

Description of master thesis

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Rapid modeling of geological structures

Geologist often make sketches of geological structures, both in order to communicate ideas amongst themselves, and to other interested people. We propose to develop a computer program to aid in this sketching.

In developing this program, the following techniques will be explored:

- Having an initial empty sandbox from which the structures can be “carved”
- Drawing layers by turning and sketching on the sides of the box
 - Constraints on drawing. No layer-/self-intersection
 - Layers will be interpolated from this
 - Modifying layers by sketching on them and pushing or pulling
- Drawing rivers by sketching on the surface of horizons
 - Will carve out a plausible river following this path
 - Allows adjustments of size and depth
 - Adjusting of sealeves determines deposits
- Drawing ridges and valleys
 - Drawing the path of the new feature on existing terrain
 - Adjust look of contour along this path
 - Possibly change the height by similar approach as in Teddy
- Picking layers with mouse pointer
 - Further editing of layer is then possible

- Changing color
 - Setting transparency
- Expanding sketch with new cubes
 - Drawing layers in the new cube might use the edges of layers in adjacent cube
 - While drawing lines will snap to existing lines
- Representations
 - The terrain features will be modeled and stored by some sort of implicit representation
 - Might be possible to go back and forth in the history of this structure to make changes without losing later work
- Procedural geologic modeling
 - Generate deposits by specifying terrain and sea level and such
 - Changes to the generated structures might change the initial conditions needed to make such an end result
- Visualization options
 - Generating simulations of seismic data

Illustrations of use case

Here we show a possible sequence of manipulations to quickly create some geological structures in a scene.

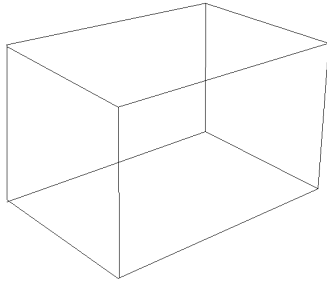


Figure 1: We start with the empty box

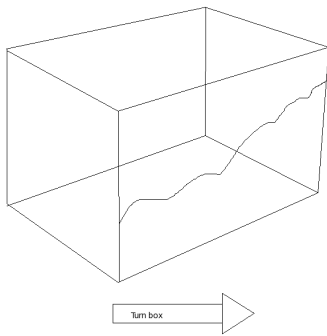


Figure 2: We draw the imagined layer in the box by turning it and drawing on the sides

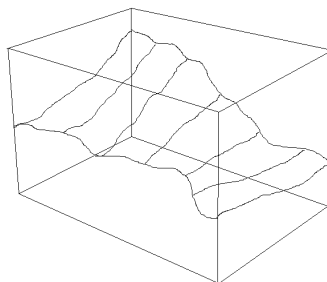


Figure 3: A layer is interpolated from the four sides we draw

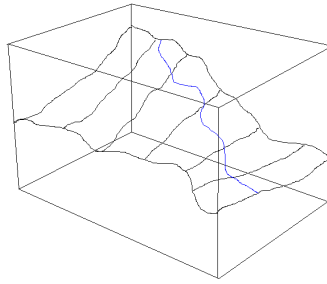


Figure 4: We draw a river path on this layer

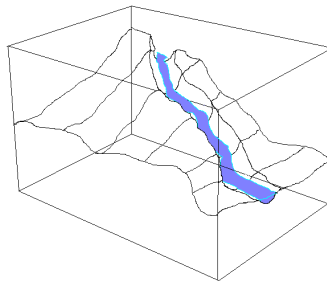


Figure 5: The computer will carve out from this layer as needed to make a river follow this path in a plausible way

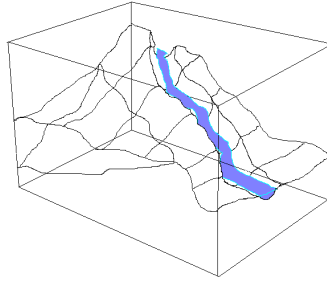


Figure 6: Now we draw a new layer. This can use the previous layer as a drawing surface in stead of only the sides of the box

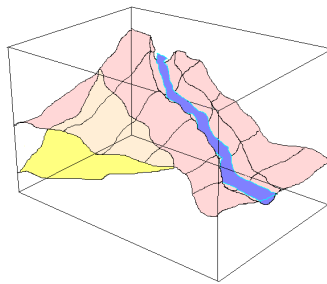


Figure 7: We add some color to the layers. In this figure the layers are partially transparent.

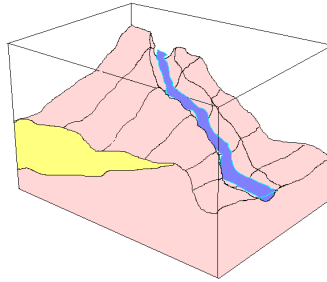


Figure 8: Here we have turned of tranparency and the sides become opaque

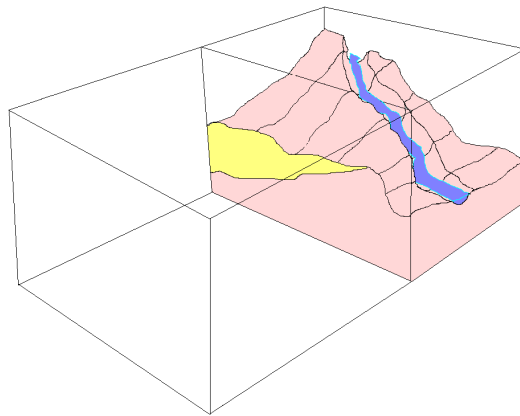


Figure 9: Now we might add a new cube to expand our drawing

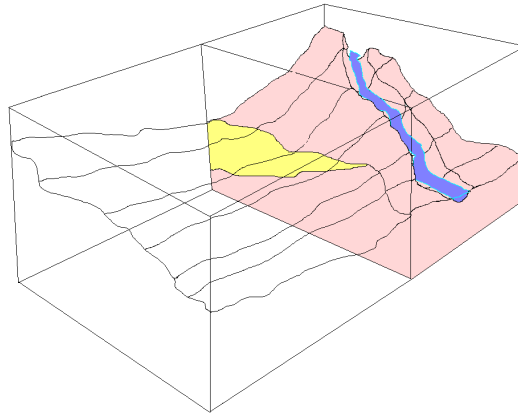


Figure 10: Drawing a new layer. Lines snap towards existing lines in adjacent cube.

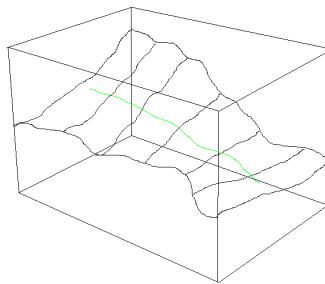


Figure 11: To create a new ridge or valley, start by drawing the ridge or valley path on the existing terrain.

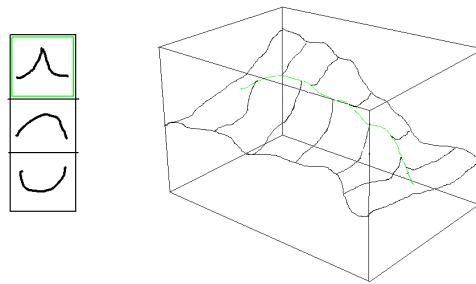


Figure 12: Now chose what the contour will look like and the new feature will be created. It should be possible to create different contours along different positions on the path drawn.

Reading list

- Sequence stratigraphy-A global theory for local success, Neal
- Interactive thickness visualization of articular cartilage, Mlejnek

Plan

These are features that are planned implemented for the next iteration

0.1 Oversketching

The ability to easily modify the sketch by drawing “pencil” strokes that go outside the lines.

0.2 Profile drawing

To draw the profile of features on the terrain on seperate canvas

0.3 Brush size

Brush size modifies the accuracy of strokes

0.4 Delete

To be able to undo/redo, is very important

0.5 Edit horizon

Must be able to pick an existing horizon to edit. Find user friendly technique for this.

0.6 Prepare for meeting with geologists

For the meeting I want to get as much useful information as possible. In order for this to be possible, there should already be a first “story”. I want to show them a possible scenario that is now possible with the program, and what I see as possible goals/directions. If they “get it” and are able to contribute with their vision for completing the story, this would be very useful.

0.7 Procedural linking

To be able to model the start scenario witht for example a river, and them have the program modify the terrain to create deposits from the river, is a useful feature. If it was possible to also go in the other direction, and demand some deposits in an area, and then have the program create a scaenario with a river, could be interessting.

0.8 Cube visualization

The cube visualization must be improved. The edges can be drawn. There could be a grid on the cube. There could be shadows on the cube to increase spatial awareness.

0.9 Spline order

There should be an enforced order to draw the splines, or to interpret the splines. Otherwise the result can be unexpected.

0.10 Shading

There must be lighting and shading on the surfaces, in order to better visualize their topology.

0.11 Drawing on the surfaces

Splines