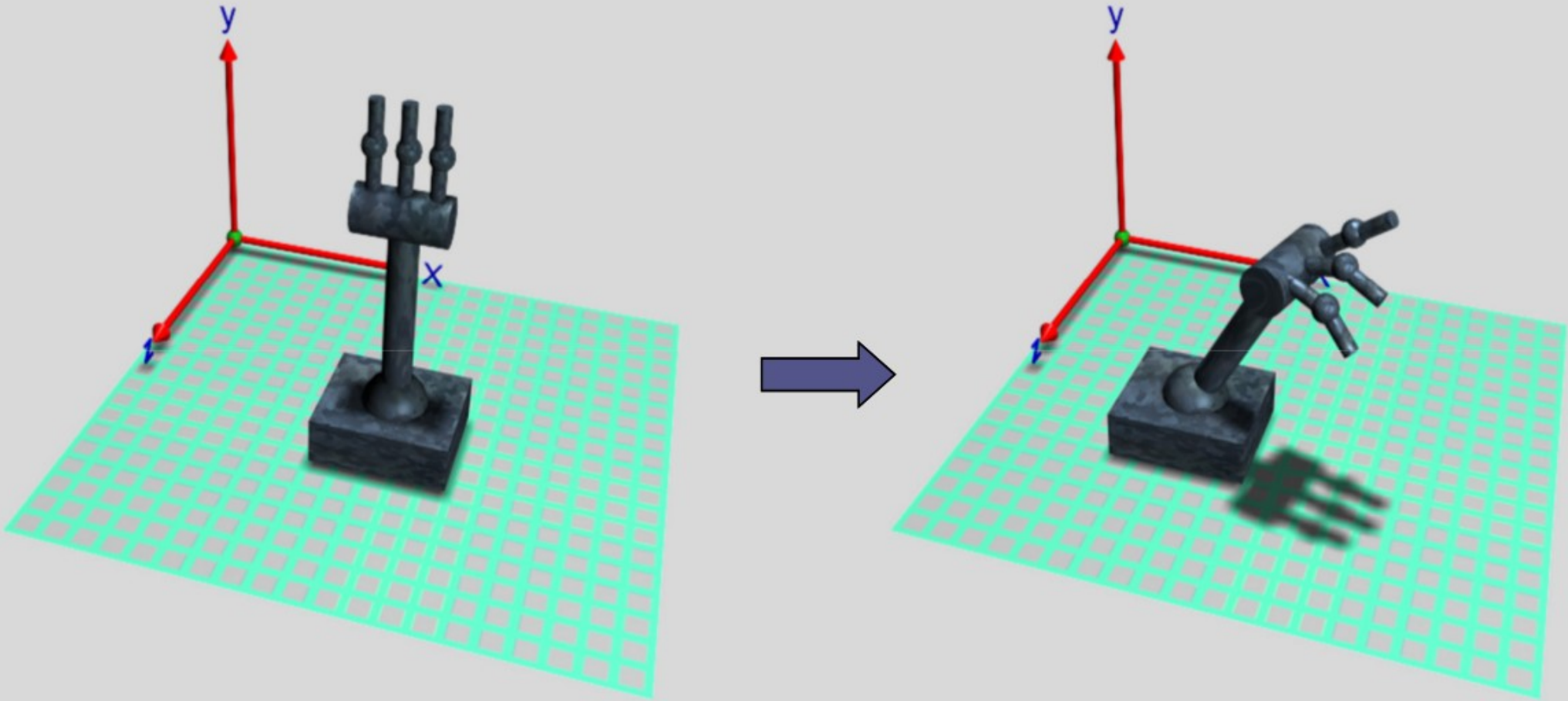
Animated

Anton Gerdelan
gerdela@scss.tcd.ie
Trinity College Dublin

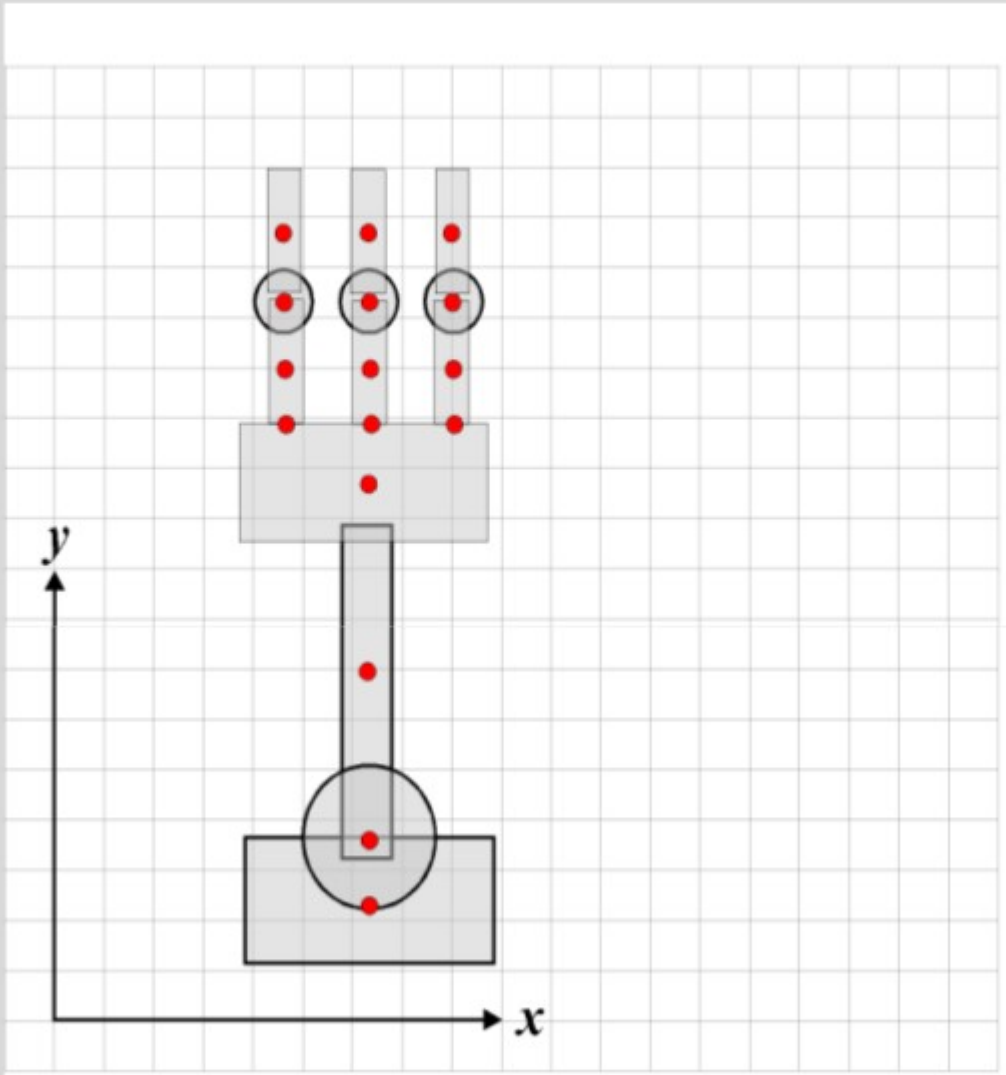
Hierarchical Transformations

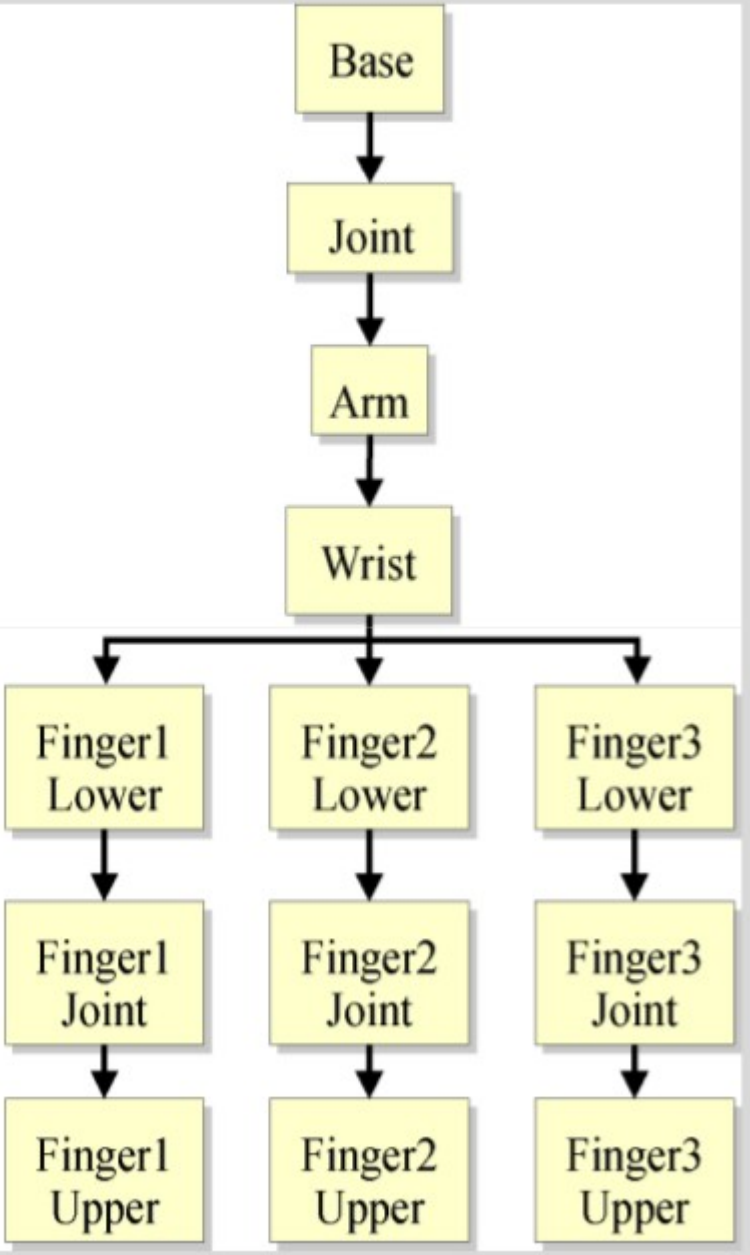


Each finger is a child of the parent (wrist)

$\Rightarrow$ independent control over the orientation of the fingers relative to the wrist

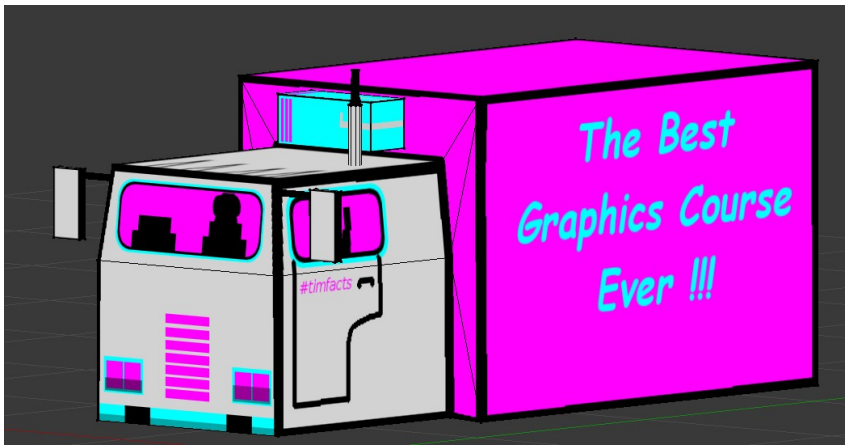
Hierarchical Transformations

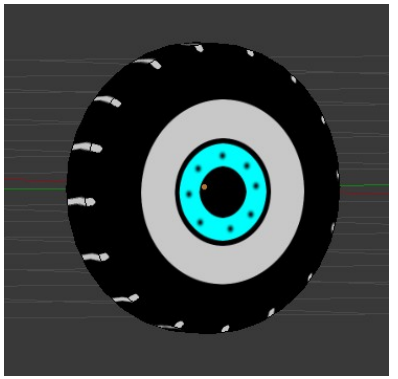




Hierarchical Animation

- `body_M = body_T * body_R`
- `wheel_local_M = wheel_local_T * wheel_local_R`
- `wheel_M = body_M * wheel_local_M`

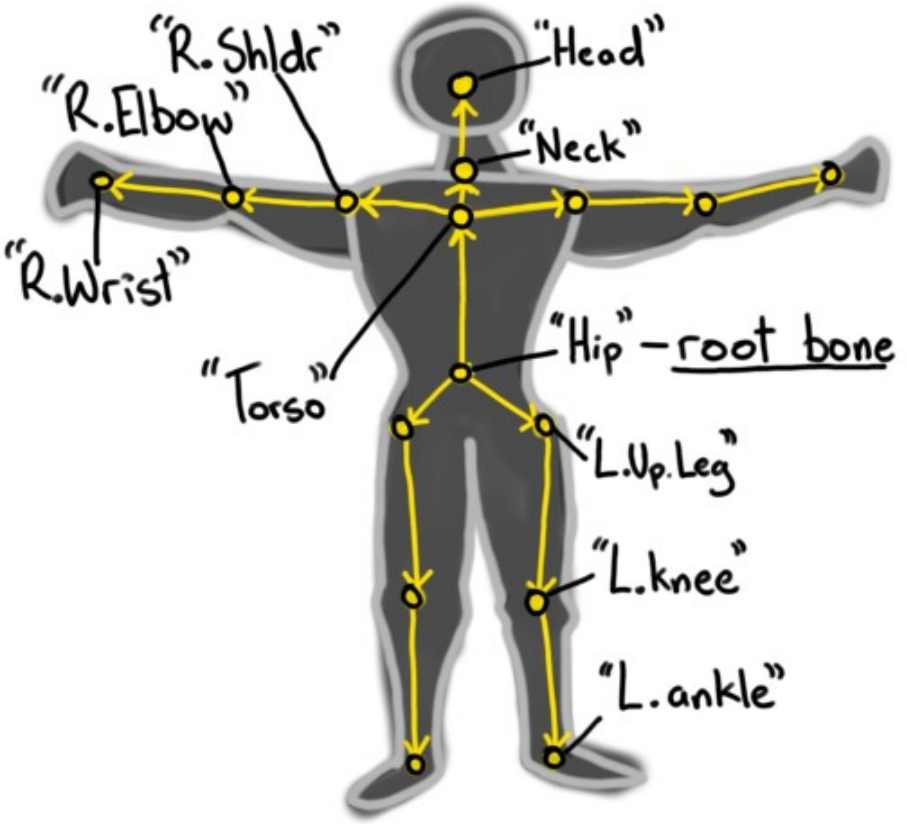




Wheel local translation is offset from truck origin
Wheel local rotation is the current angle (+ speed * elapsed time)

Skinned Animation

- Hierarchy within one mesh
- Create a “skeleton” of bones
- Each vertex associated with one or more bones “**weight-painting**”
- When animating: create a matrix for each bone

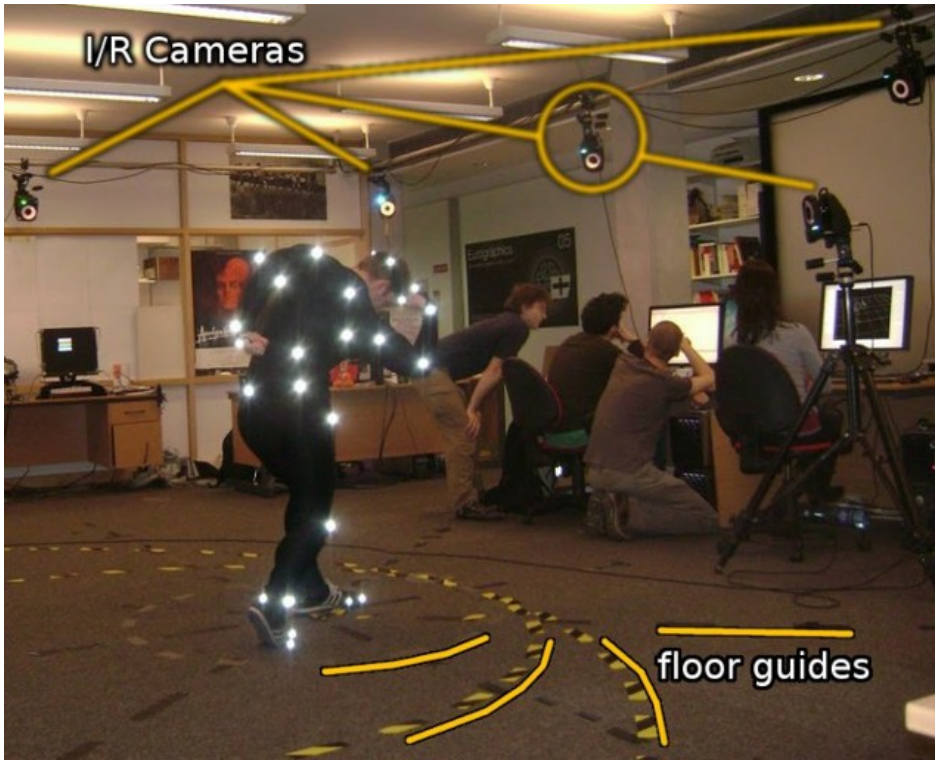


Simple Skinned Animation: Vertex Shader

```
#version 150

in vec3 vp;
in vec3 vn;
in vec2 vt;
in float bone_id;

uniform mat4 P, V, M, bone_matrices[32];

out vec3 p_eye, n_eye;
out vec2 st;

void main () {
	mat4 bone_mat = bone_matrices[int(bone_id)];
	p_eye = vec3 (V * M * bone_mat * vec4 (vp, 1.0));
	n_eye = vec3 (V * M * bone_mat * vec4 (vn, 0.0));
	st = vt;
	gl_Position = P * vec4 (p_eye, 1.0);
}
```

Motion Capture

- Infrared with markers or
- Kinect for depth capture or
- some other webcam-based system
- Markers captured in 3d
- Mapping software creates skeleton
- Export key-framed clips



Particle Systems

- William Reeves "*Particle Systems: A Technique for Modeling a Class of Fuzzy Objects*", ACM Transactions on Graphics, 1983.
- Visualising "nebulous" things – smoke, clouds, water sprays, fire, explosions...
- **Remind me I have demo video**

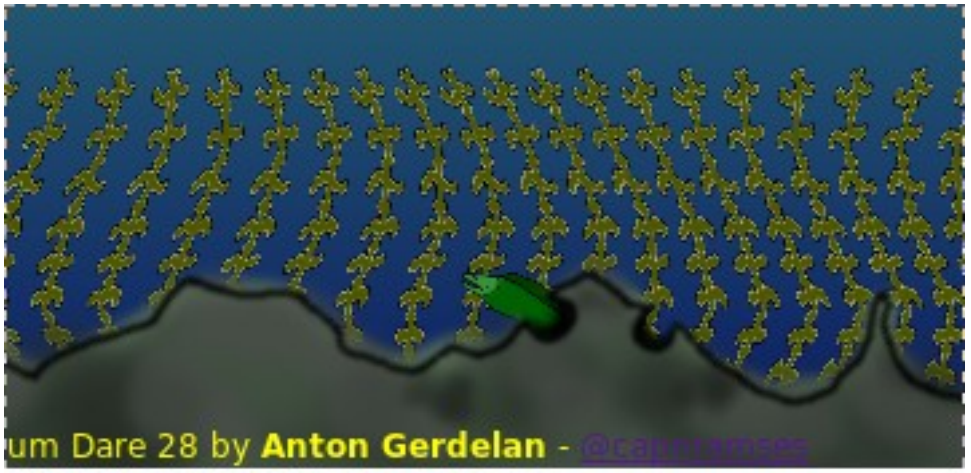
Boids (bird-oids) aka “flocking”

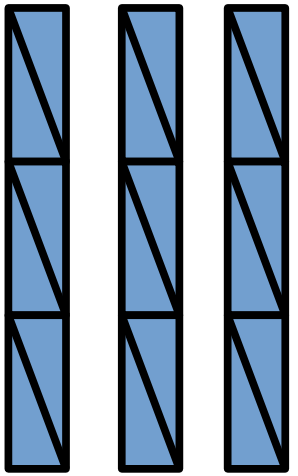
- Craig Reynolds "*Flocks, herds and schools: A distributed behavioral model*", SIGGRAPH'87
- Basically a simple behaviour and motion sim. Weighted balance of:
  - Steer towards common heading
  - Steer away if too close
  - Steer toward average position

Boids in Tim Burton film *Batman Returns.* Warner Bros. 1992

Other Vertex Shader Animation

- Waves using sin() cos() etc.
  - Water, flags, cloth...?
- Seaweed in http://antongerdelan.net/dolphin_rescue/





```
vec2 pos = vp;
if (pos.y > -0.9) {
        pos.x += sin (t + M[3][0] * 4.0 + pos.y * 2.0) * 0.25;
}
```

Time in seconds

X offset of the strand of weed

Other Vertex Shader Animation

- Waves demo http://youtu.be/1zGrq7DfAtk
- Hopefully that worked in the lecture
- Addition of several waves in vertex shader
- Environment map
  - Reflection
  - Refraction
  - Lighting with wave normals calculated (partial derivative)

Animation and Shaders

- Hierarchy and skeletons (more detail in Animation course)
- Time as a uniform
- Vertex shader
- Interpolation
- Closed-system simulations
- Limitation – moving a particle system so that old particles don't move too.
- Possible solution - “**transform feedback**”. Not fantastic.