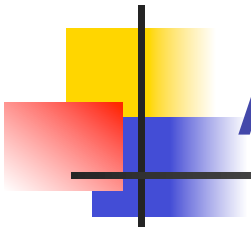
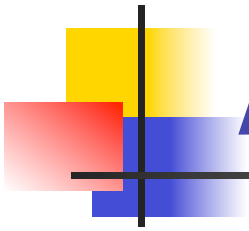
# So you want to animate a particle system



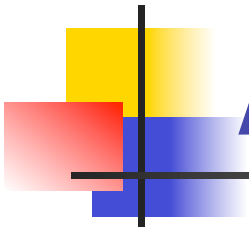
# Assignment #5a

- Which is something that you may wish to do since it is assignment #5a.



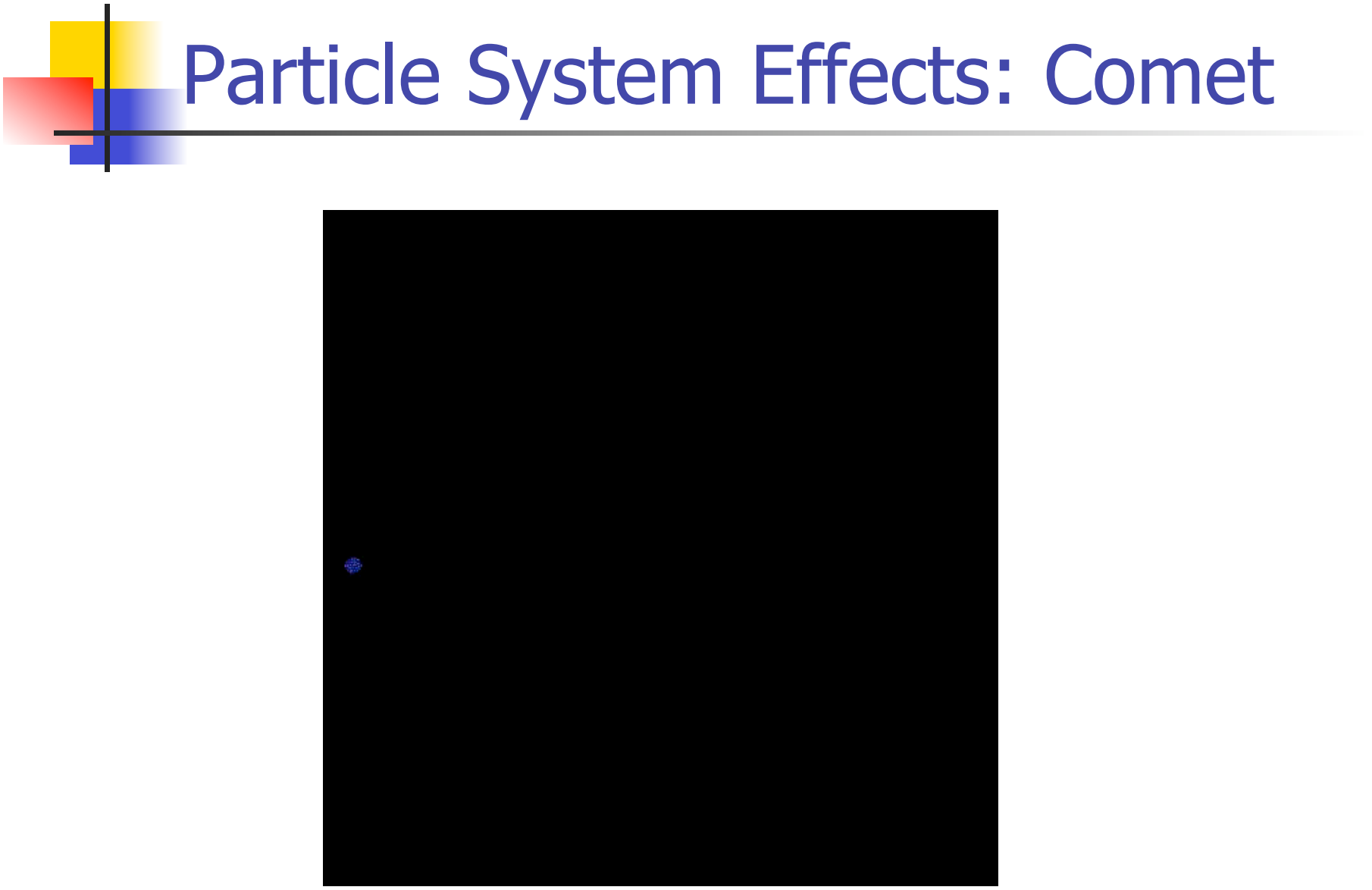
# Assignment #5a

- Then again….maybe not
  - Must do 1 of the 2
    - Particle Systems
    - Behavioral Motion
  - NOTE: Assignment 4 is articulated figure motion and will be given (and due) before Assignment 5b

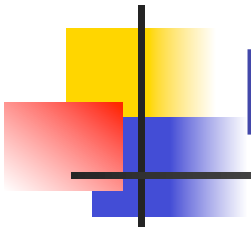


# Assignment #5a

- Goal:
  - To implement a simple particle system
  - Simulate the tail of a moving comet

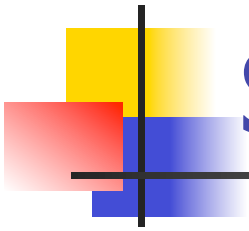


# Particle System Effects: Comet



# Particle Systems

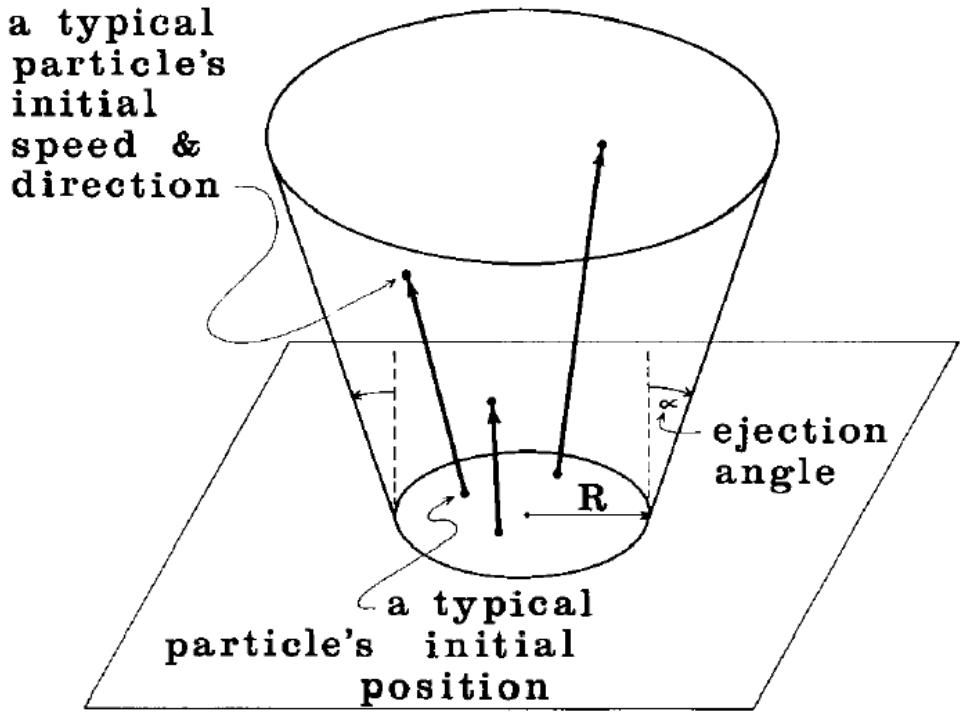
- Basic Model
  - New particles are generated
  - Each new particle is assigned its own set of attributes
  - Any particles that have existed for a predetermined time are destroyed
  - The remaining particles are transformed and moved according to their dynamic attributes
  - An image of the remaining particles is rendered



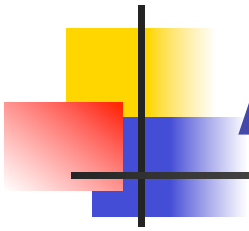
# Step 1: Particle Generation

- Particles will be emitted from a point emitter representing the center of the comet.
  - Generation rate (parameter)
- Comet motion will be controlled by keyframes.
  - Comet path (parameter)

# Step 1: Particle Generation

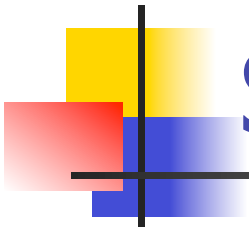



Initial velocity within a cone



# Assignment #5a

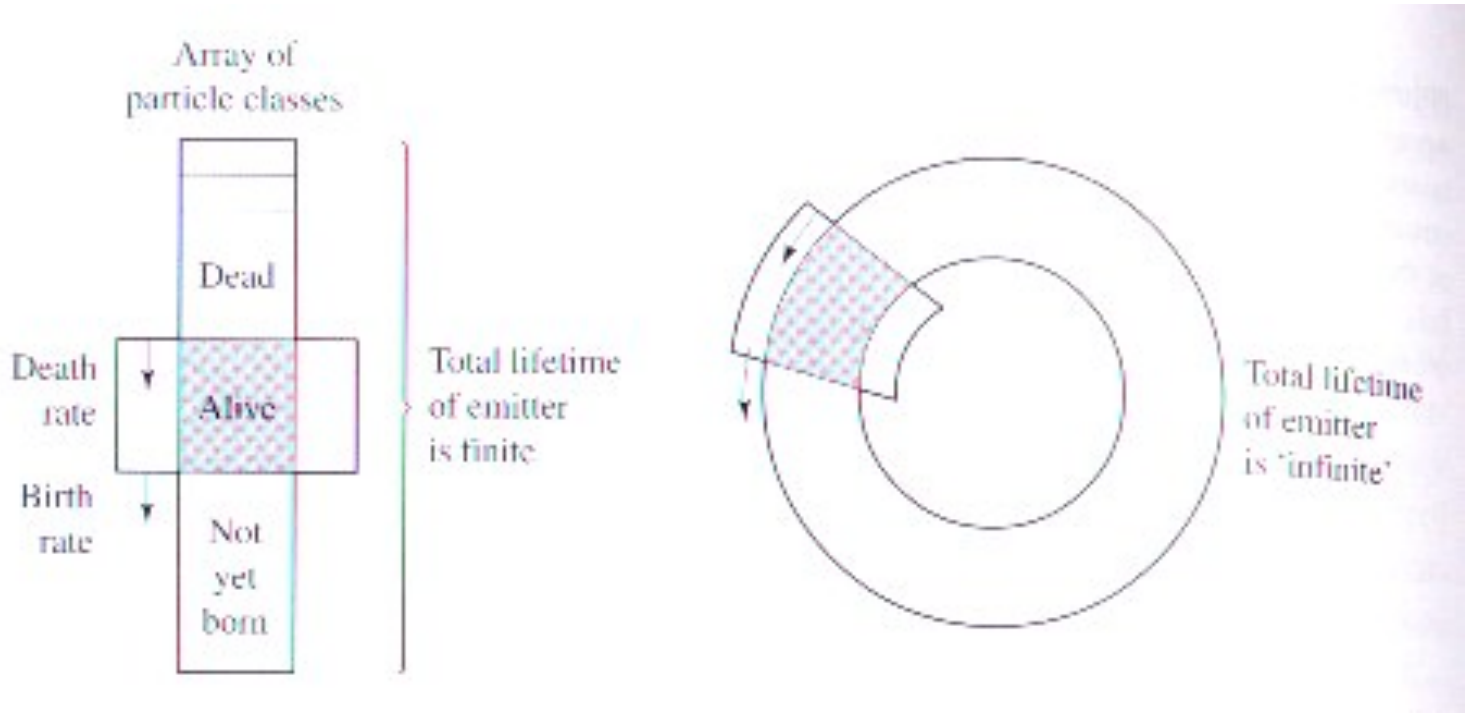
- Program may be:
  - Interactive – show the animation in window on the screen
  - Batch – create an app that will produce a set of input files for a renderer.



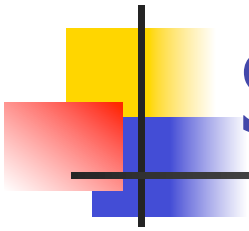
# Step 2: Assign Attributes

- Particle Attributes
  - Initial position (comet)
  - Initial velocity
    - (within a cone – cone = parameter)
    - Following the reverse path of comet
  - Initial size (all can be same size)
  - Initial color (all can be same color – or not)
  - Initial transparency (all can be same alpha – or not)
  - Shape (point)
  - Mass (all same mass – or not)
  - Lifetime (random within some range – range = parameter)
- Usually assigned using controlled randomness
- Be creative

# Step 3: Particle Termination

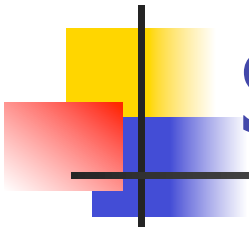



Feel free to use particle store – or not



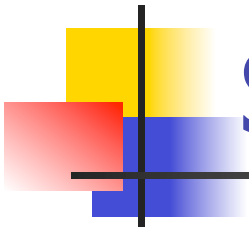
# Step 4: Particle Motion

- Particles are guided by simple dynamical simulation
  - F = MA
  - A = acceleration (initial push, gravity, etc)
  - V = current velocity = dt * A + $V_{prev}$
  - X = current position = dt * V + $X_{prev}$
- No need to consider rotation.



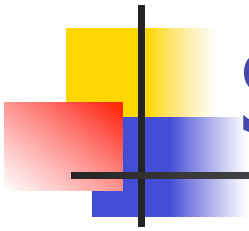
# Step 4: Particle Motion

- Collisions
  - No collisions – perhaps
- Forces
  - No additional forces



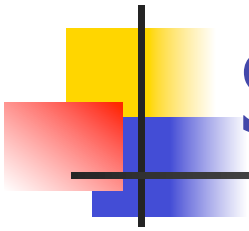
# Step 4: Particle Motion

- Recall from dynamics simulation
  - Step 1
    - Calculate Forces, F(t) – NOTHING TO DO HERE
  - Step 2
    - update position (integrate velocity)
      - $s(t+\Delta t) = s(t) + v(t)\Delta t$
    - update Momentum (integrate force/acceleration)
      - $M(t+\Delta t) = M(t) + F(t)\,\Delta t$
  - Step 3
    - Calculate velocities
      - $v(t+\Delta t) = M(t+\Delta t)/m$



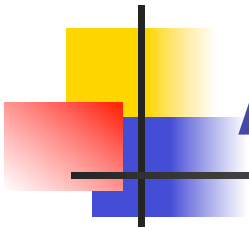
# Step 5:Particle Rendering

- Particle is modeled as a point light source
  - No physical geometry
  - Do not reflect light
  - Adds color to pixel (based on transparency/ color)
- Particles only cast shadows on objects in environment, not each other



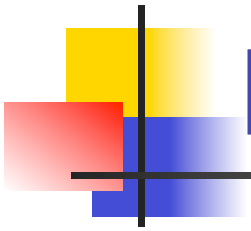
# Step 5: Particle Rendering

- Particle's color and transparency can be a function of:
  - Lifetime left
- Particle shape can be a function of
  - Can use lines to model motion blur



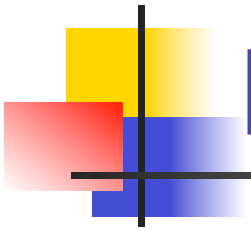
# Assignment #5a

- Parameter set
  - Genrate = generation rate (avg # particles / frame)
  - Emission cone
  - Lifetime range
  - leader = path of leader
  - Others as you see appropriate



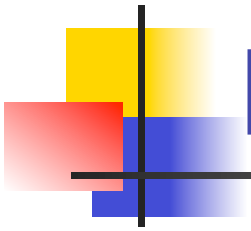
# Following the comet

- Comet path will be given as keyframes
  - Leader boid motion will be determined by keyframes alone.
  - Format:
    - `t x y z`
    - 1 line per keyframe
    - Make last key position equal to first (loop)
    - Use format from assignment 1
  - Use interpolation routines from assignment 1



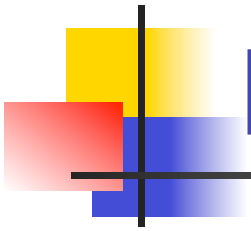
# Following the comet

- Continuous loop of comet
  - For batch animations, must indicate number of comet loops to animate



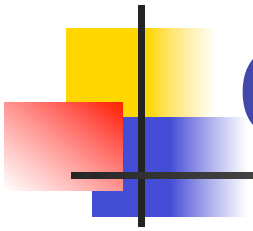
# Bells and Whistles

- 20 points
  - Basic particle system
- Extras (5 points each)
  - Implementation of other kind of forces.
  - Collision of particles with a static wall.



# Due dates

- Due
  - Wednesday, February 18th (this or behavioural motion)
- Submission
  - Via mycourses
  - Please include documentation on
    - how to run your app
    - How to build your app
      - Makefile
      - Visual Studio (.dws, and .dsp files)
    - Renderer used if batch
  - Include Platform and which assignment (Particle or Flocking) on dropbox description.



# Questions?