# Sketch & sculpt:
# perception, interaction & modeling

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# Sketchpad (Ivan Sutherland 1963)

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

# video IN: 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.

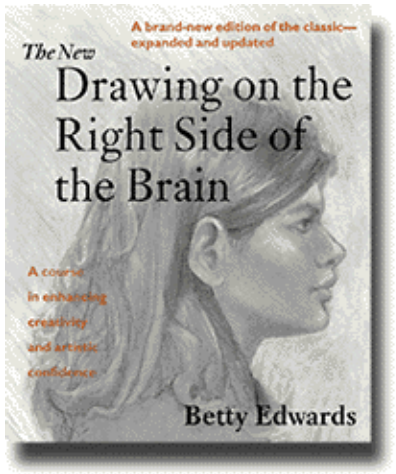
[**J. Gibson, 1950**. The Perception of the Visual World, *Houghton Mifflin*.]

# video OUT: Sketching & Sculpting

Most children between the ages of about 9-11 have a passion for realistic drawing. They become sharply critical of their childhood drawings and begin to draw certain favorite subjects over and over again … Anything short of perfect realism may be regarded as failure.

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

[**B. Edwards, 1999.** Drawing on the Right Side of the Brain, *Tarcher/Putnam.*]



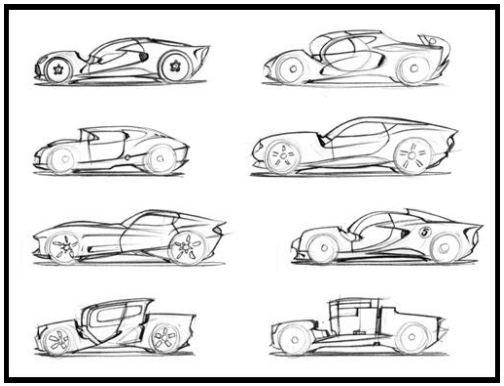

**…regardless, we all mould, gesture and doodle!**

# Design sketches: Ideation

© Frank Gehry

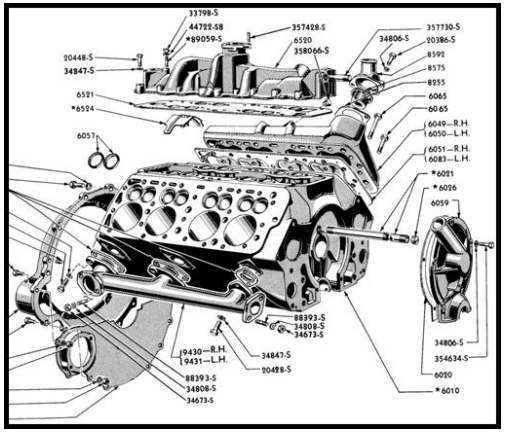
© Carol Highsmith

# 3D Design Drawing



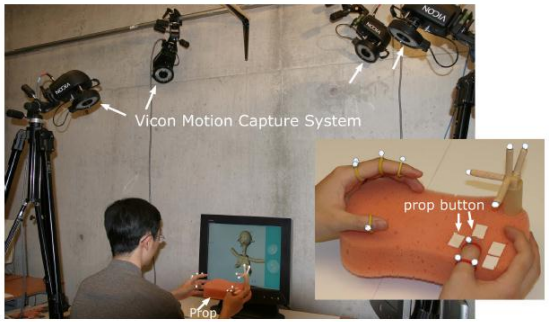
Concept Sketches

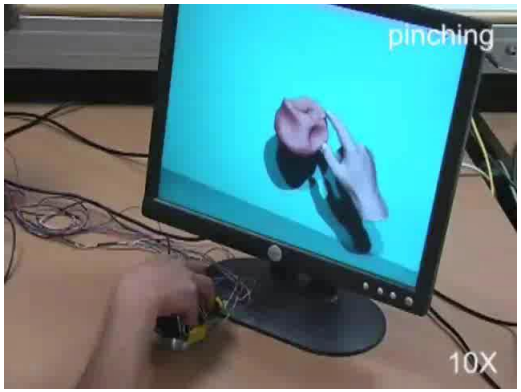
Production Drawings



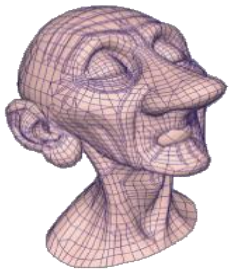
Construction Plans

# Sculpting




digital



physical

# Sculpting Workflows

3D

- Primitive creation and coarse manipulation.
- Primitive composition.
- 3D navigation.
- Volume control.

2D

- Sketching on surfaces: chiseling, brush based refinement.
- Surface parameterization and transport for cut and paste.

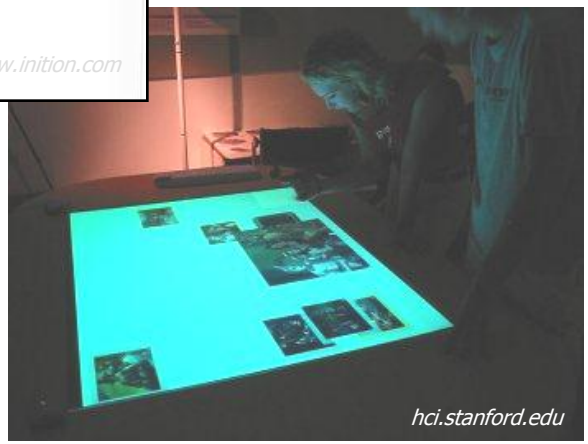
# Physical sculpting challenges

- No digital affordances (undo, history, variability).
- Occlusion problems in 3D scanning.
- Raw 3D scan to usable digital model is non-trivial.
- 3D printing is slow, limited.
- Iteration cycle is long and expensive.

# Devices

- Online/interactive
- Immersion



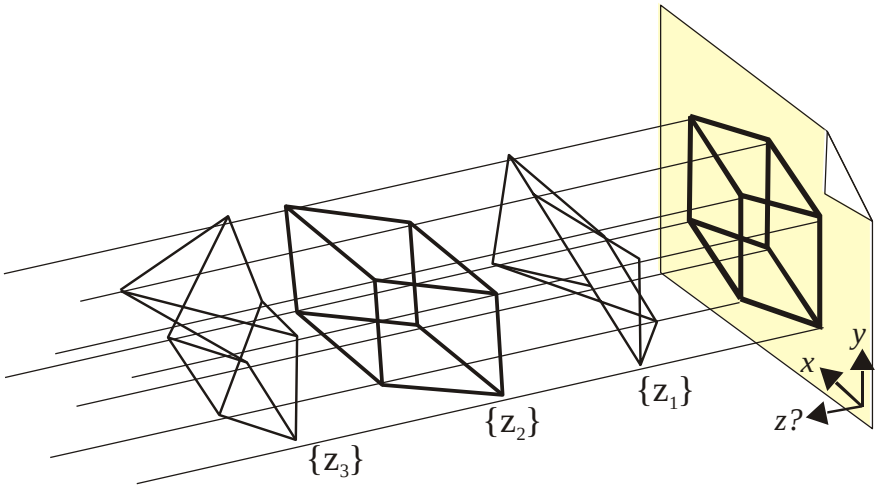


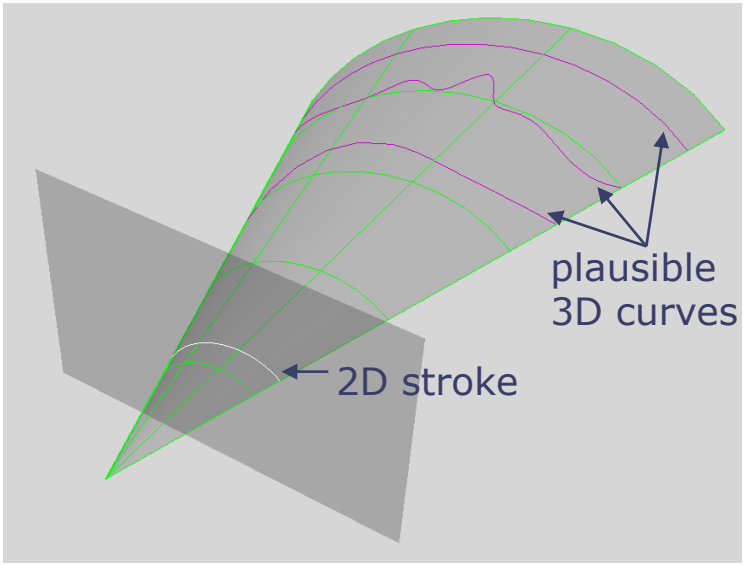
# Digital sketching & sculpting challenges

- 2D input (mouse, pen tablet) to define 3D.
- 3D input (phantom, mocap) have poorer fidelity, haptics and ergonomics compared to 2D input.
- Inferring 3D shape from 2D input is inherently ambiguous.
- 3D shape is viewed on a 2D display (volumetric and stereo displays have poorer fidelity).

# Challenge

## 2D to 3D: “Depth” component is ambiguous



# Human perception †

Combination of

- Visual rules
- Visual memory

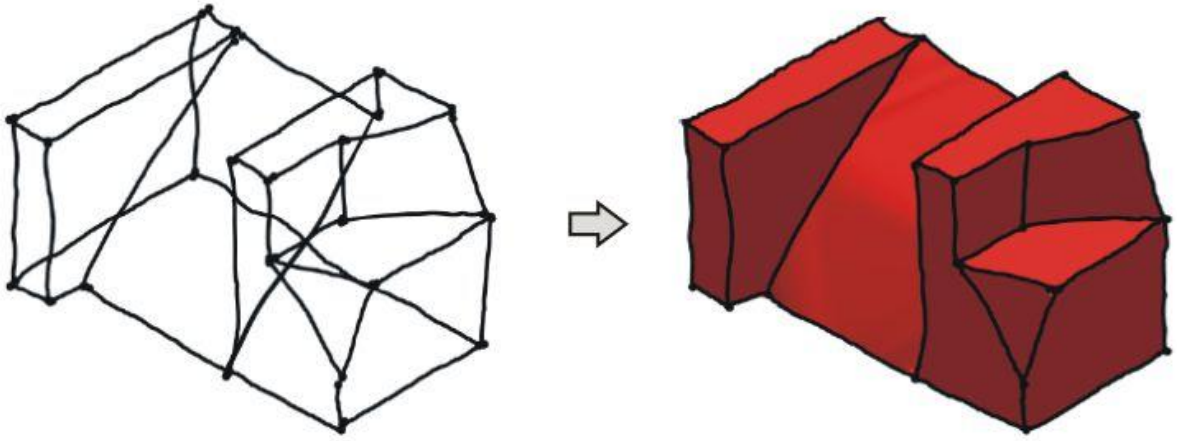
† D. Hoffman, *Visual Intelligence: How We Create What We See*, W.W. Norton & Company, 2000.

# 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.

…



# Visual rules

- May lead to implausible reconstructions

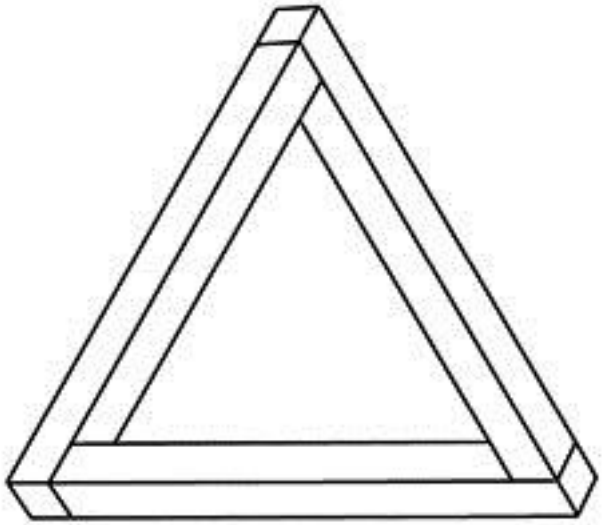
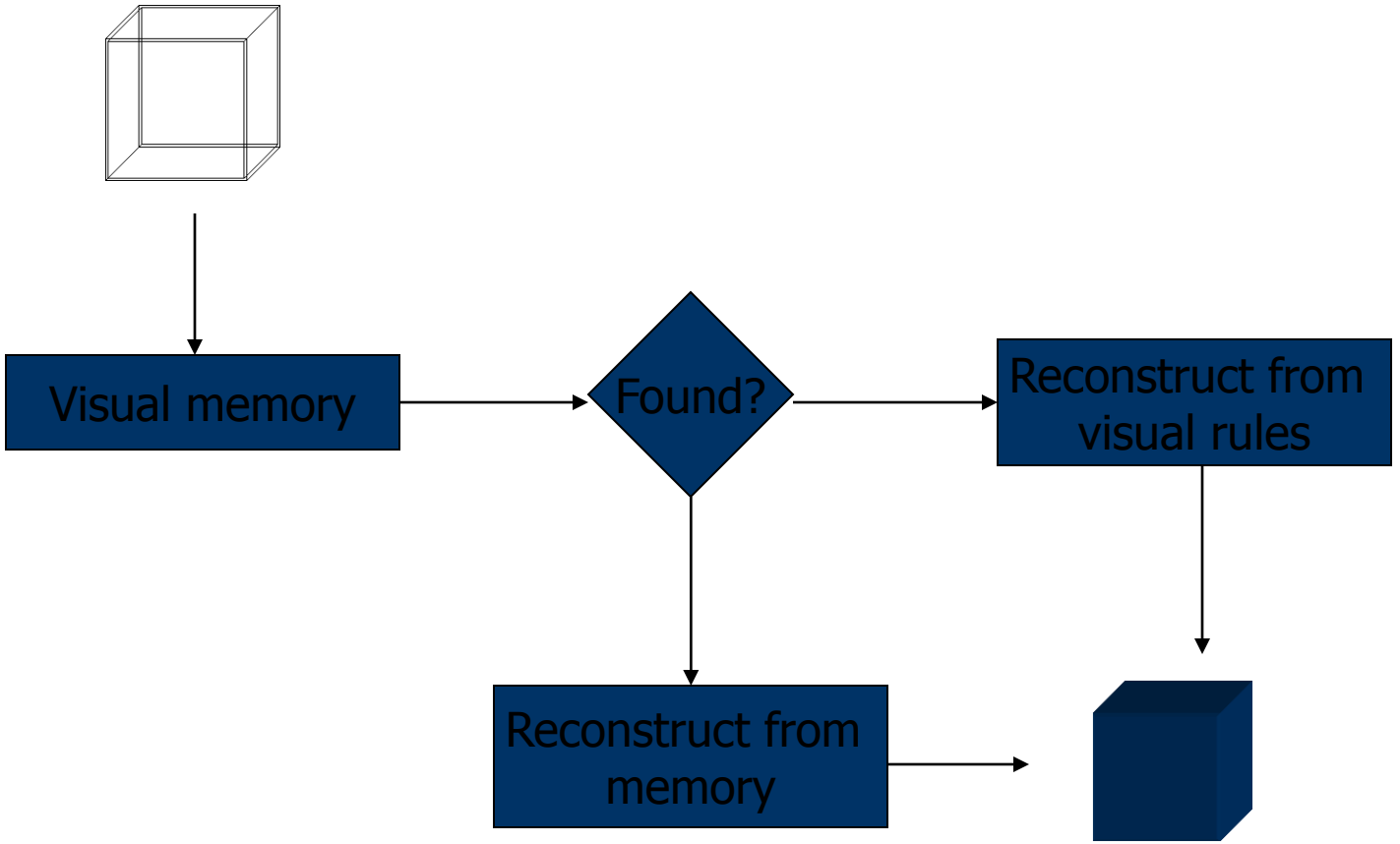


Figure: http://www.at-bristol.co.uk/Optical/ImpossibleTriangle_main.htm
Pictures: http://im-possible.info/english/articles/real/real3.html

# Visual memory

- Allows for more rich reconstruction
  - How much can we actually see in this image? How much do we infer?

# Perception flowchart



# Issues in Digital Sketching

2D

- Stroke filtering. (clothoids, multi-stroke… what are we filtering?)
- Stroke Processing. (sketch widgets, gestures…)
- Strokes and multi-touch. (gestures, symmetric drawing…)
- Stroke appearance (NPR, neatening…)
- Stroke dynamics (pressure, tilt, direction, temporal order…)
- Seamless UI Control (sketch widgets, crossing menus, gestures…)
- Navigation (paper manip., onion skinning…)
- 2D curve creation: (What are desirable curves, how do we perceive them in relation to our design knowledge?).
- Stroke Perception (what spatio-temporal information do they convey?)

3D (Additional dimension for 3D design, animation or 2D design explorations)

- 3D Navigation. (camera tools, single/multi-view, view bookmarks…).
- 3D curve creation: (2D stroke to 3D curves perception & inference).
- Animation (motion trails, evolving shape fronts…)
- Alternate Designs (co-locating them in space…)