Geometry and Kinematics of a Convertible's Rear Side Window

Conference on Geometry - Theory and Applications

Vorau, 2011 - 06 - 23

The Task

Rear Side Windows of Convertibles

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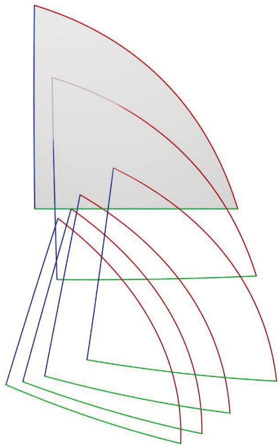
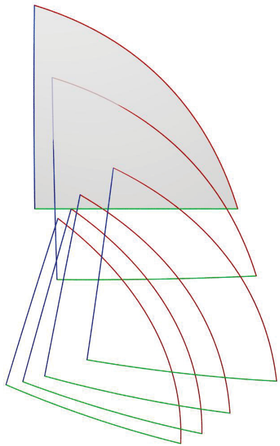
Input Data:



Input Data:

a surface S (rear side window suggested by the stylist)



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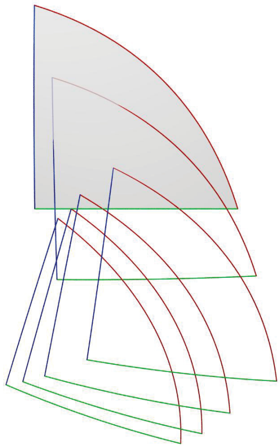
a couple of single window sheet positions



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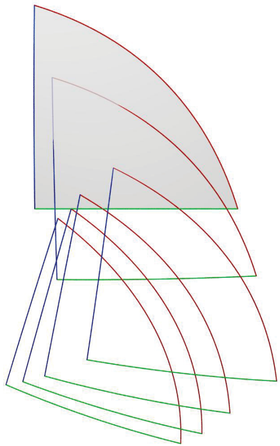
a surface S (rear side window suggested by the stylist)

a couple of single window sheet positions

the boundary curves:

- front boundary curve b
- roofline curve r
- daylight curve d



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a surface S (rear side window suggested by the stylist)

a couple of single window sheet positions

the boundary curves:

- front boundary curve b
- roofline curve r
- daylight curve d

Wanted:

a motion of S that

- interpolates the given positions and
- minimizes the stress on the sealing

Strategy:

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Step 3: Construction of a set of intermediate window surfaces S_β

The basic idea

In order to find the appropriate window motion
we first construct the 'perfect window surface' S_d.

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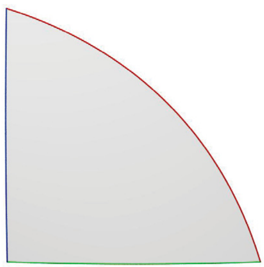

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the generating curve of S_d: daylight curve d

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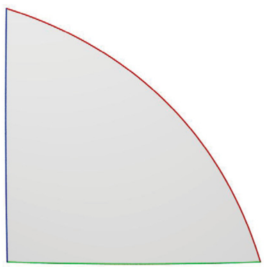

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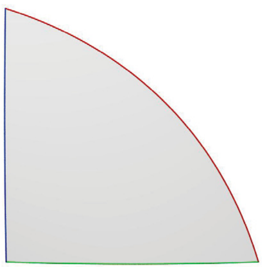

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the generating curve of S_d: daylight curve d

S_d maintains the roofline curve r

S_d maintains the front boundary curve b

Step 1: A substitute window surface

The inverse problem:

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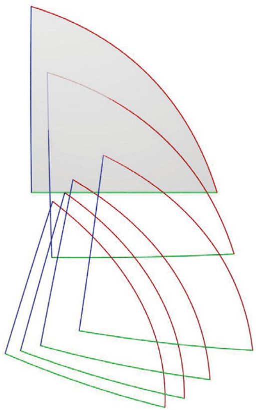
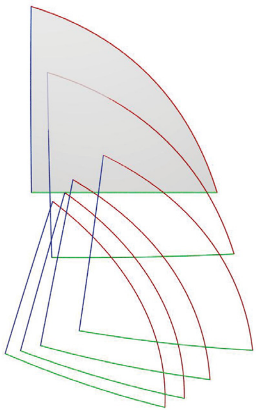
Sliding the window through the daylight curve (motion μ) ...

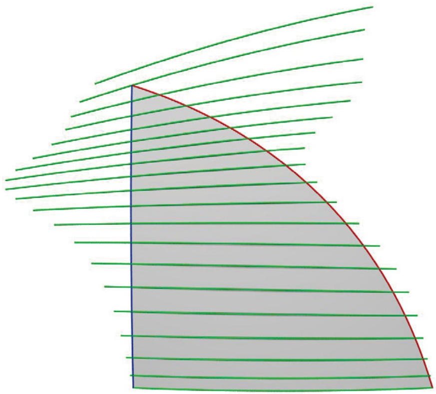


The inverse problem:

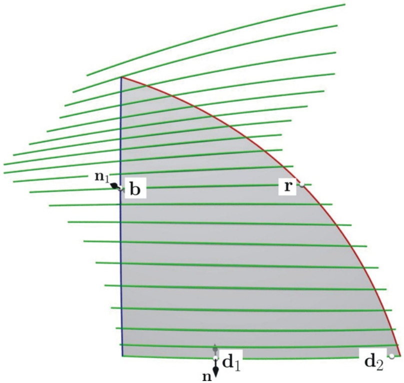
Sliding the window through the daylight curve (motion μ) ...



amounts to slipping the daylight curve across the window (inverse motion μ^*).



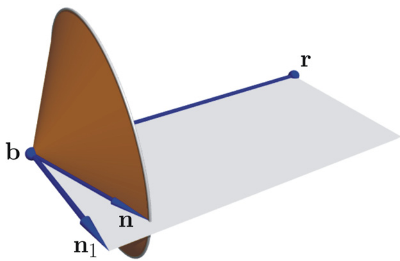
Additional Constraints:



Additional Constraints:

Each given window sheet position suggests a certain position of the daylight curve during the motion μ^*.

Fine tuning the positions recognizes the tangent planes along the front boundary curve.



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Minimizing the angle between the two normals: The chord and the two normals have to be coplanar.

Step 2: A suitable window motion

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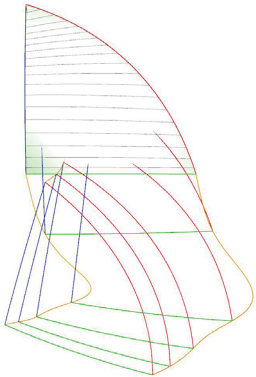
An interpolation problem in the space of Euclidean Motions:

Result: A smooth spatial motion μ^* recognizing all conditions.

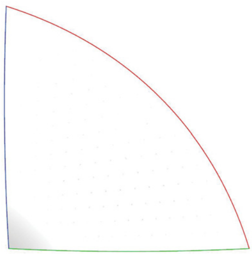


An interpolation problem in the space of Euclidean Motions:

Result: A smooth spatial motion μ^* recognizing all conditions.

The inverse motion μ: A smooth spatial motion assuming each of the given window positions.

The window motion μ will move S_d perfectly.
Zero stress on the sealing.



The window motion μ will move S_d perfectly.
Zero stress on the sealing.

μ will most probably be a good match for the given surface S.
The distance between S and S_d is an indicator for the stress exerted to the sealing.

Step 3: Intermediate window surfaces

What if the given window surface S stresses the sealings beyond their prescribed limits?

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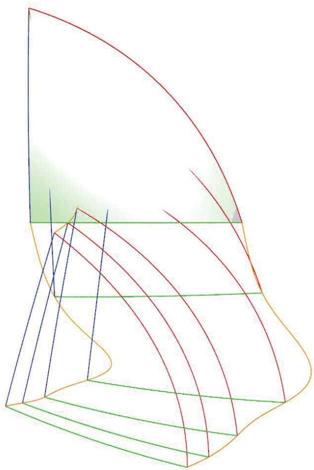
We stick to the constructed window motion μ.



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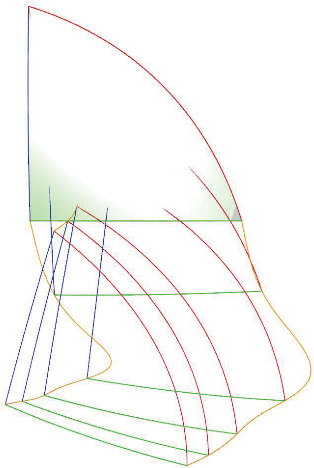

What if the given window surface S stresses the sealings beyond their prescribed limits?

We stick to the constructed window motion μ.

μ will move S_d without any stress to the daylight sealing.

We construct a set of new window surface S_β out of S and S_d: intermediate surfaces S_β

$$S_\beta \ldots \mathbf{x}_\beta(u,v,w) := \mathbf{x}(u,v,w) + \beta(u,v,w)\cdot(\mathbf{x}_d(u,v,w) - \mathbf{x}(u,v,w))$$

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$$c \quad := \quad \frac{(k+l+m)^{k+l+m}}{k^k\; l^l\; m^m} \cdot b_0$$

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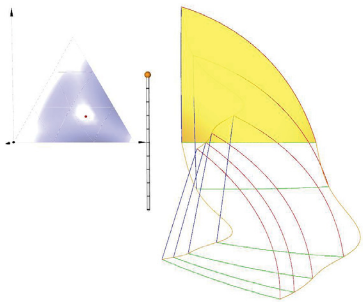
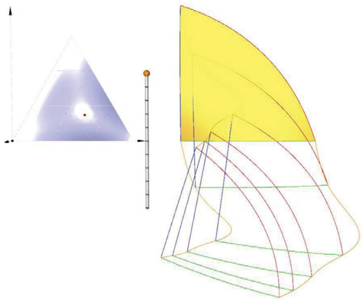
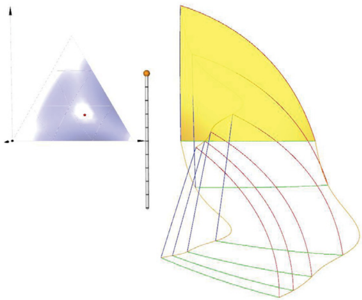




The intermediate surfaces S_β will enable the engineer to control



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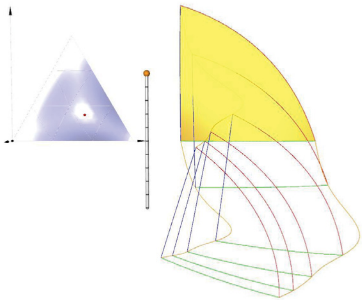
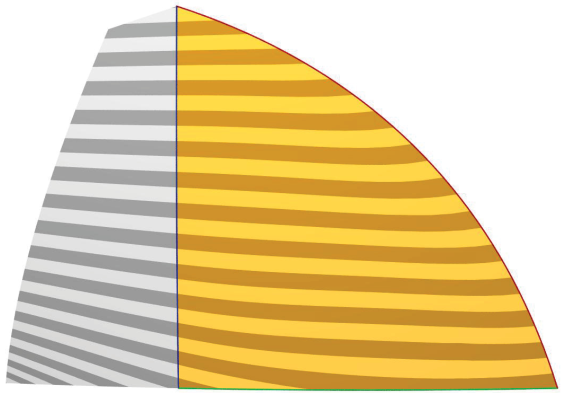
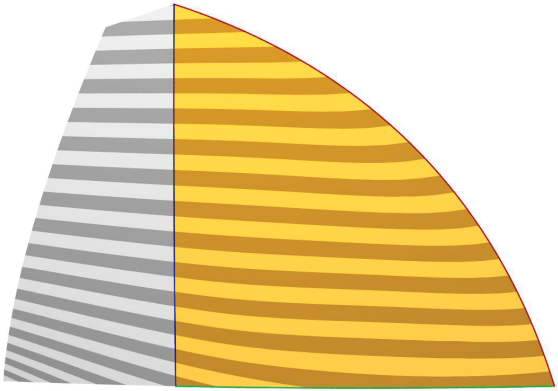


The intermediate surfaces S_β will enable the engineer to control

- the maximum stress to the sealing
- and the smoothness conditions along the boundary curves.





Thanks for your attention!