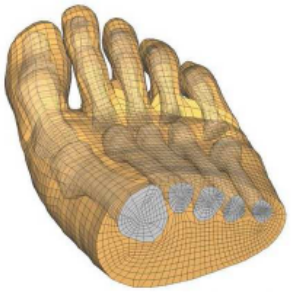
Creating Models with Piecewise Linear Interpolation

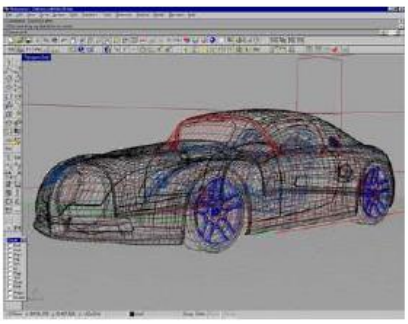


Piecewise linear interpolation is used extensively to create tessellations of objects. The model of the foot to the left includes 17 bones and soft tissue. The Cavanagh lab at the Cleveland Clinic Foundation uses the model for bioengineering and footwear design purposes. Such models are often used in conjunction with numerical methods for partial differential equations to model complex physical phenomena.

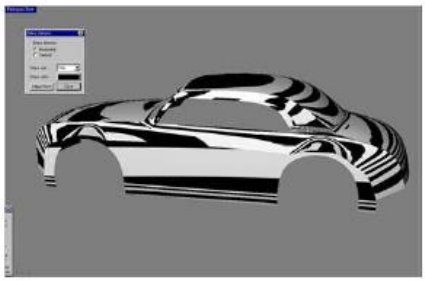
Splines at Boeing

During World War II, the British aircraft industry constructed templates for airplanes by passing thin wooden strips (called "splines") through key interpolation points in a design laid out on the floor of a large design loft. In the 1960's, work by Boeing researchers allowed numerical splines to replace these "lofting" techniques. Each day in 1996, Boeing airplanes made more than 42,000 flights, and within the company more than 10,000 design applications and 20,000 engineering applications were run [24]. Thus the Boeing Company was responsible for roughly 500 million spline evaluations each day, and this number was expected to rise each year. [35]. Splines are used extensively at Boeing and throughout the manufacturing and engineering sector.

NURBS – Non-Uniform Rational B-Splines (NURBS) are a set of mathematical functions that can accurately model complex geometrical shapes in 2 or 3 dimensions. They are used in such fields as computer graphics and manufacturing, where they are often combined with computer aided design (CAD) software. In the picture below to the left, we see a NURBS model of a car created in the CAD software, Rhinoceros, which is NURBS modeling software for Windows. The company's webpage `http://www.rhino3d.com` has a gallery of models that include jewelry, architecture, automobiles and cartoon characters. In the picture on the right, we see the same car after it is fully rendered.



Note that the reflections on the car are smooth curves. Acquiring smooth *reflection lines* is a goal in automotive design. A dent in the car's body, on the other hand, produces a discontinuity in the reflection line through the deformity. In the early days of car design, prototype cars were molded in clay and then painted to be reflective. Today, many aspects of automobile design occur within a computer. For example, computers can simulate reflection lines as seen below in the picture to the left. To the right, reflection lines are inspected as a quality assurance tool, something that many high-end automakers do just before the car leaves the factory. [30]



- Natural to use for modeling of smooth shapes, e.g.,
  - Body of an automobile
  - Shape of cartoon characters (Shrek)
  - Motion curves in animation, etc.