2. Capture the voice of the customer in the Engineering Requirements.

Customer Requirements	**Engineering Requirements**
Detect color	More than 95% color classification accuracy
Detect shape	More than 90% shape classification accuracy
Detect position	Locates the centroid with x and y positions
Detect accurately	System must detect different shapes and color accurately getting 10 out 12
MATLAB connected with webcam	Must be done in MATLAB with webcam input

Customer Requirements	**Engineering Requirements**	**Test Method**
System must pot selected ball into selected pocket	Cue mechanism must strike cue ball within 5% angular accuracy with sufficient force to pot said ball.	Run 10 trials per ball-pocket combo and measure success rate
System must avoid potting the 8-ball	Webcam must identify and exclude 8-ball.	Place 8-ball on table and verify it is never selected or targeted
System must accept user input via GUI	GUI must allow ball and pocket selections within 10 second response time	Time GUI response and validate correct input mapping
System must be quiet and smooth	Motorized components must operate less than 75 dB and with a less than 10% velocity ripple	Measure sound level and motion profile during operation
System must be safe	No exposed moving parts. Emergency stop button available. Clean wiring.	Visual inspection and functional test of safety features
System must be efficient and fast	Full shot cycle must be completed in less than 30 seconds	Time from user input to ball potting over 20 trials

3. Generate creative solutions to the engineering problem

1. Linear Cue Slider:

- Cue mounted on a linear rail, actuated by a stepper motor.

- Pros: Simple, precise

- Cons: Limited angle control

2. Rotating Arm with Cue

- Arm pivots around cue ball, striking at variable angles.

- Pros: Full angular range

- Cons: Requires precise control

3. Spring Loaded Cue with Servo Trigger

- Cue held under tension, released by servo

- Pros: Fast and powerful

- Cons: Hard to control force

4. Electromagnetic Plunger

- Solenoid based striker for cue ball

- Pros: Compact and fast operation

- Cons: System needs high current in order to work.

5. Air Powered Cue

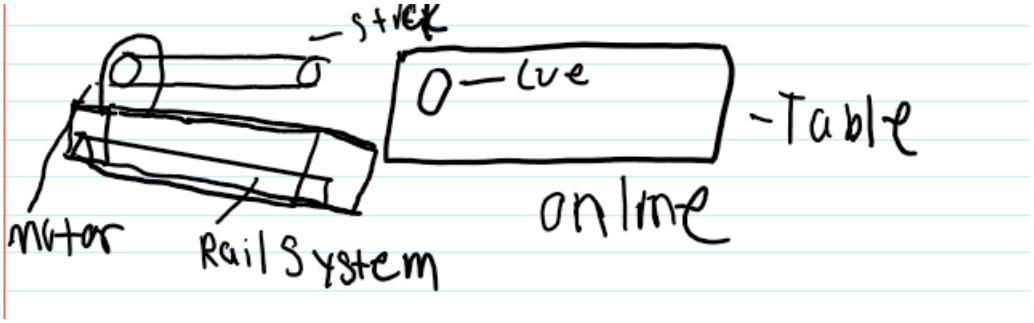
- Pneumatic burst pushes cue forward

- Pros: Quiet and smooth

- Cons: Requires air system

Top 3:

1. Linear cue slide
   - A cue mounted on a linear rail aligned with the cue ball. A stepper motor will drive the cue forward in a straight line to hit the cue. The cue stick will be on the back of the table, according to the customer's requirements it will be placed on one half of the table each time. The rail system will allow the cue stick to move and position itself behind the cue ball to be able to aim and hit the ball into the desired ball that is chosen from the webcam dictation system.
   - Main features would be precise linear motion, simple design and easy to control force with the motor speed



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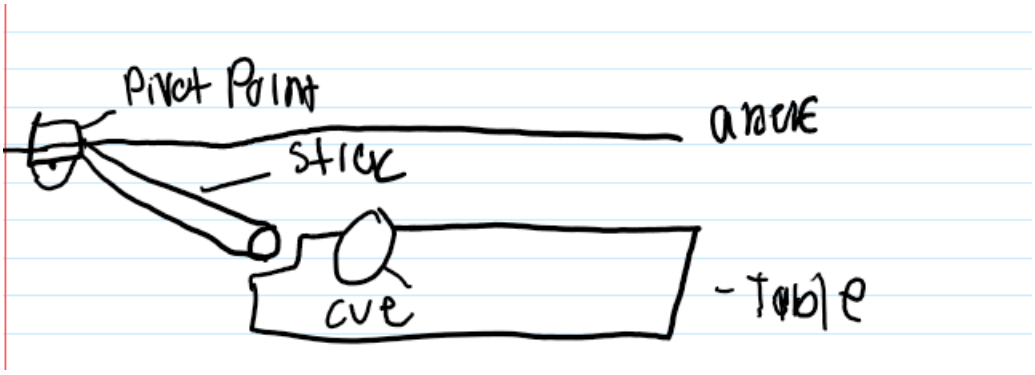
   - In the sketch up, you have the rail system with the motor driving the cue stick that is placed behind the pool table that is in line of the cue stick. There will also be the webcam placed above the table to be able to scan the field of play and determine the ball we need to hit and to which hole in the table to hit it.
2. Rotating arm and cue
   - A motorized arm pivots around the cue ball, allowing variable angle strikes. The cue is mounted at the end of the arm and actuated to hit the ball.
   - Main features: Full angular range. High flexibility for shot direction and requires coordinated control of angle and force.



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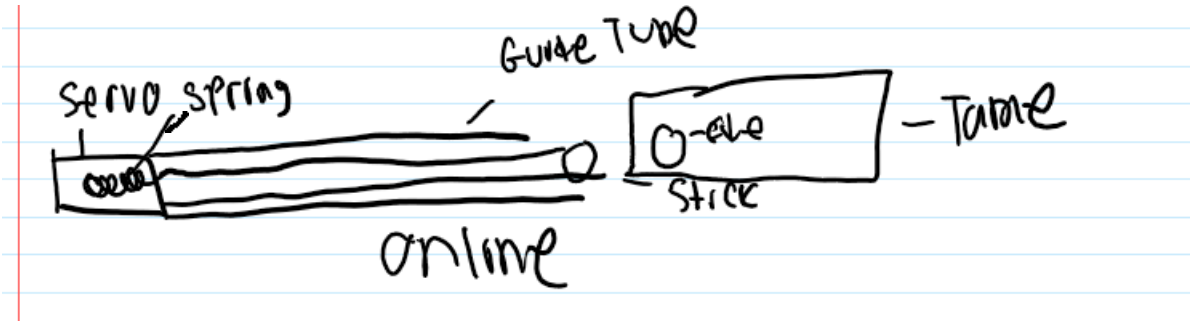
3. Spring loaded cue with servo trigger
   - Cue is held under tension using a spring or elastic band. A servo releases the tension to strike the cue ball.
   - Main features: Fast, powerful, simple to make a release mechanism, would be hard to get the force precise.



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Criteria	Weight	Concept 1	Concept 2	Concept 3
Accuracy	4	9	8	6
Cost	2	8	6	9
Ease of implementation	3	9	7	6
Safety	1	9	8	5
Speed	2	6	9	7
Robustness	2	8	7	9
Total Score		116	105	97

Weight: 1-4 Least to most important

Linear Cue Slider is the winning design.