

# *The Science and Art of Video Games*

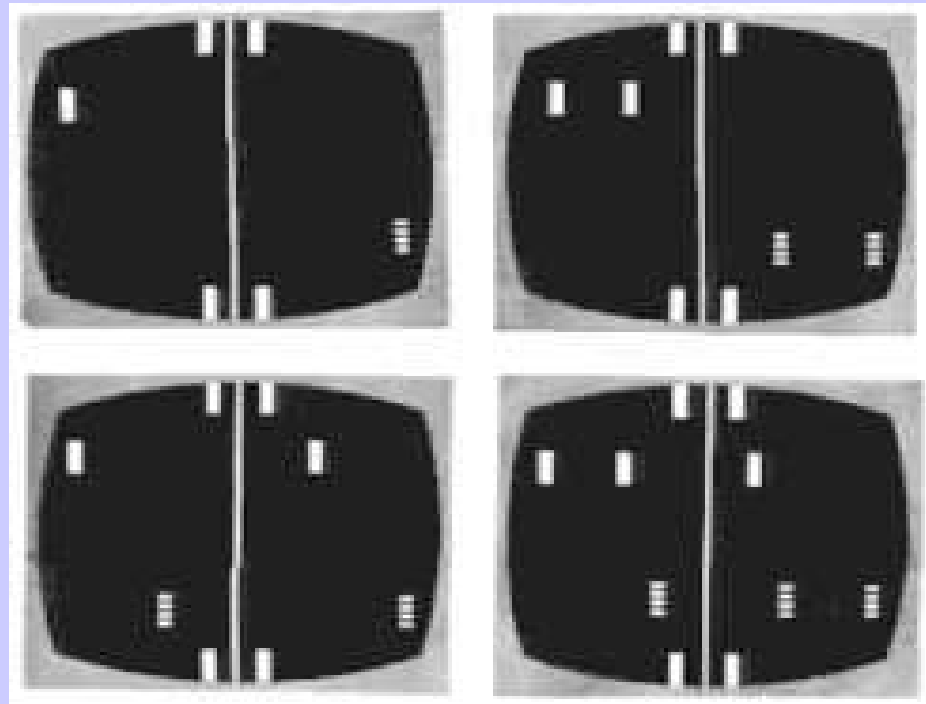
What does it take to make a game?

Jeff Lander

**DARWIN**  *Software  
Creation*

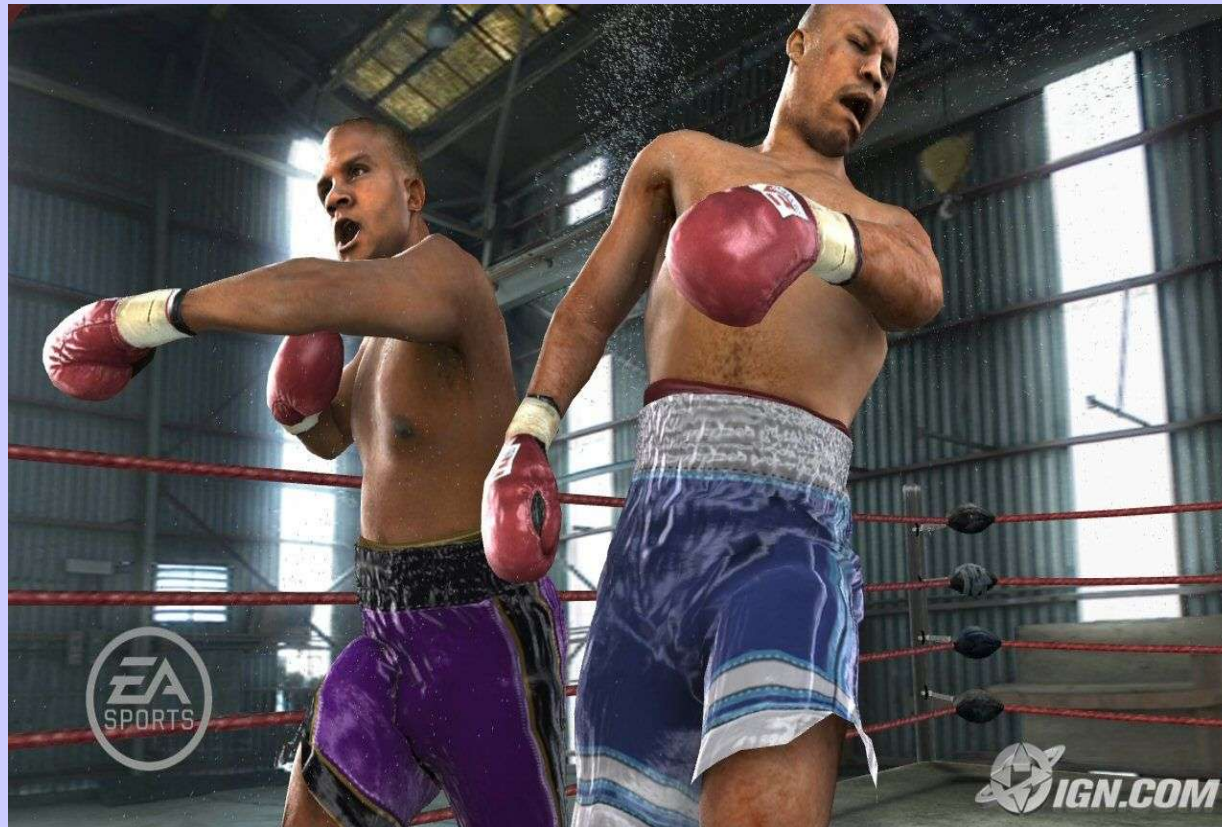
# *History of Video games*

- ◆ What did it take to get from here...



# *History of Video games*

◆ To here...



# Console Game Systems

- ◆ Atari 2600 (1977)
  - ◆ 8bit, 128 Bytes RAM
  - ◆ 320x200
  - ◆ Team Sizes 1-5 common
  - ◆ Sales 25 M
  - ◆ Budgets <\$100K
  
- ◆ Sega Genesis (1989)
  - ◆ 16bit, 128K RAM/VRAM
  - ◆ 320x224
  - ◆ Team Sizes 5-15
  - ◆ Sales 150 M
  - ◆ Budgets <\$250K



# Console Game Systems

- ◆ Sony Playstation (1994)
  - ◆ 32bit, 2M RAM/1M VRAM
  - ◆ Graphics 320x240
  - ◆ CD Media 640MB
  - ◆ Team Sizes 5-50
  - ◆ Sales 100 M+
  - ◆ 8000+ titles, 950M+ sold
  - ◆ Budgets <\$1M



# Console Game Systems

- ◆ Sony Playstation 2(2000)
  - ◆ 128bit, 32M RAM, 4M VR
  - ◆ 640x440
  - ◆ DVD Media 4 GB
  - ◆ Team Sizes 15-100
  - ◆ Sales 75 M+
  - ◆ Budgets \$5-12M+



# Console Game Systems

- ◆ Sony Playstation 3 (2006?)
  - ◆ 256M RAM, 256M VR
  - ◆ 2 TFLOPS
  - ◆ 1920x1080
  - ◆ BlueRay Media 25-50 GB
  - ◆ Team Sizes 50+?
  - ◆ Budgets \$8M+?
  - ◆ Sales ???



# *What kind of Jobs are there?*

- ◆ Production
  - ◆ Programming
  - ◆ Art
  - ◆ Design
  - ◆ Production and Test
  - ◆ Sound
- ◆ Non-production
  - ◆ IT
  - ◆ Finance
  - ◆ Marketing
  - ◆ Legal
  - ◆ Office Support
- ◆ Salaries average \$40K-\$150K and up.



# *Game Production*

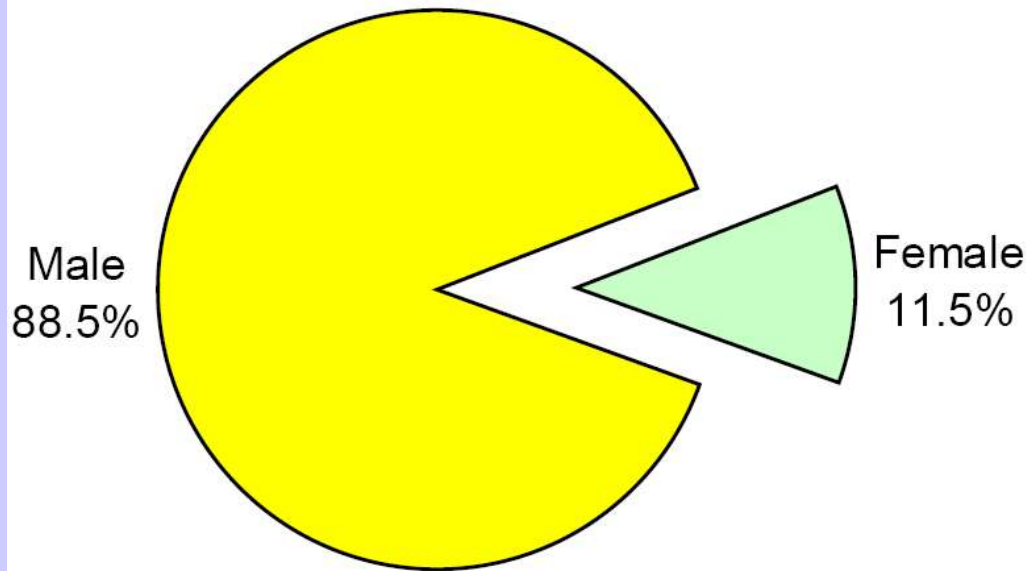
- ◆ Modern console games
  - ◆ 1.5 years+ for development
- ◆ Steps for production
  - ◆ Pitch and Design (1-6 months)
  - ◆ Preproduction (1-6 months)
  - ◆ Production (1 – 2 years)
  - ◆ Post-production
    - ◆ Testing, balance, localization

# *Diversity*

- ◆ Inclusive and welcoming industry
  - ◆ Need to meet and exceed the entry requirements
  - ◆ Meritocracy
  - ◆ Too few women represented (but are welcome)
  - ◆ Lack of local talent leads to searching the world
    - ◆ Current team has 20% work visa employees
    - ◆ Representing 15+ countries
- ◆ Production focus
  - ◆ Can lead to long hours and hard work
  - ◆ Maturing industry with growing pains

# Diversity

## ◆ Example: Women in Game Development



	Male	Female
Ops/IT/HR	53%	47%
Writing	70%	30%
Mkt/PR/Sales	75%	25%
Production	79%	21%
QA	87%	13%
Executive	88%	12%
Visual Arts	89%	11%
Design	90%	10%
Audio	90%	10%
Programming	95%	5%

# *Education is the Key*

- ◆ Math and Physics are our main tools
  - ◆ Writing and Language skills are useful as well
- ◆ Geometry, Trigonometry, Linear Algebra
  - ◆ Some calculus
- ◆ Newtonian Physics
  - ◆ Personally have never needed Einstein but...
- ◆ Advanced High School level is ideal
  - ◆ Many need to relearn forgotten skills

# *What kind of Education?*

- ◆ The type of problems we solve are:
  - ◆ Mathematic, Scientific, as well as Artistic

What type of problems?

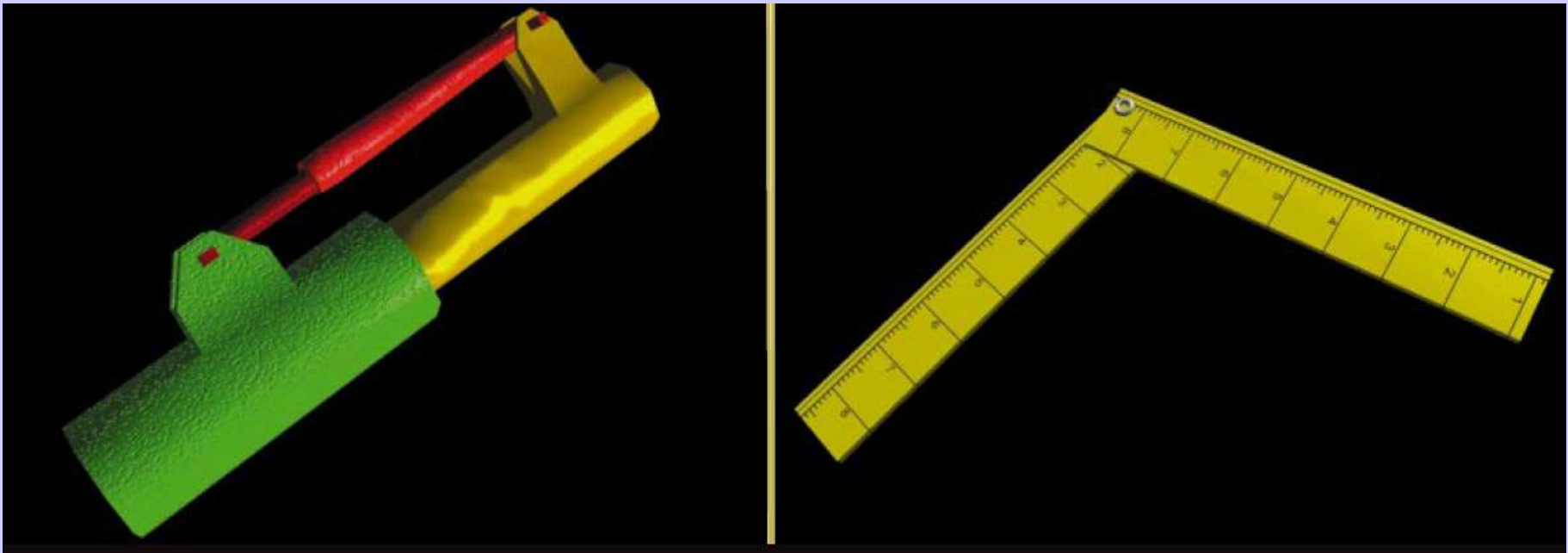
Let's start with something simple.

# *The Reach*



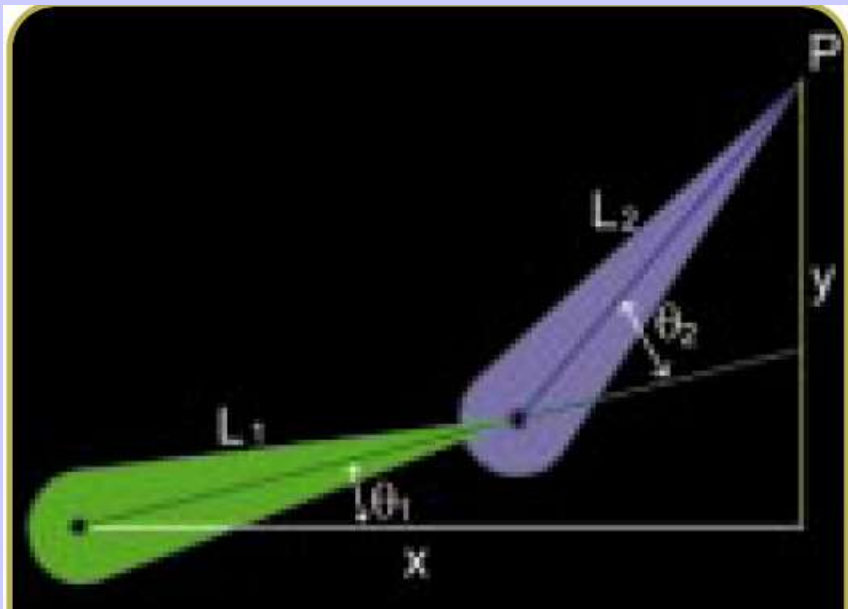
# *The Reach*

- ◆ When we reach we are using degrees of freedom.
- ◆ Control of DOF is key to making problems solveable.



# The Reach

- ◆ But for even easy problems, the math gets a bit tricky.



$$P_X = (L_1 * \cos(\theta_1)) + (L_2 * \cos(\theta_1 + \theta_2))$$
$$P_Y = (L_1 * \sin(\theta_1)) + (L_2 * \sin(\theta_1 + \theta_2))$$

$$\cos(a+b) = \cos(a)\cos(b) - \sin(a)\sin(b)$$
$$\sin(a+b) = \cos(a)\sin(b) + \sin(a)\cos(b)$$

$$\cos(\theta_2) = \frac{x^2 + y^2 - L_1^2 - L_2^2}{2L_1L_2}$$

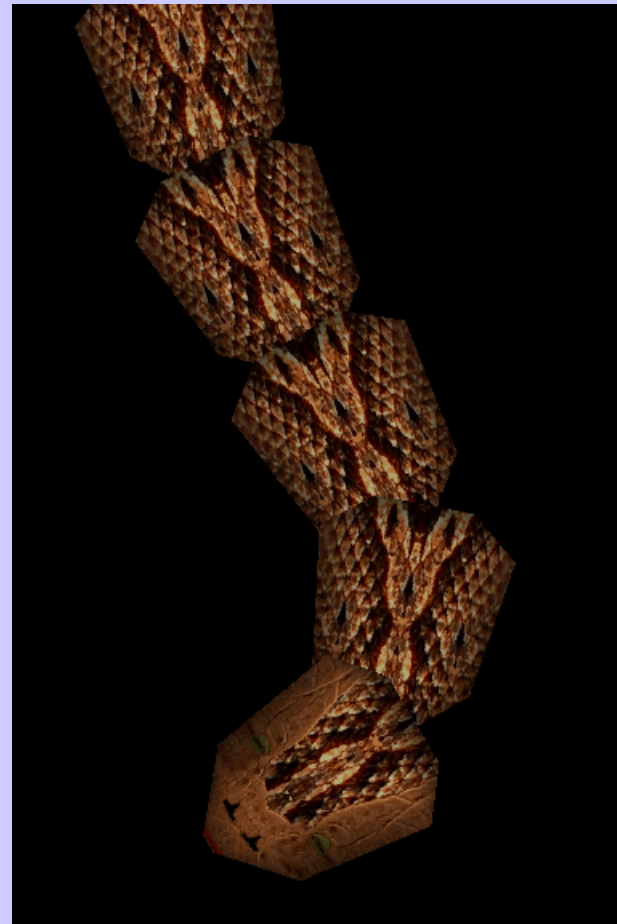
$$\theta_2 = \text{Acos} \frac{x^2 + y^2 - L_1^2 - L_2^2}{2L_1L_2}$$

$$\theta_1 = \frac{-(L_1 \sin(\theta_2))x + (L_1 + L_2 \cos(\theta_2))y}{2L_1L_2}$$



# *The Reach*

- ◆ For more complex problems, we need to be more clever.

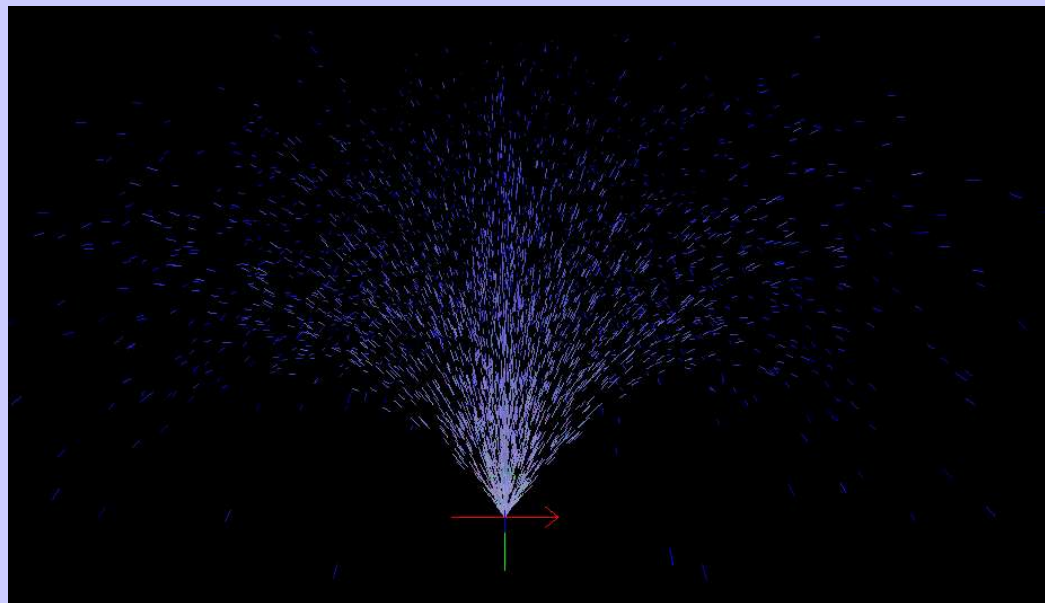


# *Math*

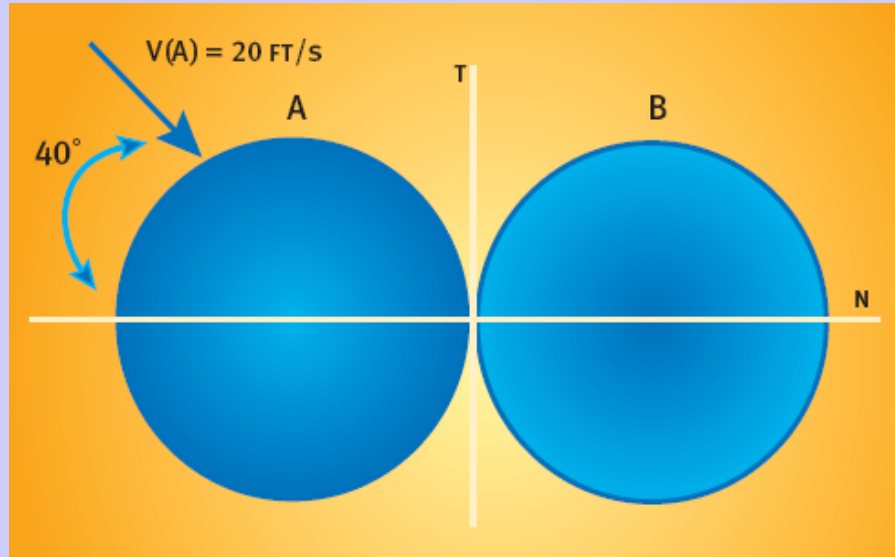
## ◆ Vector, Matrices, Dot Products, Trig

$$h = h_0 + v_0t - (gt^2)/2$$

This is one of the most powerful tools  
in our belt.

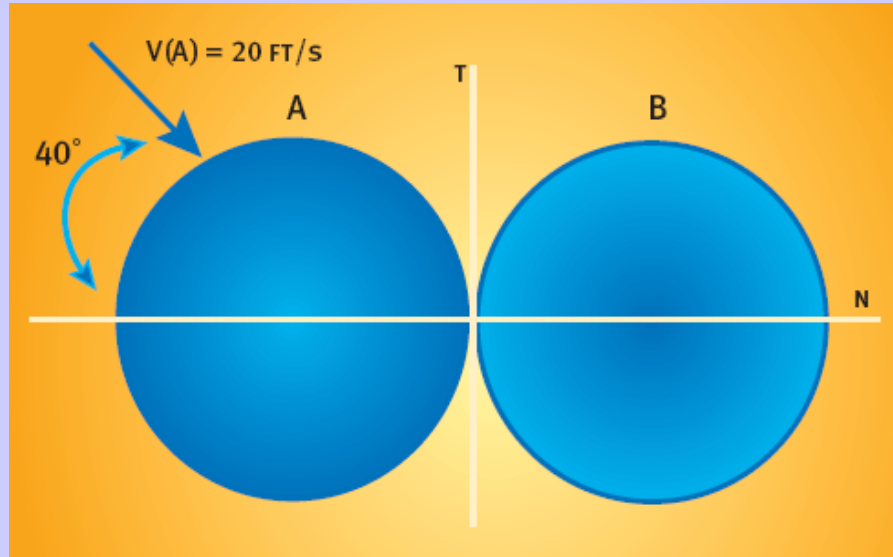


# Math



A little game of pool

# Math



```
VdotN = contact->normal.Dot(&ball->v);  
Vn = contact->normal * VdotN;  
Vt = ball->v - Vn;  
Vn1 = Vn * contact->Kr;  
ball->v = Vt - Vn1;  
Vn1 = Vn * (1.0f - contact->Kr);  
ball2->v += Vn1;
```

# *No Math for Me!*

- ◆ What about artists and designers?
  - ◆ Are math and science skills required
  - ◆ A common language is needed to convey ideas

# *No Math for Me! I do the art.*

- ◆ Give me that motion in 8 directions.
  - ◆ What angles would those be at?
- ◆ I need a walking turn that goes 10 meters and ends at 130 degrees.
- ◆ Euler angles, IK effectors, keyframes, meters per second.

# *No Math for Me! I do the design.*

- ◆ I am creating a puzzle where the player needs to compete to jump the furthest.
  - ◆ What controls are important for the player to use in this design?

# No Math for Me! I do the design.

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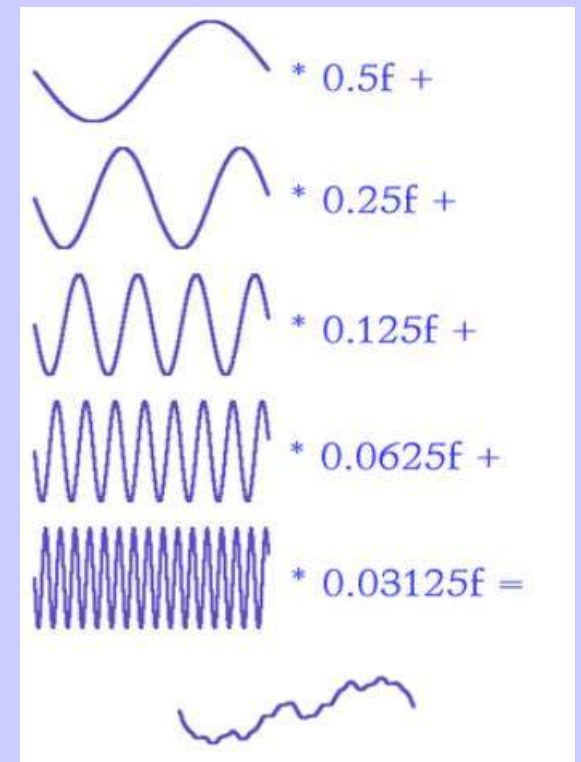
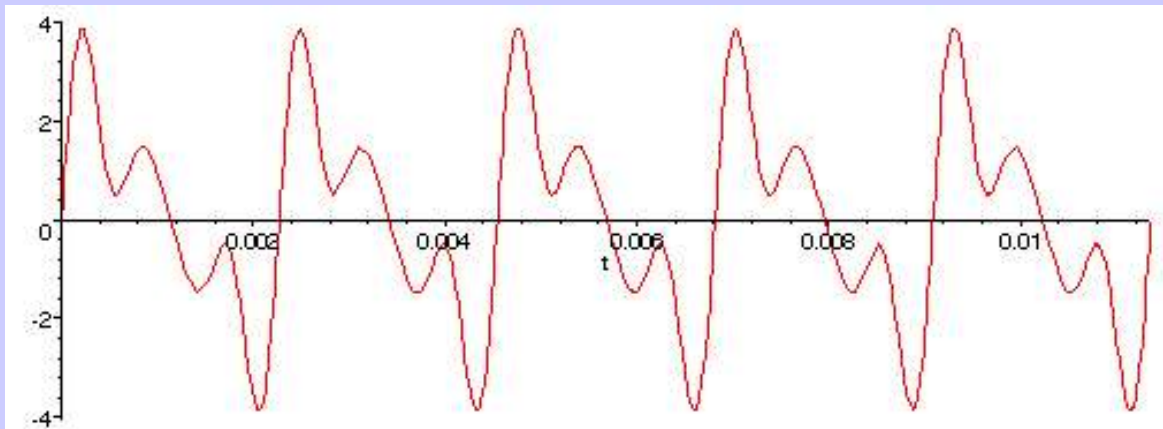
# *No Math for Me! I do the design.*

- ◆ I want waves of alien spaceships to attack the player.
- ◆ It needs to be a pattern the player can learn
  - ◆ It can't be random.
  - ◆ Must be repeatable
- ◆ Has to look chaotic and fun
- ◆ How would you design such a system?



# *No Math for Me! I do the design.*

- ◆ Simple math functions combined reveal complexity.



# *No Math for Me! I do the design.*

- ◆ Modern adventure games have hundreds of weapons, items, spells, with various power and costs.
- ◆ How do you balance and adjust all those various values?
- ◆ Tuning power of enemies and weapons.
  - ◆  $\text{Damage} = \text{strength} * (1 + \text{random}(0.2))$

# *Conclusion*

- ◆ Great opportunities in the Game Industry for people just like you.
- ◆ It does require some work from you.
- ◆ The tools needed are right in front of you.
- ◆ You can tell your parents that your next game is actually research.

# *More Information*

- ◆ [www.darwin3d.com](http://www.darwin3d.com)
- ◆ [jeffl@darwin3d.com](mailto:jeffl@darwin3d.com)
- ◆ [www.igda.org](http://www.igda.org)
  - ◆ International Game Developer's Association
  - ◆ Chapter meetings here in Los Angeles