# Electronic Drum

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Synthesizing Drum Sounds

- A drum is simply a vibrating membrane
- A membrane can be approximated by a mesh of closely spaced masses
- These masses would experience forces from their nearest neighbors
- The positions of these masses would correspond to air displacement by the actual membrane

Discretized Drum Membrane
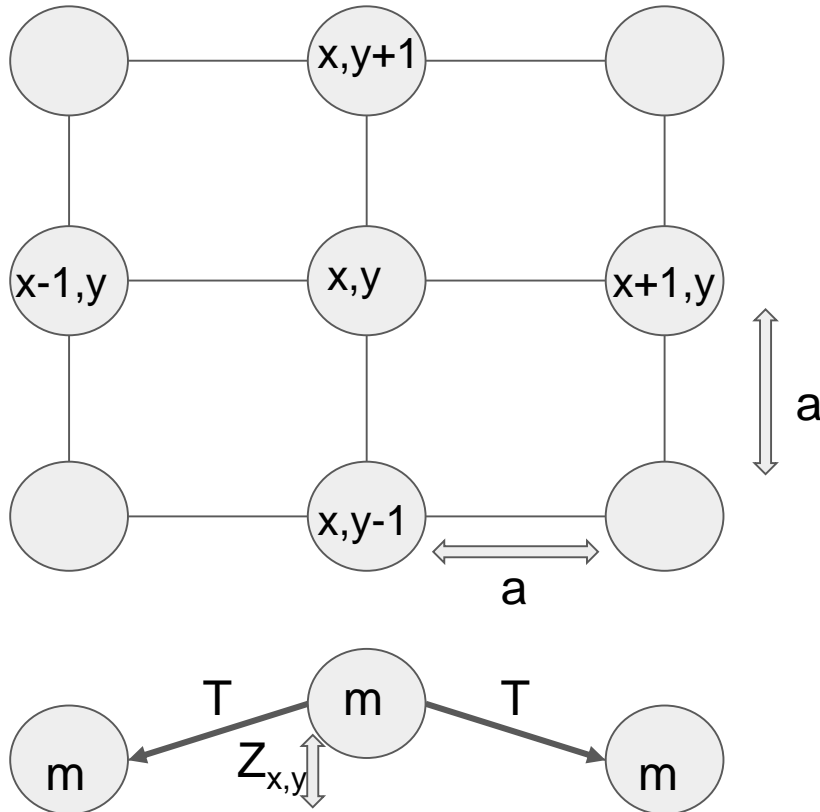
- Each mass has mass m
- Vertical and horizontal spacing is a
- Tension between each mass is T
- $Z_{x,y}$ represents displacement out of page for each mass

Equations of Motion of Drum Membrane

- Γ is the damping constant
- F_d is the driving force from drum pad input

$$F_{x,y} = ma_{x,y} = \frac{T}{a}\left(Z_{x+1,y} + Z_{x-1,y} + Z_{x,y+1} + Z_{x,y-1}\right) + \Gamma v_{x,y} + F_d$$
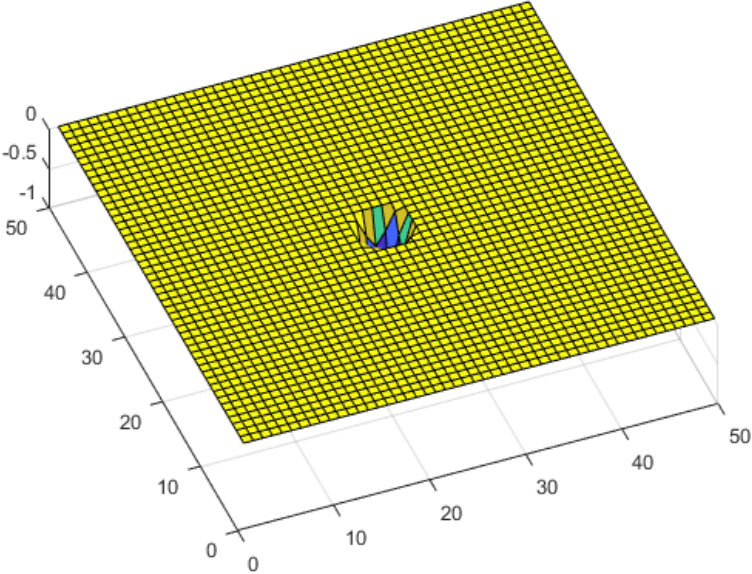
Time Evolution of Simulation

- Euler's method can be used to compute position and velocity of each mass after small time step, dt
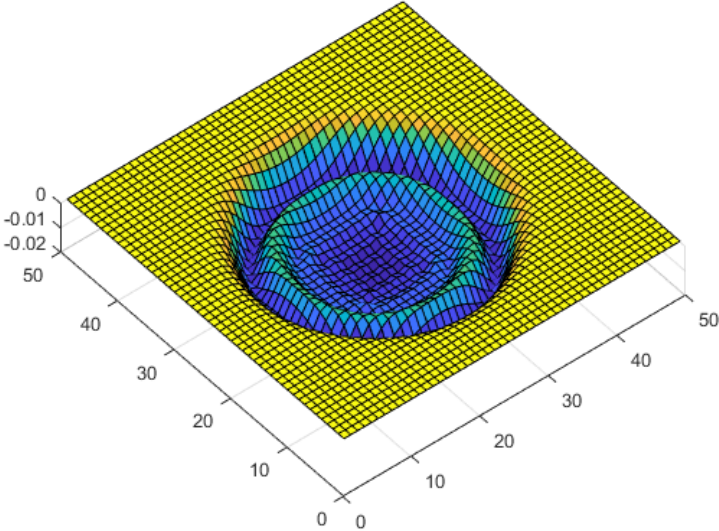- Audio output is proportional to the sum of each $Z_{x,y}$

$$v_{x,y}(t + dt) = v_{x,y}(t) + \frac{F_{x,y}}{m} dt$$

$$Z_{x,y}(t + dt) = Z_{x,y}(t) + v_{x,y}(t)dt + \frac{F_{x,y}}{2m}(dt)^2$$

Drum Simulation in Matlab (early results)

Initial

After some time...

Drum Simulation in Matlab Audio

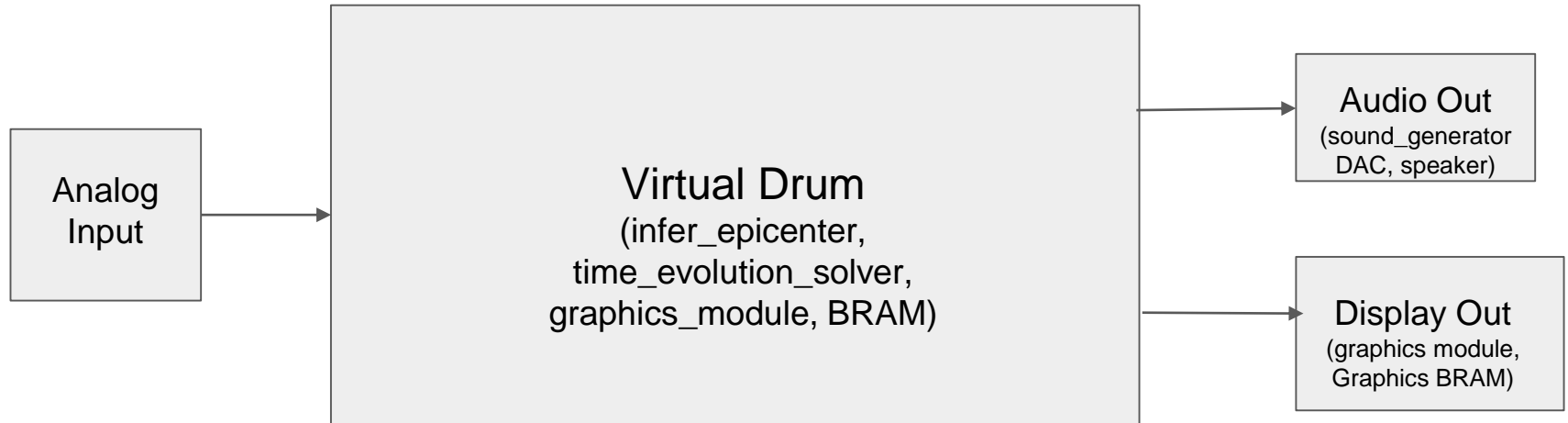[Drum Hit file](#)

Second Order
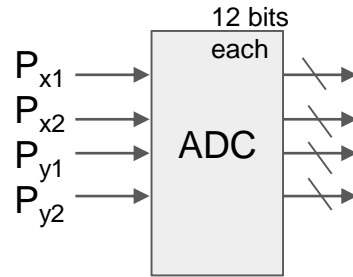
First Order

External Hardware

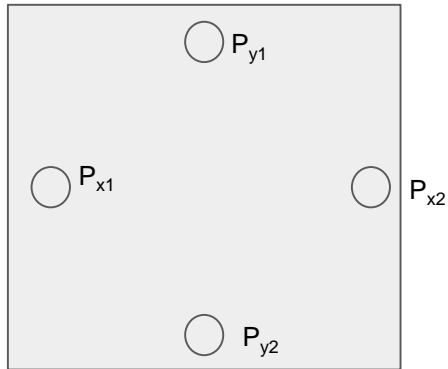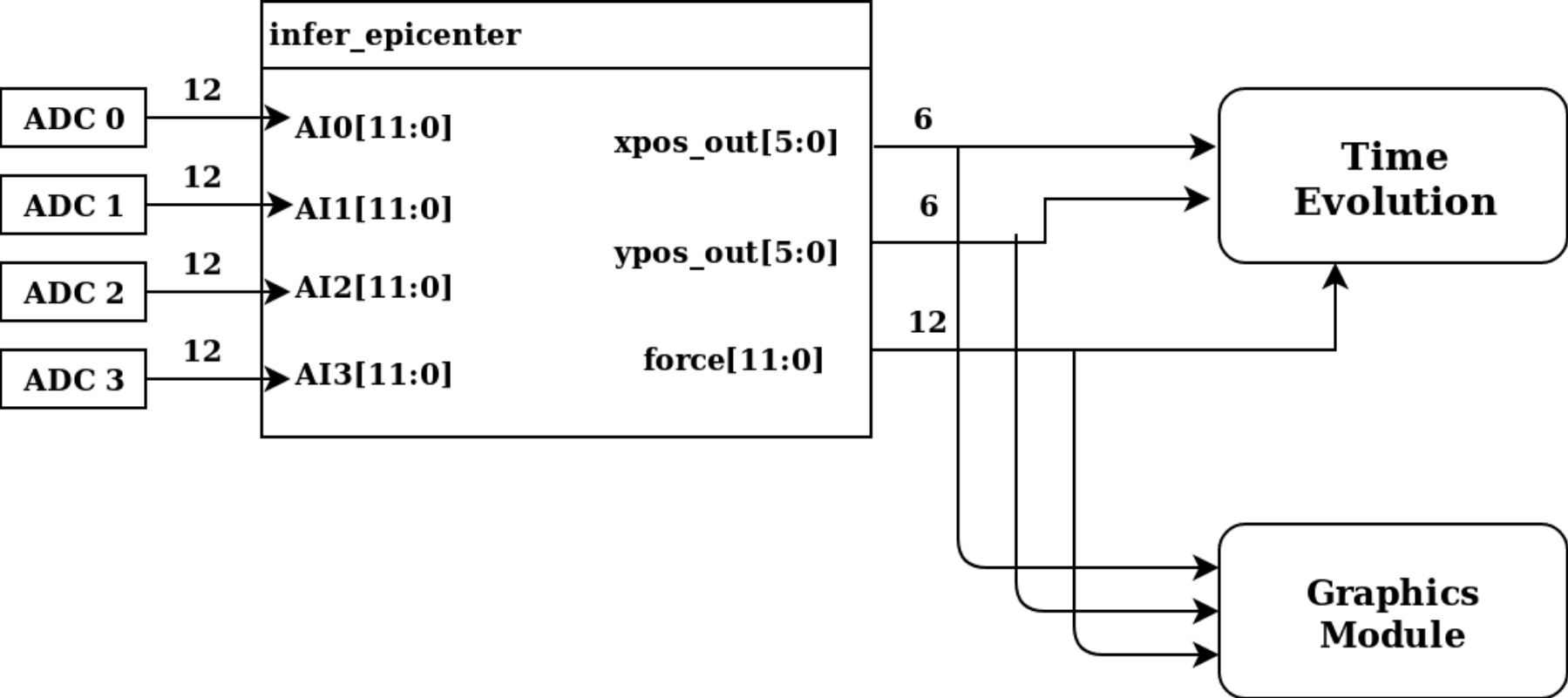- Four Piezo Disks
- Op amps?
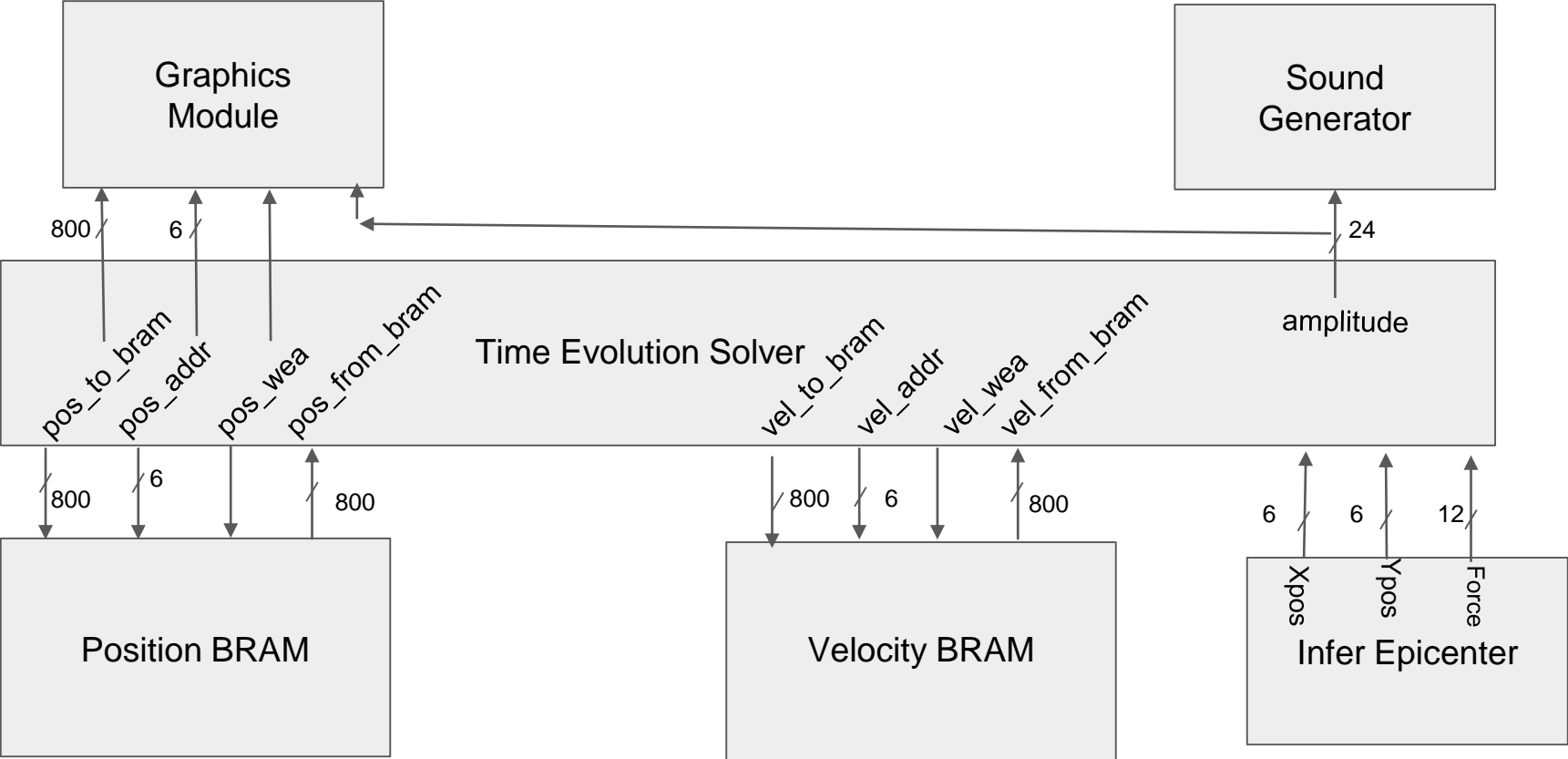- Amp + Speaker
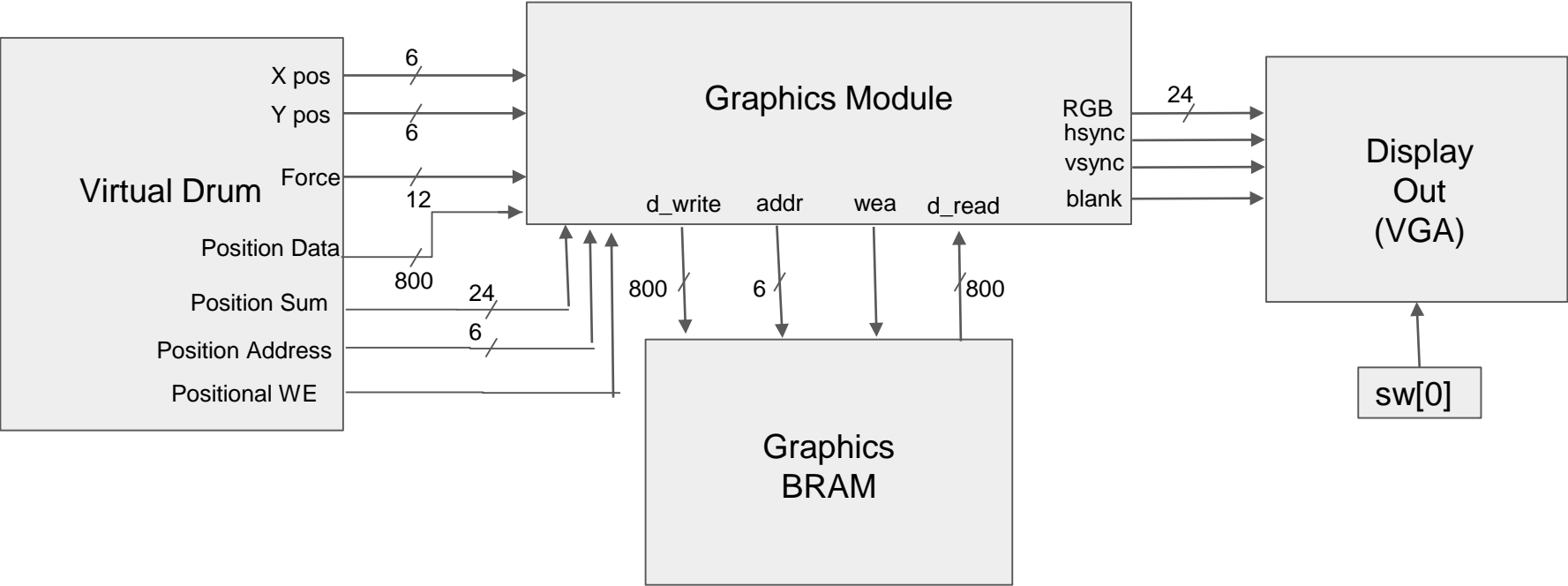
System Overview

Analog Inputs
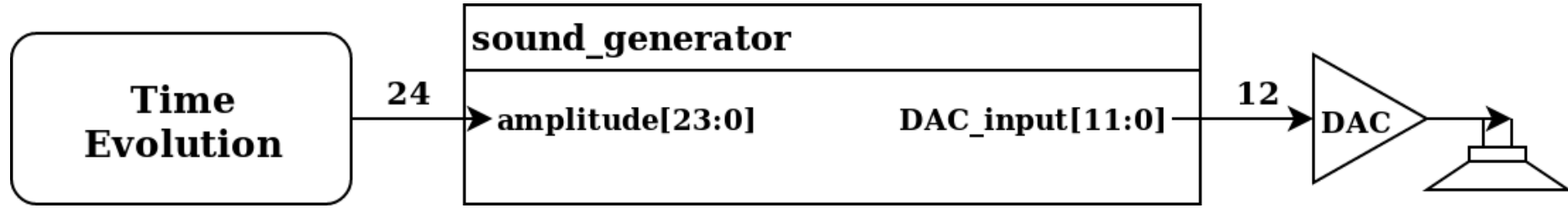
Inferring Epicenter

Simulation Time Evolution

Image Generation

Sound Generation

Timeline

- As of now
  - Basic design
  - Matlab simulations
- 11/4 - 11/10 (This week)
  - Order parts
  - Begin writing verilog for small Drum membrane simulation
  - Begin writing graphics module
- 11/11 - 11/17
  - Begin testing and debugging graphics module
  - Begin testing and debugging simulation
  - Assemble Drum pad hardware
  - Begin writing Infer epicenter module

- 11/18 - 11/24
  - Test and debug infer epicenter module
  - Finalize graphics module
  - Scale up drum membrane simulation
    - Start working on audio generation
- 11/25 - 12/1
  - Finalize Simulation + audio generation
  - Finalize Graphics module
  - Finalize + calibrate infer epicenter module
- 12/2 - 12/8
  - Final debugging
- 12/8 - 12/11
  - Panic

Q and A