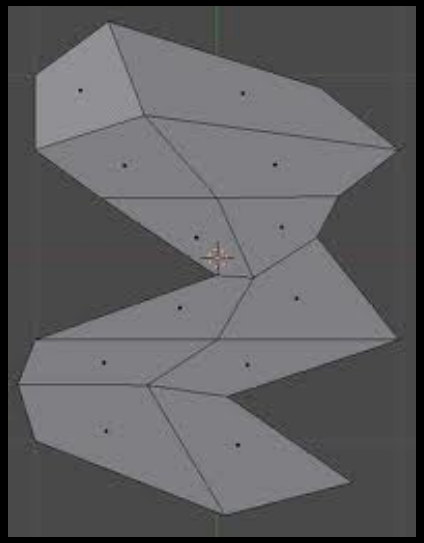
Note 06-Modeling

Metaverse

Modeling by polygon

- Polygonal geometry
  - Most common type of geometry



Creation

- All CG and CAD applications come equipped with a basic set of very similar tools
  - has their own special tools
- Follow three things:
  - Add detail
  - Remove detail
  - Modify detail

Creation

- Detail
  - vertices, edges, faces, or full objects
  - various ways to control how vertices, edges, and faces are added, deleted, or moved
- Move your vertices manually... --> impractical times ==> tricky modeling

Geometric Primitives

- Pre-defined common shapes
  - cones, cubes, cylinders, planes, spheres, and etc.
- box modeling (coarse to fine)

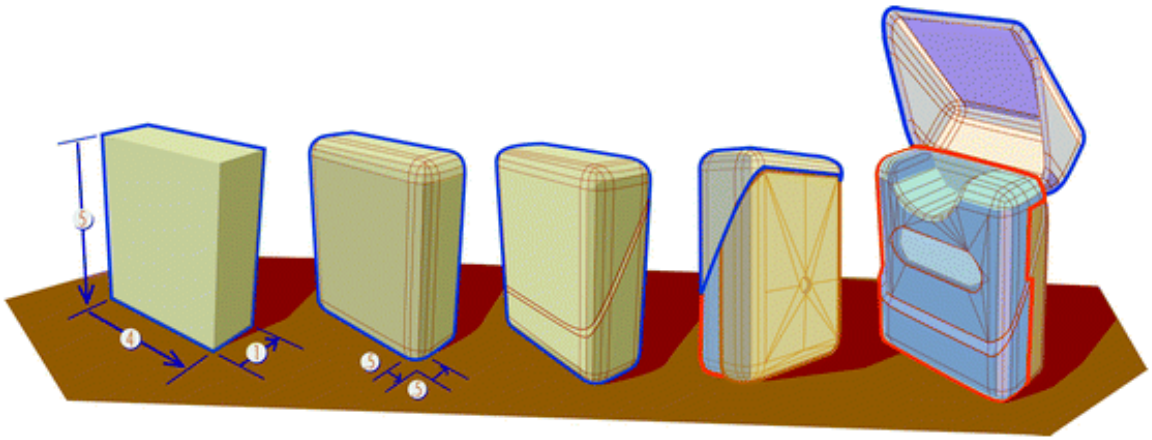
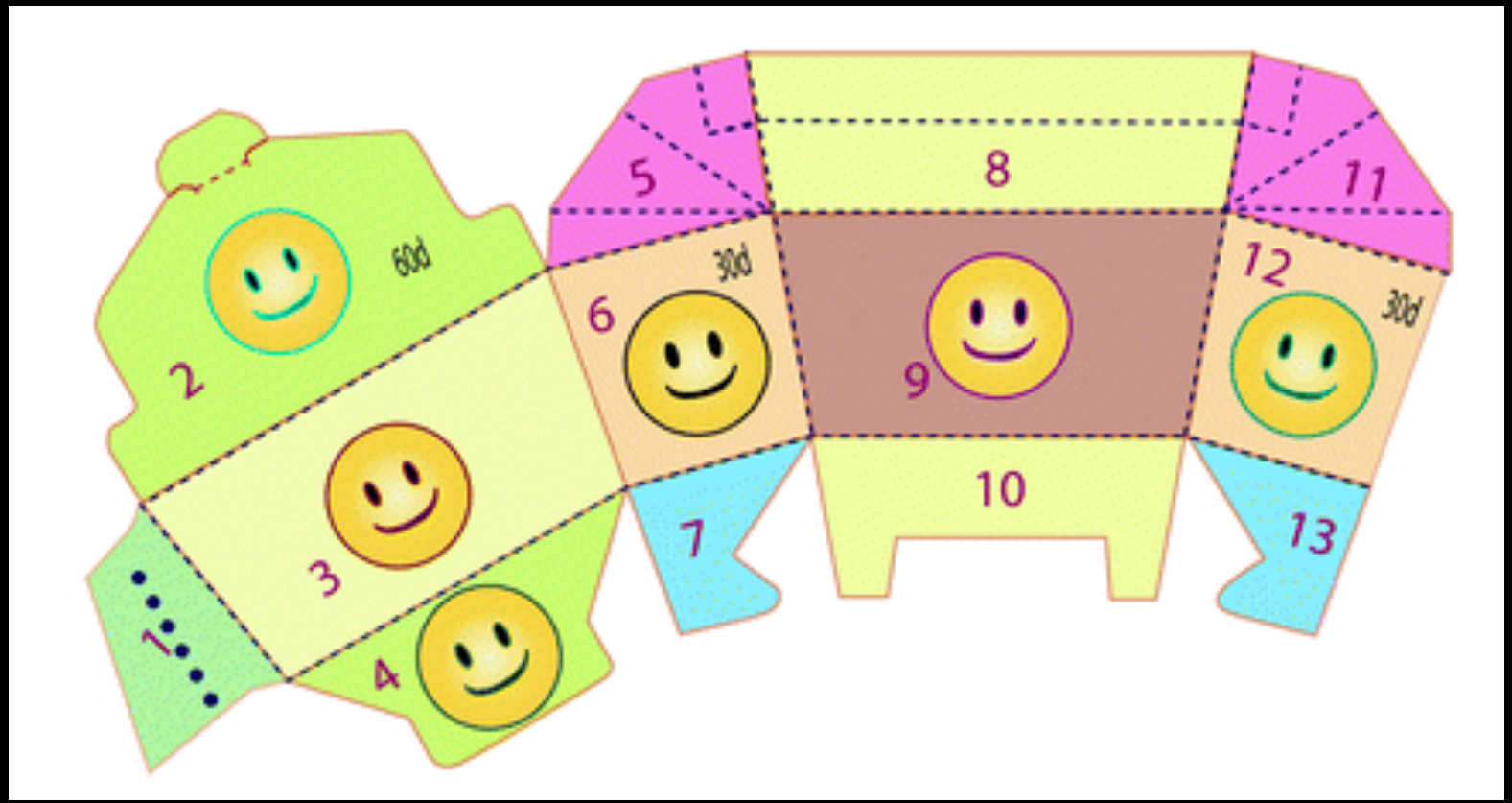


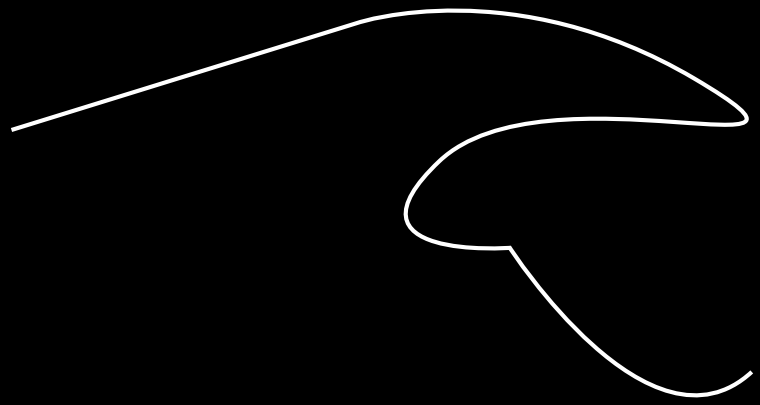
Fig. 6.1 A container of floss modeled using the box modeling technique

Direct input



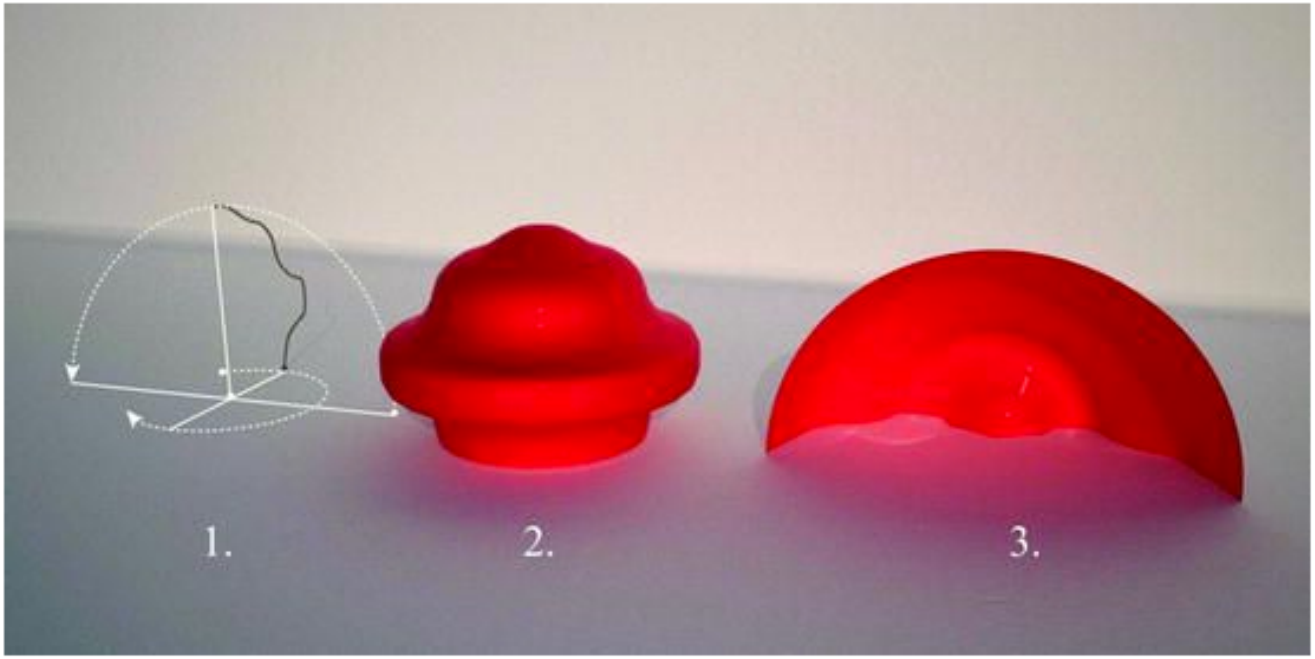
Spline controls

- Spline: special type of curve that allows adjustment by manipulating tangent and control points



Spline controls

- A curve defined and then used as the basis for the shape of some polygonal geometry



Spline controls

- Problem:
  - to build a complex assembly of curved parts out of splines can be time-consuming
  - But.. powerful for modeling of curved shape

- NURBS
  - Non-Uniform Rational B-spline curved Surface
  - we will discuss it !

Conversion and Import

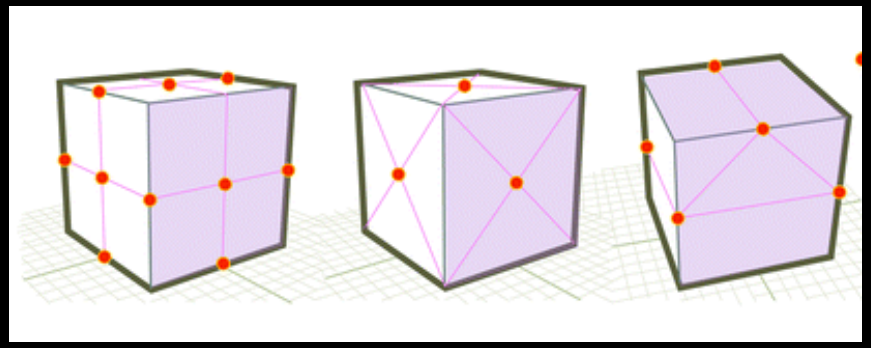
- Conversion
  - sub-division surface --> polygon
  - NURBS --> polygon
- Import
  - import the geometry which was made in another applications

Modification

- modify an existing object by...
  - adding to it
  - moving its elements
  - deleting parts of it

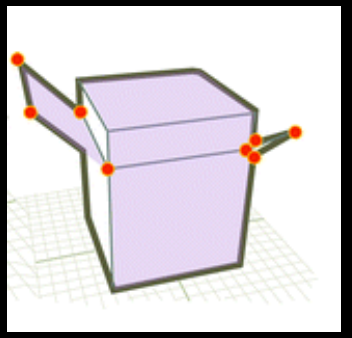
Adding Vertices

- Subdivision
  - draw new edges on every selected face or every face.
  - diamond pattern, squared pattern and etc.



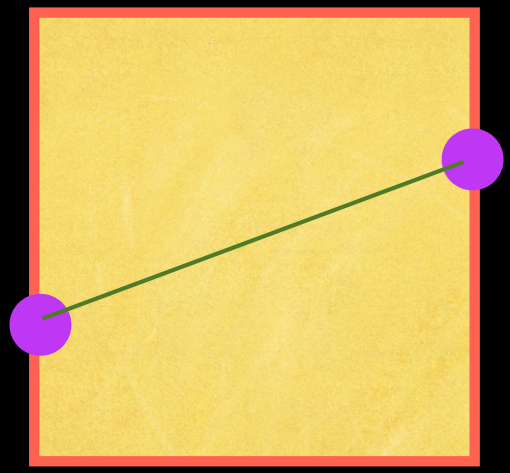
Adding Vertices

- Extrusion
  - detaches the selected face or faces from its neighboring faces, then connects the two groups with new faces
    - edge extrusion
    - vertex extrusion
    - Face extrude around edge



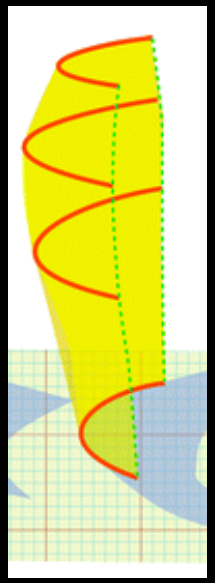
Adding Vertices

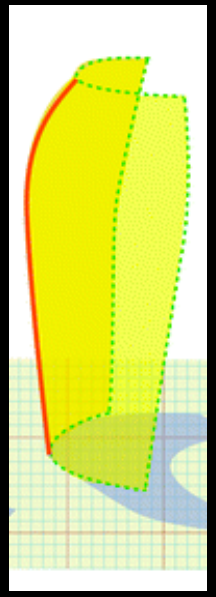
- Face cutting
  - crete new edges and vertices by cutting across faces
  - several tools
    - controlled cuts
    - Place cuts
    - subdivision



Spline Creation

- Loft and revolve





Deleting Vertices

- Delete points
  - Delete
  - Collapse
  - Cut
  - bevel

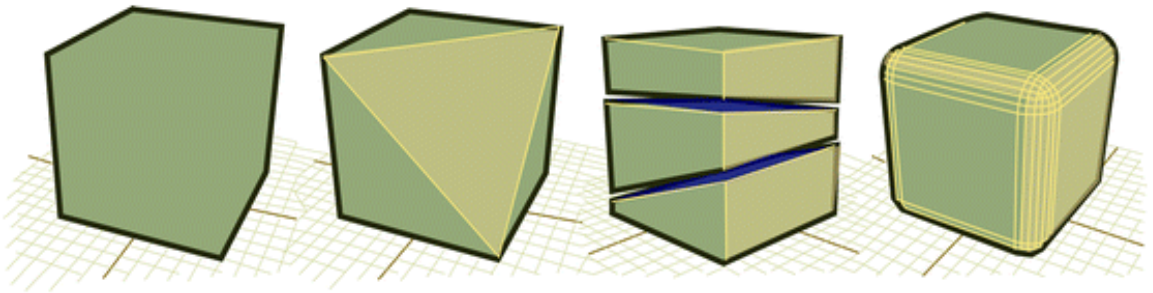


Fig. 6.6 Four tools that delete points: (*1*) delete, (*2*) collapse, (*3*) cut, (*4*) bevel

Booleans

- Evaluate two or more objects for intersection, and then a new polyset is created

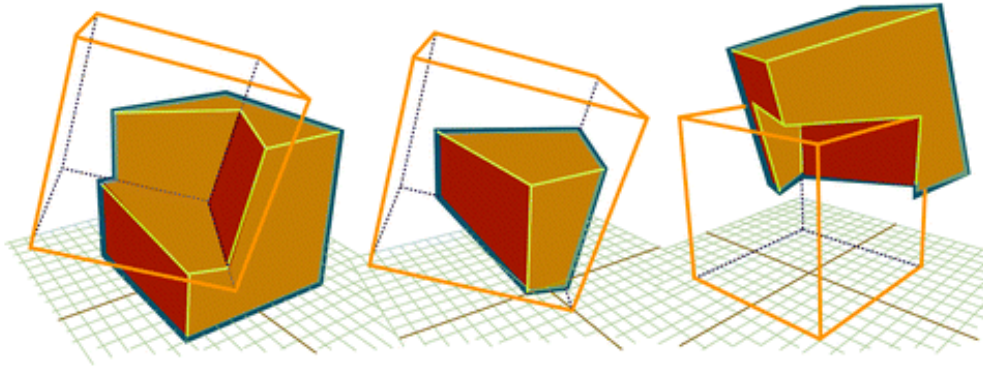


Fig. 6.7 Three types of Boolean operation: (*1*) subtract first selected, (*2*) intersect, (*3*) subtract second selected

Part Modeling

- Create model with many separate parts

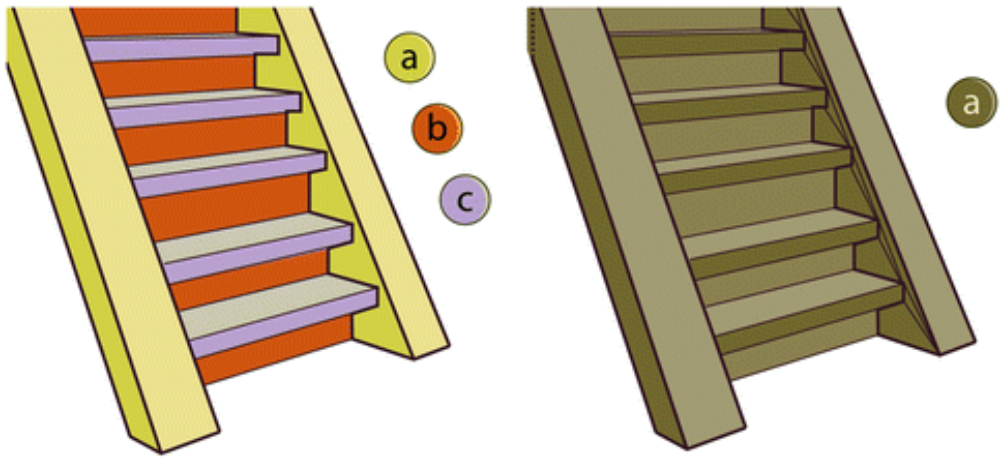


Fig. 6.8 On *right*, a box-modeled section of stairs is all one piece. On *left*, different parts of the stairs are modeled as separate objects. When built as one piece, each part is incised into any part it contacts. This increases the poly count without providing structural information

NURBS

- NURBS geometry is used to create mathematically accurate curved surface
  - such as in automobiles and airplanes
  - for cinematic sequence : high resolution geomety

NURBS:Introduction

- Advantage of NURBS surface in film
  - render well and more easily controlled for animation than dense polygonal mesh
- In video game
  - rarely used,
  - used as intermediate object of polygonal model

NURBS define

- Non-uniform rational Bezier spline

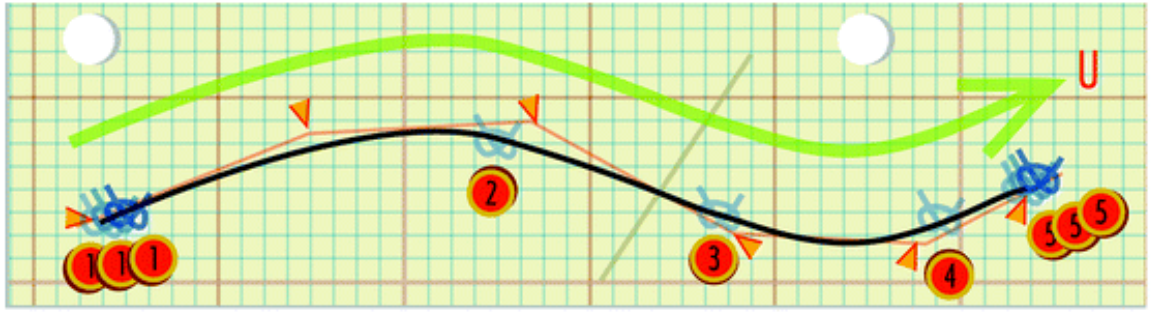
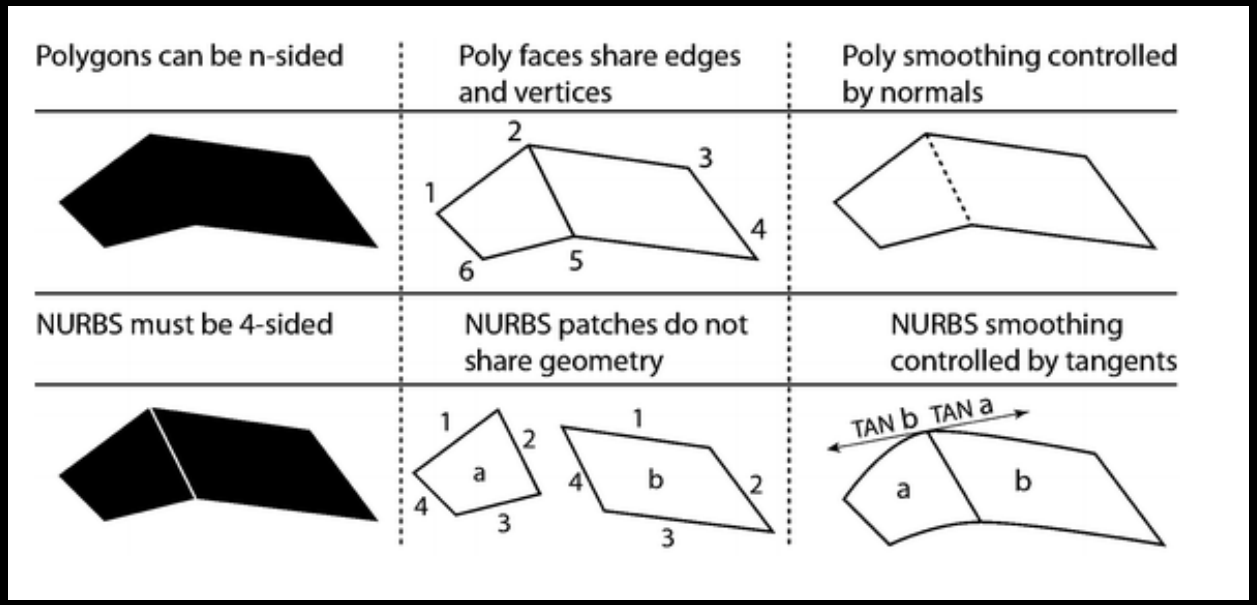


Fig. 14.2 Knot numbering is based on position within a curve, not ordinal value. If three knots are in the same location, they have the same value

Limitations

- NURBS surface are always four-sided



Genus

- The genus of a surface describes its topological complexity based on the number of enclosed loop in the object

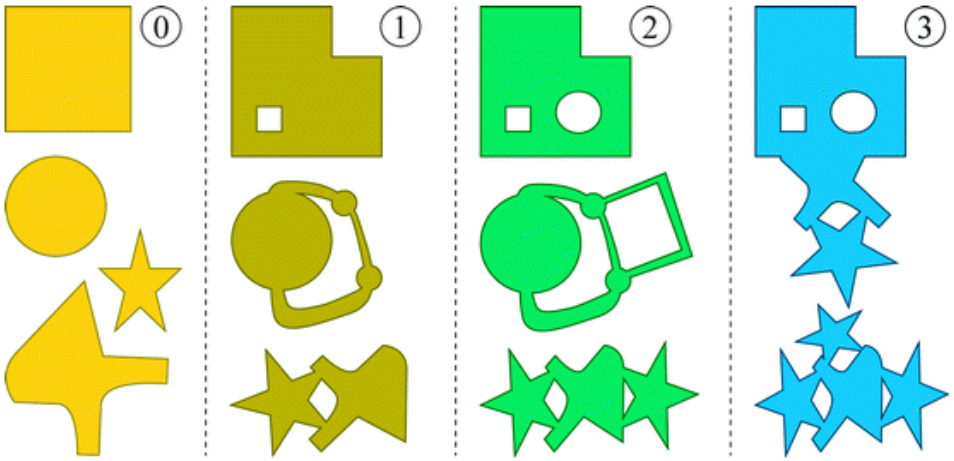
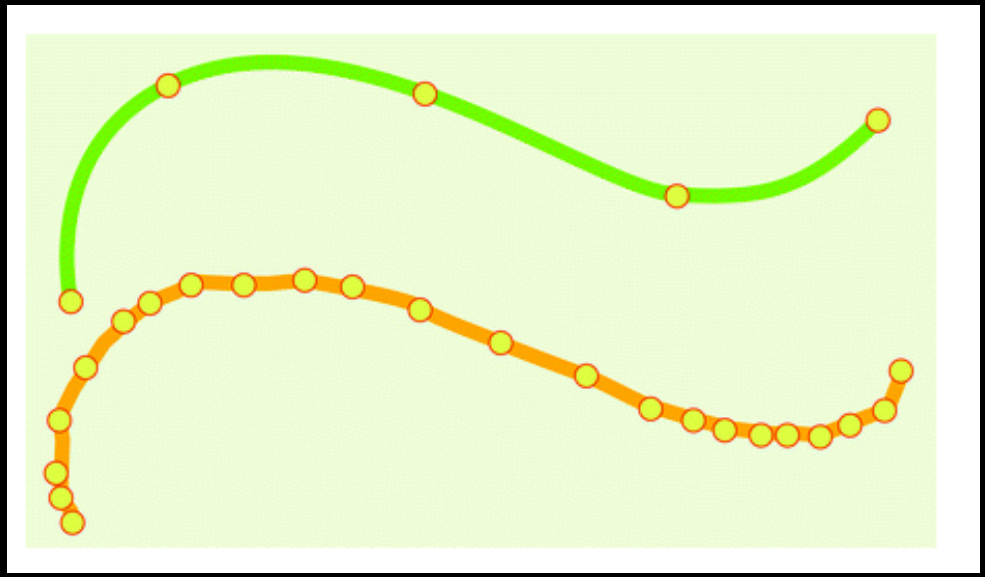


Fig. 14.4 Each of these columns of shapes are genus *0*, *1*, *2*, and *3*, respectively. The genus of any object is the number of completely enclosed holes

high genus models are more complicated to make with NURBS patches.

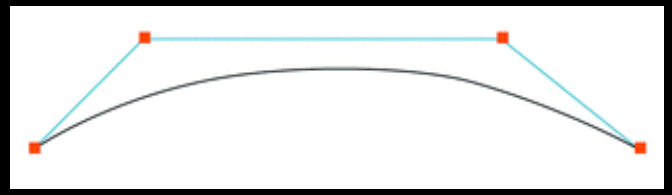
Surfaces and Curves

- Curves
  - always smoother!



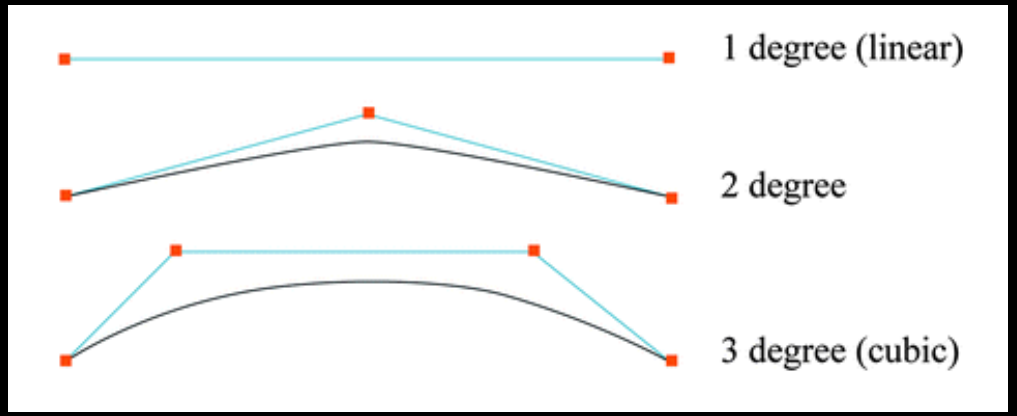
Curve Components

- Control Vertices (CVs)
  - used to influence the shape of a curve
  - not embedded in a curve



Curve Components

- Degree
  - One-degree curve : perfectly straight line
  - Two-degree curve: third point is inserted between it's start and end points
  - ...



Curve Components

- Tangency
  - is a line that touches but does not intersect a curve or surface

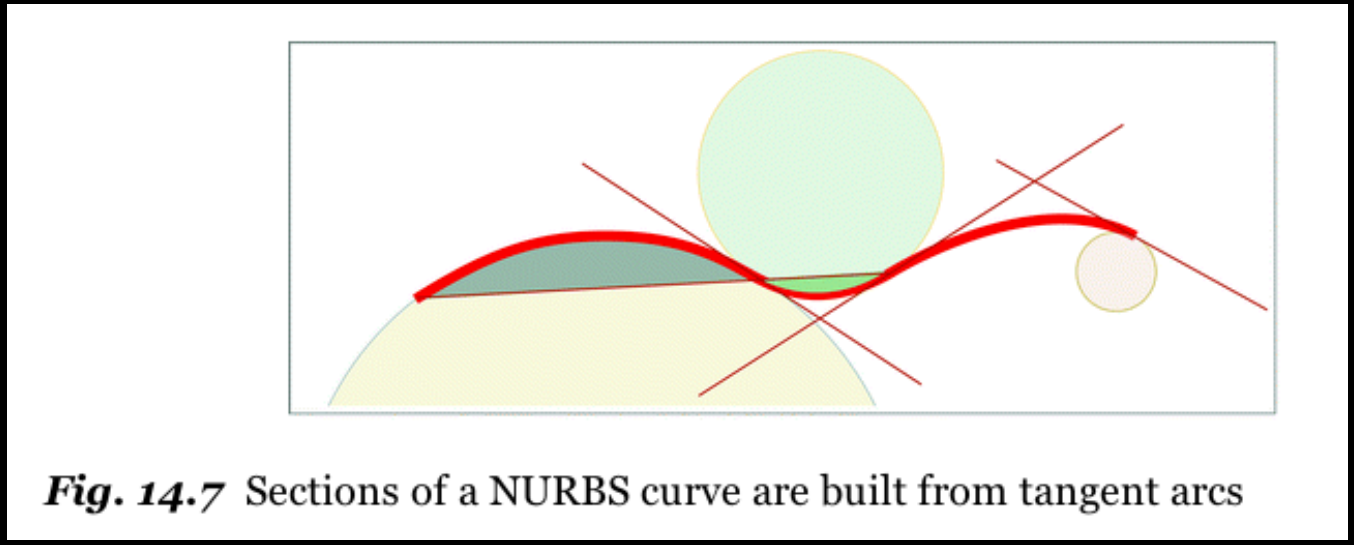


Fig. 14.7 Sections of a NURBS curve are built from tangent arcs

- curvature?

Curve Components

- Tangency in a NURBS
  - curve's out tangent is equal to another curve's in tangent at a common point

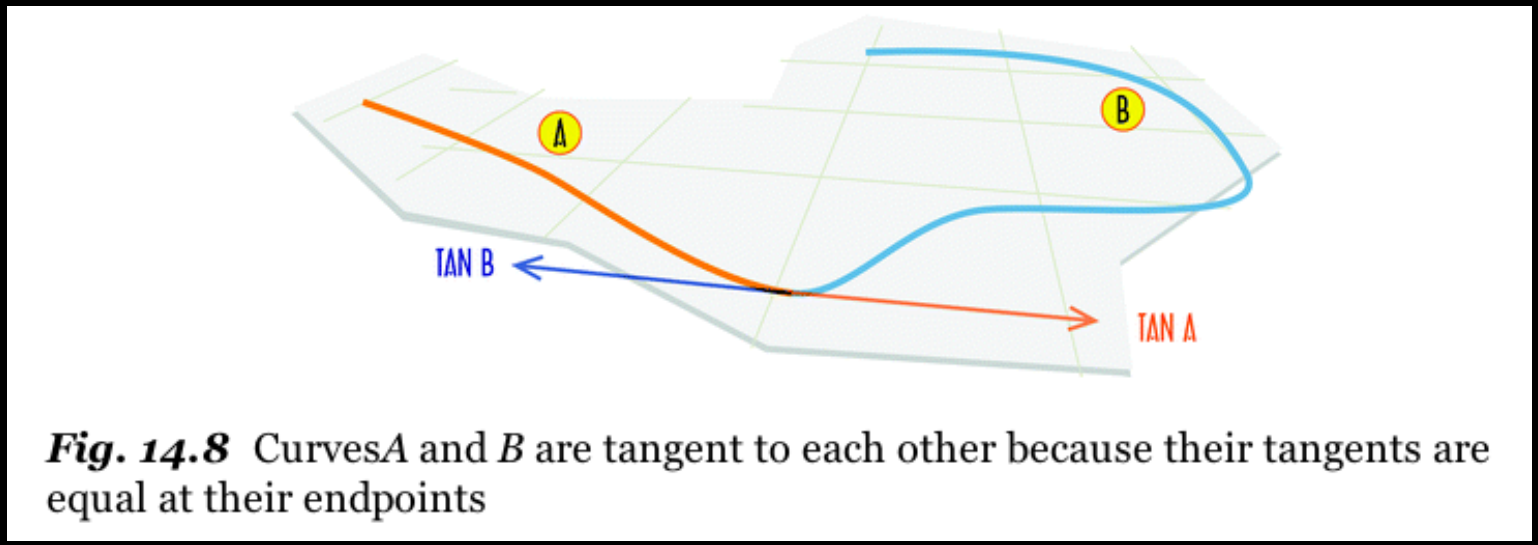
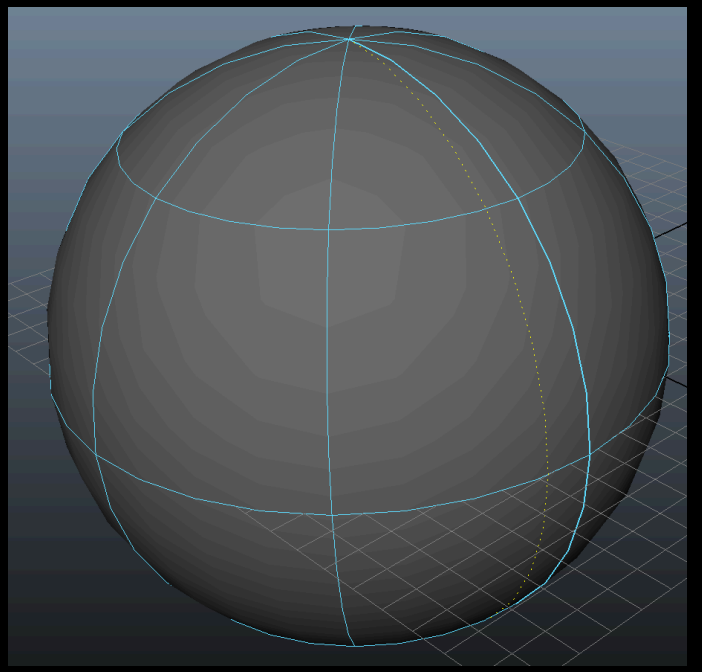


Fig. 14.8 Curves*A* and *B* are tangent to each other because their tangents are equal at their endpoints

Continuity?

Curve Components

- Isoparms
  - is a coordinate in the local space of the curve



Curve Components

- Curve on Surface
  - curve that has been projected onto a surface

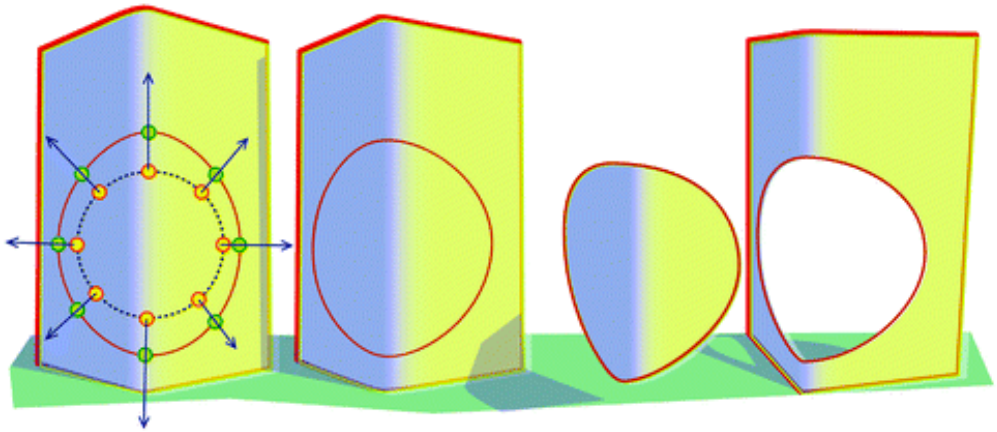
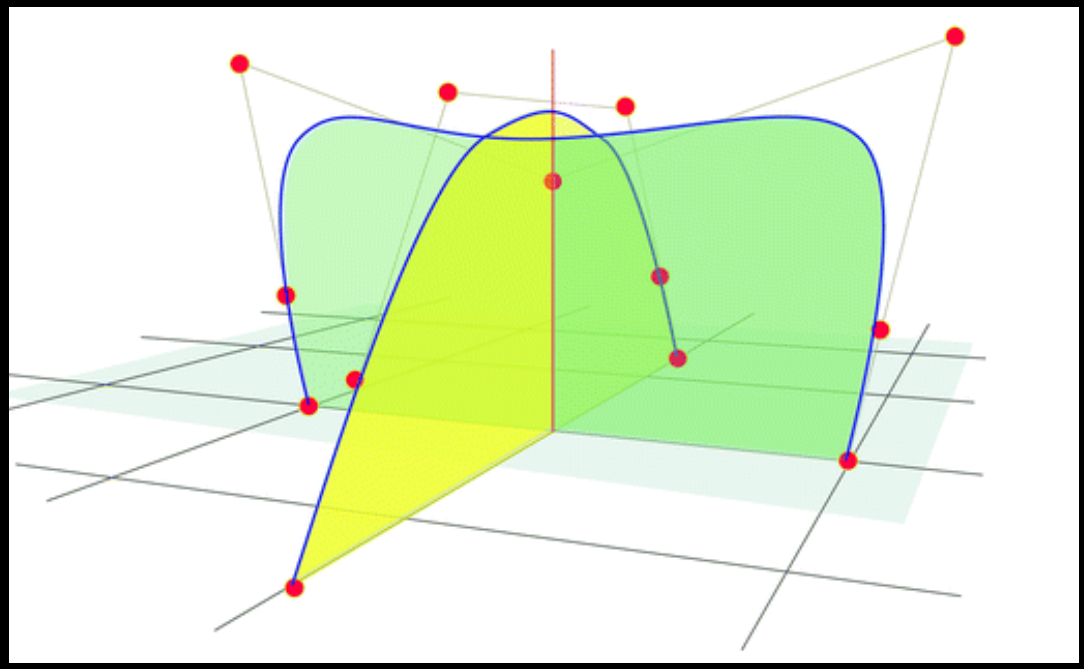


Fig. 14.9 A curve is first projected to create a curve on surface. Then, the curve on surface is used to define a section of the surface to be trimmed away

Curve Components

- Curve Intersection
  - .....



Curve based modeling

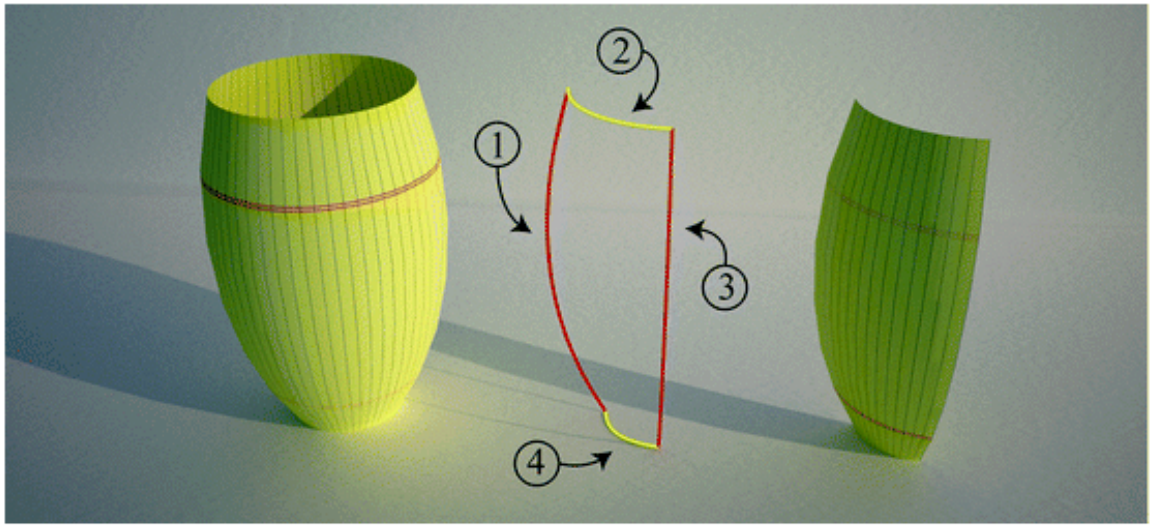


Fig. 14.17 The surface on *left* was made by revolving curve *1*. The surface on the *right* was built out of curves*1–4*. Other surfaces could be made from any one or combination of the four curves shown here, depending on the tool used

Surface

- NURBS surface is a parameter-baseed object
  - it may be edited by modifying parameters

    - Edit point position
    - Control vertex position
    - Control vertex weight
    - Number of Knots
    - Tangent length, direction
    - continuity... etc

NURBS Normals

- NURBS objects have more normals than polygonal object --> smoother render. why?

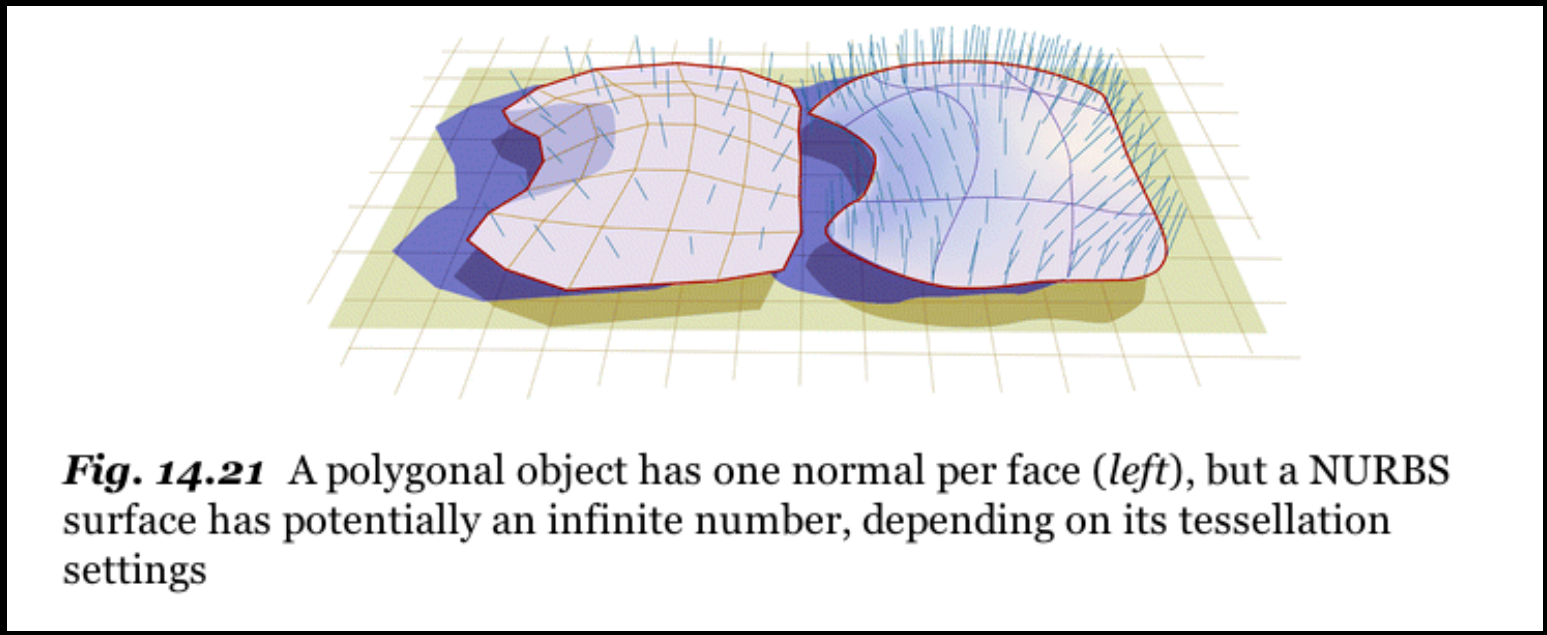


Fig. 14.21 A polygonal object has one normal per face (*left*), but a NURBS surface has potentially an infinite number, depending on its tessellation settings

NURBS Modeling

- with primitives
  - work best for shapes that have no significant insets of extrusion!

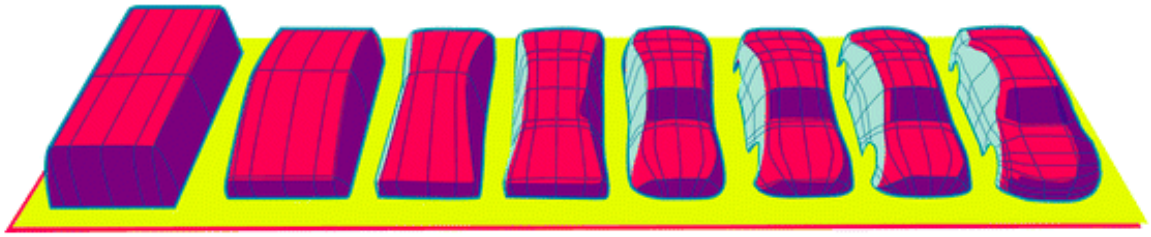


Fig. 14.20 A quick object layout can be made with a single NURBS patch, but it is not suitable if a high level of detail is needed

NURBS Modeling

- from curves

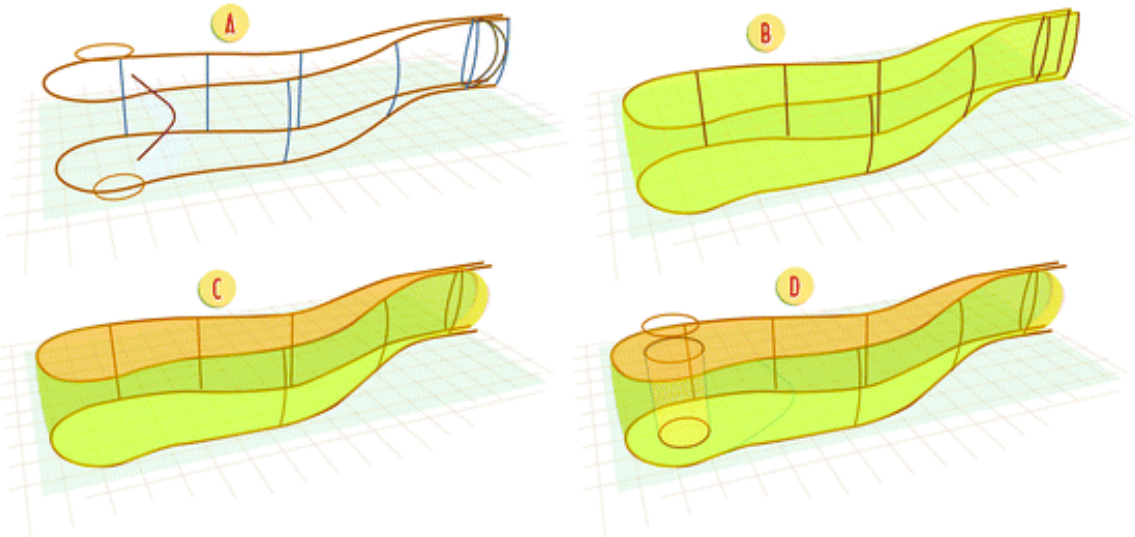


Fig. 14.22 To build this bicycle quick release lever, the surfaces have to be built in a specific order, as shown

NURBS Modeling

- from curves: Curve direction!