Industrial motivations: Conceptual Automotive Styling Tools (CAST)

Karan Singh

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

Conceptual modeling

- What is conceptual modeling?

  The transformation a mental design concept into a digital object, that is easy to refine and reuse.

Conceptual modeling

- Why is it important?

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

Agenda

- Desirable properties of a conceptual modeler.
- What makes automotive design unique.
- Existing modeling trends.
- A proposed workflow for conceptual automotive design.

Conceptual design desirables

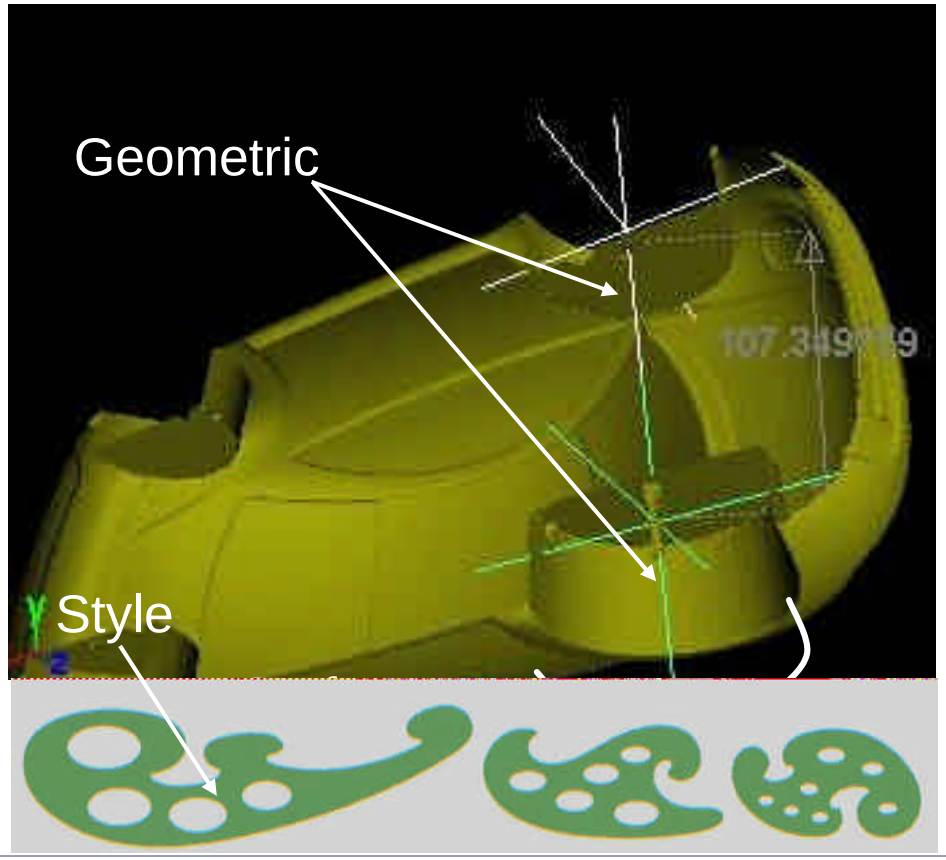
- Abstraction from underlying surface math.
- Invite creative exploration.
- Allow for precision and constraints.
- Workflow mimics traditional design media.
- Leverages domain expertise.
- Intuitive and interactive.

What makes automotive design unique?

- Is free-form and exploratory.
- Smooth shapes: C^2 continuity.

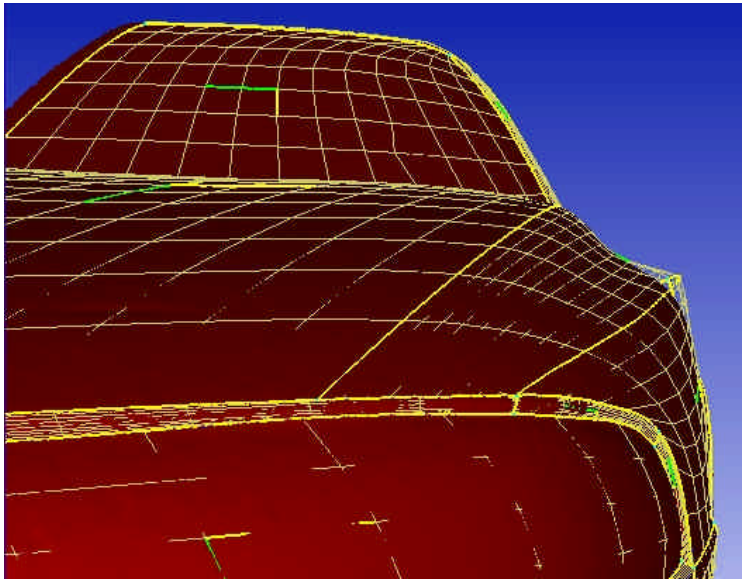
What makes automotive design unique?

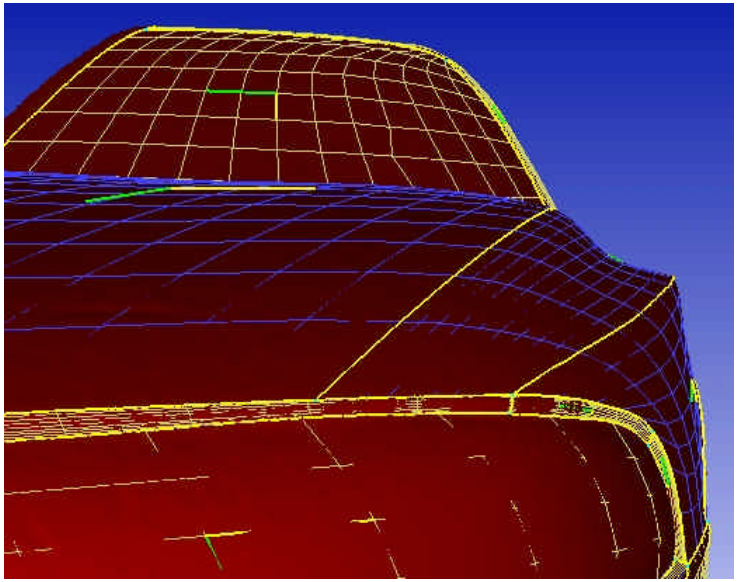
- Embodies geometric, surface and style constraints.



What makes automotive design unique?

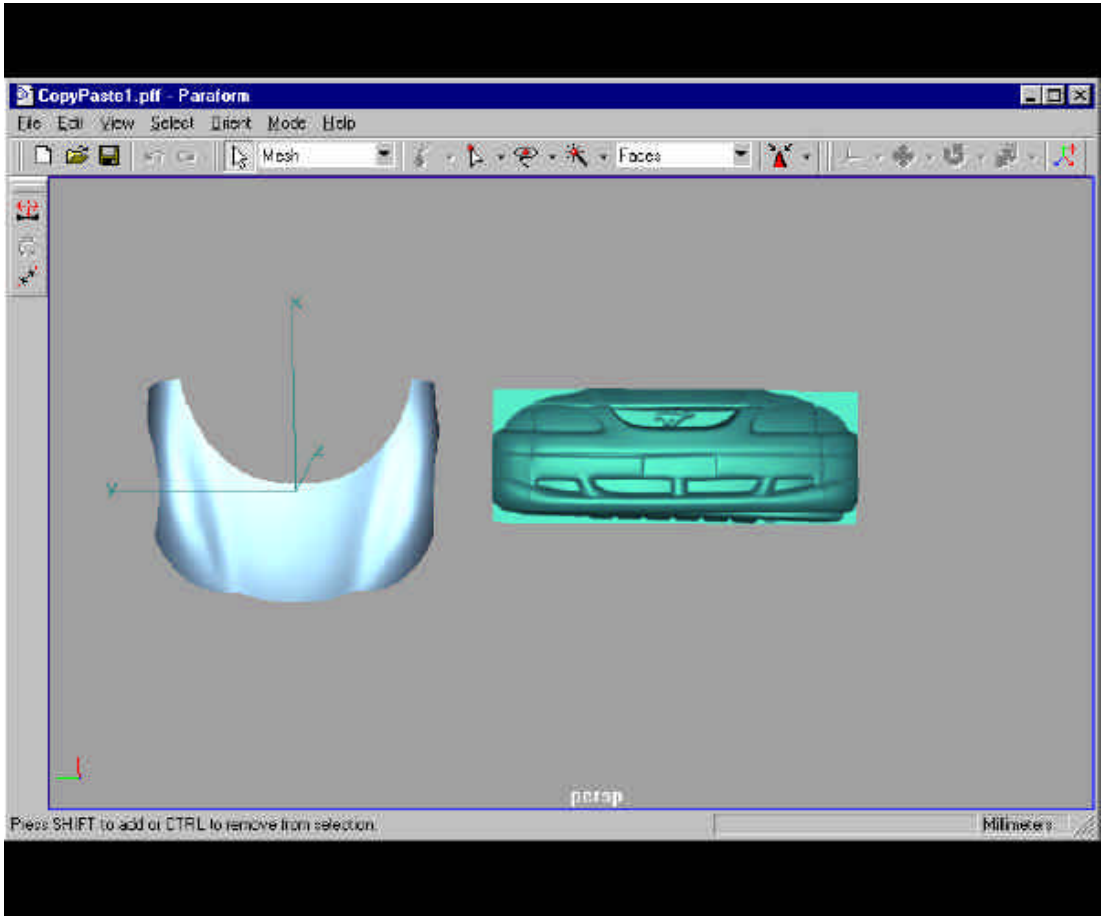
- Character or flow lines captured intrinsically.





What makes automotive design unique?

- Flexible re-use of legacy data.

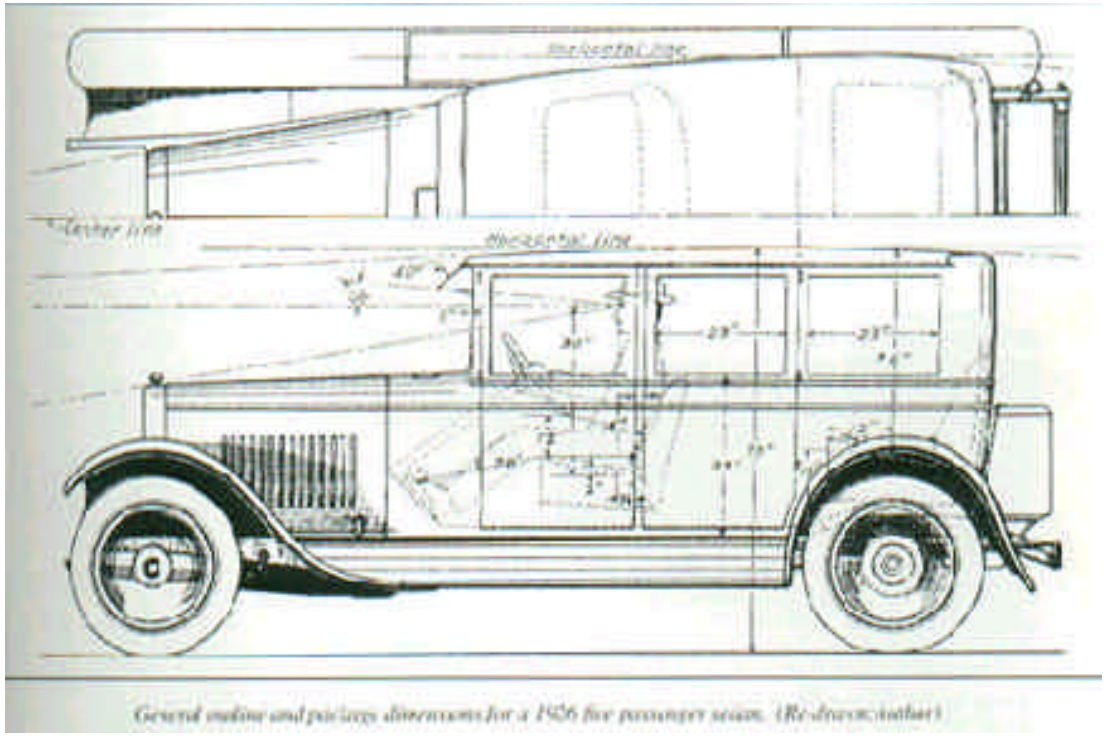


What makes automotive design unique?

- Interfaces digital and physical modeling.

What makes automotive design unique?

- Well developed design paradigms rooted in physical media.



What makes automotive design unique?

- Is free-form and exploratory.
- Smooth shapes: C^2 continuity.
- Embodies geometric, surface and style constraints.
- Character or flow lines captured intrinsically.
- Flexible re-use of legacy data.
- Interfaces digital and physical modeling.
- Well developed design paradigms rooted in physical media.

Object Representations: parametric patches

- Advantages
  - Smoothness.
  - Precision (Analytic shapes).
  - Curves (Character, flow lines).

- Limitations
  - Patches get in the way (Patch layout, trims).
  - Smoothness across patch boundaries.
  - Editing paradigms are restricted by topology.

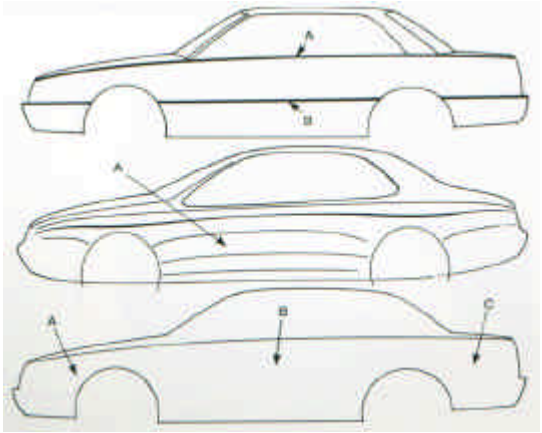
Existing Paradigms: points and meshes

- Advantages
  - Smooth dense meshes are now feasible.
  - Few restrictions on topology.
  - More flexible editing paradigms possible.
  - Conversion to and from physical data is easy.

- Limitations
  - Points and Meshes are not intrinsically “smooth”.
  - Too free (no analytic shapes).
  - No concept of curves or character lines.

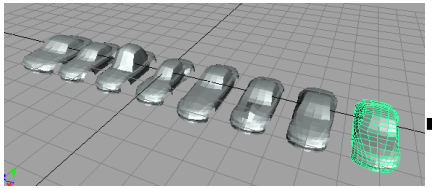
An automotive designers toolbox

- Ideas.
- Sketches.
- Clay/foam.
- Engineering Criteria.
- Sweeps.
- Steels.
- Paint box.

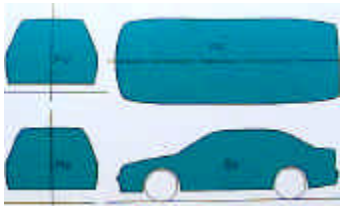


- Whats missing? **A refinable digital 3D model.**

An automotive design workflow proposal

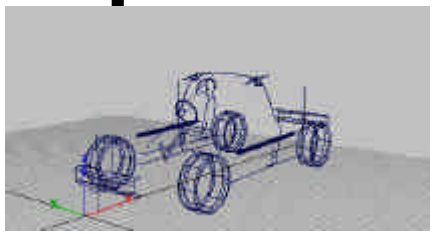


Parameterized shapes

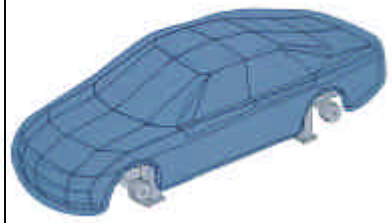


Sketches

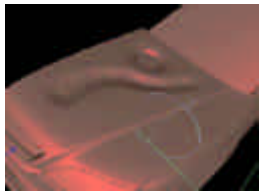
Small clay model (1/24- 1/8)



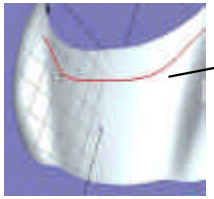
Engineering criteria

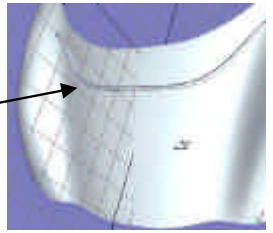


Rough digital model from parametric shapes, digitized clay, feature lines or sketches. Characater lines can be edited for stylistic change.

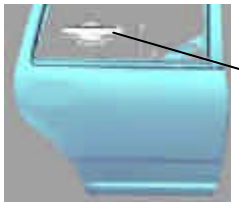


digital sculpting tools





analytic feature sculpting



cut and paste

Refined digital model using a palette of refinement tools as shown. Iterations converge to a final design.

NC Milling

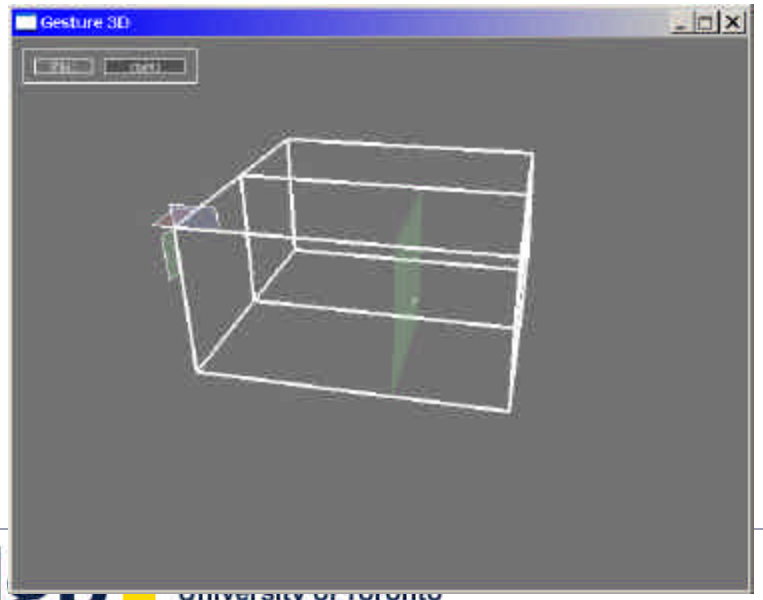
Evaluation design fidelity checks

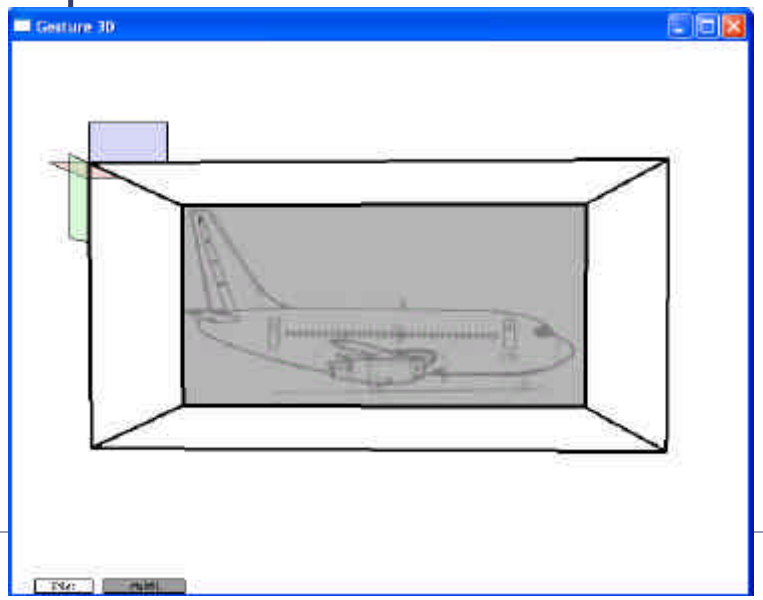
Model presentation with photorealism using interactive large- scale display devices.

Rough digital model Input

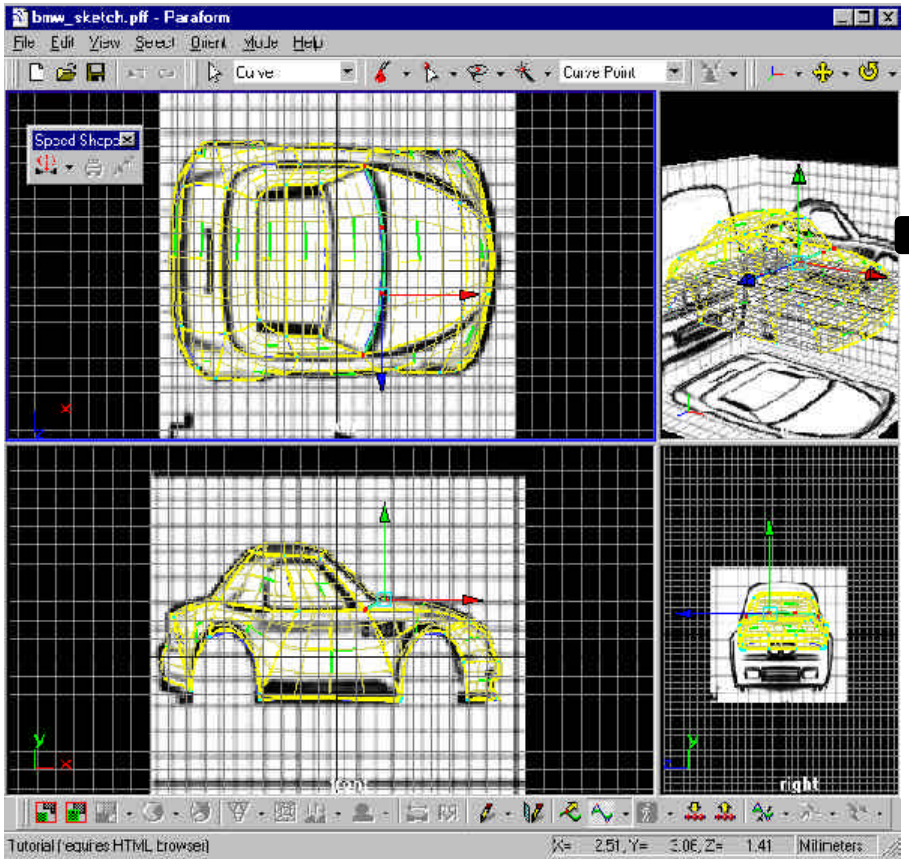
- Design collateral (sketches, clay, parameteric models).
- Feature lines.
- Engineering and stylistic constraints.

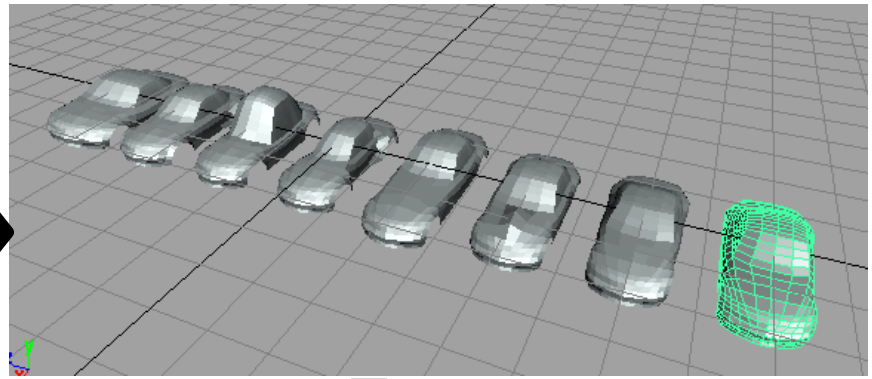
CHALLENGE: Co-locating and registering salient design content within a common 3D space.

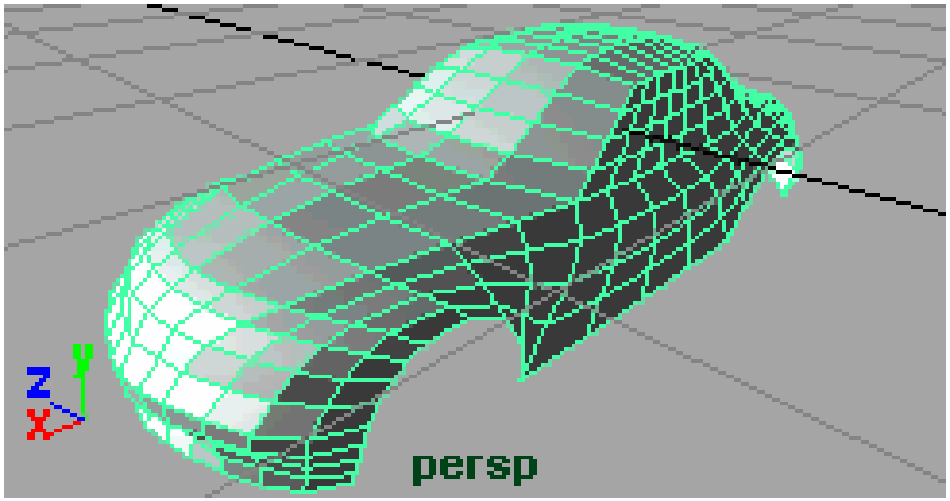




Rough digital model

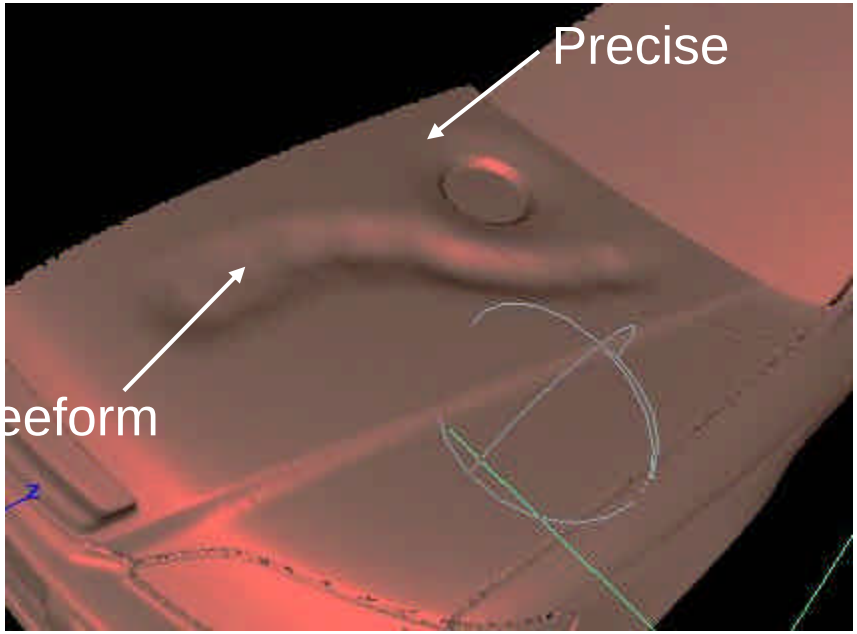


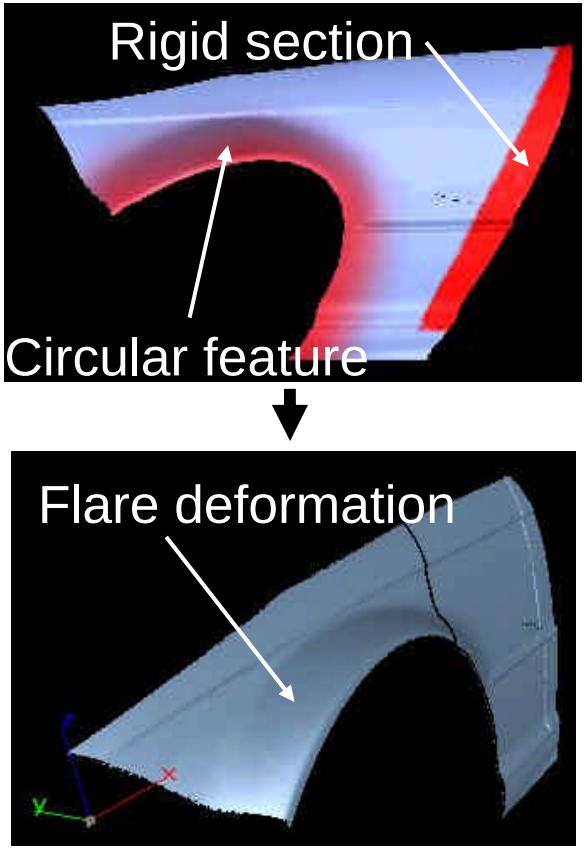




Digital model refinement tools

- Constraint preserving global deformations.
- Cut and paste.
- Feature based editing.
- Local deformations.





Local

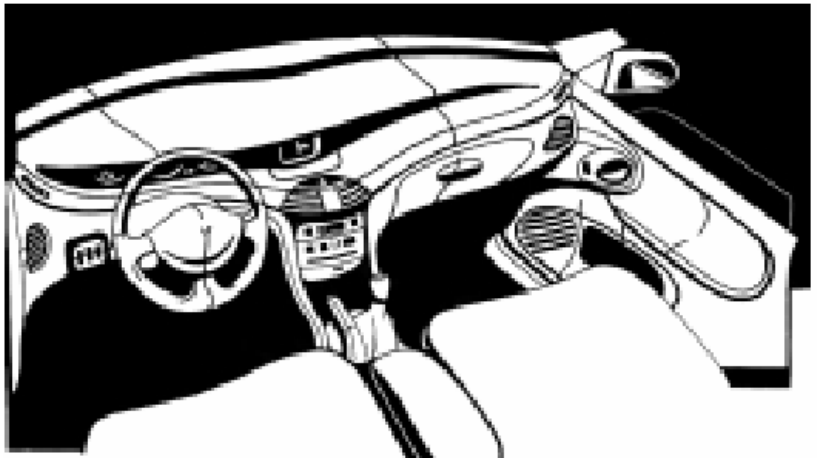
Global

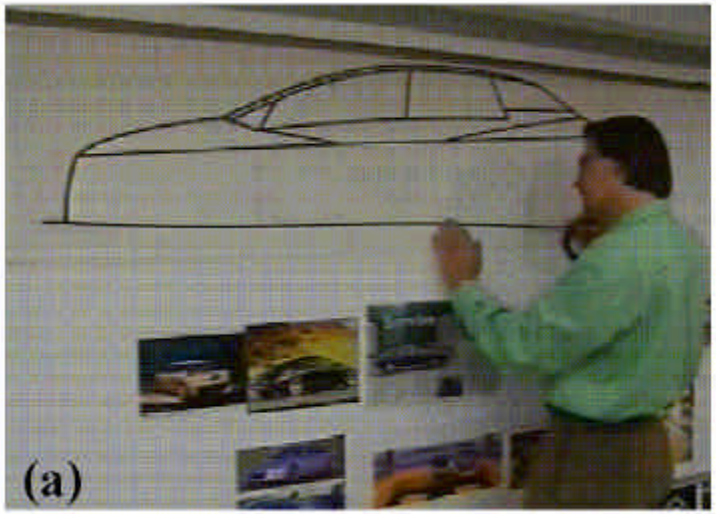
Modeling interfaces

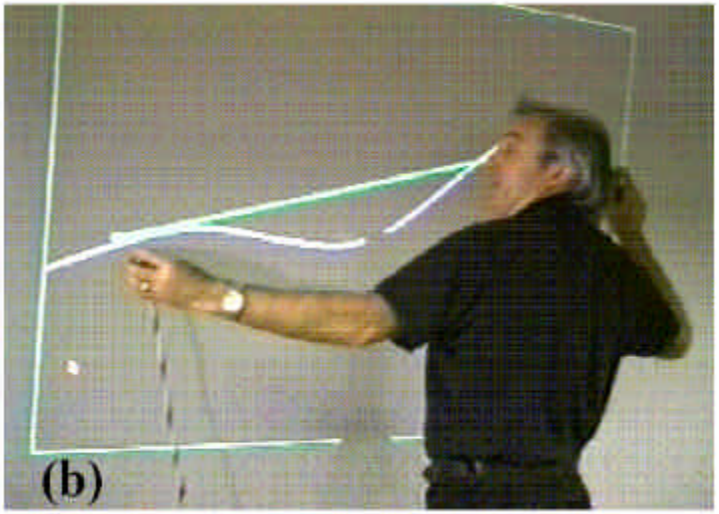
- Tape Drawing.
- ShapeTape.
- Steels, Sweeps.
- Pen, puck and tablet.
- Haptic sculpting.
- 3D scanning and printing.

Modeling interfaces

- Tape Drawing.







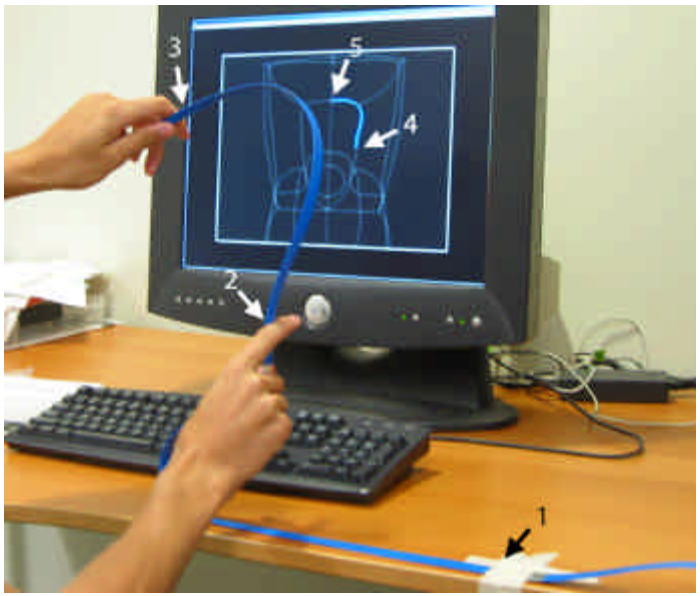
Physical tape

Digital tape

Modeling interfaces

- ShapeTape.
- Steels, Sweeps.

Steel



ShapeTape

Modeling interfaces

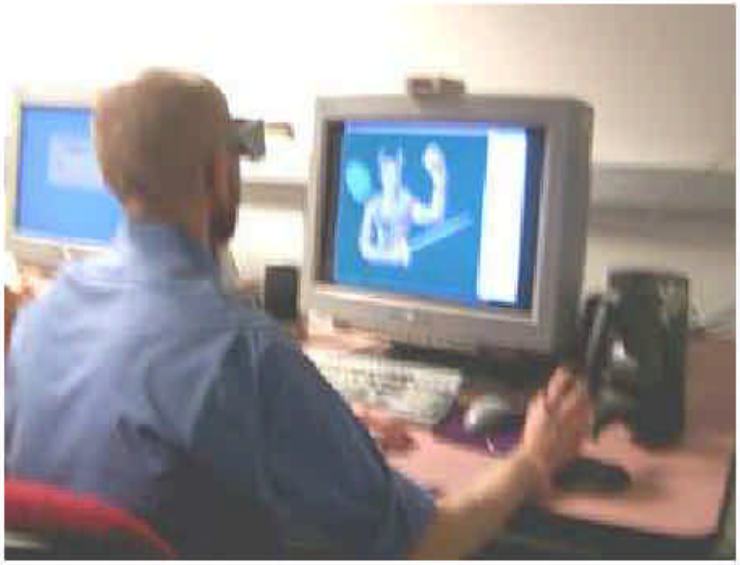
- Steels, Sweeps.
- Pen, puck and tablet.

Physical sweep

Digital sweep

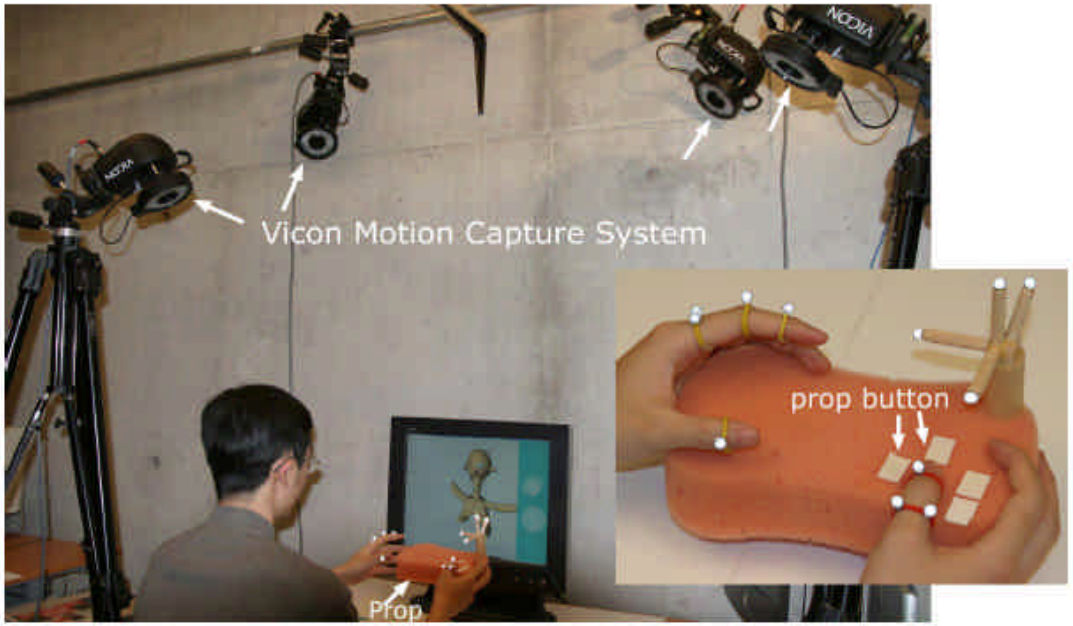
Modeling interfaces

- Haptic sculpting.



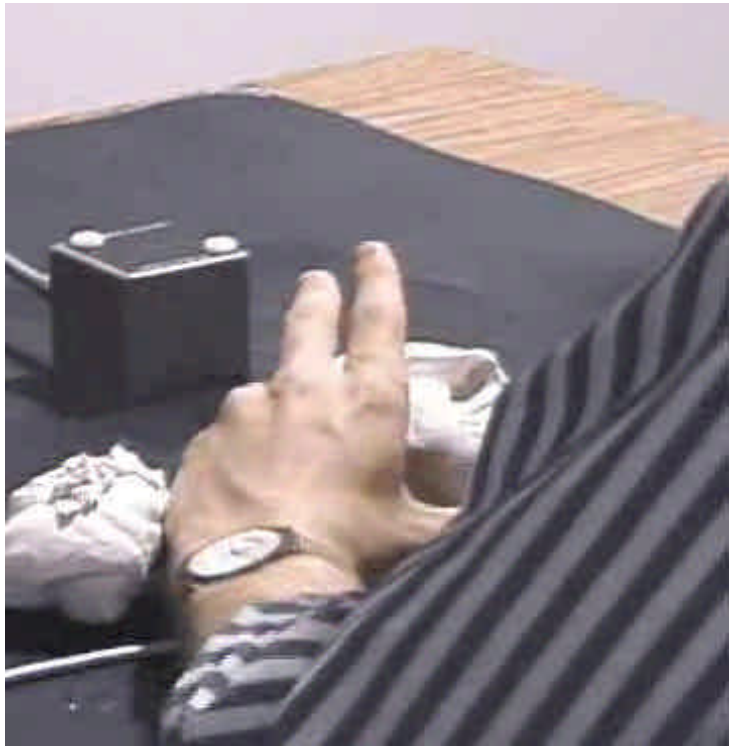
Modeling interfaces

- Motion Capture.



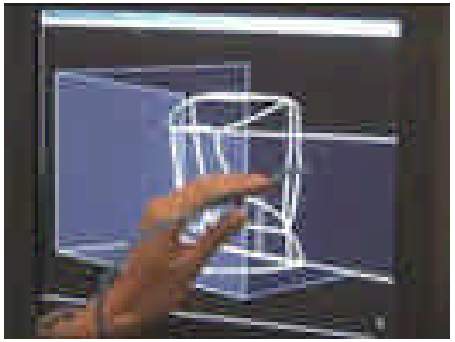
Modeling interfaces

- 3D scanning and printing.

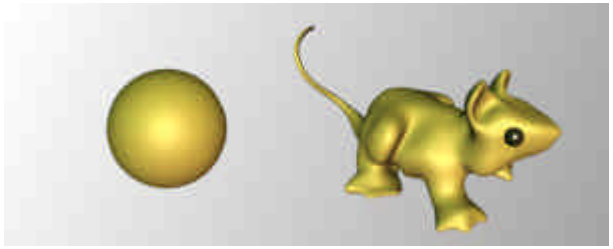


Putting it together

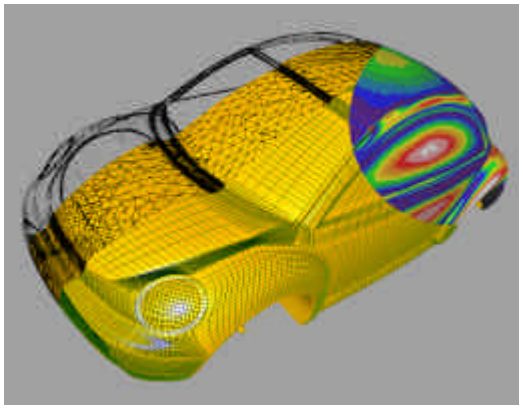

Physical shape modeling



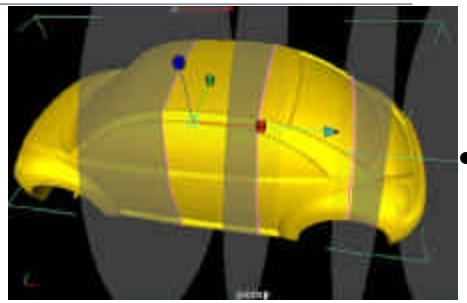
3D interaction devices (shapeTape)



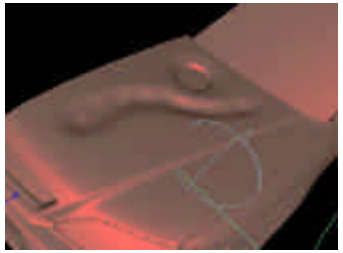
Digital modeling (Teddy, sweepers)



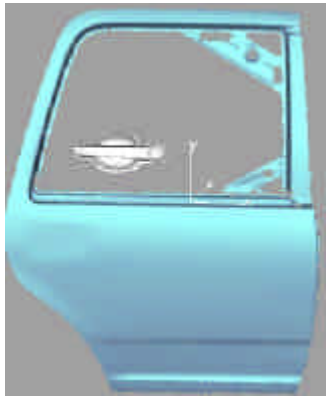
Mathematical shape representations



Global warps (stretching)



Local space edits (sculpting)



Cut, paste/ Laplacian editing

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