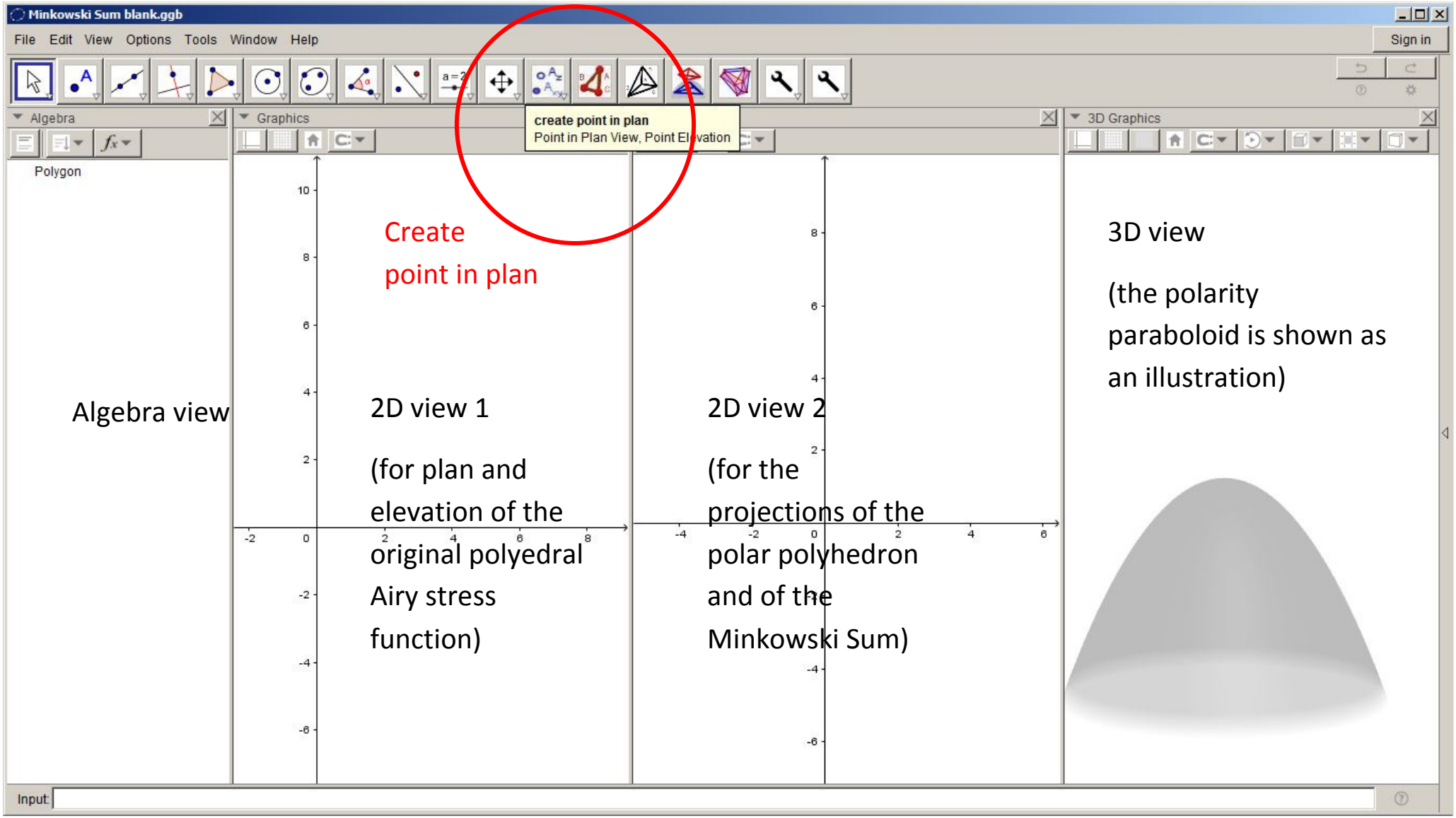
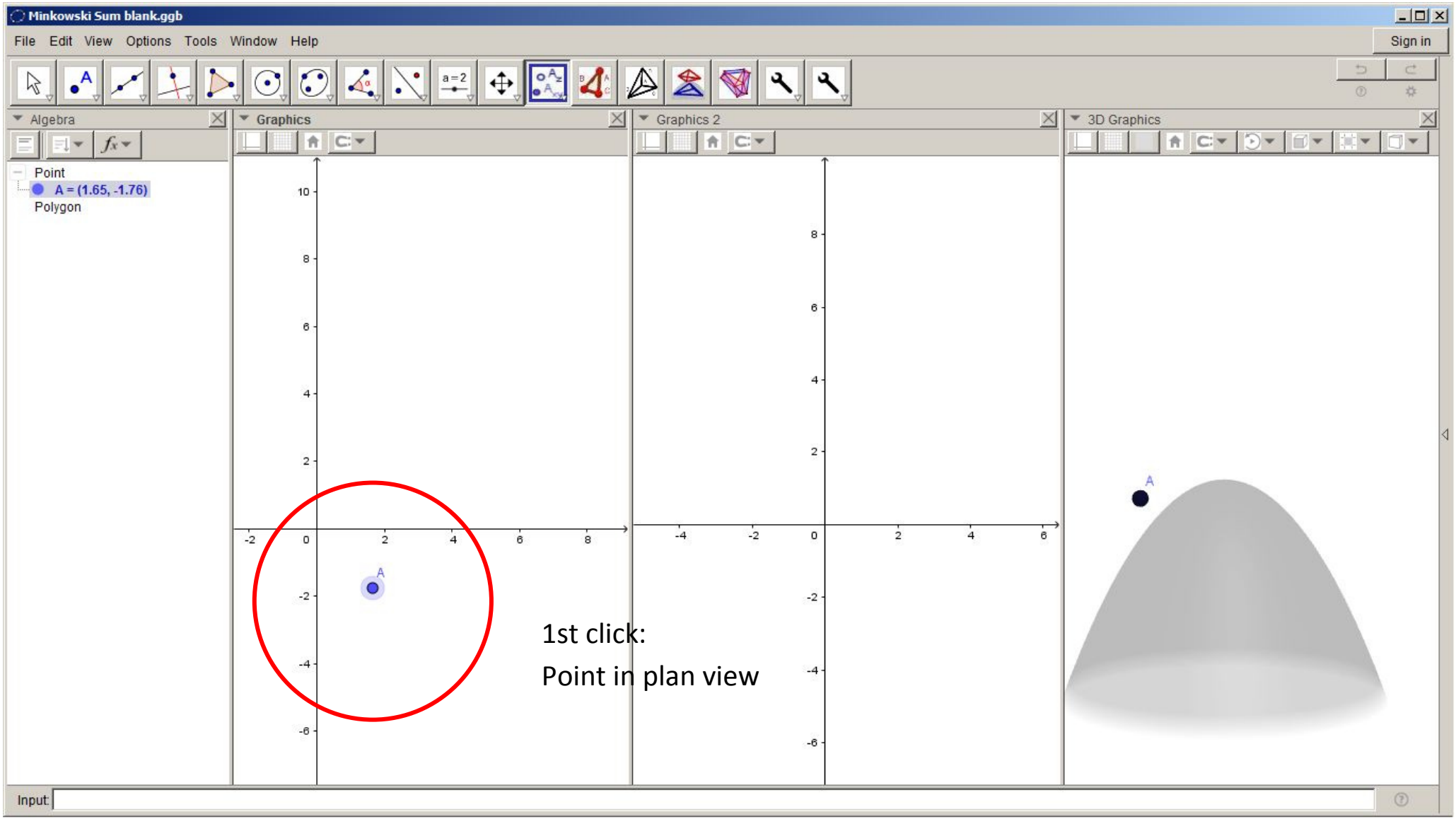
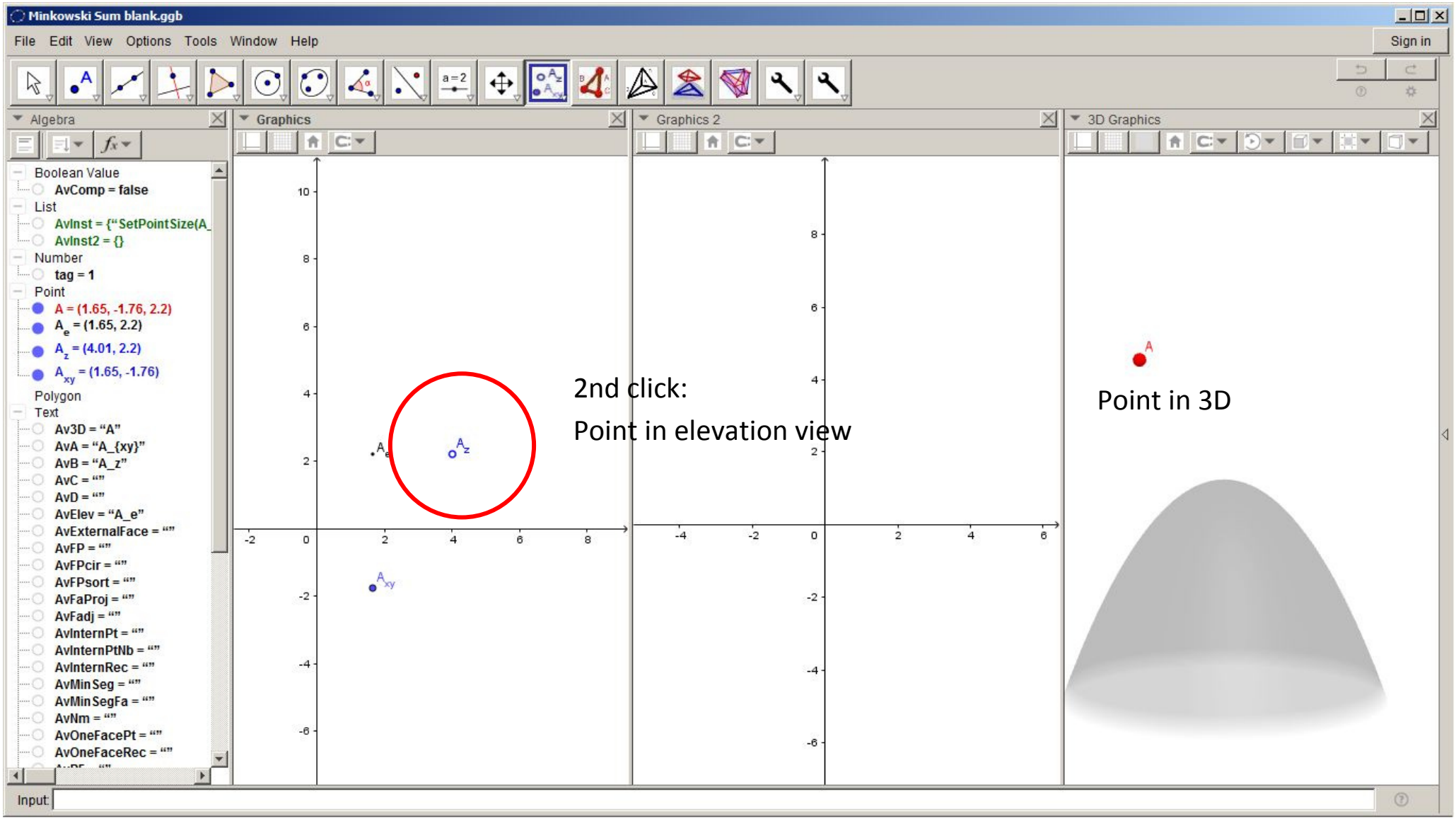
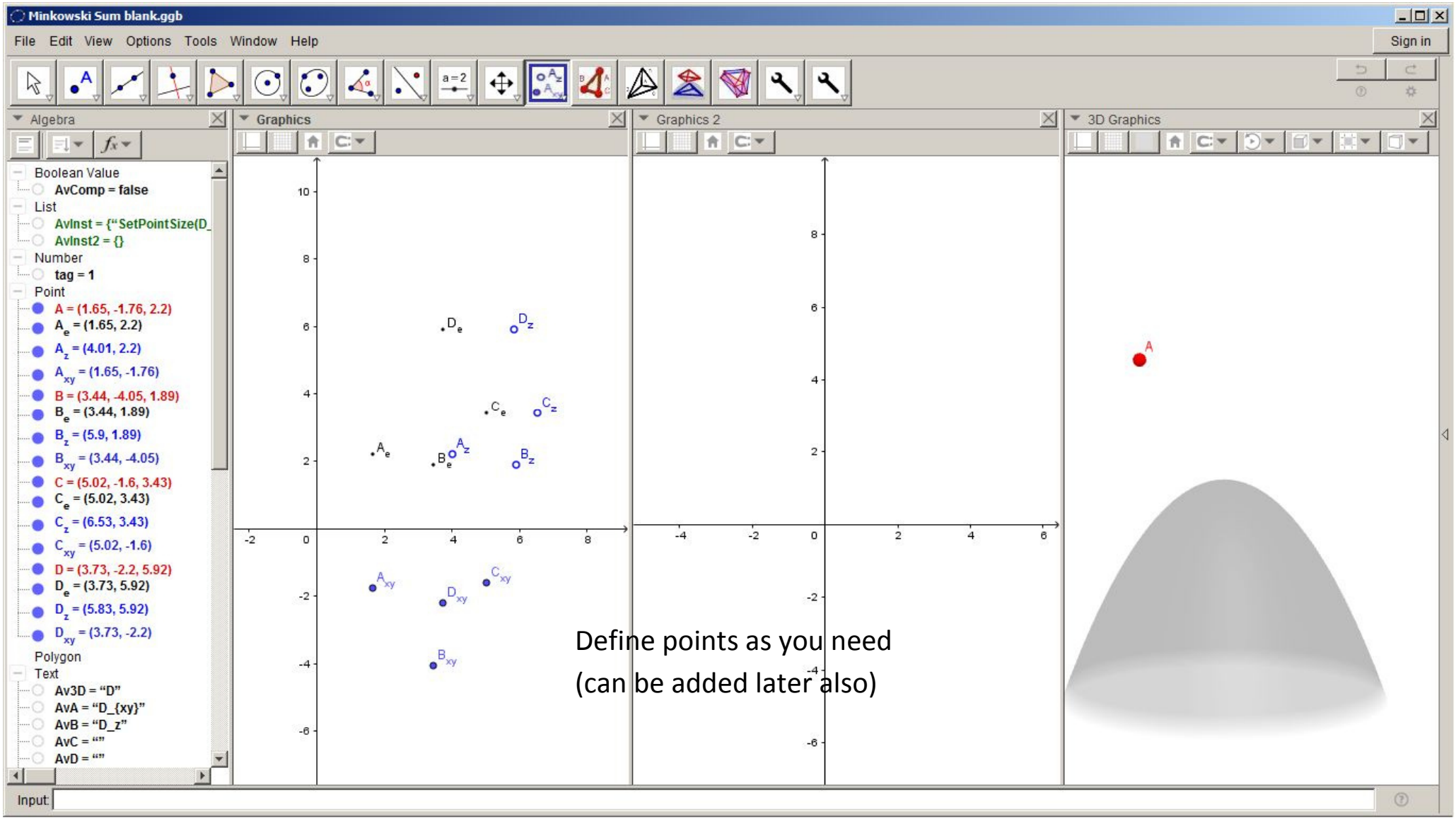
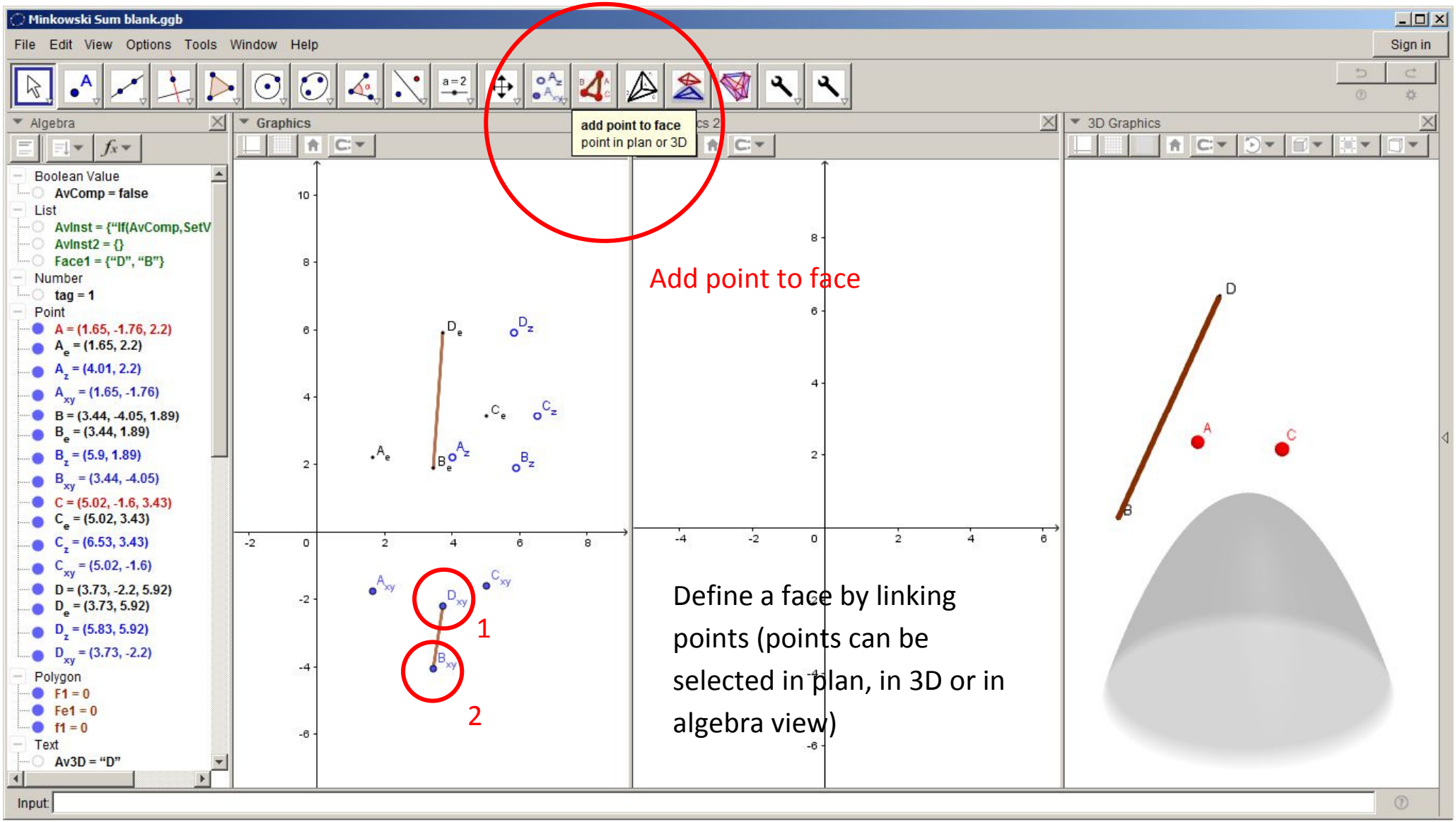
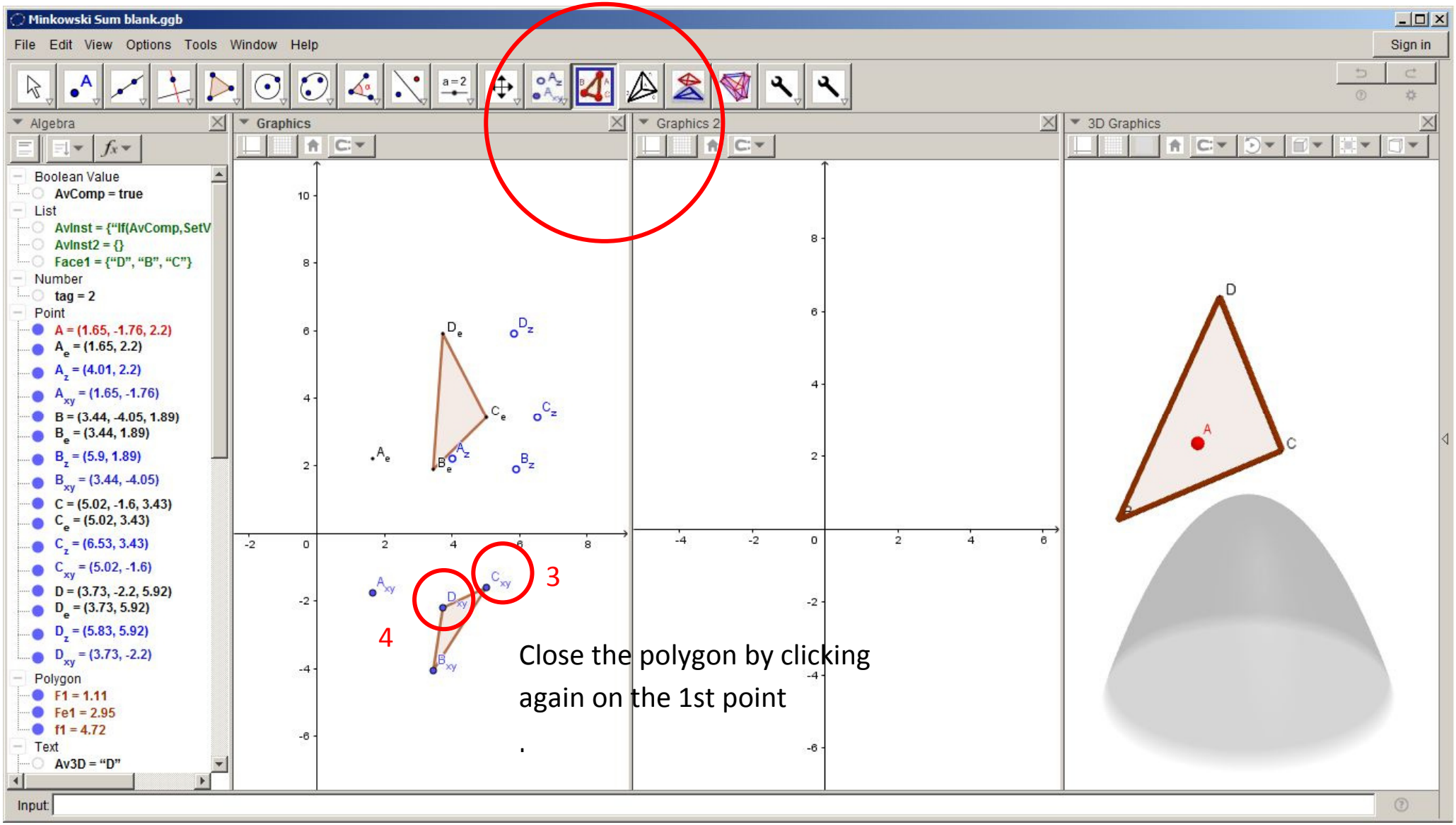

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
create point in plan
Point in Plan View, Point El vation
Algebra
Polygon
Graphics
3D Graphics
Create
point in plan
Algebra view
2D view 1
(for plan and
elevation of the
original polyedral
Airy stress
function)
2D view 2
(for the
projections of the
polar polyhedron
and of the
Minkowski Sum)
3D view
(the polarity
paraboloid is shown as
an illustration)
Input:

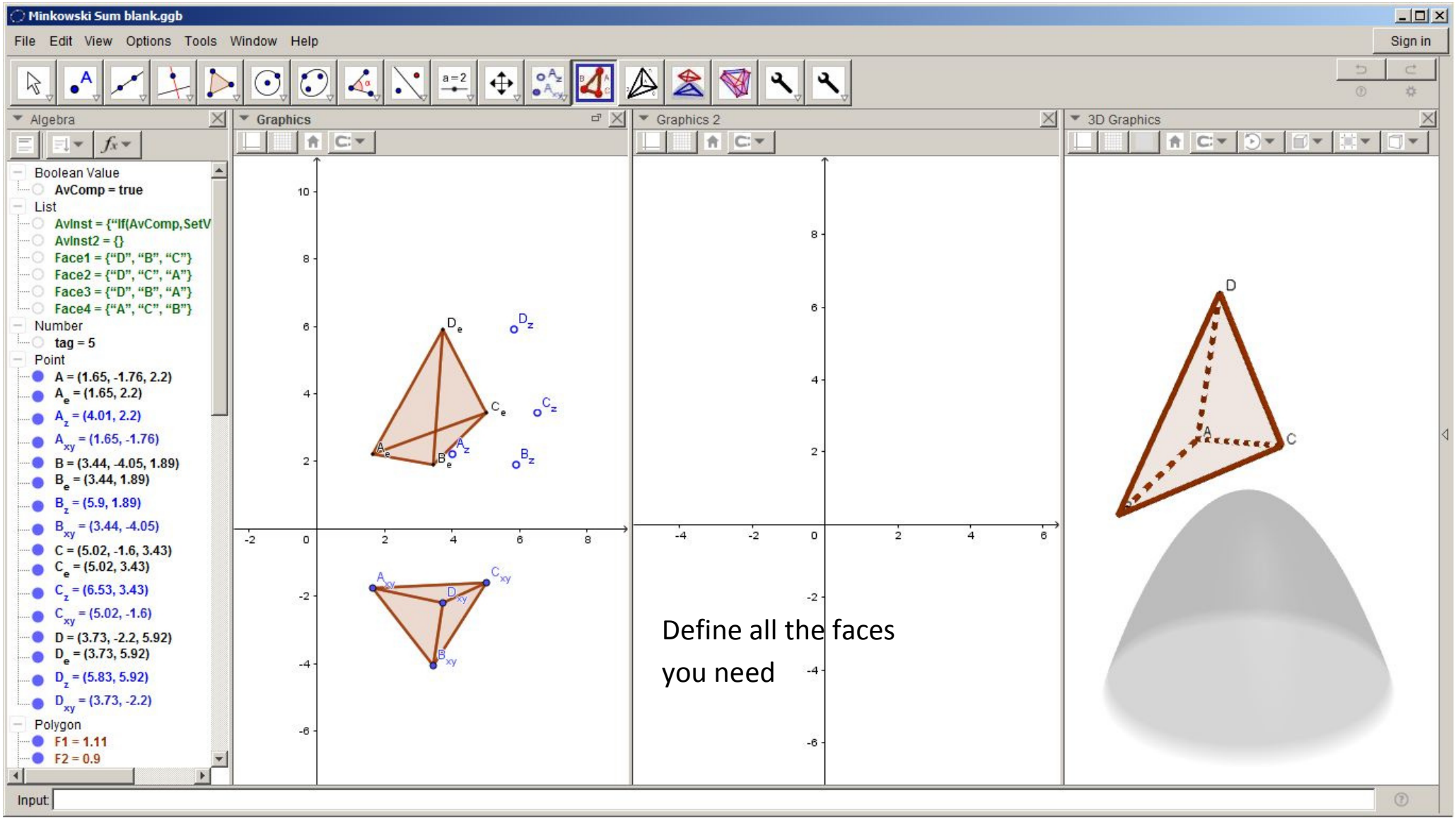

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Point
A = (1.65, -1.76)
Polygon
Graphics
Graphics 2
3D Graphics
A
1st click:
Point in plan view
Input:

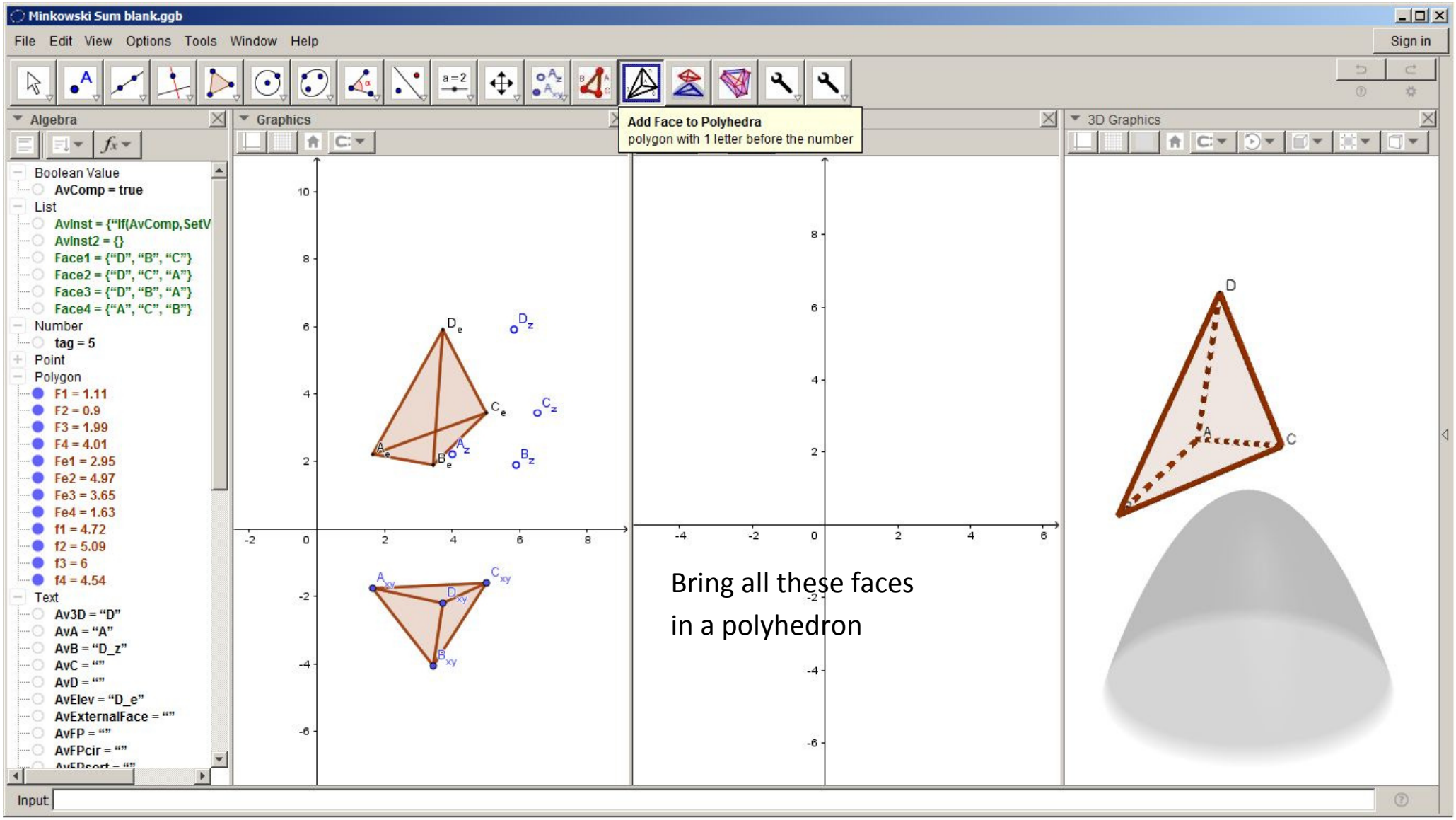

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = false
List
AvInst = {"SetPointSize(A_
AvInst2 = {}
Number
tag = 1
Point
A = (1.65, -1.76, 2.2)
A_e = (1.65, 2.2)
A_z = (4.01, 2.2)
A_xy = (1.65, -1.76)
Polygon
Text
Av3D = "A"
AvA = "A_{xy}"
AvB = "A_z"
AvC = ""
AvD = ""
AvElev = "A_e"
AvExternalFace = ""
AvFP = ""
AvFPcir = ""
AvFPsort = ""
AvFaProj = ""
AvFadj = ""
AvInternPt = ""
AvInternPtNb = ""
AvInternRec = ""
AvMinSeg = ""
AvMinSegFa = ""
AvNm = ""
AvOneFacePt = ""
AvOneFaceRec = ""
2nd click:
Point in elevation view
Point in 3D
Input:

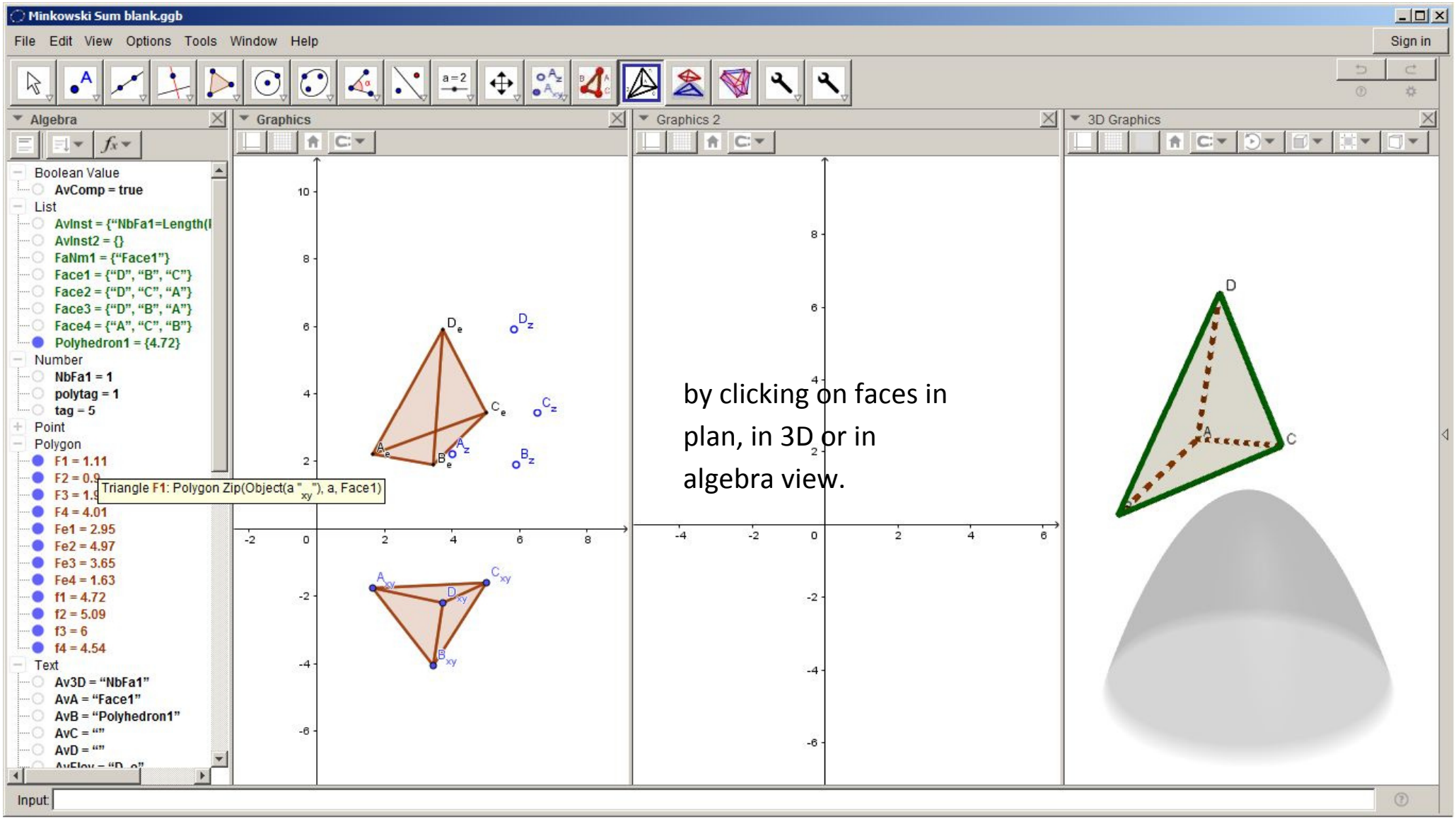

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = false
List
AvInst = {"SetPointSize(D_
AvInst2 = {}
Number
tag = 1
Point
A = (1.65, -1.76, 2.2)
A_e = (1.65, 2.2)
A_z = (4.01, 2.2)
A_xy = (1.65, -1.76)
B = (3.44, -4.05, 1.89)
B_e = (3.44, 1.89)
B_z = (5.9, 1.89)
B_xy = (3.44, -4.05)
C = (5.02, -1.6, 3.43)
C_e = (5.02, 3.43)
C_z = (6.53, 3.43)
C_xy = (5.02, -1.6)
D = (3.73, -2.2, 5.92)
D_e = (3.73, 5.92)
D_z = (5.83, 5.92)
D_xy = (3.73, -2.2)
Polygon
Text
Av3D = "D"
AvA = "D_{xy}"
AvB = "D_z"
AvC = ""
AvD = ""
Input:
Define points as you need
(can be added later also)

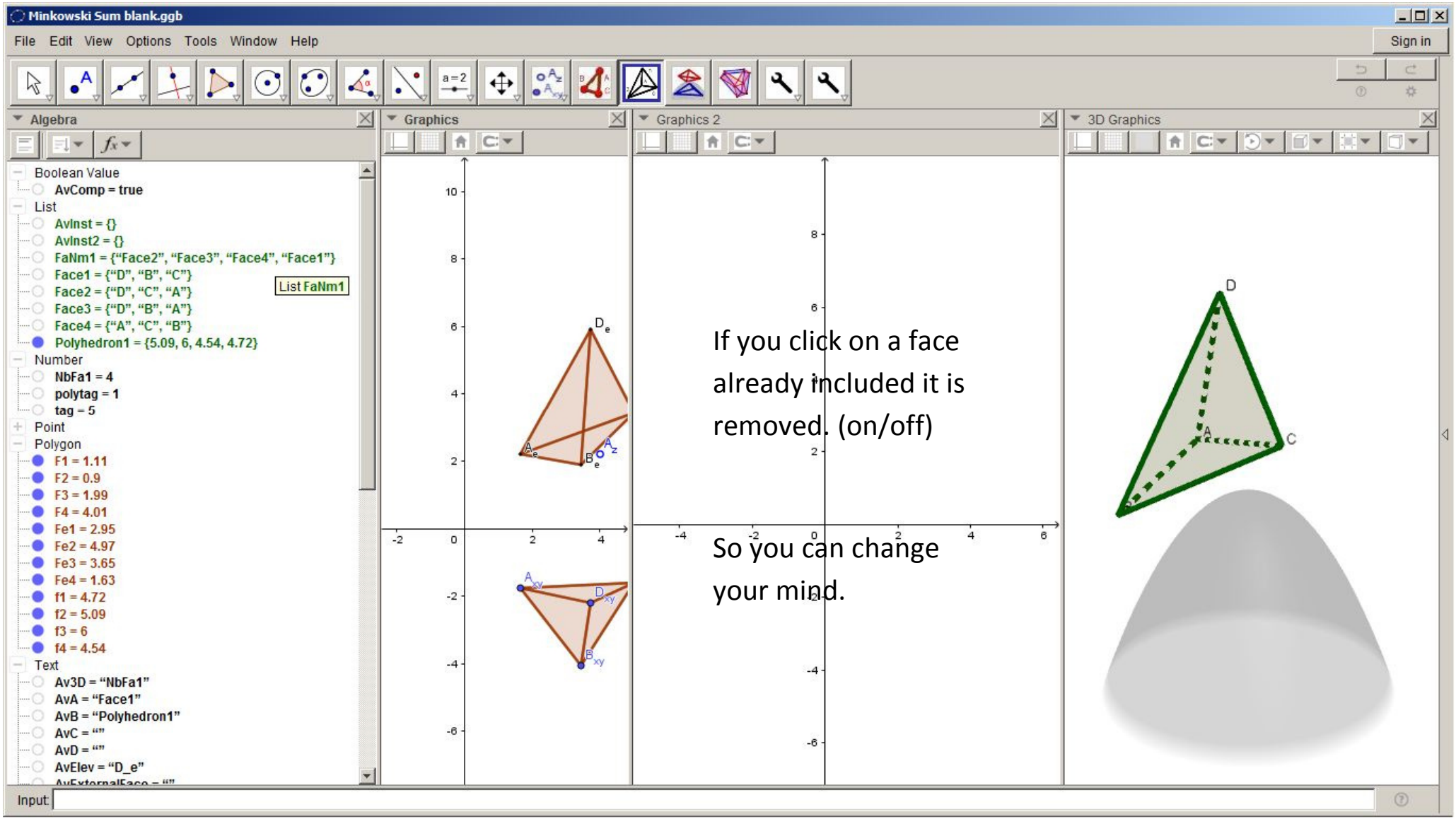

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
add point to face
point in plan or 3D
Algebra
Graphics
3D Graphics
Boolean Value
AvComp = false
List
AvInst = {"If(AvComp,SetV
AvInst2 = {}
Face1 = {"D", "B"}
Number
tag = 1
Point
A = (1.65, -1.76, 2.2)
A_e = (1.65, 2.2)
A_z = (4.01, 2.2)
A_xy = (1.65, -1.76)
B = (3.44, -4.05, 1.89)
B_e = (3.44, 1.89)
B_z = (5.9, 1.89)
B_xy = (3.44, -4.05)
C = (5.02, -1.6, 3.43)
C_e = (5.02, 3.43)
C_z = (6.53, 3.43)
C_xy = (5.02, -1.6)
D = (3.73, -2.2, 5.92)
D_e = (3.73, 5.92)
D_z = (5.83, 5.92)
D_xy = (3.73, -2.2)
Polygon
F1 = 0
Fe1 = 0
f1 = 0
Text
Av3D = "D"
Add point to face
Define a face by linking points (points can be selected in plan, in 3D or in algebra view)
1
2
Input:

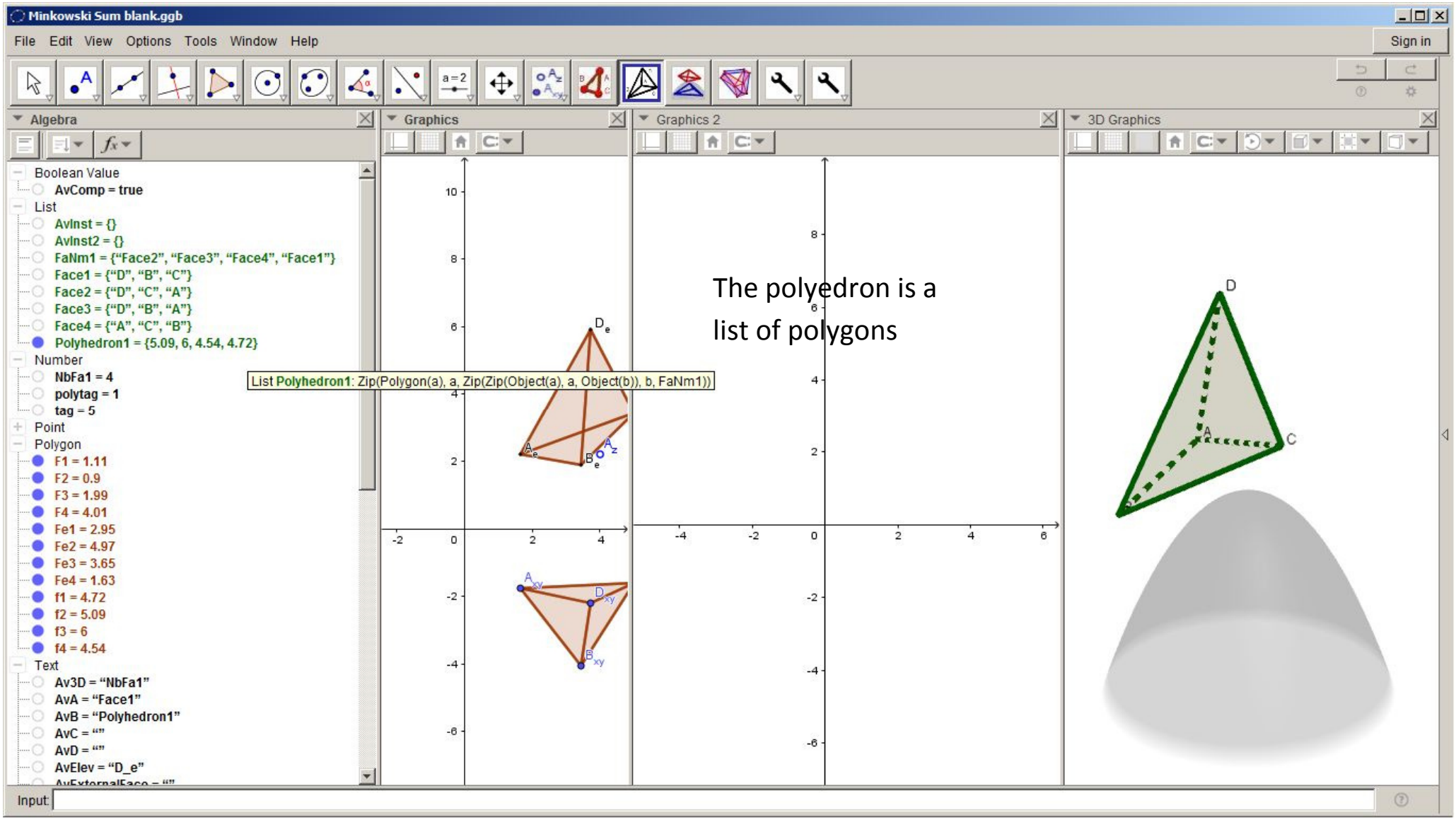

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {"If(AvComp,SetV
AvInst2 = {}
Face1 = {"D", "B", "C"}
Number
tag = 2
Point
A = (1.65, -1.76, 2.2)
A_e = (1.65, 2.2)
A_z = (4.01, 2.2)
A_xy = (1.65, -1.76)
B = (3.44, -4.05, 1.89)
B_e = (3.44, 1.89)
B_z = (5.9, 1.89)
B_xy = (3.44, -4.05)
C = (5.02, -1.6, 3.43)
C_e = (5.02, 3.43)
C_z = (6.53, 3.43)
C_xy = (5.02, -1.6)
D = (3.73, -2.2, 5.92)
D_e = (3.73, 5.92)
D_z = (5.83, 5.92)
D_xy = (3.73, -2.2)
Polygon
F1 = 1.11
Fe1 = 2.95
f1 = 4.72
Text
Av3D = "D"
3
4
Close the polygon by clicking
again on the 1st point
.
Input:

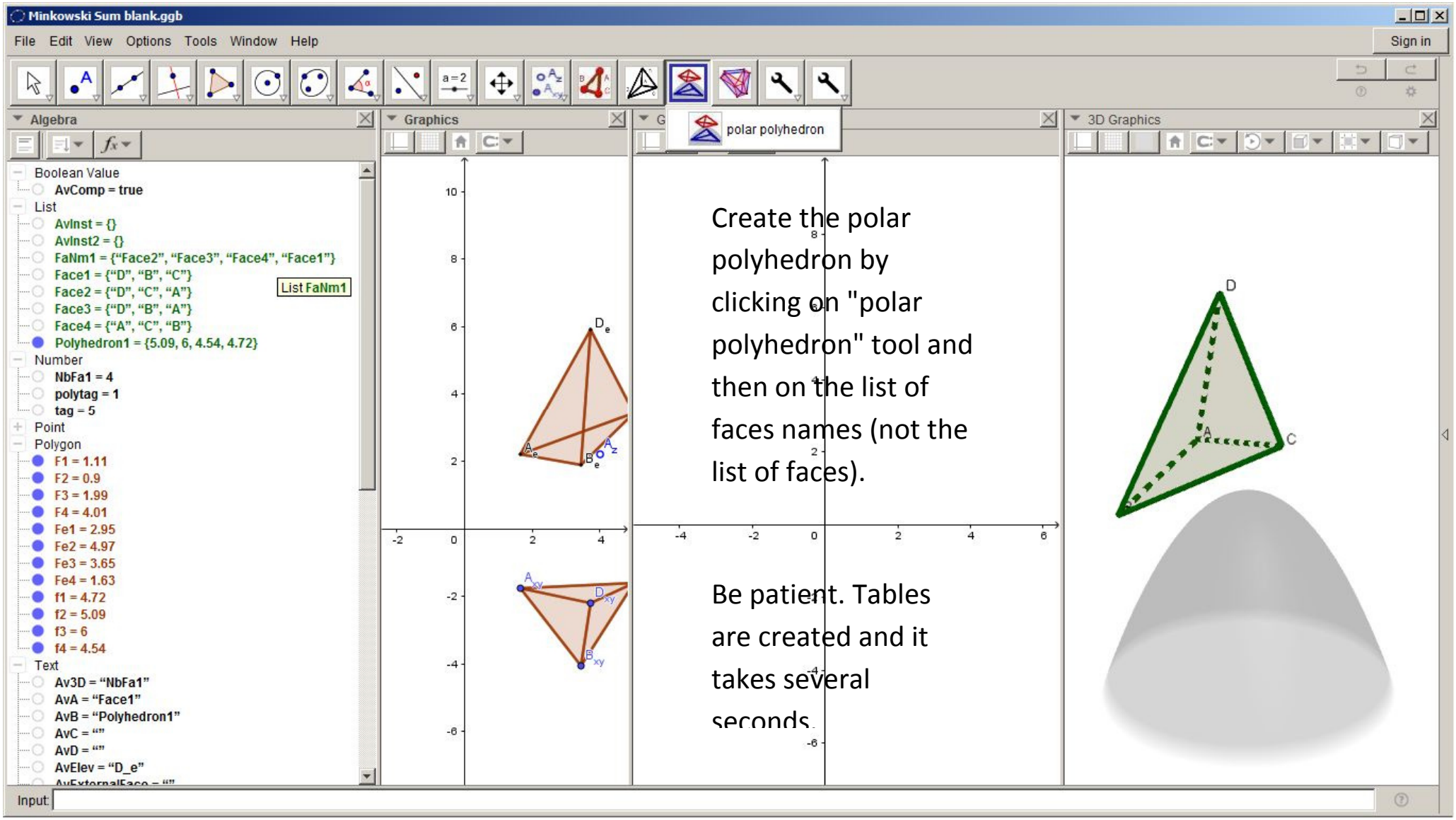

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {"If(AvComp,SetV
AvInst2 = {}
Face1 = {"D", "B", "C"}
Face2 = {"D", "C", "A"}
Face3 = {"D", "B", "A"}
Face4 = {"A", "C", "B"}
Number
tag = 5
Point
A = (1.65, -1.76, 2.2)
A_e = (1.65, 2.2)
A_z = (4.01, 2.2)
A_xy = (1.65, -1.76)
B = (3.44, -4.05, 1.89)
B_e = (3.44, 1.89)
B_z = (5.9, 1.89)
B_xy = (3.44, -4.05)
C = (5.02, -1.6, 3.43)
C_e = (5.02, 3.43)
C_z = (6.53, 3.43)
C_xy = (5.02, -1.6)
D = (3.73, -2.2, 5.92)
D_e = (3.73, 5.92)
D_z = (5.83, 5.92)
D_xy = (3.73, -2.2)
Polygon
F1 = 1.11
F2 = 0.9
Define all the faces
you need
Input:


Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Add Face to Polyhedra
polygon with 1 letter before the number
Algebra
Boolean Value
AvComp = true
List
AvInst = {"If(AvComp,SetV
AvInst2 = {}
Face1 = {"D", "B", "C"}
Face2 = {"D", "C", "A"}
Face3 = {"D", "B", "A"}
Face4 = {"A", "C", "B"}
Number
tag = 5
Point
Polygon
F1 = 1.11
F2 = 0.9
F3 = 1.99
F4 = 4.01
Fe1 = 2.95
Fe2 = 4.97
Fe3 = 3.65
Fe4 = 1.63
f1 = 4.72
f2 = 5.09
f3 = 6
f4 = 4.54
Text
Av3D = "D"
AvA = "A"
AvB = "D_z"
AvC = ""
AvD = ""
AvElev = "D_e"
AvExternalFace = ""
AvFP = ""
AvFPcir = ""
Graphics
3D Graphics
Bring all these faces
in a polyhedron
Input:


Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {"NbFa1=Length(
AvInst2 = {}
FaNm1 = {"Face1"}
Face1 = {"D", "B", "C"}
Face2 = {"D", "C", "A"}
Face3 = {"D", "B", "A"}
Face4 = {"A", "C", "B"}
Polyhedron1 = {4.72}
Number
NbFa1 = 1
polytag = 1
tag = 5
Point
Polygon
F1 = 1.11
F2 = 0.9
F3 = 1.9
F4 = 4.01
Fe1 = 2.95
Fe2 = 4.97
Fe3 = 3.65
Fe4 = 1.63
f1 = 4.72
f2 = 5.09
f3 = 6
f4 = 4.54
Text
Av3D = "NbFa1"
AvA = "Face1"
AvB = "Polyhedron1"
AvC = ""
AvD = ""
Triangle F1: Polygon Zip(Object(a "_xy"), a, Face1)
by clicking on faces in plan, in 3D or in algebra view.
D
A
C
Input:

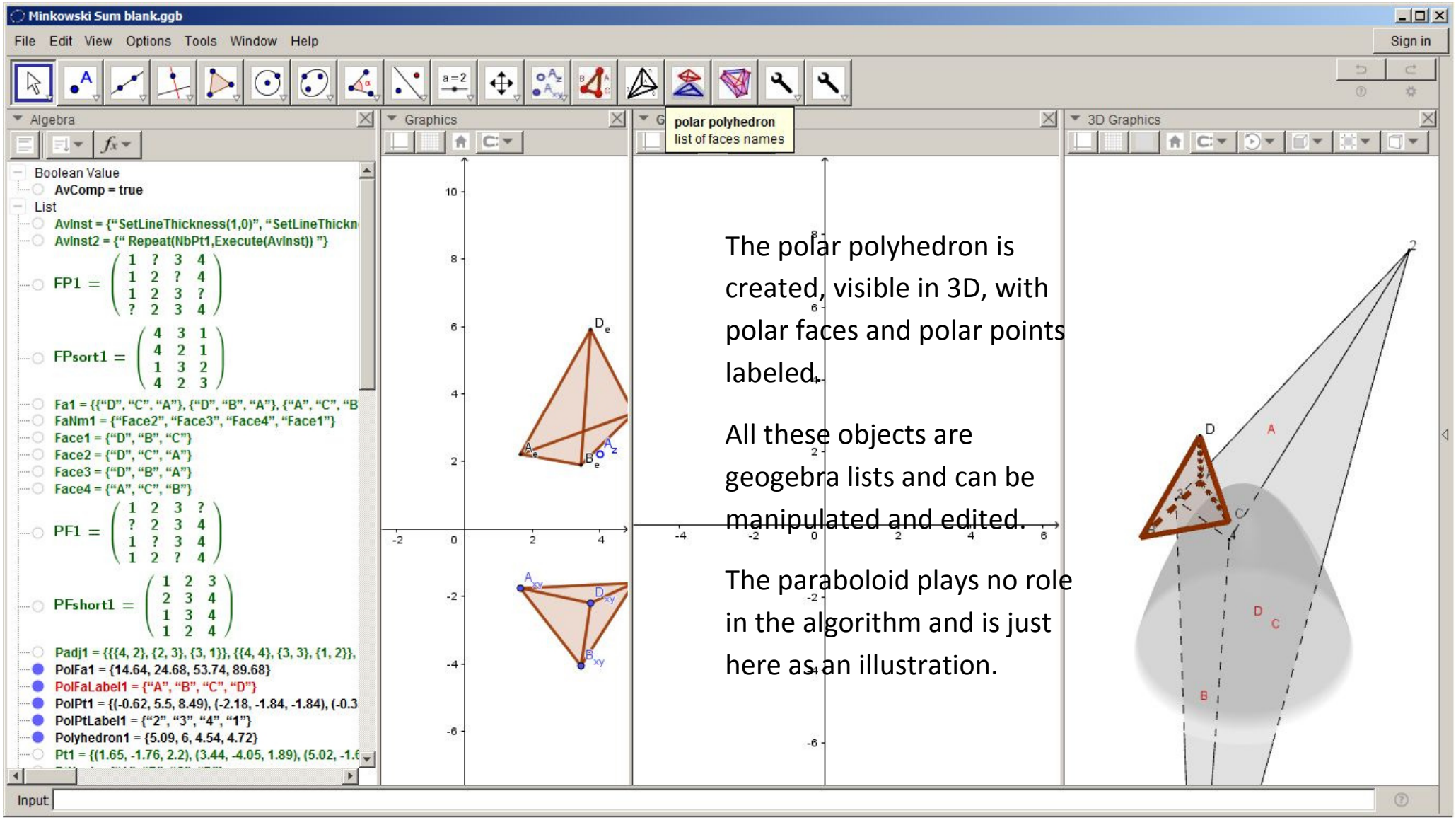

Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {}
AvInst2 = {}
FaNm1 = {“Face2”, “Face3”, “Face4”, “Face1”}
Face1 = {“D”, “B”, “C”}
List FaNm1
Face2 = {“D”, “C”, “A”}
Face3 = {“D”, “B”, “A”}
Face4 = {“A”, “C”, “B”}
Polyhedron1 = {5.09, 6, 4.54, 4.72}
Number
NbFa1 = 4
polytag = 1
tag = 5
Point
Polygon
F1 = 1.11
F2 = 0.9
F3 = 1.99
F4 = 4.01
Fe1 = 2.95
Fe2 = 4.97
Fe3 = 3.65
Fe4 = 1.63
f1 = 4.72
f2 = 5.09
f3 = 6
f4 = 4.54
Text
Av3D = “NbFa1”
AvA = “Face1”
AvB = “Polyhedron1”
AvC = “”
AvD = “”
AvElev = “D_e”
If you click on a face already included it is removed. (on/off)
So you can change your mind.
D
A
C
Input:


Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {}
AvInst2 = {}
FaNm1 = {"Face2", "Face3", "Face4", "Face1"}
Face1 = {"D", "B", "C"}
Face2 = {"D", "C", "A"}
Face3 = {"D", "B", "A"}
Face4 = {"A", "C", "B"}
Polyhedron1 = {5.09, 6, 4.54, 4.72}
Number
NbFa1 = 4
polytag = 1
tag = 5
Point
Polygon
F1 = 1.11
F2 = 0.9
F3 = 1.99
F4 = 4.01
Fe1 = 2.95
Fe2 = 4.97
Fe3 = 3.65
Fe4 = 1.63
f1 = 4.72
f2 = 5.09
f3 = 6
f4 = 4.54
Text
Av3D = "NbFa1"
AvA = "Face1"
AvB = "Polyhedron1"
AvC = ""
AvD = ""
AvElev = "D_e"
List Polyhedron1: Zip(Polygon(a), a, Zip(Zip(Object(a), a, Object(b)), b, FaNm1))
The polyedron is a
list of polygons
D
A
C
Input:



Create the polar polyhedron by clicking on "polar polyhedron" tool and then on the list of faces names (not the list of faces).

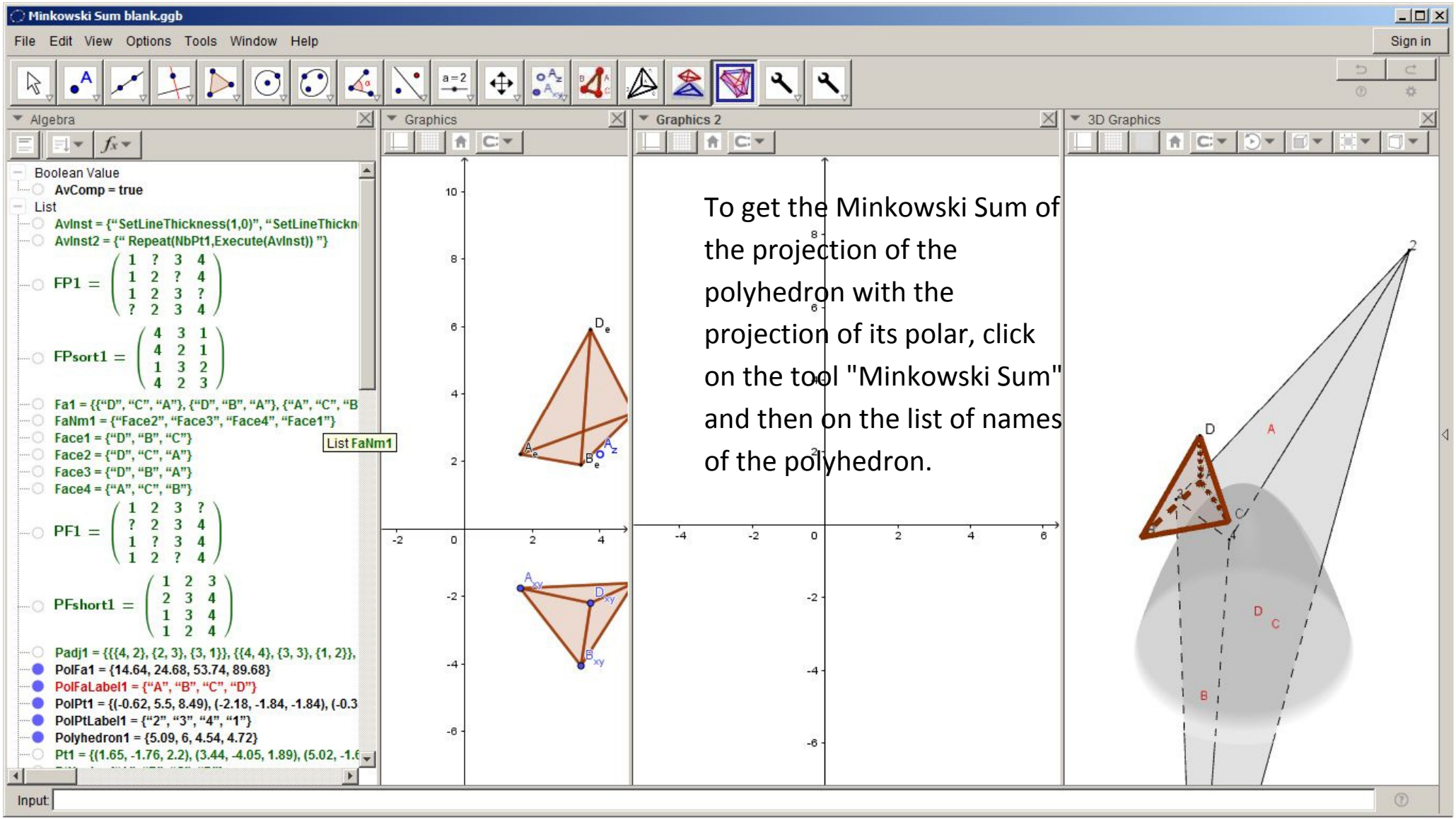
Be patient. Tables are created and it takes several seconds.

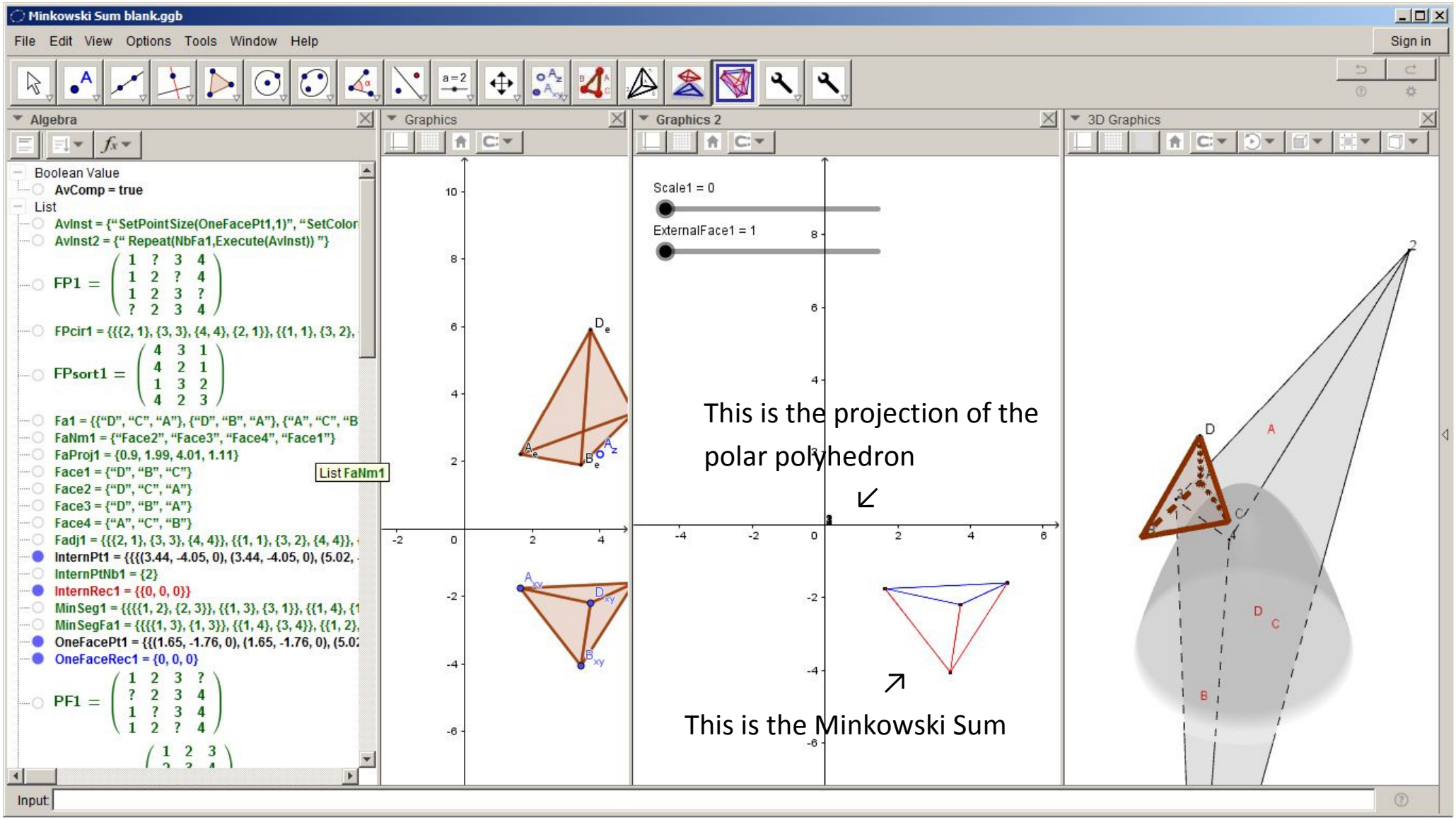


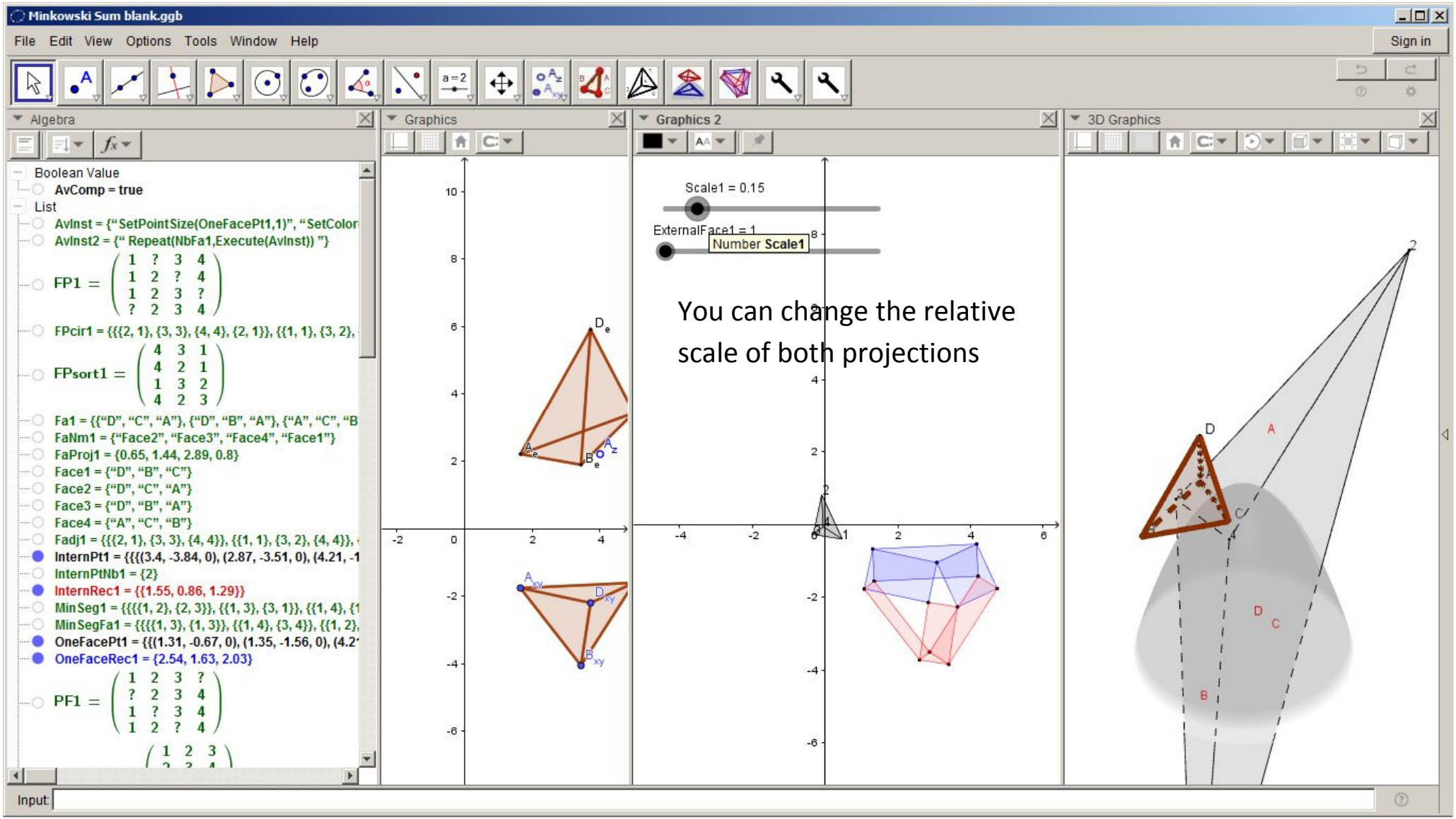
The polar polyhedron is created, visible in 3D, with polar faces and polar points labeled.

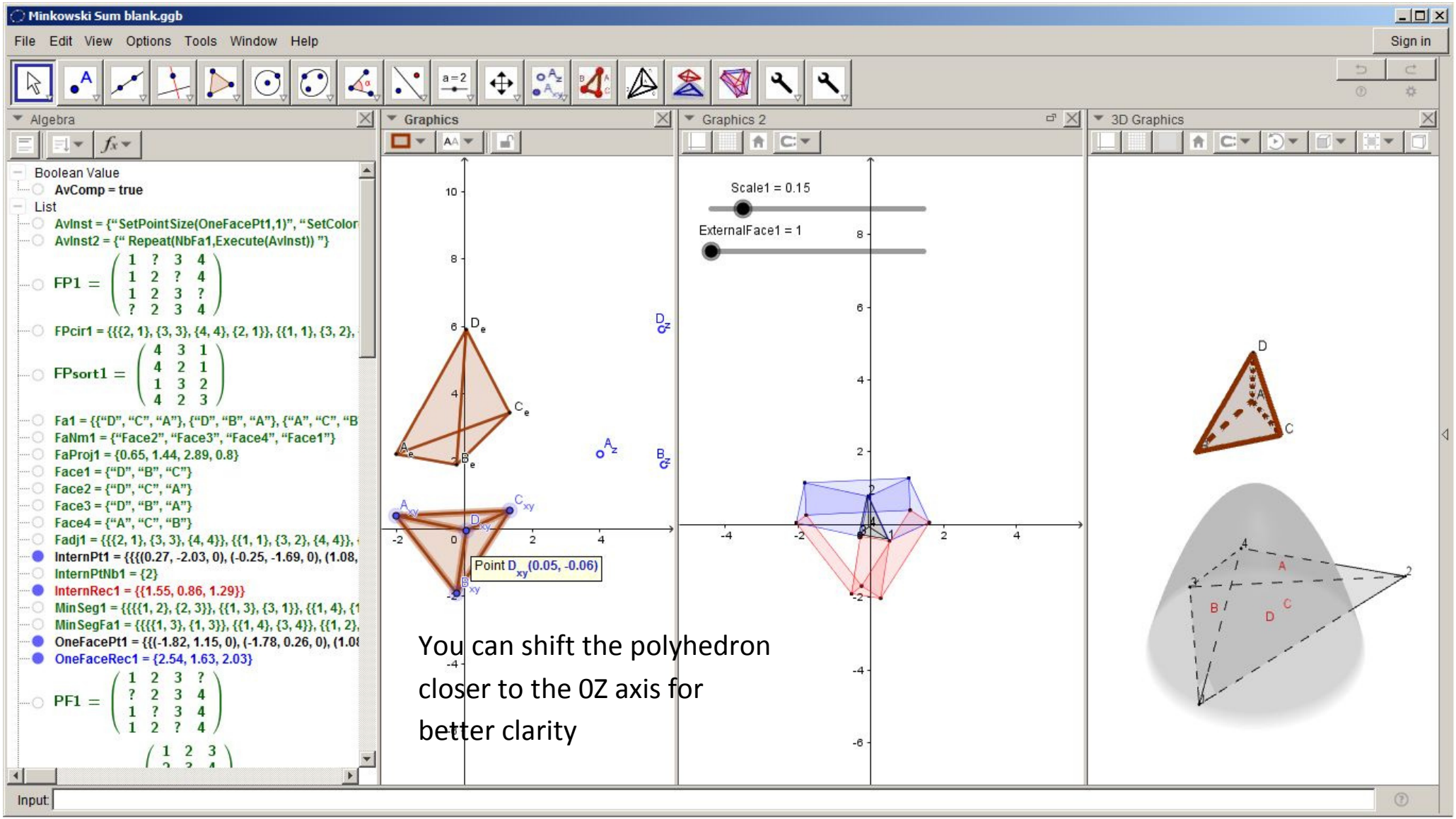
All these objects are geogebra lists and can be manipulated and edited.

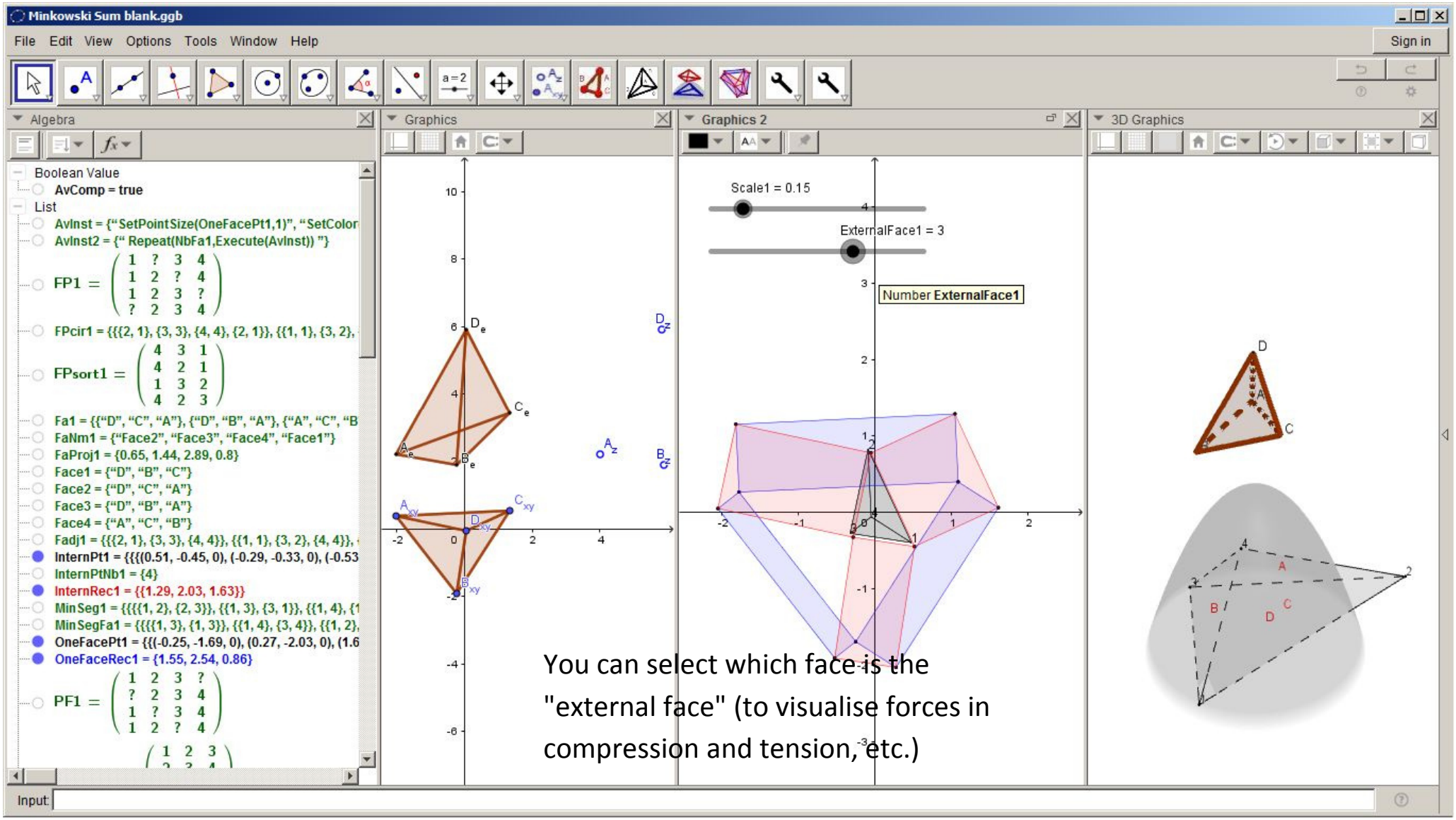
The paraboloid plays no role in the algorithm and is just here as an illustration.


Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {“SetLineThickness(1,0)”, “SetLineThickn
AvInst2 = {“ Repeat(NbPt1,Execute(AvInst)) ”}
FP1 =
FPsort1 =
Fa1 = {{“D”, “C”, “A”}, {“D”, “B”, “A”}, {“A”, “C”, “B
FaNm1 = {“Face2”, “Face3”, “Face4”, “Face1”}
Face1 = {“D”, “B”, “C”}
Face2 = {“D”, “C”, “A”}
Face3 = {“D”, “B”, “A”}
Face4 = {“A”, “C”, “B”}
PF1 =
PFshort1 =
Padj1 = {{{4, 2}, {2, 3}, {3, 1}}, {{4, 4}, {3, 3}, {1, 2}},
PolFa1 = {14.64, 24.68, 53.74, 89.68}
PolFaLabel1 = {“A”, “B”, “C”, “D”}
PolPt1 = {(-0.62, 5.5, 8.49), (-2.18, -1.84, -1.84), (-0.3
PolPtLabel1 = {“2”, “3”, “4”, “1”}
Polyhedron1 = {5.09, 6, 4.54, 4.72}
Pt1 = {(1.65, -1.76, 2.2), (3.44, -4.05, 1.89), (5.02, -1.6
List FaNm1
To get the Minkowski Sum of the projection of the polyhedron with the projection of its polar, click on the tool "Minkowski Sum" and then on the list of names of the polyhedron.
Input:


Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {"SetPointSize(OneFacePt1,1)", "SetColor
AvInst2 = {" Repeat(NbFa1,Execute(AvInst)) "}
FP1 =
FPcir1 = {{{2, 1}, {3, 3}, {4, 4}, {2, 1}}, {{1, 1}, {3, 2},
FPsort1 =
Fa1 = {{"D", "C", "A"}, {"D", "B", "A"}, {"A", "C", "B
FaNm1 = {"Face2", "Face3", "Face4", "Face1"}
FaProj1 = {0.9, 1.99, 4.01, 1.11}
Face1 = {"D", "B", "C"}
Face2 = {"D", "C", "A"}
Face3 = {"D", "B", "A"}
Face4 = {"A", "C", "B"}
Fadj1 = {{{2, 1}, {3, 3}, {4, 4}}, {{1, 1}, {3, 2}, {4, 4}},
InternPt1 = {{{(3.44, -4.05, 0), (3.44, -4.05, 0), (5.02,
InternPtNb1 = {2}
InternRec1 = {{0, 0, 0}}
MinSeg1 = {{{{1, 2}, {2, 3}}, {{1, 3}, {3, 1}}, {{1, 4}, {1
MinSegFa1 = {{{{1, 3}, {1, 3}}, {{1, 4}, {3, 4}}, {{1, 2},
OneFacePt1 = {{{1.65, -1.76, 0), (1.65, -1.76, 0), (5.0
OneFaceRec1 = {0, 0, 0}
PF1 =
List FaNm1
Scale1 = 0
ExternalFace1 = 1
This is the projection of the polar polyhedron
This is the Minkowski Sum
Input:


Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {" SetPointSize(OneFacePt1,1)", " SetColor
AvInst2 = {" Repeat(NbFa1,Execute(AvInst)) "}
FP1 =
FPcir1 = {{{2, 1}, {3, 3}, {4, 4}, {2, 1}}, {{1, 1}, {3, 2},
FPsort1 =
Fa1 = {{"D", "C", "A"}, {"D", "B", "A"}, {"A", "C", "B
FaNm1 = {"Face2", "Face3", "Face4", "Face1"}
FaProj1 = {0.65, 1.44, 2.89, 0.8}
Face1 = {"D", "B", "C"}
Face2 = {"D", "C", "A"}
Face3 = {"D", "B", "A"}
Face4 = {"A", "C", "B"}
Fadj1 = {{{2, 1}, {3, 3}, {4, 4}}, {{1, 1}, {3, 2}, {4, 4}},
InternPt1 = {{{3.4, -3.84, 0), (2.87, -3.51, 0), (4.21, -1
InternPtNb1 = {2}
InternRec1 = {{1.55, 0.86, 1.29}}
MinSeg1 = {{{1, 2}, {2, 3}}, {{1, 3}, {3, 1}}, {{1, 4}, {1
MinSegFa1 = {{{1, 3}, {1, 3}}, {{1, 4}, {3, 4}}, {{1, 2},
OneFacePt1 = {{(1.31, -0.67, 0), (1.35, -1.56, 0), (4.2
OneFaceRec1 = {2.54, 1.63, 2.03}
PF1 =
Scale1 = 0.15
ExternalFace1 = 1
Number Scale1
You can change the relative scale of both projections
Input:


Minkowski Sum blank.ggb
File Edit View Options Tools Window Help
Sign in
Algebra
Graphics
Graphics 2
3D Graphics
Boolean Value
AvComp = true
List
AvInst = {"SetPointSize(OneFacePt1,1)", "SetColor
AvInst2 = {" Repeat(NbFa1,Execute(AvInst)) "}
FP1 =
FPcir1 = {{{2, 1}, {3, 3}, {4, 4}, {2, 1}}, {{1, 1}, {3, 2},
FPsort1 =
Fa1 = {{"D", "C", "A"}, {"D", "B", "A"}, {"A", "C", "B
FaNm1 = {"Face2", "Face3", "Face4", "Face1"}
FaProj1 = {0.65, 1.44, 2.89, 0.8}
Face1 = {"D", "B", "C"}
Face2 = {"D", "C", "A"}
Face3 = {"D", "B", "A"}
Face4 = {"A", "C", "B"}
Fadj1 = {{{2, 1}, {3, 3}, {4, 4}}, {{1, 1}, {3, 2}, {4, 4}},
InternPt1 = {{{(0.27, -2.03, 0), (-0.25, -1.69, 0), (1.08,
InternPtNb1 = {2}
InternRec1 = {{1.55, 0.86, 1.29}}
MinSeg1 = {{{{1, 2}, {2, 3}}, {{1, 3}, {3, 1}}, {{1, 4}, {1
MinSegFa1 = {{{{1, 3}, {1, 3}}, {{1, 4}, {3, 4}}, {{1, 2},
OneFacePt1 = {{{-1.82, 1.15, 0), (-1.78, 0.26, 0), (1.0
OneFaceRec1 = {2.54, 1.63, 2.03}
PF1 =
Point D_xy(0.05, -0.06)
Scale1 = 0.15
ExternalFace1 = 1
You can shift the polyhedron closer to the 0Z axis for better clarity
Input:



You can select which face is the "external face" (to visualise forces in compression and tension, etc.)