, remote on/off switch) MCS - Functional feed rotor that drops ball consistently on the ball ramp MCS - Functional potentiometer speed adjustments for feed rotor. MCS - At least a max feed rate of one ball per 0.08 seconds.	MCS - All controls working except Oscilation/Remote MCS - Control box holds majority of electronics MCS - Control box is mounted to frame	MCS - Functional Remote at 60 FT minimum MCS - Oscilation on/off button functions MCS - Oscilation range covers full court width when machine is placed at kitchen line MCS - Oscilation range potentiometer functions MCS - Oscilation speed potentiometer functions MCS - Oscilation speed potentiometer ranges from zero to one arc per second	