

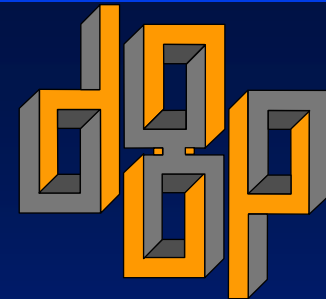
Feature Based Retargeting of Parameterized Geometry

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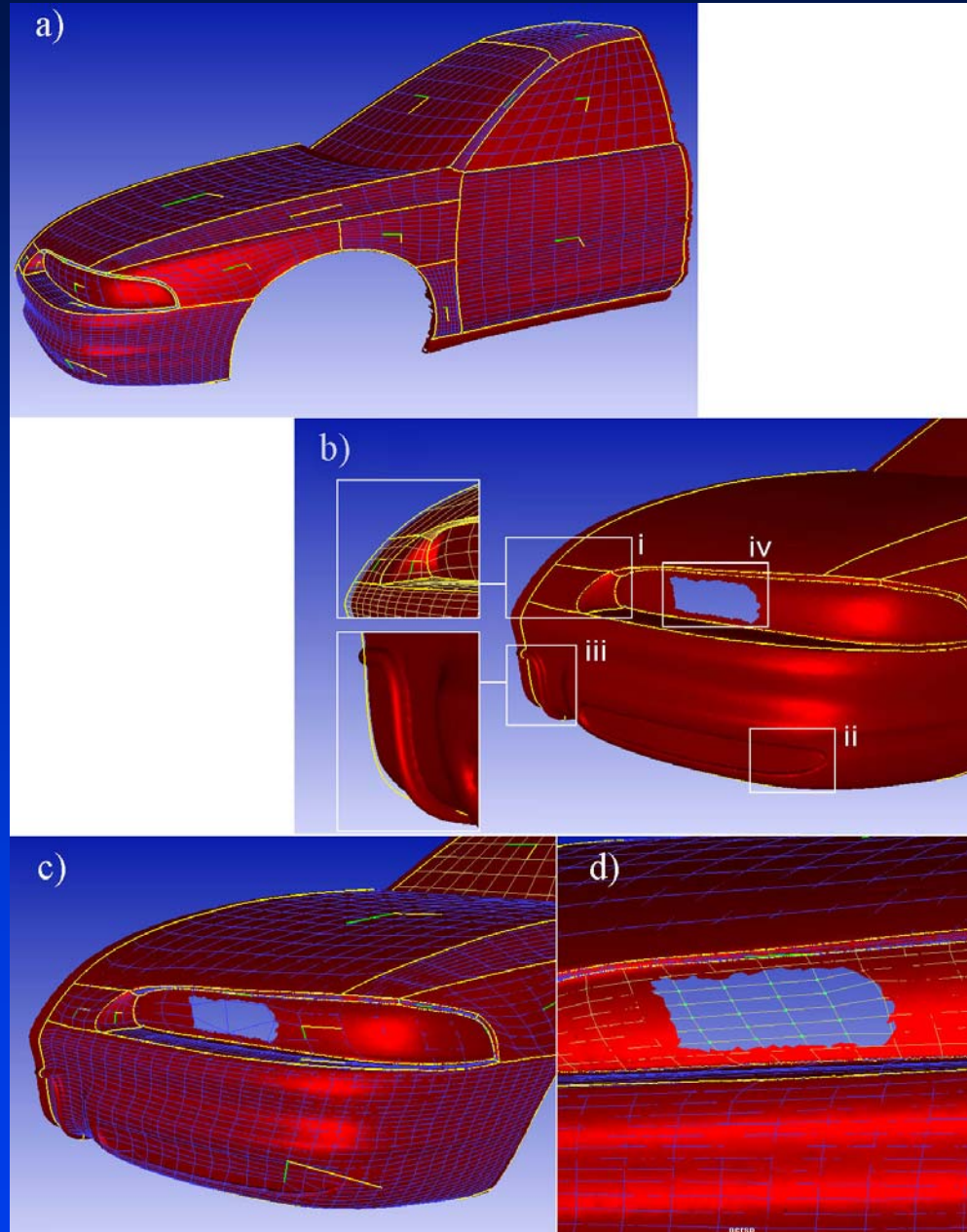
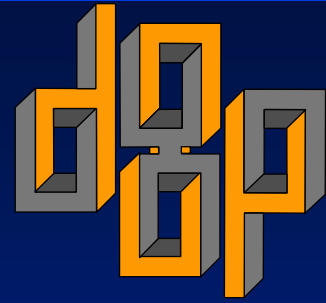


Problem

Given geometry M_1 with a parameterization P_1 , retarget P_1 to unparameterized geometry M_2 while minimizing the difference in geometric features between corresponding parameter values of M_1 and M_2 .

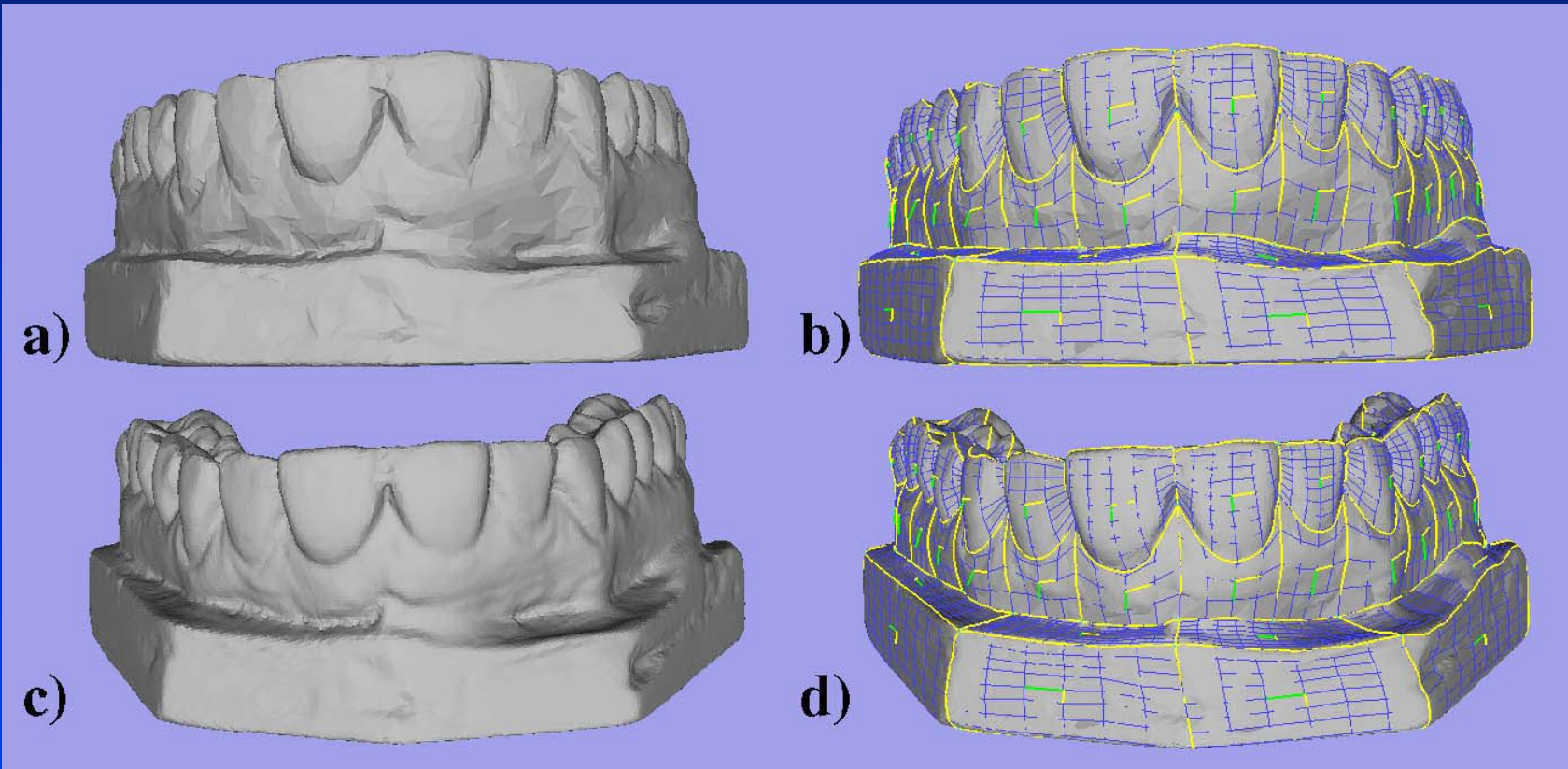
Motivation

- Automotive Design.



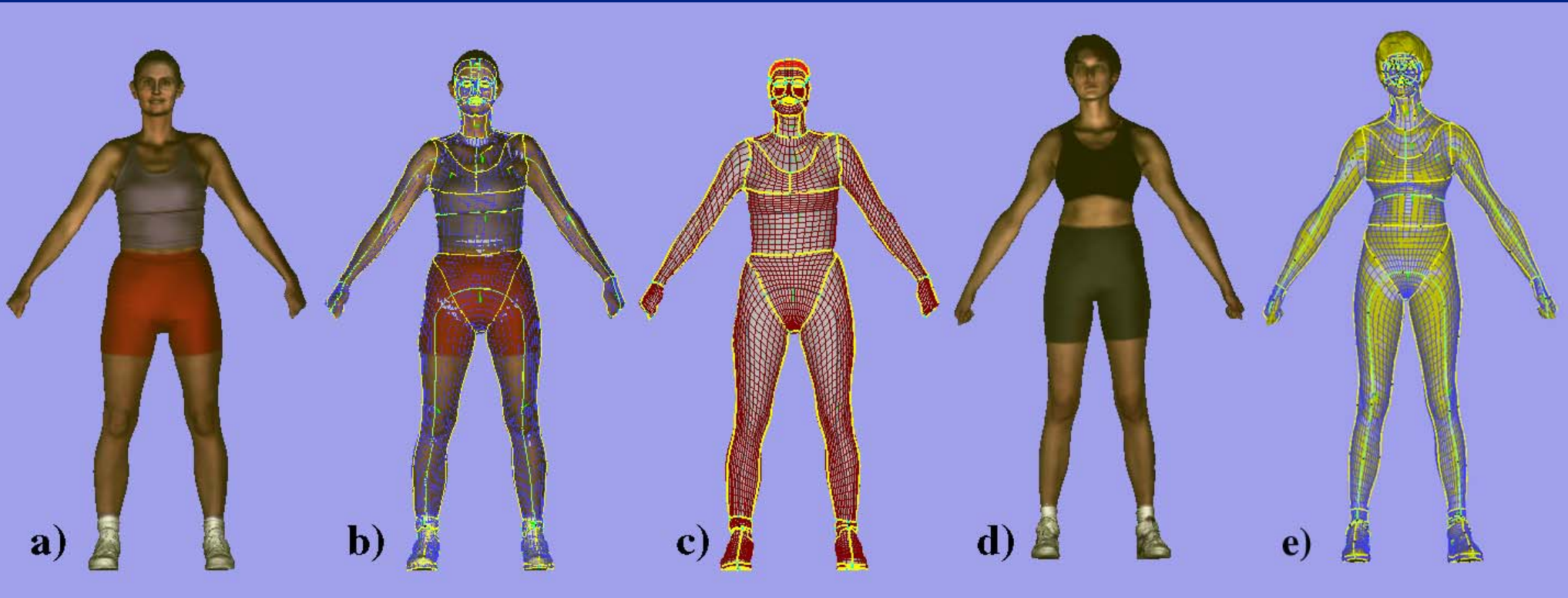
Motivation

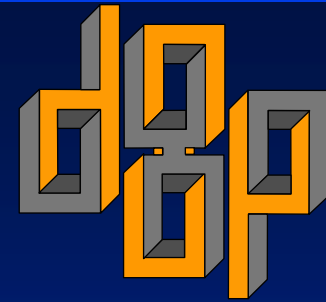
- Manufacturing.



Motivation

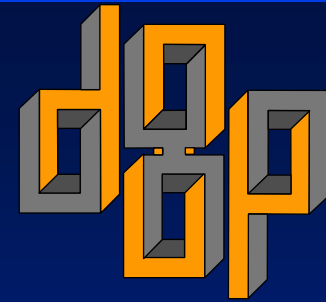
- Animation.





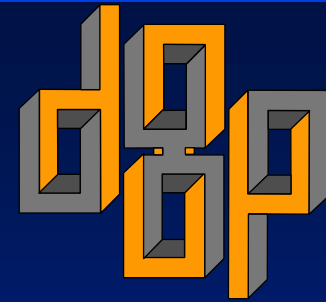
Diverse surfacing requirements

- Structural analysis.
- Annotation and segmentation.
- Legacy data reuse.
- Repair of incomplete or noisy data.
- Character reuse for animation.
- Parting line aesthetics.
- Repetitive surfacing.
- Domain Expertise.



Related Work

- Feature based parametric mapping.
 - *Feature based metamorphosis (Beier Neely 92, Leros et al 95).*
 - *Parameterization & Texture mapping (Litwinowicz Miller 94, Lee et al 98-01).*
 - *Dual domain extrapolation (Levy 03)*
 - *Anisotropic polygonal remeshing (Alliez et al 03).*
- Surface Fitting.
 - *User guided (Krishnamurthy Levoy 96, Zwicker et al 02).*
 - *Automated (Weiss et al 02 , Blanz et al 99, Litke et al 01).*
- Commercial surfacing applications (Paraform, Geomagic, Rapidform, GSI....)



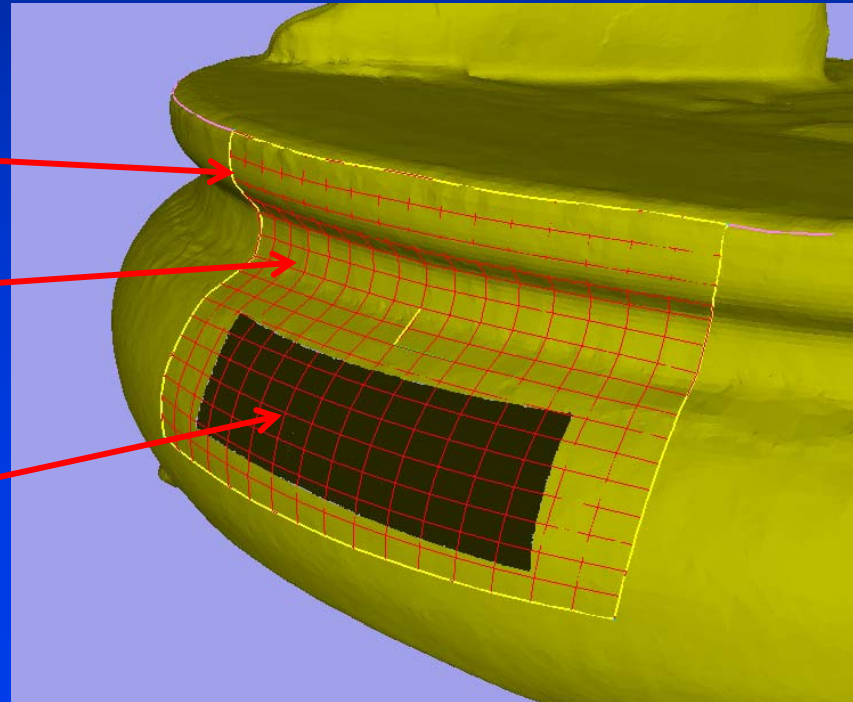
Templates

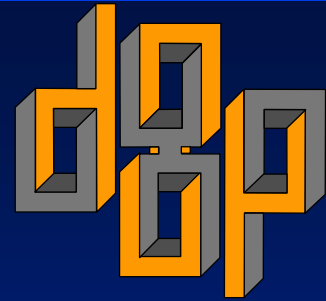
- *Template* = *patch-layout* capturing seams and internal parameterization of all or part of a model.
- Templates are represented as high resolution polygonal grids with a mixture of *space-points* and *face-points*.

Template

Face-points

Space-points



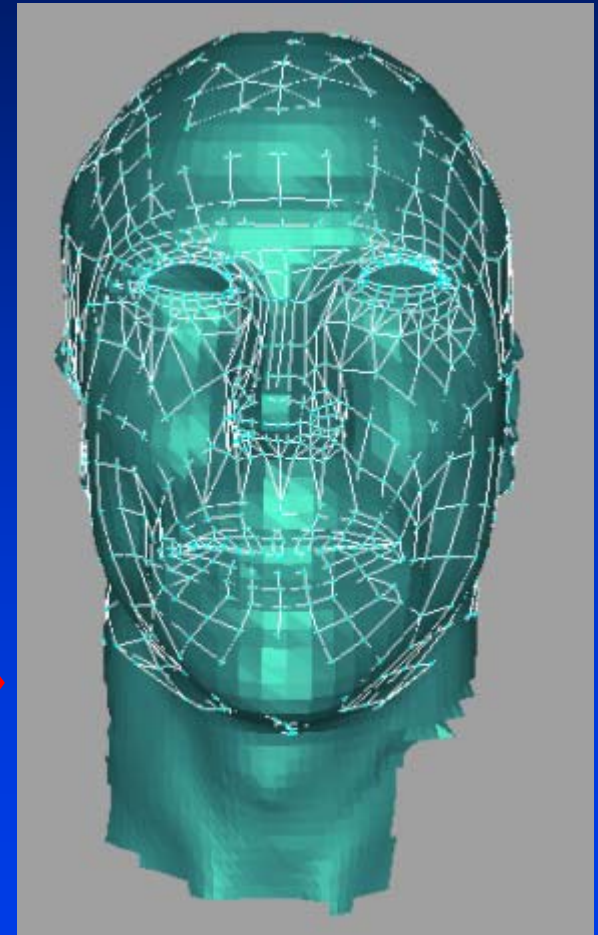
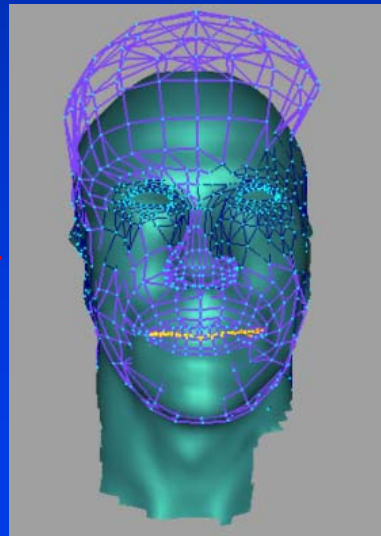
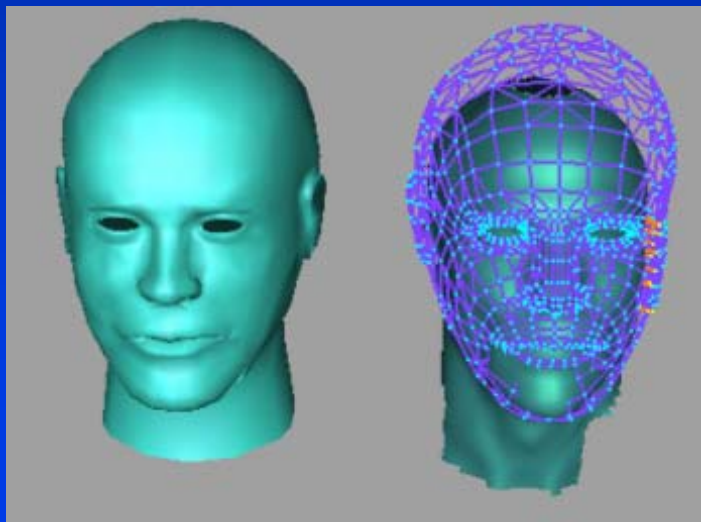


Problem

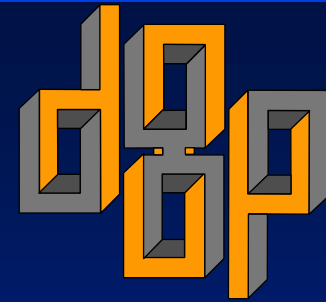
Given mesh M_1 with associated template P_1 , retarget P_1 to unparameterized mesh M_2 .

Template mapping

- Detachment and alignment.
- Feature constraint specification.
- Template optimization and attachment.

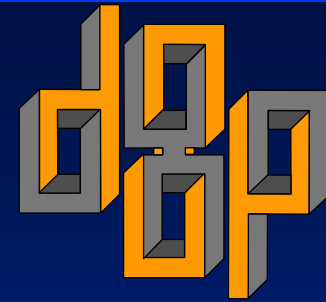


Alignment & feature definition Optimization & attachment



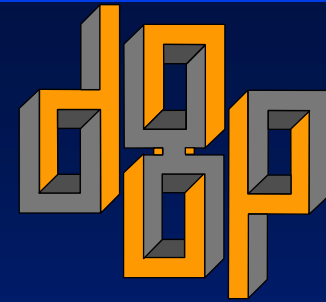
Detachment and alignment

- Manual.
- Iterative closest point.
- Skeletal.



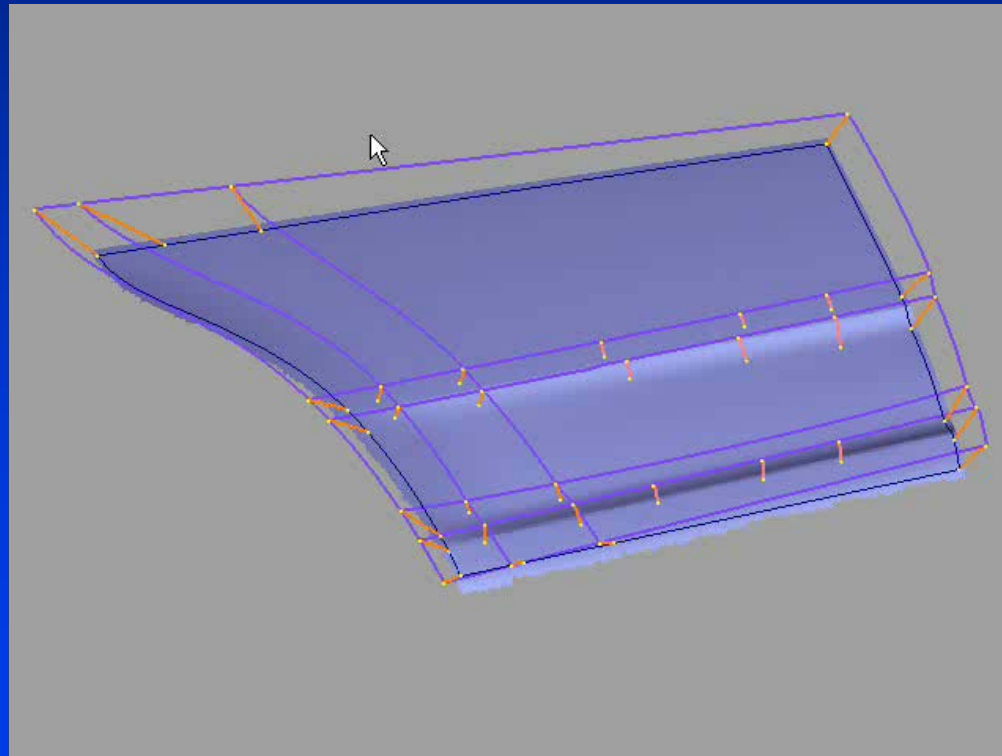
Feature constraint specification

- Anchors.
- Normal, curvature and color maps.
- Curve constraints.

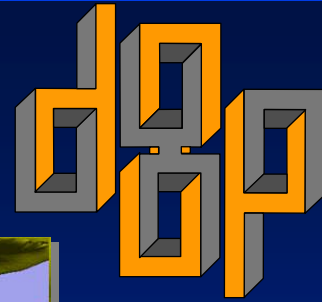


Feature constraint specification

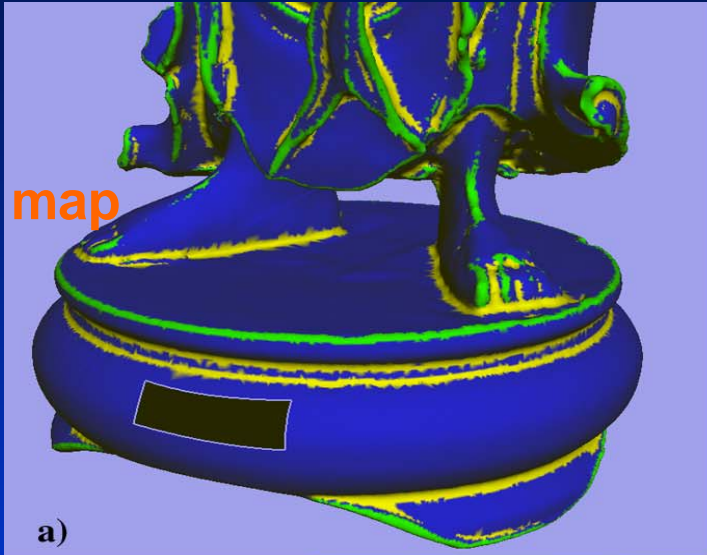
- Anchors and curve constraints.



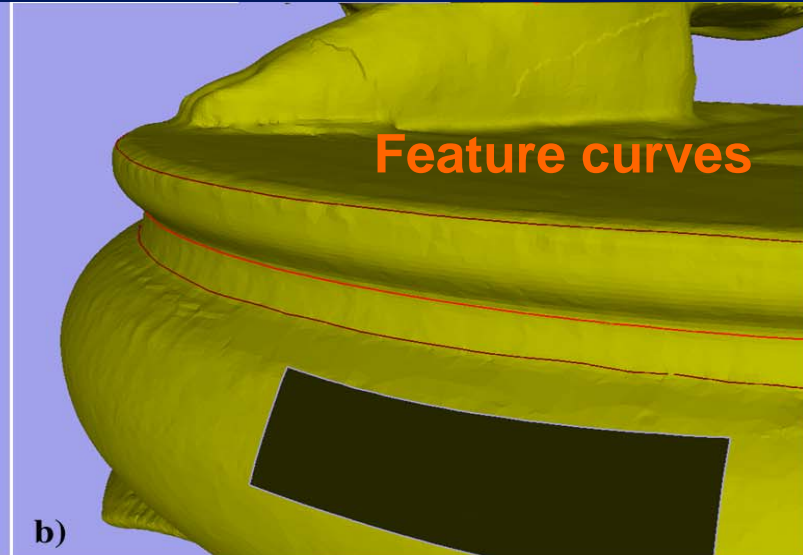
Feature constraint specification



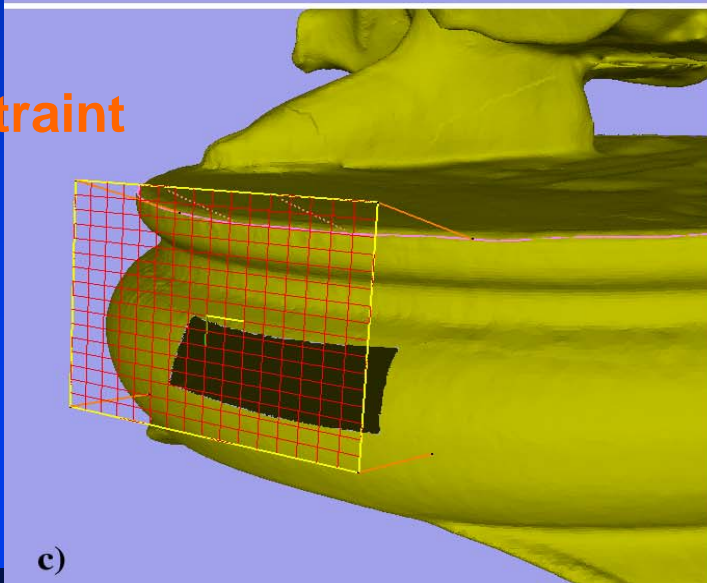
Curvature map



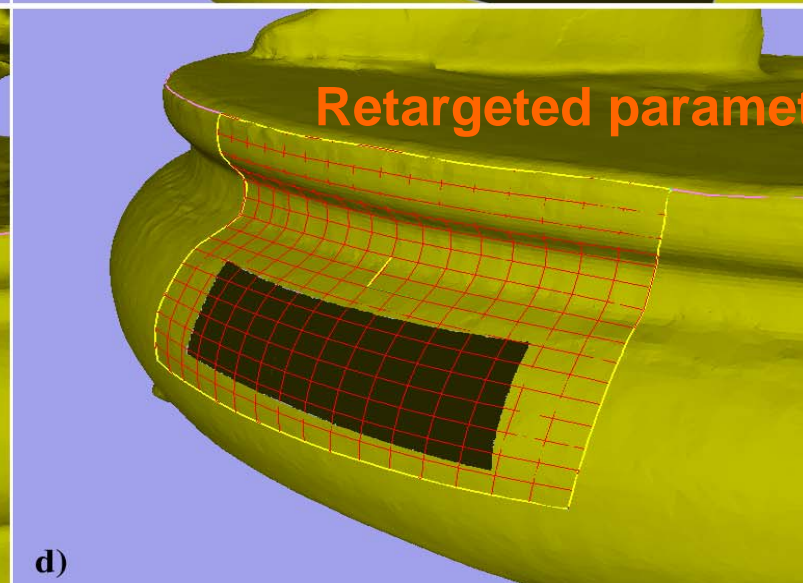
Feature curves

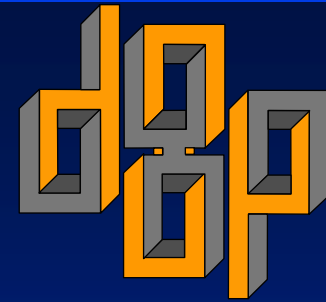


Curve constraint



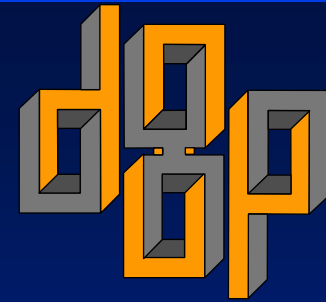
Retargeted parametric patch





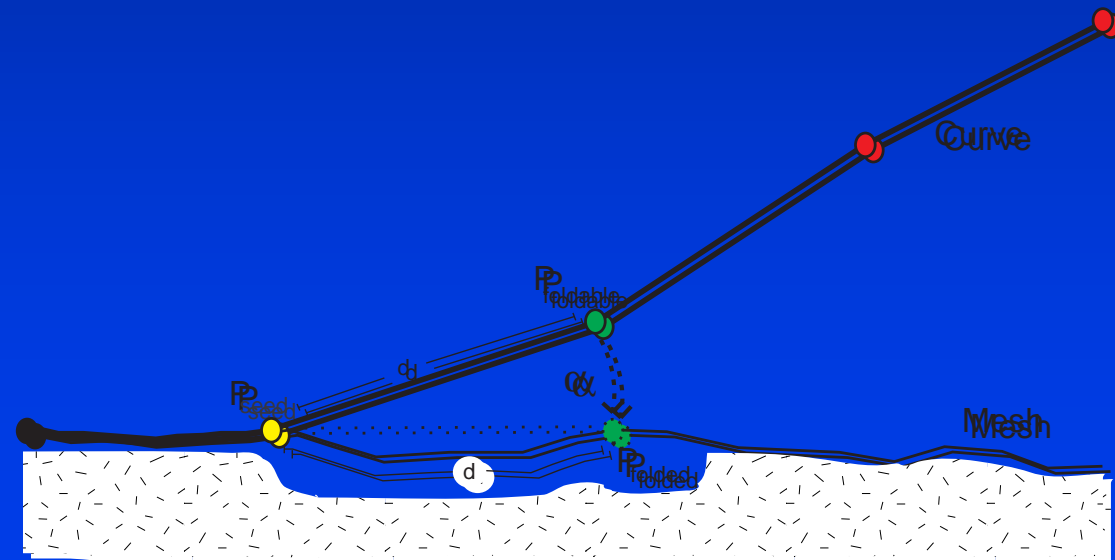
Template optimization and attachment

- Retargeting is formulated as iterative constraint optimization using various energy functions.
- Hybrid space/face point formulation allows mixing of 3D and 2D parametric energy terms.
- Energy terms include:
 - *3D thin-plate energy (curvature continuity in unconstrained regions).*
 - *2D surface energy (minimize internal distortion of parameterization).*
 - *Feature energy (attraction of points to geometric features).*
 - *Snapping energy (forces proximal points onto mesh).*
 - *Folding energy (controls the transition of unconstrained space points to constrained face points).*

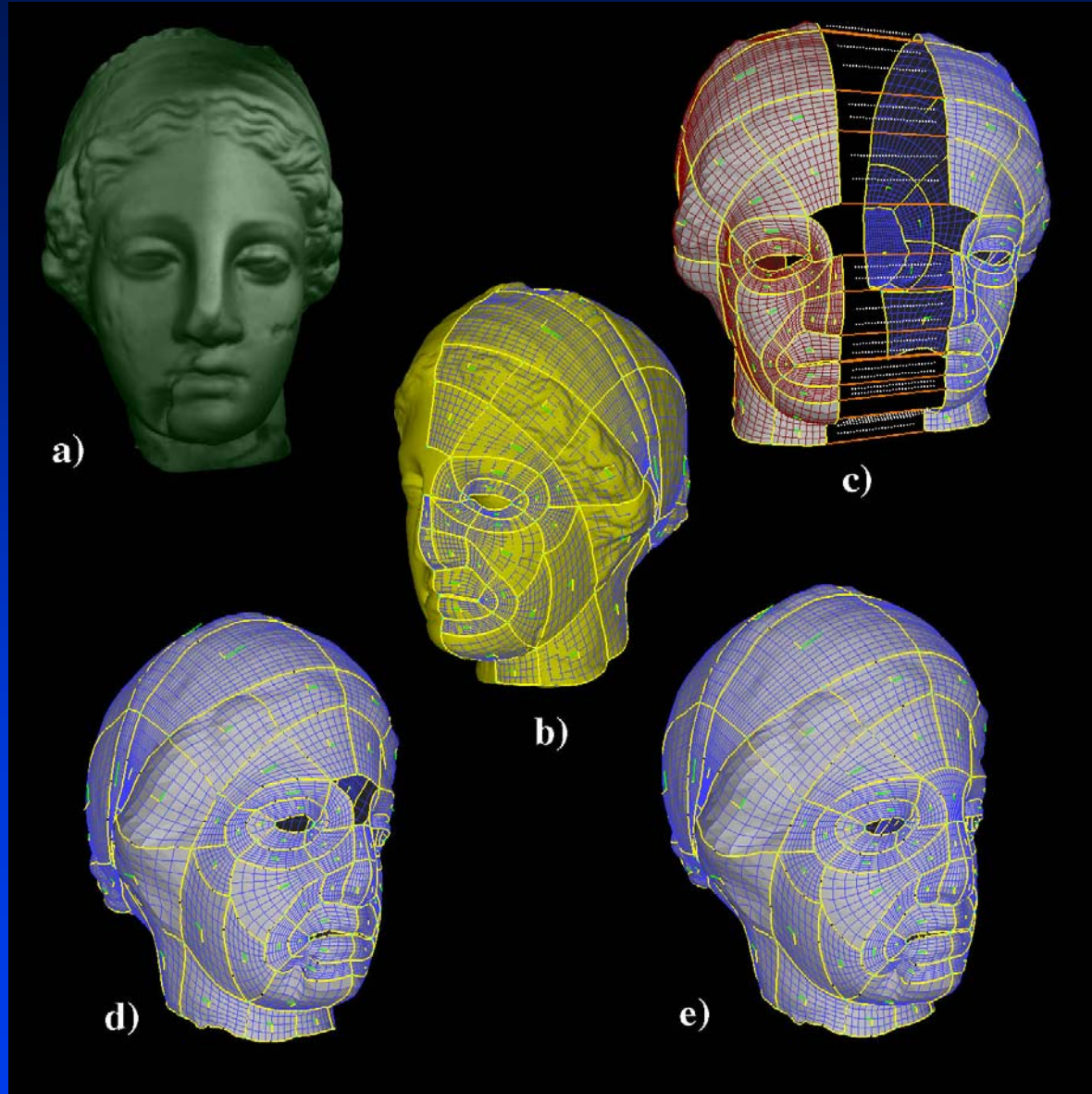
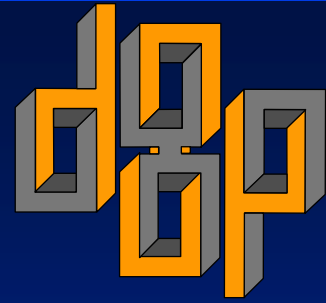


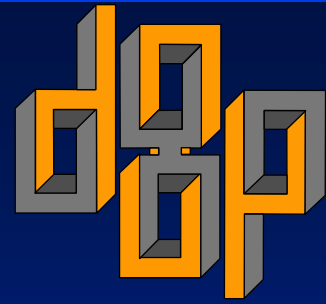
Folding energy

- Folding begins once constrained points get attached to the mesh.
- $P_{foldable}$ is an unconstrained space-pt connected to a constrained face-pt P_{seed} .
- Folding energy is a function of the angle α , drawing points from space towards the target geometry.
- Simulated annealing adaptively changes the energy value based on the number of points folded in a prior iteration.

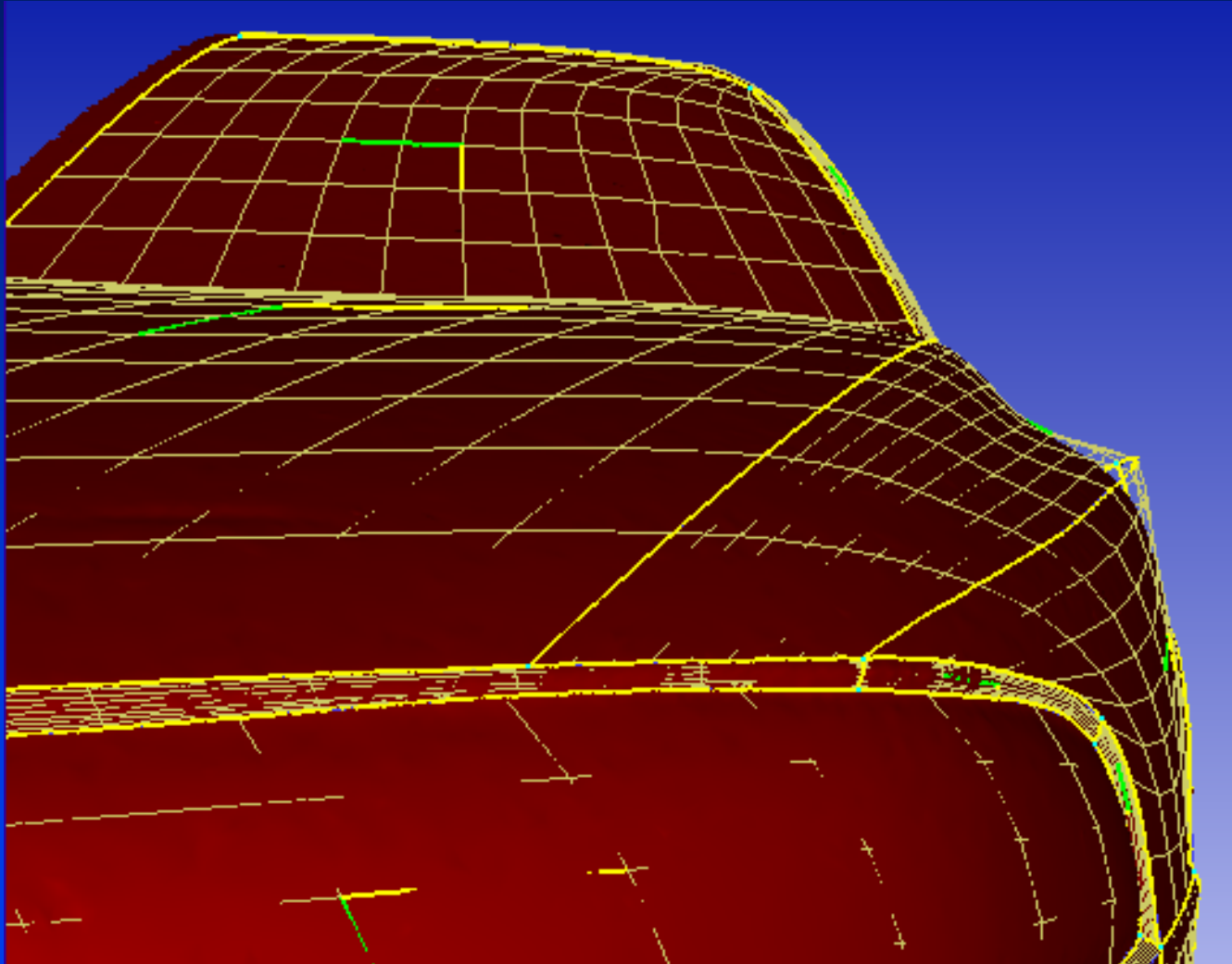


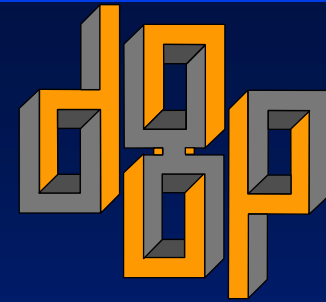
Examples



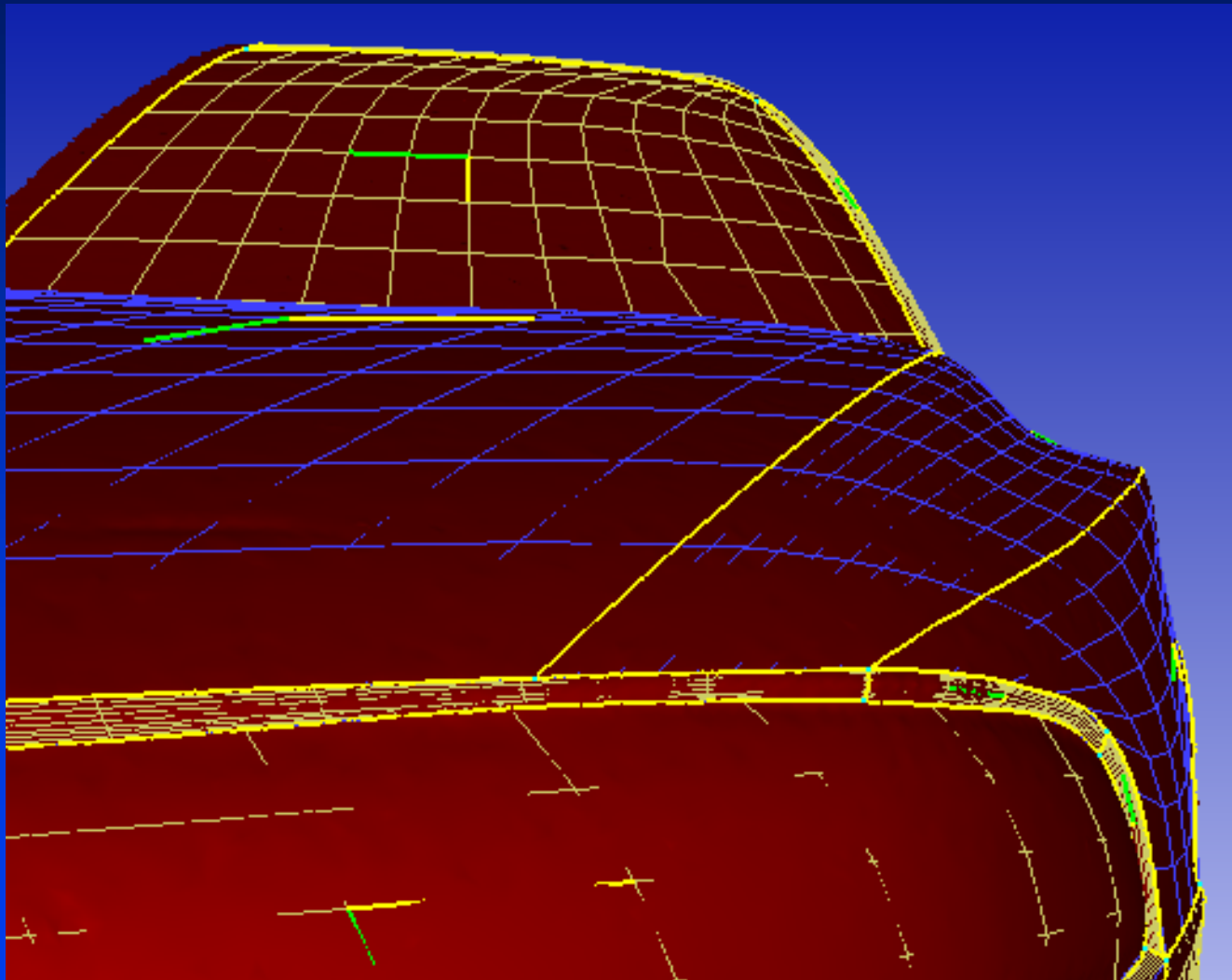


Applications (inverse templates)

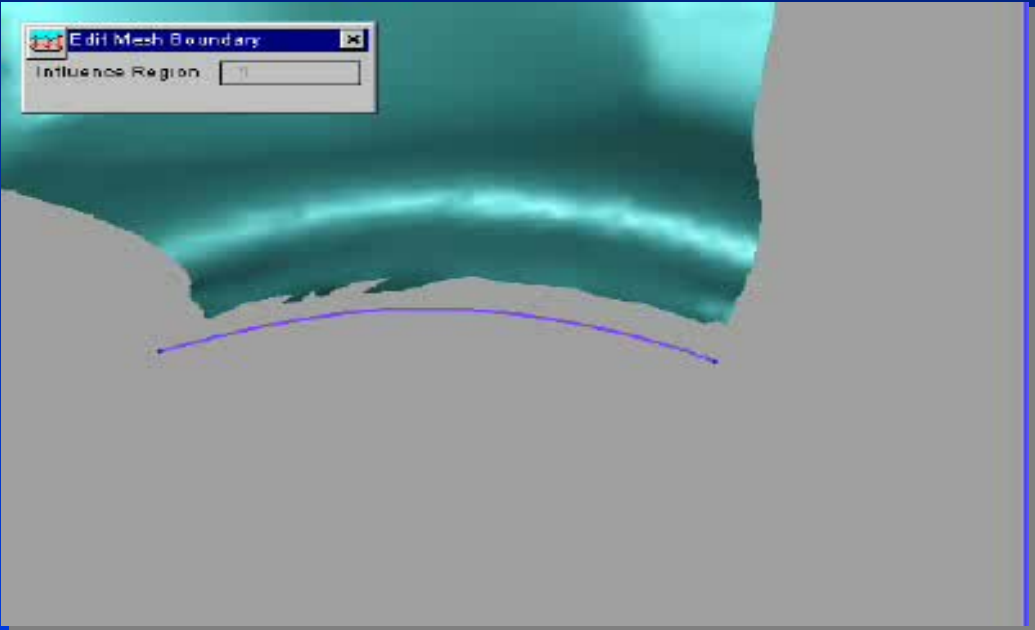
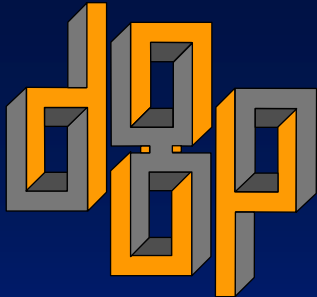




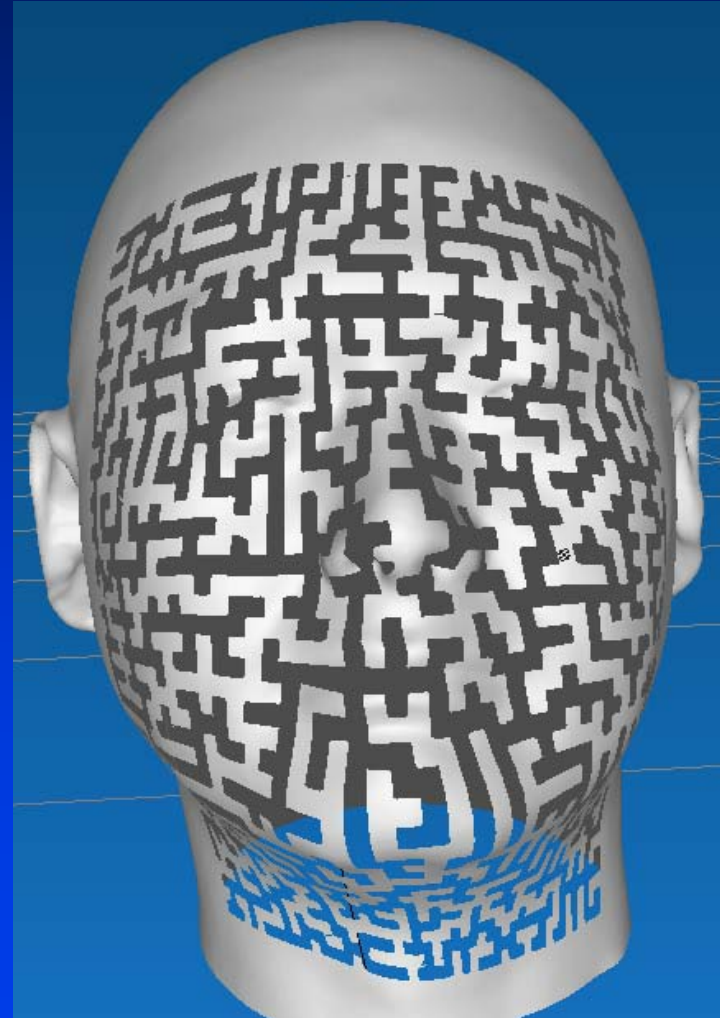
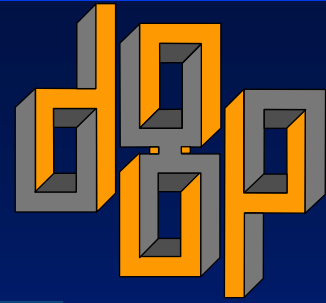
Applications (inverse templates)



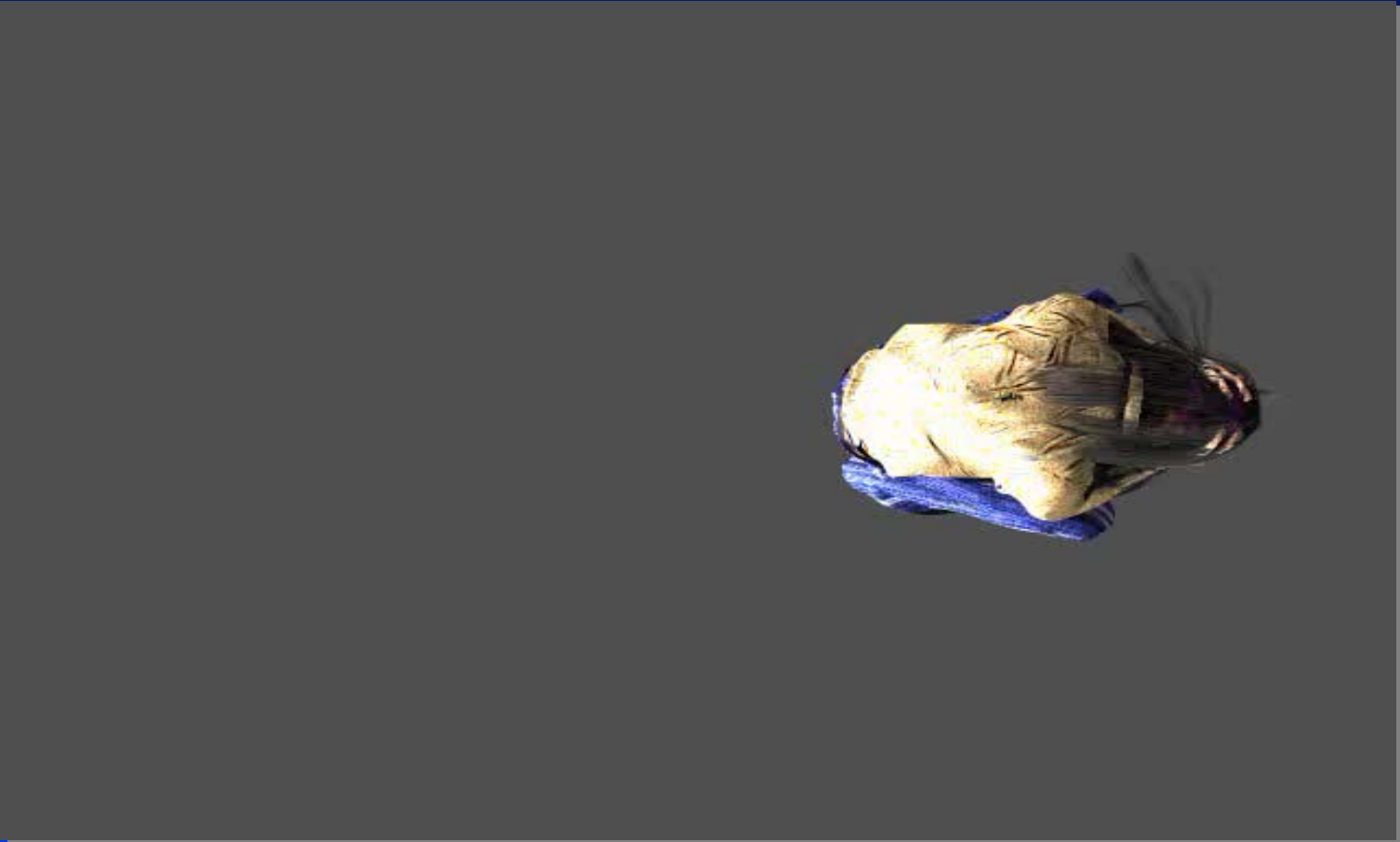
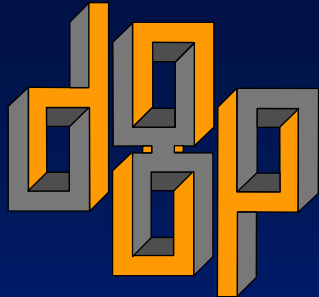
Applications (fixing geometry)



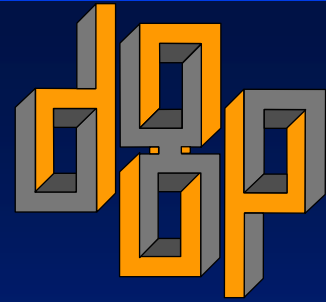
Future Directions



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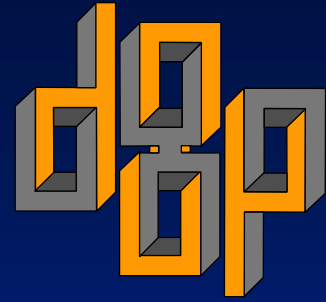


Summary



**...an interactive feature based optimization framework
for retargeting parameterized geometry.**

Acknowledgements



- MITACS
- Paraform Inc.