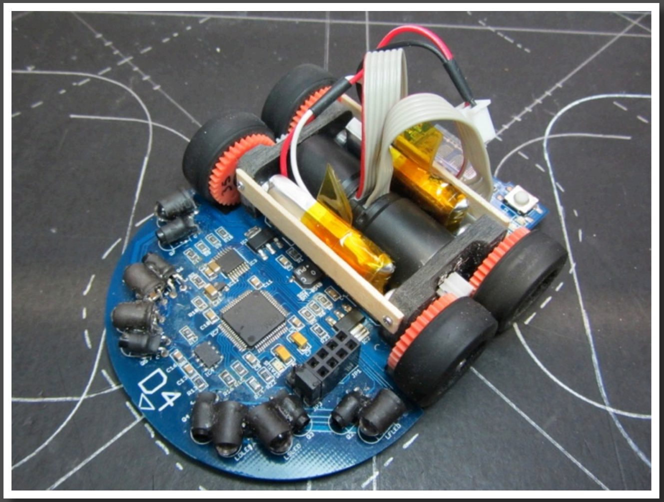
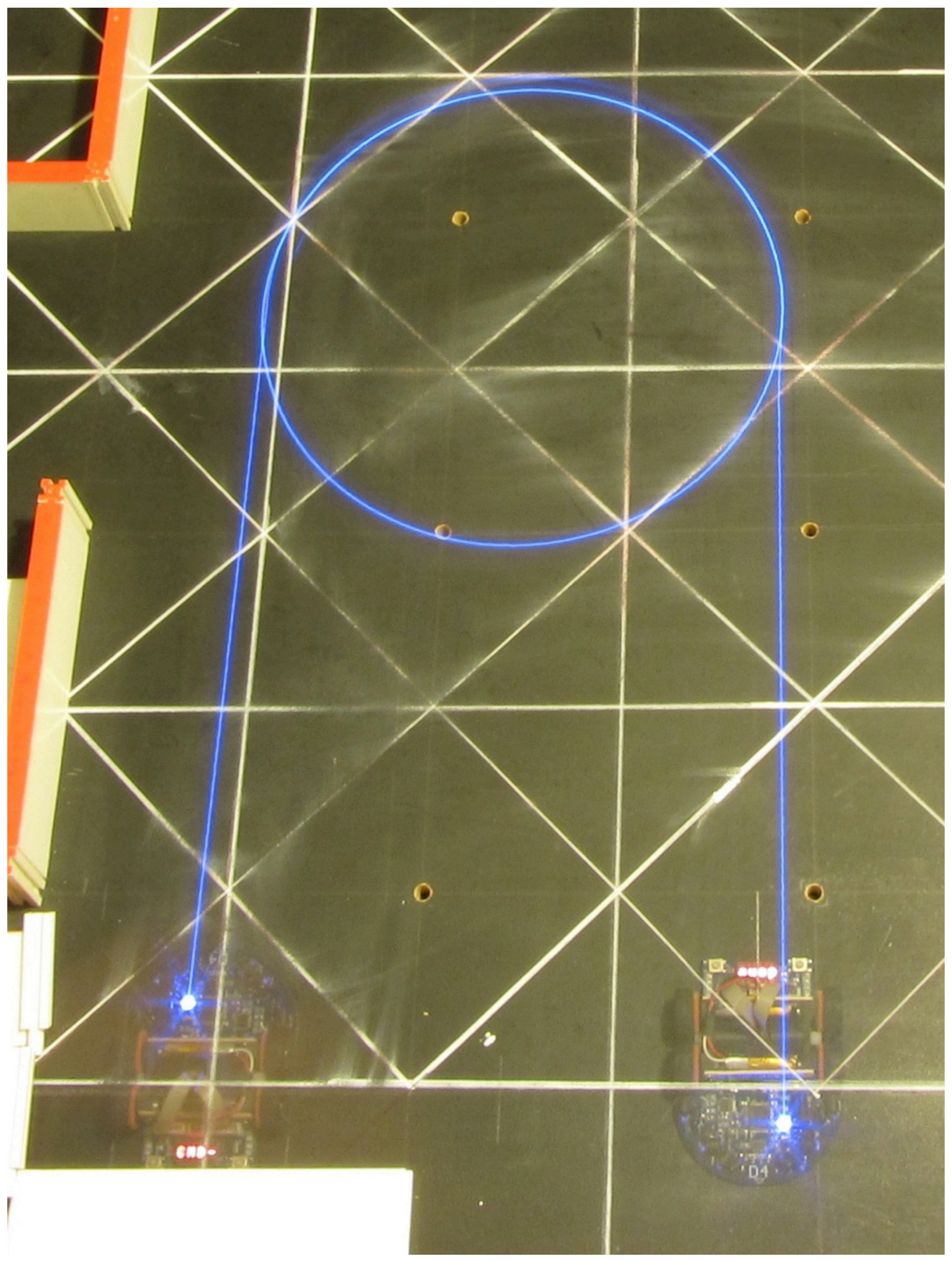


CONSTANT RADIUS VARIABLE SPEED TURNS

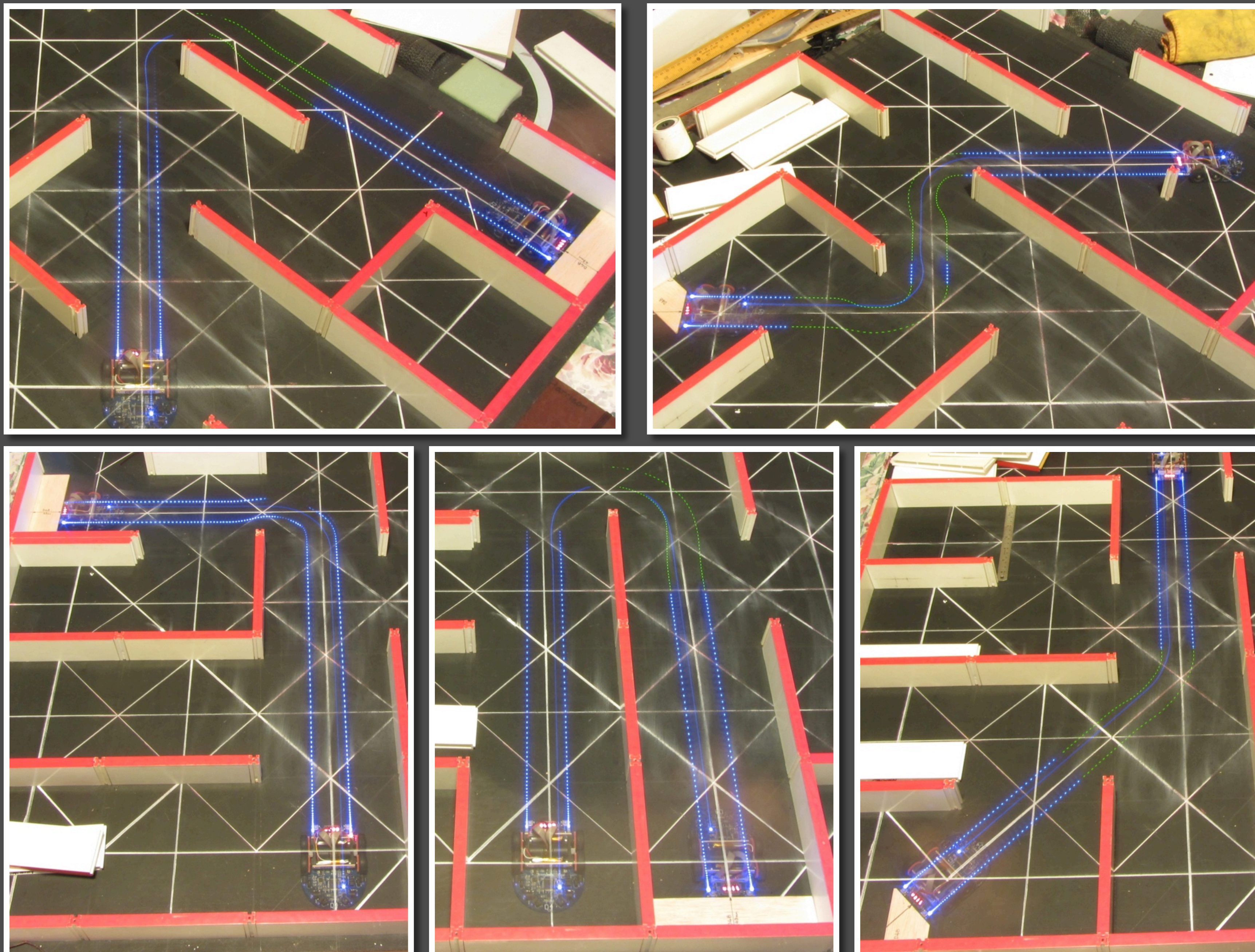
Peter Harrison
Minos 2015



Micromouse turns need to be stable and repeatable.

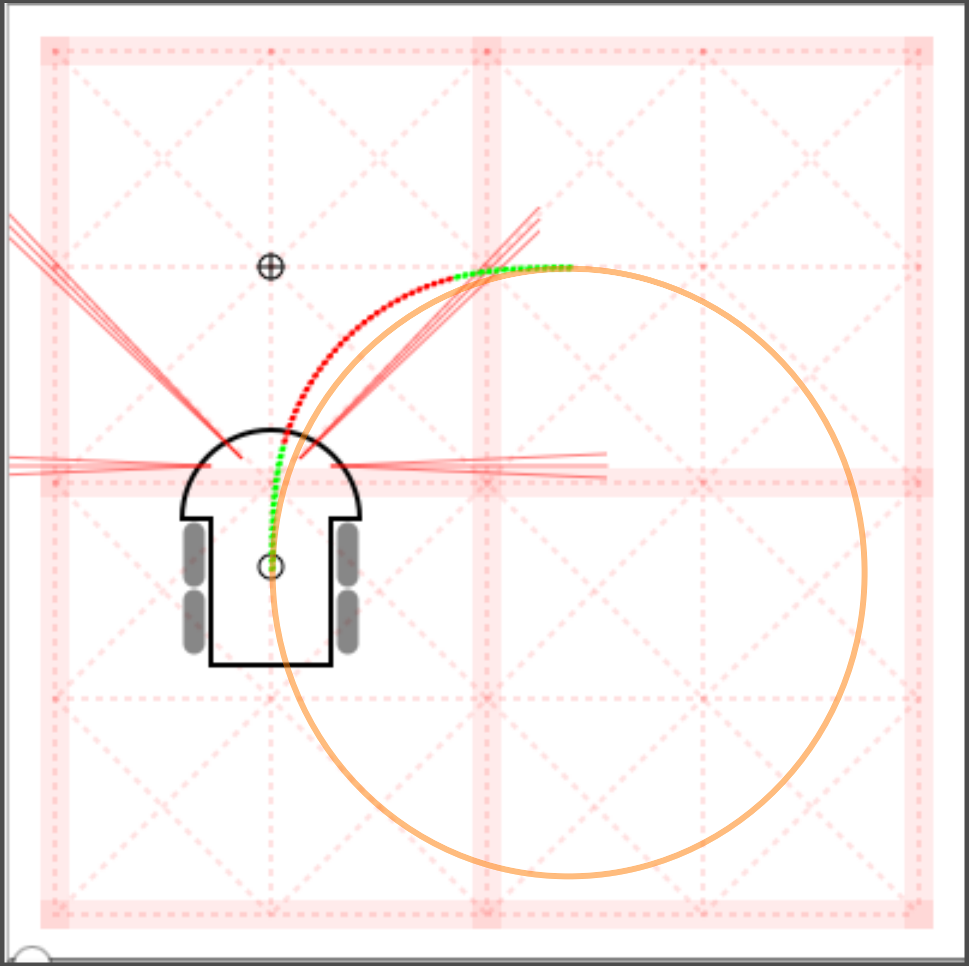
They should keep the same shape at all speeds.

There are several types of turn needed.



TURN CONSTRAINTS

- Start point
- Radius
  - Minimum
  - Effective
- Speed
  - Forward
  - Angular
- Acceleration
  - Angular
  - Centripetal
- Exit Point
- Variable Speed



SOME MATHS…

- Constant radius turn

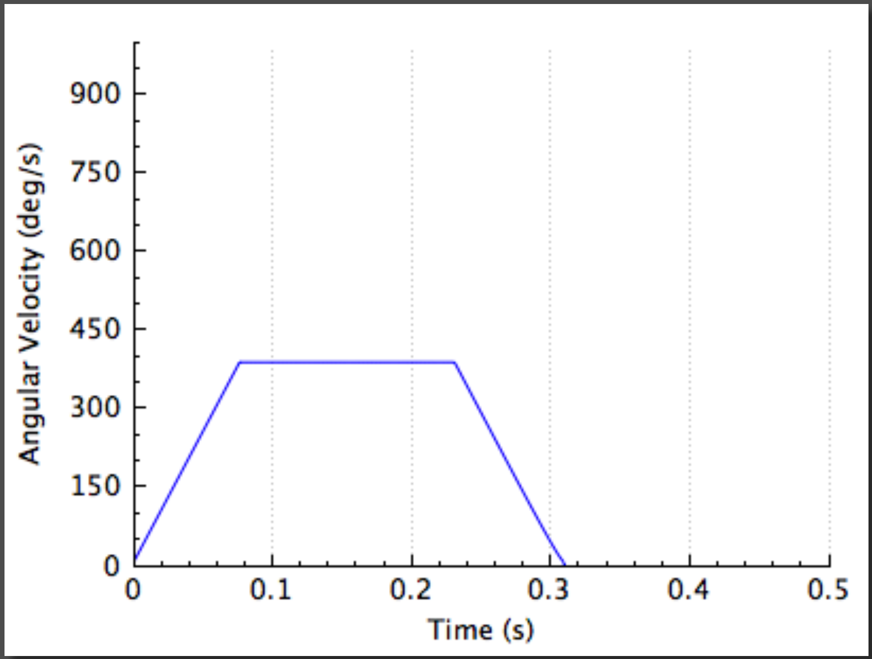
$$v = r\omega$$

$$a = \frac{v^2}{r}$$

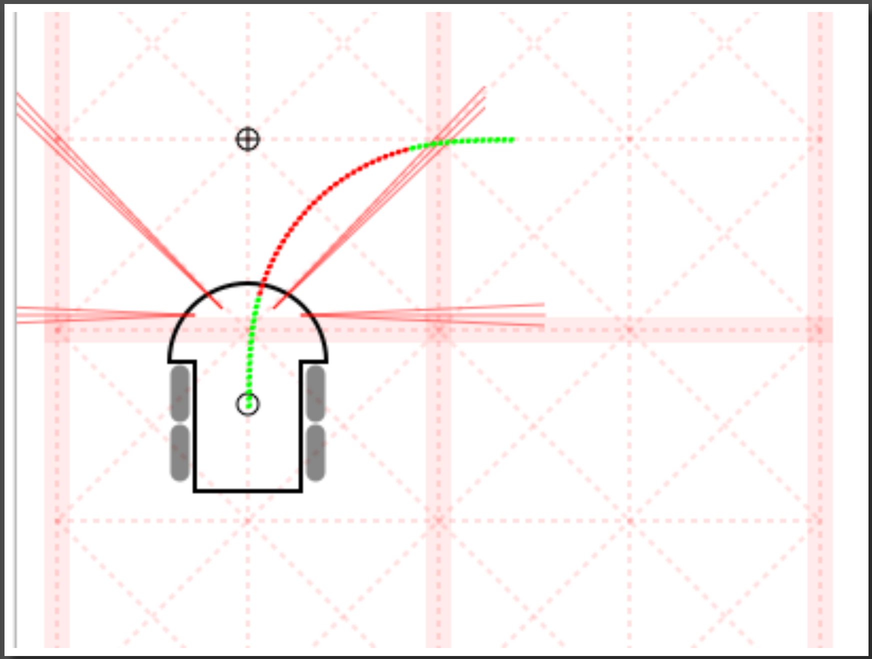
- Two equations with four variables
- Fix the radius and the centripetal acceleration

$$v = \sqrt{ar}$$

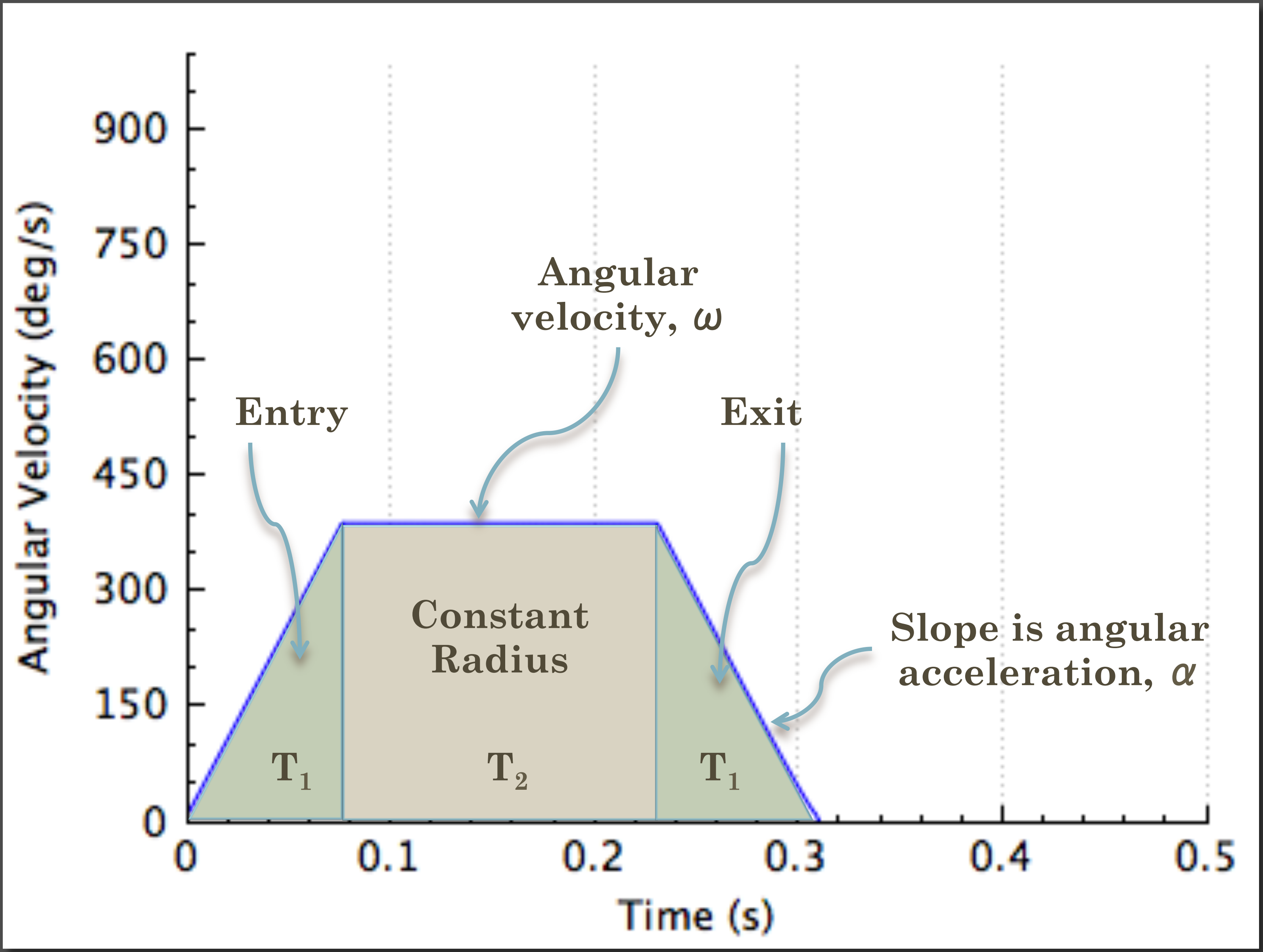
$$\omega = \sqrt{a/r}$$



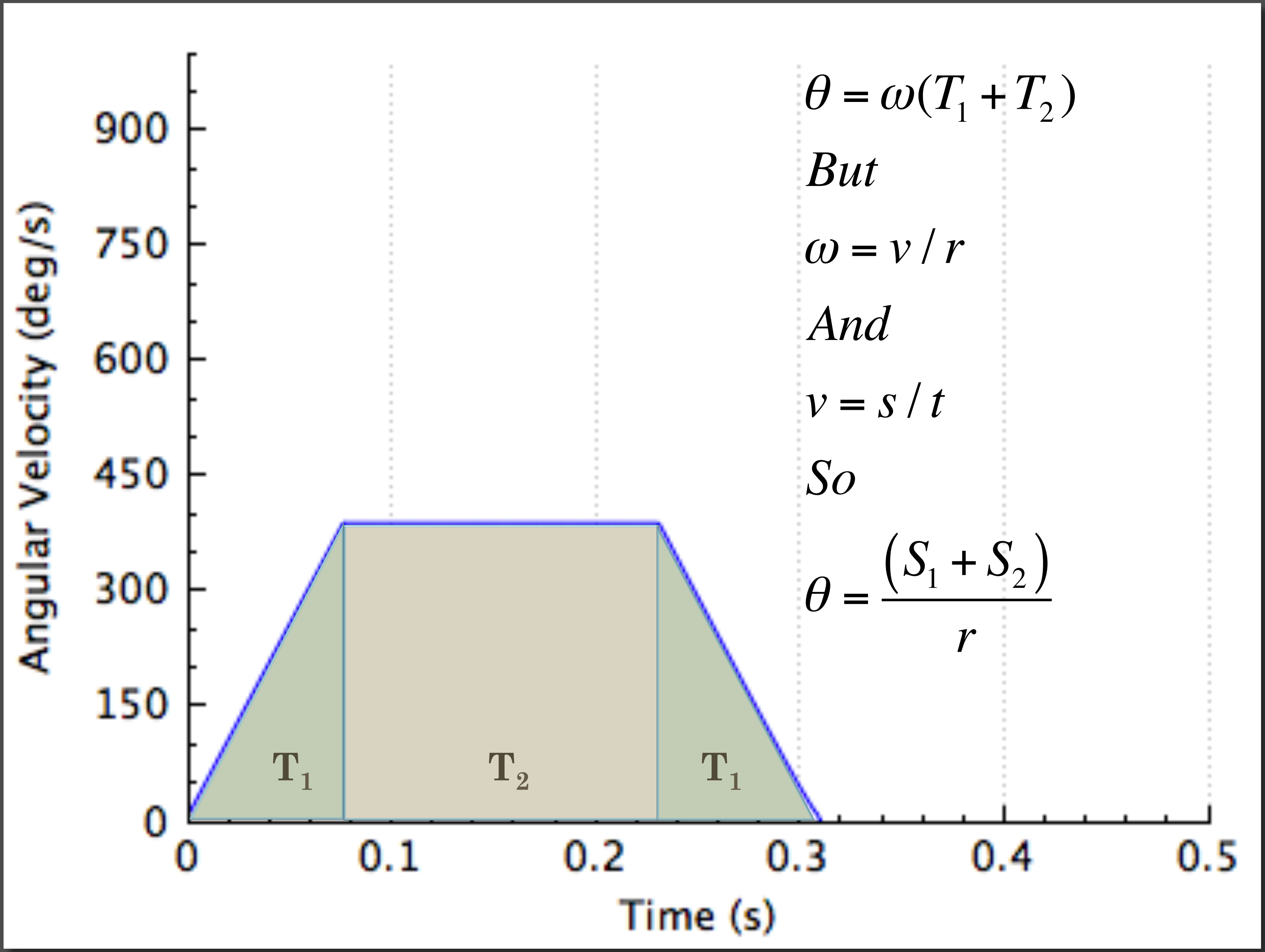
A simple trapezoidal profile for angular velocity against time



The profile has three distinct phases



Angular velocity, ω
Entry
Exit
Constant Radius
Slope is angular acceleration, α
T1
T2
T1
Angular Velocity (deg/s)
900
750
600
450
300
150
0
0
0.1
0.2
0.3
0.4
0.5
Time (s)



Make T_1 a simple fraction of T_2. Half is fine

- For any given turn,
  - Choose the total angle
  - Decide on the minimum radius
  - Select the centripetal acceleration
  - Calculate a tangential velocity

$$v = \sqrt{ar}$$

  - Calculate the angular velocity

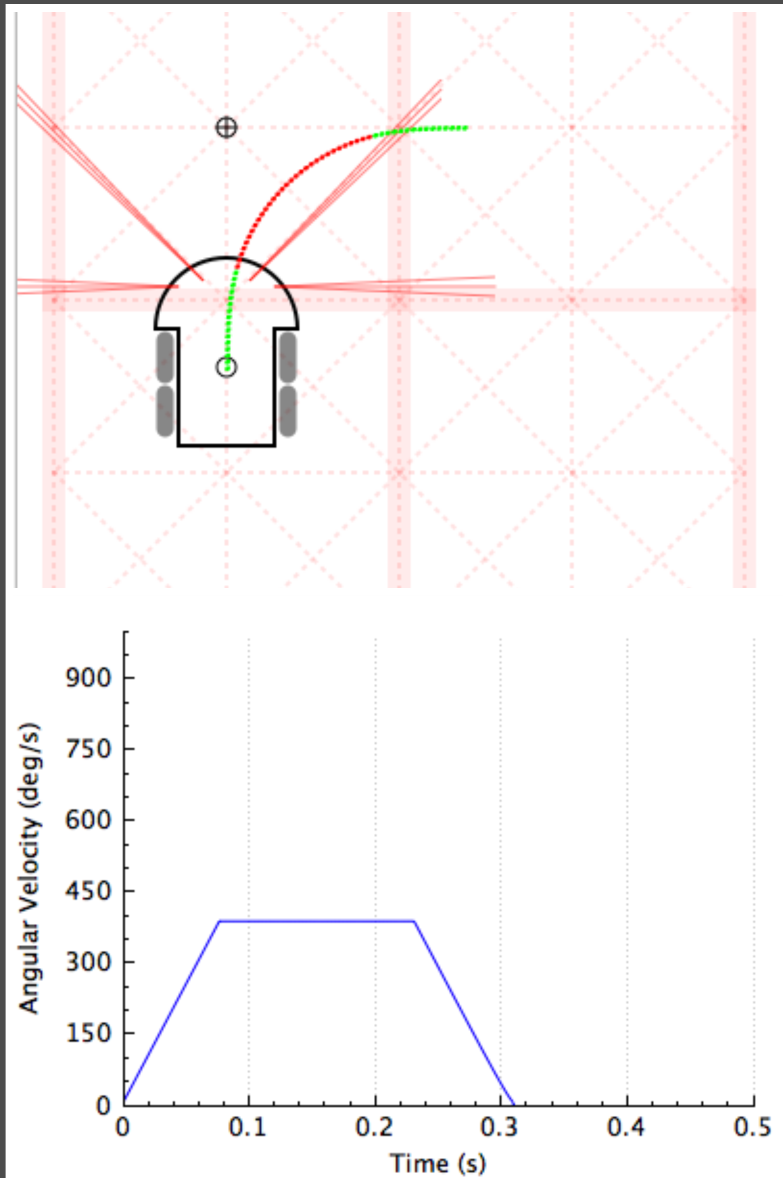
$$\omega = \sqrt{a/r}$$

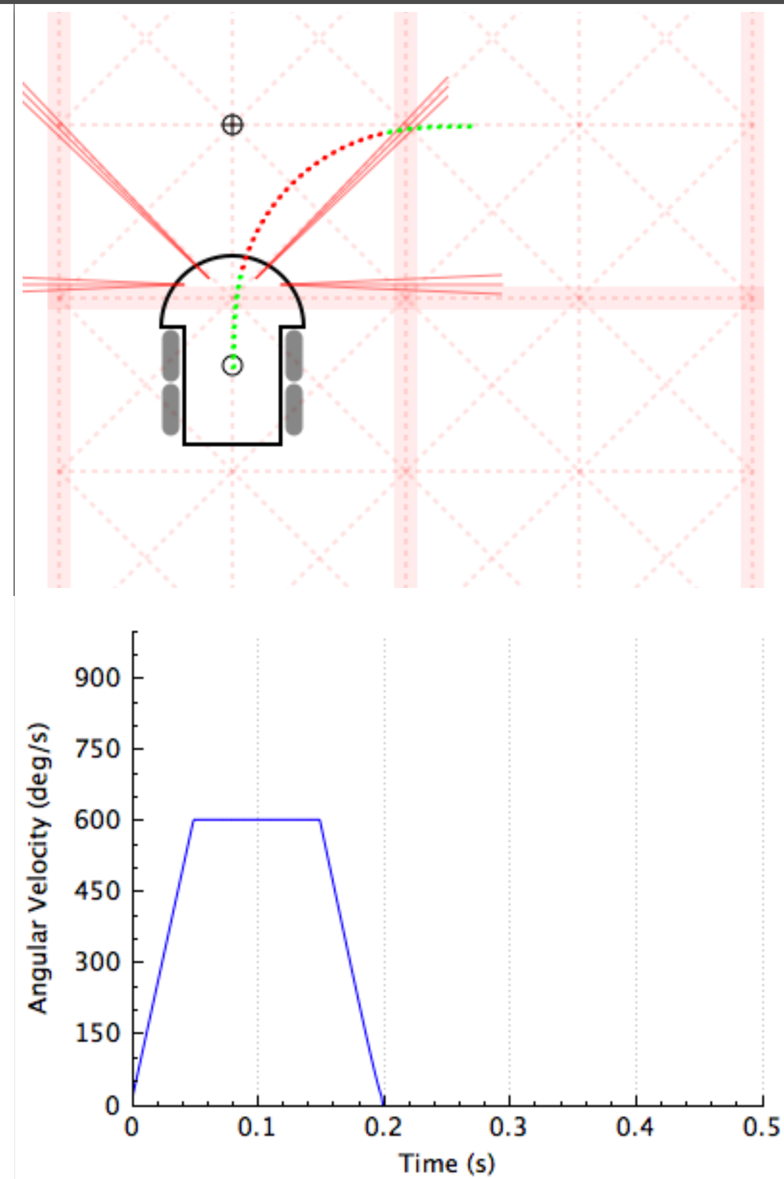
  - Select a value for S_1
  - Adjust S_2 on test (or use gyro)

RUNNING THE TURN

- Aim to end the straight at your chosen tangential velocity
- Use whatever speed you actually end at to adjust angular velocity in proportion
- Increase angular velocity parametrically over distance S_1
- Run the constant radius segment
- Unwind the Angular velocity to zero over distance S_1

Performing the same turn at different speeds





670 mm/s

1040 mm/s