# Lab 7 Report: Bezier Curves and Surfaces

Summary

The purpose of this project was to implement Bezier curves and surfaces as part of a hierarchical modeling system. This involved creating data types and functions for Bezier curves and surfaces, integrating them into the system, and demonstrating their functionality through various images and animations.

Required Images

1. 2D Bezier Curve

Description: This image was created using **test7a.c**, which implemented the de Casteljau algorithm to subdivide the Bezier curve until the control points were close enough to be approximated by straight lines. The bounding box threshold for subdivision was set to 10 pixels. The curves were recursively subdivided and drawn as line segments.
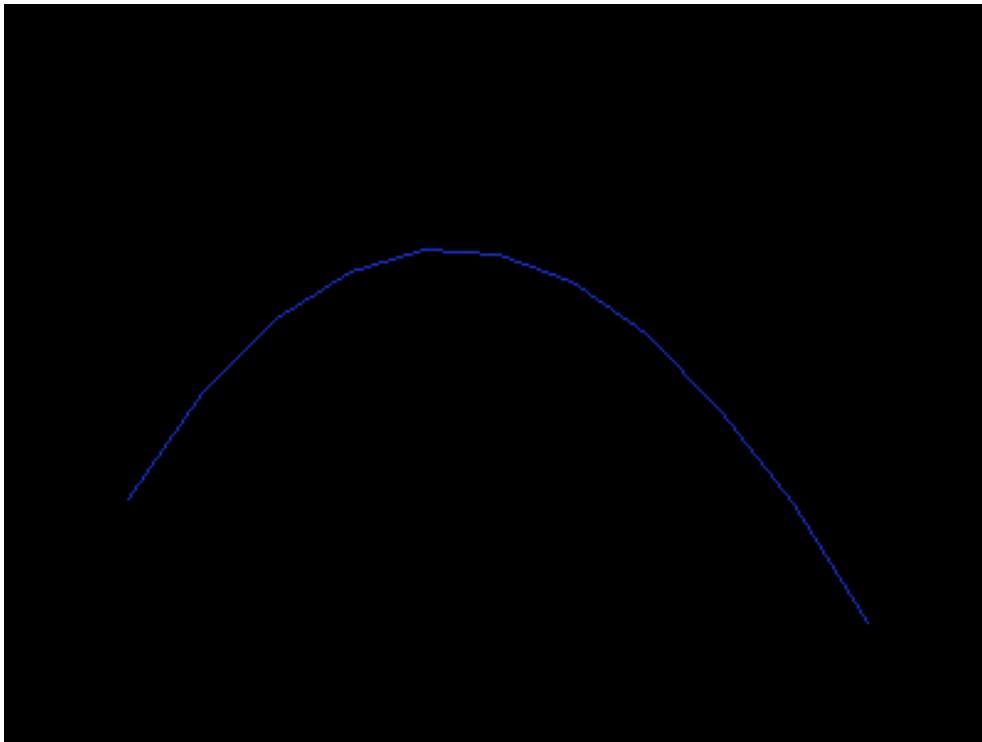
2. Bezier Curve with Subdivision Levels

<u>Description</u>: These animations show Bezier curves drawn with 0, 2, and 4 levels of subdivision, respectively. **test7b.c** was used to generate these sequences, demonstrating the effect of increasing subdivision levels on the curve smoothness.
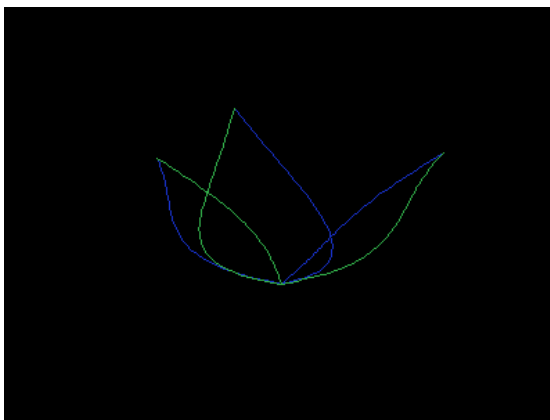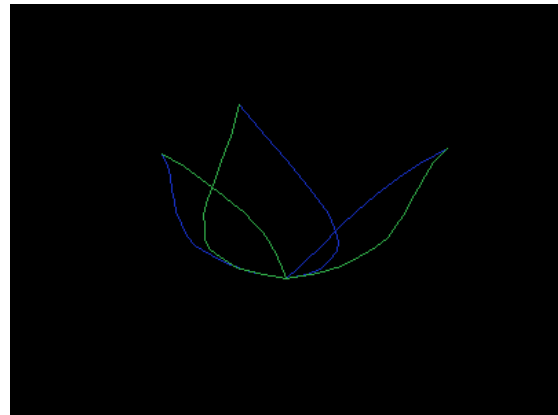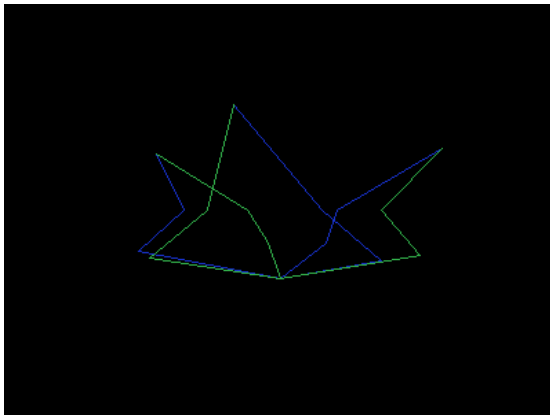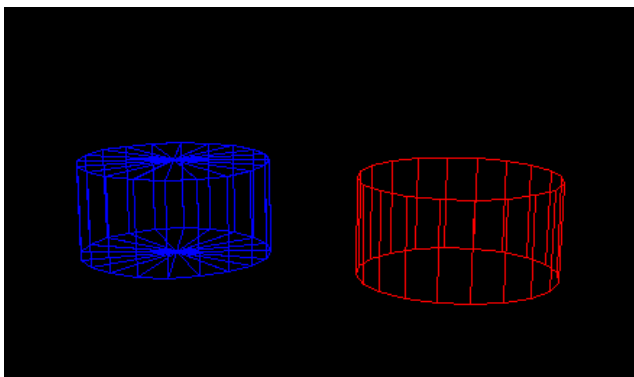
3. *Bezier Surface with Subdivision Levels*

Description: These animations display a Bezier surface with 0, 1, and 3 levels of subdivision. *test7c.c* was utilized to create these sequences, illustrating how subdivision levels affect the surface detail and smoothness.
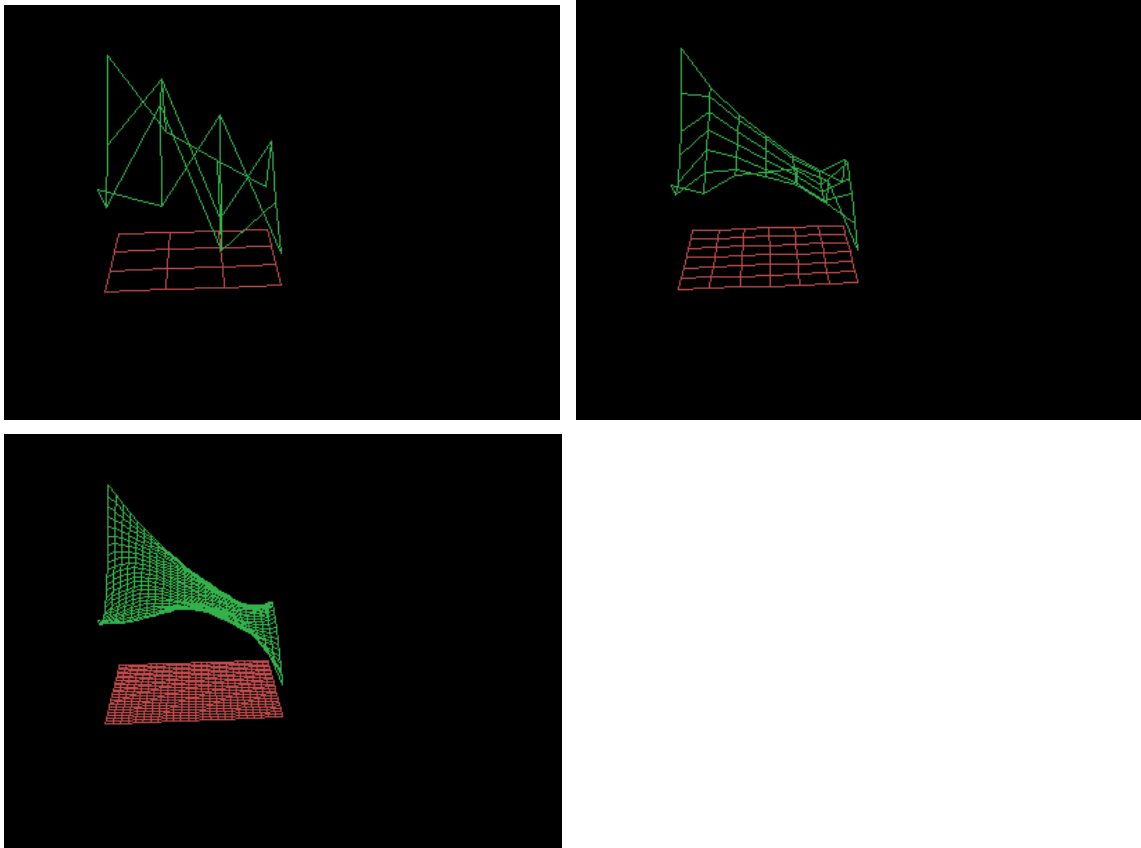

4. *Cylinder*

Description: This image displays a cylinder created using the *module_cylinder* function. The function allows for parameterization by the number of subdivisions, ensuring smooth and accurate cylindrical shapes.

5. *Additional 3D Primitives - Sphere + Pyramid*

Description: These images showcase a sphere and tetrahedron, created using the functions *module_sphere* and *module_pyramid* for these 3D primitives. Each primitive demonstrates the system's versatility in modeling various geometric shapes. My pictures illustrate the capability of my program to produce solid and line renderings of the shapes.
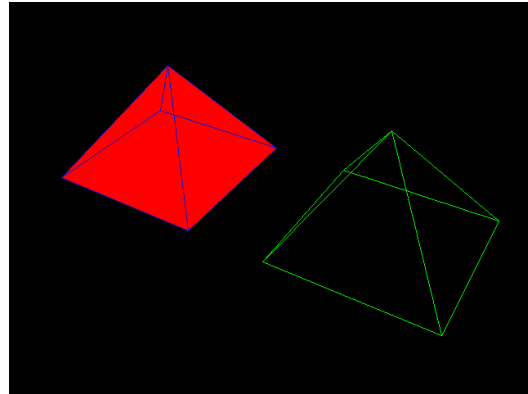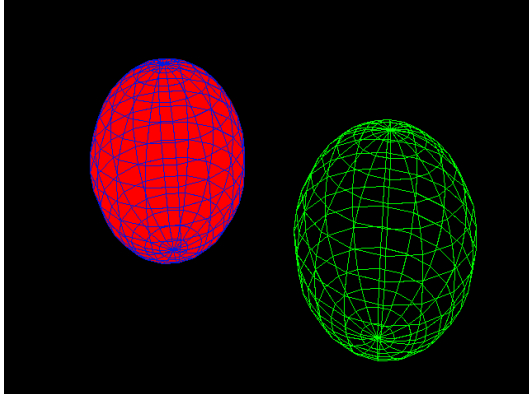


Extensions

1. *Polygons for the Bezier Surface*

Description: These animations display a Bezier surface with filled squares as the polygon implementations and 3 levels of subdivision. *lab7d.c* was utilized to create these sequences, illustrating how subdivision levels affect the surface detail and smoothness. It creates a more visually smooth appearance than lines.
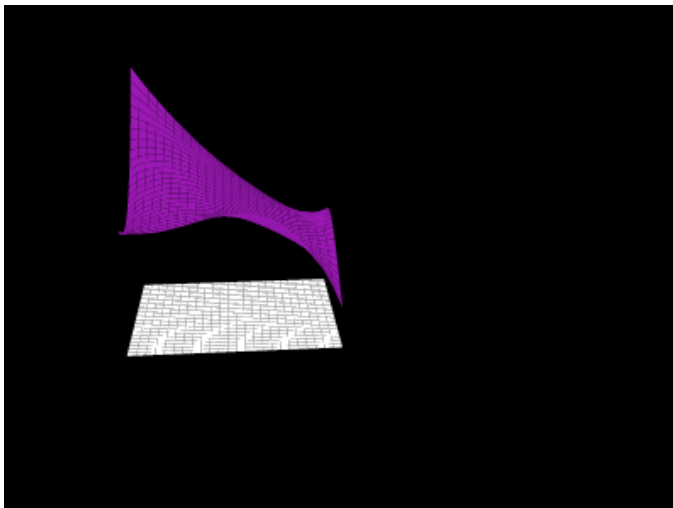
<u>Portfolio</u>

1. **Curtain (Bezier Surface, Cylinder, Sphere)**

   <u>Description</u>: This creative scene showcases a realistic curtain modeled using a Bezier surface to capture the flowing blue fabric, a cylinder for the curtain rod, and a sphere for the decorative end caps. The detailed curves and surfaces demonstrate the flexibility of Bezier modeling in creating smooth, natural shapes.
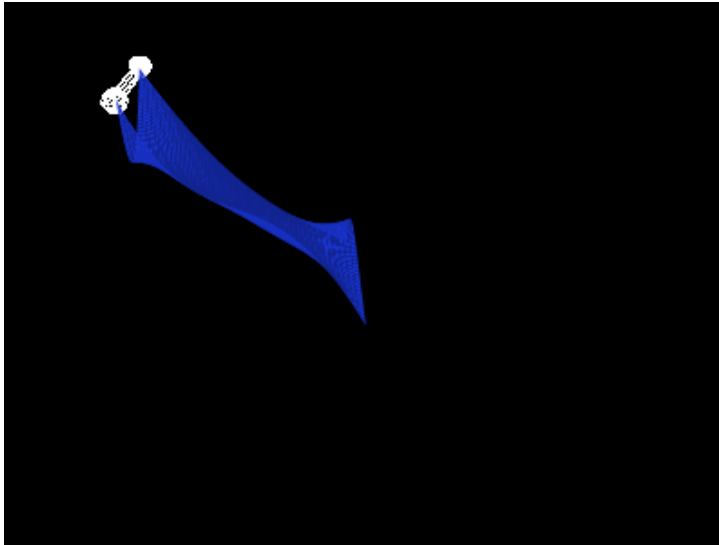
2. **Carpet (Bezier Surface, Pyramid)**

   <u>Description</u>: This image features a richly textured red carpet created using a Bezier surface to represent its soft, uneven surface, paired with four gold pyramids to add a touch of geometric contrast as tassels. The combination of these elements highlights the versatility of Bezier surfaces in modeling both organic and structured forms.
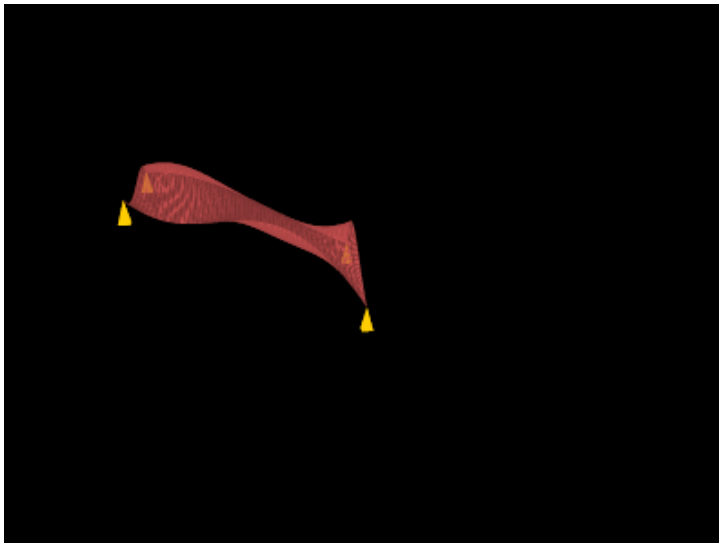
<u>Reflection</u>

This project enhanced my understanding of Bezier curves and surfaces and their implementation within a hierarchical modeling system. The process of recursive subdivision using the de Casteljau algorithm was particularly enlightening, as it illustrated the mathematical beauty and practicality of Bezier models. Additionally, integrating these curves and surfaces into a larger system provided valuable experience in managing complex data structures and transformations.

<u>Acknowledgements</u>

I would like to recognize the following for helping me complete this assignment:

- **Instructor and Course Material:** Professor Maxwell's lecture notes and videos provided me with guidance and reference materials for implementing the algorithms. My chat with him during office hours helped me figure out an issue with my subdivision helper methods and his code from the Lab 6 test files helped me build my cylinder module.

- **Classmates:** N/A

- **Online Resources:** Various online tutorials and articles from sites like [W3schools](#) on scanline and barycentric algorithms contributed to my understanding of the concepts.