Univerzitetni in visokošolski študijski programi

Osnove 3D modeliranja

Izbirni predmet

Helena Gabrijelčič Tomc

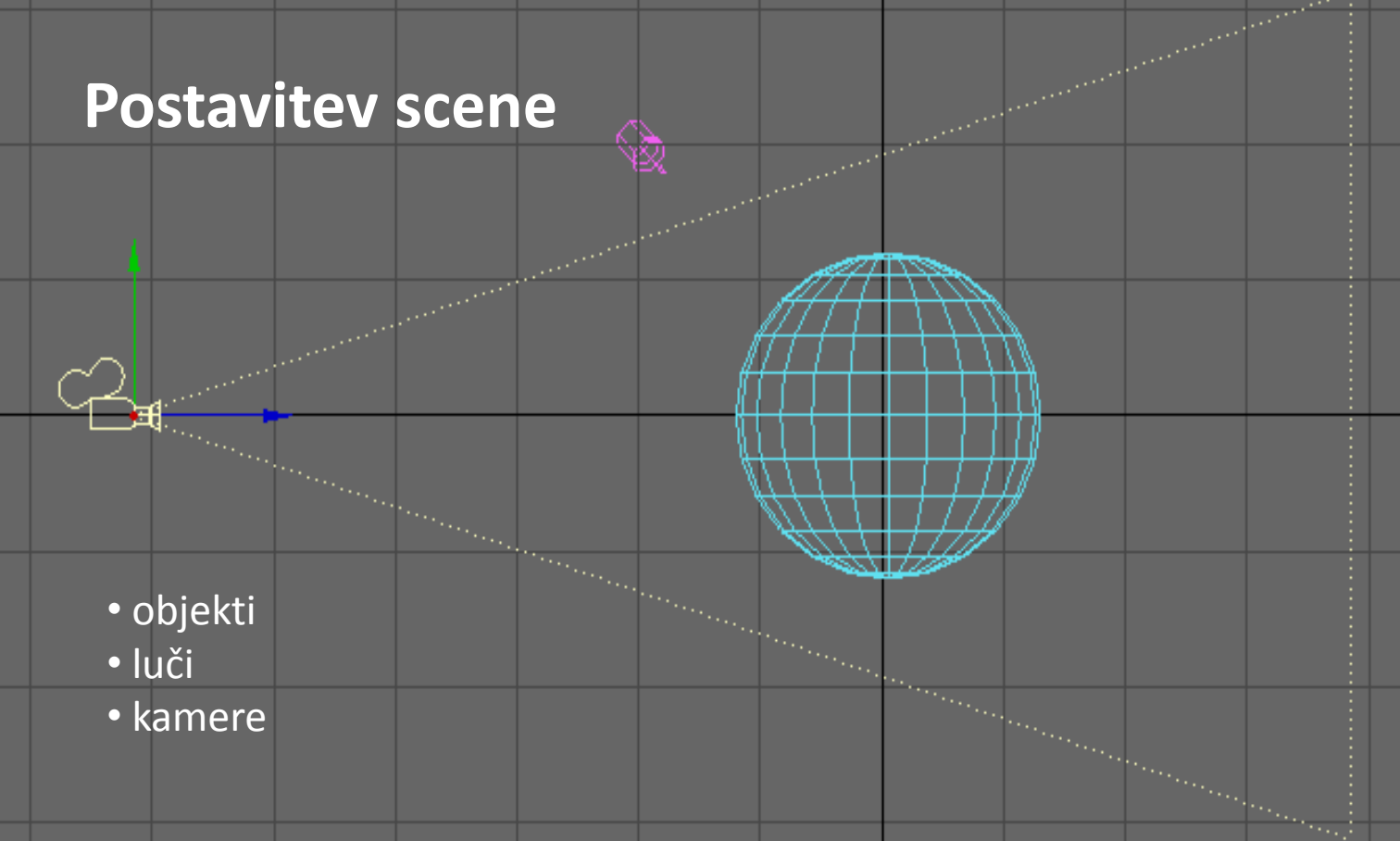
GRAFIKE
UNI: Grafične in interaktivne komunikacije
VS: Grafična in medijska tehnika

TEKSTILSTVA
UNI: Načrtovanje tekstilij in oblačil
VS: Proizvodnja tekstilij in oblačil

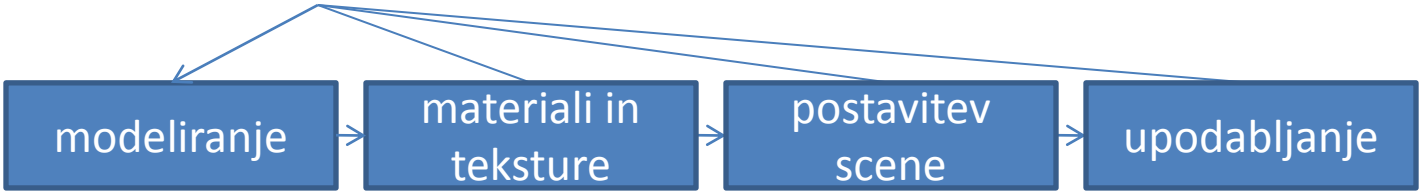
Osnove 3D modeliranja

modeliranje in modelirna orodja

Postavitev scene

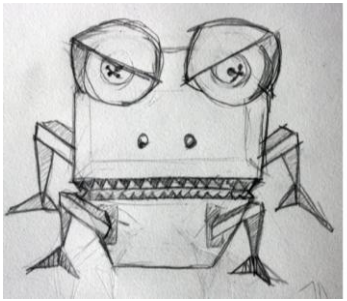


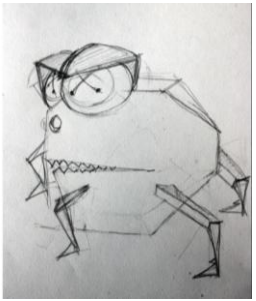
- objekti
- luči
- kamere

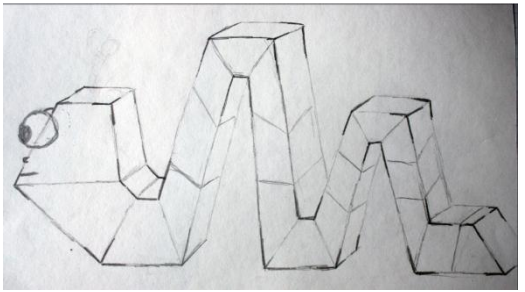


Kaj je 3D modeliranje?

Načrtovanje modeliranja

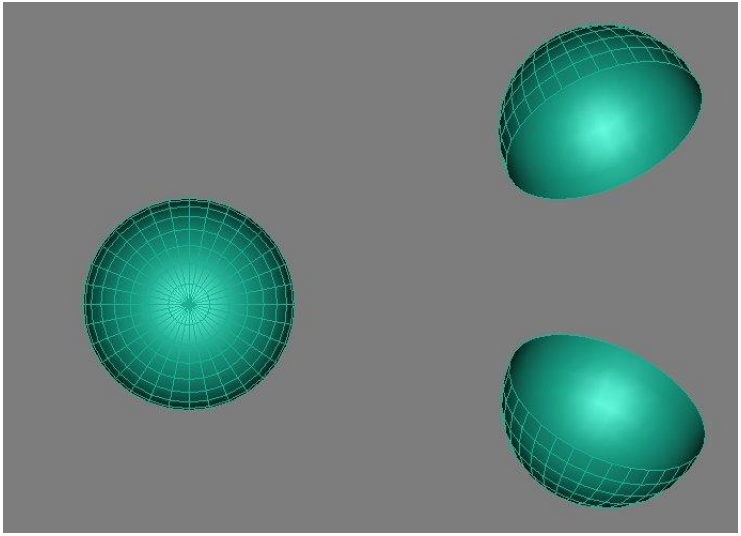


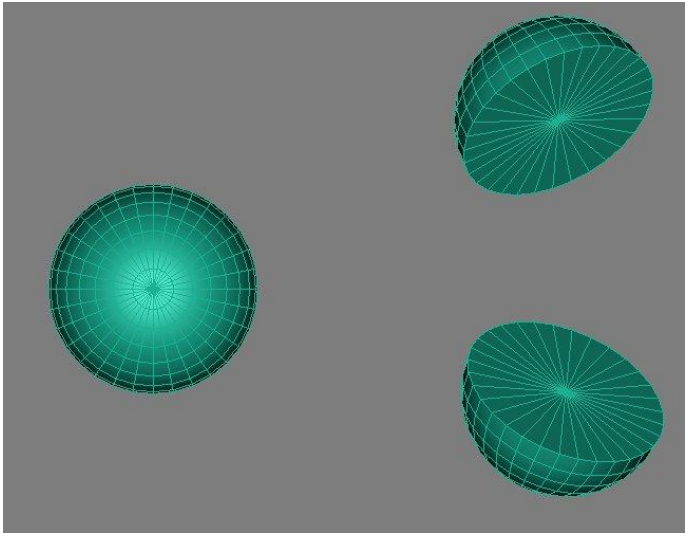




- postopek in zaporedje
- modelirna tehnika
- delo s plastmi
- dočanje materialov (senčenje, luči)
- gibanje objekta: gibljivi deli

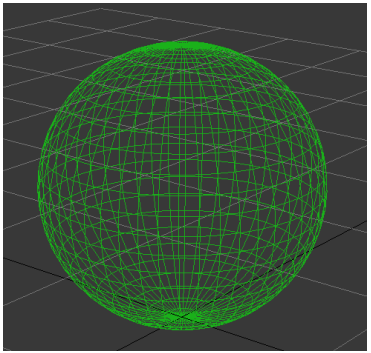
- ploskovno (surface modeling)
- prostorsko (solid modeling)
- CAD vs. CAM

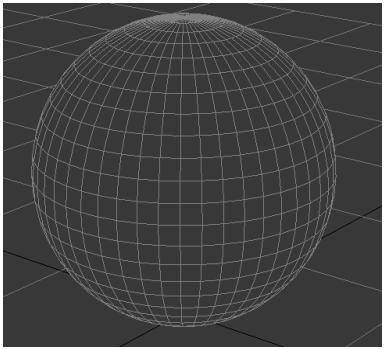




Načini prikaza

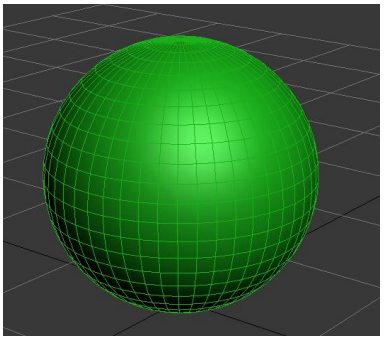
žični model

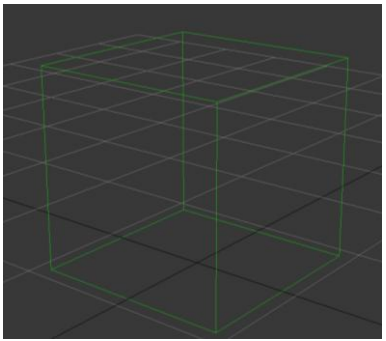




žični model
brez nevidnih robov

polni model
brez tekstur





objemajoči kvader

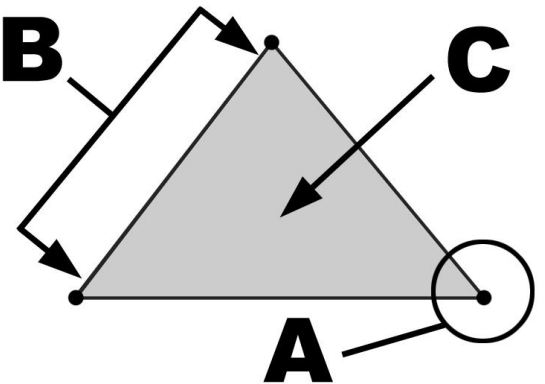
Tehnike modeliranja I

- primitivi
- oblike in krivulje (shapes, splines)
- poligoni (polygons, polys)
- mreže (meshes)
- krivulje in površine krivulj (splines, patches)
- NURBS (Non-Uniform Rational B-Spline)

Modeliranje s primitivi

http://www.youtube.com/watch?v=q69kQvtSTJE
http://vimeo.com/2168099
http://www.youtube.com/watch?v=bZ1JmuyPIXQ

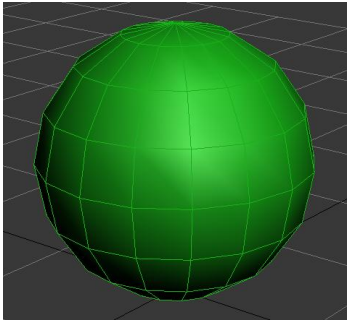
Poligoni (Polygons)

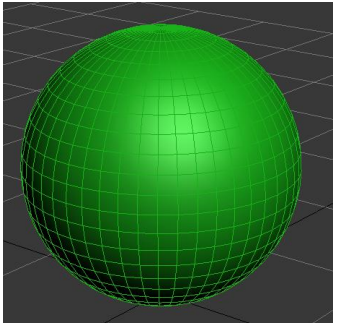


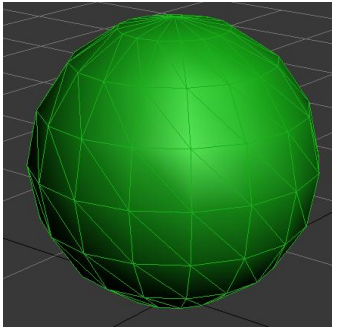
- verteks
- rob
- lice poligona (površina, ploskev, “face”)
- robovi se stikajo z najmanj dvema drugima poligonoma
- število robov

Poligoni so definirani z:

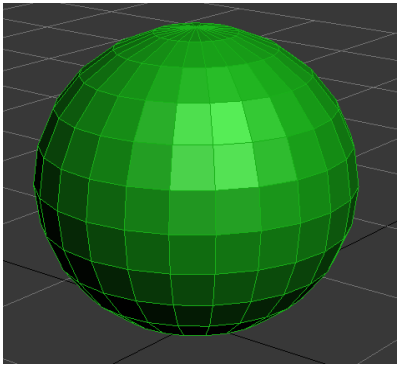
- velikostjo
- številom stranic
- postavitvijo stranic
- postavitvijo poligona v prostoru
- povezavo z ostalimi poligoni v objektu

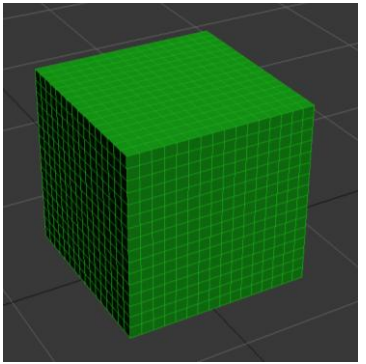


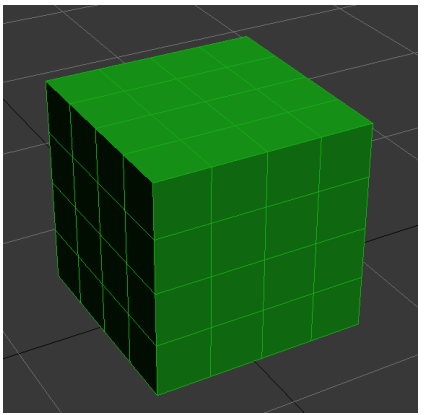


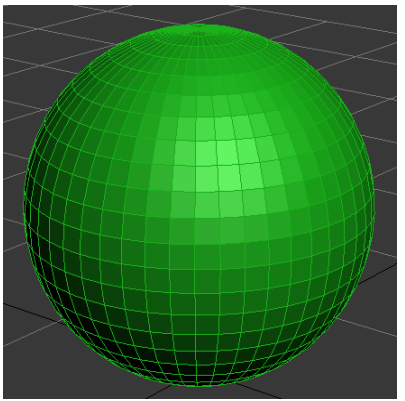


- poligonska mreža
- ločljivost modela
- uporaba
- optimizacija



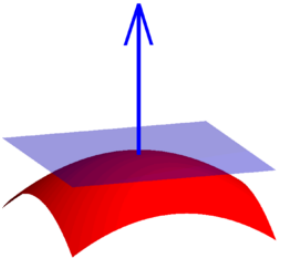


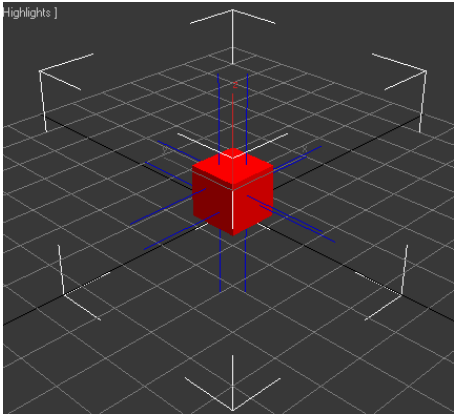


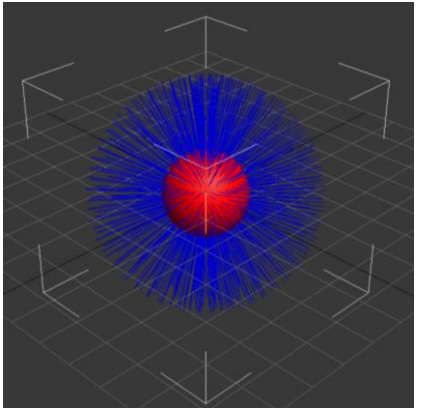


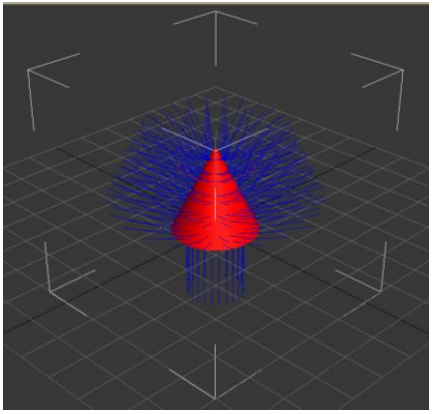
Normala (normalni vektor) poligona

Kaj je normala?
Smer, senčenje, glajenje, osvetjevanje



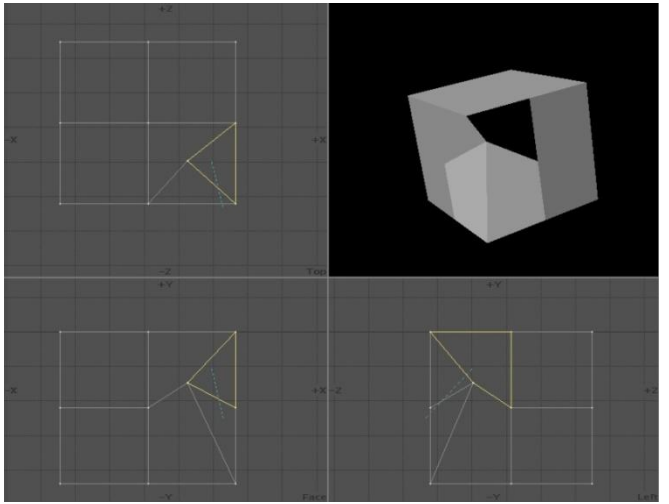




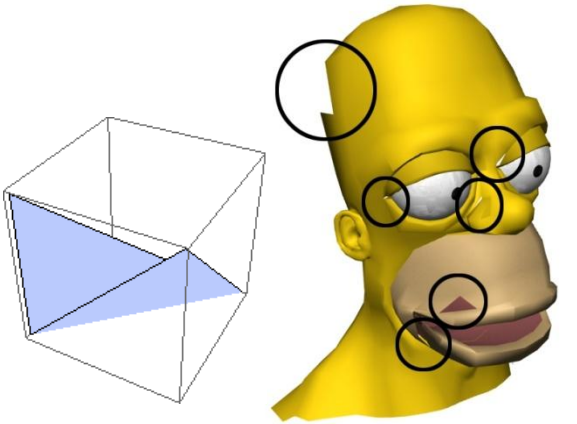


http://hr.wikipedia.org/wiki/Normala

Usmerjenost in planarnost poligonov



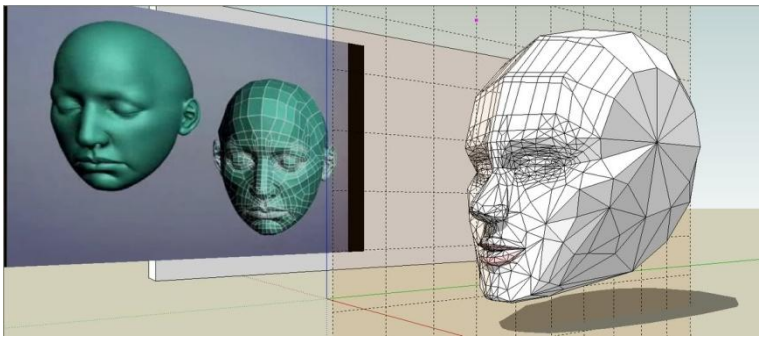
smer, normala poligona



nekoplanaren poligon (kvadriseti)

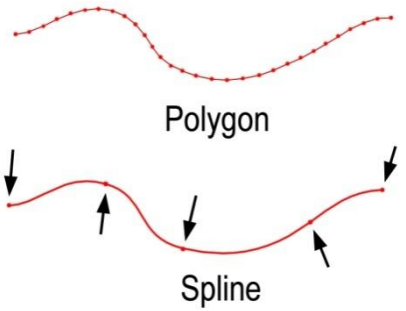
Prednosti uporabe poligonov

- modeliranje z nizko ločljivostjo
- možnost spremembe mreže poligonov
- povečevanje detajlov površine
- intuitivnost



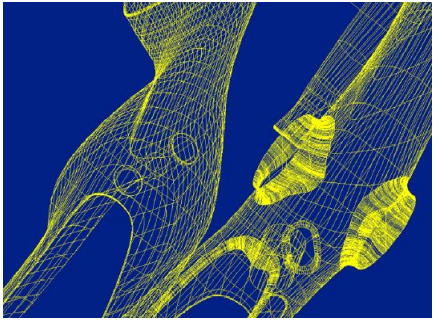
http://forums.sketchucation.com/viewtopic.php?f=18&t=33894&p=297860#p297860

Slabosti uporabe poligonov

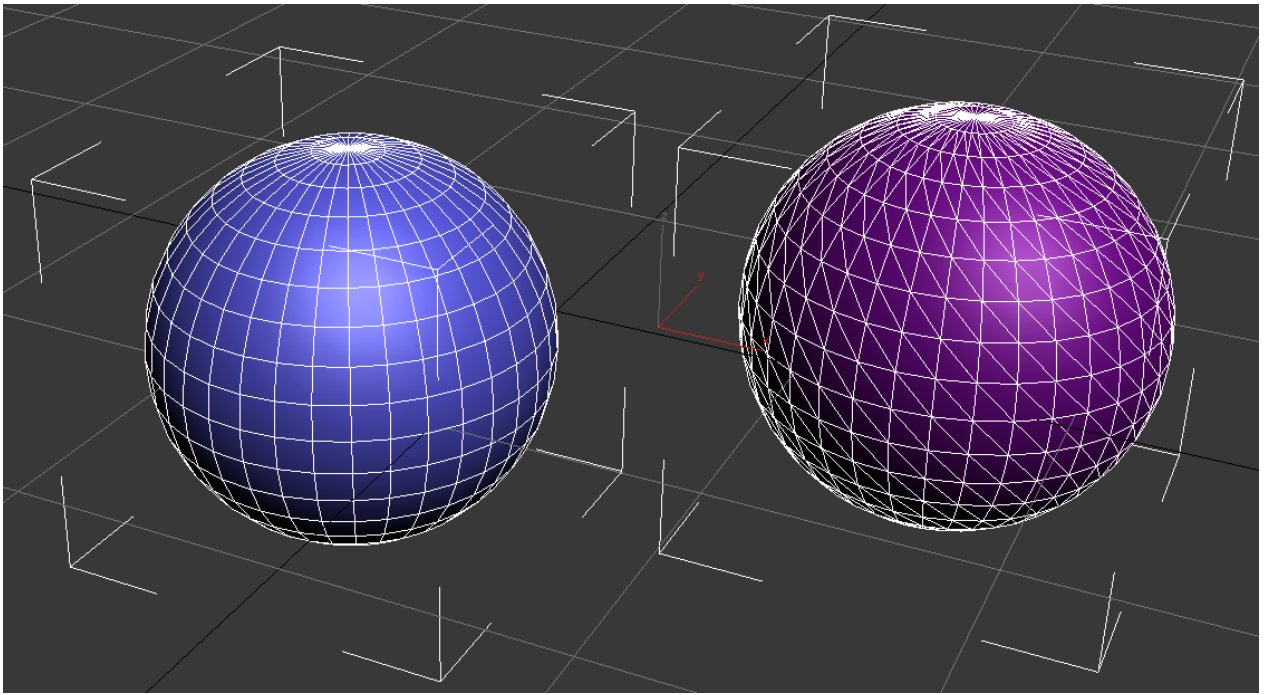


poligon vs. krivulje

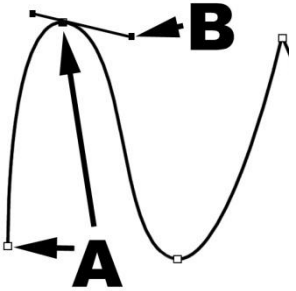
- problem neskončnih krivulj
- zahtevna pretvorba v krivulje (NURBS)
- vidne deformacije pri operacijah

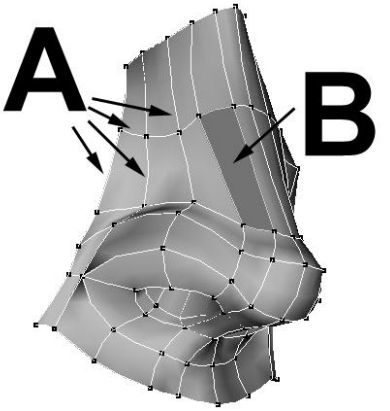


Mreže (Meshes)



Krivulje in mreža krivulj (splines, patches)

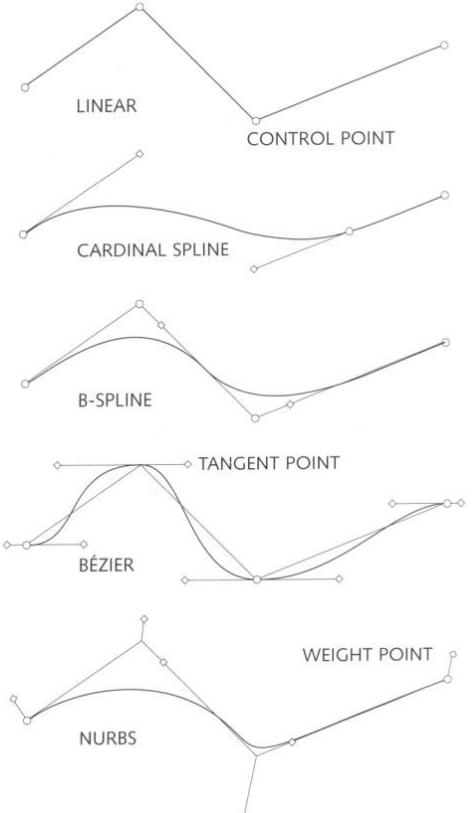


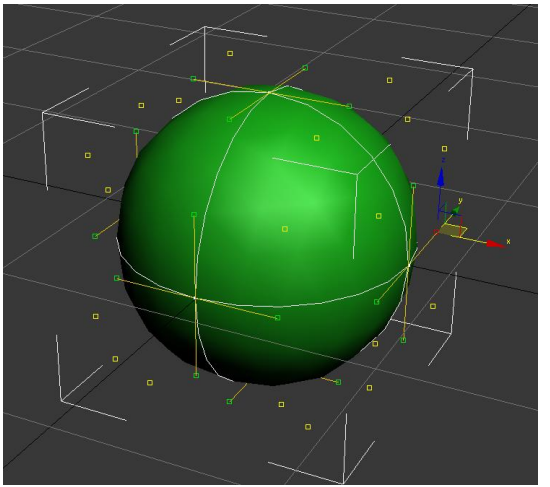


spline-patching

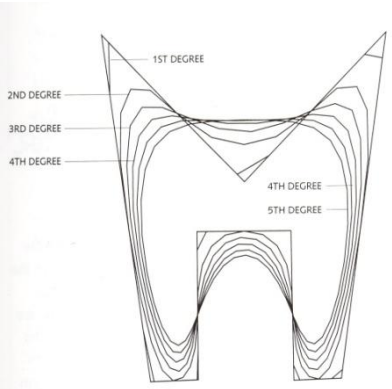
upodabljanje: E. Catmull [CATM74]

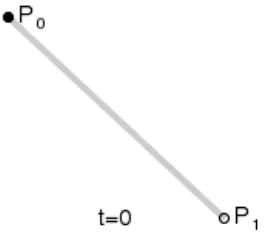
- kontrolna točka
- tangentna točka, kontrolna ročica
- krivulja
- v numerični analizi je to posebna krivulja, ki je določena deloma s polinomi

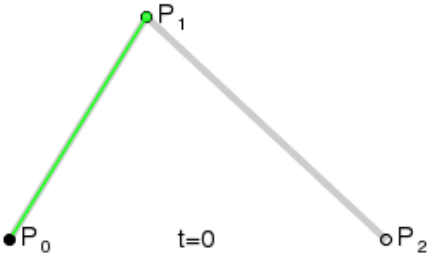

LINEAR
CONTROL POINT
CARDINAL SPLINE
B-SPLINE
TANGENT POINT
BÉZIER
WEIGHT POINT
NURBS

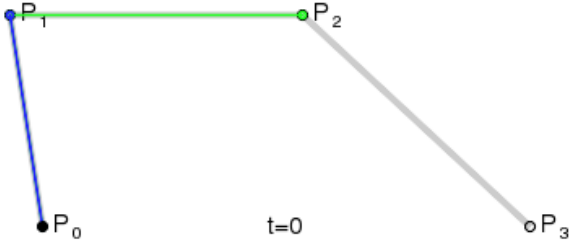


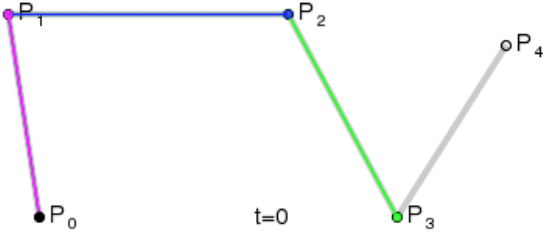
konstrukcija Bézierove krivulje 1., 2., 3. in 4. reda





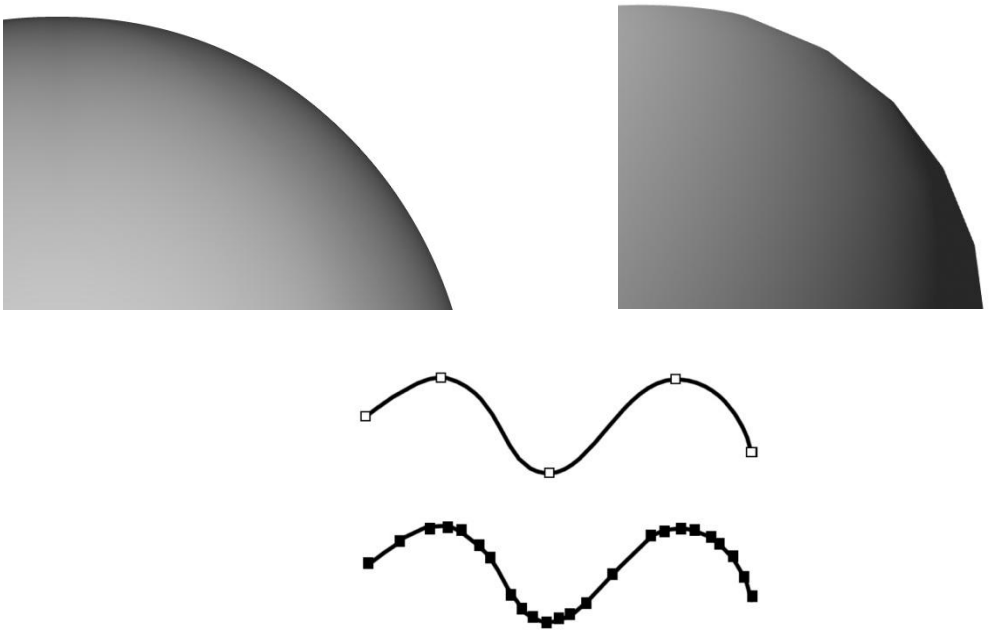






http://en.wikipedia.org/wiki/B%C3%A9zier_curve

Pretvorba krivulje - poligoni

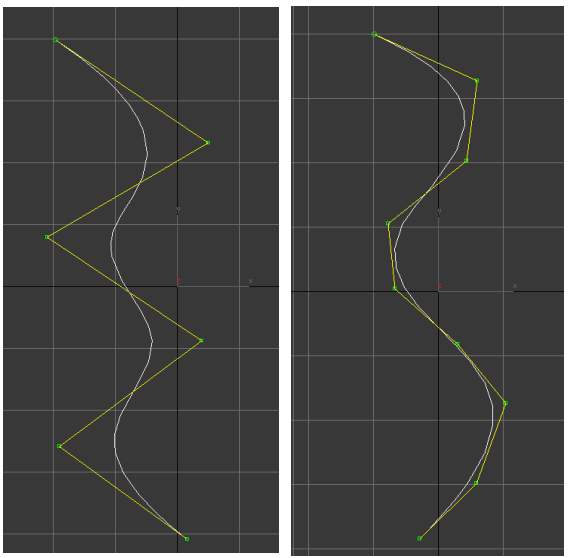


NURBS (Non Uniform Rational Basis (B-) Spline)

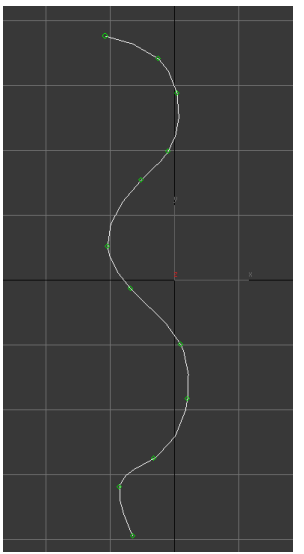
$N_{i,n}(u)$

I – št. kontrolnih točk,
n – stopnja B- funkcije

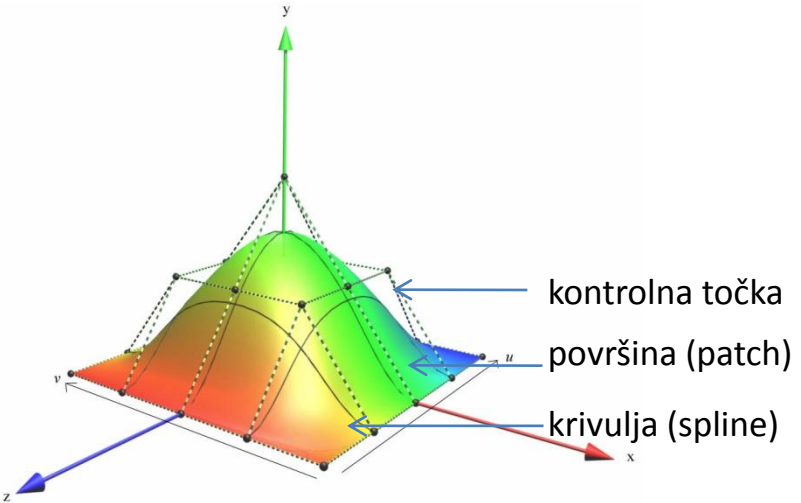
kontrolne točke (control points)



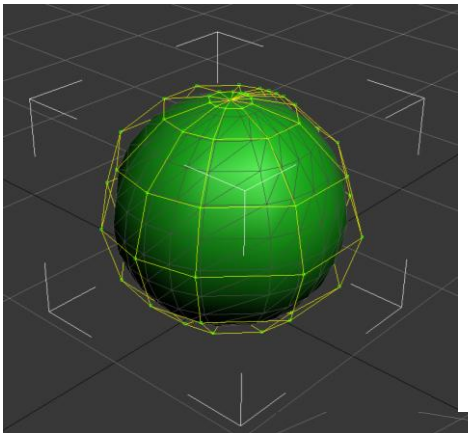
urejevalne točke (edit points)

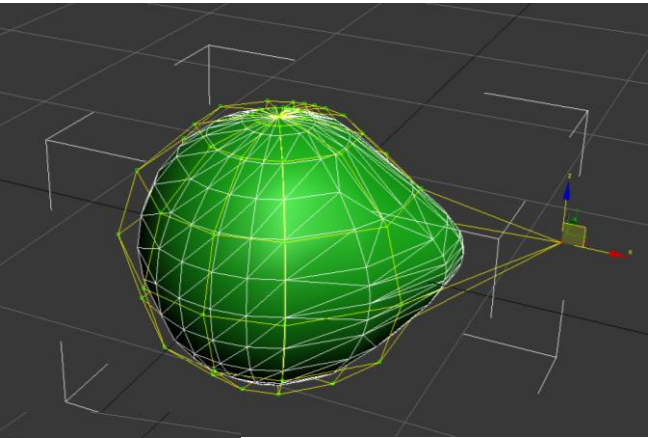


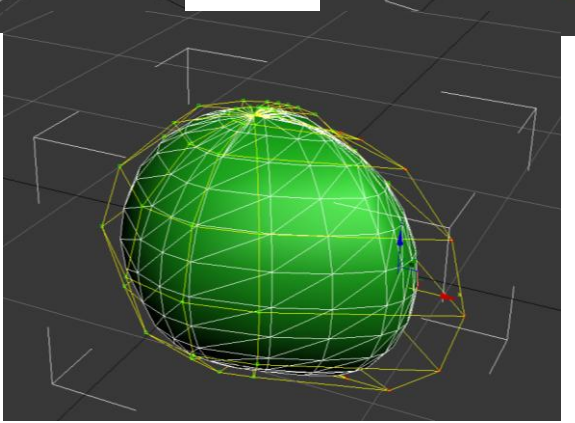
NURBS površine

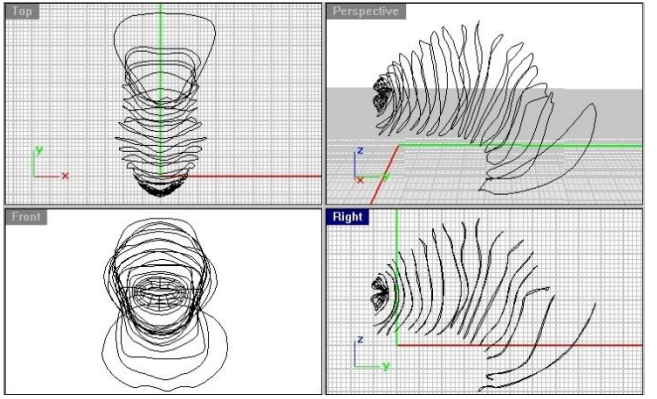


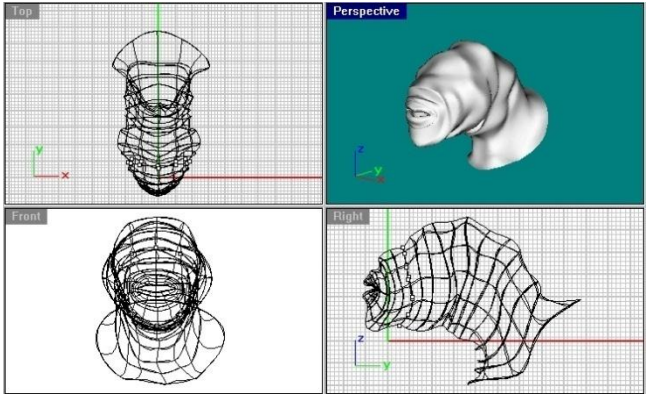
- UV parametrični prostor je UV koordinatni sistem
- izoparametri so križajoče se linije











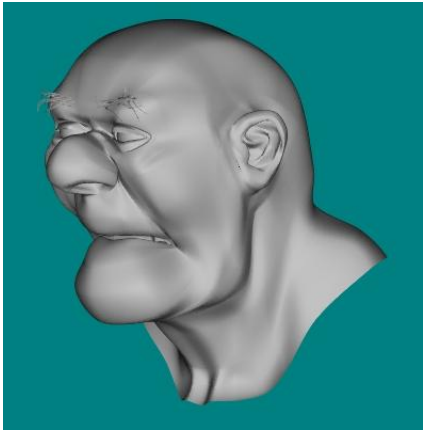
lofting

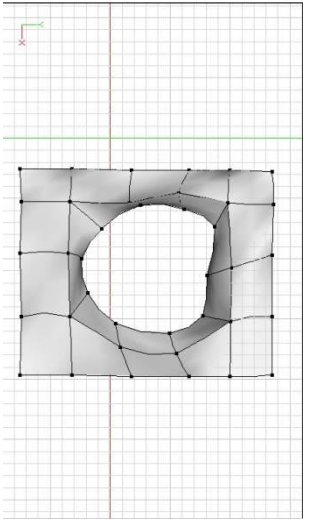
Prednosti uporabe krivulj

- neskončna natančnost krivulj
- matematična določljivost z ustreznimi algoritmi
- dodajanje kontrolnih točk brez spremembe geometrije
- hitra pretvorba v poligone
- fleksibilnost oblik
- manjše napake pri deformacijah krivulj

Slabosti uporabe krivulj

krivulja - poligon





- problem detajlov
- kompleksen delokrog
- intuitivnost uporabe kontrolnih točk
- luknje

Modelirna orodja in tehnike

- modeliranje po predlogi (Image as Reference)

- manipulacija poligonov
  1. osnovne transformacije (premik, nagib, rotacija)
  2. množenje poligonov - rez poligona *(Cut)*
  2. množenje poligonov - zaokrožanje robov *(Bevel, Chamfer)*
  3. množenje poligonov celega objekta *(Tesselation)*

- porazdeljene ploskve: subdivizija *(Subdivision Surface, Subdivision modeling)*

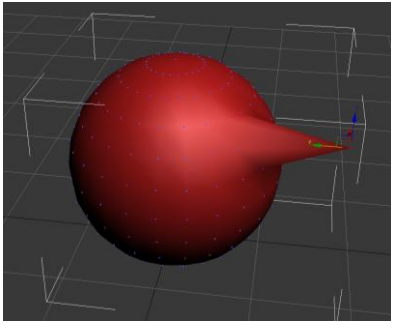
- modeliranje z množenjem
  1. rotacija okoli osi, vrtenje *(Rotate, Lathe, Lattice, Revolve)*
  2. izrinjanje *(Extrude, Sweep)*; frontalno izrinjanje *(Frontal Extrusion)*
  3. izrinjanje po poti, profil po krivulji *(Path Manipulation)*

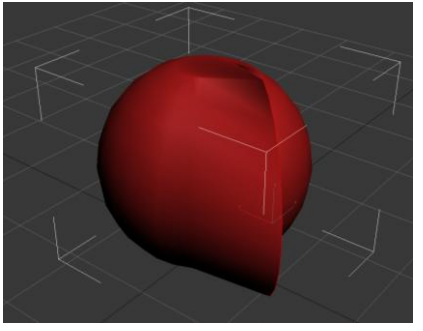
- kloniranje in urejanje (Cloning, Array)

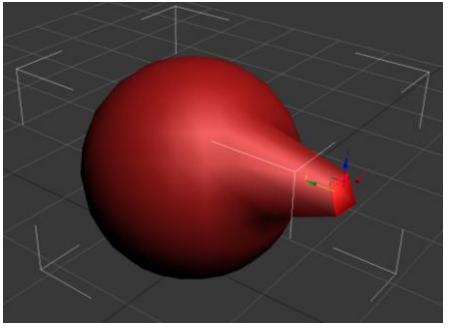
- Booleovi operatorji (Boolean operators)

Osnovne transformacije poligonov

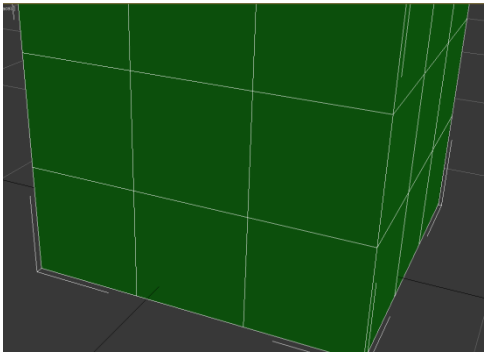
- premik, nagib, rotacija
- verteksi
- robovi
- površine poligonov

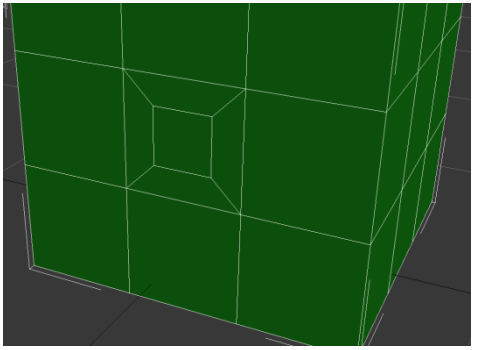


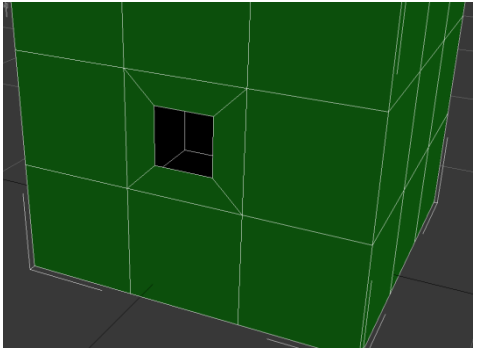


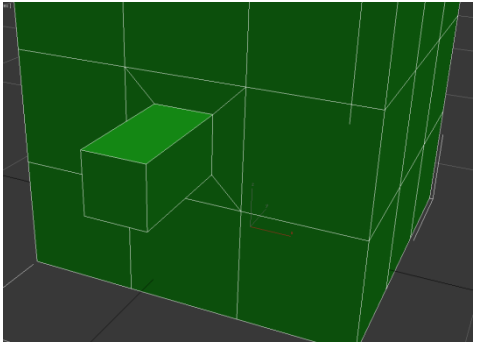


Množenje poligonov - rez poligona





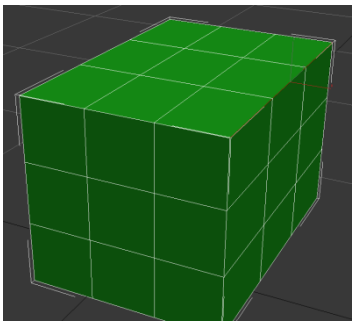


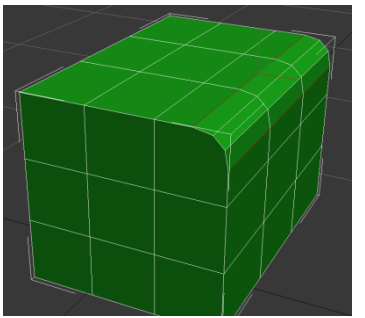


Množenje poligonov – zaokroževanje robov

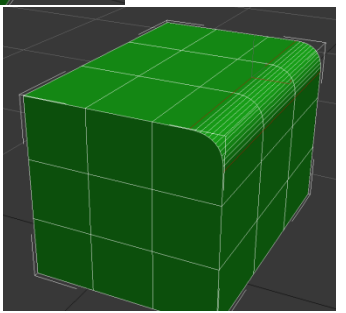
N=n+1

(N je število novo nastalih poligonov, n pa število robov prvotnega poligona)





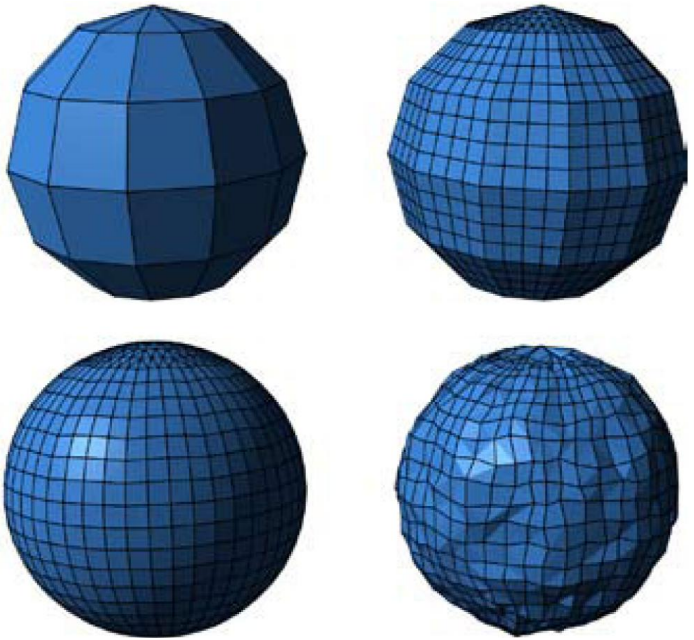
i=3



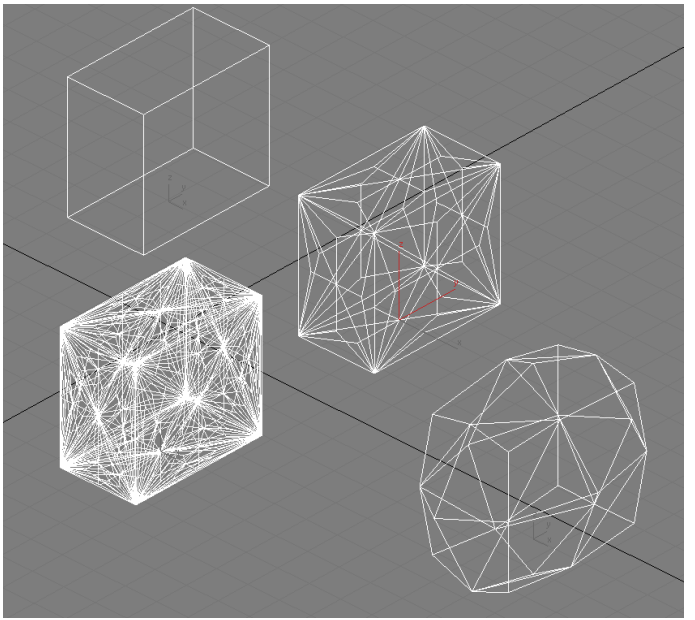
i=12

Množenje poligonov celega objekta

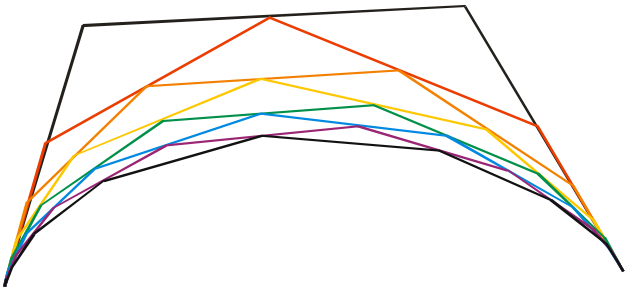
- linearno
- z interpolacijo
- z motnjo

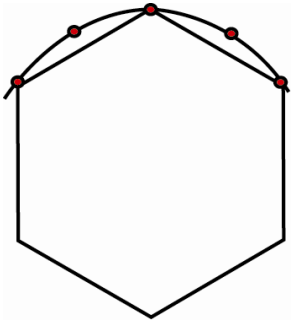


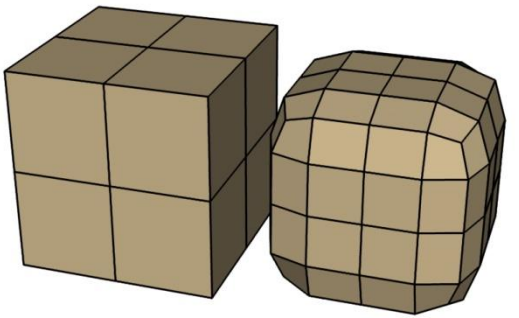
- število ponavljanj: iteracije
- z ali brez vpliva na geometrijo (robovi!)



Porazdeljene ploskve (Subdivizija)

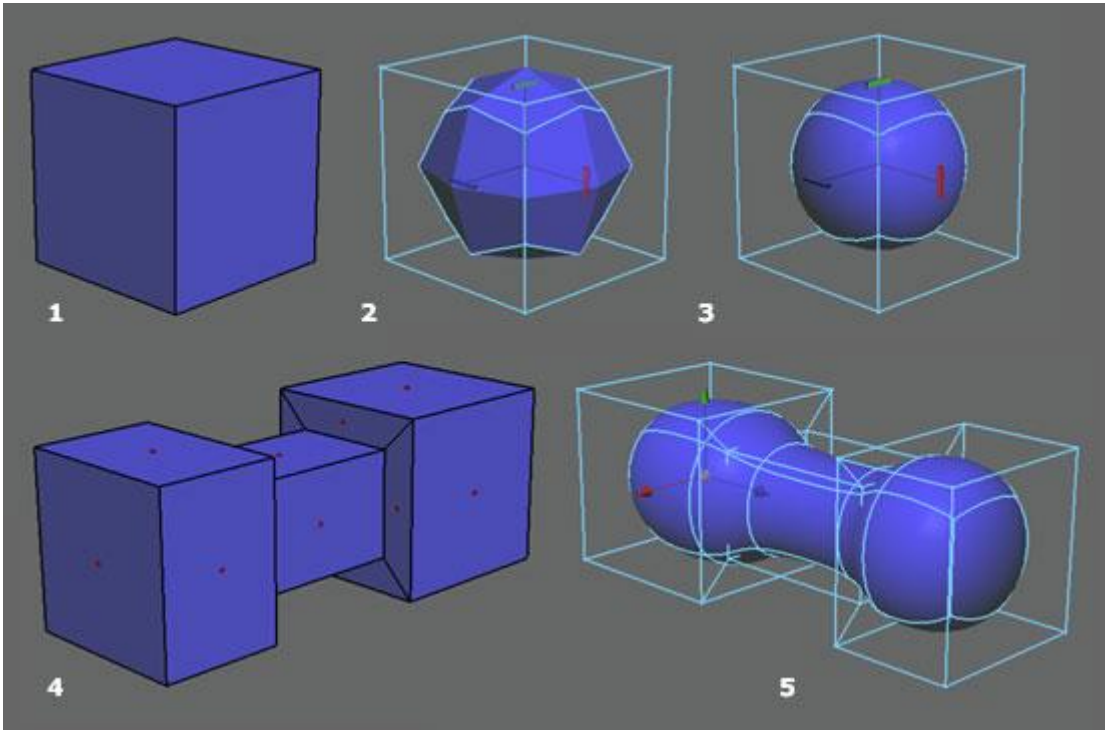






http://vimeo.com/2650080

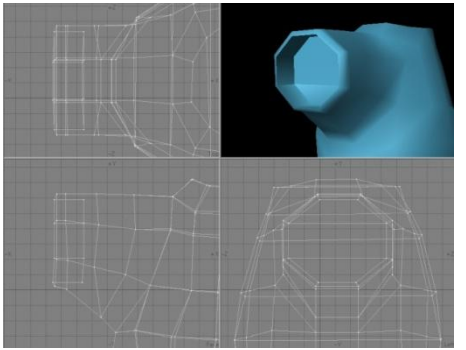
kontrolna kletka (Control Cage)

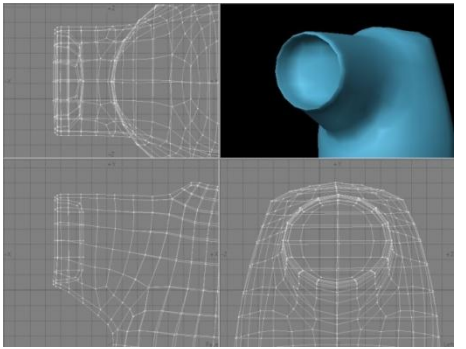


http://www.blendernewbies.com/tools/subdivisionmodeling/subd_PRIMER/page2.html

Uporaba:
- sprememba geometrije objekta
- nizkoločljivostno modeliranje + subdivizija
- detajli

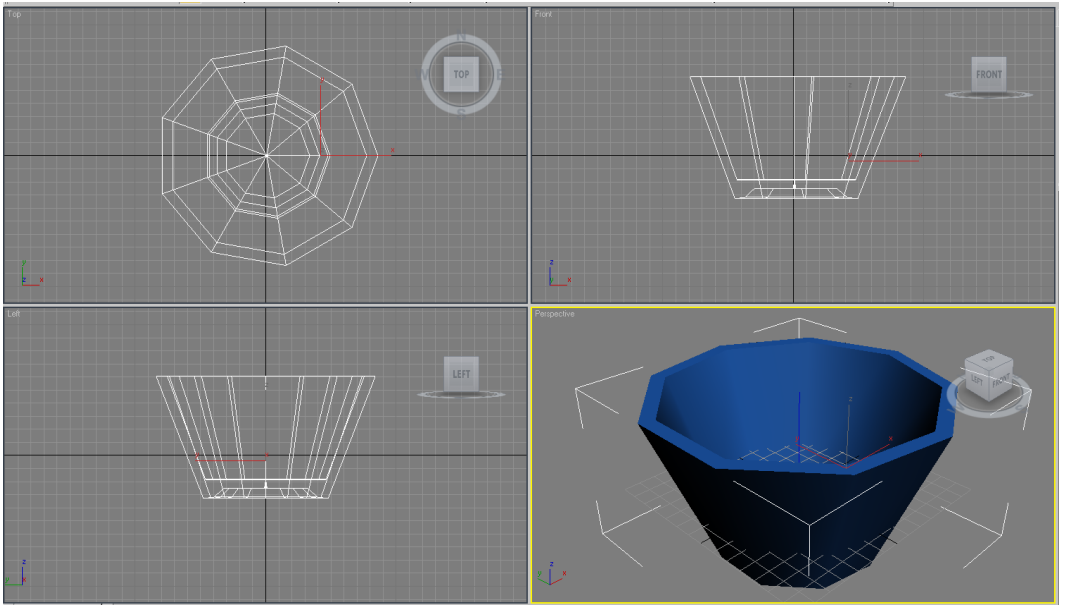
Slabosti:
- ni neskončnih krivulj
- deluje najbolje na kvadrisetih
- ni uporaben za tehnične objekte



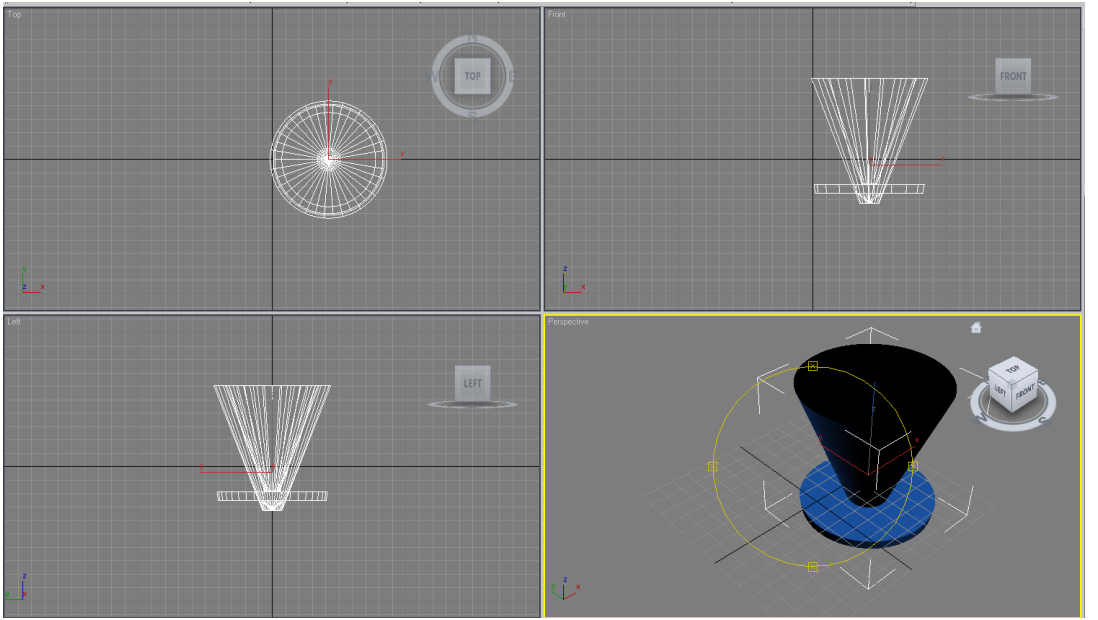


Modeliranje z množenjem - Rotacija okoli osi

- začetni kot
- končni kot
- število segmentov
- zamik (offset)
- os rotacije

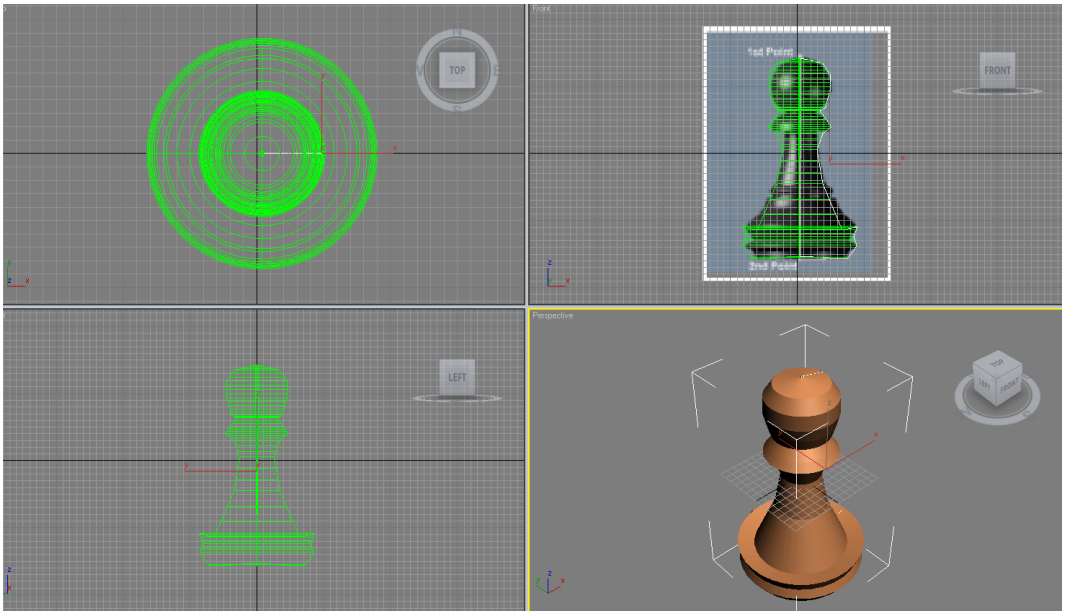


rotacija: 9 segmentov, okoli minimalne osi



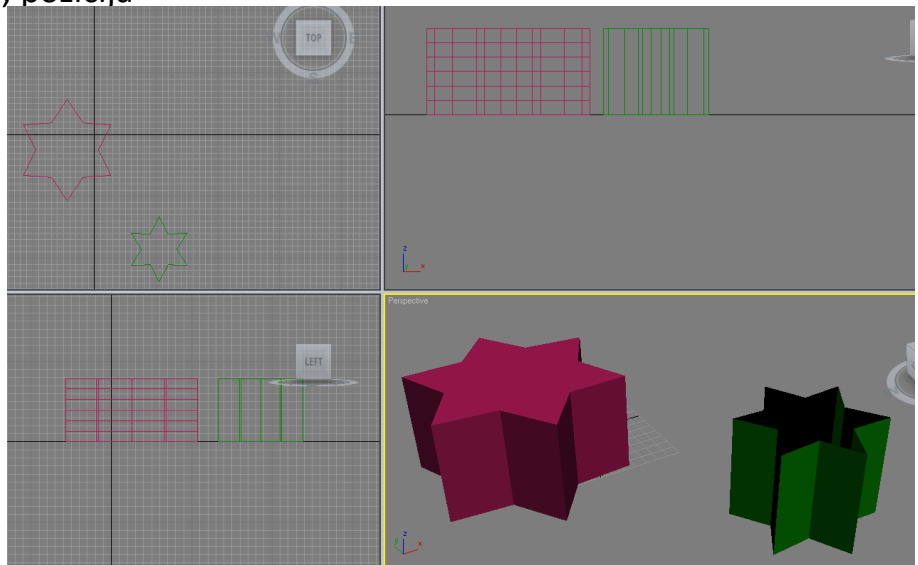
rotacija: 40 segmentov, okoli centralne os

figurica šaha



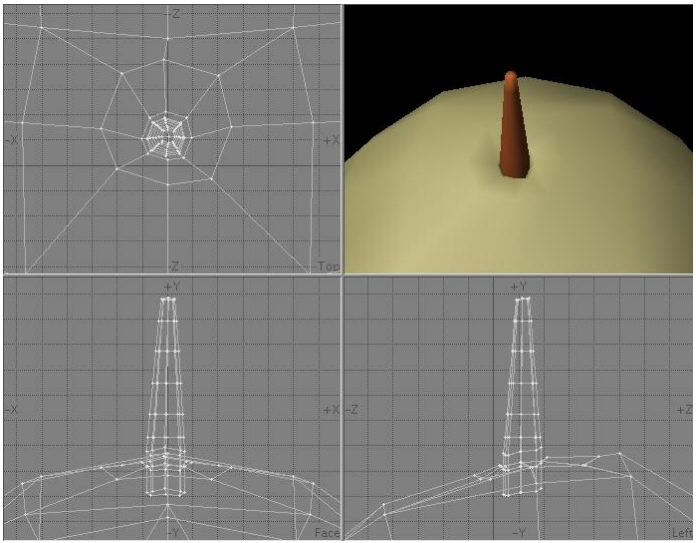
Modeliranje z množenjem - Izrinjanje, izvlek

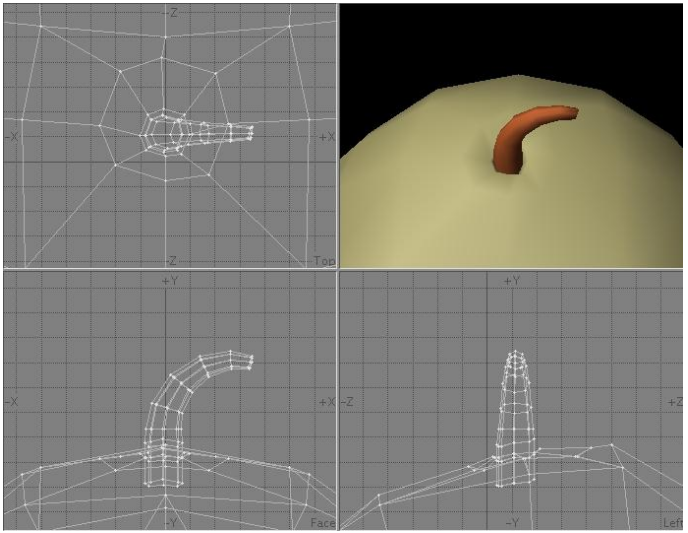
- dodajanje novih poligonov
- linearno izrinjanje: dodana le debelina
- os ekstrudiranja
- število segmentov
- razdalja, jakost izrinjanja-izvleka, pozicija
- odprtost/zaprtost telesa



Frontana ekstruzija (uklon)

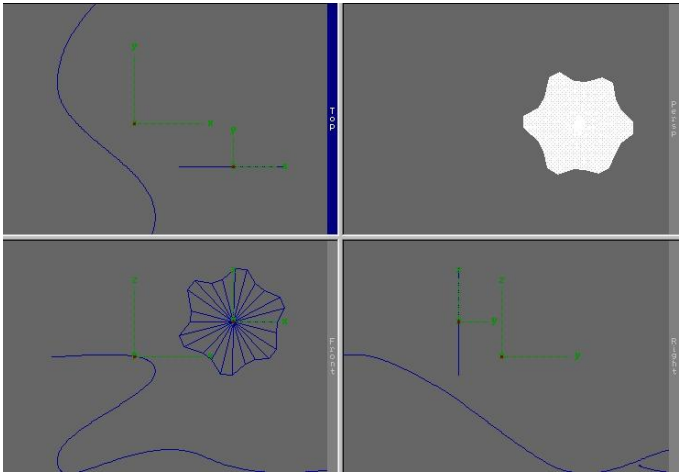
- fizični premik poligonov na novo lokacijo
- v vseh smereh xyz

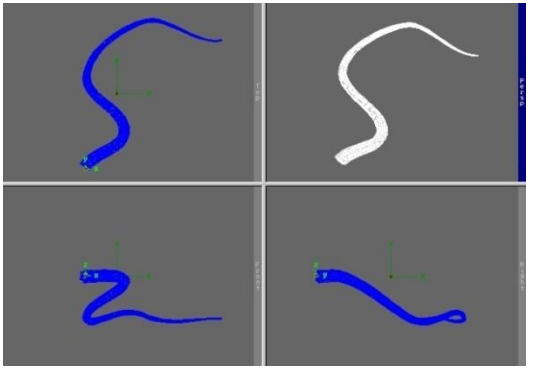




Modeliranje z množenjem - Izrinjanje po poti

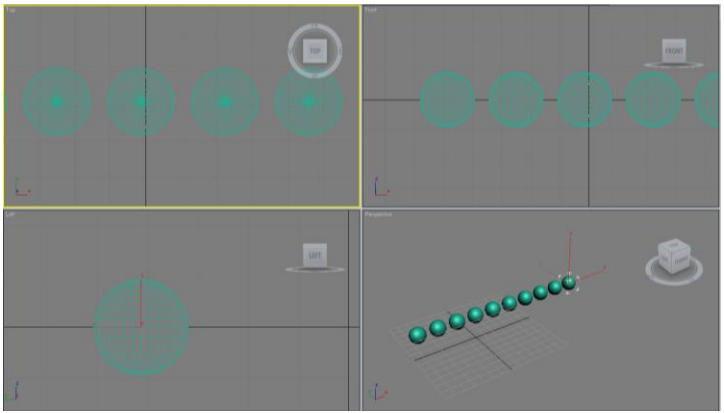
- nelinearno izrinjanje: dodana ukrivljenost
- pot (neskončna ločljivost)
- oblika objekta
- način množenja objektov
- rotacija
- zamik od poti

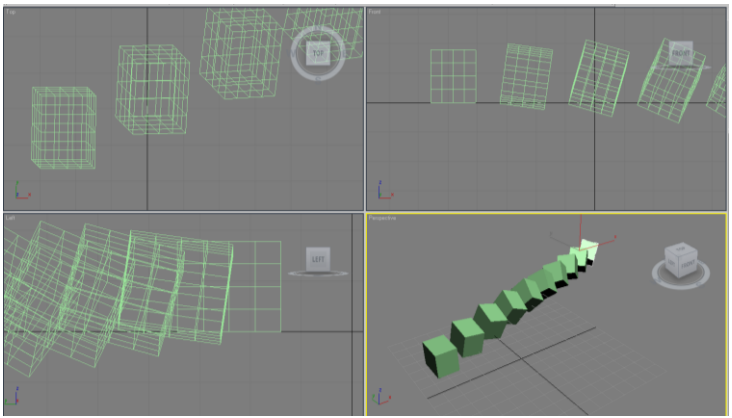




Kloniranje in razporejanje

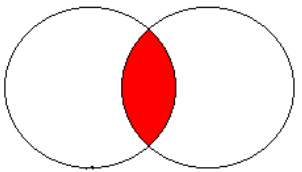
- število klonov
- zamik-premik novih klonov, rotacija
- skaliranje
- 1D (linijsko), 2D (površinsko) ali 3D (prostorsko)



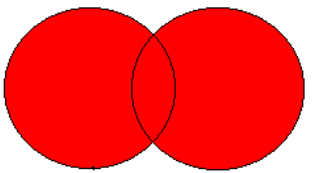


primeri: stopnice, zid, streha, ograja

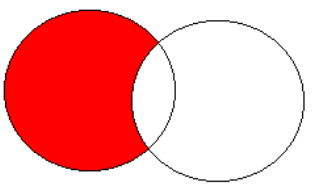
Boolove operacije



IN

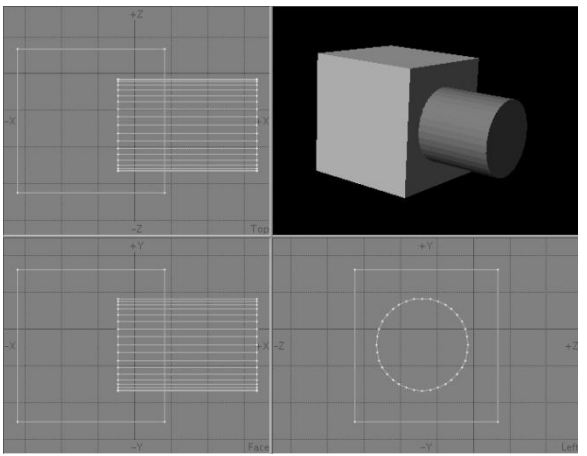


ALI

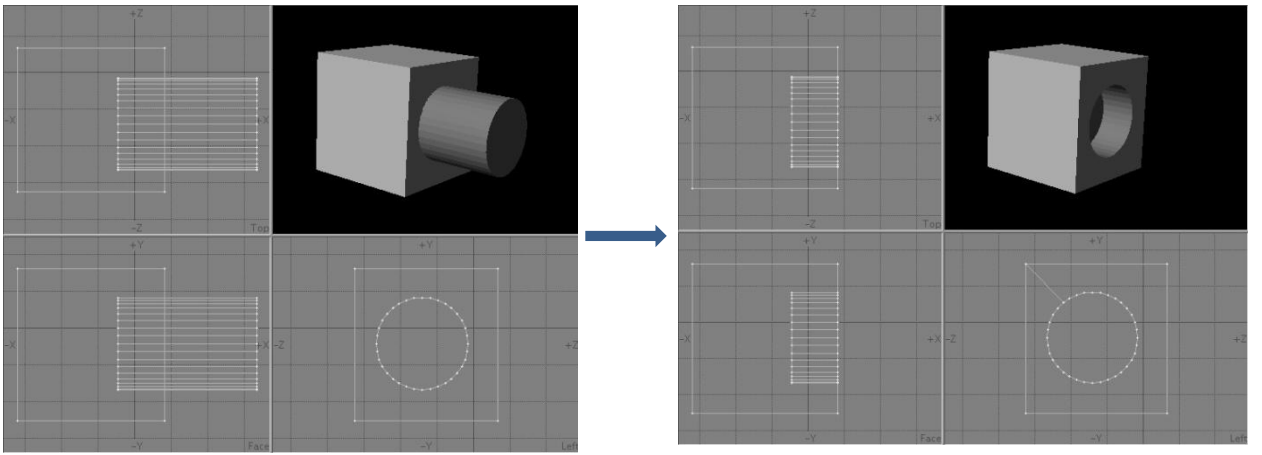


NE

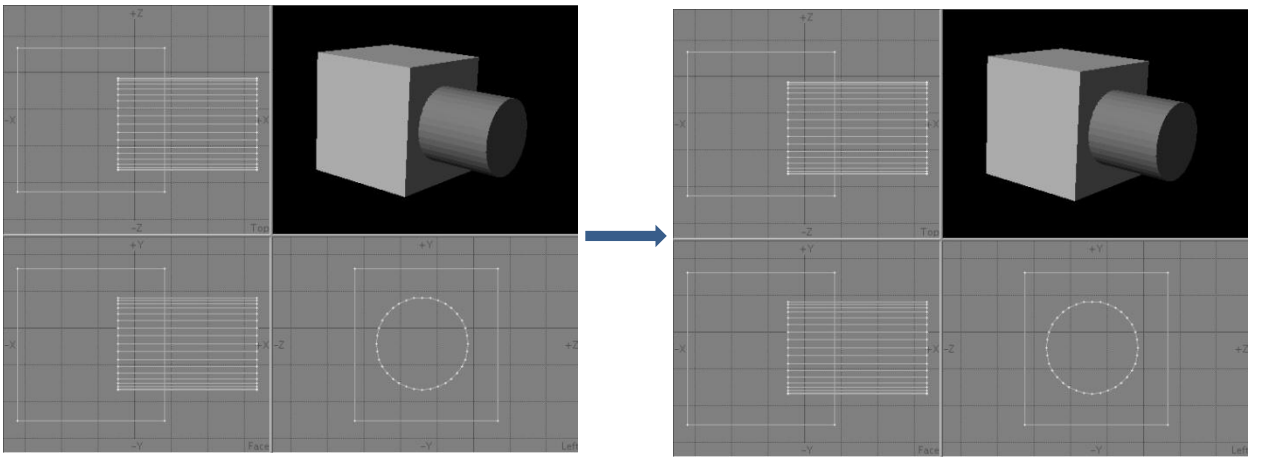
izhodišče



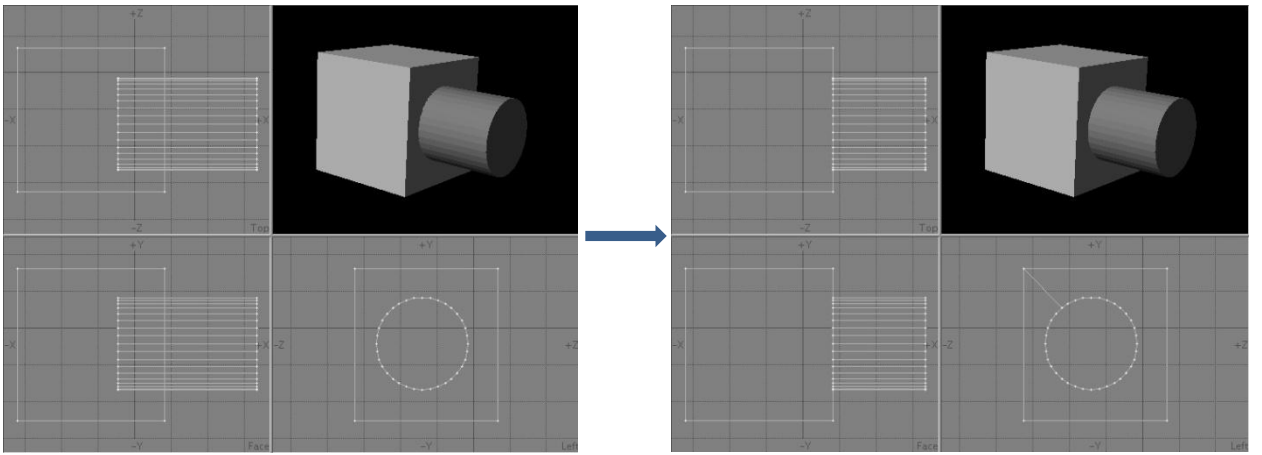
Subtrakcija – odvzemanje



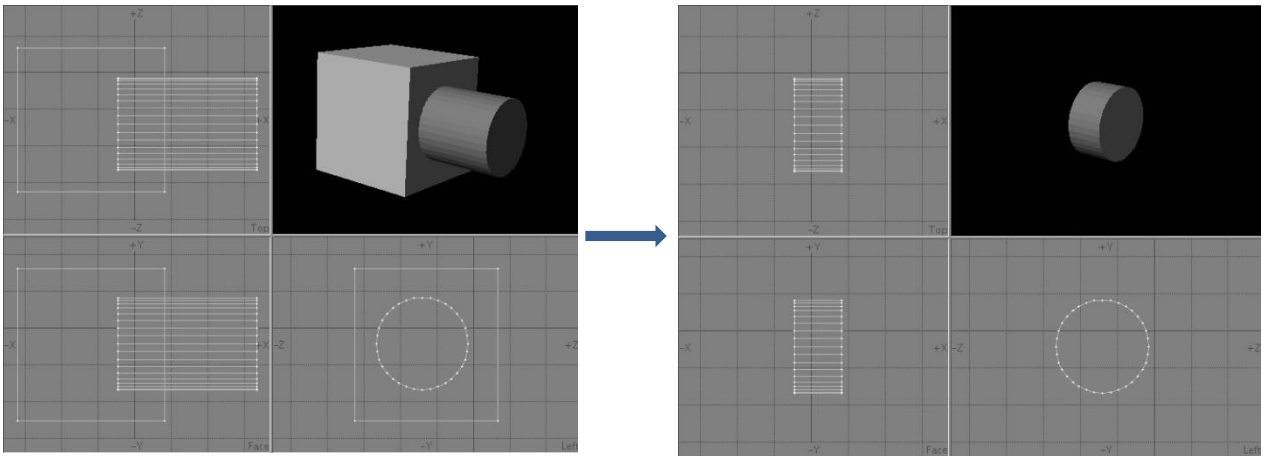
Adicija – dodajanje

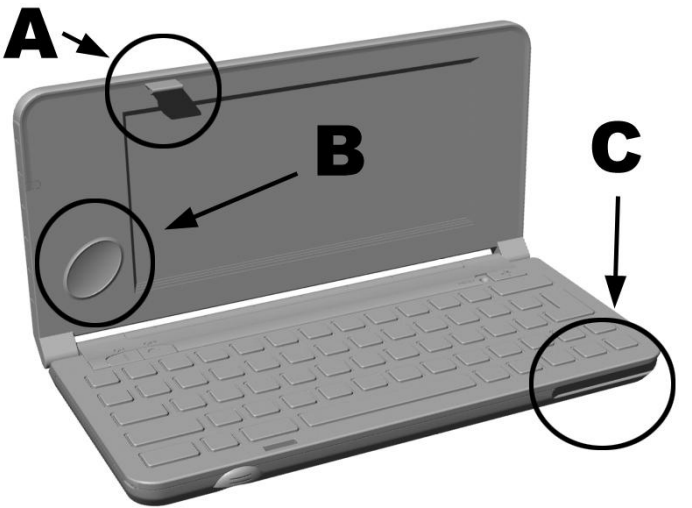


Unija – združevanje



Presek




A
B
C

Primeri animacij:

1. Leonid Larionov: The Butterfly 

2. Burcu Alada9: Rock & The Bird 

3. Daniel Nigren: Ice Egg