CSC 2521, Fall 2015
Interactive Modeling & Fabrication

Karan Singh

dgp
Dynamic Graphics Project
University of Toronto
www.dgp.toronto.edu

Goals

- Fundamentals of 3D shape modeling:
    - Curve and Mesh-based representations.
    - Geometry processing: curvature, segmentation, symmetry, deformation...

- Interaction techniques for shape modeling:
    - pen-based, multi-touch, full-body, AR/VR.

- Fabrication.

- Evaluation:
    - Design and Modeling Assignment 25%.
    - Technical Paper presentation 25%.
    - Project (2-3 people working together) 50% (mid-term evaluation 10%, report 10%).

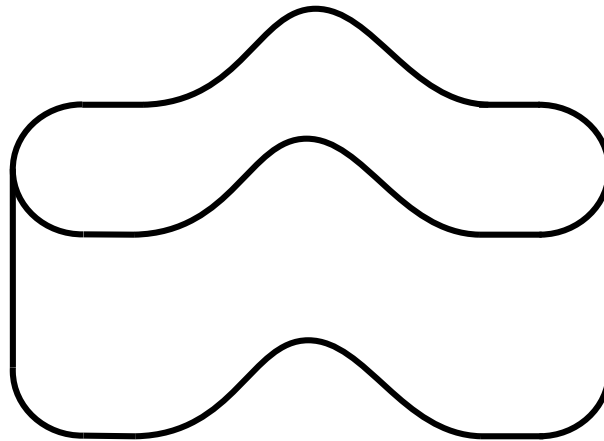# What is this course about?

Creative visual communication

The transformation of a creative vision into a physical reality, that is easy to digitally refine and reuse.
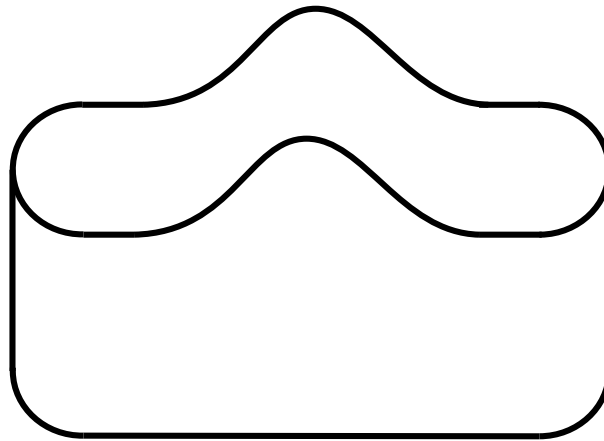
Sketchpad (Ivan Sutherland 1963)

Humans have an audio IN and OUT,
a video IN but no explicit video OUT!

video IN: Projection & Perception

video IN: Projection & Perception

video IN: Projection & Perception

- **Visual field:** one eye looking straight at the horizon, with a narrow cone of vision, while standing still.
- **Visual world:** two eyes looking all around with peripheral vision, while moving dynamically.

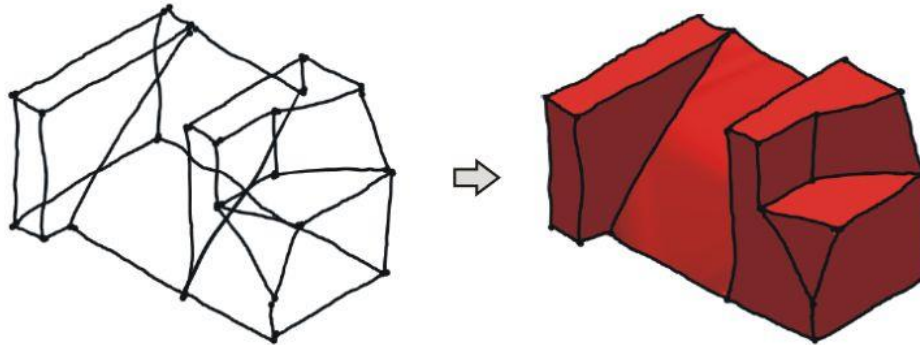[**J. Gibson, 1950**. The Perception of the Visual World, *Houghton Mifflin*.]

Human visual perception combines:
- Visual rules.
- Visual memory.

video IN: visual rules

- Interpret straight/coincident/collinear lines as straight/coincident/collinear lines in 3D.
- Proximity: nearby in sketch -> nearby in 3D.
- Smoothness: Interpret a smooth stroke as smooth in 3D.
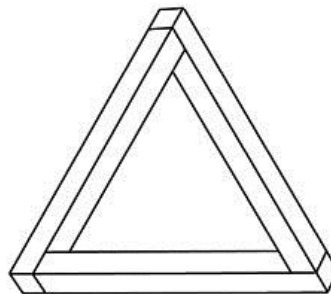
…

…may lead to implausible reconstructions
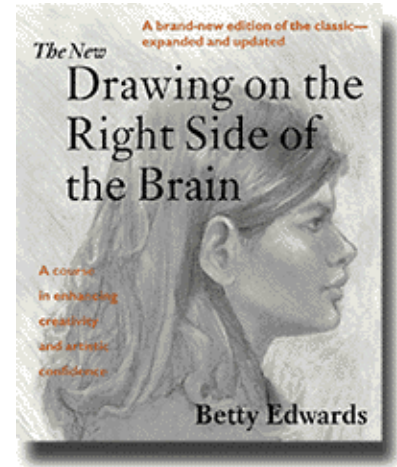
Video IN: visual memory

How much can we actually see in this image? How much do we infer?
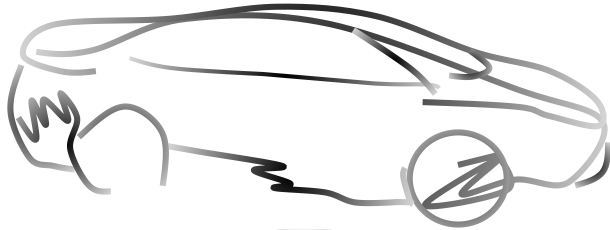
video OUT: Sketching & Sculpting

Most children between the ages of about 9-11 have a passion for realistic drawing.

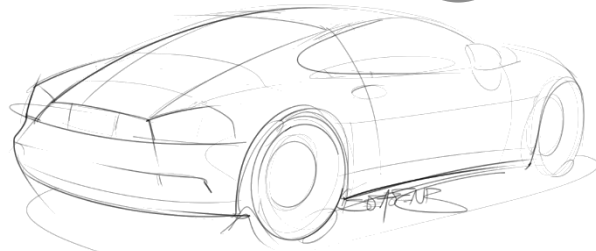…many adolescents say, "This is terrible! I have no talent for art. I'm not doing it anymore."

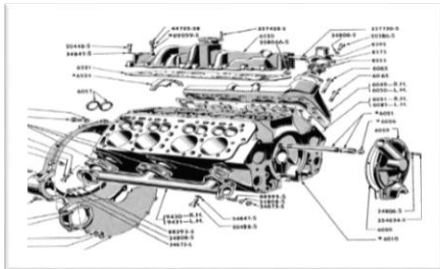**…regardless, we all mould, gesture and doodle!**
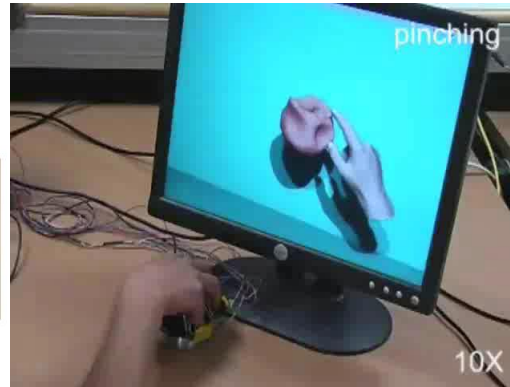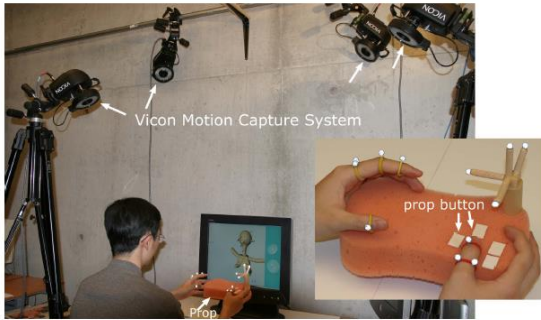
Sketching

Ideation doodle
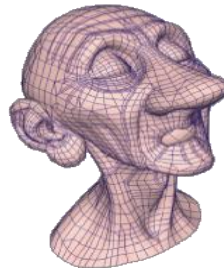
Concept sketch

Production drawing

Construction plan

Sculpting

digital

physical

Issues in interaction for modeling

2D

- stroke filtering   fairing, clothoids…
- stroke processing   recognition, regularization…
- stroke appearance   NPR, stylization…
- stroke dynamics   pressure, tilt, direction, temporal order…
- seamless UI Control   widgets, gestures, crossing, multi-stroke…
- navigation   paper manipulation, onion skinning…
- 2D curve modeling   what are desirable curves?
- stroke perception   How do we perceive them?

3D

- 3D scanning/printing   occlusion and feasibility…
- 3D navigation   camera tools, single/multi-view…
- 3D curve and surface modeling   what are desirable surfaces?
- immersive input and displays   can we draw in 3D?
- fabrication   can we build as we create?

3D geometric representations

- Point.
- Point-cloud.
- Poly-line.
- Polygon mesh: Quads, Triangles…
- Parametric curve/surface: Hermite, Bezier, B-Spline, NURBS…
- Subdivision curve/surface: Chaikin's curve, Catmull-Clark…
- Voxels.
- Implicit functions, level-sets, blobby models.
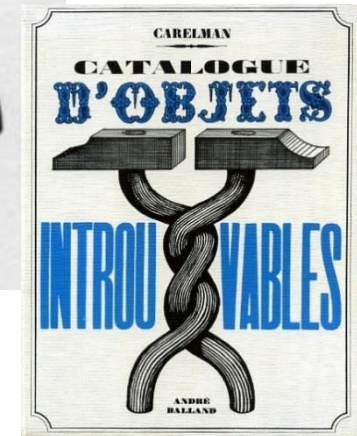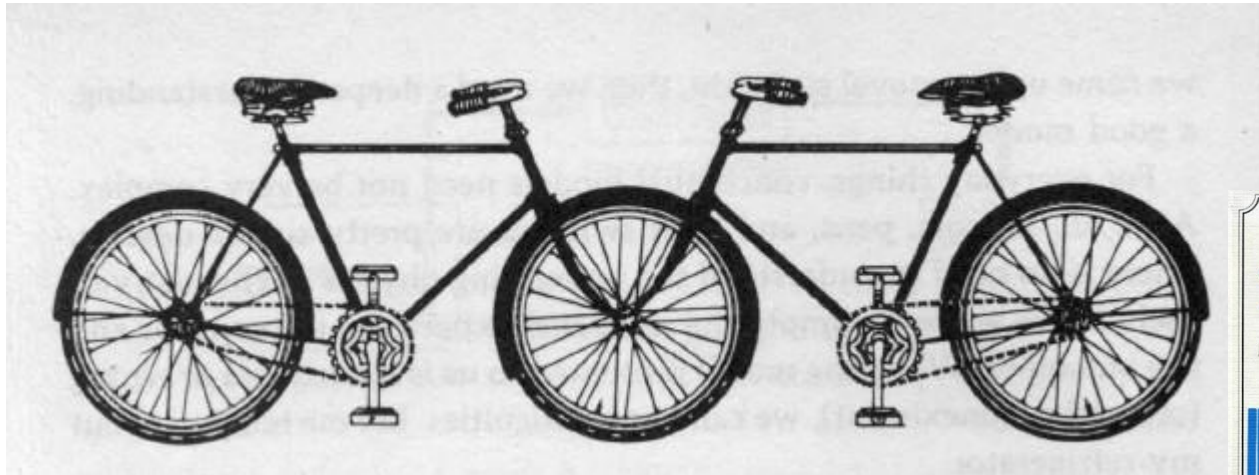- Texture maps.
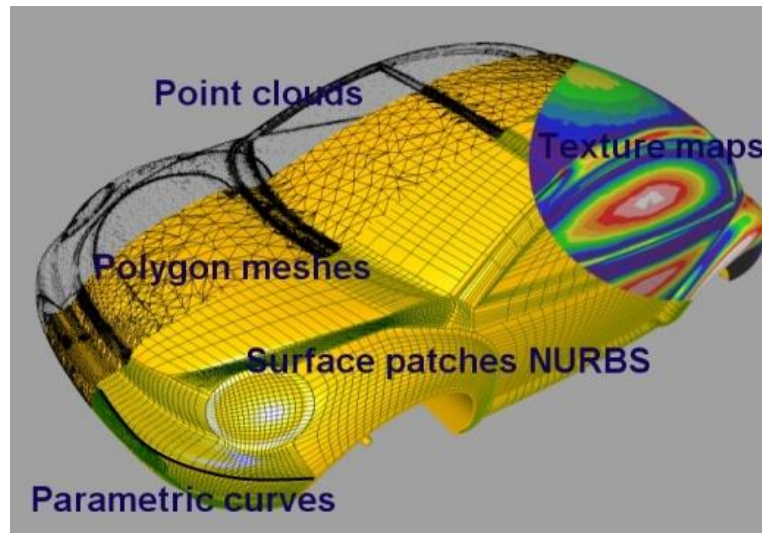
3D modeling: form + function
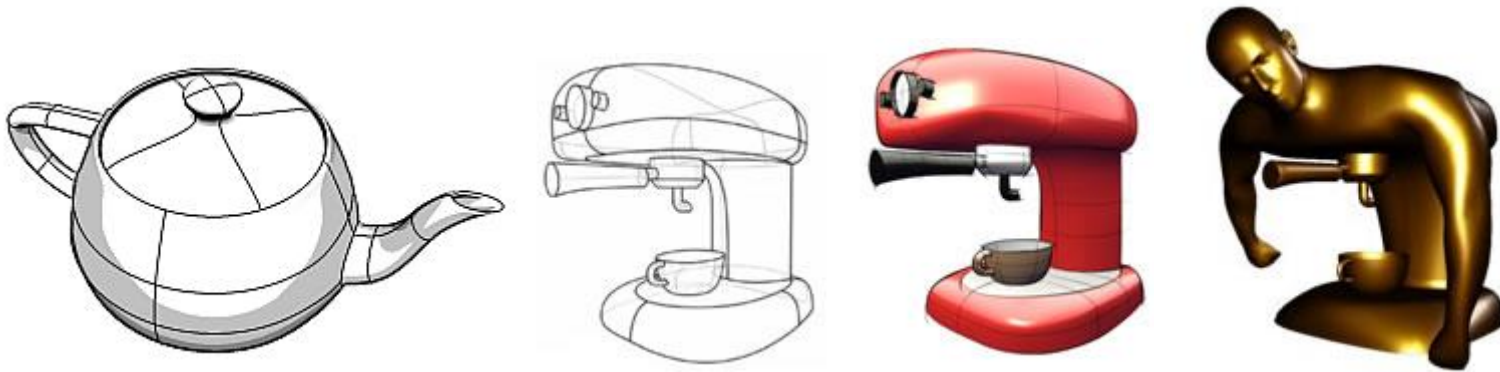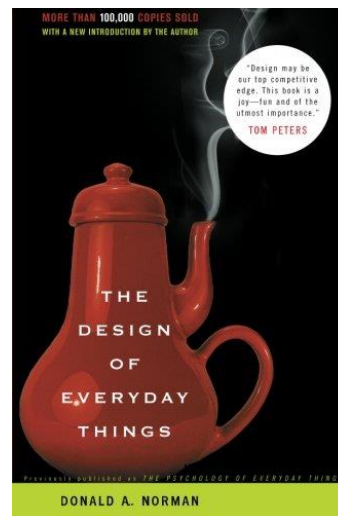

What do these objects do?

3D modeling: good design

- Affordance.
- Visibility.
- Conceptual Model.
- Mapping.
- Feedback.

3D modeling: good design

"Darn these hooves! I hit the wrong switch again! Who designs these instrument panels, raccoons?"