CSC 2521 Fall 2013: Interactive Geometry

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NUS June 17-19, 2013

Goals

- Fundamentals of 3D shape modeling:
  - curve and mesh-based representations.
  - discrete differential geometry: curvature, volume, features, symmetry...
  - Deformations: both spatial and variational.
- Fundamentals of 3D interaction techniques:
  - pen-based, multi-touch, full-body interaction.
- State of the art in interactive 3D modeling.
- Technical tools for solving geometry and stroke interaction problems.
- Evaluation:
  - Design and Modeling Assignment 20%.
  - Technical Paper presentation 30%.
  - Project (2-3 people working together) 50% (mid-term evaluation 10%, report 10%).

What is this course about?

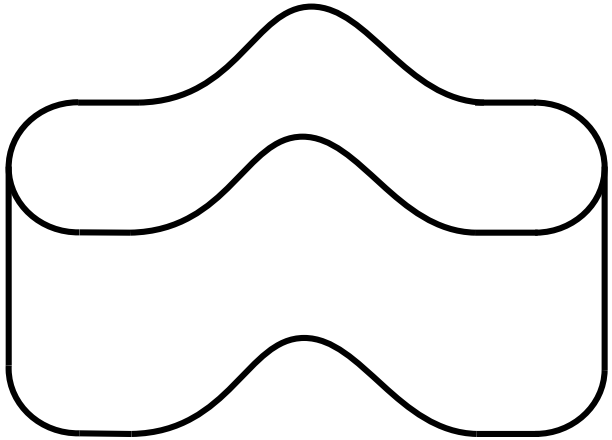
Creative visual communication

The transformation of a creative vision into a digital reality, that is easy to refine and reuse.

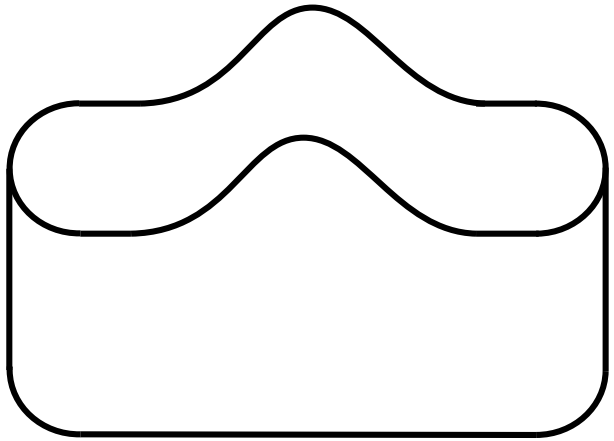
Sketchpad (Ivan Sutherland 1963)

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*.]

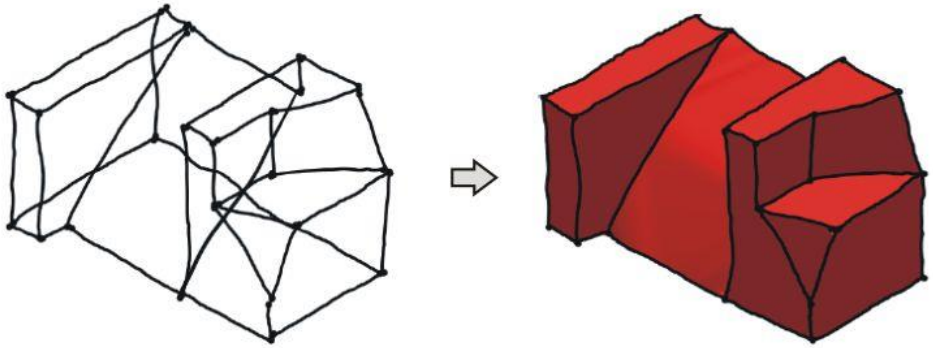
Human visual perception combines:

- 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

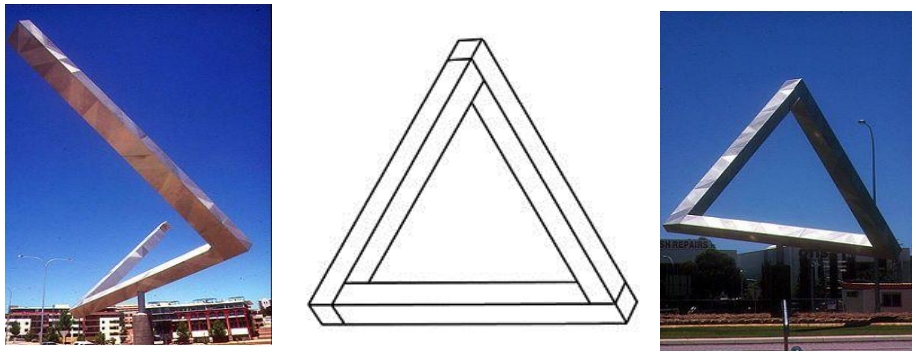


Figure: http://www.at-bristol.co.uk/Optical/ImpossibleTriangle_main.htm
Pictures: http://im-possible.info/english/articles/real/real3.html

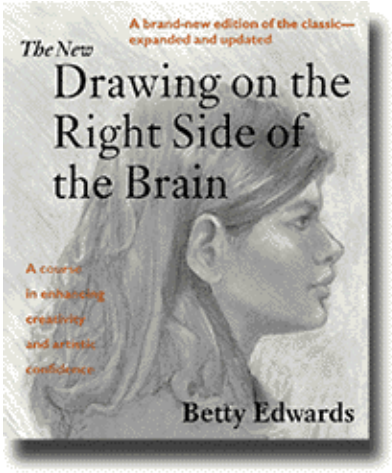
Video IN: visual memory

How much can we actually see in this image? How much do we infer?

video OUT: Sketching & Sculpting

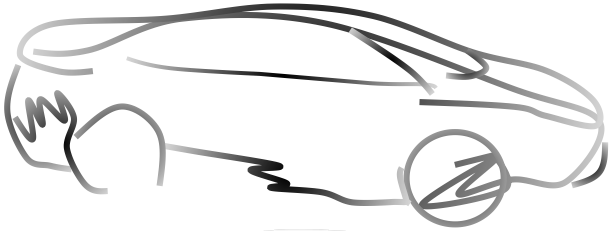
Most children between the ages of about 9-11 have a passion for realistic drawing.

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

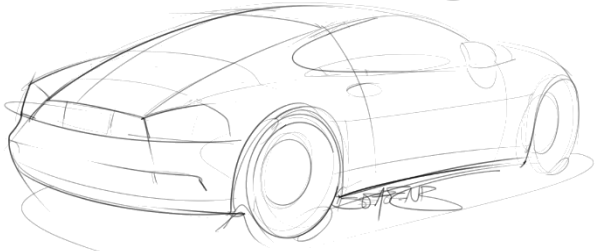


…regardless, we all mould, gesture and doodle!

Sketching

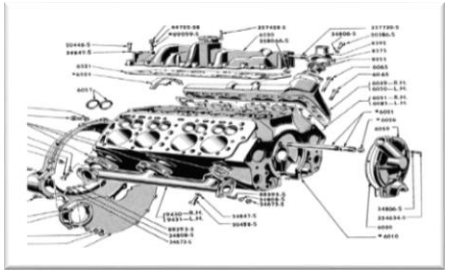


Ideation doodle



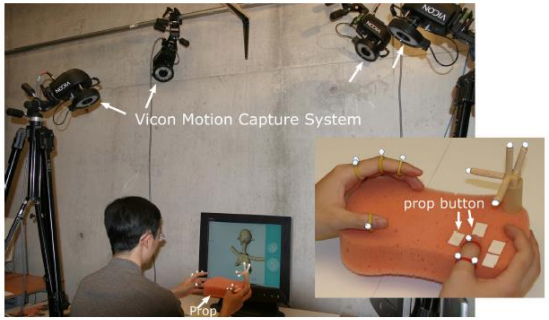
Concept sketch

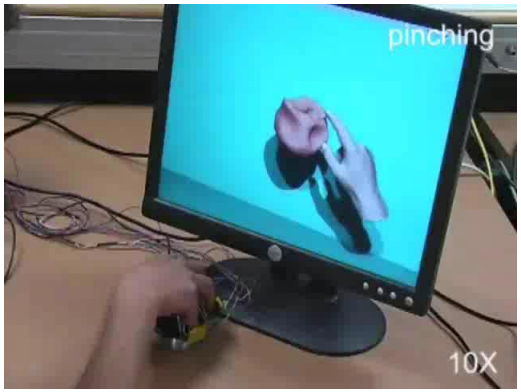
Production drawing



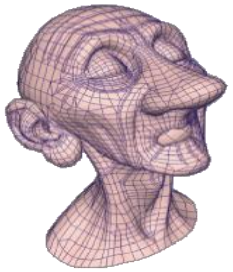
Construction plan

Sculpting





digital



physical

Issues in interaction for modeling

2D

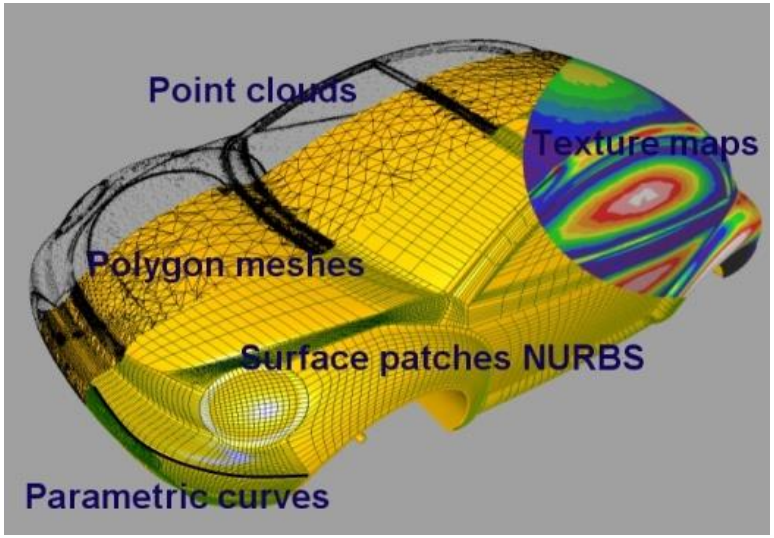
- stroke filtering — fairing, clothoids…
- stroke processing — recognition, regularization…
- stroke appearance — NPR, stylization…
- stroke dynamics — pressure, tilt, direction, temporal order…
- seamless UI Control — widgets, gestures, crossing, multi-stroke…
- navigation — paper manipulation, onion 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
- Alternate designs — co-locating them in space…

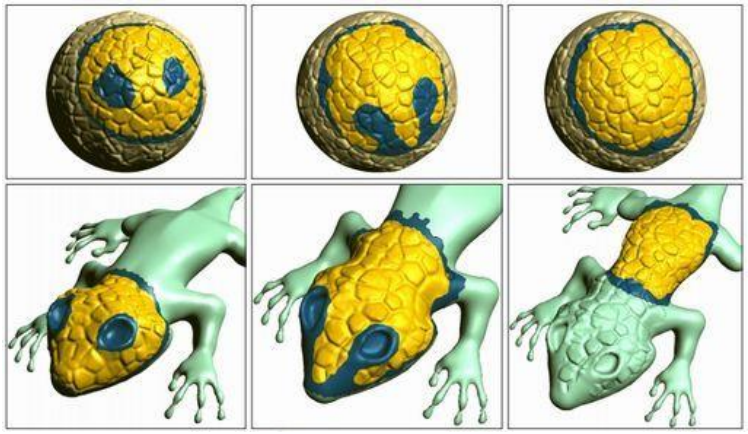
3D geometric representations

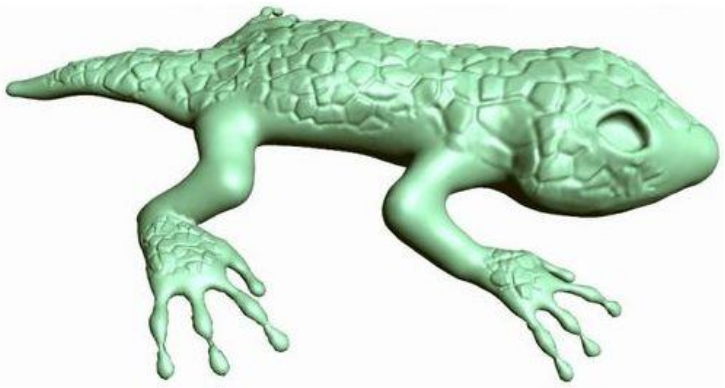
- Point.
- Point-cloud.
- Poly-line.
- Polygon mesh: Quads, Triangles…
- Parametric curve/surface: Hermite, Bezier, B-Spline, NURBS...
- Subdivision curve/surface: Chaikin's curve, Catmull-Clark…
- Voxels.
- Implicit functions, level-sets, blobby models.
- Texture maps.



3D modeling operations

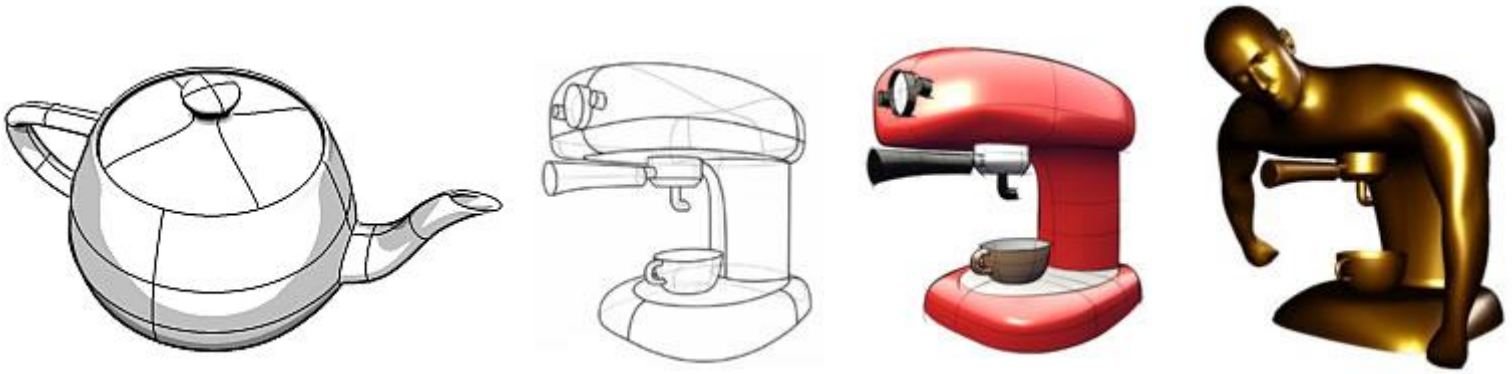
- CSG.
- Extrusion.
- Revolve.
- Loft.
- Cut and Paste.
- Clone Brush.





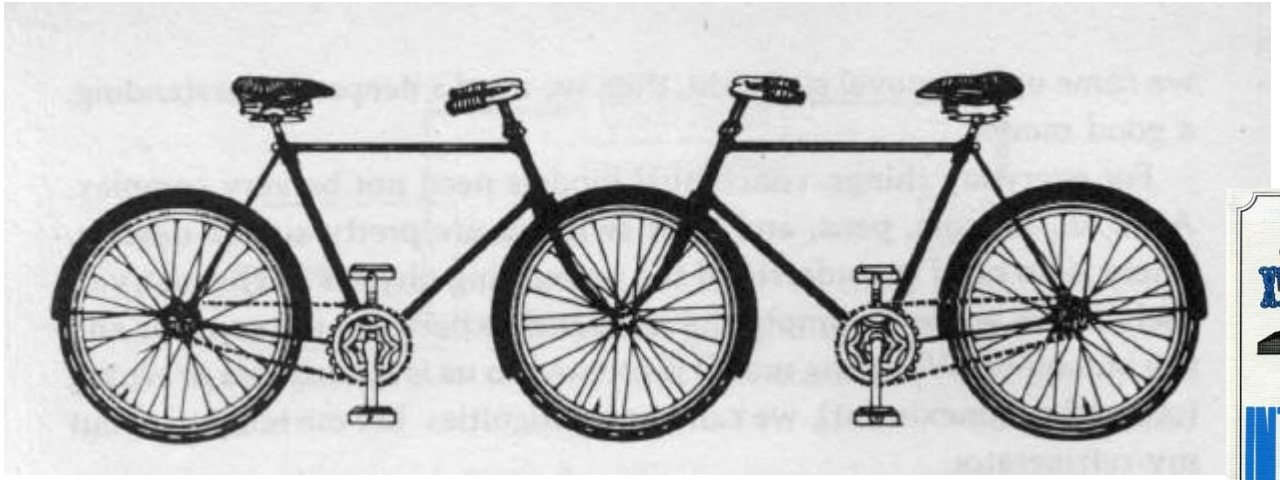
…interactive session

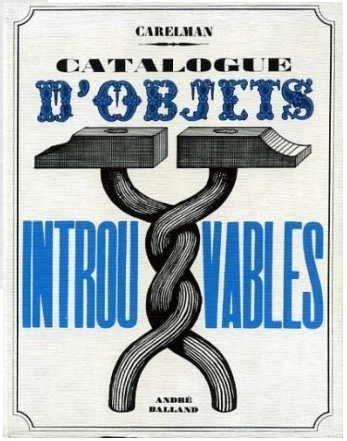
3D modeling: form + function



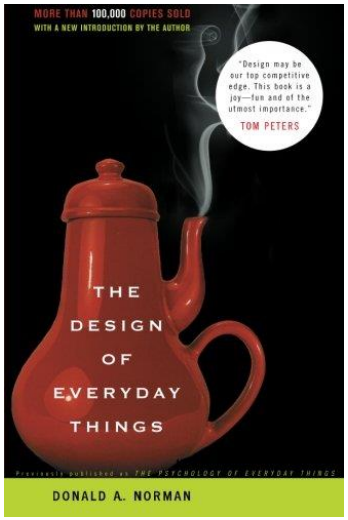
What do these objects do?

3D modeling: good design

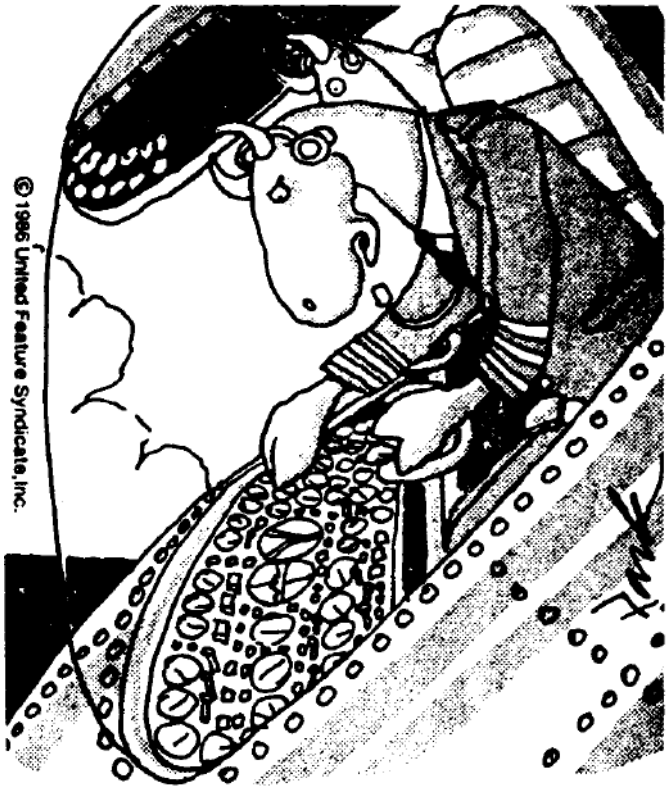




- Affordance.
- Visibility.
- Conceptual Model.
- Mapping.
- Feedback.



3D modeling: good design



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

Next Lecture

- 3D Curve representations and modeling case studies.