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Fabric Tessellation: Realizing Freeform Surfaces by Smocking

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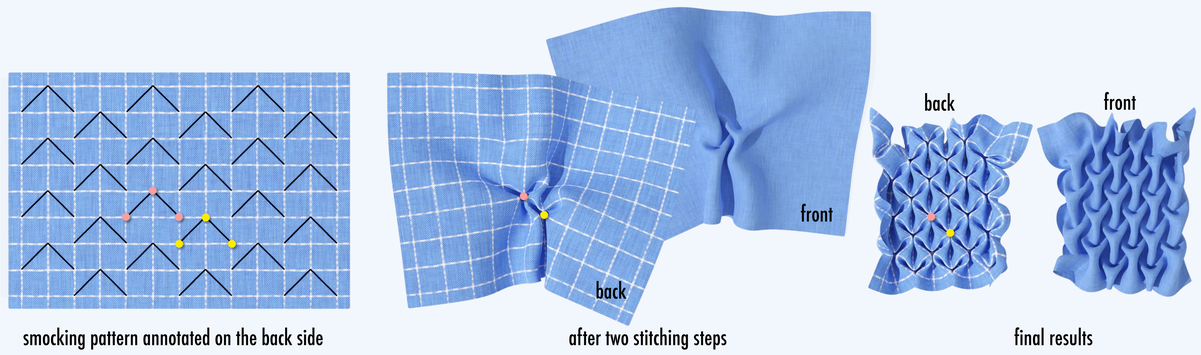
What is smocking?

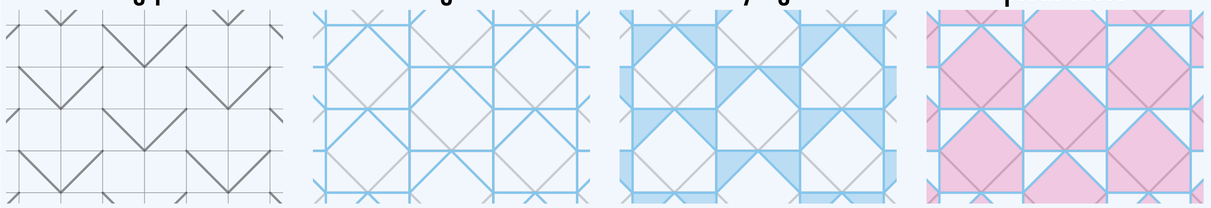
- Stitch the endpoints in the same stitching line together and secure with a knot



smocking pattern annotated on the back side | after two stitching steps | final results

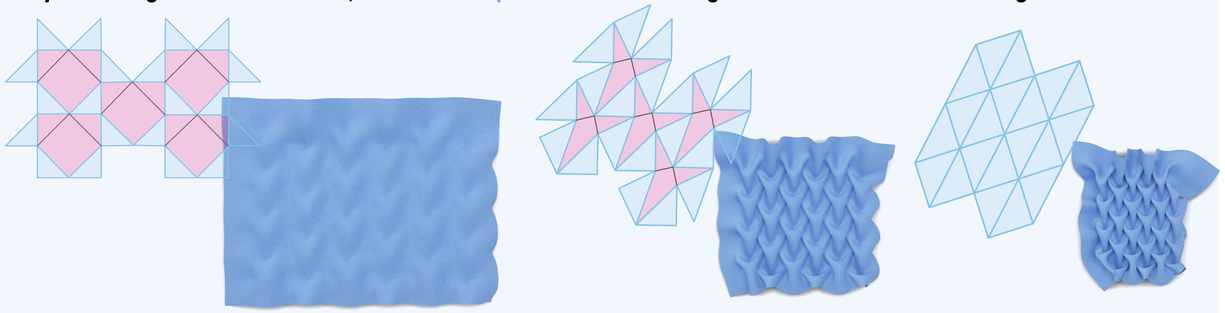
- The forward problem has been solved: "Digital 3D Smocking Design", Ren et al. *ACM ToG 2024*

Formulation : Tangram



definition we construct the **tangram** graph from a given smocking pattern that contains all the **underlay edges**, i.e., the edges that connect two different stitching lines;

definition we call a region an **underlay face** if it is bounded by underlay edges and does not contain any stitching lines. Otherwise, we call it a **pleat face** if the region contains some stitching lines.



definition The tangram of a smocking pattern is **closed** when the underlay faces and edges are rigidly rotaed to reach a configuration where all stitching lines have zero length.

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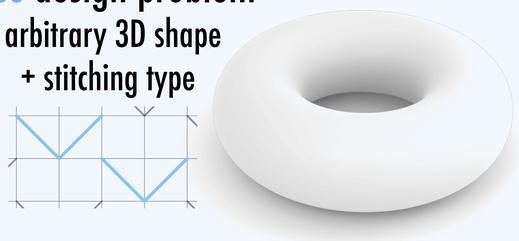
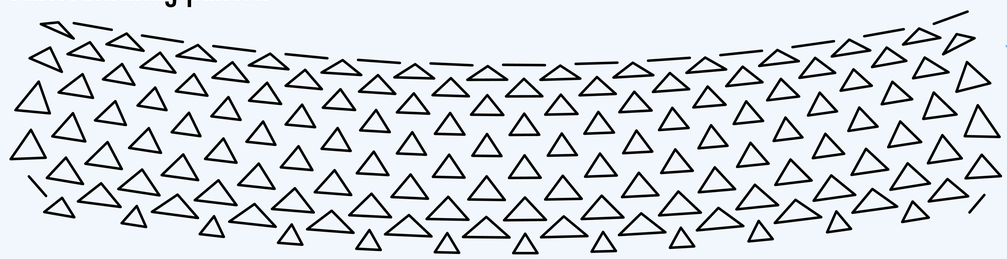
Inverse design problem

input arbitrary 3D shape + stitching type

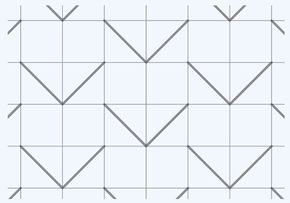


requirements
- approximate the input shape
- with nicely shaped pleats

output 2D fabric stitching pattern



Methodology



5.optimize the 2D stitching pattern directly to achieve the target lengths in 3D

$$\min_{x \in \mathbb{R}^2} \sum \left(\|x_i - x_j\| - \ell \right)^2$$