Interactive 3D 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.*]
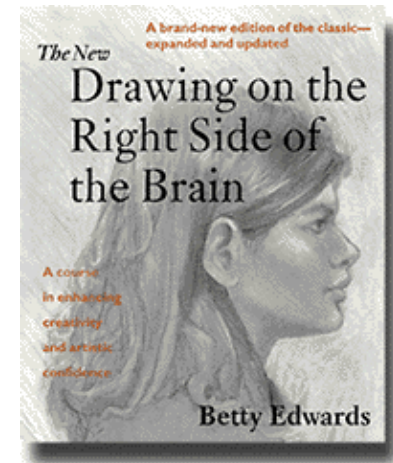
…regardless, we all mould, gesture and doodle!
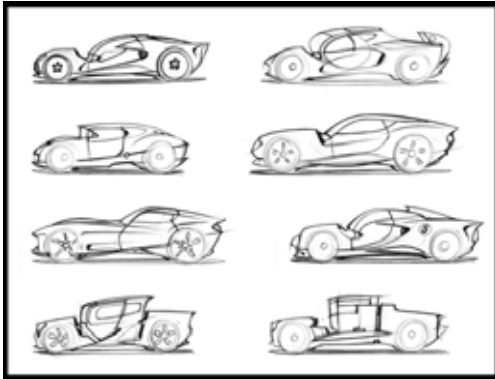
Design sketches: Ideation
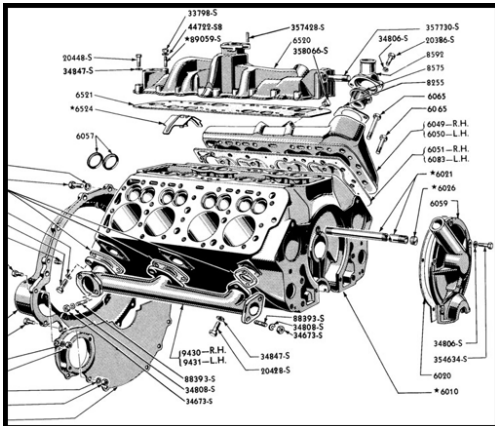

© Frank Gehry

© Carol Highsmith
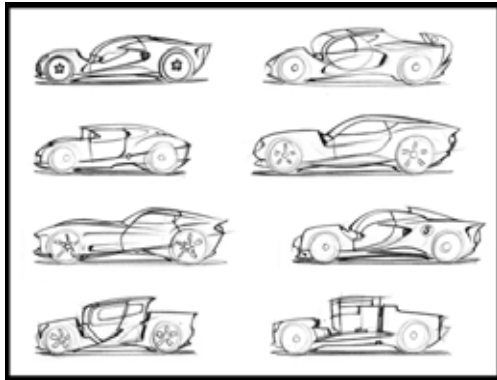
3D Design Drawing

Concept Sketches

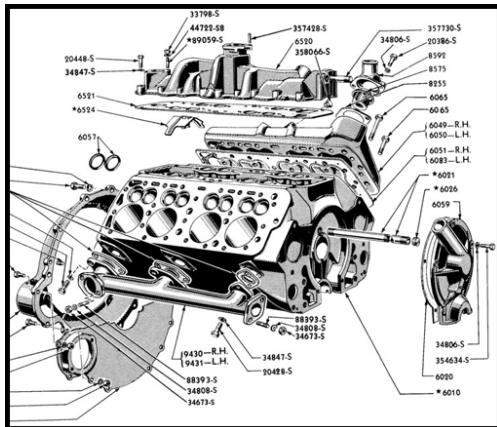Production Drawings

Construction Plans

3D Design Drawing

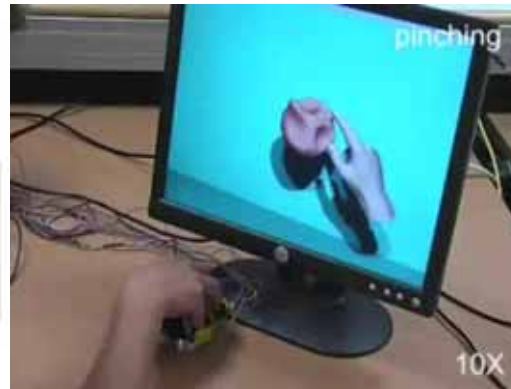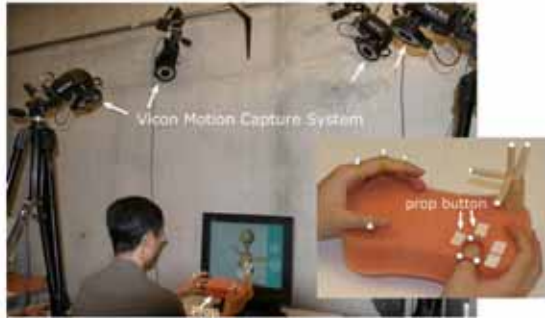

Concept Sketches

Production Drawings

Construction Plans

Sculpting

digital

physical

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

www.inition.com

www.pocketpcmag.com

hci.stanford.edu

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

plausible 3D curves

2D stroke

$\{z_1\}$

$\{z_2\}$

$\{z_3\}$

x

y

$z?$
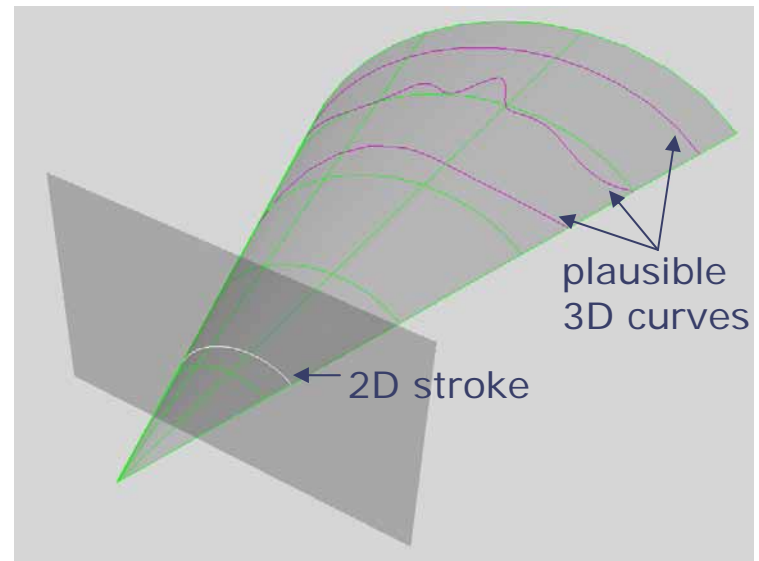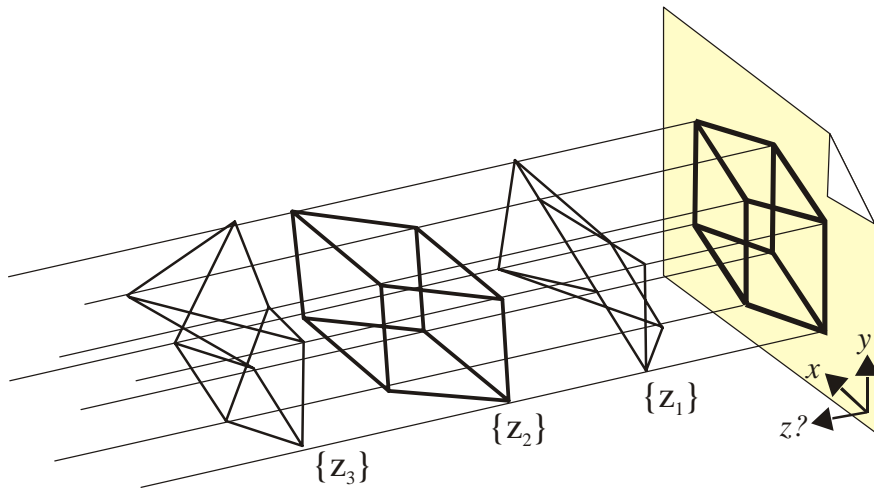
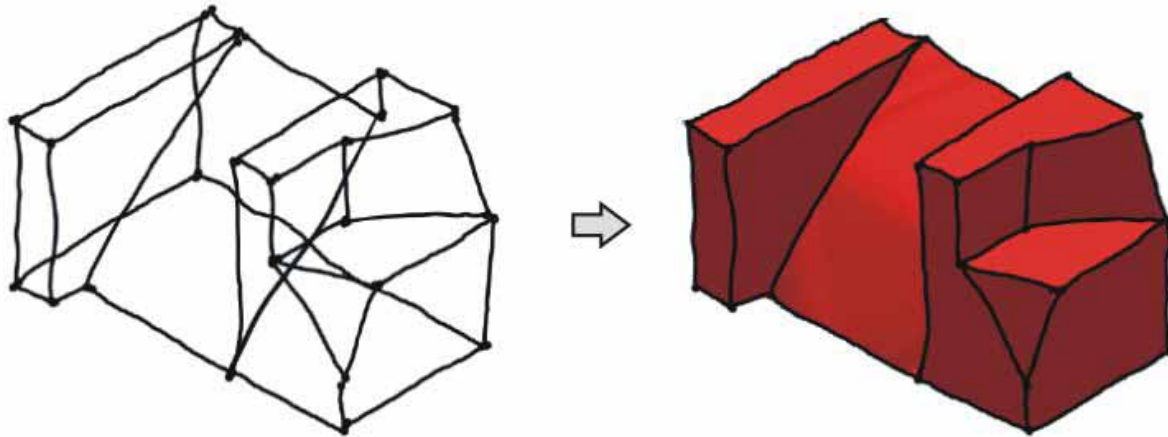# Human perception [†]

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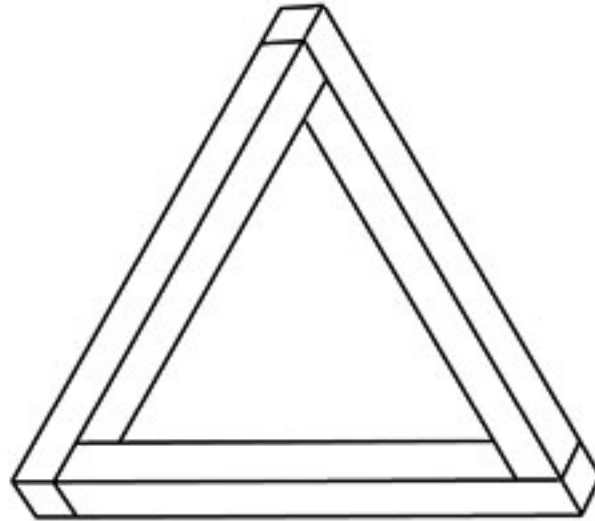
Figure: http://www.at-bristol.co.uk/Optical/ImpossibleTriangle_main.htm
Pictures: http://im-possible.info/english/articles/real/real3.html

Visual memory

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

Perception flowchart
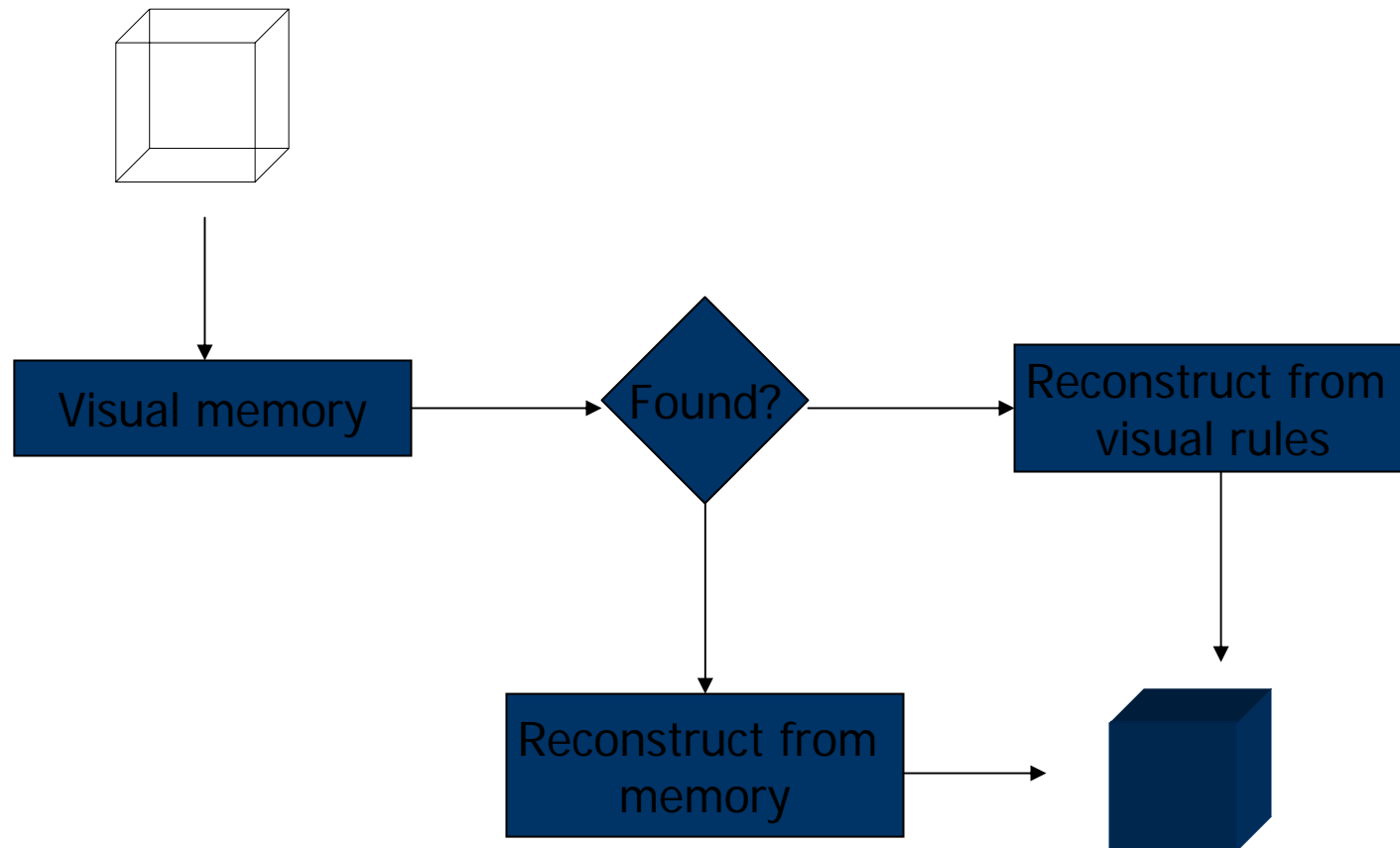
Sketching Workflows

2D

- Stroke filtering   fairing, sharpening...
- Stroke Processing   widgets, gestures, UI control...
- Stroke appearance   NPR, neatening...
- Stroke dynamics   pressure, tilt, direction...
- Navigation   paper manip., onion skinning...
- 2D curve creation   what are desirable curves?
- 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...

...moves on to filling in regions of space/colouring/painting.

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.

Approaches to interactive 3D modeling

Sketch

- Shape Inflation (Teddy ShapeShop)
- Multi-view   (ILoveSketch)
- Single-view (Analytic 3D drawing, on surface drawing

Sculpt
- Extrusion-based (surface modeling Rhino, Sketchup...)
- CSG-based (solid modeling, blobby modeling)
- Surface composition (meshmixer)

videos

videos

projects