

# A Gradient Mesh Tool for Non-Rectangular Gradient Meshes

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Figure 1: Our gradient mesh tool (left) enables the user to create complex colour gradients of arbitrary topology (right).

## ABSTRACT

The gradient mesh tool, implemented in vector graphics software like Adobe Illustrator, is a popular tool for creating and manipulating complex colour gradients. The mesh-based tool is restricted to rectangular gradient meshes, making it hard for the user to work with more complicated shapes such as shapes with holes. We propose a new gradient mesh tool that supports non-rectangular meshes, with native support for a wide range of different shapes. A user study indicates that our tool is easier to use when drawing colour gradients inside complicated shapes.

## CCS CONCEPTS

• Computing methodologies → Graphics systems and interfaces;

## KEYWORDS

colour gradients, vector graphics, software tools

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## 1 INTRODUCTION

In vector graphics design, working with complex colour functions is challenging. The restrictions of the linear gradient tool is one reason designers turn to pixel-based tools, like Adobe Photoshop, when

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the design turns complicated. This issue has been acknowledged in the research community and a wide range of different approaches have been proposed to make the design of colour gradients more effortless [Lopez-Moreno et al. 2013; Orzan et al. 2008; Shao et al. 2012; Vergne et al. 2012].

The gradient mesh tool, found in graphics packages like Adobe Illustrator, Corel CorelDraw, and InkScape, is a popular tool for complex colour gradient design. It is useful in scenarios where the linear gradient tool does not suffice. However, it does not support non-rectangular gradients: the mesh which the user interacts with must be of rectangular topology. In this poster, we propose a new tool for gradient mesh editing where the user can create and manipulate non-rectangular colour gradients, like the one shown in Figure 1. Our approach takes advantage of a recent gradient mesh interpolation technique that supports arbitrary mesh topology [Lieng et al. 2016]. Being able to model non-rectangular gradient meshes provides significant practical advantages, especially for vector shapes with holes.

## 2 PROBLEM DESCRIPTION

In previous gradient mesh tools, there are two approaches to mesh creation. The first option converts a vector graphics object compatible with a rectangular gradient (i.e. a vector shape without holes) to a mesh of control points. The user is required to input the number of rows and columns of the gradient mesh. This creation method is dependent on a grid-based representation and is incompatible with non-rectangular gradient meshes. An arbitrary non-rectangular mesh corresponds to general polygonal meshes, which cannot be represented by a grid-based data structure. Instead, a structure such as the half-edge data structure must be used.

The second option is a point-and-click interface where the user clicks on a location inside the target shape and a new control point is created at this location. This is attractive as the creation operation is independent from the underlying data structure and can give rise to several interpretations. However, the interaction produces

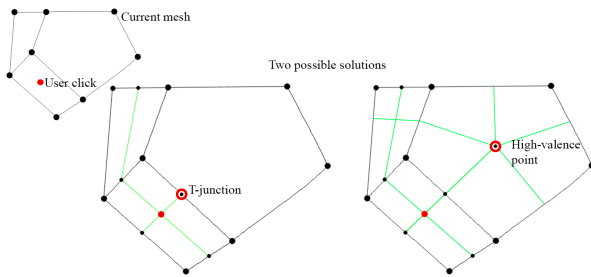


Figure 2: Current point-and-click interfaces give rise to ambiguous cases for irregular meshes. A new control point is inserted at the location where the user clicks (red point). New edges are inserted from this point (green edges). Two possible solutions are shown for mesh alteration at the irregular face (the pentagon); both options give rise to poor mesh quality. Top left: Gradient mesh before interaction. Middle: A T-junction. Right: A high-valence control point.

a global alteration: when a control point is added, a new row and column is added to the entire mesh. It is therefore challenging to achieve local gradient edits and the user must consequently plan the structure of the mesh so that the number of rows and columns is kept to a minimum. This would be even more challenging in the non-rectangular setting. Figure 2 illustrates a point-and-click interaction inside a polygon adjacent to a pentagon. The effect of such an interaction is ambiguous and any solution would be ad-hoc.

### 3 A NEW TOOL FOR GRADIENT MESHES

Our approach takes inspiration from the pen tool found in SketchUp. Our tool provides operations such as edge split and face deletion. Code and a demonstration video of the tool is available as supplementary material.

In the following, we describe typical interactions with our tool to create and refine gradient meshes. The user create initial meshes *face-by-face*, which can later be refined and manipulated. Our **line tool** enables the user to create single polygonal faces of arbitrary topology. The mesh is expanded by iteratively adding faces to it. To add a face, the user selects an existing control point and places new ones on the canvas. The face is closed by clicking on an existing control point. A non-manifold mesh can be achieved if the initial control point closes the face, as shown in Fig. 3.

The user can further locally edit and refine the gradient mesh. The **edge split tool** splits a selected edge into two pieces. The inserted control point should then be connected to another point to avoid valence-2 control points. Note that edges are modelled as cubic Bezier curves: each control point is associated with a gradient constraint for each of its edges. The constraint control the local influence of the colour of the control point. Such constraints is a standard feature of gradient meshes. To ensure that the curve of the edge is maintained when the edge is split, the position of new control points are calculated using De Casteljau's algorithm. Finally, adjacent edges can be collapsed for mesh simplification and faces can be removed to introduce holes (Figure 3). We also support alterations at finer levels, using the multi-resolution adjustments of Lieng et al. [Lieng et al. 2016].

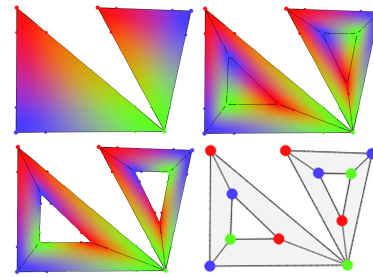


Figure 3: A non-manifold mesh with internal holes. Top: Faces are added iteratively. Bottom left: The inner faces have been removed. Bottom right: The gradient mesh.

## 4 INFORMAL USER STUDY

We performed an informal user study where five subjects were tested: two professional designers and three art students. The subjects were given two task (creating one baseline rectangular mesh and one non-rectangular mesh), each completed with our tool and with Adobe Illustrator's gradient mesh tool. The tests were complemented with an user survey. For the baseline test, all subjects were able to create a regular mesh. The data from this test suggest that Adobe Illustrator either provides a generally better user interface (with better support for operations like undo), or that it was easier to work with Illustrator over our tool since the users already were familiar with Illustrator. For the non-regular mesh, users preferred our tool over Illustrator's. The subjects praised our tool for enabling face-specific manipulation capabilities such as face deletion. Additional data from the user study can be found in the supplementary material.

## 5 FUTURE WORK

Though our gradient mesh tool offers opportunities to work with non-rectangular gradient meshes, it is not a full experience graphical design software application. In the future, we aim to rewrite our tool as a plug-in for Adobe Illustrator. This presents several issues, as the underlying mesh representation in Illustrator differs from ours. One approach can be to incorporate Pixar's OpenSubdiv library with Illustrator's SDK.

## REFERENCES

- Henrik Lieng, Jiří Kosinka, Jingjing Shen, and Neil A. Dodgson. 2016. A Colour Interpolation Scheme for Topologically Unrestricted Gradient Meshes. *Computer Graphics Forum* (2016), to appear.
- Jorge Lopez-Moreno, Stefan Popov, Adrien Bousseau, Maneesh Agrawala, and George Drettakis. 2013. Depicting Stylized Materials with Vector Shade Trees. *ACM Trans. Graph.* 32, 4, Article 118 (July 2013), 10 pages.
- Alexandrina Orzan, Adrien Bousseau, Holger Winnemöller, Pascal Barla, Joëlle Thollot, and David Salesin. 2008. Diffusion Curves: A Vector Representation for Smooth-shaded Images. *ACM Trans. Graph.* 27, 3, Article 92 (Aug. 2008), 8 pages.
- C. Shao, A. Bousseau, A. Sheffer, and K. Singh. 2012. CrossShade: Shading Concept Sketches Using Cross-section Curves. *ACM Trans. Graph.* 31, 4, Article 45 (July 2012), 11 pages.
- R. Vergne, P. Barla, R. W. Fleming, and X. Granier. 2012. Surface Flows for Image-based Shading Design. *ACM Trans. Graph.* 31, 4, Article 94 (July 2012), 9 pages.