meshmixer: an interface for rapid mesh composition

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The Problem

In recent years a wide variety of mesh editing techniques have been developed for tasks such as smoothing, deformation, and parameterization. Comparatively fewer alternatives are available for composition tasks, such as combining parts of existing meshes. As designs often evolve from a combination of existing ideas and models, rapid composition techniques could significantly improve the workflow of mesh-based modeling tools. In our work we are exploring shape reuse and composition problems in 3D mesh modeling.

The Research

Shape composition approaches generally fall into two categories - *part fusion* and *detail transfer*. Part fusion methods allow arbitrary surface parts to be cut from one model and automatically stitched into an existing hole in another [Sharf et al. 2006], while detail transfer techniques copy displacement maps [Biermann et al. 2002] or differential information [Botsch and Sorkine 2008] from source to target via compatible planar parameterizations.

Although the technical aspects of shape composition have been well-explored, the modeling tools described to date focus on fully automatic solutions, which have the side effect of taking the artist "out of the loop". Design exploration is also inefficient, as when the result is unsatisfactory one must start from scratch. For example, most part fusion methods assume that a suitable hole already exists in the target surface.

Such workflows clearly lack the simplicity and efficiency of similar interactions found in 2D image editors, where an artist can simply drag selected pixels from one location to another. Similarly, detail transfer techniques have focused on "cut-and-paste" edits, copying entire enclosed regions. Examining 2D image editors, we note that a much more powerful and efficient interaction is the *clone brush*, an intuitive tool which allows the artist to *selectively* transfer details between the corresponding areas.

Inspired by these 2D interactions, we have developed *meshmixer*, a composition tool for arbitrary surface meshes based on two novel interfaces. To perform fusion-style tasks for boundary-based features, we present *Geometry Drag-and-Drop*. This technique allows an artist to select a complex part and drag it along the surface to a new location, or onto another surface. We automatically fill the hole left behind, smoothly deform the part to conform to the target surface, and provide additional blending and part-rigidity enhancements. For detail transfer we introduce the *Mesh Clone Brush*, which allows the artist to paint directly onto the surface to precisely specify the spatial extent and intensity of the transferred details. Both tools operate in real-time, providing instant feedback and opportunity for refinement.

To implement these tools, we adapt and extend recent techniques for dynamic mesh parameterization [Schmidt et al. 2006] and linear variational deformation [Botsch and Sorkine 2008]. We have also explored a novel *geometric* differential deformation, which produces results similar to variational methods but is not dependent on mesh topology. Since we imagine that mesh composition will be most useful in the context of other mesh modeling techniques, meshmixer also incorporates state-of-the-art smoothing and deformation tools, again based on recent work in linear variational

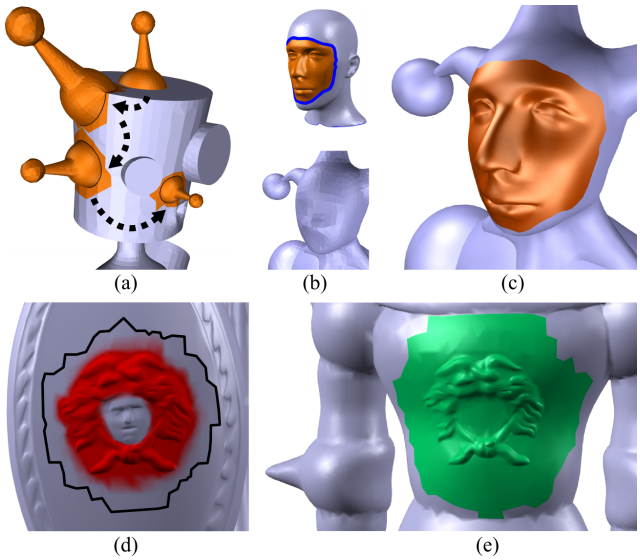

Figure 1: *We present a novel artist-oriented interface for surface composition. Arbitrary mesh parts can be dragged-and-dropped from either one location on a surface to another (a), or between two completely different surfaces (b,c). In either case, the hole left behind is automatically filled. Our mesh clone brush supports precise control over the extent of detail transfer tasks by painting directly onto the mesh surface (d,e).*

modeling. We will discuss lessons learned from attempting to apply these methods in a practical system.

The fluidity and efficiency of our tools supports an interaction style that has not been available in any previous system, allowing detailed 3D models to be quickly assembled from arbitrary input meshes. We are evaluating meshmixer by distributing it freely over the internet, to date it has been tested by hundreds of artists, hobbyists, and 3D professionals. We distill the highly positive feedback gathered during this experience into a set of *workflows* encompassing tasks common to different user groups, and explain how our techniques can be applied to simplify these workflows.

References

BIERMANN, H., MARTIN, I., BERNARDINI, F., AND ZORIN, D. 2002. Cut-and-paste editing of multiresolution surfaces. *ACM Trans. Graph. 21*, 3, 312–321.

BOTSCH, M., AND SORKINE, O. 2008. On linear variational surface deformation methods. *IEEE Trans. Vis. Comp. Graph. 14*, 1, 213–230.

SCHMIDT, R., GRIMM, C., AND WYVILL, B. 2006. Interactive decal compositing with discrete exponential maps. *ACM Trans. Graph. 25*, 3, 605–613.

SHARF, A., BLUMENKRANTS, M., SHAMIR, A., AND COHEN-OR, D. 2006. SnapPaste: an interactive technique for easy mesh composition. *Vis. Comput. 22*, 9, 835–844.

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