

Moderato: 3D Sketch CAD with Quick Positioned Working Plane and Texture Modelling

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Keywords

sketch, early stage, interface, 3D modelling

Introduction and Related Work

The lack of computer systems that can be easily used during the early stages of the architectural design process has been discussed for many years. The usual argument starts with the recognition that hand drawn sketches are an important tool in the early stage of both professional and student design because they can be used to visualise the designer's ideas quickly and have the flexibility to handle any shape the designer imagines. Research has then mostly focused on using computer based sketch recognition to directly produce three dimensional models from hand drawn sketches. However sketch recognition still has certain problems that require the drawing action of users to be constrained in some way in order to be solved. If sketch recognition is still imperfect, the possibility of directly sketching within digital 3D space should be considered.

Some systems allowing user to sketch in digital 3D space have been developed which do not depend on sketch recognition. Although Piranesi[Schofield 1994], [Schofield, Richens 1995], [Richens 1999] does not aim to support sketch design, it does allow the user to paint in the Z-buffer

space - an unique idea termed "interactive rendering."

SketchVRML[Jozen, Wang, Sasada] tries to generate 3D geometrical data automatically from 2D hand drawn sketches by adding the depth value to the drawn lines according to the strength of line strokes.

SketchBoX[Stellingwerff 1999] provides translucent surfaces in digital 3D space which can be glued onto existing objects or arranged anywhere in space. These surfaces have texture map data which can be modified by painting onto the texture. Transparent textures can be painted onto the surfaces to create see-through portions. Moderato also uses this technique to model a polygon's shape.

The Moderato Concept

My understanding of the importance of sketch design is as follows. In the early stages of architectural design, when designers get a new idea in their mind, they draw it down onto the paper as fast as possible before it disappears from their mind. The sketch makes a convenient tool because it allows designers to visualise the idea very quickly. Further-

more, a sketch can be used to visualise the ideas even if the drawn figures are quite ambiguous - this further speeds the drawing of a sketch whilst avoiding fixing a particular idea at such an early stage. Lastly, because there is no geometrical constraint on sketch drawing, designers can draw any type of shape in a sketch. I have derived three keywords expressing the sketch's advantages from this analysis as below.

Speed: allows designers to visualise their ideas quickly

Ambiguity: allows designers to evolve their ideas

Flexibility: allows designers to handle any geometrical figure

Moderato is a 3D Sketch CAD system running on Windows95/98, which has been developed with reference to these keywords and allows designers to "sketch" digital objects in 3D digital space without the need for sketch recognition.

Positioning of the working plane for "Speed"

In Moderato, a quick input interface is realised by reducing the complex procedures normally required to position the working plane as much as possible. The left mouse button is used for object creation and working plane positioning whilst the right button is used for picking up the attributes of an object. Only one mouse button is used for the input operation since it is likely that a pen tablet device will be connected instead of a mouse device.

See Figure 1. Generally, clicking the mouse button is always assigned to shifting the working plane, whilst clicking+dragging is always used for creating objects. If the user clicks on an existing object, the working plane is shifted to the orientation of that object, centred on the point clicked. Repeated clicks without moving the mouse rotate the working plane about the point, cycling through the three axial orientations. Clicking+dragging creates new objects and also modifies and moves existing objects.

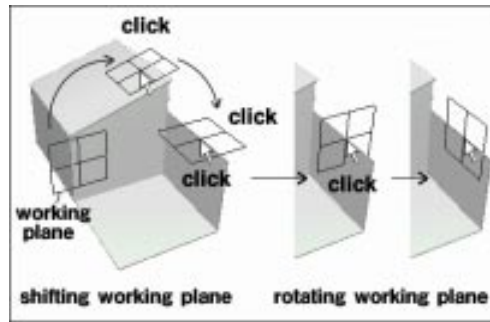


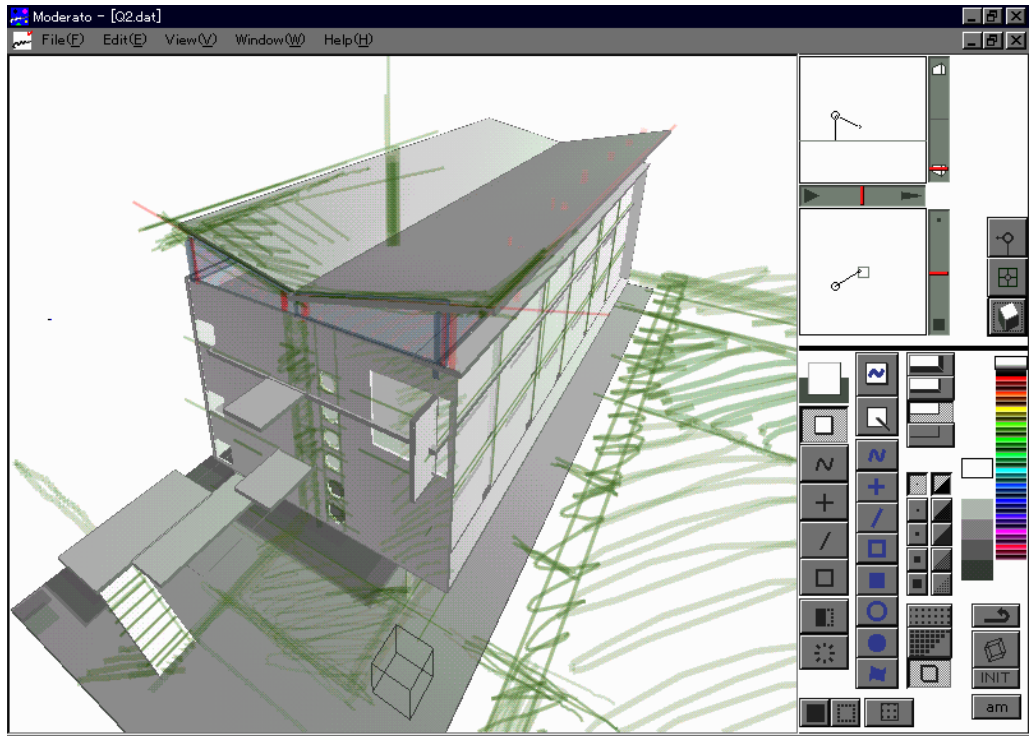
Figure 1.
"Shift and rotate working plane"

This interface removes the need for constant switching between modes and uses a maximum of three clicks to orient the working plane. Although the working plane can only be positioned onto an existing object, arbitrary orientations can easily be achieved by creating new objects as "scaffolding." I call this technique "shift and rotate working plane."

Modelling polygon objects for "Flexibility"

Moderato stores a texture map for each polygon. This texture data can be altered whenever the user is modelling: the texture can be modified just as if the user were using a 2D painting system, except the surface is a 3D plane. The texture maps contain both colour and transparency information and are mapped using the standard "billboarding" technique (OpenGL Programming Guide [Woo, Neider, Davis 1997]). This means that painting a transparent texture onto a polygon makes the painted area see-through: painting transparent textures can be used to delete parts of a polygon, painting in solid textures reconstructs parts of a polygon. This allows polygons to be any shape within the limits of the texture map's resolution. I call this technique "texture modelling." Using this technique, Moderato supports flexible sketch-like modelling.

Figure 2.
Sketch example



Rendering of line object for “Ambiguity”

The line objects handled in Moderato can render themselves in a number of ways to mimic, for example, physical pencil lines or airbrush lines. Each line carries attributes such as opacity, airbrush, wiggle and taper as well as colour and width. This rendering is a kind of non-photorealistic rendering. Although they do not aim to reproduce exactly physical pencil or airbrush marks, these lines do contain expressive qualities and aim to help create sketches that are engaging as well as ambiguous.

Evaluation and Conclusions

Using Moderato, lines can be drawn as a rough sketch at first, followed immediately by polygon modelling, and finally the details on polygons can be created using texture modelling. (See Figure 2.) The shape of a building can be defined gradually from ambiguous shapes to more detailed shapes on a single platform and always in 3D digital space.

To date, during the early stages of the architectural design process, sketching and 3D modelling

have been separated. Moderato creates a new design environment within which designers may visualize and refine their early design ideas. Although physical pencils and paper can not sketch in 3D space, they still have some advantage of “speed”, “ambiguity” and “flexibility” over Moderato. Although physical pencils and paper would be still used at the same time, Moderato provides the comfortable an unique design environment for both professional and student.

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