The Science and Art of Video Games
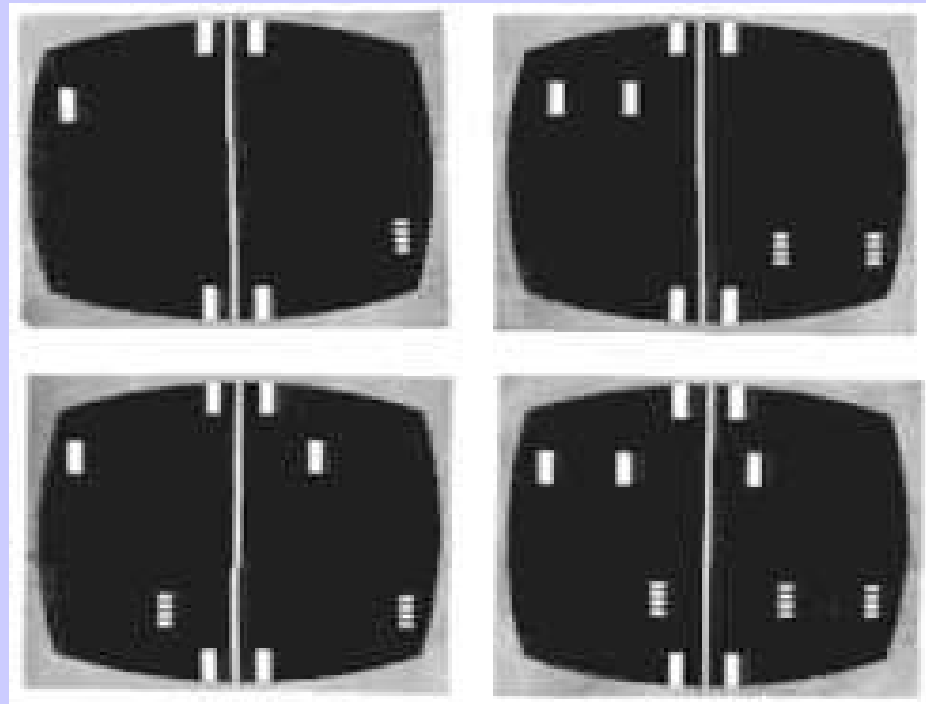
What does it take to make a game?

Jeff Lander

DARWIN 3D 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
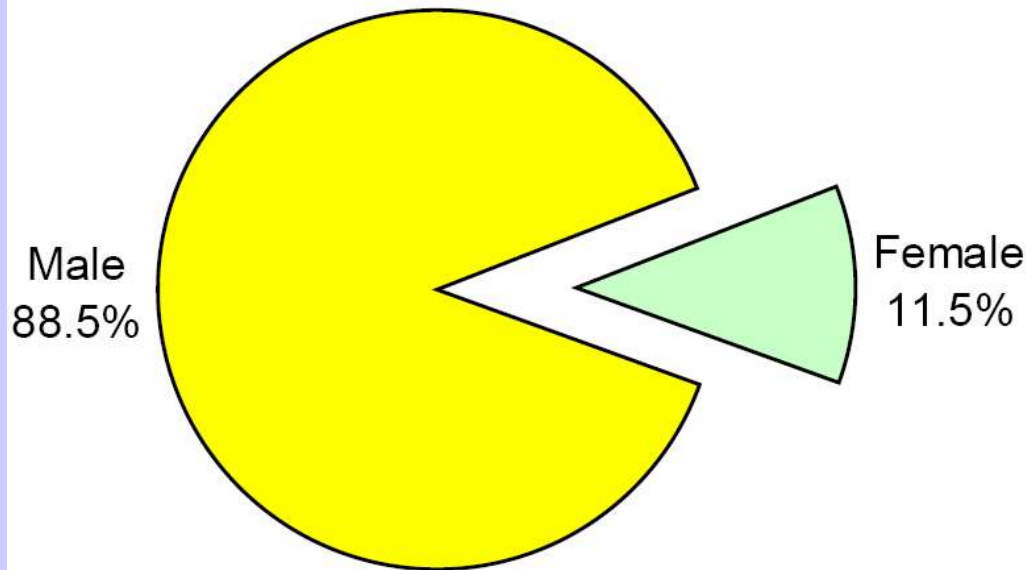
- Modern console games
  - 1.5 years+ for development
- Steps for production
  - Pitch and Design (1-6 months)
  - Preproduction (1-6 months)
  - Production (1 – 2 years)
  - Post-production
    - Testing, balance, localization

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%

Male 88.5%   Female 11.5%

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 Einstien but...
- ◆ Advanced High School level is ideal
  - ◆ Many need to relearn forgotten skills

What kind of Education?

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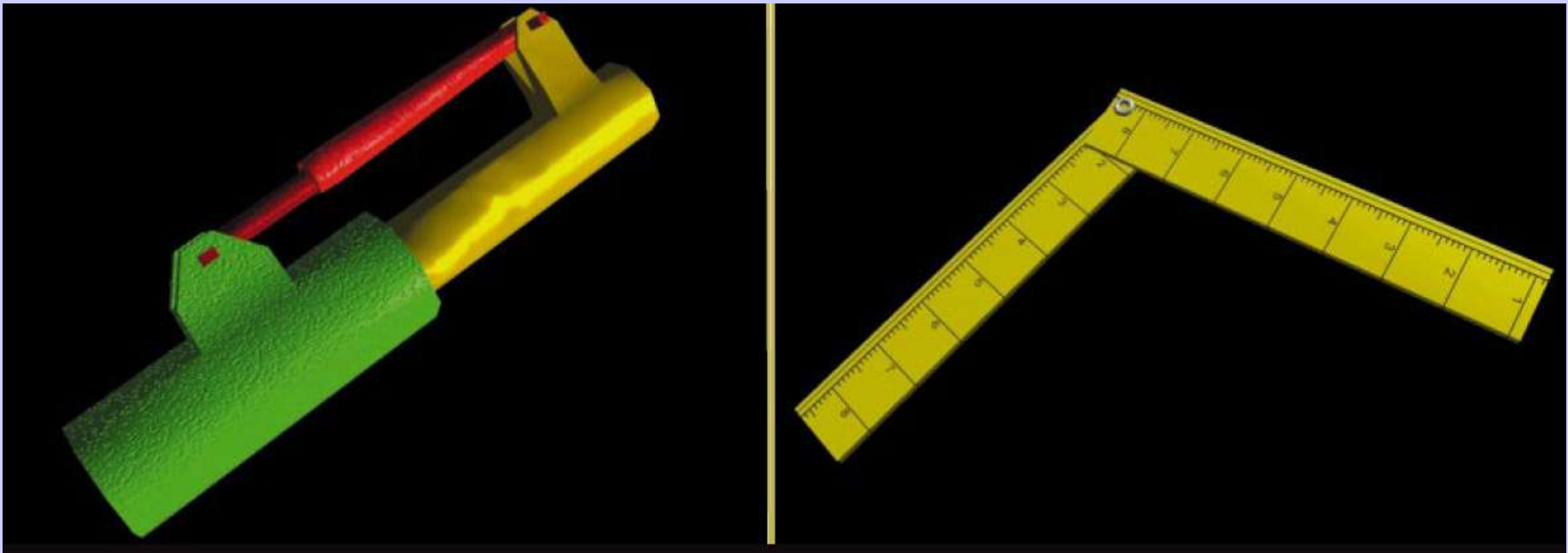 - ◆ Mathematic, Scientific, as well as Artistic

What type of problems?
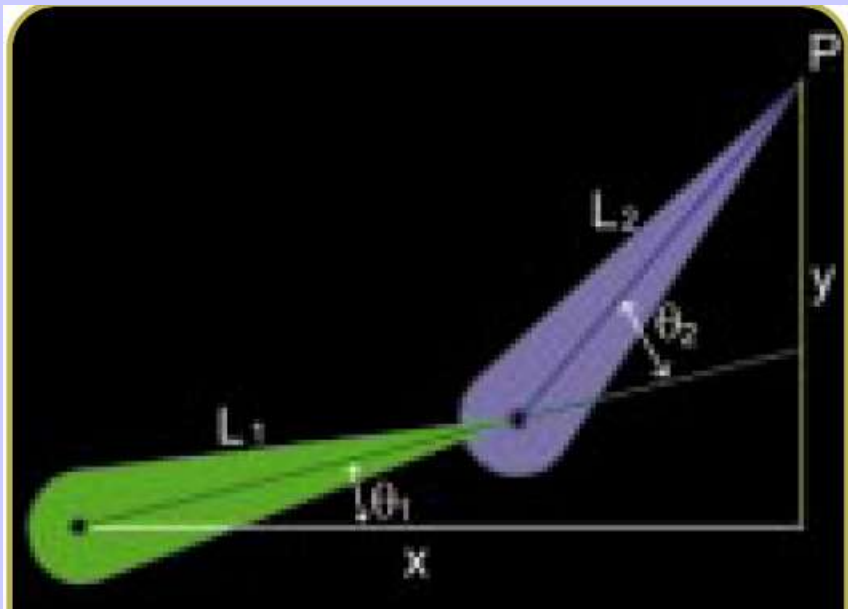Let's start with something simple.

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.

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

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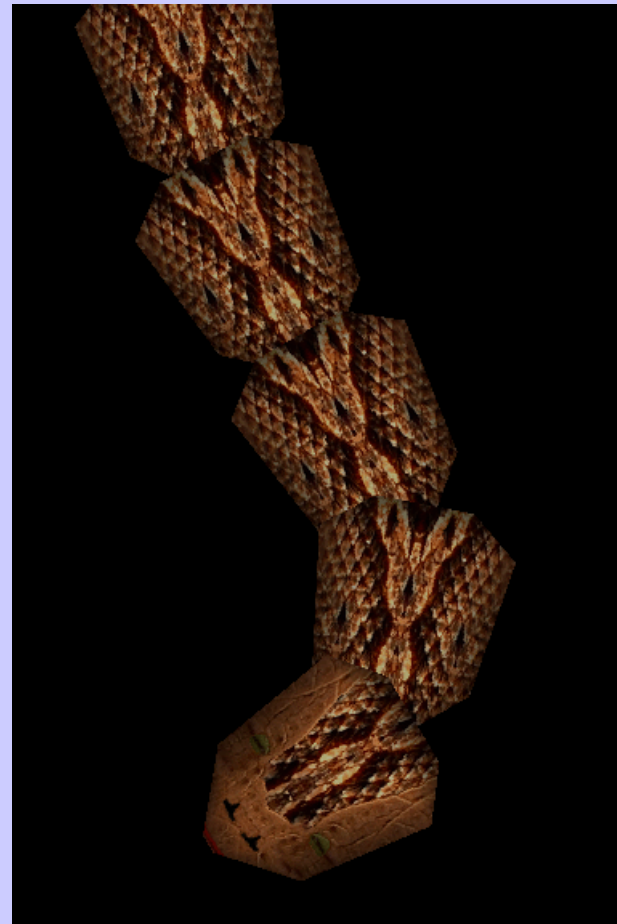$$\sin(a+b) = \cos(a)\sin(b) + \sin(a)\cos(b)$$

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

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

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

The Reach

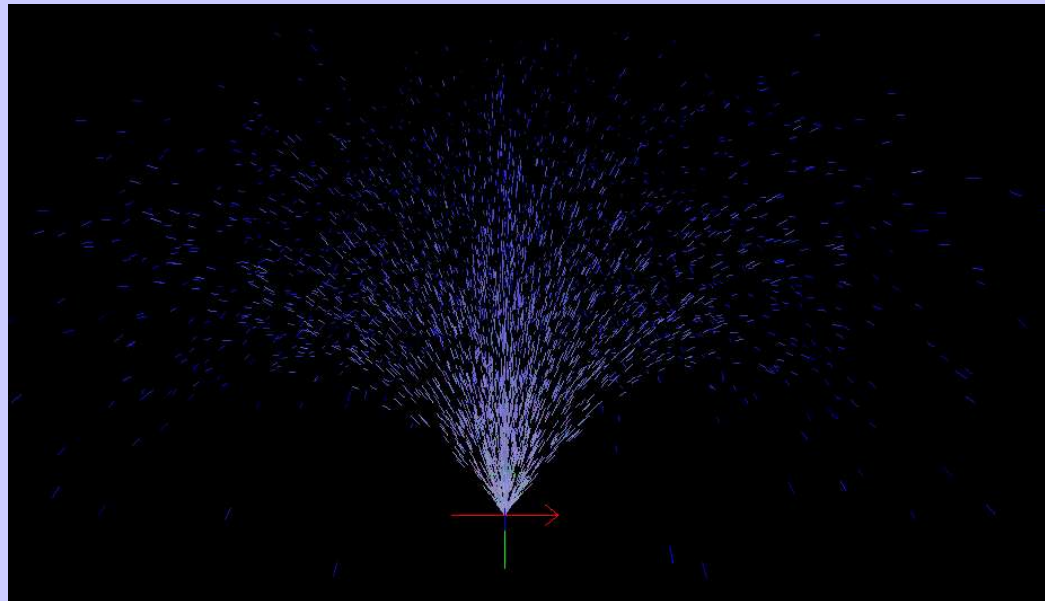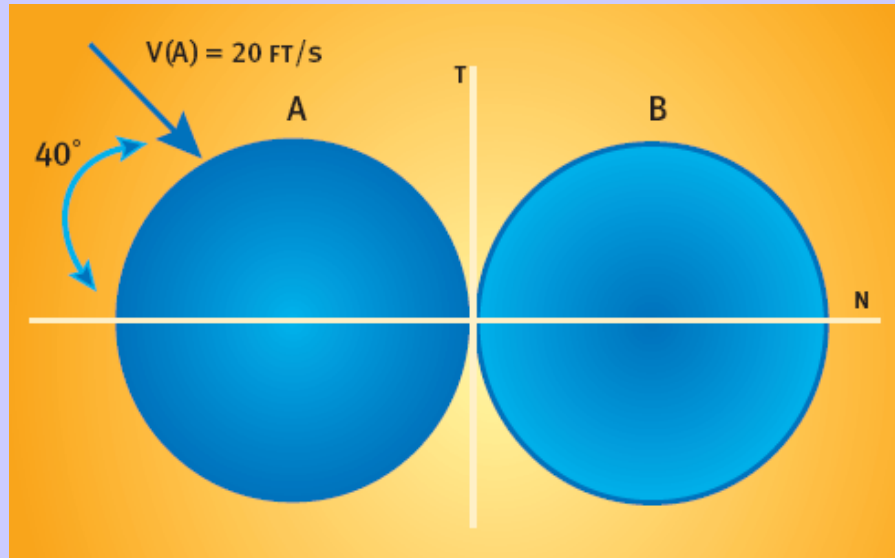◆ For more complex problems, we need to be more clever.

Math

◆ Vector, Matrices, Dot Products, Trig

$$h = h0 + v0t - (gt^2)/2$$

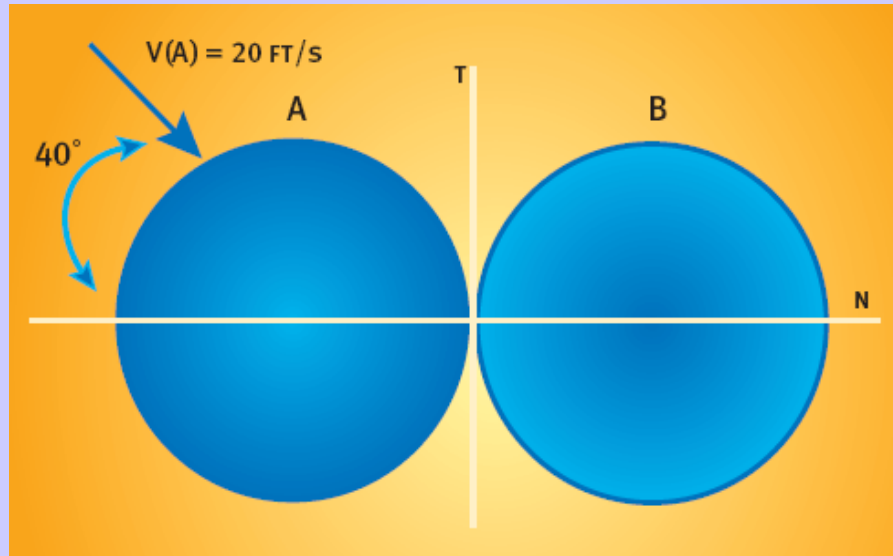This is one of the most powerful tools
in our belt.

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.

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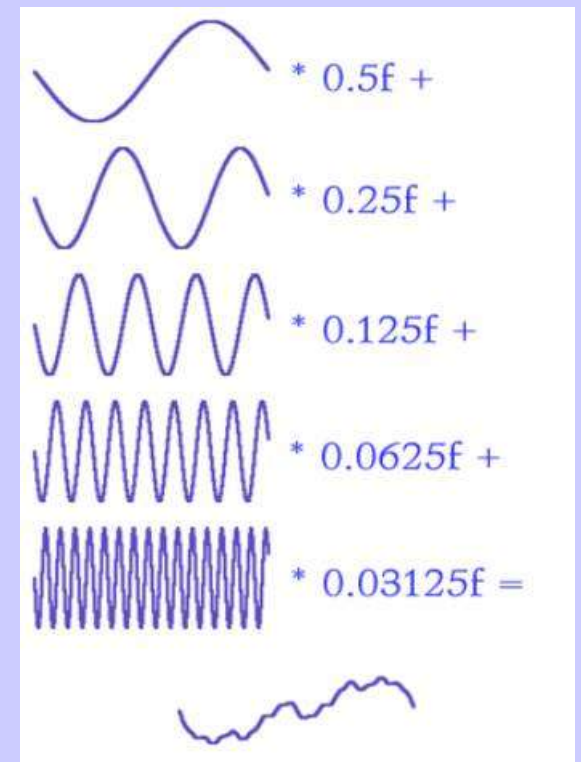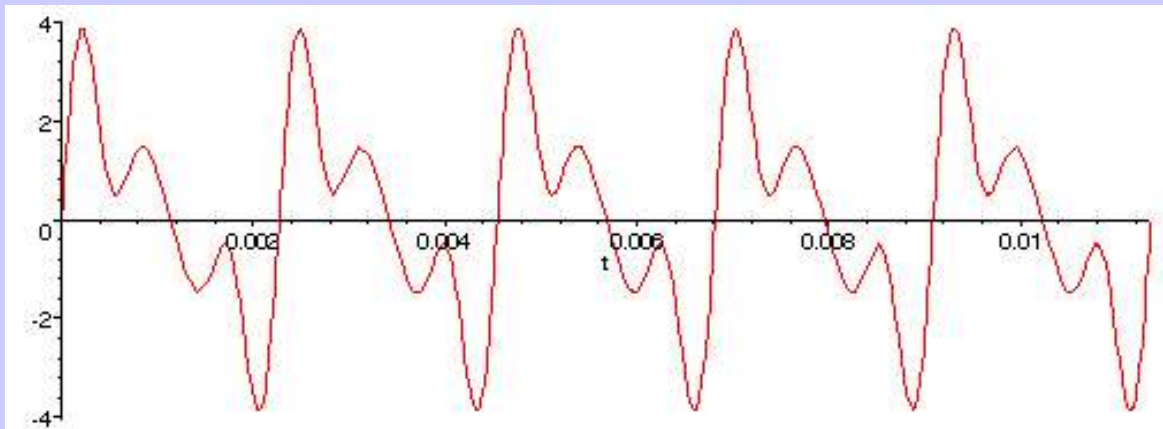 ◆ What controls are important for the player to use in this design?

No Math for Me! I do the design.

- ◆ 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.
  - ◆ Damage = strength * (1 + 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
- jeffl@darwin3d.com
- www.igda.org
    - International Game Developer's Association
    - Chapter meetings here in Los Angeles