

MODELAÇÃO GEOMÉTRICA E GENERATIVA



20241115



BEATRIZ MARTINS

U LISBOA

UNIVERSIDADE
DE LISBOA



FACULDADE DE ARQUITETURA
UNIVERSIDADE DE LISBOA

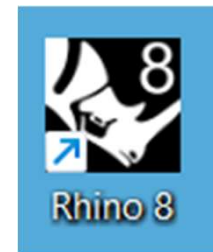
MGG

Mestrado Integrado em Arquitectura
Ano Lectivo 2025-2026 2º Semestre
Docente - Nuno Alão 2º Ano





INSTALAÇÃO DO RHINO



Filezilla: <ftp.fa.ulisboa.pt>

Aula. 1 – Apresentação.

APRESENTAÇÃO DO PROGRAMA
ANÁLISE DA INTERFACE
COMPARAÇÃO COM PROGRAMAS USADOS ANTERIORMENTE.
EXERCÍCIOS PARA USO DE COMANDOS BÁSICOS: FORMAS ARQUIMEDIANAS CUBO
TRUNCADO A $\frac{1}{3}$ DA ARESTA

Aula. 2 – Sumário.

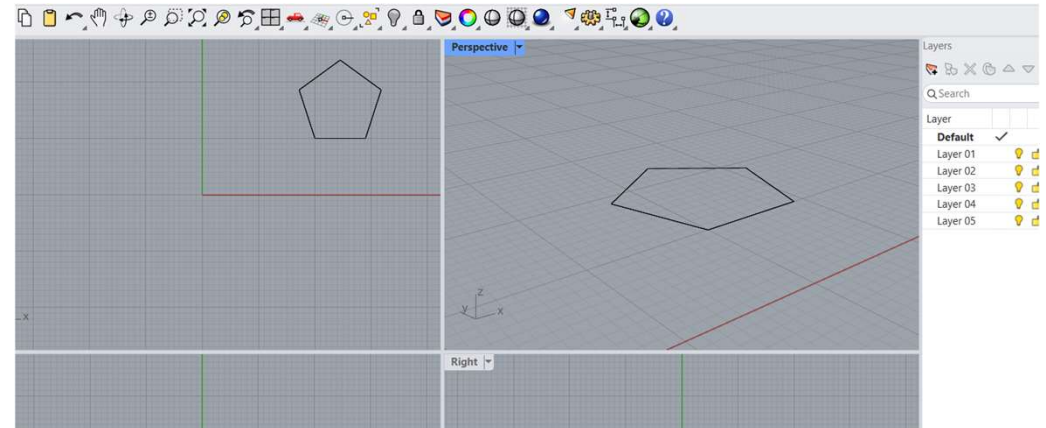
Files – NEW – escolher
medidas

COMANDOS

- LINHA (LI) –
- POLYLINE –
 - U – UNDO
- SINGLE POINT-
 - WIRECUT-
 - ARRAY POLAR
- DOT – pequena bolha de
texto que pode ser
alterada

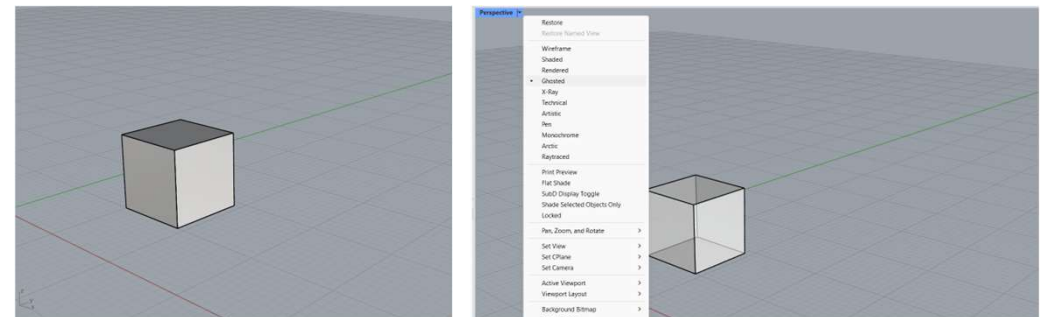
POLYLINE

20,10
@9<72
@9<144
@9<216
C

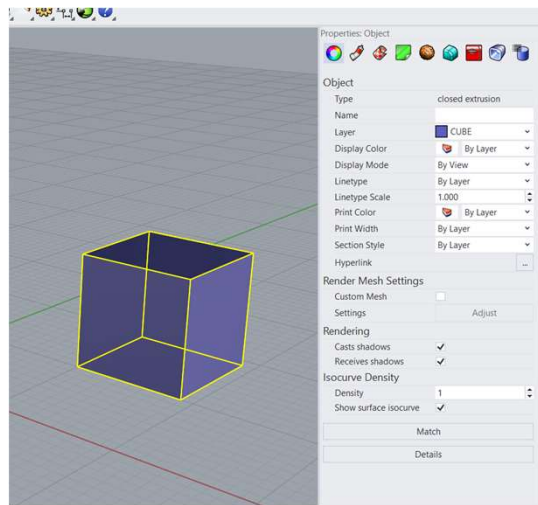


CUBE

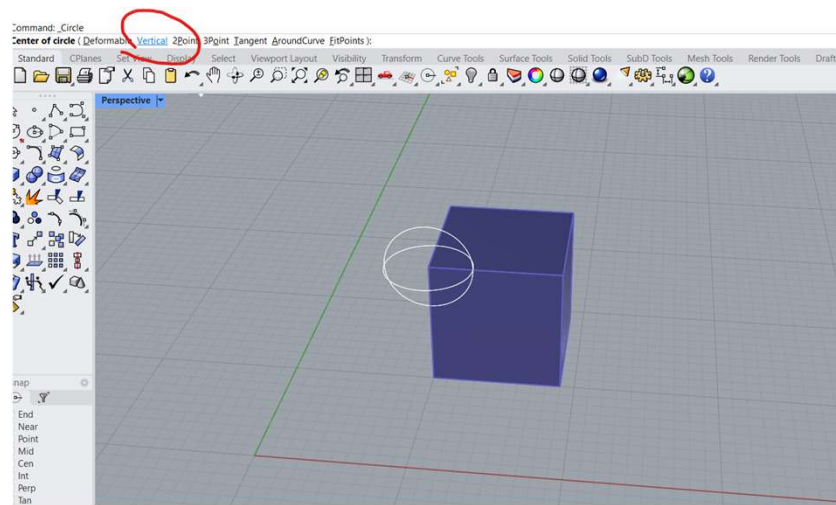
10,10
@9,9
9



Aula. 2.



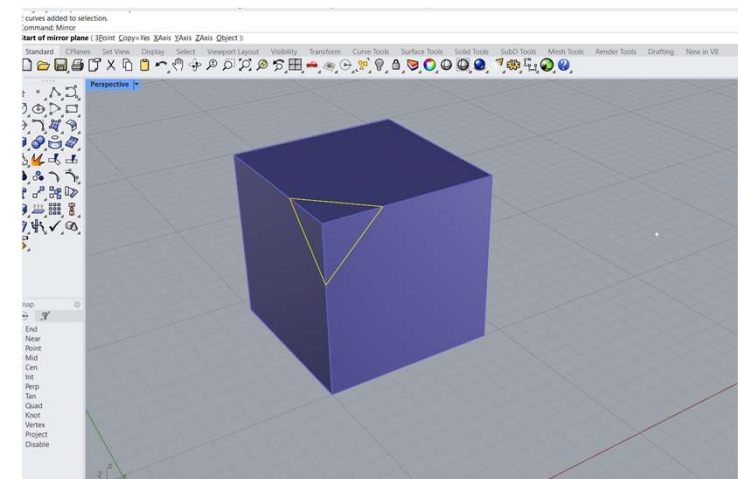
Para trocar um elemento de camada selecionar o objeto e ir a propriedades



CIRCLE – 1/3 da aresta – criar círculo horizontal e vertical

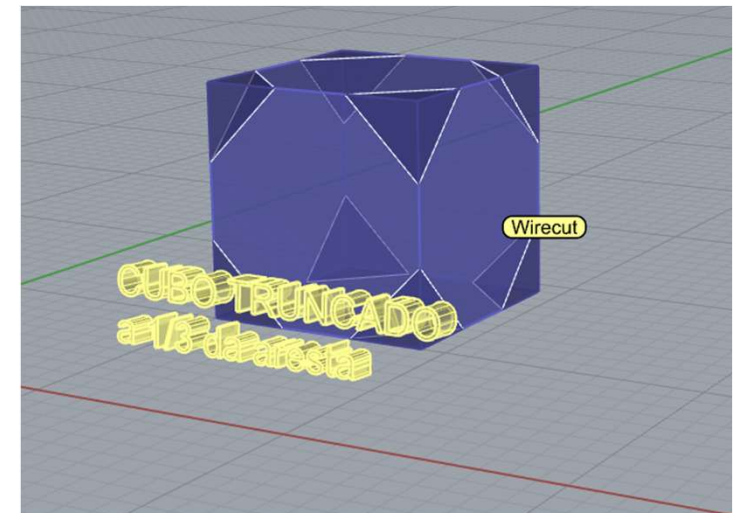
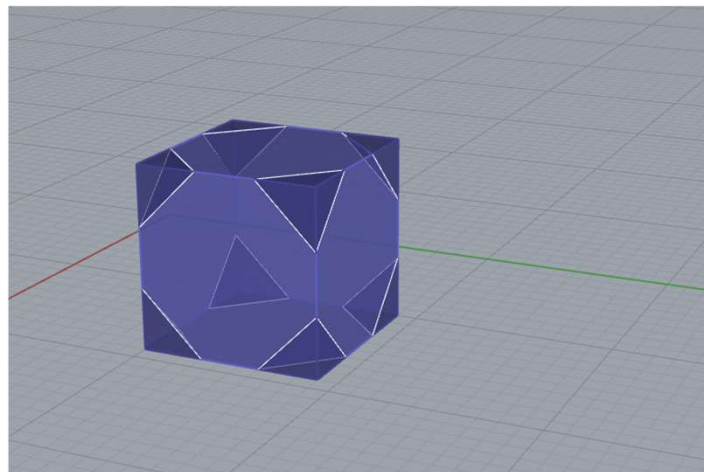
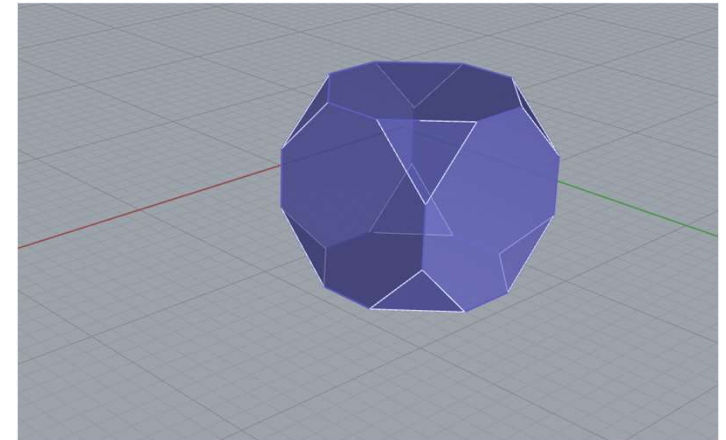
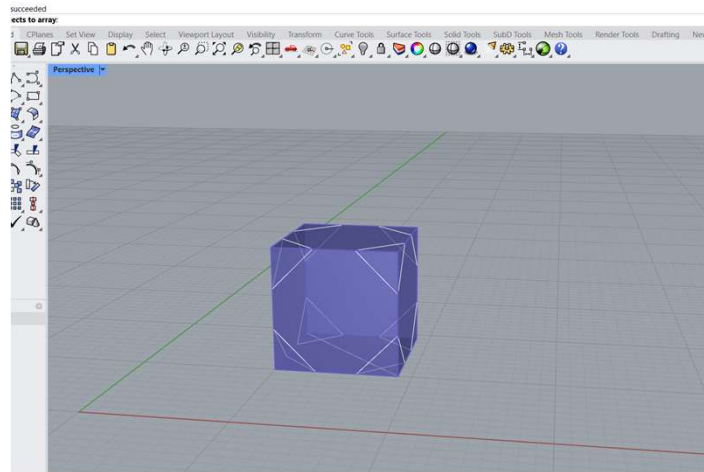
POLYLINE – unir intercessões

MIRROR – para o vértice de baixo



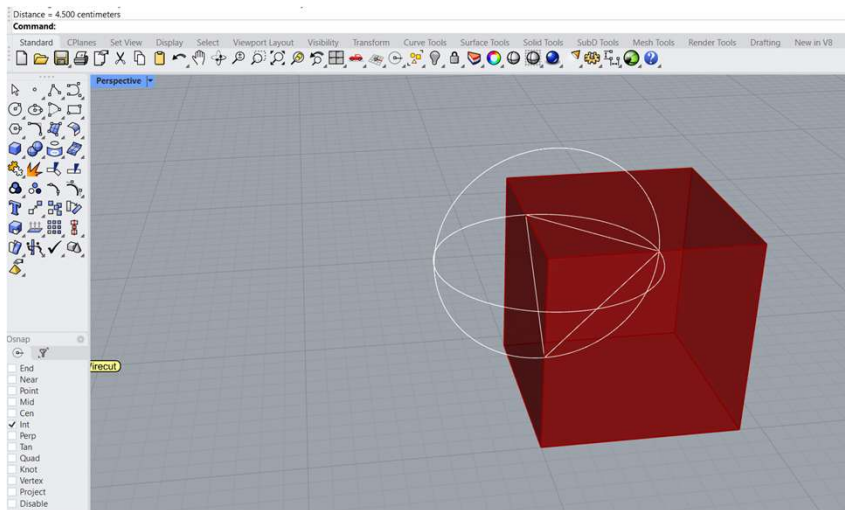
Aula. 2.

ARRAY POLAR - Select -
Axis - Select mid points - 360° -
repetir para todos os vértices
WIRECUT - select line - enter
- select cube - enter - puxar -
separa os vértices criados do resto
do polígono
Mudar vértices para outra camada
e removê-los

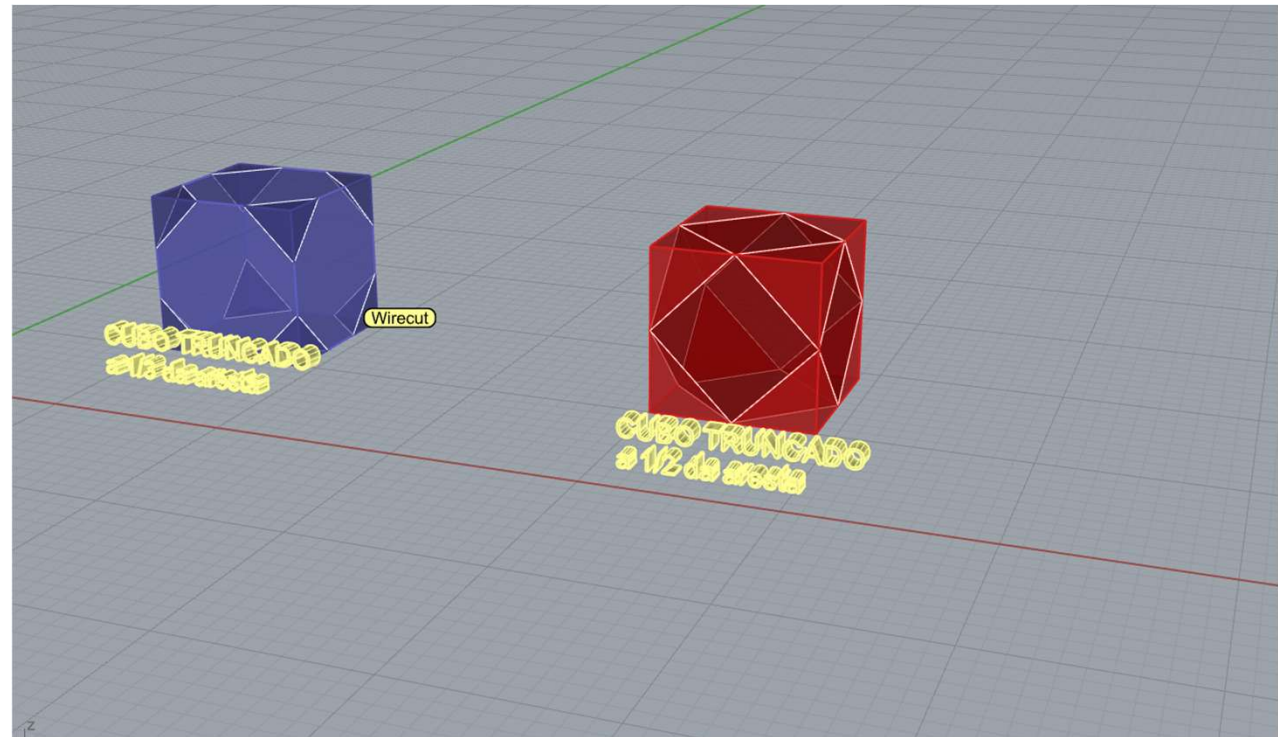


Aula. 2.

BOX – Criar um cubo (9 un por 9 un)
CIRCLE – 1/2 da aresta – criar círculo horizontal e vertical
POLYLINE – unir intercessões
Ou utilizar a função **MID** do **OSNAP** para criar os triângulos em volta dos vértices
WIRECUT – **select line** – **enter** – **select cube** – **enter** –
puxar – separa os vértices criados do resto do polígono
Mudar vértices para outra camada e removê-los



TPC - CUBOCTAEDRO



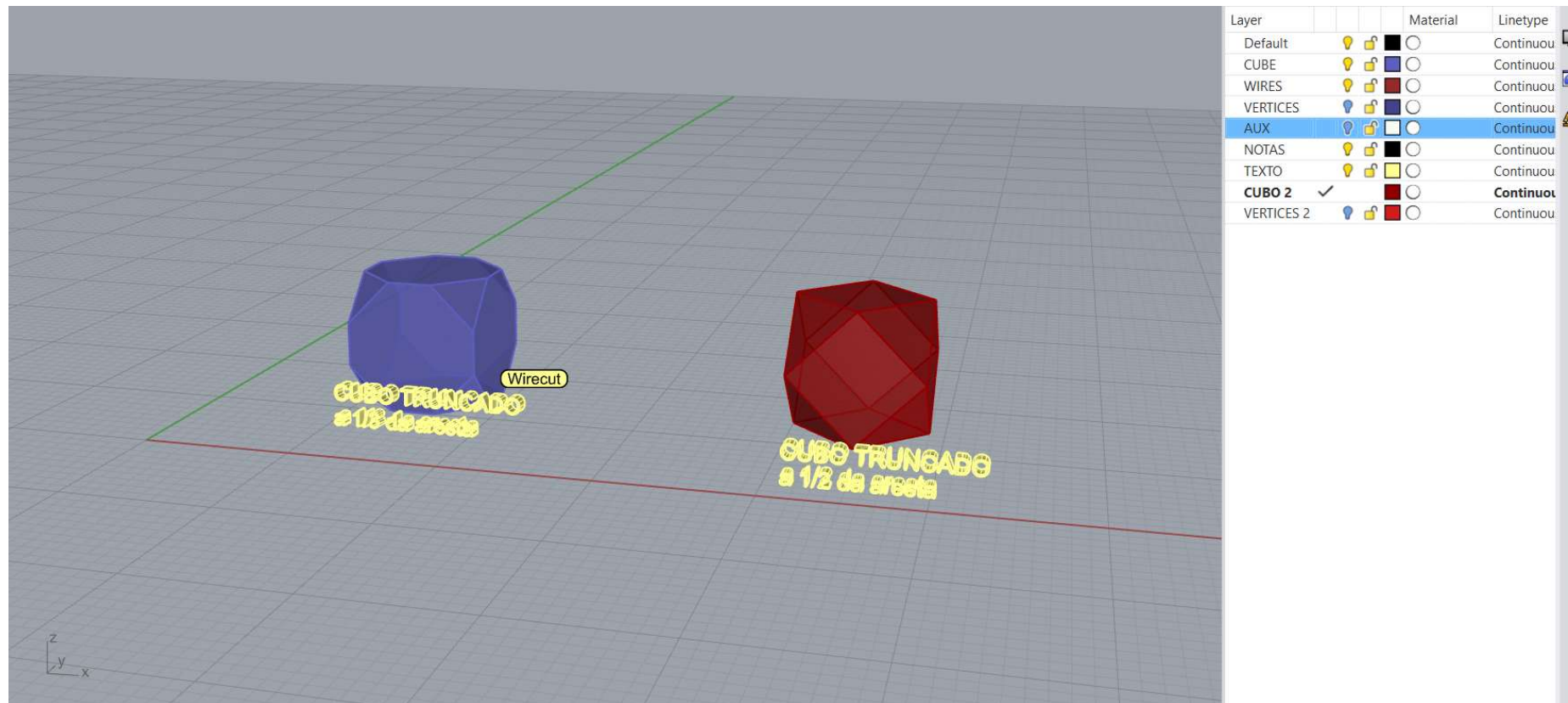
Aula. 2.

-

DETERMINAÇÃO DOS POLIEDROS DUAIS DAS FORMAS DETERMINADAS
CUBO TRUNCADO E CUBOCTAEDRO
CONSTRUÇÃO DO DODECADERO TRUNCADO E SEM DUAL

Aula. 3 – Sumário.

CUBO TRUNCADO E CUBOCTAEDRO



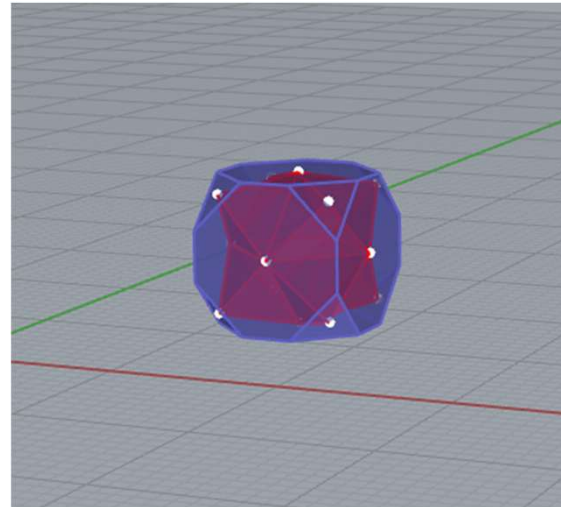
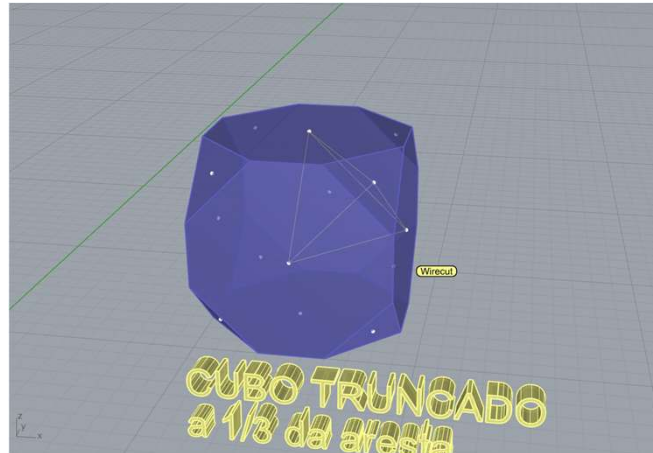
Aula. 3.

POINT – colocar um ponto no centro de todas as faces do sólido utilizando a função CEN do OSNAP

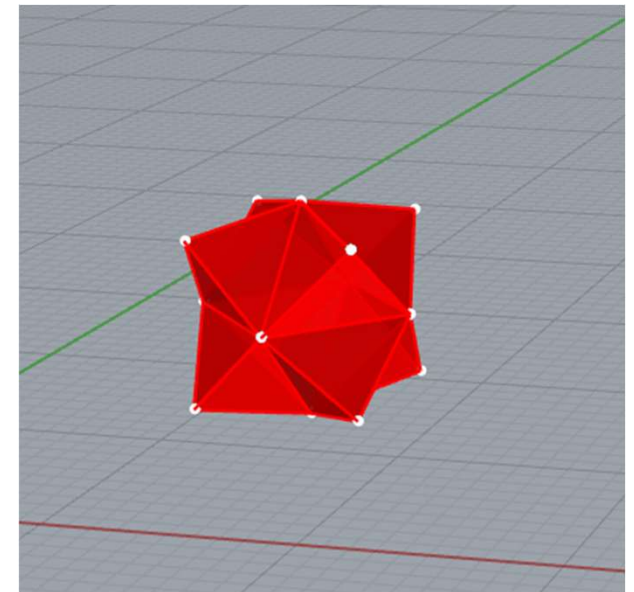
POLYLINE - unir determinados pontos

SURFACE FROM PLANAR CURVES – tornar linhas em faces

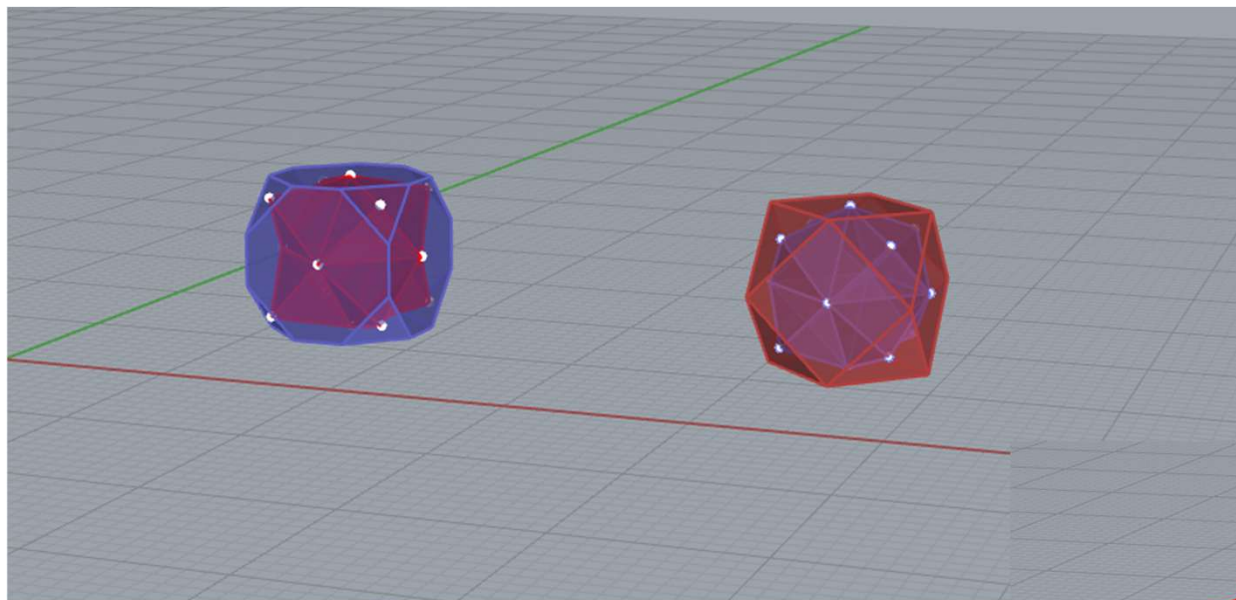
ARRAY POLAR – 4 – 360° – para completar o sólido



DUAL DE UM CUBO TRUNCADO A 1/3 DE ARESTA

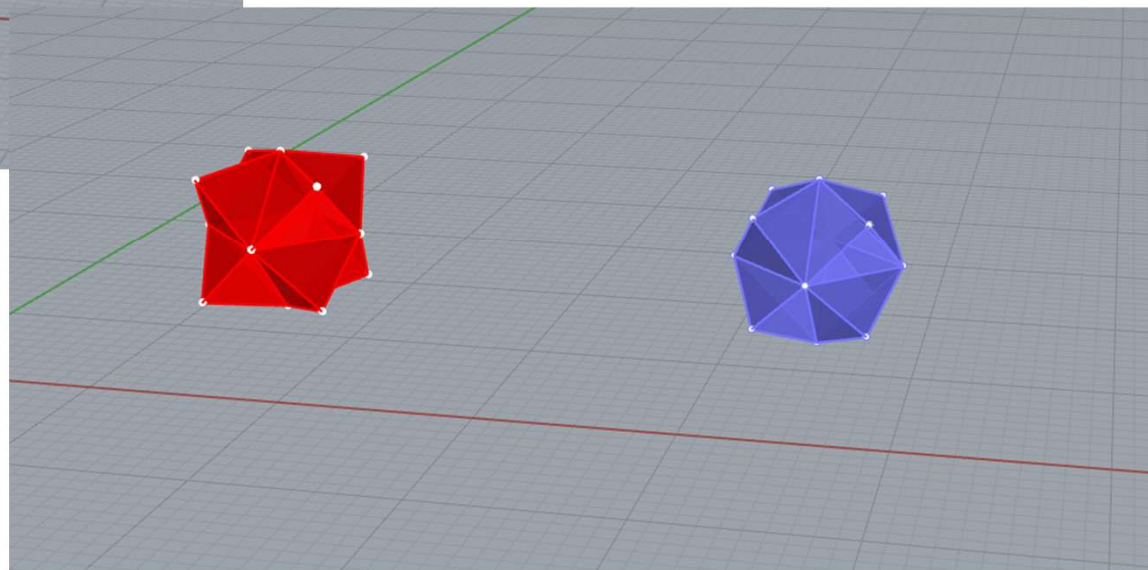


Aula. 3.



DUAIS

Repetir processo para o
cuboctaedro



Aula. 3.

MODELAÇÃO E ANÁLISE DOS SÓLIDOS ARQUIMEDIANOS

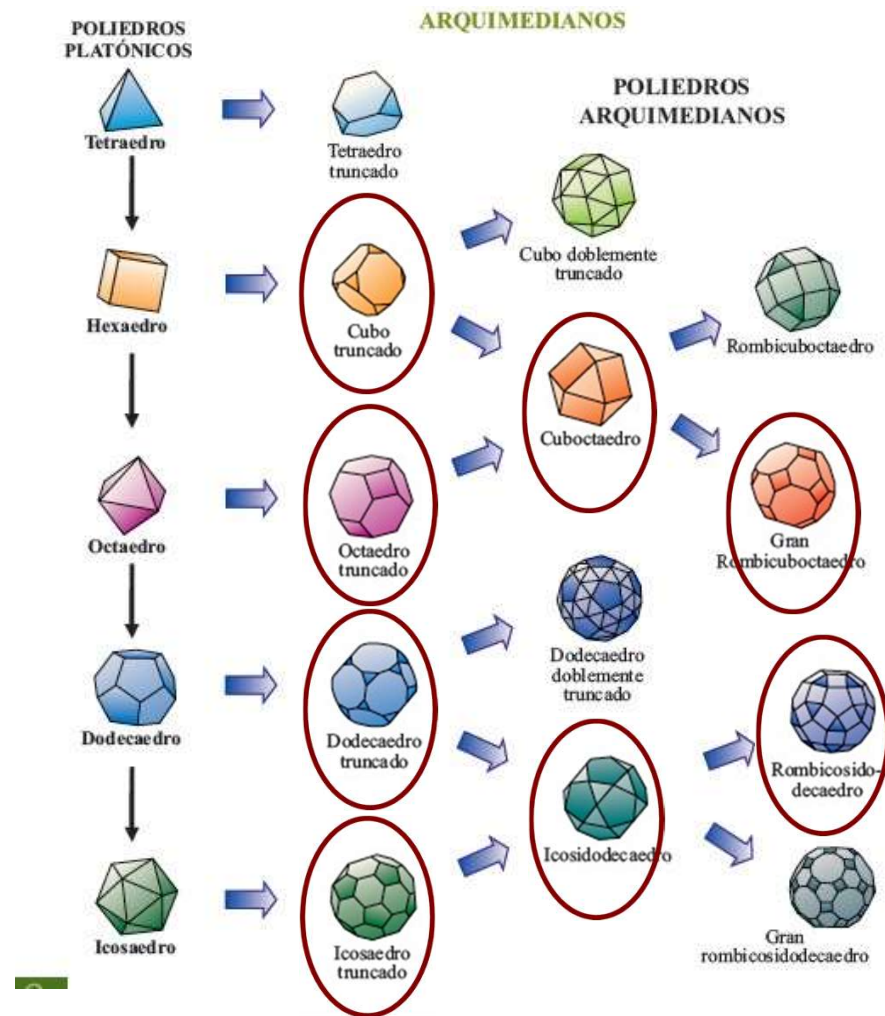
Trabalho 1.

Trabalho: 7 sólidos arquimedianos – até
15/03

Com os respectivos duais
Escolher da foto

Os 2 da aula contam para o trabalho
- entrega:

Layout do caderno diário (bem
apresentado, em render ou planta | vista |
alçado – no rhino)
Ficheiro do trabalho



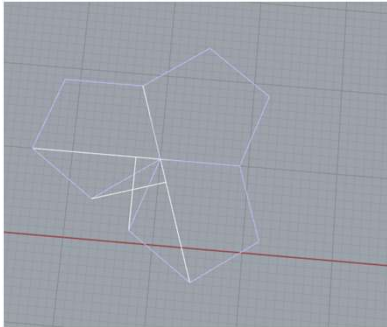
Trabalho 1.

**PENTAGONO:
POLYLINE**

@9<0
@9<72
@9<144
@9<216
c

MIRROR (2x)

Prolongar as linhas
Linha perpendicular do
vértice até á linha
oposta



CÍRCULO – Vertical – com o centro a intercessão da linha prolongada com a perpendicular

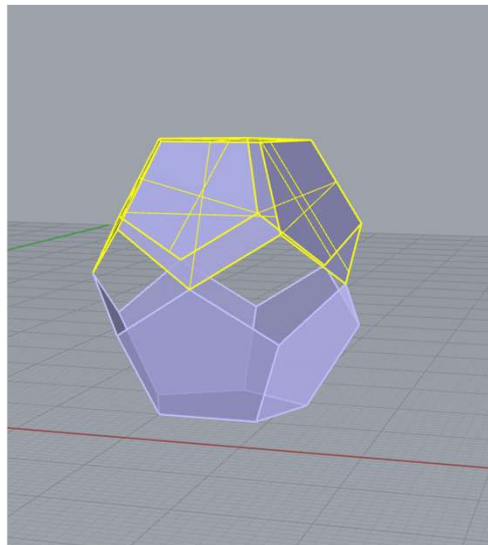
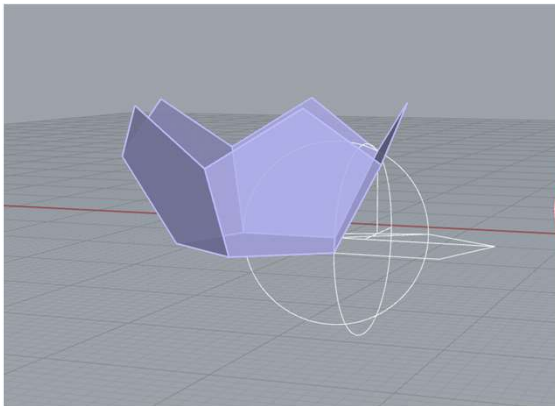
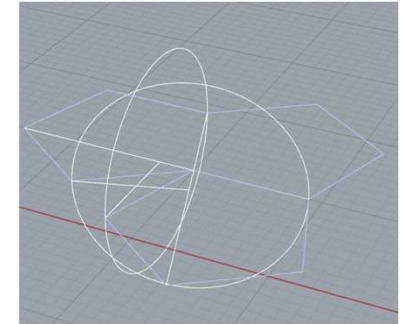
ROTATE 3D – Axis - linha junto do pentágono inicial e arrastar aresta mais próxima para o ponto onde os círculos se intercetam

SURFACE FROM PLANAR CURVES – criar face

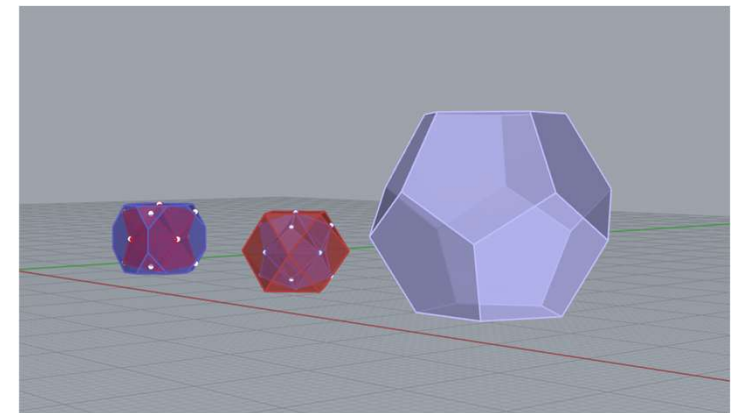
MIRROR – para fazer as outras faces do polígono

MIRROR – 3 pontos – colocar fig em cima

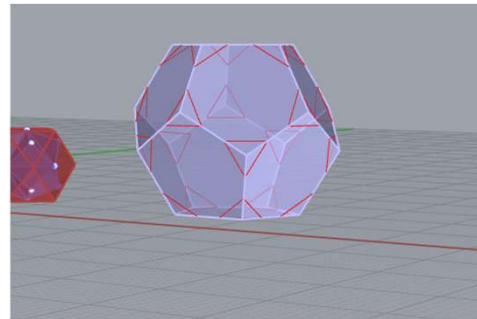
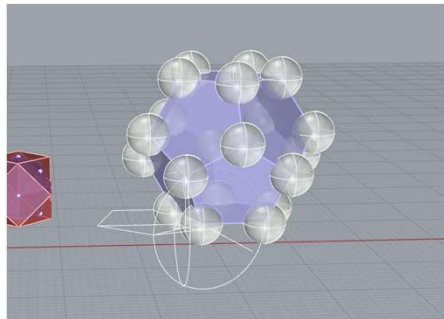
ROTATE – 36° - arrastar para baixo



DODECAEDRO



Trabalho 1.

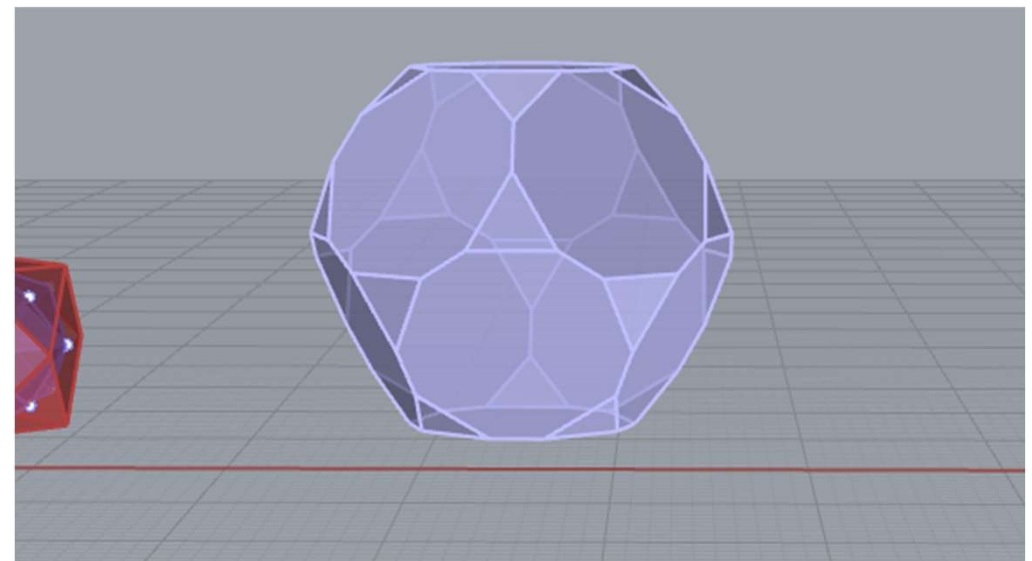
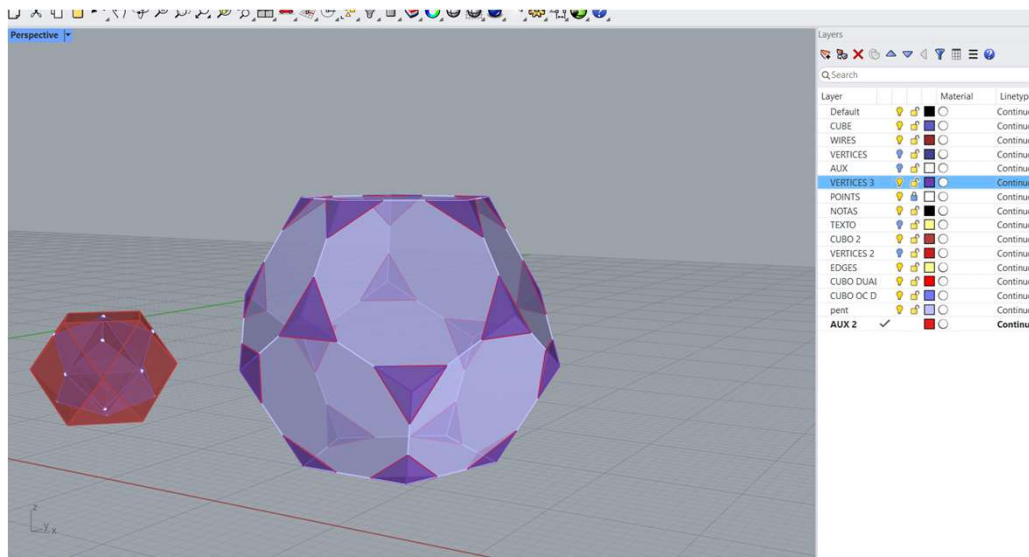


SHFERE – 3 un de raio ($1/3$ da aresta) – em todos os vértices
BOOLEAN DIFFERENCE – select esfera – enter – select figura – enter
 – dá nos a intercessão da esfera com as arestas

POLYLINE – desenhar os triângulos que serão retirados

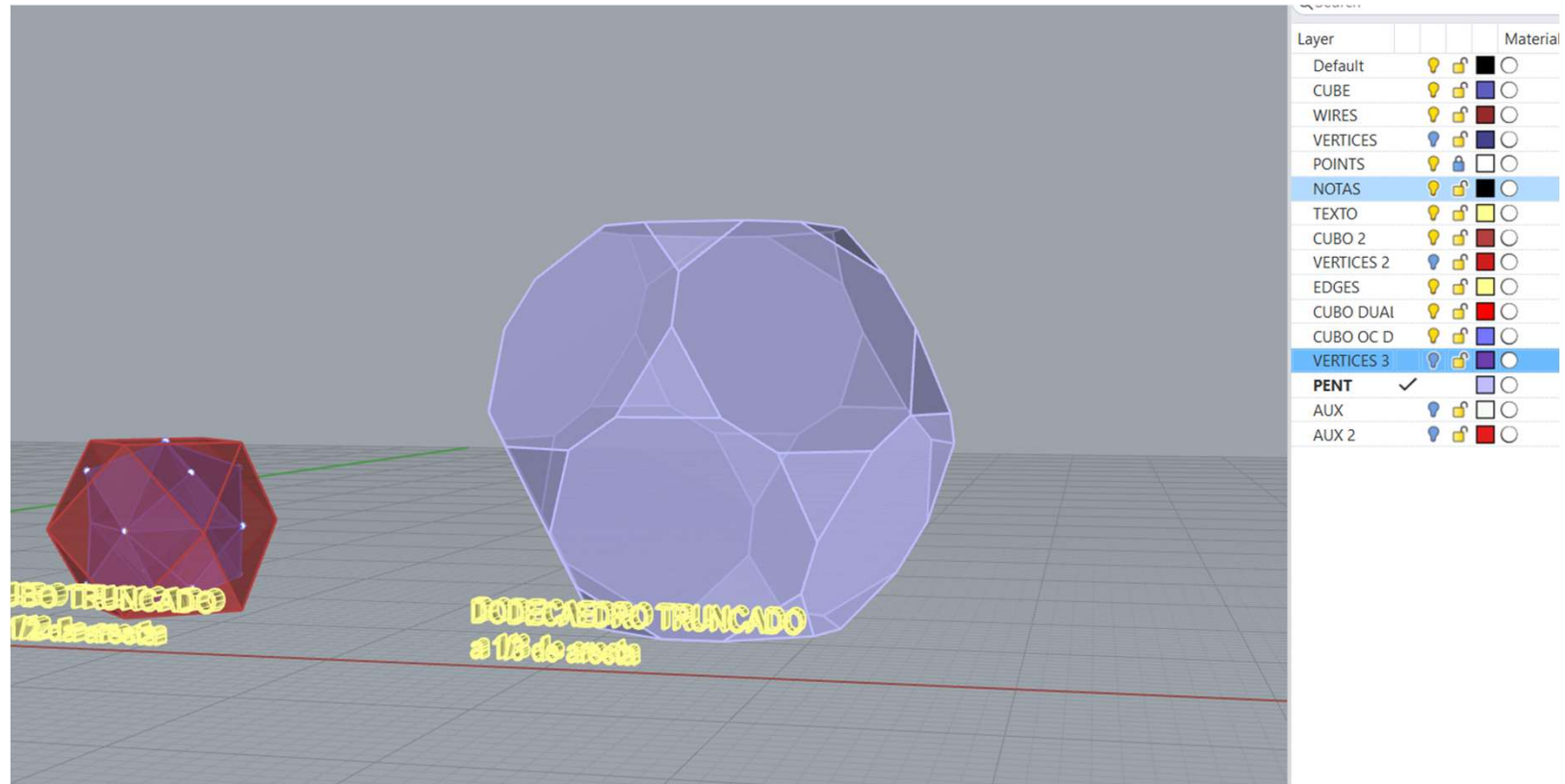
WIRE CUT – linhas – enter – fig – enter – puxar – separa os vértices do polígono

Passar vertices para outra camada e escondê-los

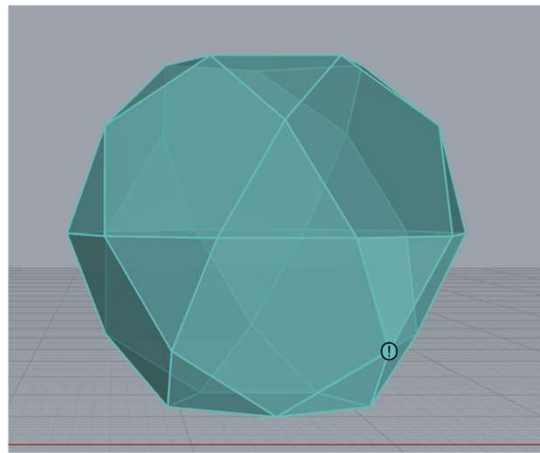
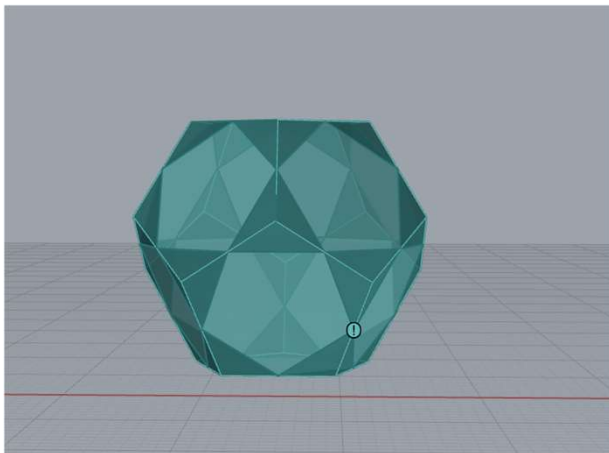
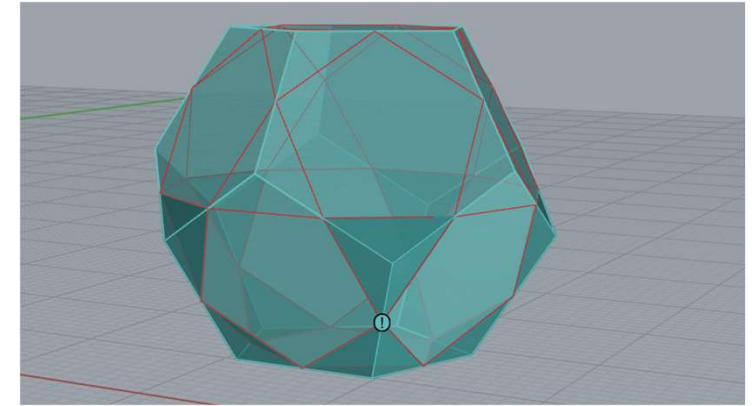
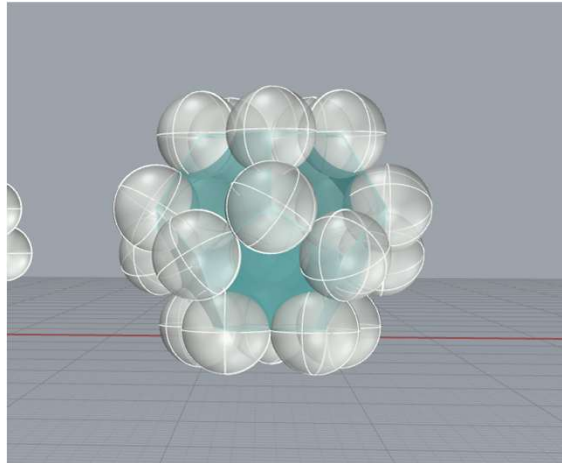
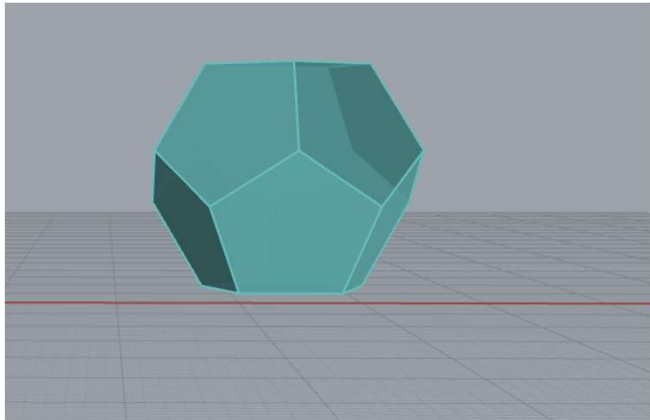


Trabalho 1.

DODECAEDRO TRUNCADO



Trabalho 1.



Iniciamos com um dodecaedro

SPHERE – 4.5 un de raio ou $\frac{1}{2}$ da aresta – colocar em todos os vértices

BOOLEAN DIFFERENCE – **select esfera** – **enter** – **select figura** – **enter** – dá nos a intercessão da esfera com as arestas

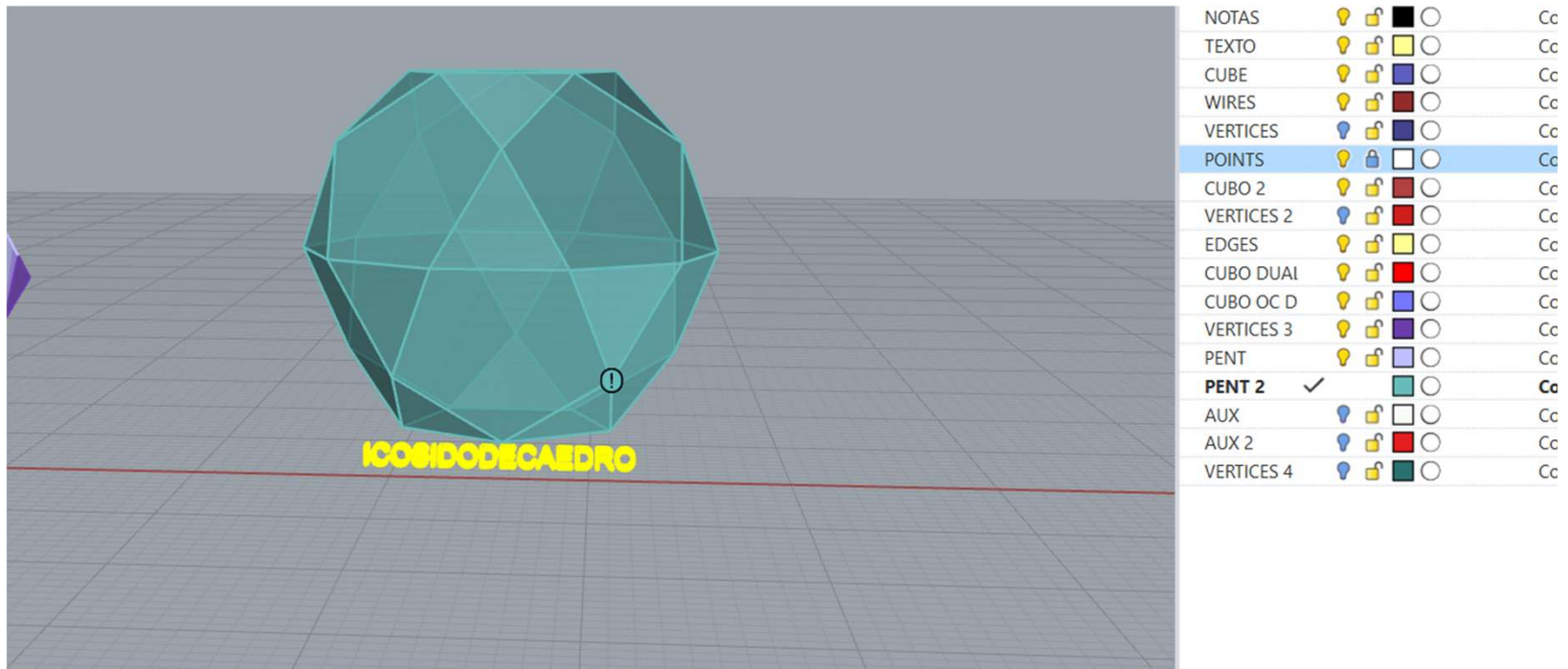
POLYLINE – desenhar os triângulos que serão retirados

WIRE CUT – **linhas** – **enter** – **fig** – **enter** – **puxar** – separa os vértices do polígono

Passar vértices para outra camada e escondê-los

Trabalho 1.

ICOSIDODECAEDRO



Trabalho 1.

A partir do icosidodecaedro

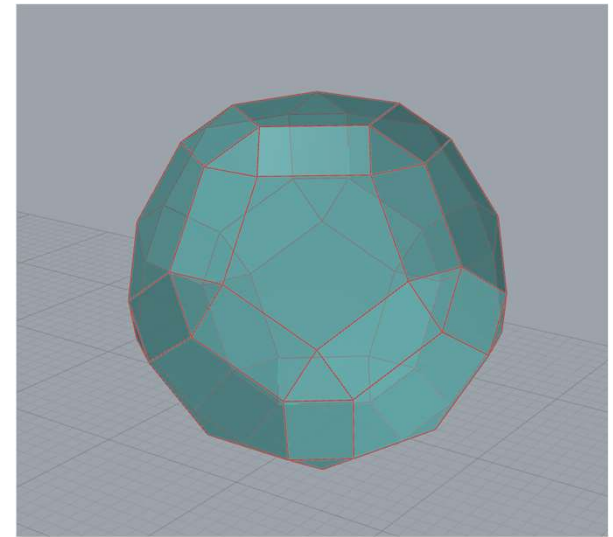
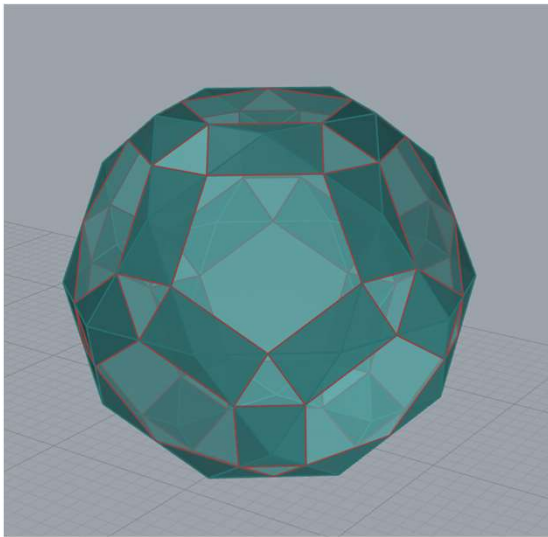
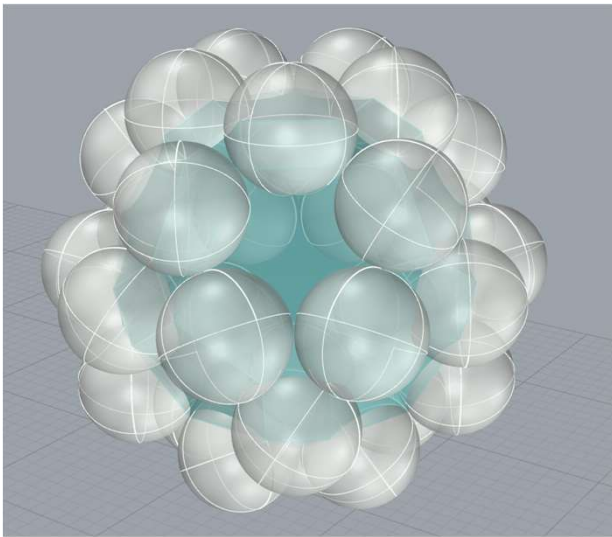
SPHERE – $\frac{1}{2}$ da aresta – colocar em todos os vértices

BOOLEAN DIFFERENCE – **select esfera** – **enter** – **select figura** – **enter** – dá nos a intercessão da esfera com as arestas

POLYLINE – desenhar os triângulos que serão retirados

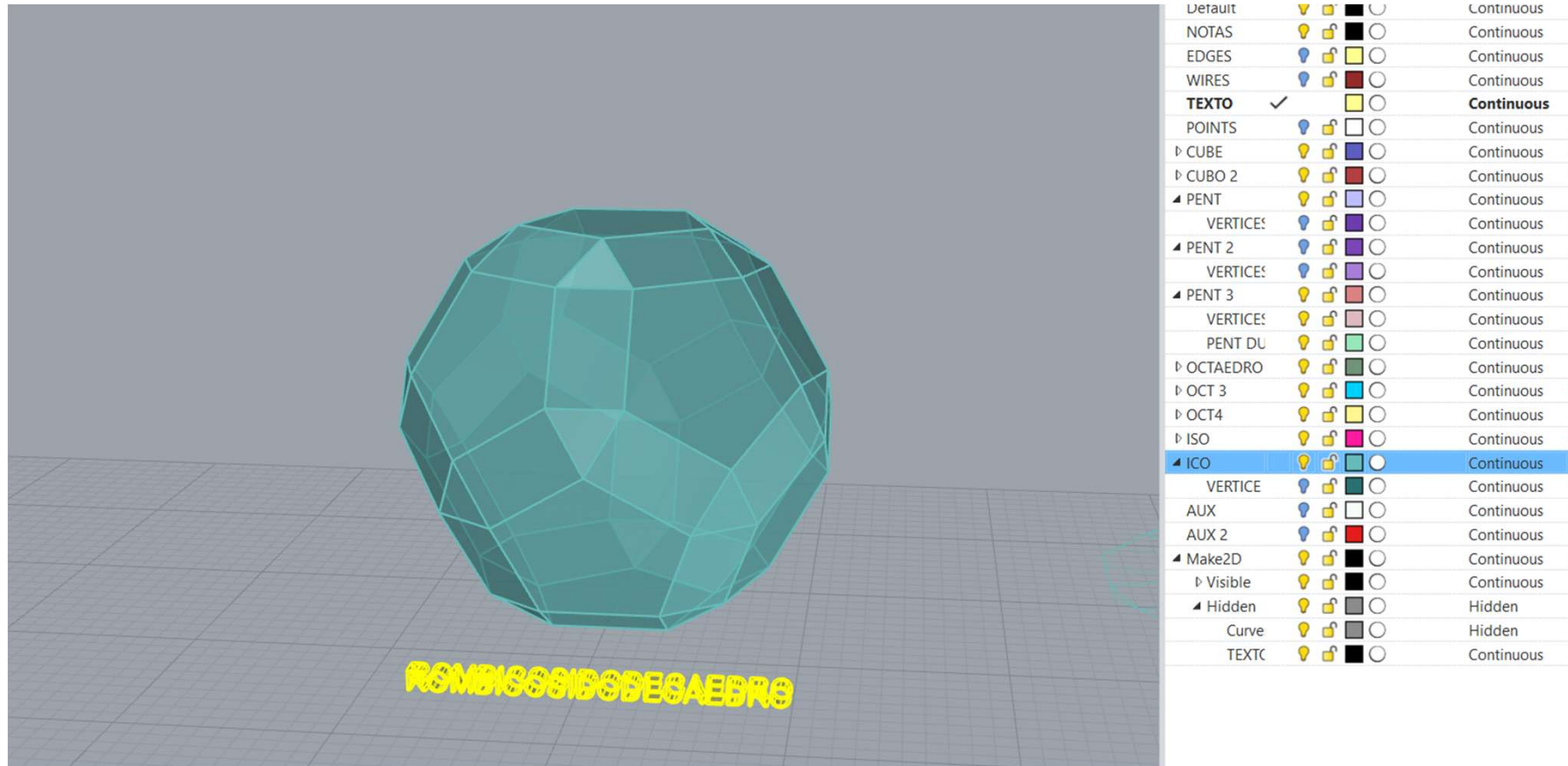
WIRECUT – **linhas** – **enter** – **fig** – **enter** – **puxar** – separa os vértices do polígono

Passar vértices para outra camada e escondê-los

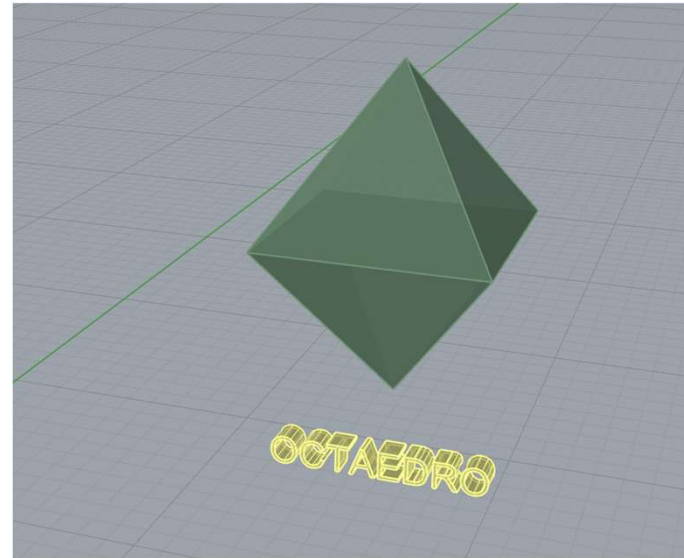
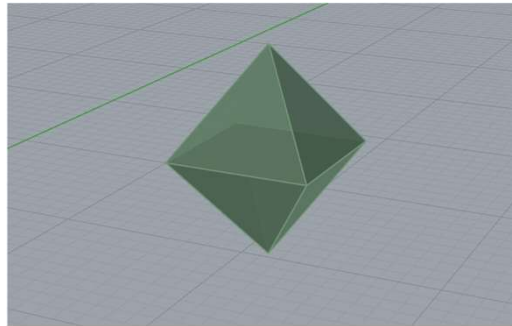
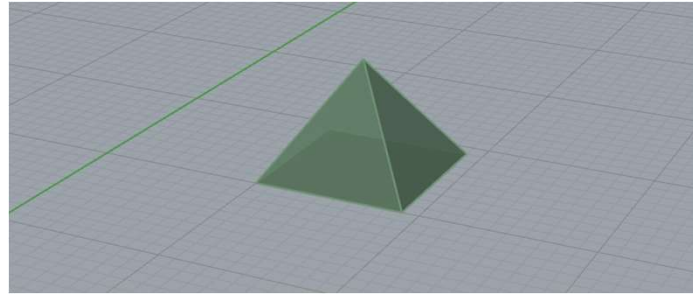
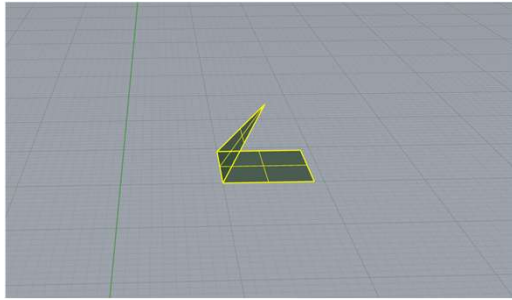


Trabalho 1.

ROMBICOSIDODECAEDRO



Trabalho 1.



OCTAEDRO

POLYLINE – criar um quadrado (9 un por 9 un)

-linha vertical no centro do quadrado

- Linha horizontal a meio de uma das arestas

CIRCLE – centro num dos vértices e raio de 9

SURFACE FROM 3 OR 4 CORNERS – criar uma das faces (triângulo)

ROTATE 3D – rodar o triângulo até á linha vertical no centro do quadrado

ARRAY POLAR – select face – 4 – 360 – para completar a pirâmide

MIRROR – 3 pontos – para obter uma pirâmide invertida

JOIN – juntar todas as faces para se tornar num só sólido

Trabalho 1.

A partir do octaedro

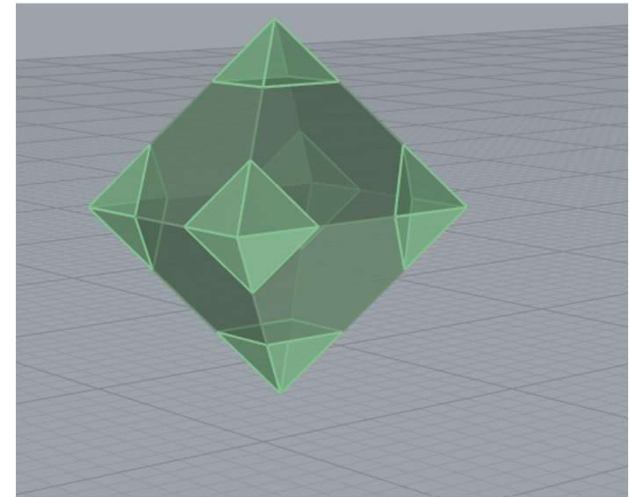
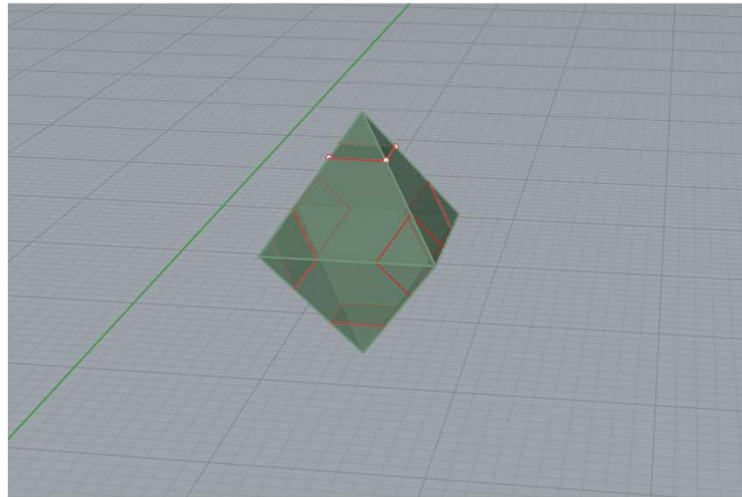
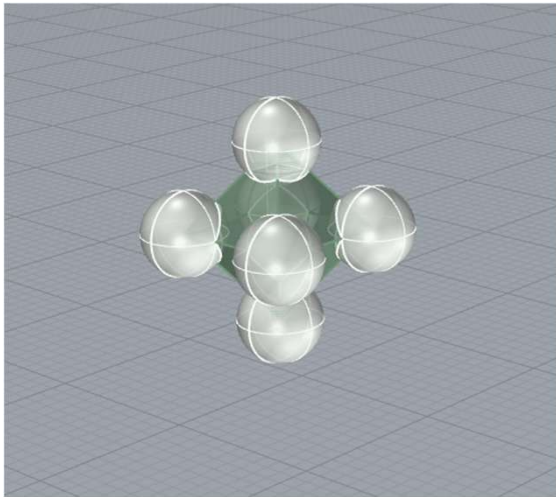
SHFERE – 3 un de raio ($1/3$ da aresta) – em todos os vértices

BOOLEAN DIFFERENCE – select esfera – enter – select figura – enter – dá nos a intercessão da esfera com as arestas

POLYLINE – desenhar os triângulos que serão retirados

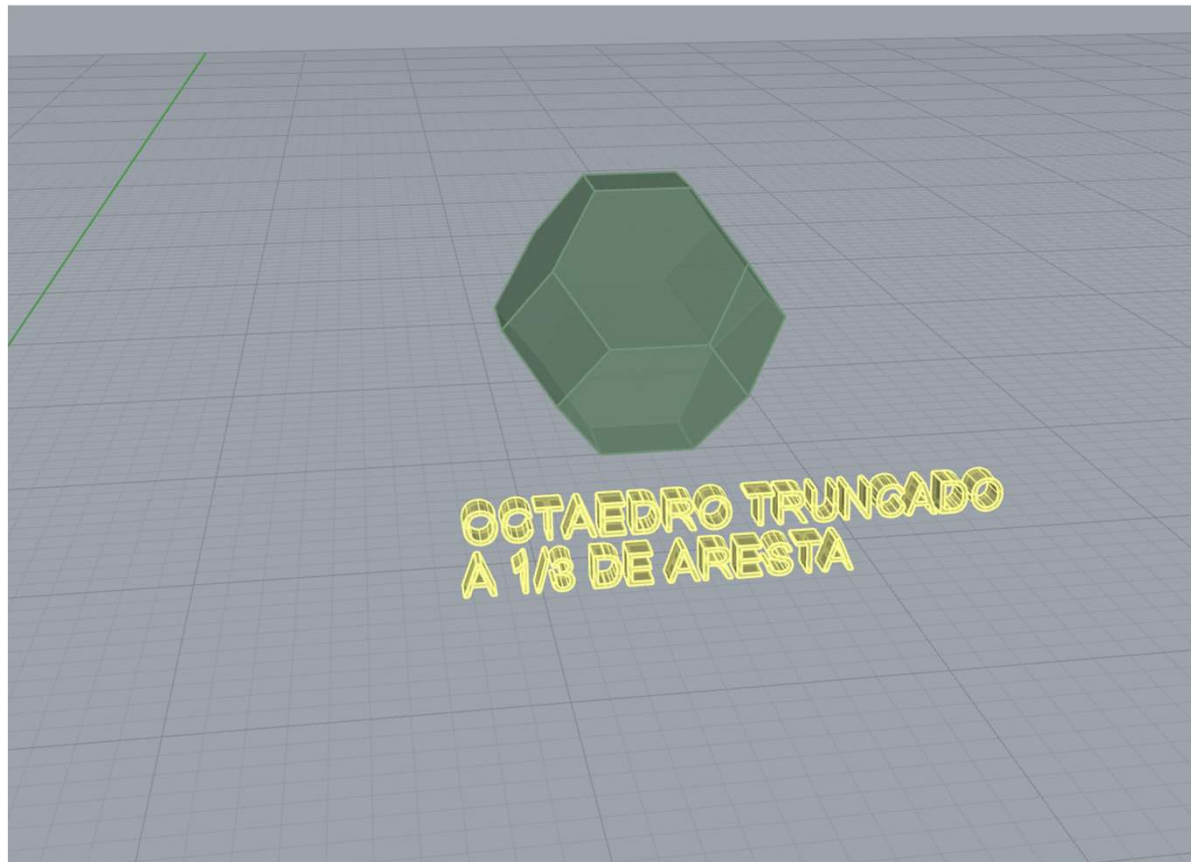
WIRECUT – linhas – enter – fig – enter – puxar – separa os vértices do polígono

Passar vértices para outra camada e escondê-los



Trabalho 1.

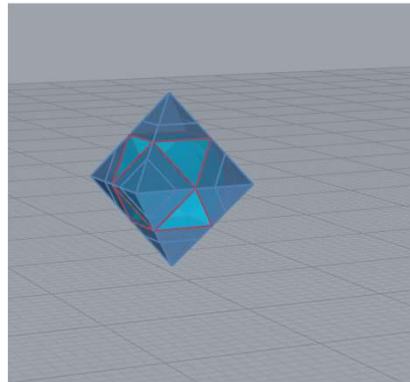
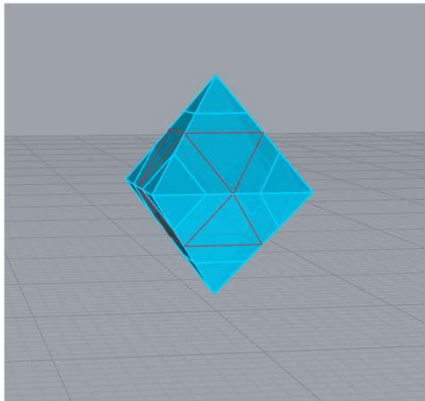
OCTAEDRO TRUNCADO



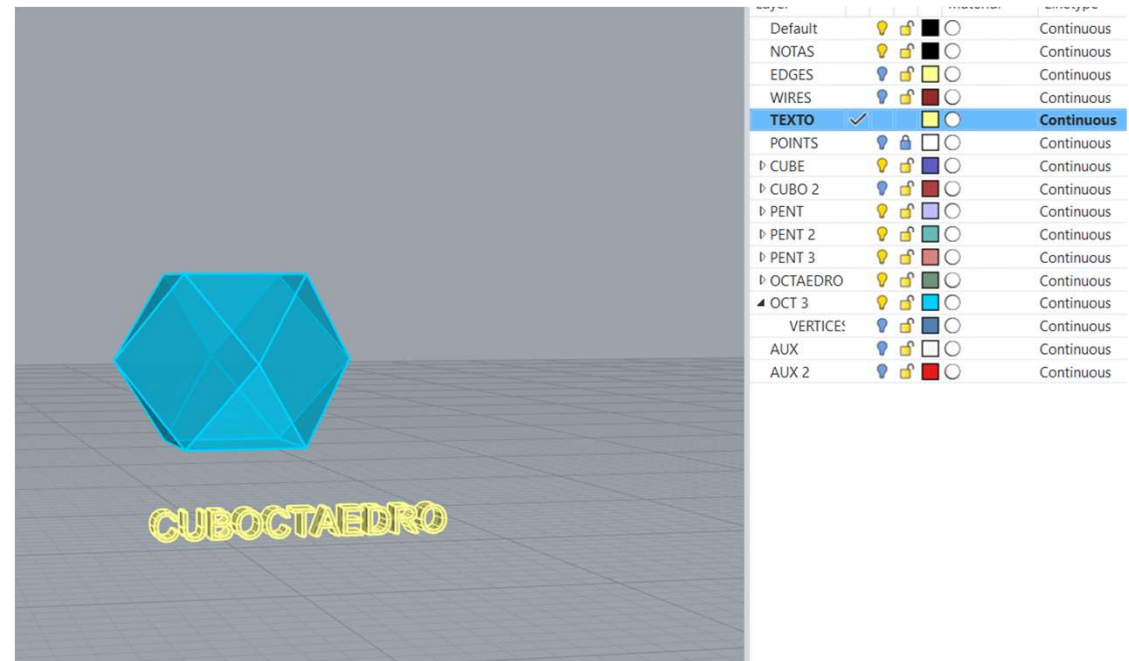
Layer		Material	Linetype
Default			Continuous
NOTAS			Continuous
TEXTO			Continuous
CUBE			Continuous
WIRES			Continuous
VERTICES			Continuous
POINTS			Continuous
CUBO 2			Continuous
VERTICES 2			Continuous
EDGES			Continuous
CUBO DUAL			Continuous
CUBO OC D			Continuous
PENT DUAL			Continuous
PENT			Continuous
VERTICES 3			Continuous
PENT 2			Continuous
PENT 3			Continuous
VERTICES 5			Continuous
VERT6			Continuous
OCTAEDRO			Continuous
VERTICES 4			Continuous
AUX			Continuous
AUX 2			Continuous

Trabalho 1.

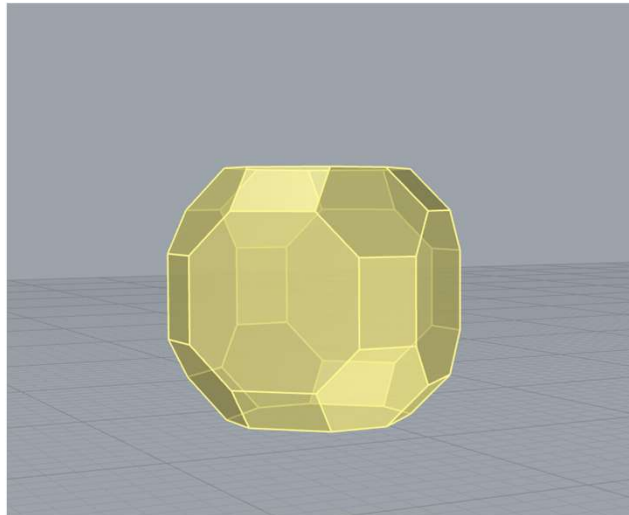
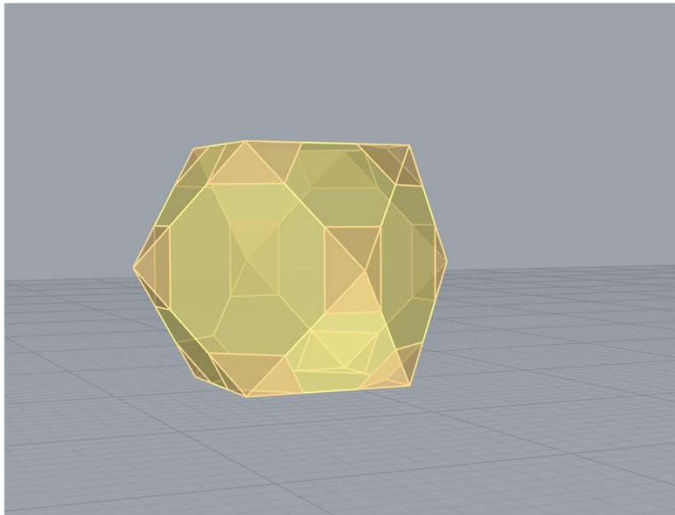
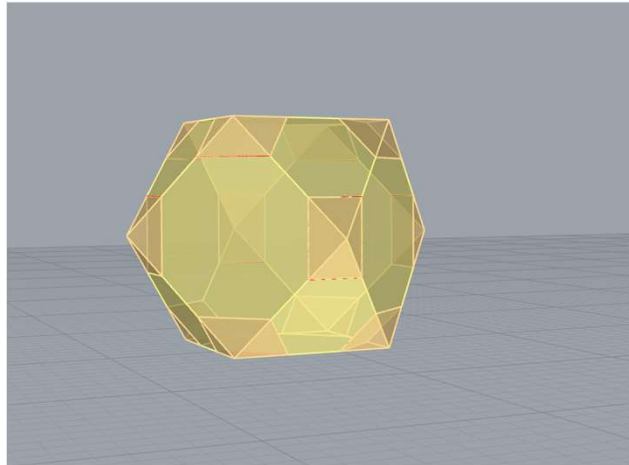
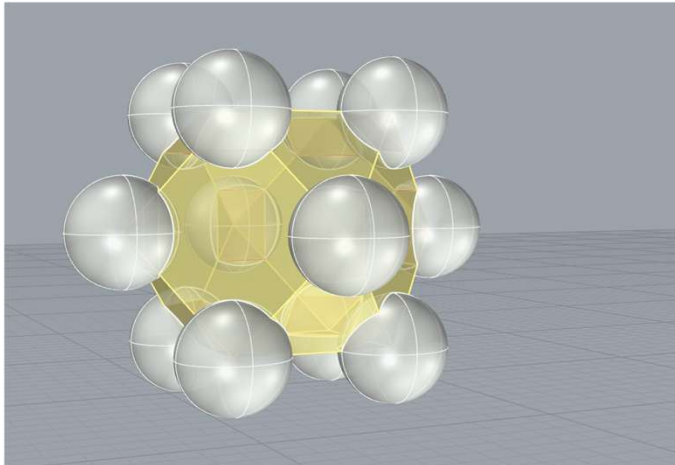
A partir do octaedro
POLYLINE – desenhar triângulos com vértices a meio das
arestas do octaedro que serão retirados
WIRE CUT – linhas – enter – fig – enter – puxar –
separa os vértices do polígono
Passar vértices para outra camada e escondê-los



CUBOCTAEDRO A PARTIR DE UM OCTAEDRO



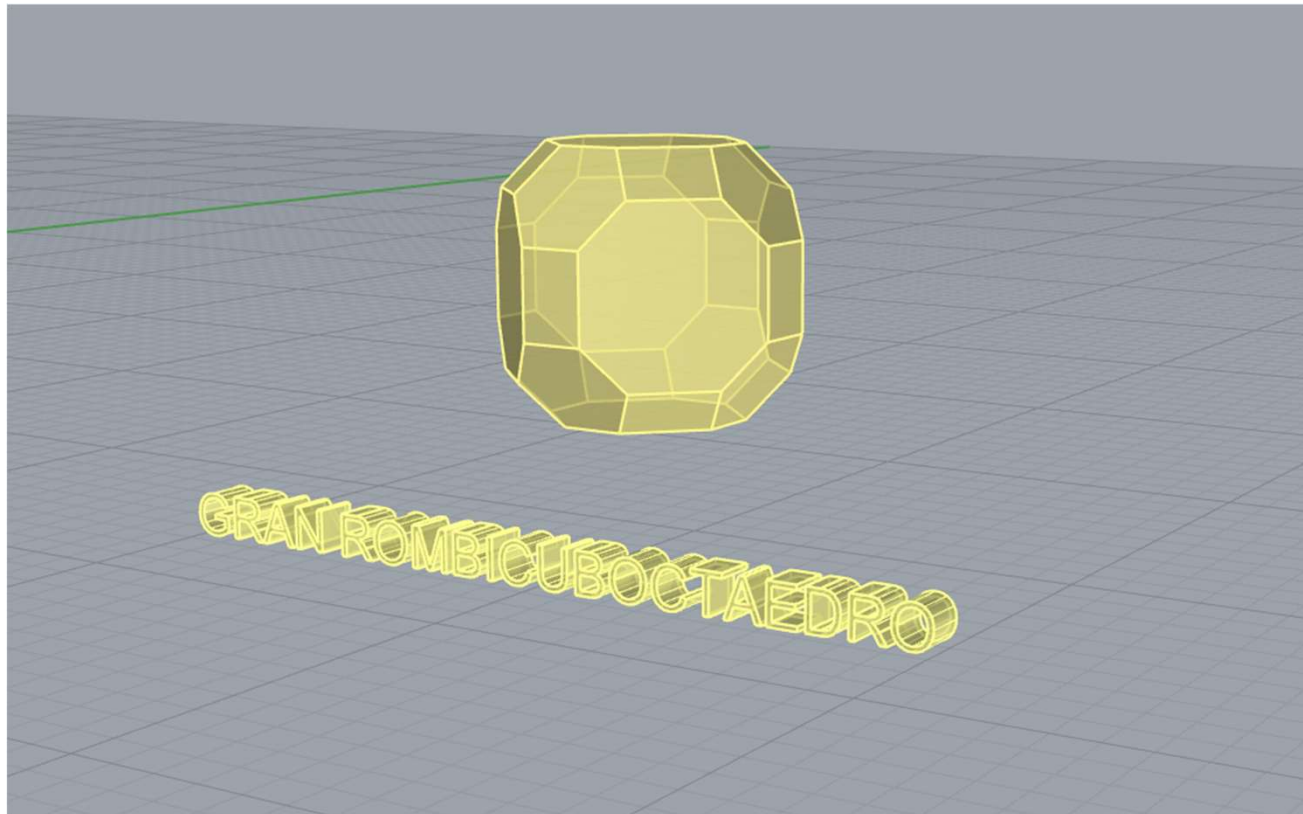
Trabalho 1.



A partir do cuboctaedro
SHFERE – 1,5 un de raio ($1/3$ da aresta) – em todos os vértices
BOOLEAN DIFFERENCE – **select esfera** – **enter** – **select figura** – **enter** – dá nos a intercessão da esfera com as arestas
POLYLINE – desenhar os triângulos que serão retirados
WIRECUT – **linhas** – **enter** – **fig** – **enter** – **puxar** – separa os vértices do polígono
 Passar vértices para outra camada e escondê-los

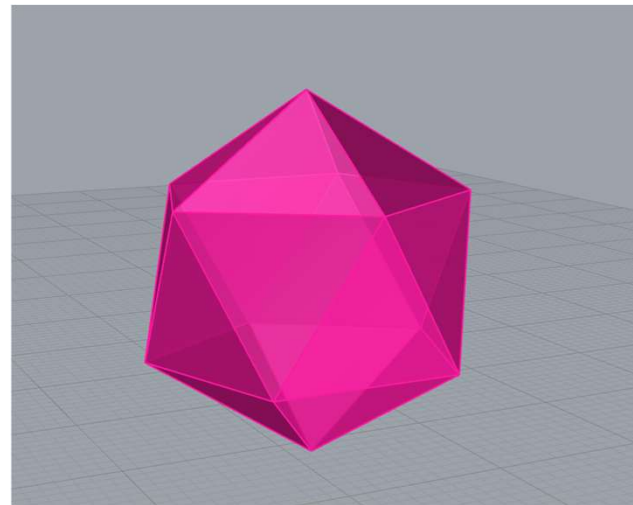
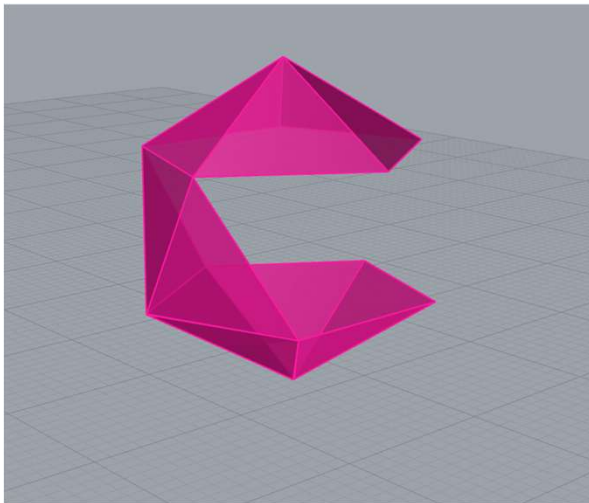
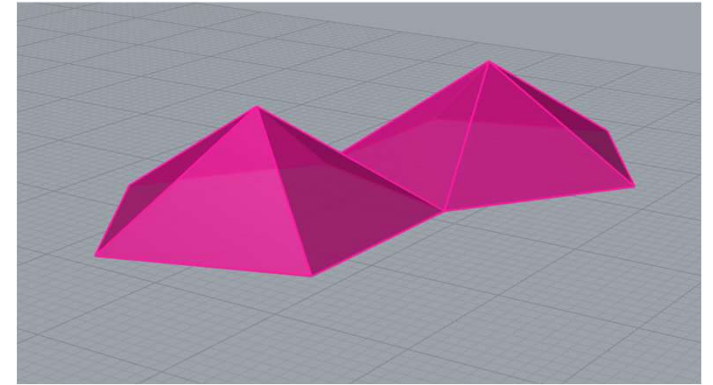
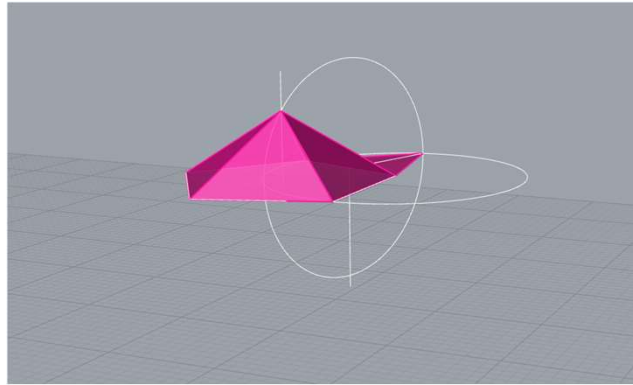
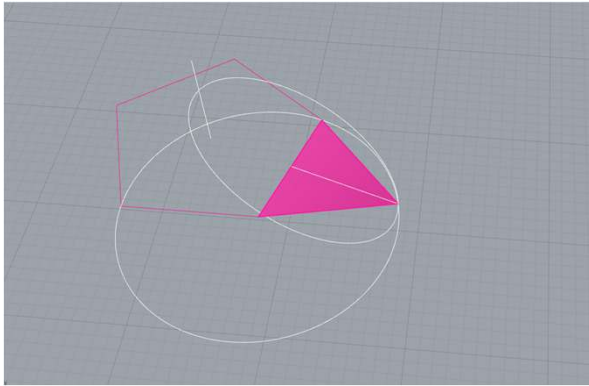
Trabalho 1.

GRAN ROMBICUBOCTARDRO



Default					Continuous
NOTAS					Continuous
EDGES					Continuous
WIRES					Continuous
TEXTO					Continuous
POINTS					Continuous
▷ CUBE					Continuous
▷ CUBO 2					Continuous
▷ PENT					Continuous
▲ PENT 2					Continuous
VERTICES					Continuous
▲ PENT 3					Continuous
PENT DU					Continuous
VERT6					Continuous
▷ OCTAEDRO					Continuous
▲ OCT 3					Continuous
VERTICES					Continuous
▲ OCT4					Continuous
VERTICES					Continuous
AUX					Continuous
AUX 2					Continuous

Trabalho 1.



ICOSAEDRO

POLYLINE – criar pentágono (aresta de 9 un)

Criar uma pirâmide pentagonal

SURFACE FROM 3 OR 4 CORNERS – para criar as faces

COPY – copiar a pirâmide

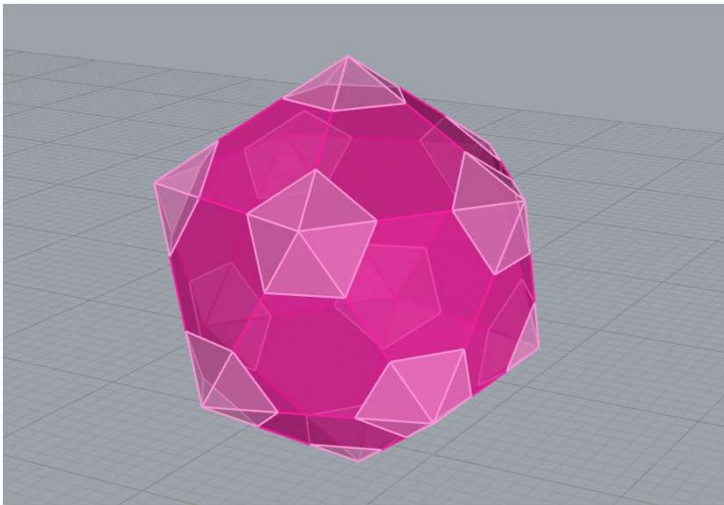
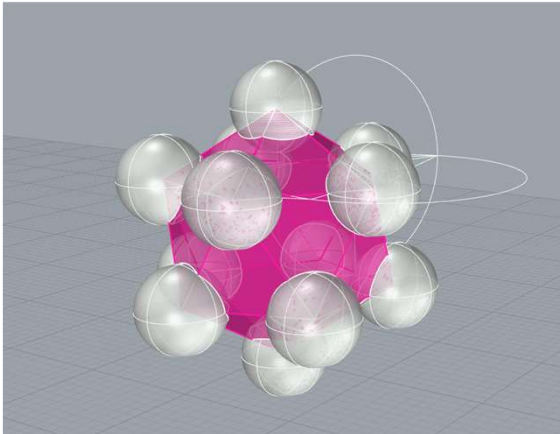
Alinhar pirâmide copiada

MIRROR – 3 pontos - para baixo

ROTATE – 36° - criara a base do polígono

ARRAY POLAR – 5 – 360° - em 2 faces para completar o sólido

Trabalho 1.



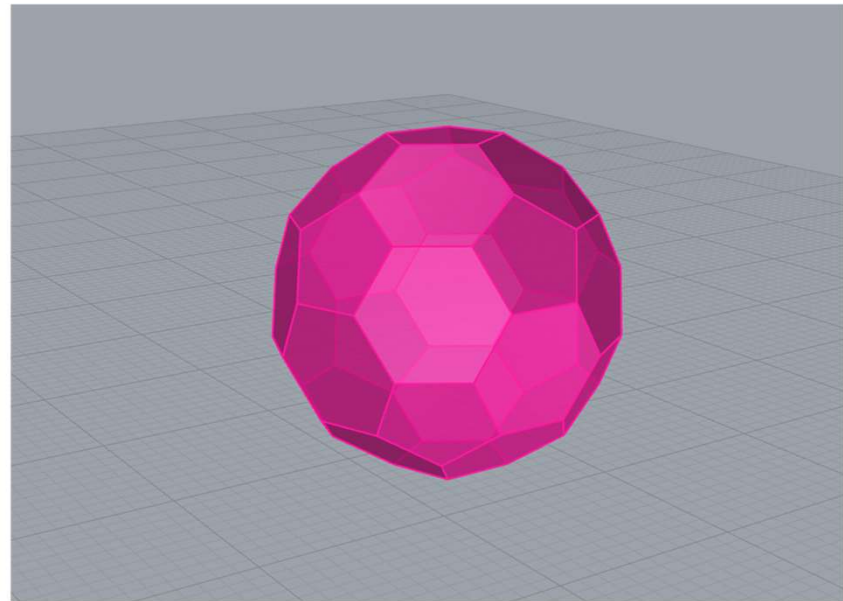
A partir do icosaedro

SHFERE – 1/3 da aresta – em todos os vértices

BOOLEAN DIFFERENCE – **select esfera** – **enter** – **select figura** – **enter** – dá nos a intercessão da esfera com as arestas

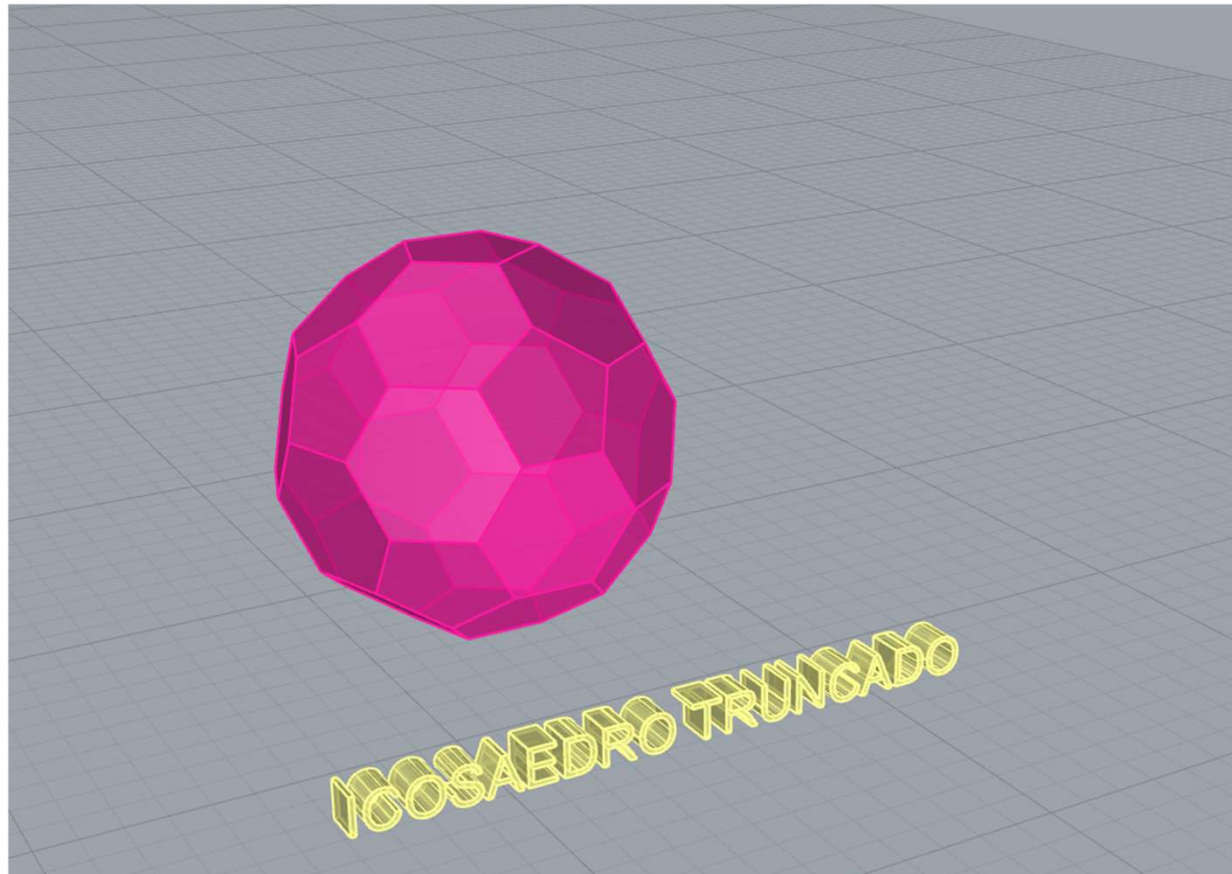
POLYLINE – desenhar os triângulos que serão retirados

WIRECUT – **linhas** – **enter** – **fig** – **enter** – **puxar** – separa os vértices do polígono
Passar vértices para outra camada e escondê-los



Trabalho 1.

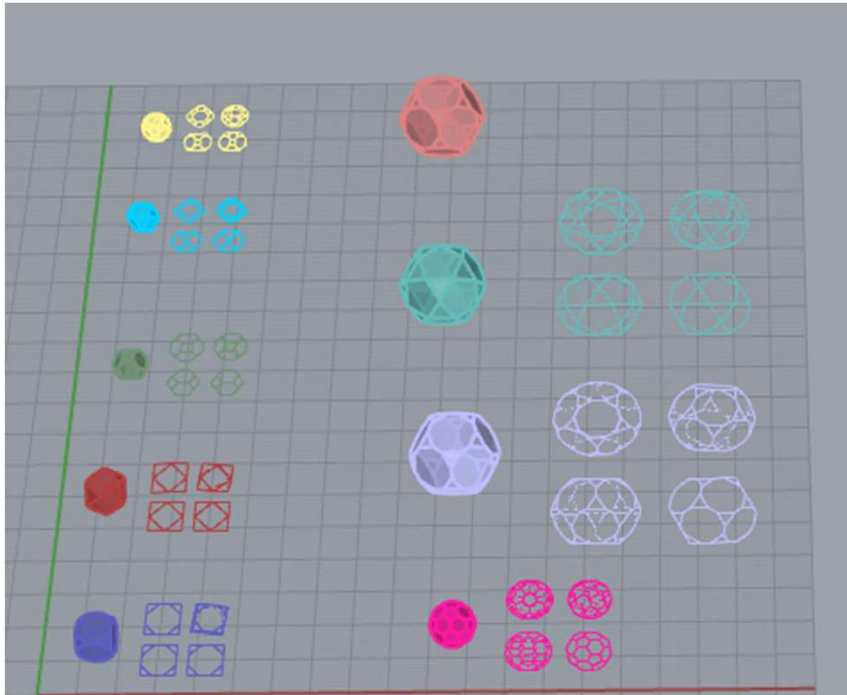
ICOSAEDRO TRUNCADO



Default					Continuous
NOTAS					Continuous
EDGES					Continuous
WIRES					Continuous
TEXTO					Continuous
POINTS					Continuous
▸ CUBE					Continuous
▸ CUBO 2					Continuous
▸ PENT					Continuous
▴ PENT 2					Continuous
VERTICES!					Continuous
▴ PENT 3					Continuous
PENT DL					Continuous
VERT6					Continuous
▸ OCTAEDRO					Continuous
▴ OCT 3					Continuous
VERTICES!					Continuous
▴ OCT4					Continuous
VERTICES!					Continuous
▴ ISO					Continuous
VERTICE					Continuous
AUX					Continuous
AUX 2					Continuous

Trabalho 1.

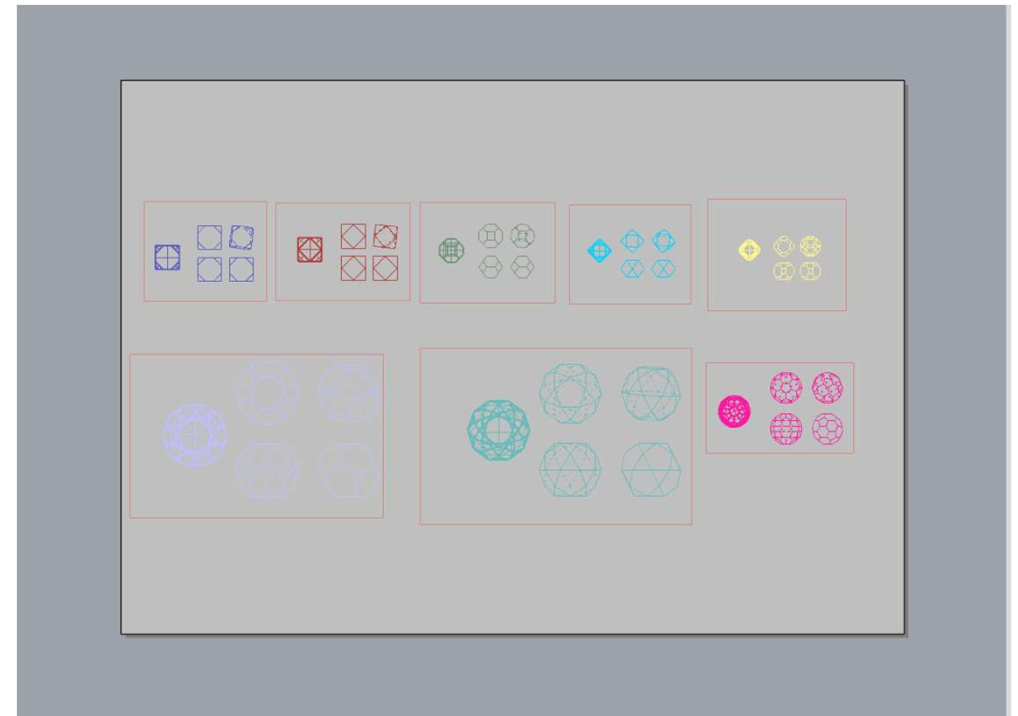
MAKE 2D – select shape – select third angle projection – okk - 4 vistas de cima, frente, perspectiva e direita



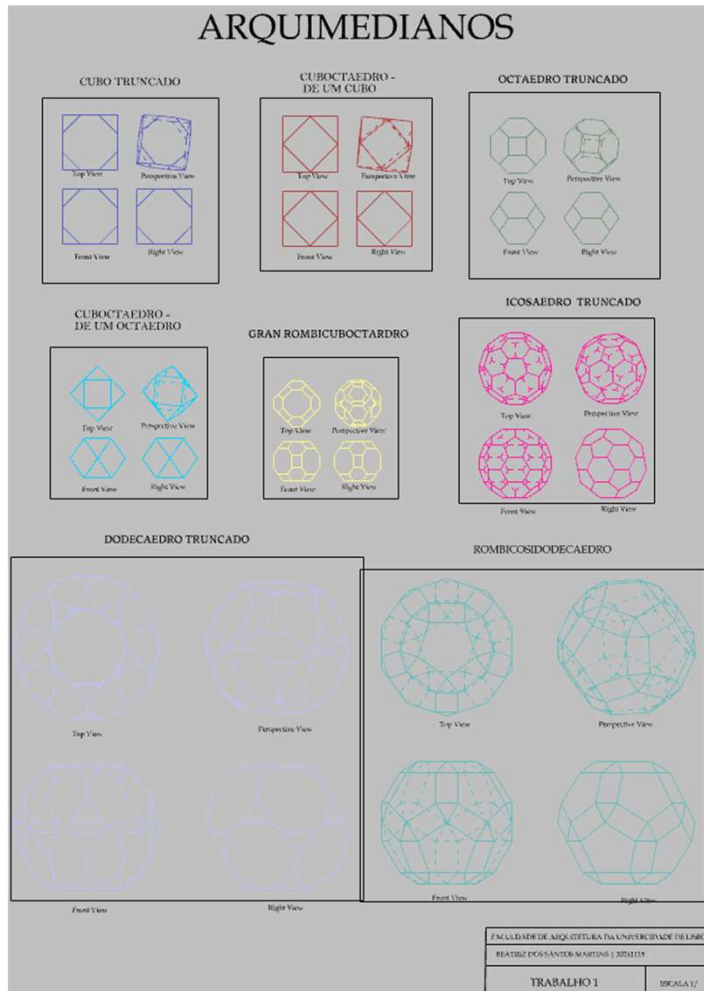
LAYOUT – okk – cria uma página para layouts

DETAIL – add – cria uma janela

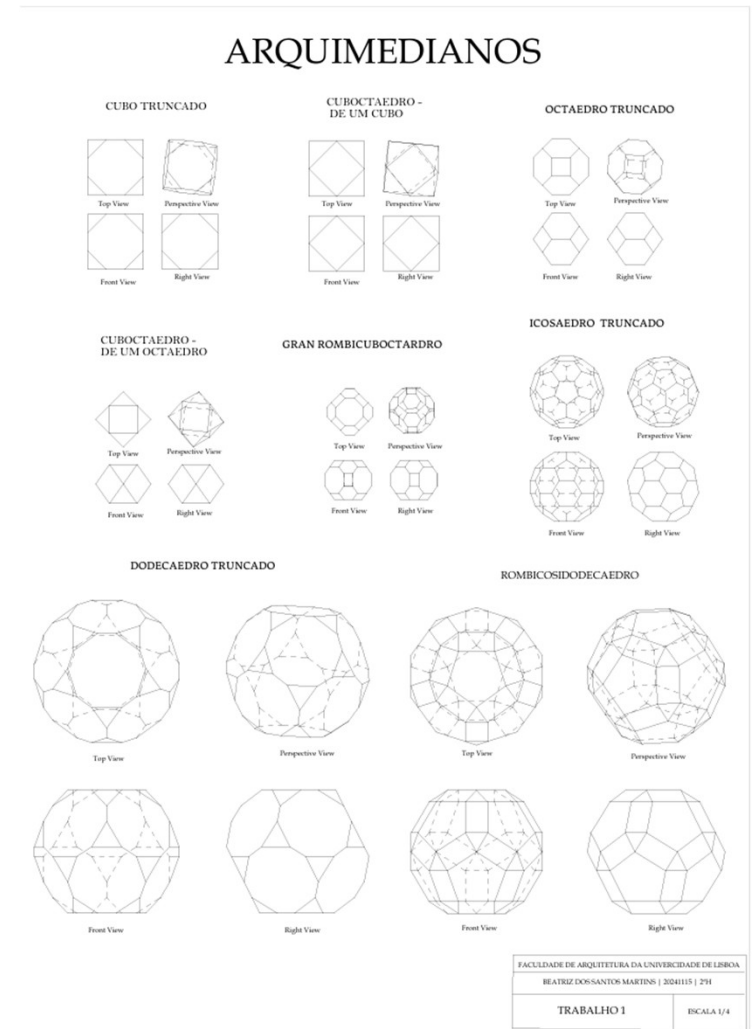
PROPERTIES – scale – alteração da escala, neste caso para 1 mm = 0,4 cm ou 1/4



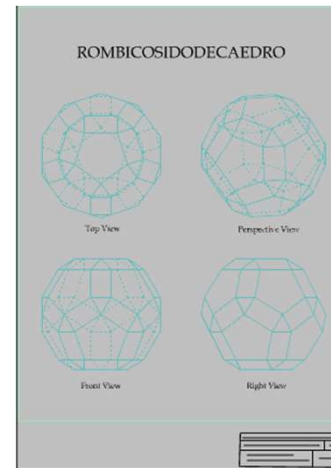
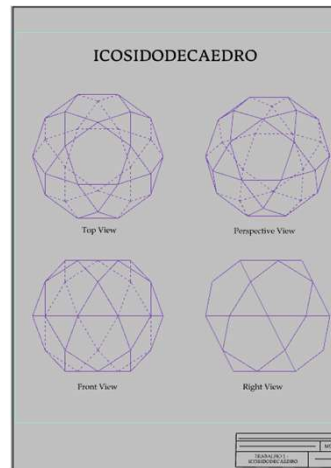
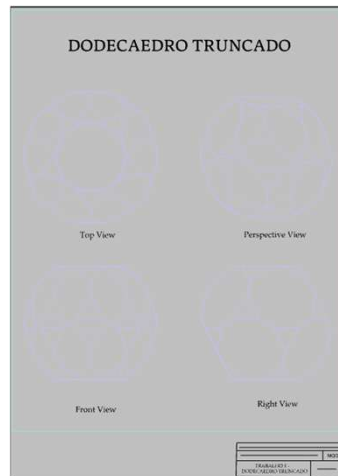
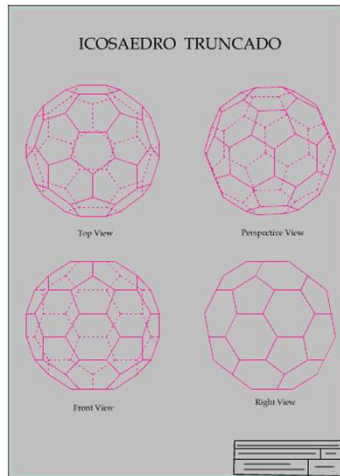
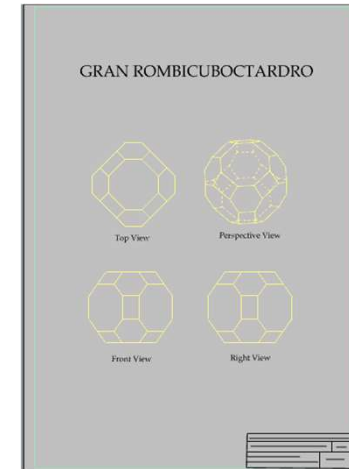
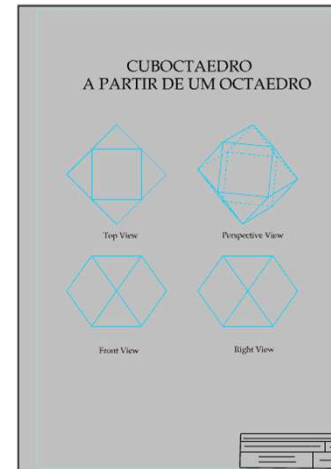
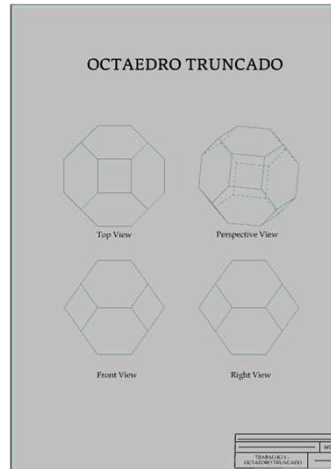
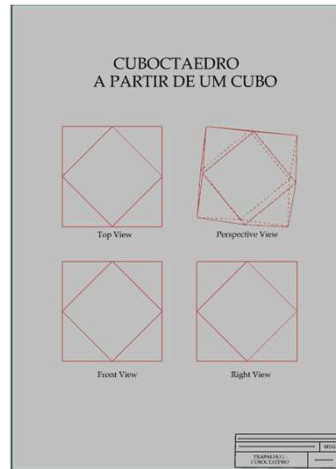
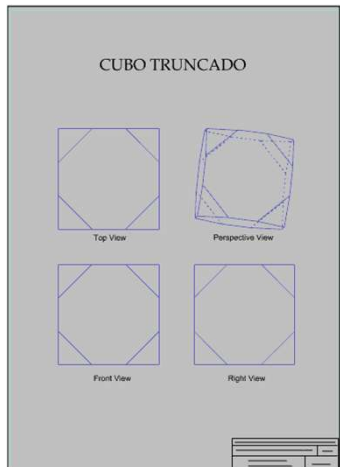
Trabalho 1.



Editar folha para A3 e Portrait
TEXT – para legendar
PRINT – como Rhino PDF – size
A3 – black and white – para salvar
o layout como um PDF



Trabalho 1.



Repetir o processo para
cada polígono

Fim do Trabalho 1.

-

ESCLARECIMENTO DE DÚVIDAS DO EXERCÍCIO 1
LAYOUTS E VISTAS

Aula. 4 – Sumário.

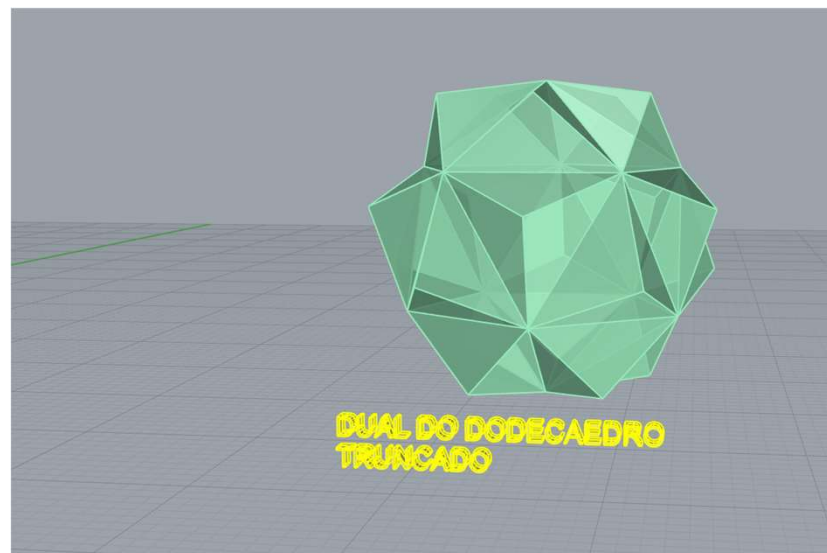
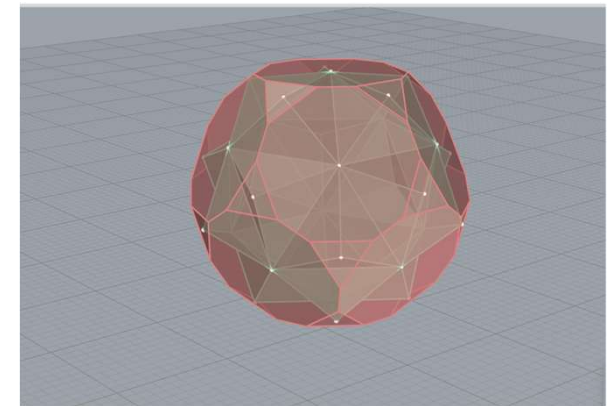
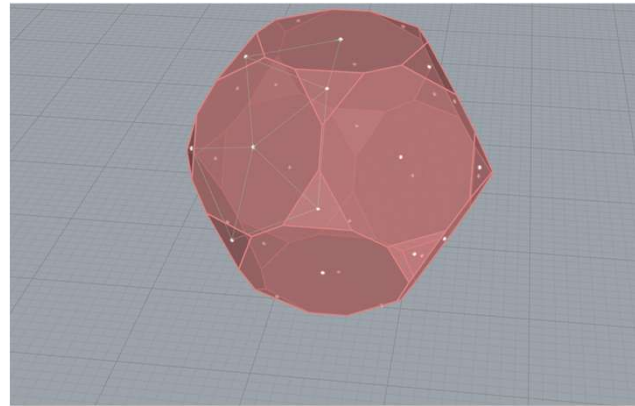
A partir de um dodecaedro
truncado

POINT – colocar um ponto no
centro de todas as faces do
solido utilizando a função CEN
do OSNAP

POLYLINE - unir
determinados pontos

**SURFACE FROM PLANAR
CURVES** – tornar linhas em
faces

ARRAY POLAR – 4 – 360° –
para completar o solido



NOTAS	👉	👍	👎	🔍	Continuous
TEXTO	✓	👍	👎	🔍	Continuous
CUBE	👉	👍	👎	🔍	Continuous
WIRES	👉	👍	👎	🔍	Continuous
VERTICES	👉	👍	👎	🔍	Continuous
POINTS	👉	👍	👎	🔍	Continuous
CUBO 2	👉	👍	👎	🔍	Continuous
VERTICES 2	👉	👍	👎	🔍	Continuous
EDGES	👉	👍	👎	🔍	Continuous
CUBO DUAL	👉	👍	👎	🔍	Continuous
CUBO OC D	👉	👍	👎	🔍	Continuous
VERTICES 3	👉	👍	👎	🔍	Continuous
VERT 6	👉	👍	👎	🔍	Continuous
PENT DUAL	👉	👍	👎	🔍	Continuous
PENT	👉	👍	👎	🔍	Continuous
PENT 2	👉	👍	👎	🔍	Continuous
PENT 3	👉	👍	👎	🔍	Continuous
VERTICES 5	👉	👍	👎	🔍	Continuous
OCTAEDRO	👉	👍	👎	🔍	Continuous
VERTICES 4	👉	👍	👎	🔍	Continuous
AUX	👉	👍	👎	🔍	Continuous
AUX 2	👉	👍	👎	🔍	Continuous

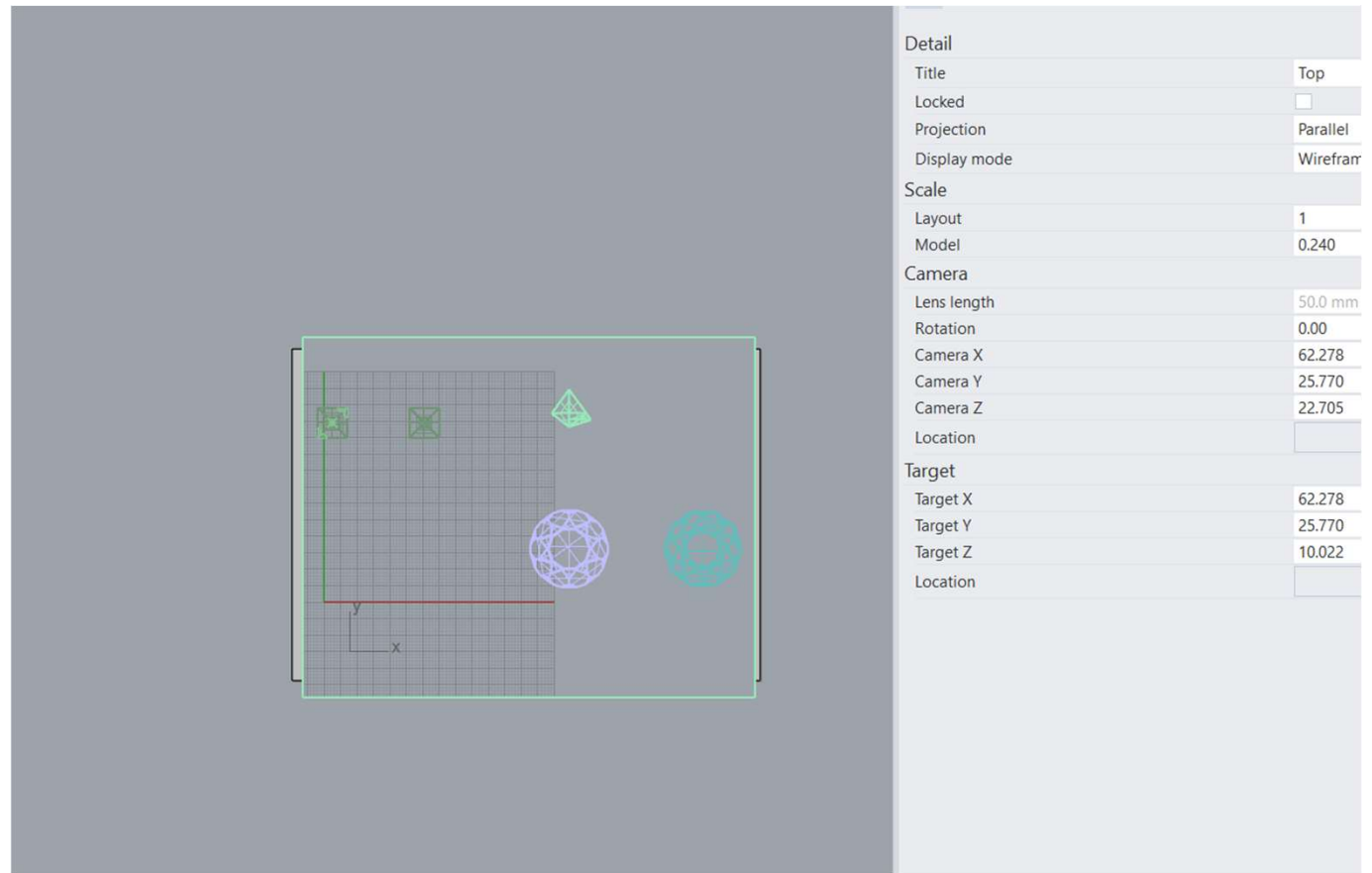
Aula. 4.

selecionar fig - **MAKE 2D**

LAYOUT – printer : rhino

PDF – **DETAIL** - **ADD** - nova
vista

PROPRITIES – para editar

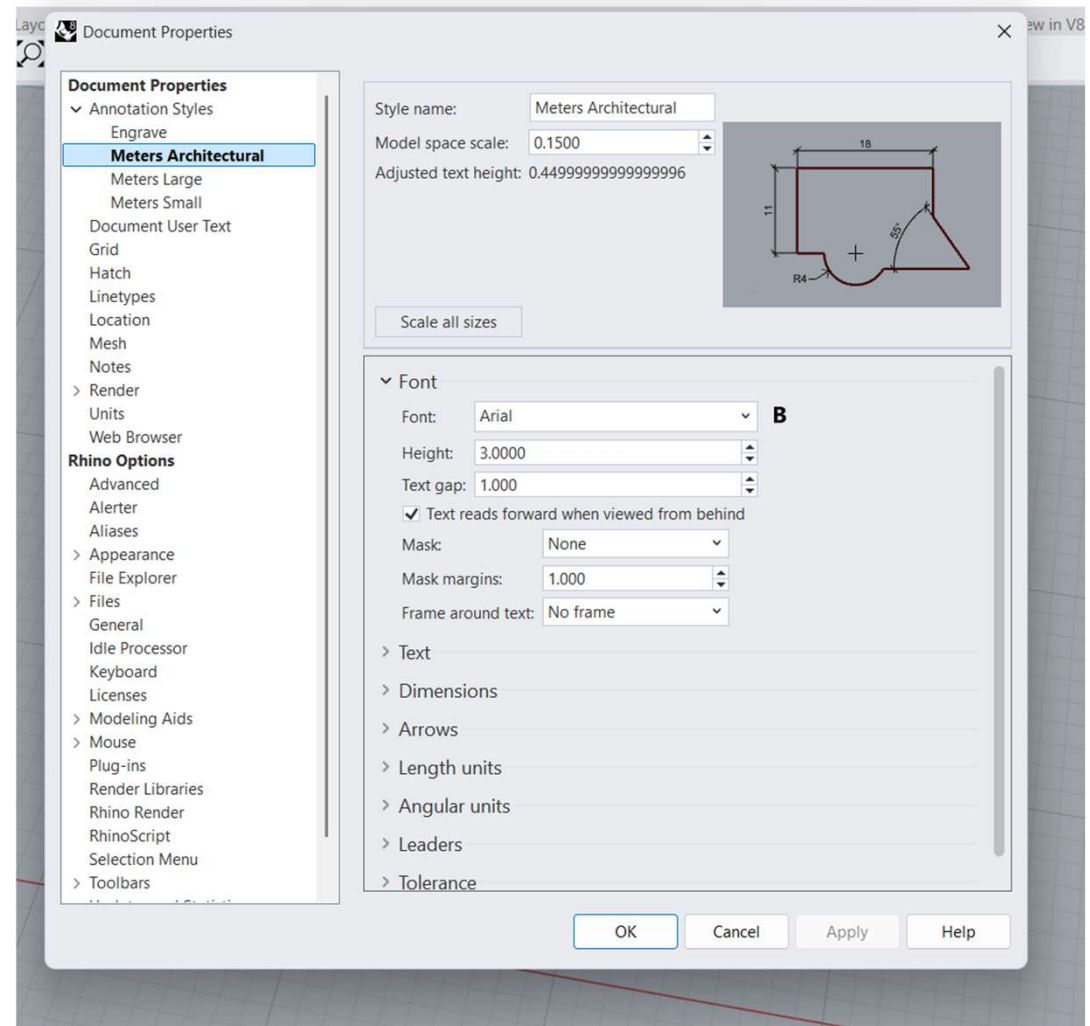
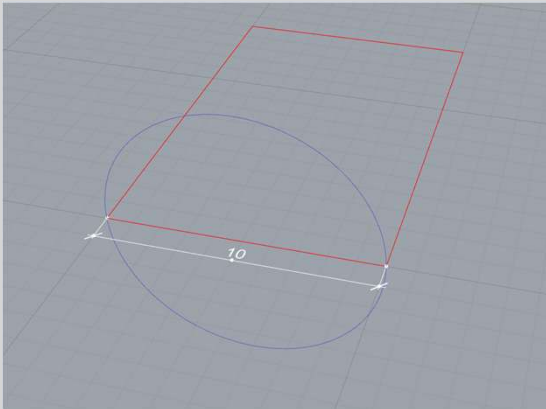


Aula. 4.

MODELAÇÃO DE SUPERFÍCIES DE ABÓBADAS E LUNETAS

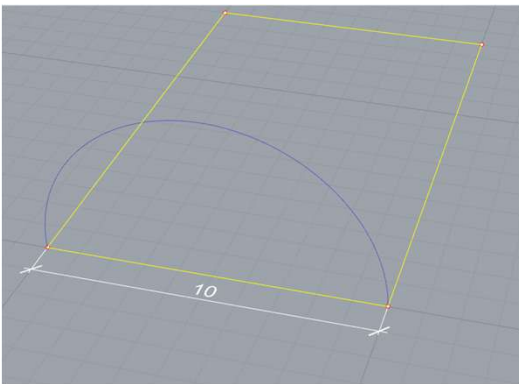
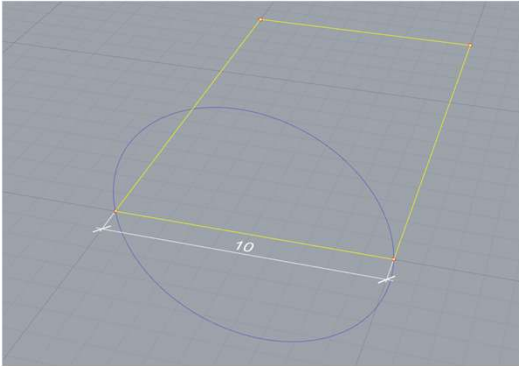
Aula. 5 – Sumário.

Retângulo
DIM – cotas
DOCUMENT PROPRITIES –
anotation styles – edit... – font

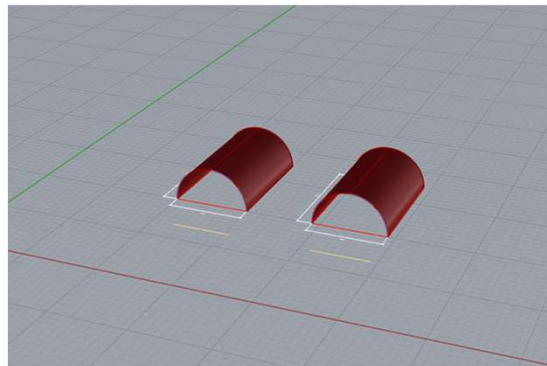
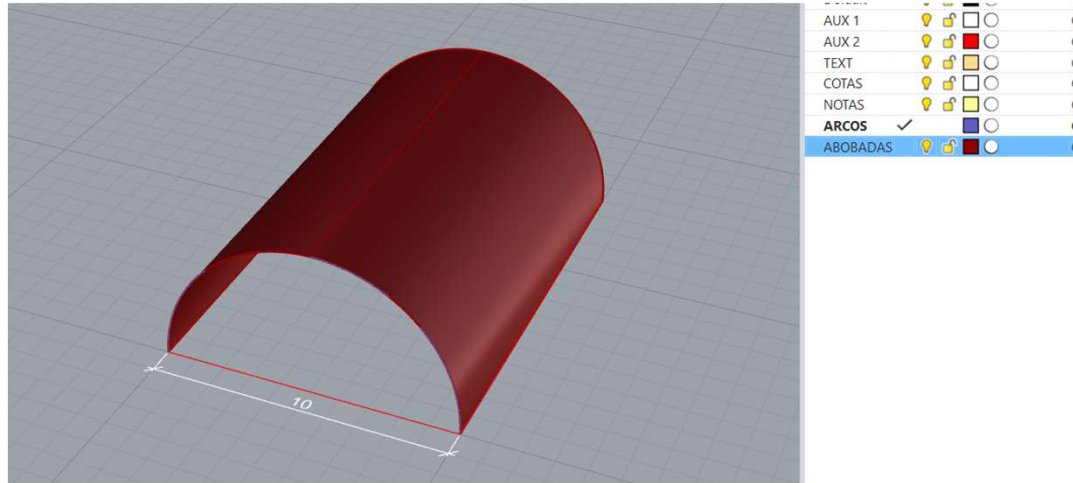


Aula. 5.

Select rectangle - **TRIM**



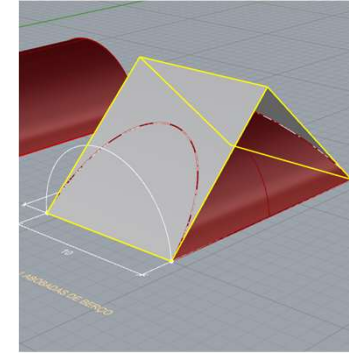
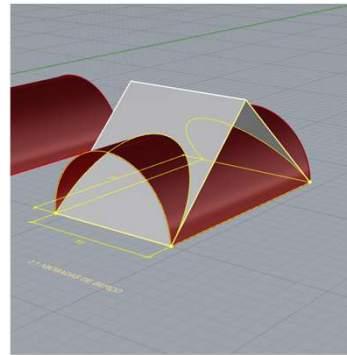
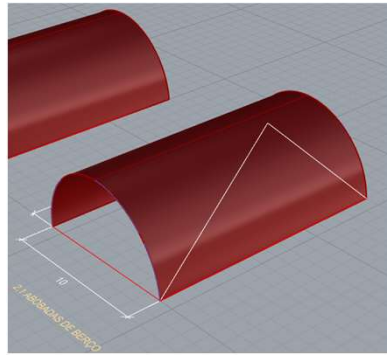
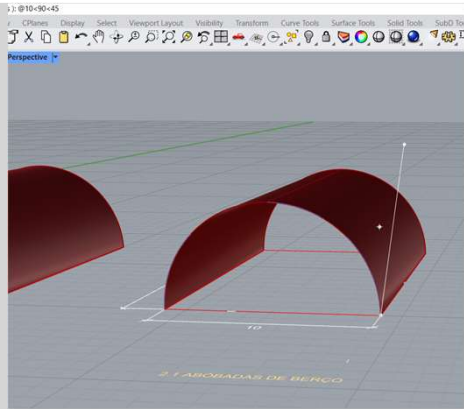
EXTRUDE - arch



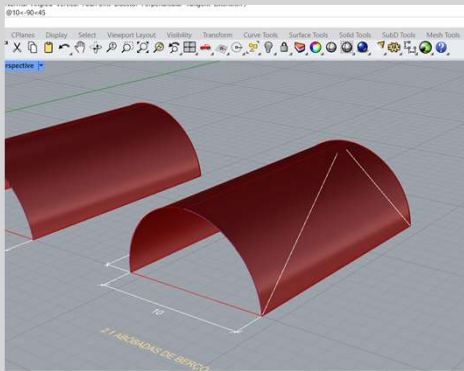
ABÓBADA DE BERÇO

Duplicate

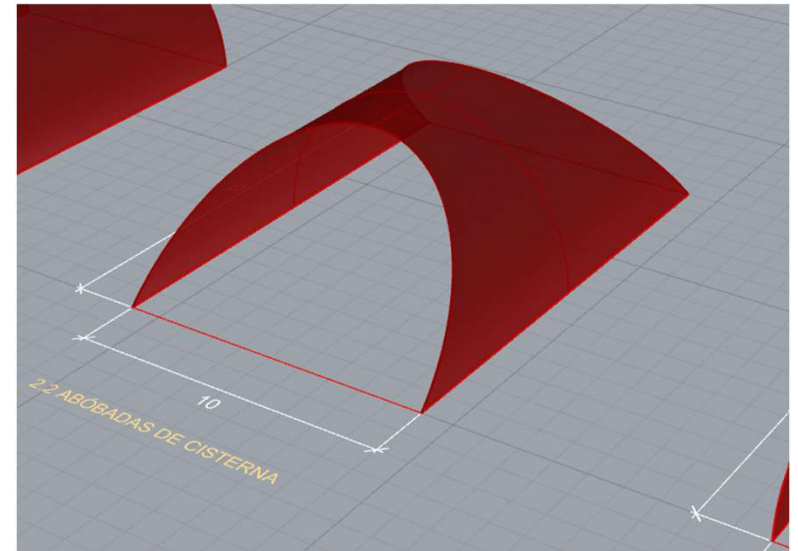
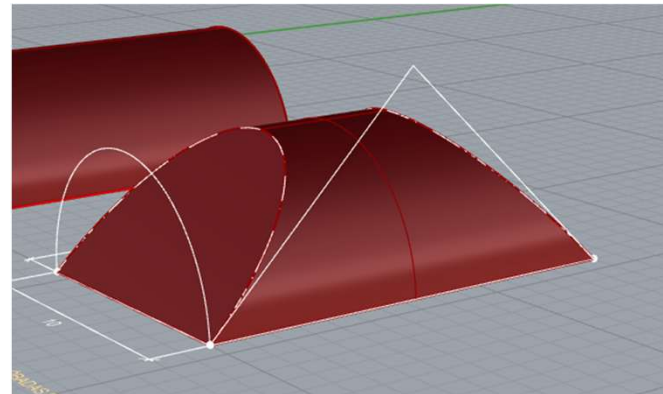
Aula. 5.



FILLET – radius – 0 – select both lines
JOIN – select both lines – enter
EXTRUDE
INTERSECT – cria curvas nos locais onde intercetam
TRIM – select things to keep – select things to TRIM



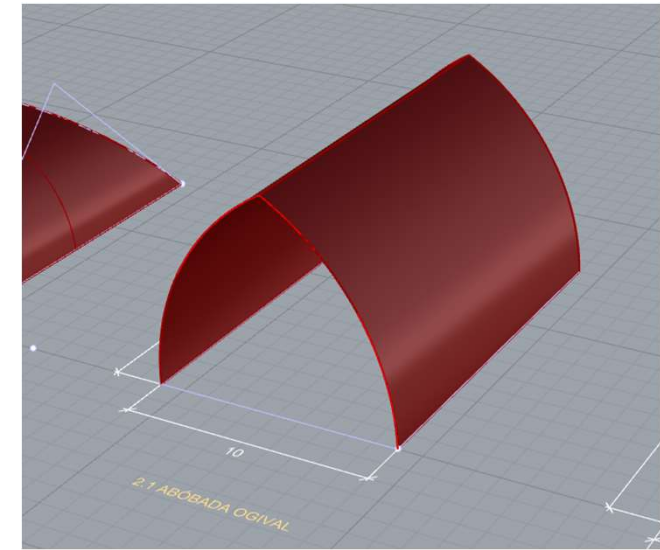
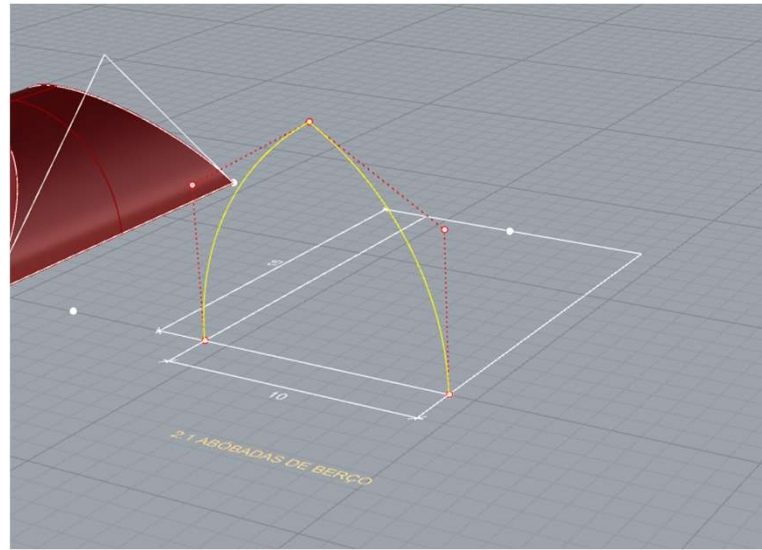
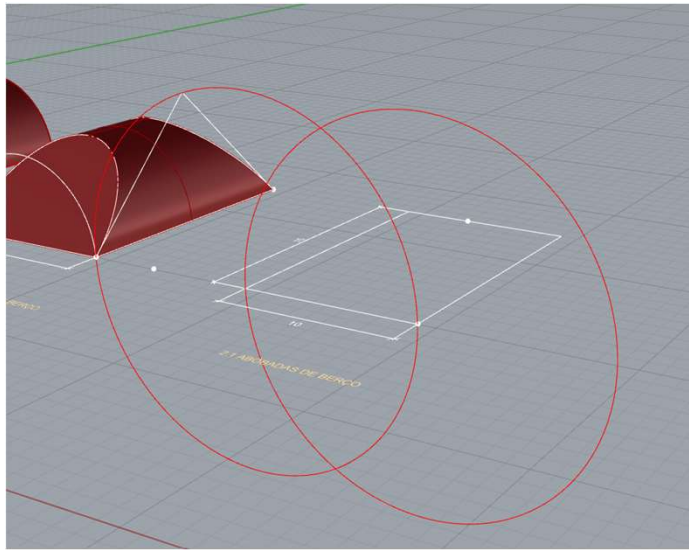
ABÓBADA DE CISTERNA



RELATIVE POLAR COORDINATE
 -@ dist < ang plane < ang vertical

LINE - @10<90<45
 - @10<-90<45

Aula. 5.



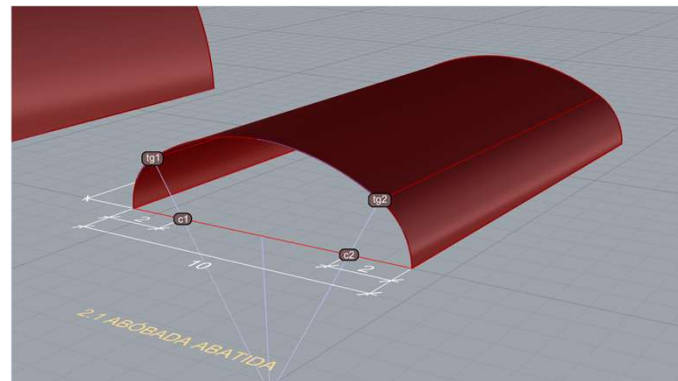
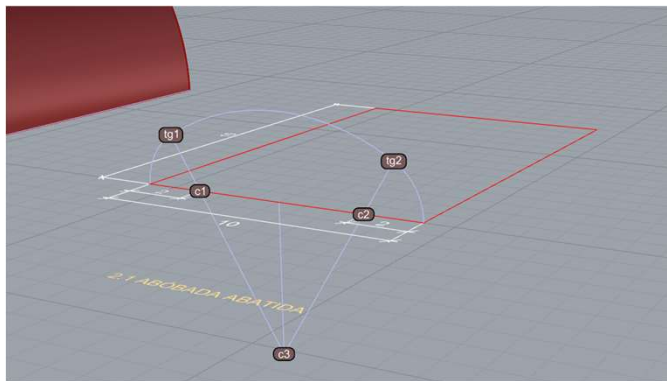
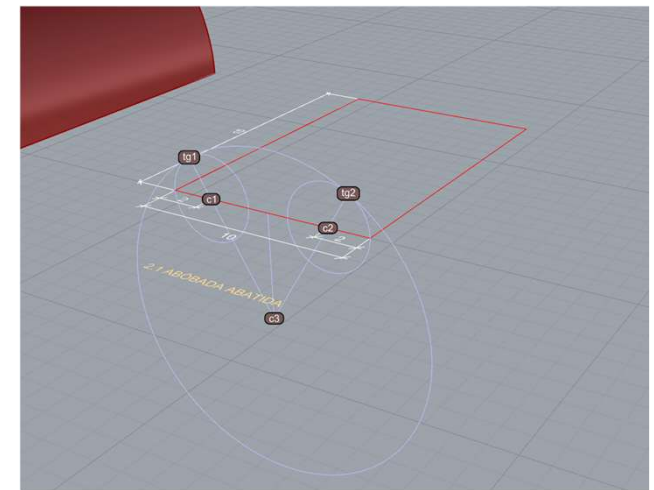
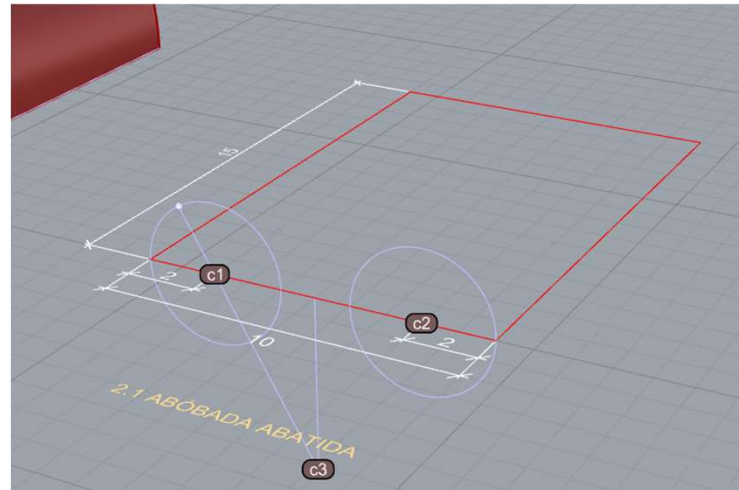
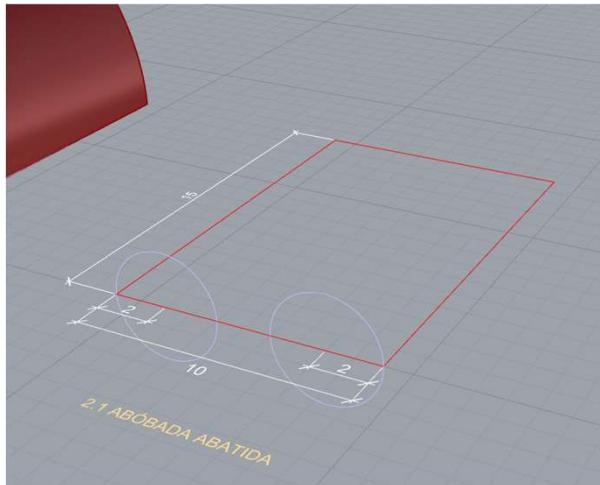
ABÓBADA OGIVAL

CIRCLE – vertical – com o centro em um dos lados do retângulo (2x)

TRIM – select circles – enter – select things to TRIM

EXTRUDE

Aula. 5.



ABÓBADA ABATIDA

Começando com um retângulo igual ao inicial
CIRCLE – vertical – (2x) – com o centro a 2 un
das arestas

LINE – 5 – para baixo

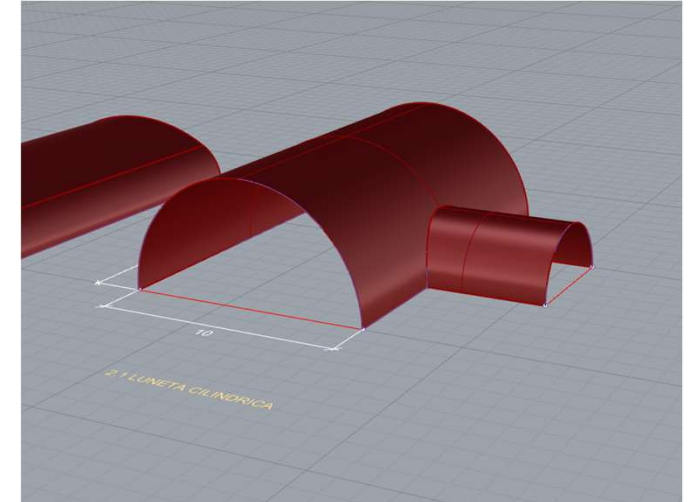
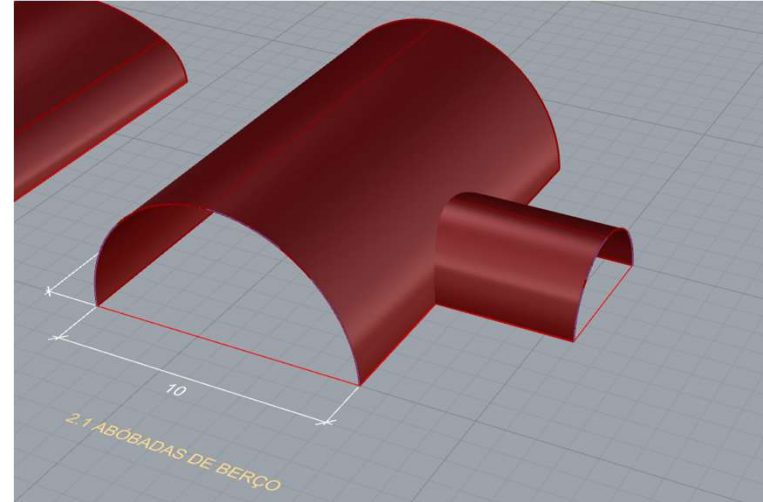
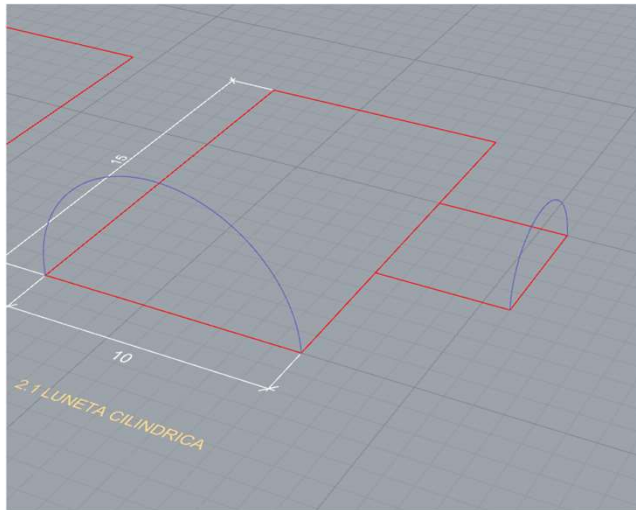
- Linha que intersesta com o centro dos círculos
CIRCLE – (na front view) – centro 3 – raio até
á interseção da tangente com os círculos

TRIM – select things to keep– enter – select
things to TRIM – enter

JOIN – arco

EXTRUDE

Aula. 5.



LUNETA CILÍNDRICA

LINE – Fazer quadrado 5 un por 5 un a meio de uma aresta

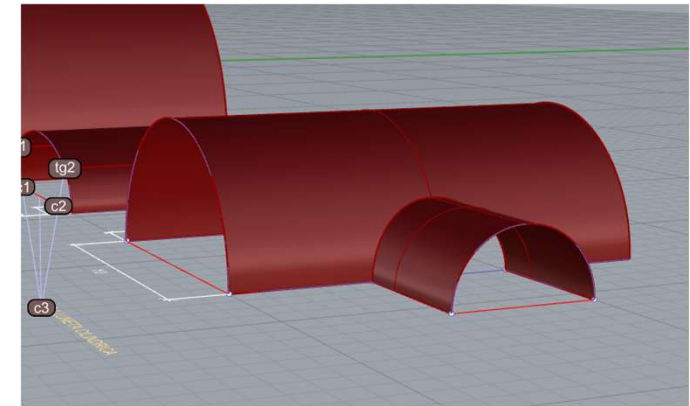
CIRCLE – vertical – centro na aresta do quadrado e do retângulo

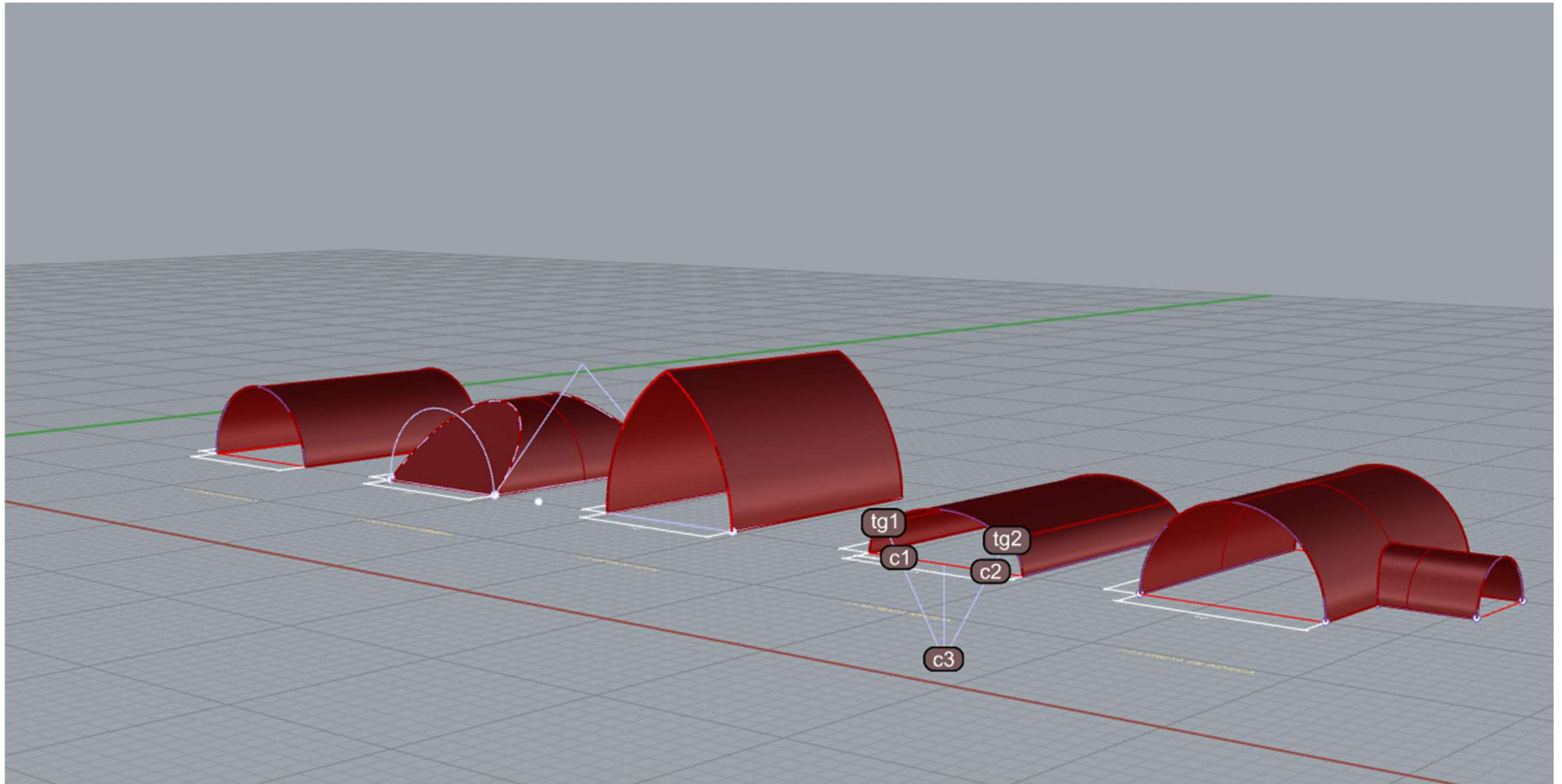
Select rectangle – **TRIM** | Select square – **TRIM**

EXTRUDE – arch (2x)

INTERSECT – criar curvas nas interseções entre o cone e a abóbada maior

Select intersection – **TRIM** – cortar a parte em excesso do arco mais pequeno



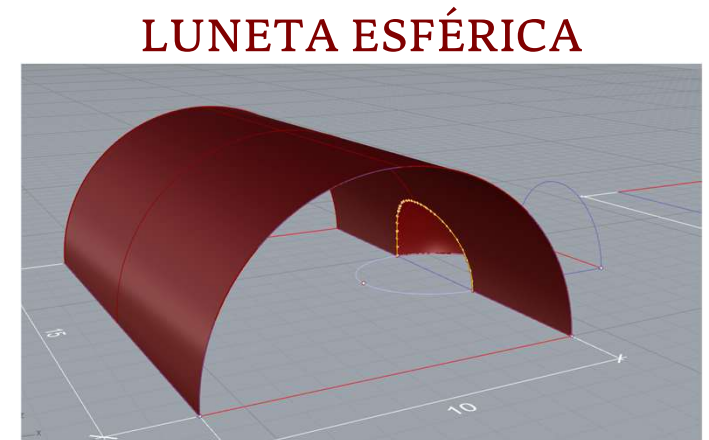
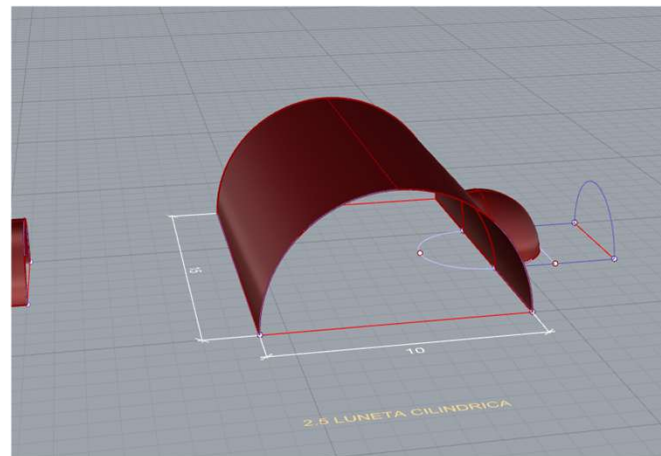
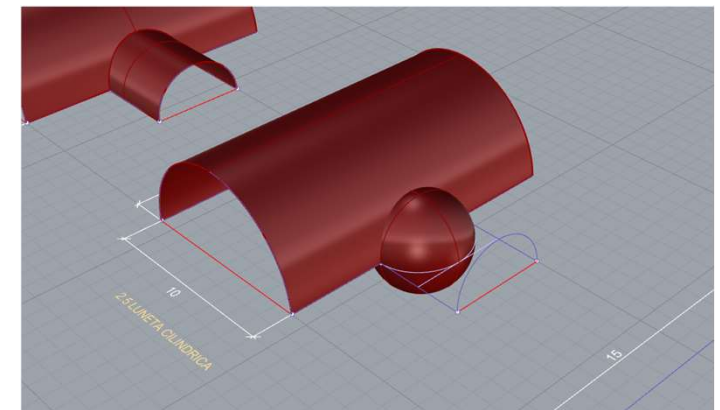
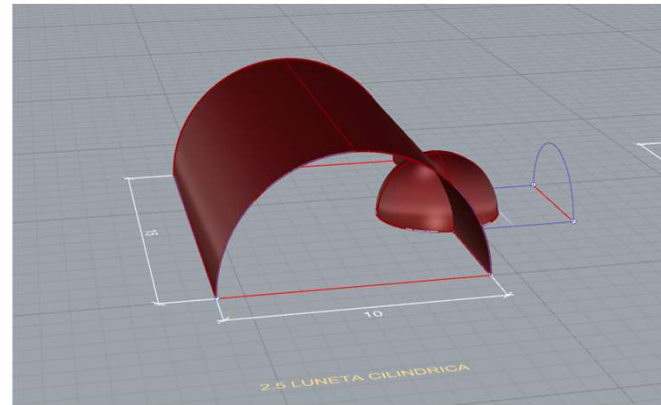
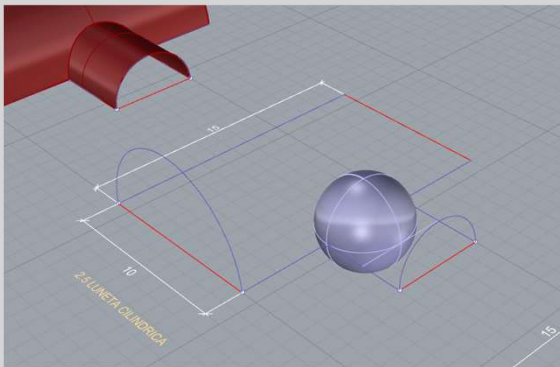
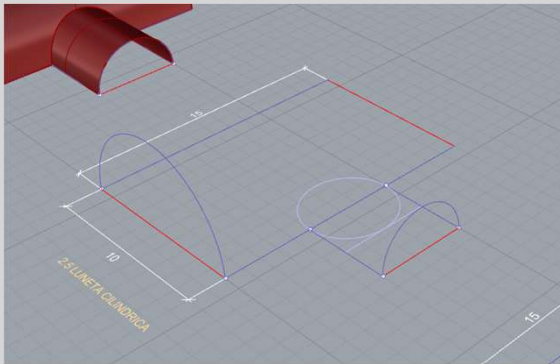


Aula. 5.

-

CONTINUAÇÃO DA MODELAÇÃO DE SUPERFÍCIES DE ABÓBADAS E LUNETAS

Aula. 6 – Sumário.



CIRCLE – no centro da aresta, com o diâmetro de 5 un

SPHERE –

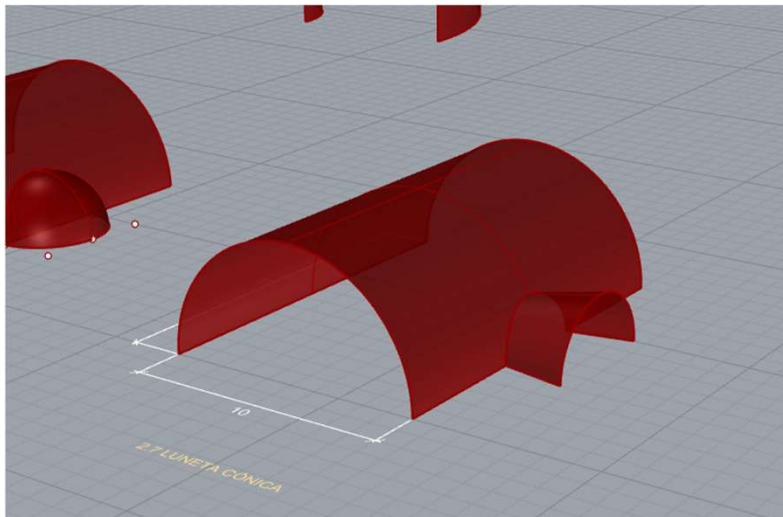
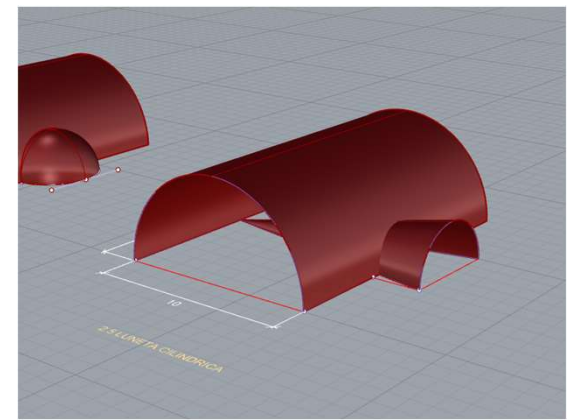
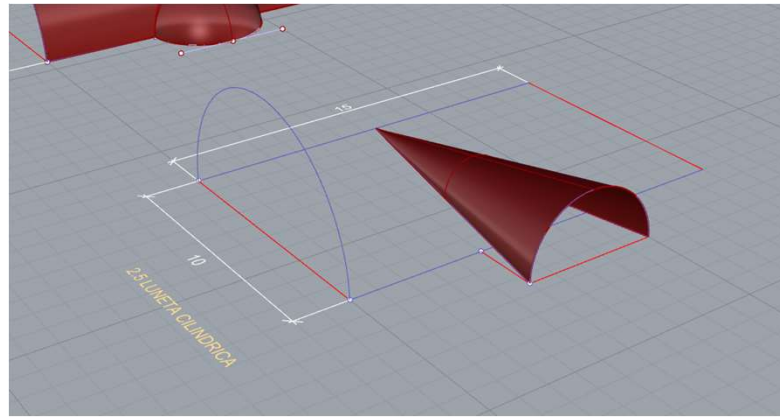
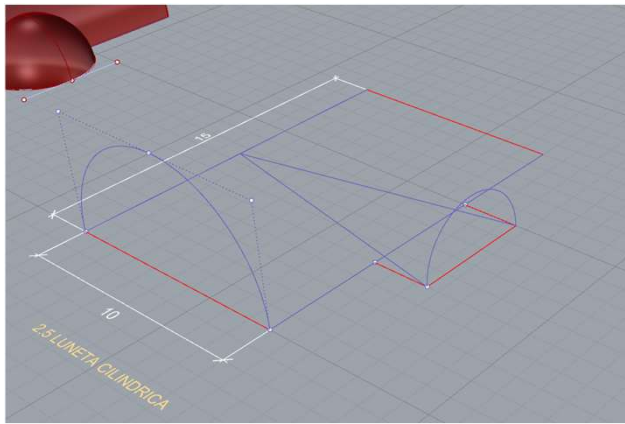
Select circle – **TRIM** – cortar parte de baixo da esfera

INTERSECT – criar curvas nas interseções entre o cone e a abóbada maior

Select intersection – **TRIM** – cortar interior da esfera

LUNETA ESFÉRICA

Aula. 6.



LUNETA CÔNICA

LINE – retângulo no centro da aresta de 2,5 un por 5 un

- Conectar os vértices do retângulo ao centro da aresta oposta

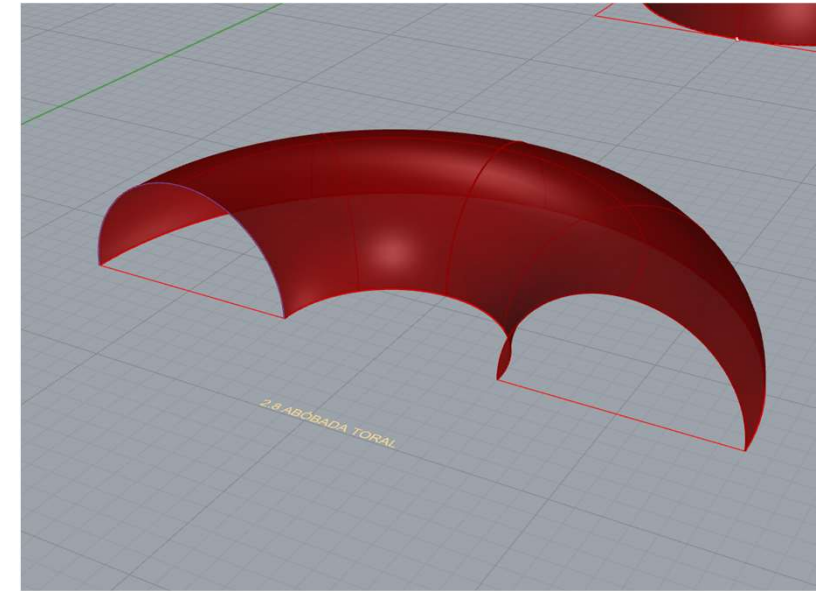
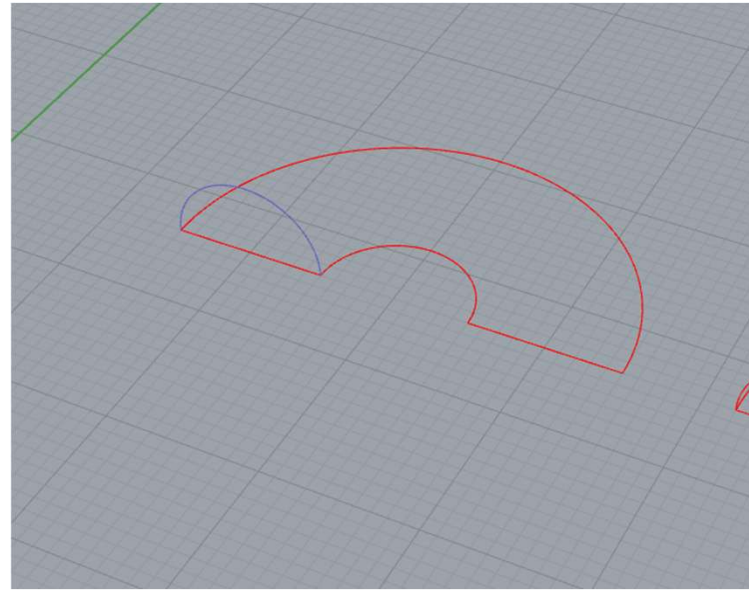
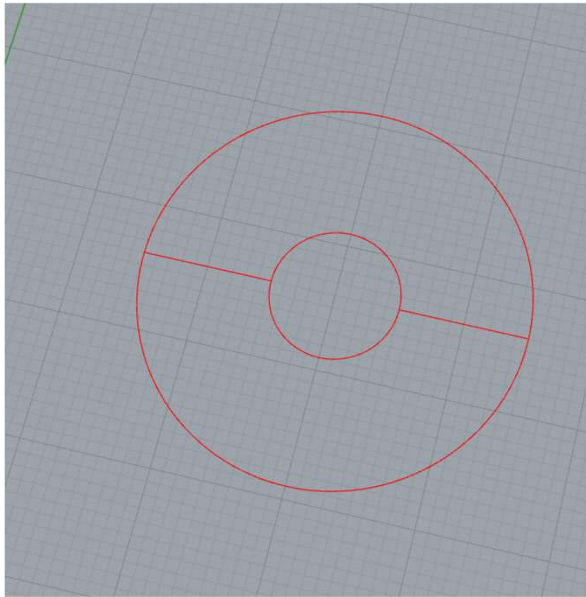
CIRCLE – vertical – no centro da base do triângulo

Select retângulo - **TRIM**

RAIL REVOLVER – select lines and arch, mid of arch, aresta – formar metade de um cone

INTERSECT – criar curvas nas interseções entre o cone e a abóbada maior

Select intersection – **TRIM** – cortar a parte do cone no interior da abóbada maior



ABÓBADA TORAL

(2) **CIRCLE** – 15 un e 5 un de raio

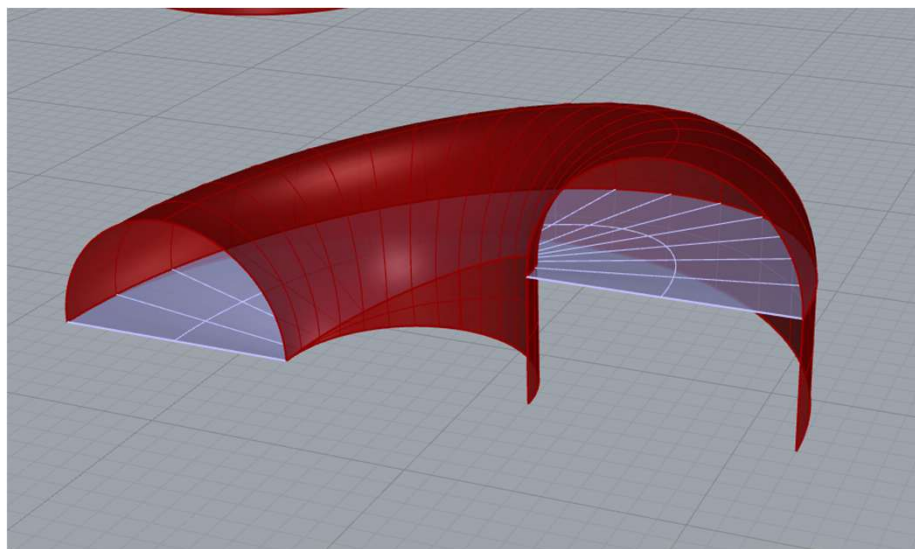
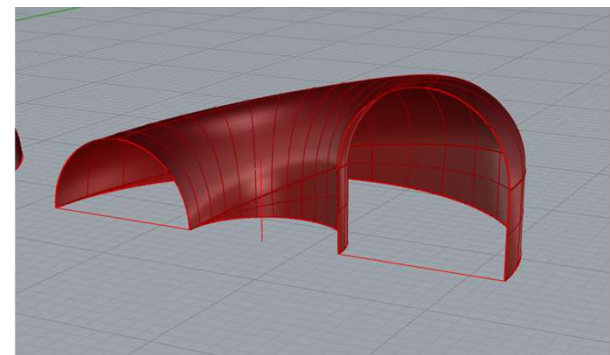
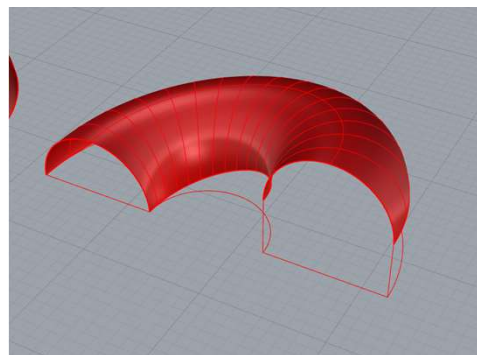
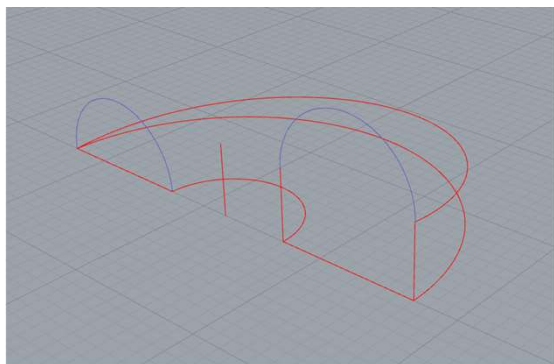
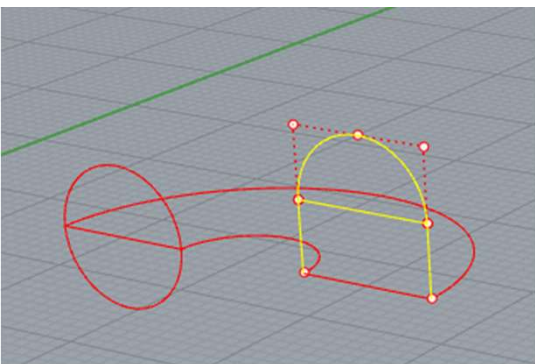
LINE – ao longo do diâmetro dos círculos

Select line – **TRIM** – cortar metade dos círculos

CIRCLE – vertical

Select line – **TRIM** – formar o arco

SWEEP 2 – select meio círculo 1 – select meio círculo 2 – select arch - enter



ABÓBADA HELICOIDAL

Copiar os 2 semicírculos e o arco

RECTANGLE – vertical – com 2.5 un de altura

CIRCLE – vertical – com o centro no topo da aresta do retângulo

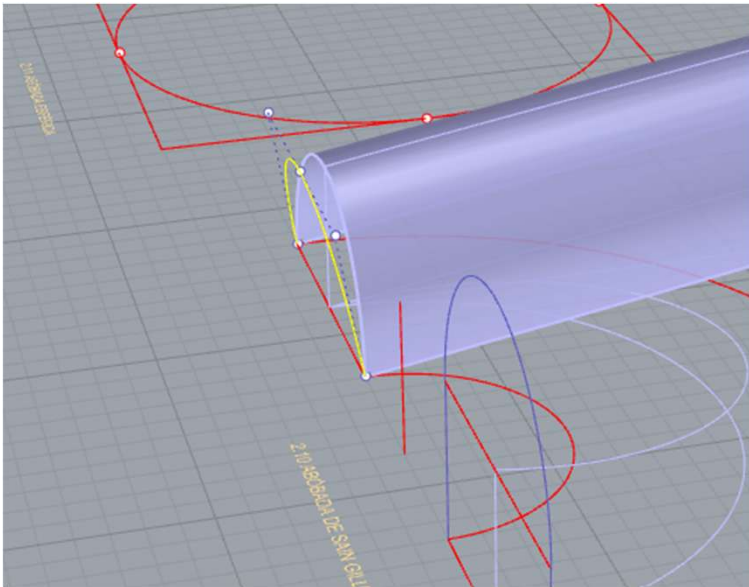
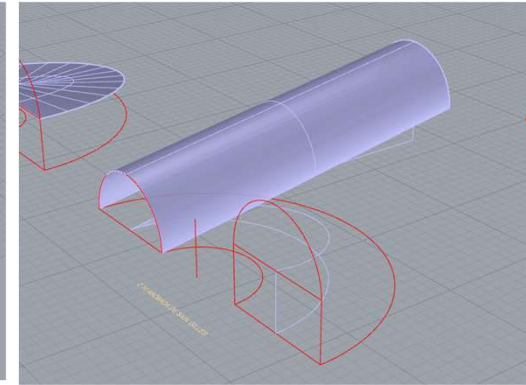
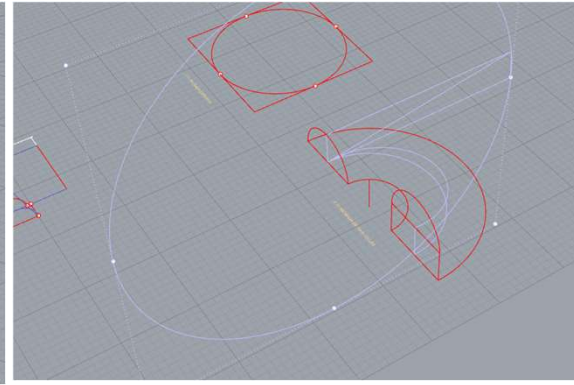
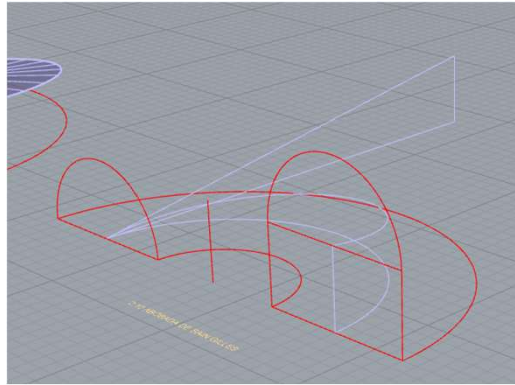
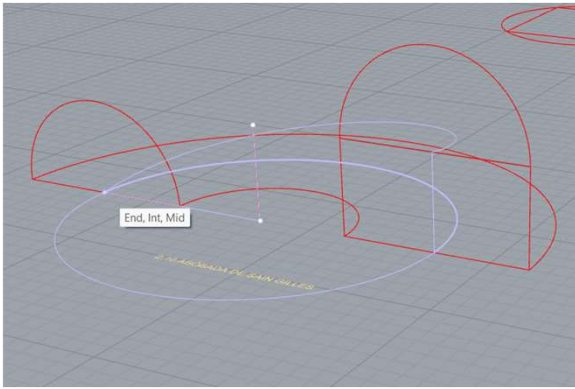
Select rectangle – **TRIM** – cortar metade de baixo do círculo

LINE – no centro do semicírculo com 5 un de altura

HELIX – vertical – select line –
arrastar até ao início do primeiro arco ou
(turns=0.5; reversetwist=yes)

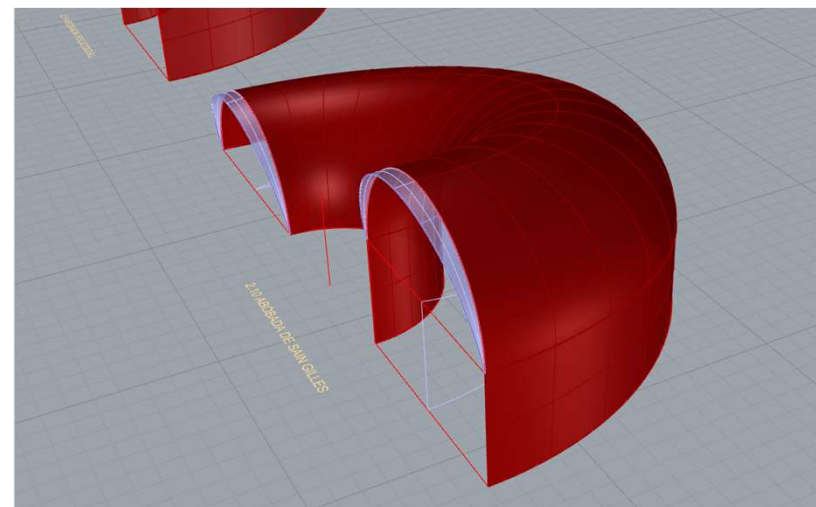
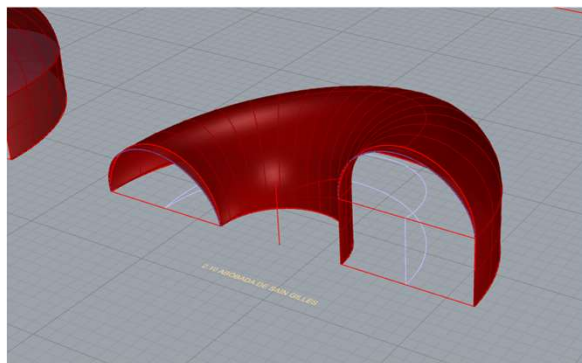
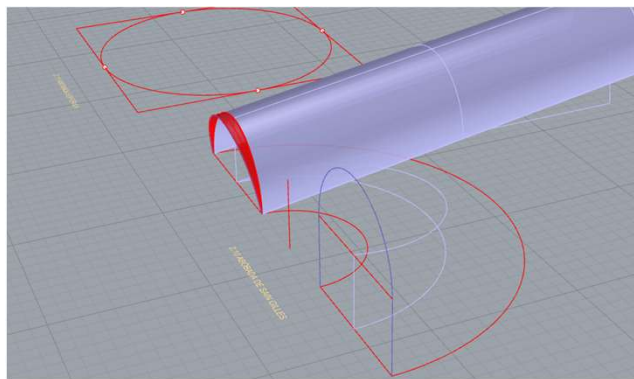
SWEEP 2 – select meio círculo 1
– select meio círculo 2 – select
arco 1 – select arco 2 – enter

LOFT – arco – hélice (2x) – cria as laterais da abóbada
SWEEP 2 – select meio círculo 1 – select meio círculo 2 –
select ambas bases dos semicírculos – enter – cria a rampa



A partir da base da abóbada helicoidal
 CIRCLE – 1 un de raio
 HELIX –
 LENGHT – determinar a medida da curva formada

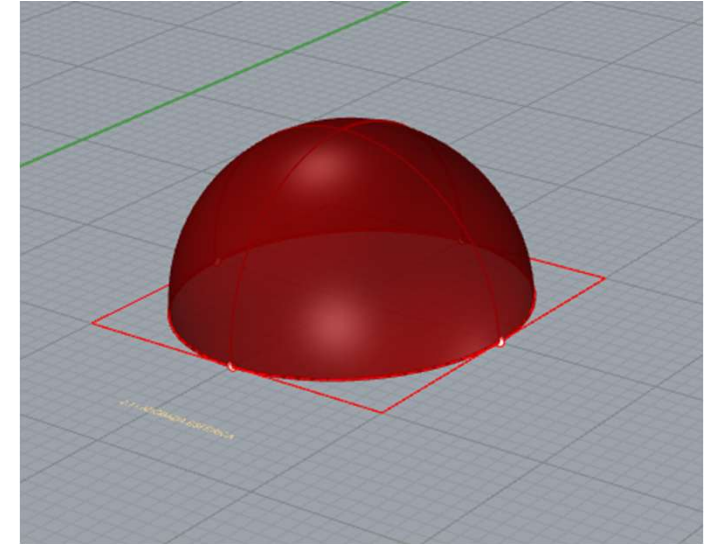
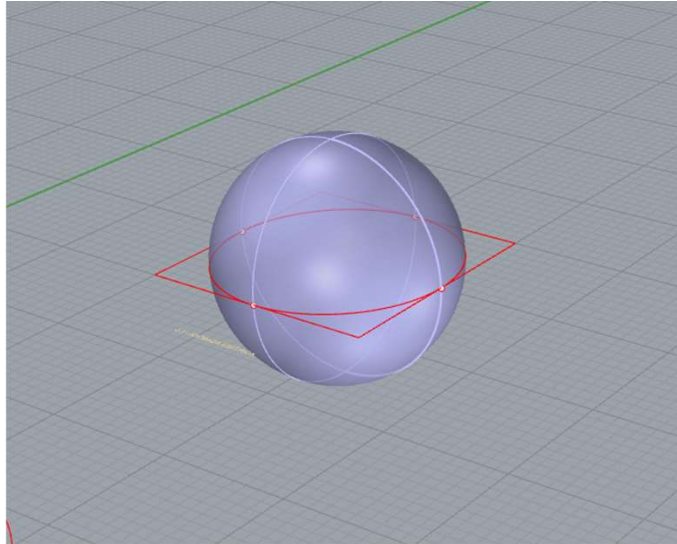
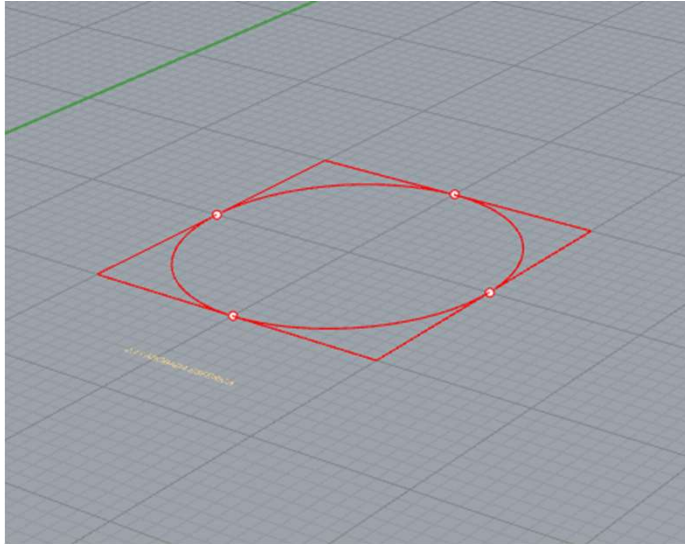
Aula. 6.



ABÓBADA DE SAIN GILLES

A partir da base da abóbada helicoidal

Aula. 6.



ABÓBADA ESFÉRICA

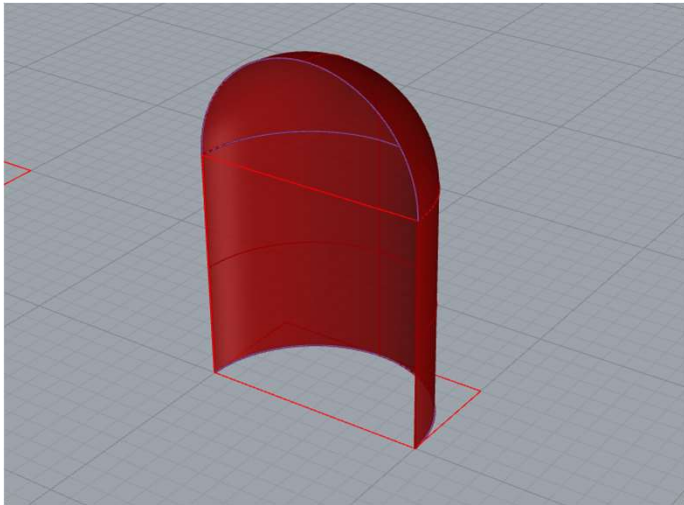
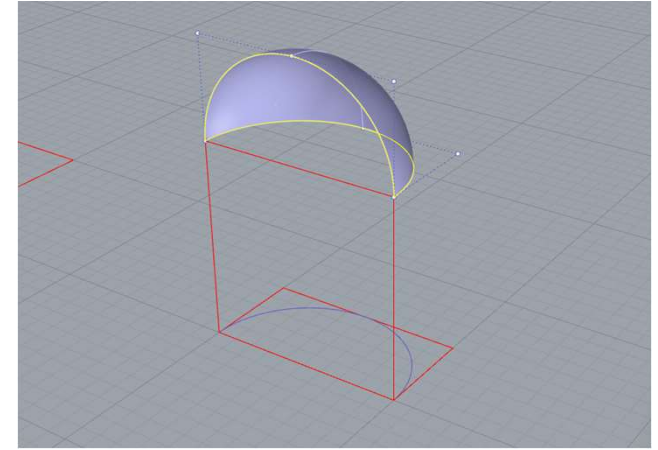
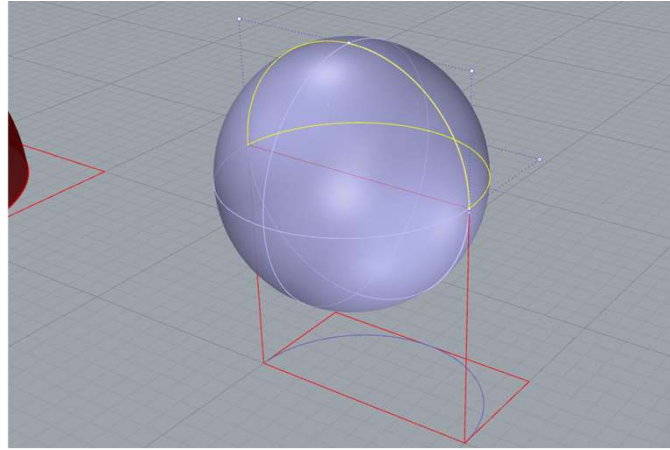
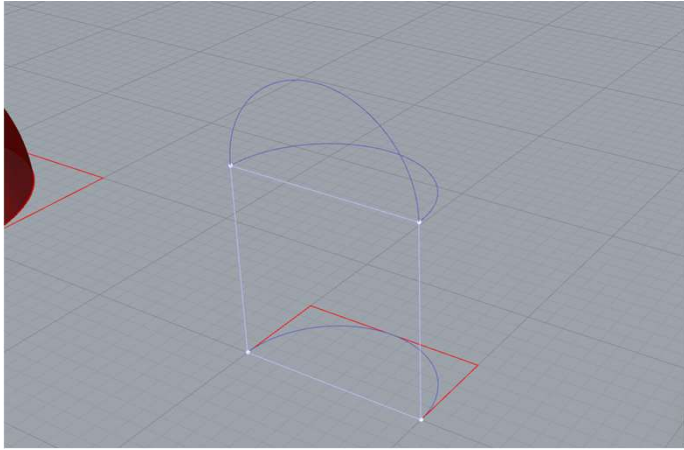
LINE – criar quadrado 20 un por 20 un

CIRCLE – circunferência no interior do quadrado (raio de 10 un)

SPHERE – a acompanhar a circunferência

INTERSECT – selecionar a esfera e a circunferência

Select a circunferência – **TRIM** – metade da esfera



ABÓBADA DE FORNO

RECTANGLE – formar um retângulo com 10 un por 5 un

- Formar um quadrado vertical com 10 un por 10 un

CIRCLE – círculo com o centro na base do quadrado

- Círculo horizontal no topo do quadrado

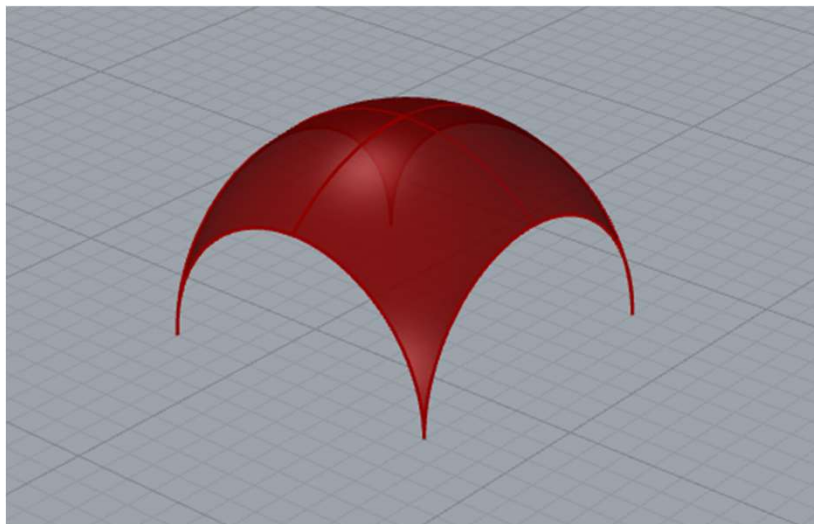
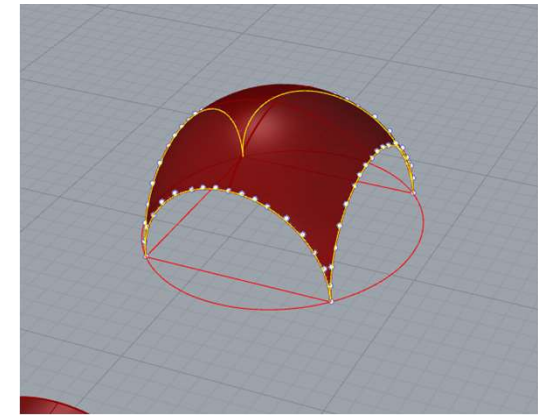
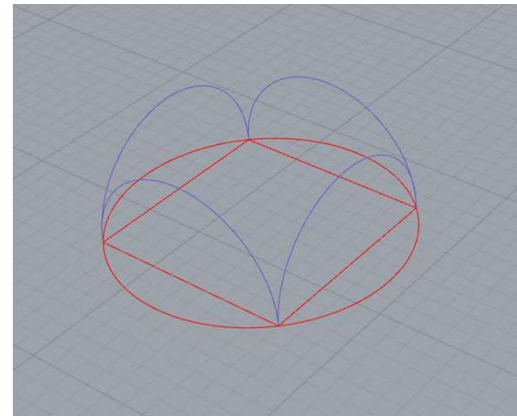
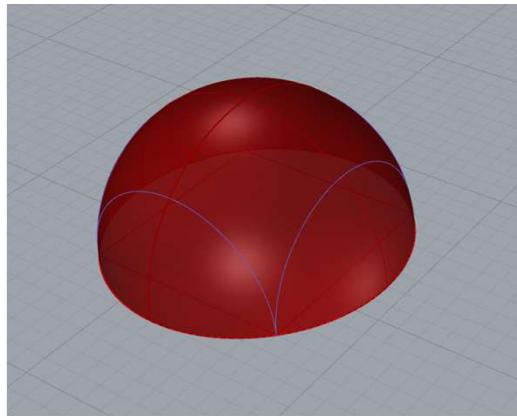
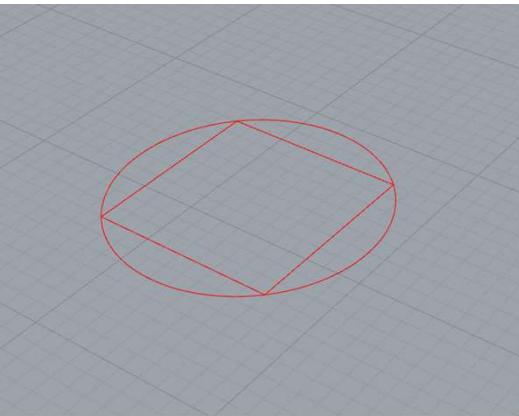
- Círculo vertical no topo do quadrado

Select quadrado – **TRIM** – metade dos círculos

SPHERE – que interseja com os 2 semicírculos no topo

Select semi-círculos – **TRIM** – resto da esfera

SWEEP 2 – select lado do quadrado – select outro lado do quadrado – select arco na base - enter



ABÓBADA DE VELA

RECTANGLE – quadrado com 10 un por 10 un

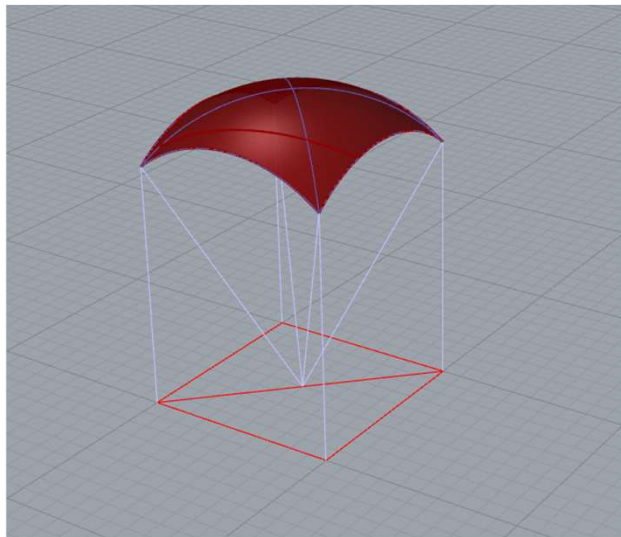
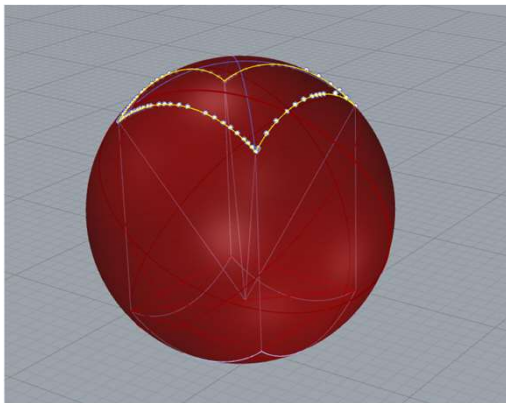
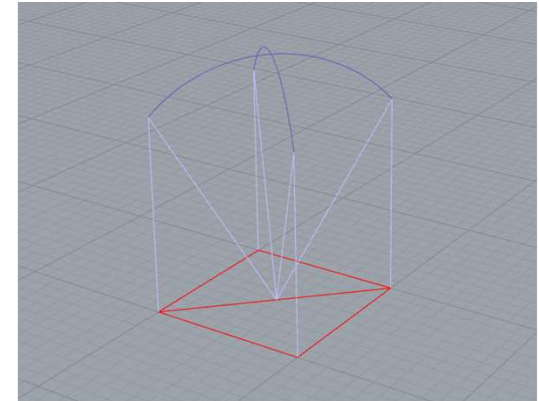
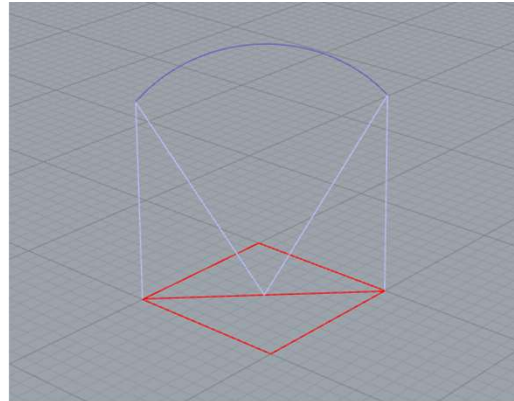
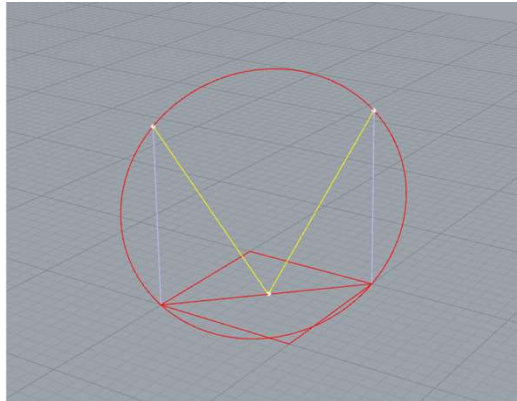
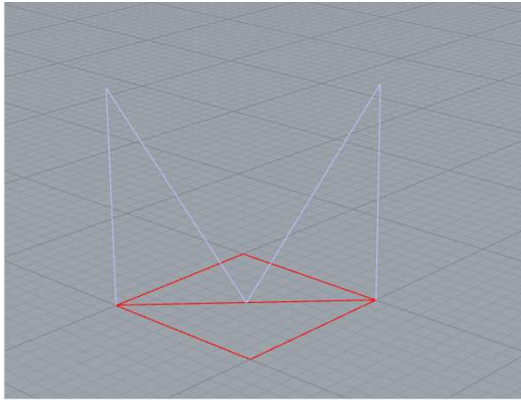
CIRCLE – em volta do quadrado

SPHERE – com as dimensões da circunferência

Select circunferência – **TRIM** – eliminar metade da esfera

PROJECT – select quadrado – select semi-esfera – cria os arcos (projeções do quadrado na esfera)

Select arch – **TRIM** – deixando apenas a abóbada desejada



ABÓBADA DE CATALÃ

RECTANGLE – fazer um quadrado com 10 un por 10 un

LINE – linha diagonal dentro do quadrado

- Linha @10<45<60

- Linha vertical do vértice do quadrado que se intersecta com a outra linha

MIRROR – ambas as linhas para o outro lado da diagonal

CIRCLE – 2 points – que passa nas 2 pontas criadas

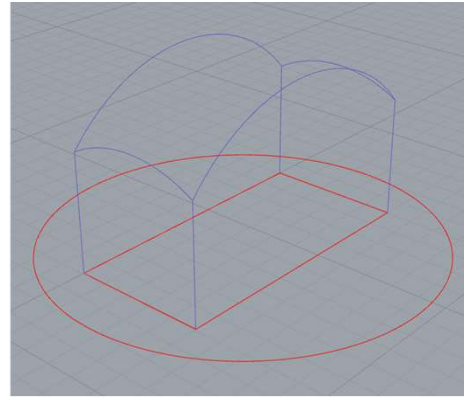
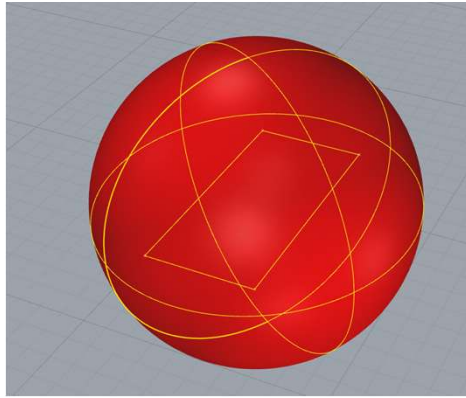
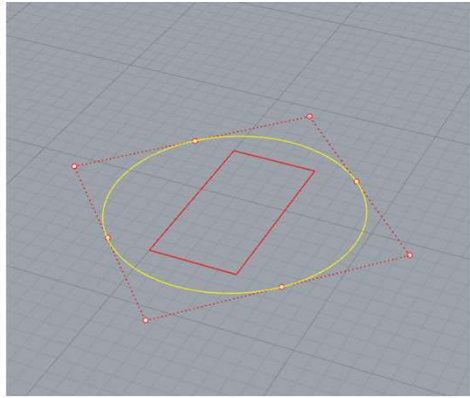
Select lines – **TRIM** – deixar apenas o arco entre a estrutura criada

MIRROR – toda a estrutura

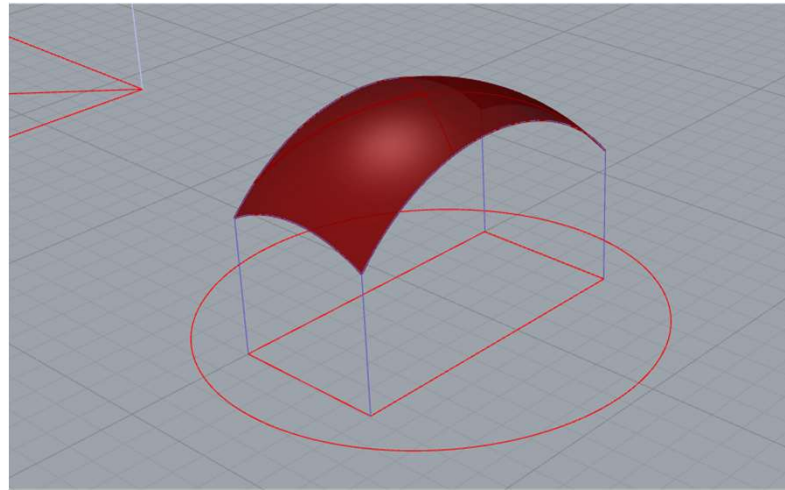
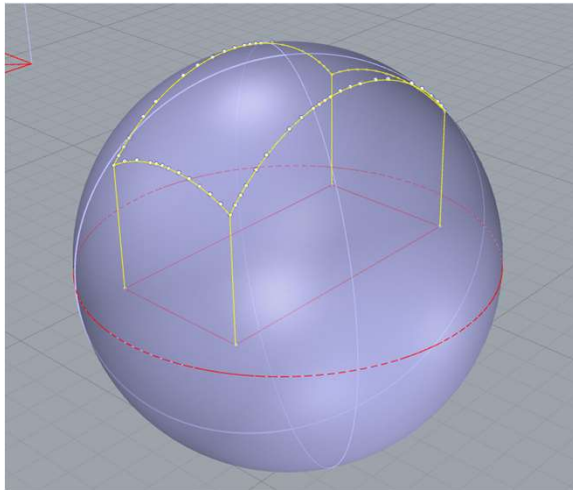
SPHERE – diameter – desde um início do arco até o vértice do quadrado oposto

PROJECT – select quadrado – select esfera

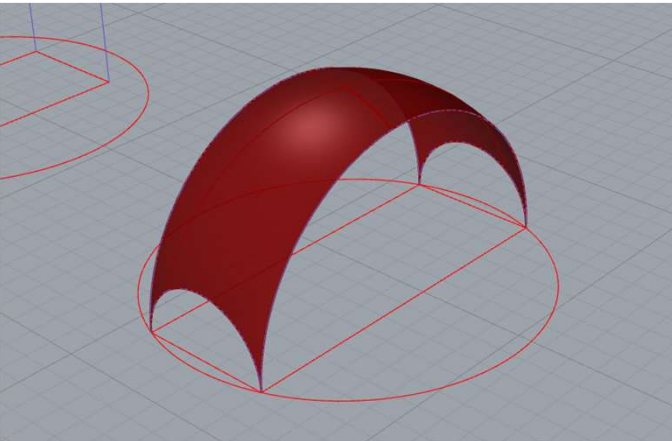
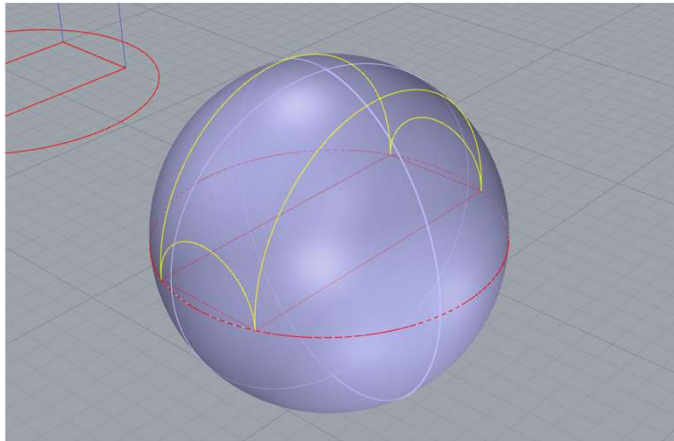
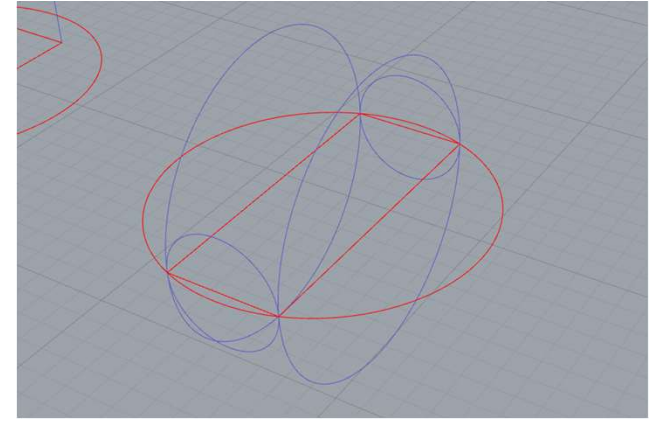
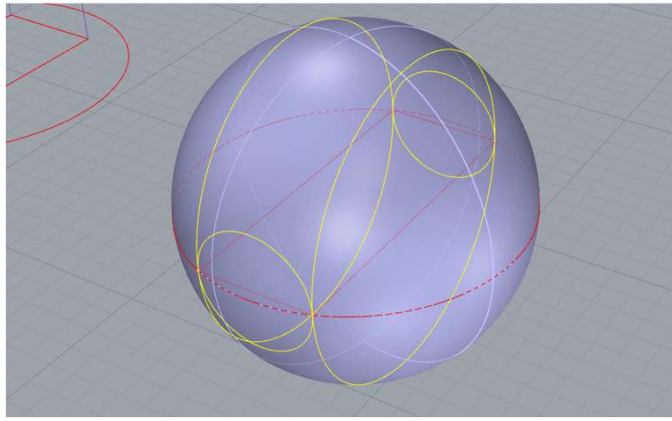
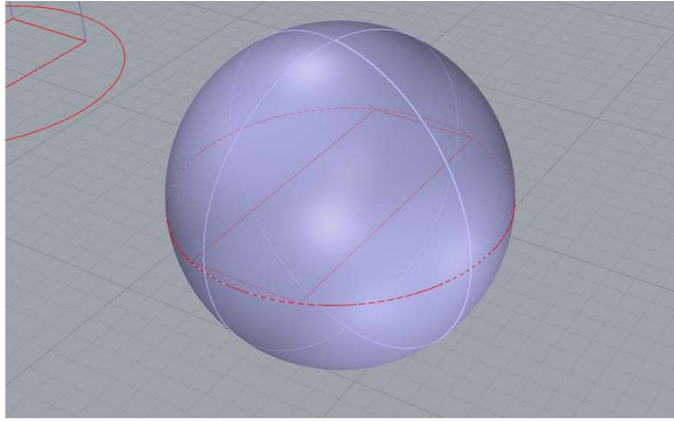
Select arcos – **TRIM** – resto da esfera



ABÓBADA DE VELA ALONGADA 1



CIRCLE – círculo com 7 de raio
 RECTANGLE – retângulo de 10 por 5 inserido
 no círculo
 SPHERE – com o mesmo raio do círculo
 PROJECT – select rectangle – select sphere –
 enter – projeção do retângulo na esfera
 Select arcs – TRIM – resto da esfera



ABÓBADA DE VELA ALONGADA 2

CIRCLE – círculo com 7 de raio

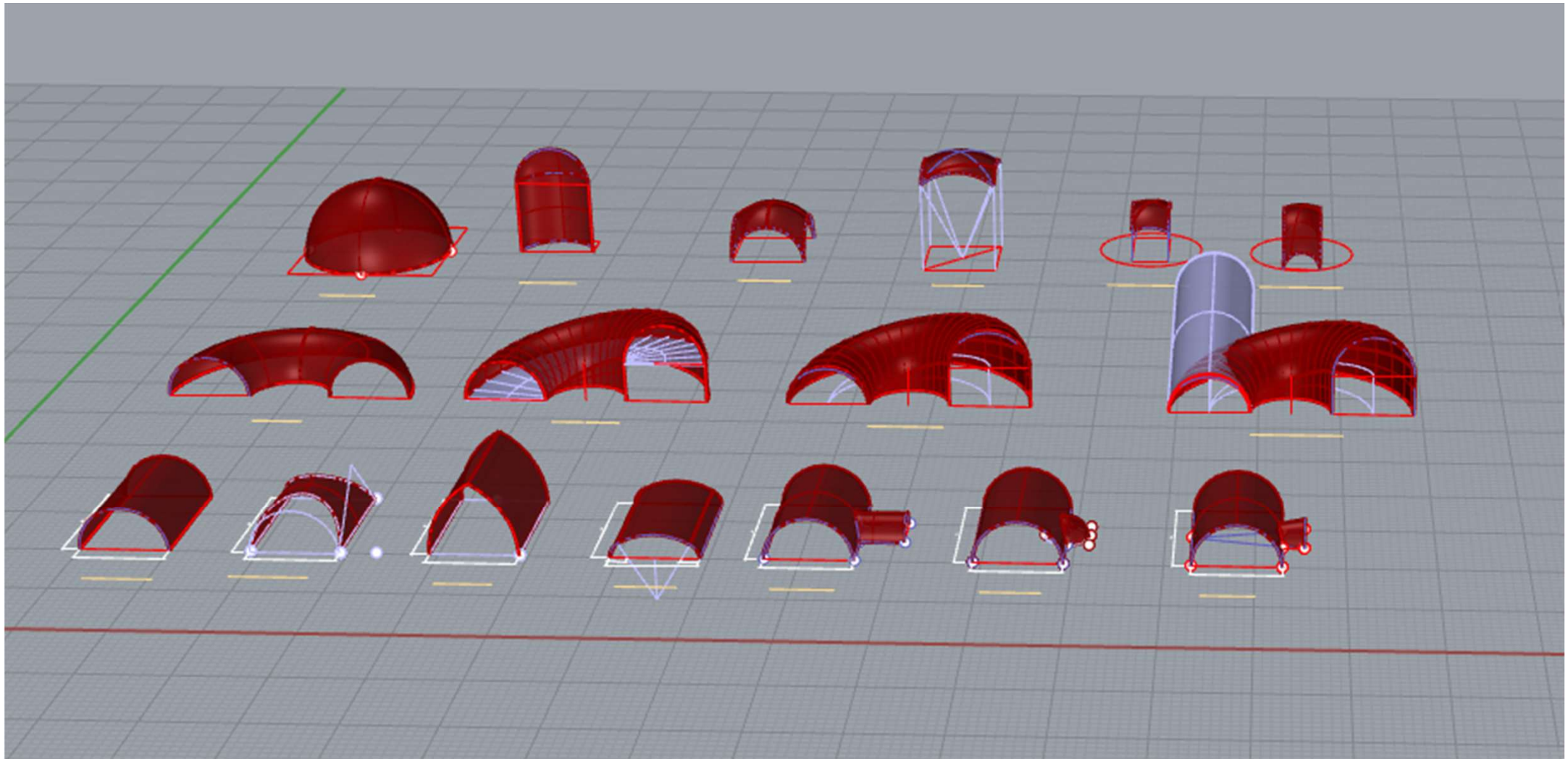
RECTANGLE – retângulo de 14 por 5 inserido
no círculo

SPHERE – com o mesmo raio do círculo

PROJECT – select rectangle – select sphere –
enter – projeção do retângulo na esfera

Select arcs – TRIM – resto da esfera

Aula. 6.

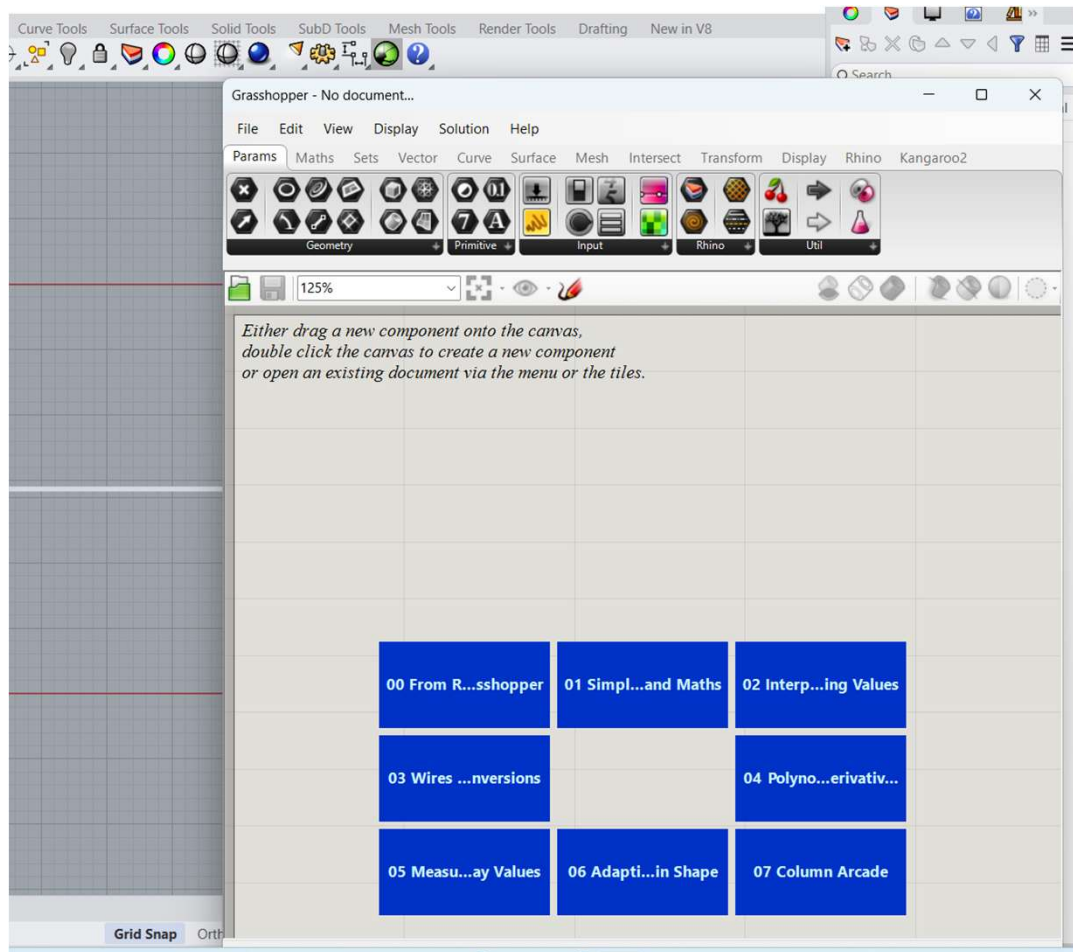


Aula. 6.

-

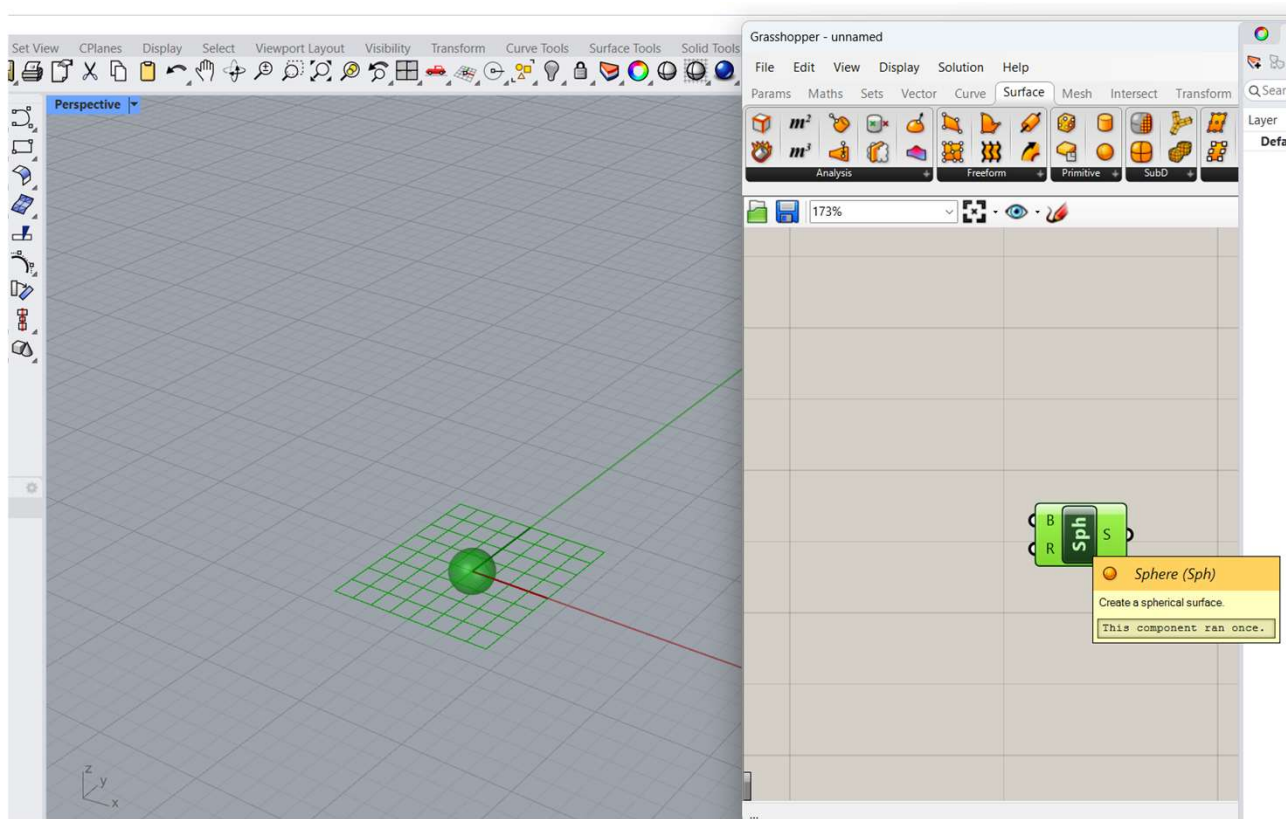
INTRODUÇÃO AO GRASSHOPPER
MODELAÇÃO DE SUPERFÍCIES CURVAS - MOLUSCOS

Aula. 7 – Sumário.



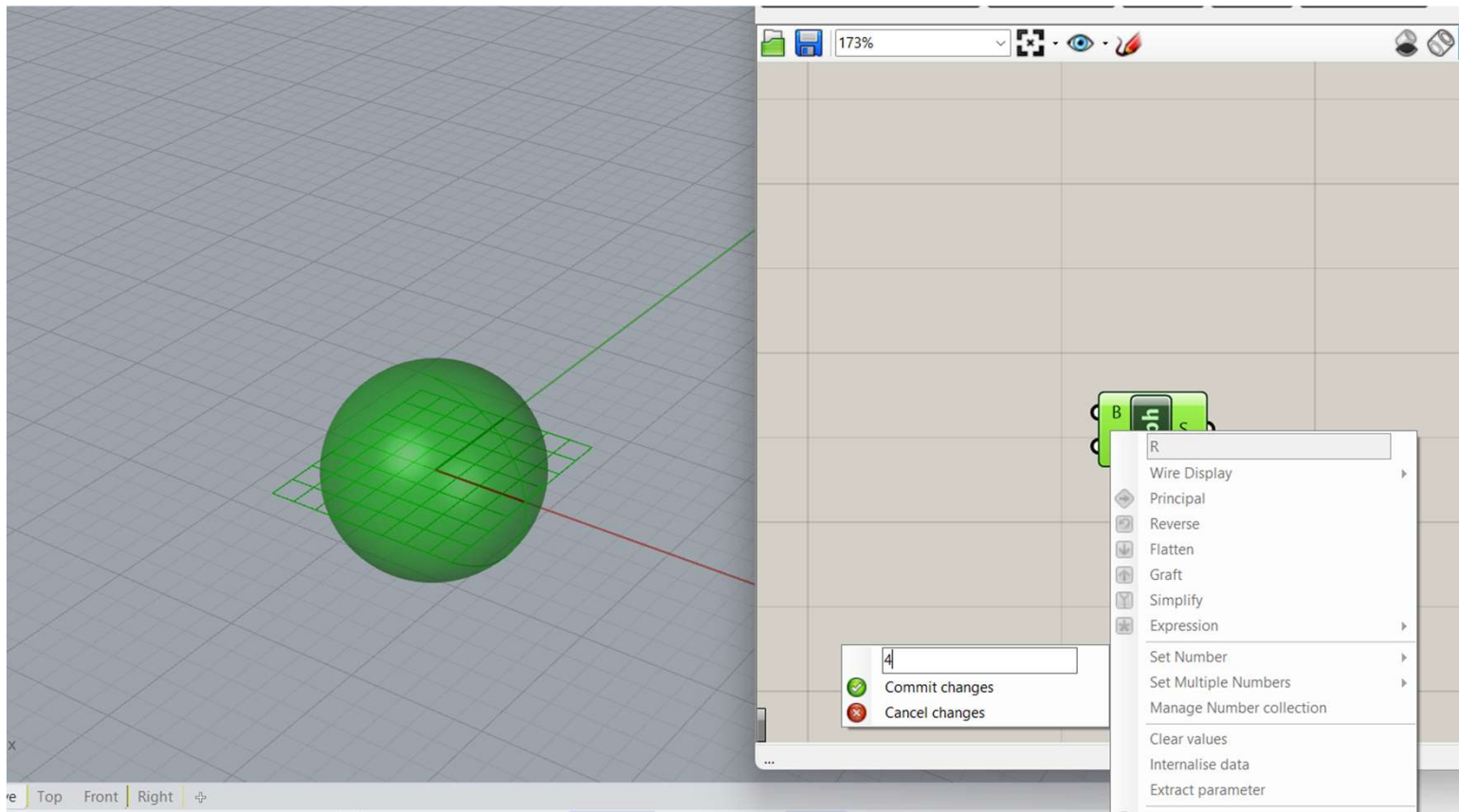
GRASSHOPPER – tem todos os componentes
Permite-nos parameterizar – dimensionar e mexer- as
nossas construções no rhino

Aula. 7.



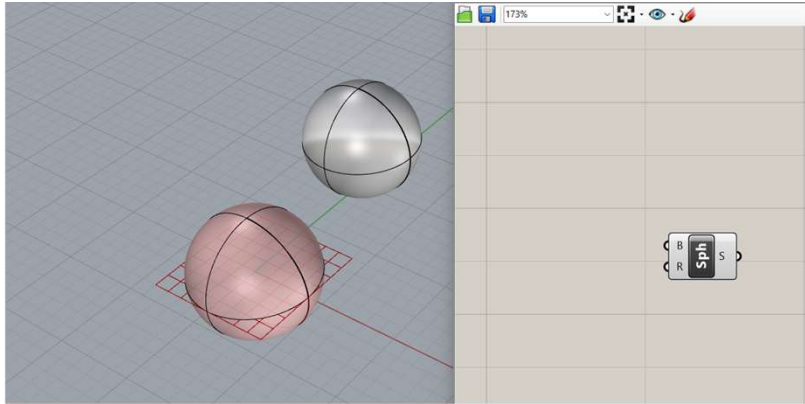
GRASSHOPPER – surface - sphere

Aula. 7.

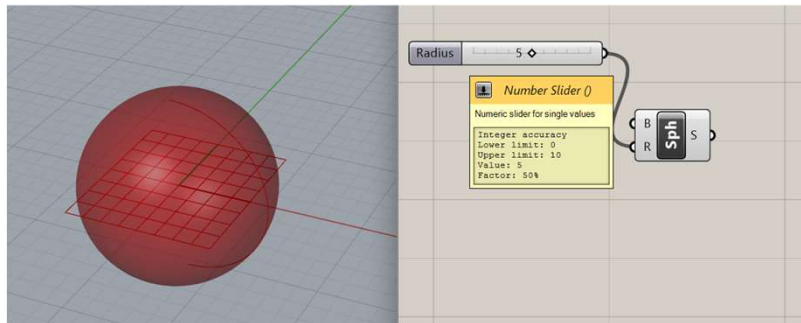


GRASSHOPPER –

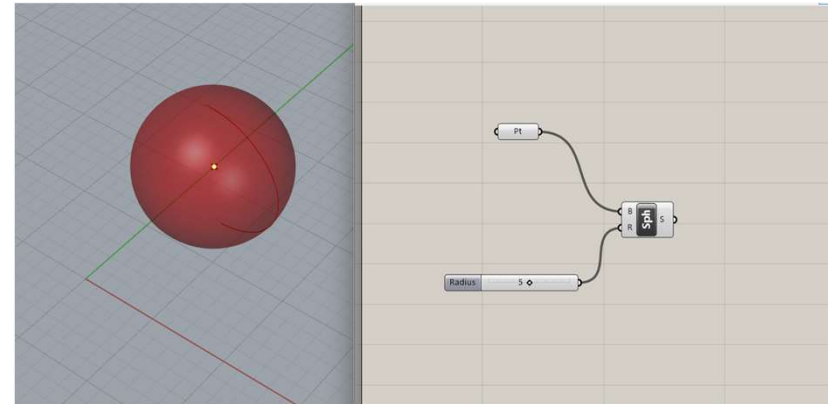
Aula. 7.



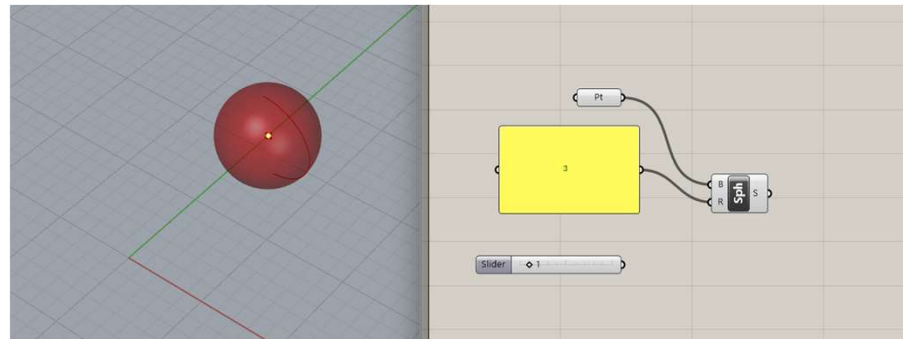
GRASSHOPPER – botão direito do rato – bake – display
– shade – cria um novo objeto que posso alterar no rhino



GRASSHOPPER – clicar 2x (botão esquerdo) – 7 – enter – cria
um slide de numeros entre 1 e 10
- Arrastar a seta da bolha até R (radius) – podemos usar a escala
para alterar o raio da esfera

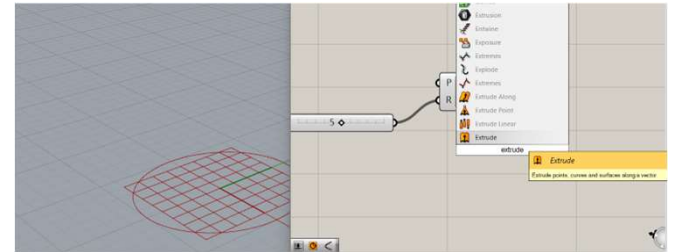
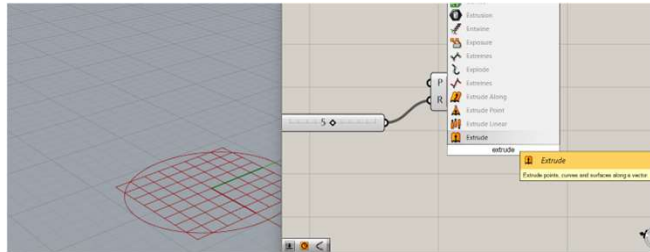
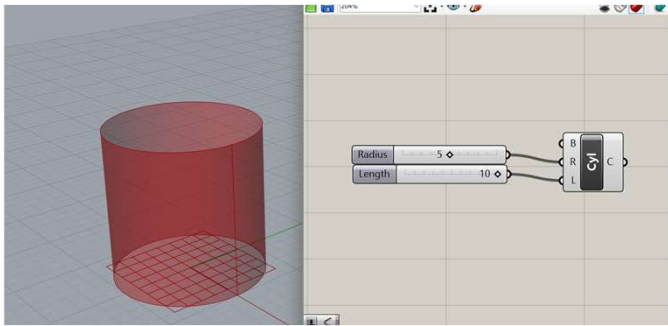


GRASSHOPPER – clicar no botão do ponto nos parametros – no
RHINO – POINT – criar um ponto – botão direito do rato em cima do
Pt – set one point – select ponto no rhino – ligar Pr a B (base) da esfera

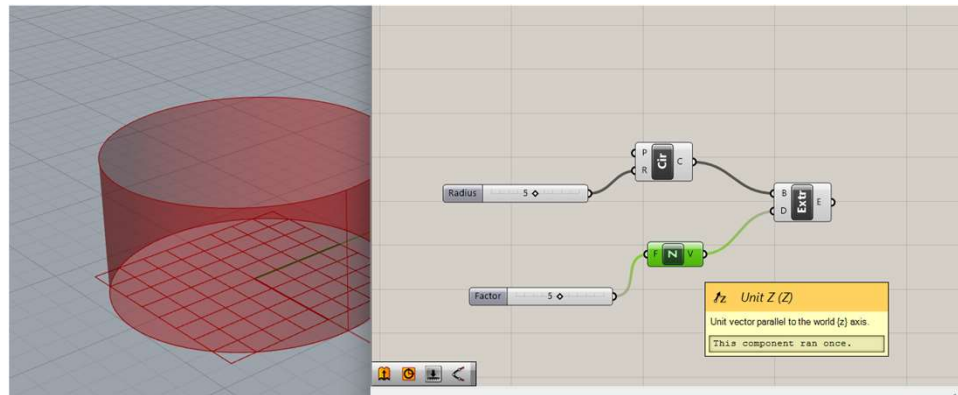


PAINEL – 3 – ligar a R

Aula. 7.

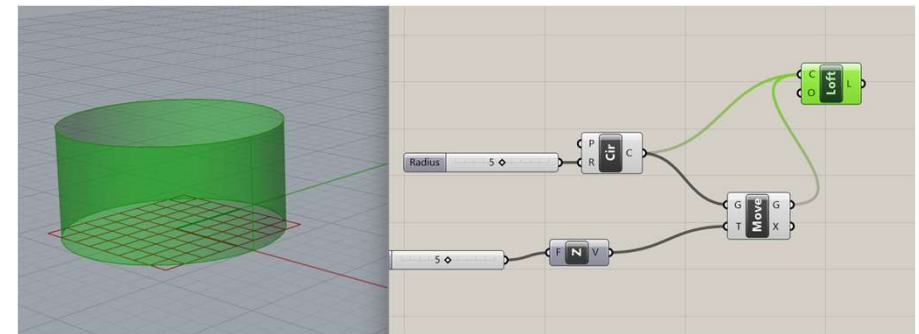
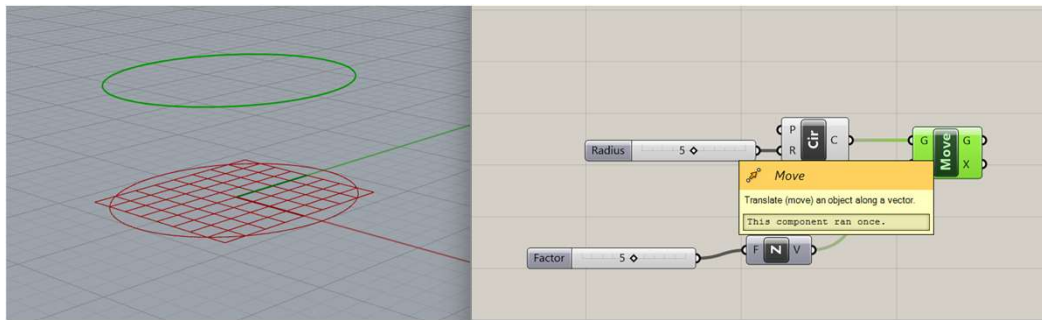


GRASSHOPPER –



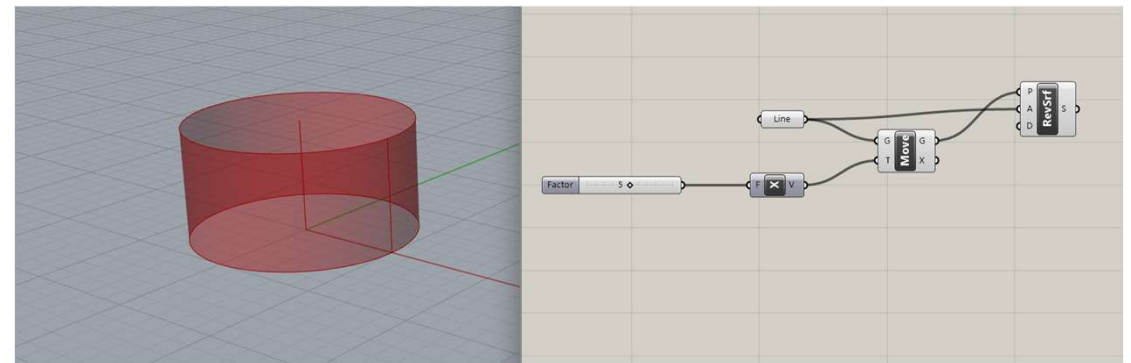
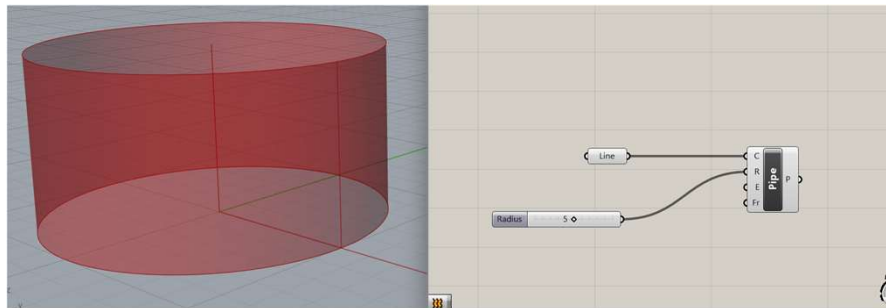
CURVES – circle – clicar 2x na tela – 5 – cria um slide –
colocar

Aula. 7.



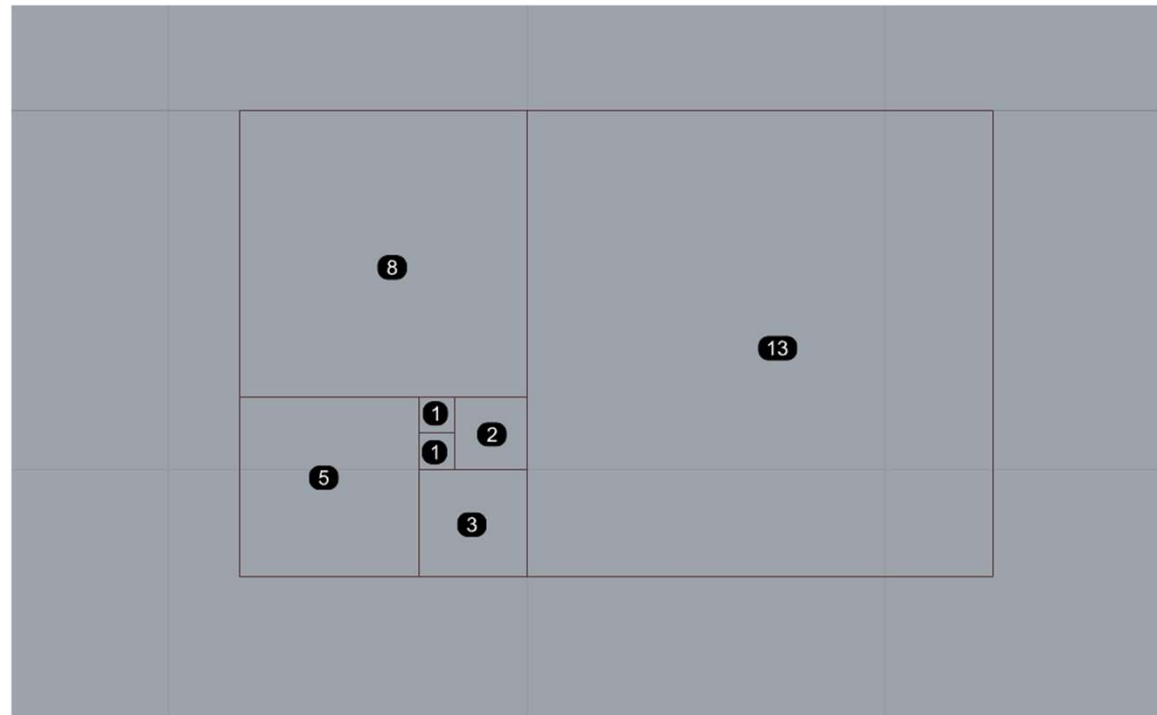
GRASSHOPPER –

LOFT – shift – para ligar a ambas as ligações



Aula. 7.

Squencia de Fibonacci



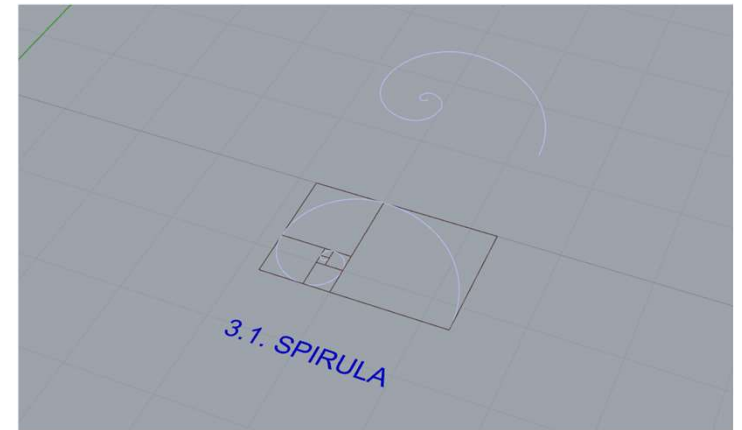
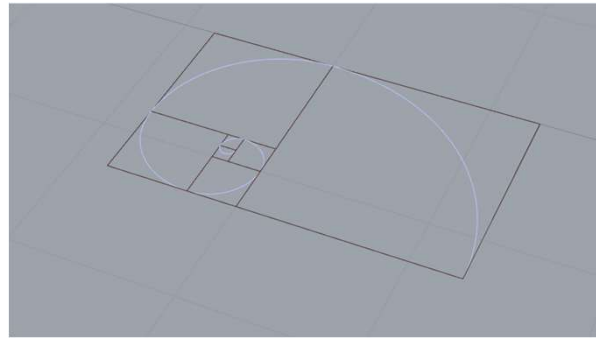
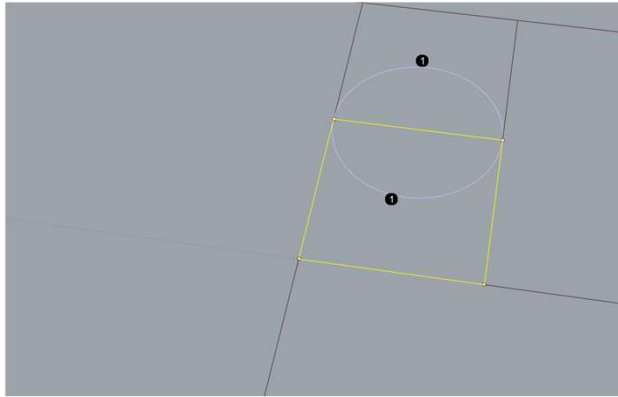
MOLUSCOS

Espiraís planas

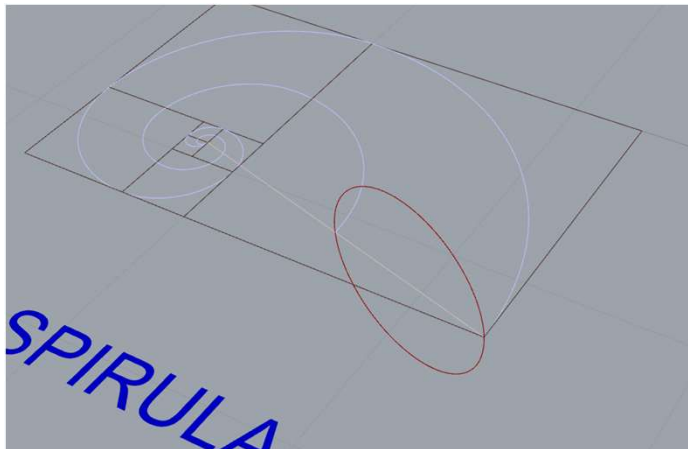
- Spirula
- Planorbis
- Nautilus

Espiraís cónicas

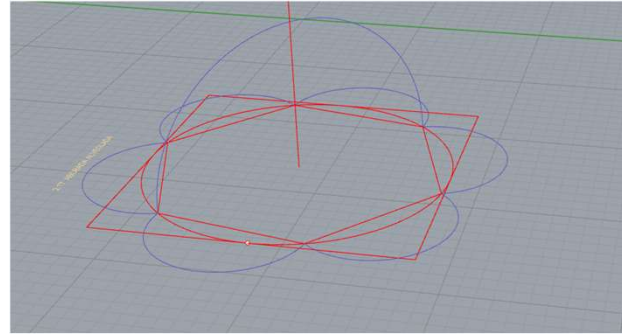
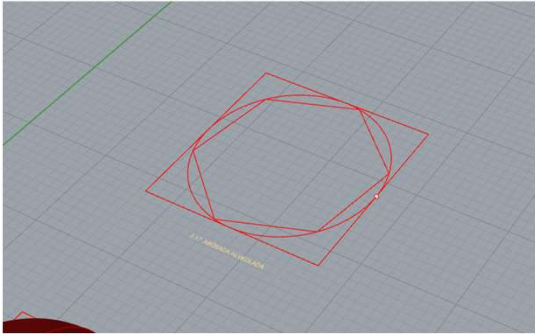
- Caracol
- Caramujo do mar



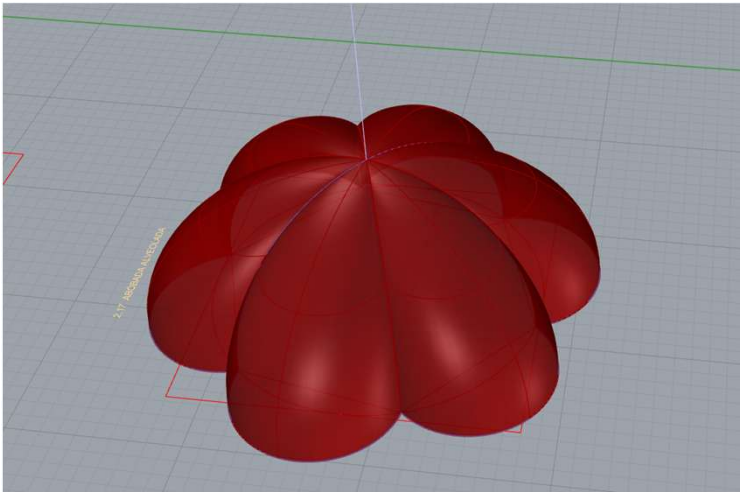
ARC -



Aula. 7.



ABÓBADA AVEOLADA



CIRCLE – círculo com 10 de raio | RECTANGLE – quadrado de 20 por 20

POLYGON – 6 – dimensão do círculo | CIRCLE – em um dos lados do hexágono

Select hexágono – TRIM – formar um arco

ARRAYPOLAR – 6 – 360 | JOIN – todos os arcos

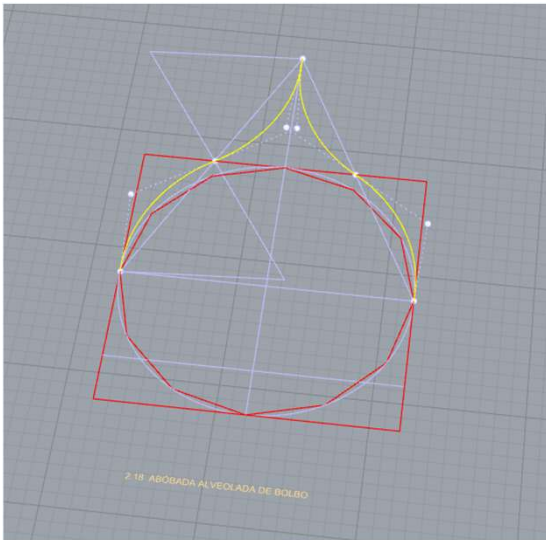
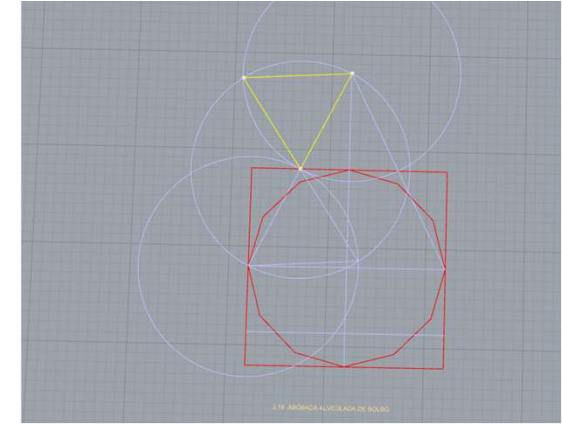
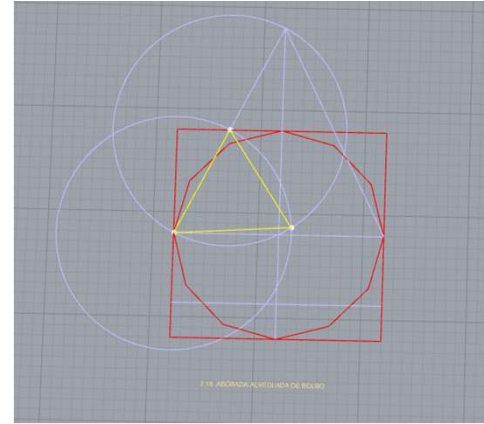
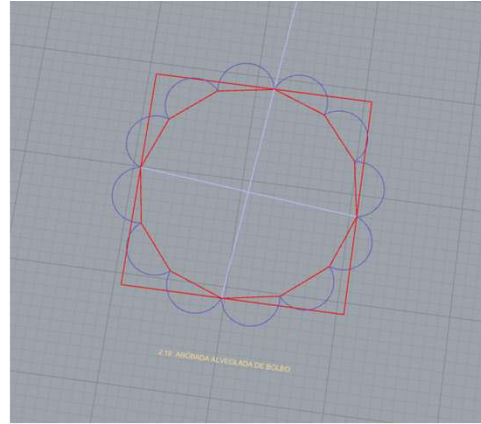
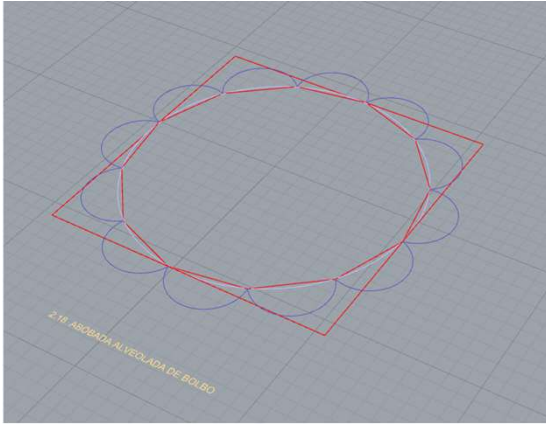
LINE – vertical – no centro os polígonos

CIRCLE – vertical – de raio 10 no centro

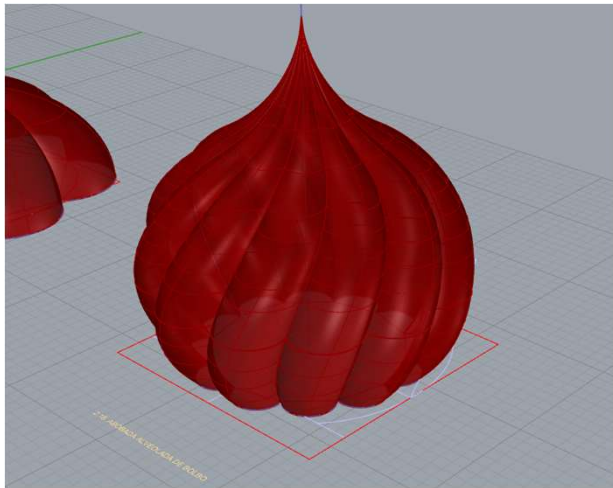
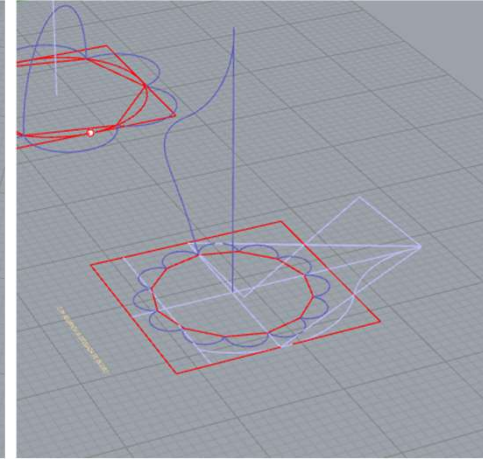
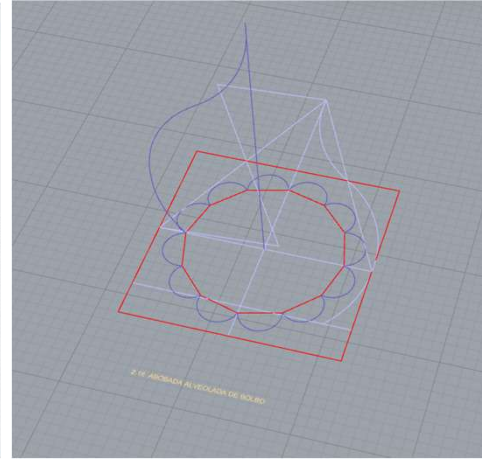
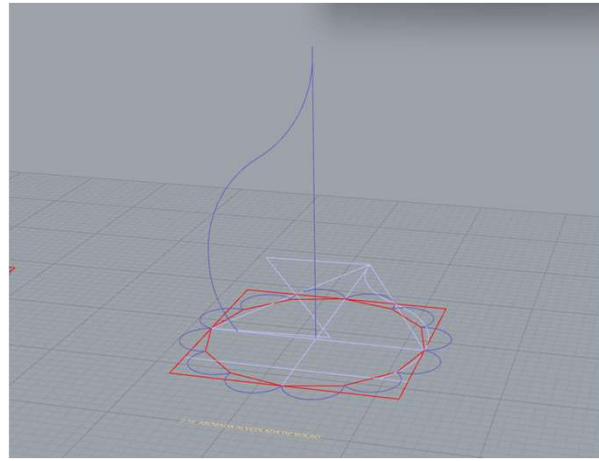
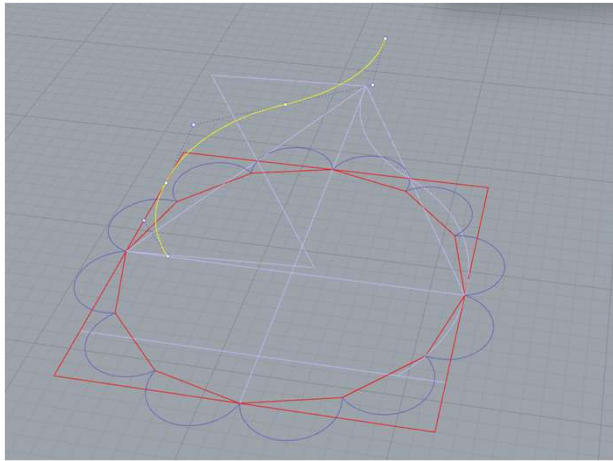
Select circle – TRIM – parte de baixo do círculo

DIVIDE – select arch – select vertical line – divide o arco em duas partes

RAILREVOLVE – select 1 parte do arco – select arcos – enter



- CIRCLE – círculo com 10 de raio | RECTANGLE – quadrado de 20 por 20
 POLYGON – 12 – dimensão do círculo | CIRCLE – em um dos lados do hexágono
 Select hexágono – TRIM – formar um arco
 ARRAYPOLAR – 12 – 360 | JOIN – todos os arcos
 LINE – que divide o quadrado ao meio
 - De 20 un do centro do quadrado para o cima
 - Linha do centro ao fundo do quadrado com 10 un
 DIVIDE – 3 – na linha de 10 un | LINE – formar um triângulo no topo
 CIRCLE – 2 points – do topo do triângulo a um dos seus lados
 - Com centro nesse lado a passar na interceção do círculo com o quadrado
 - Com o centro no topo do triângulo até á interceção
 LINE – unir as interceções dos círculos formmando 2 triângulos
 ARC – formar arcos em lados opostos dos triângulos | JOIN – os arcos



ABÓBADA AVEOLADA DE BOLBO

MOVE – a linha curva

ROTATE3D – colocar a curva vertical

SCALE – select os 12 arcos e diminui-los até á curva

TWIST – select a curva – select o eixo vertical – 45 ° –

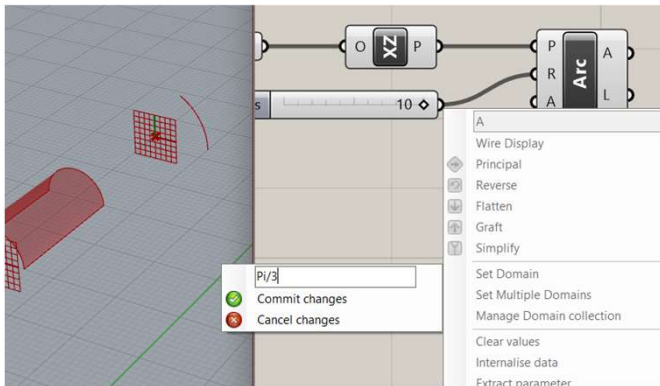
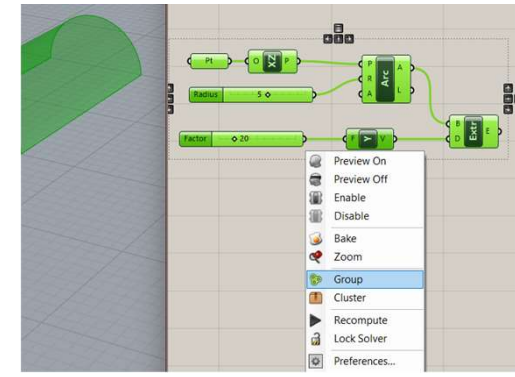
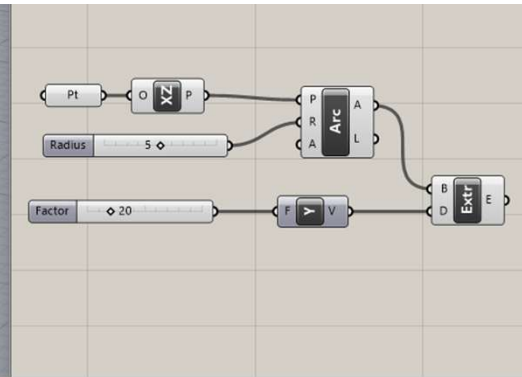
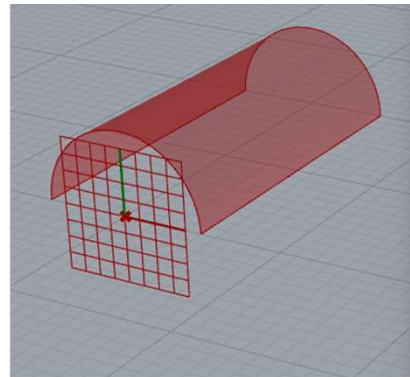
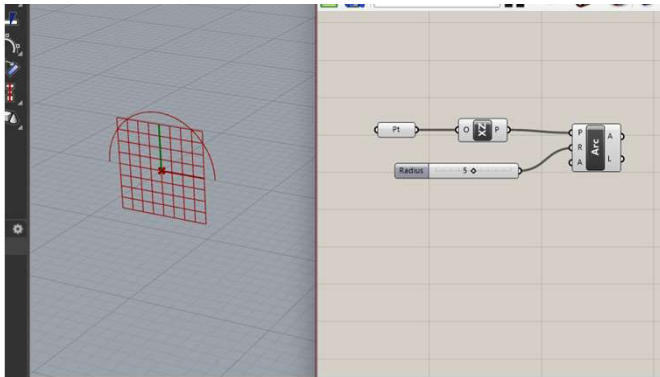
RAILREVOLVE – select curva - select os 12 arcos – select o eixo vertical - enter

T.P.C.

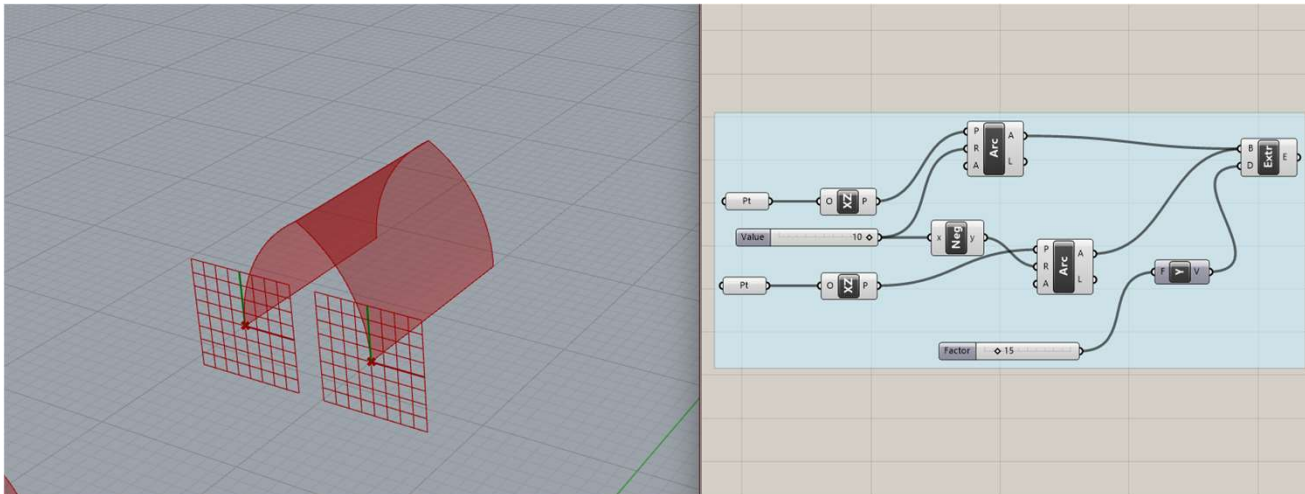
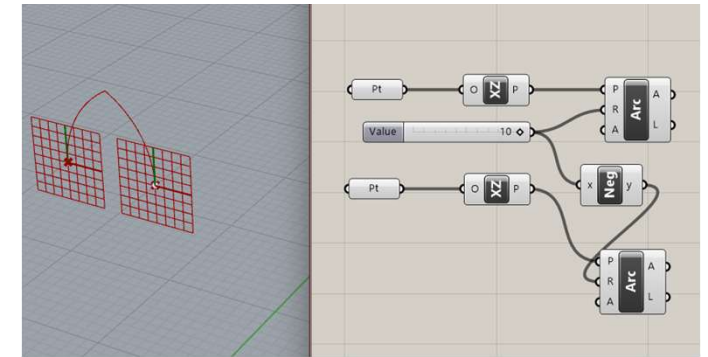
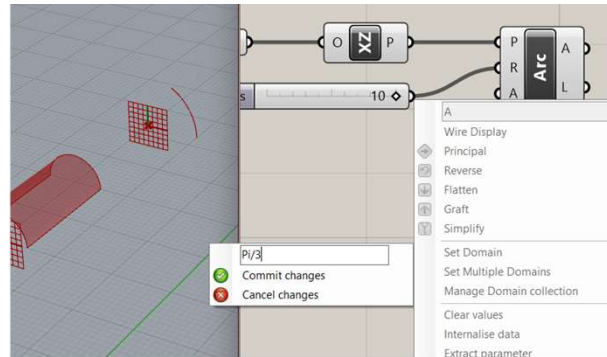
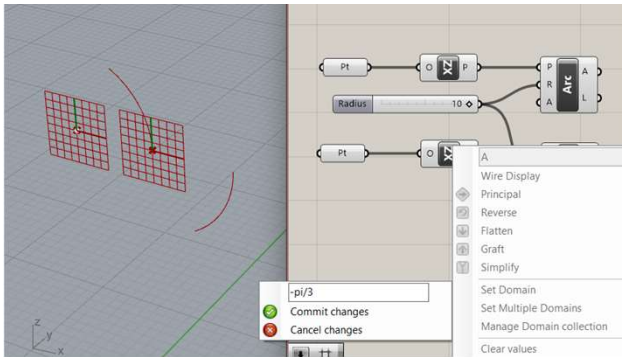
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GRASSHOPPER – SUPERFÍCIE DE ABÓBADAS
CONSTRUÇÃO DO MODELO DE UM TORO EM SCRIPT

Aula. 8 – Sumário.

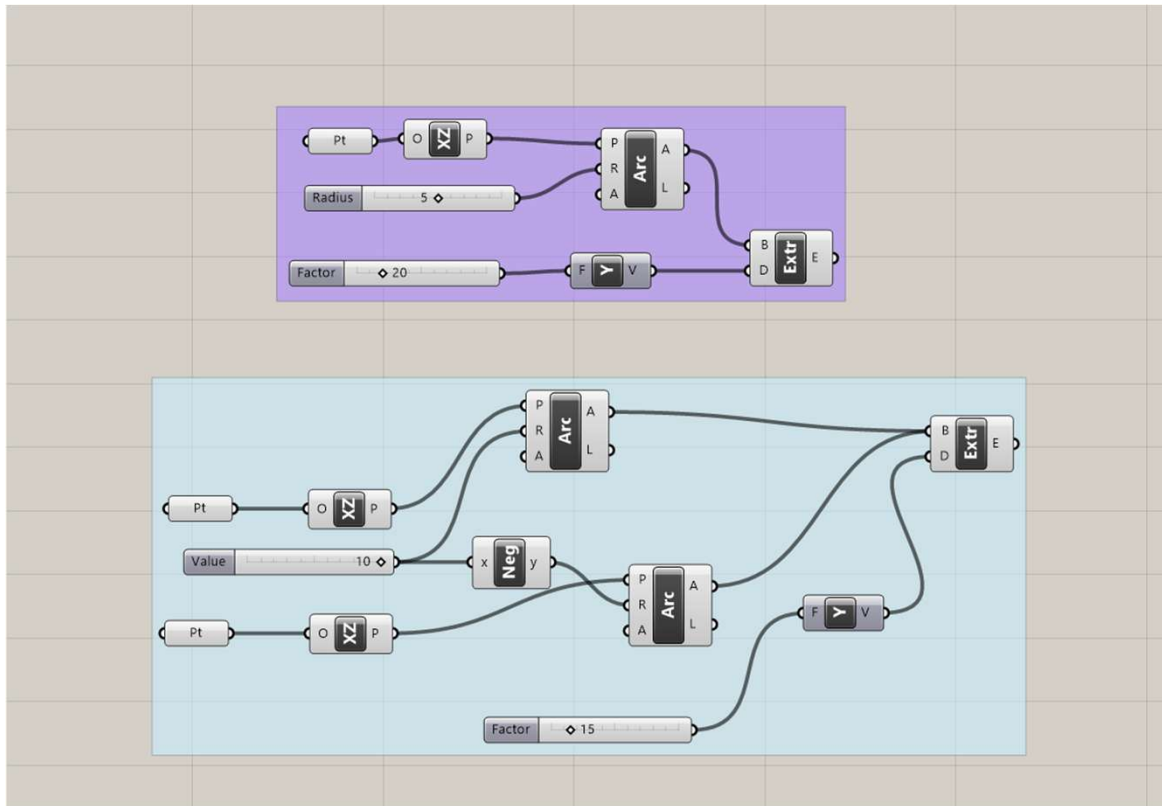


Aula. 8.



ARC -

Aula. 8.

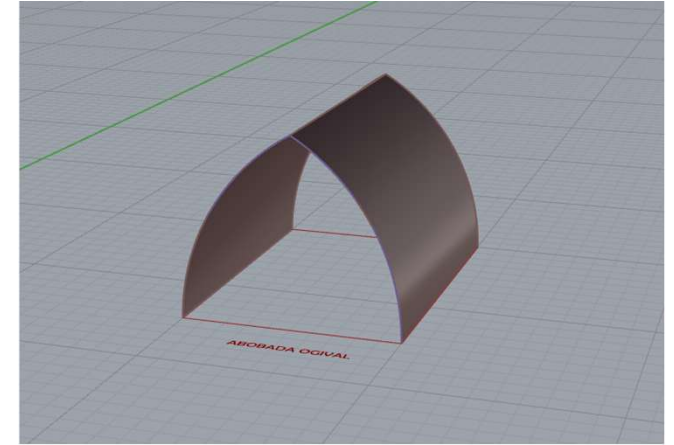
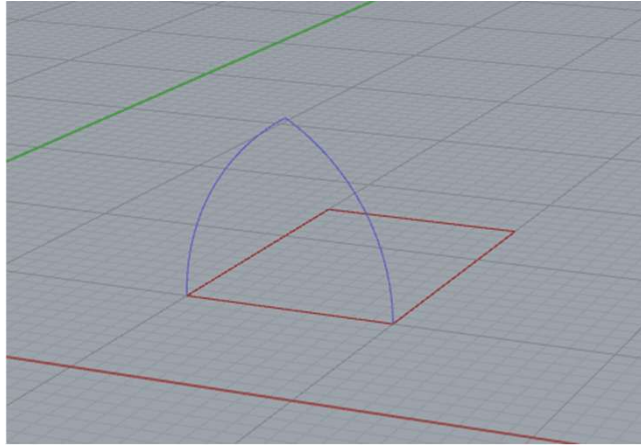
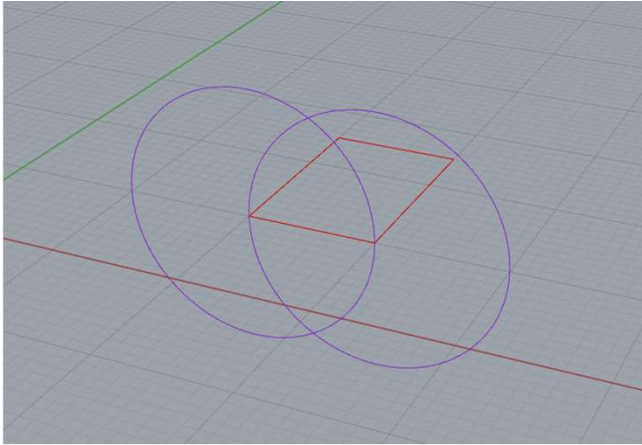


ARC -

Aula. 8.

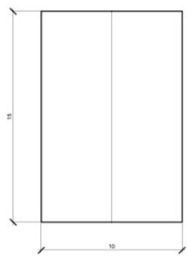
MODELAÇÃO E ESTRUTURAÇÃO DE SUPERFÍCIES DE ABÓBADA

Trabalho. 2.

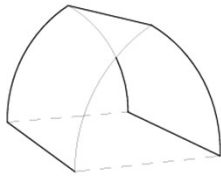


ABÓBADA OGIVAL

- Partindo de um retângulo com 10 un por 15 un
- Criamos 2 círculos verticais com o centro num dos vértices e o raio de 10 un
- Utilizamos o comando TRIM para eliminar os círculos deixando apenas o formato do arco ogival
- Executar EXTRUDE neste arco para formar a abóbada ogival



Top View



Perspective View

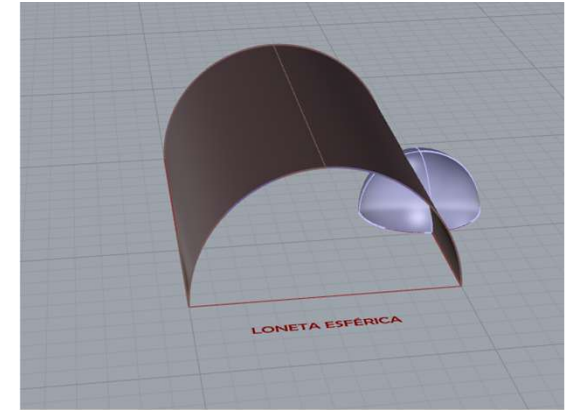
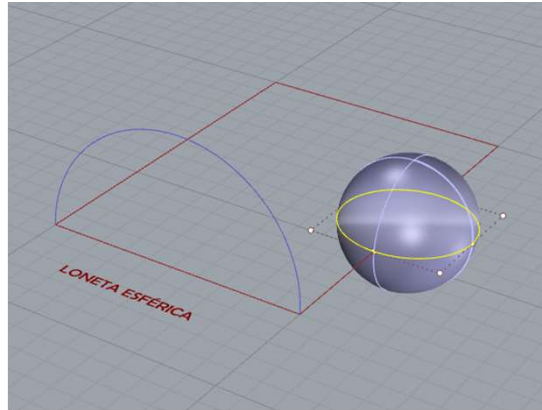
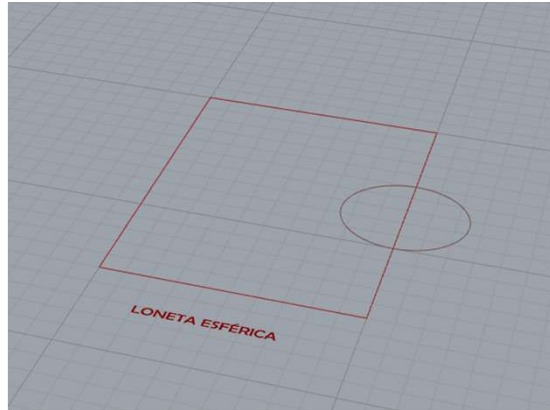


Front View



Right View

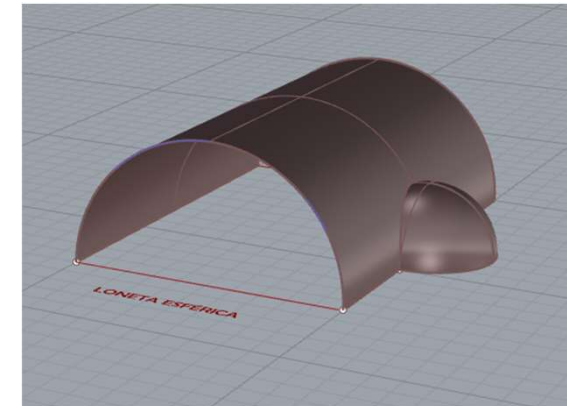
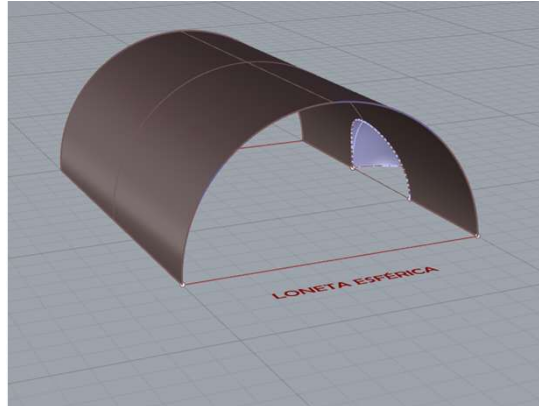
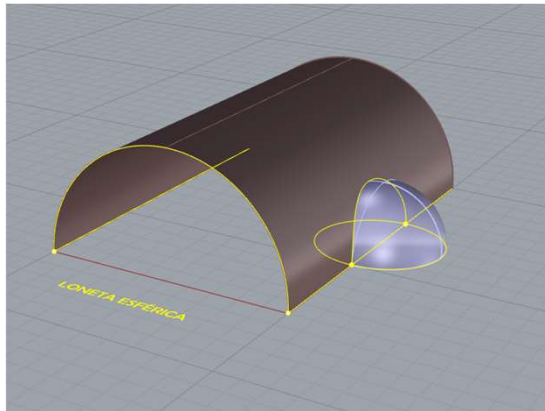
Trabalho 2.



ABÓBADA DE BERÇO COM LUNETAS ESFÉRICAS

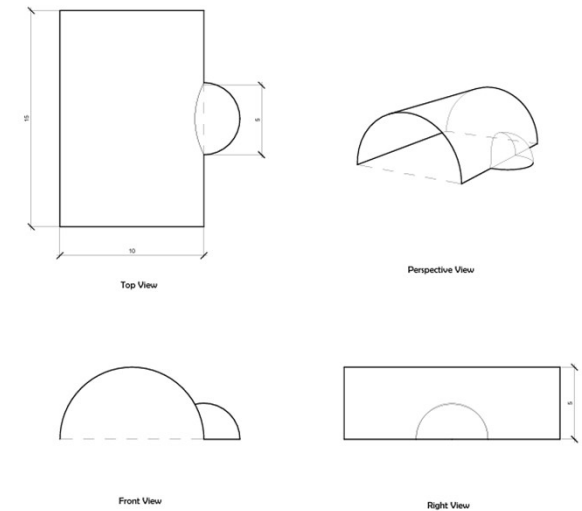
- Partindo de um retângulo com 10 un por 15 un
- Criamos um círculo com raio de 2,5 un no meio de um dos lados do retângulo e em seguida, uma esfera com a mesma medida por cima
- Construímos uma abóbada de berço a partir de um círculo vertical, eliminando a parte inferior com o TRIM e fazendo o EXTRUDE

Trabalho 2.

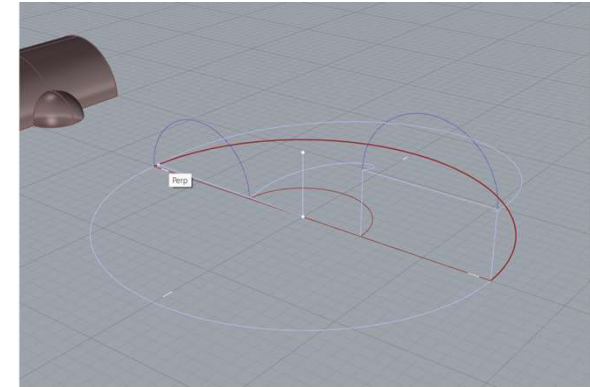
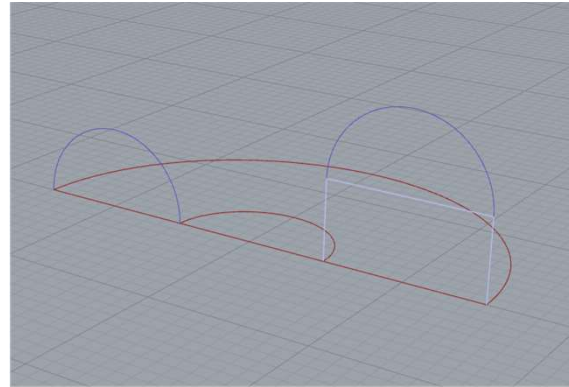
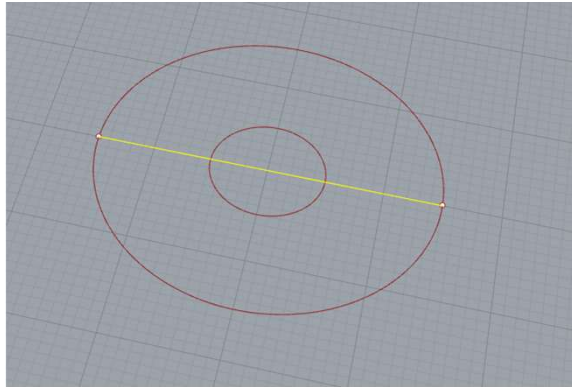


ABÓBADA DE BERÇO COM LUNETTA ESFÉRICA

- De seguida utilizamos o comando INTERSECT que cria uma curva na interseção da esfera com a abóbada
- Isto permite nos utilizar o comando TRIM novamente para eliminar as superfícies em excesso
 - Obtemos assim a abóbada de berço com uma luneta esférica



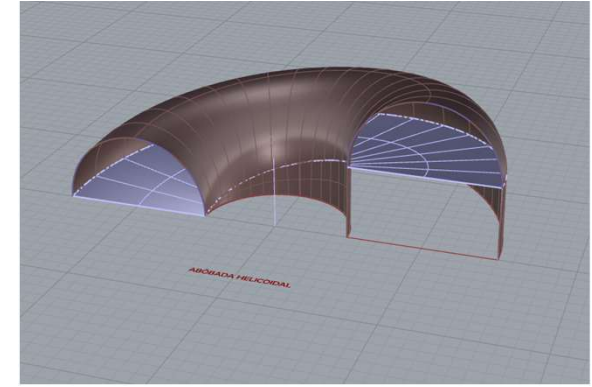
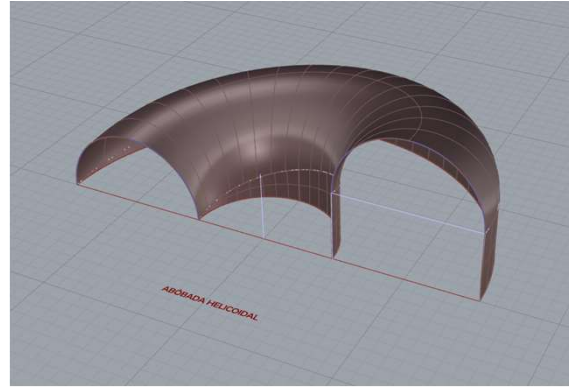
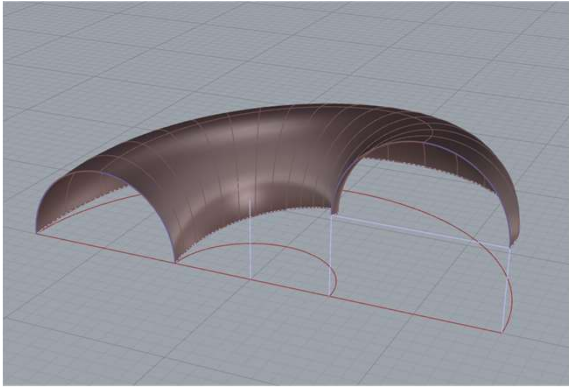
Trabalho 2.



ABÓBADA HELICOIDAL

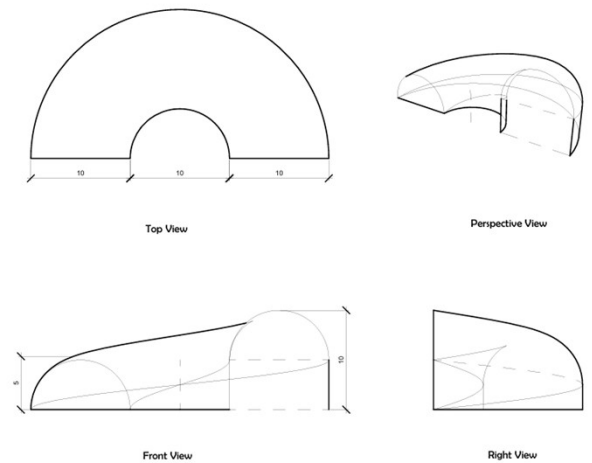
- Começamos com um círculo com raio de 5 un no centro de um círculo com raio de 15 un
 - Utilizamos o TRIM para cortar ambos os círculos ao meio
- Numa das extremidades colocamos um meio círculo vertical enquanto na outra colocamos um retângulo com 5 un de altura e com um meio círculo no seu topo
- Em seguida utilizamos o comando HELIX definir curvas que servirão como guias para o próximo passo

Trabalho 2.



ABÓBADA HELICOIDAL

- Com o comando SWEEP2 podemos executar aabóbada de cima
- O comando LOFT é então utilizado para fechar os lados
- E por fim utilizamoso SWEEP2 novamente para criar a rampa
- Construímos assim uma abóbada helicoidal



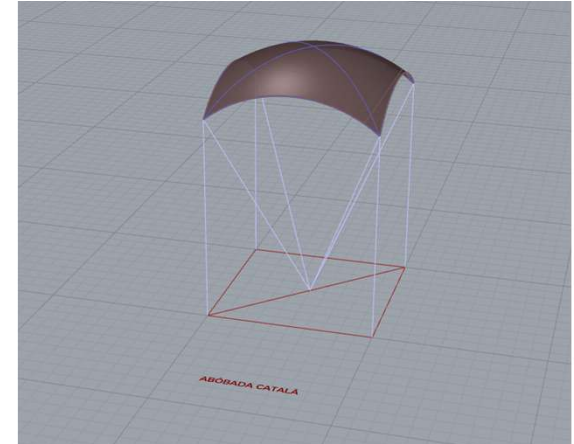
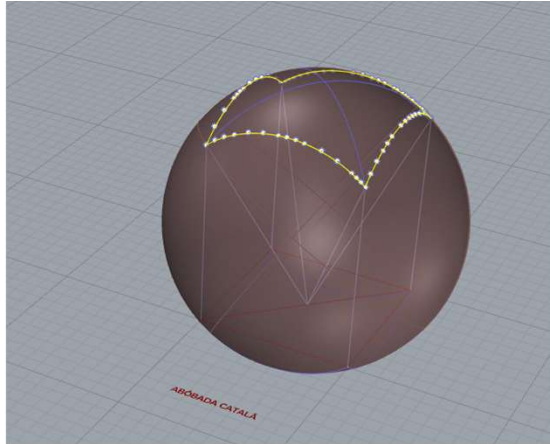
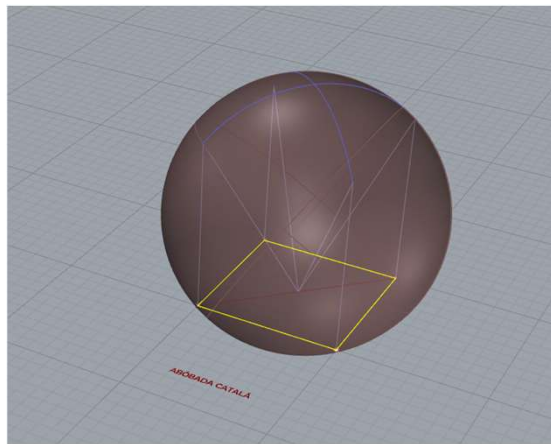
Trabalho 2.



ABÓBADA CATALÃ

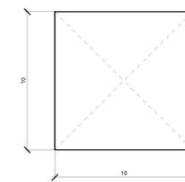
- Criamos uma linha, no centro de um quadrado com 10 de lado, com uma inclinação dada por $@10 < 45 < 60$
- Criamos uma linha vertical num vértice do quadrado que se intersecta com a linha inicial
 - Fazemos MIRROR destas linhas para o lado oposto do quadrado
 - Criamos um círculo vertical que passa pelos 2 cantos criados e pela base
 - Fazemos o TRIM e o MIRROR de modo a obter a estrutura desta abóbada

Trabalho 2.



ABÓBADA CATALÃ

- Criamos uma esfera com a mesma dimensão do círculo anterior
- Utilizando o comando PROJECT projetamos os lados do quadrado na esfera criando a base cos arcos
- Usamos TRIM para eliminar parte da esfera deixando apenas o arco catalã



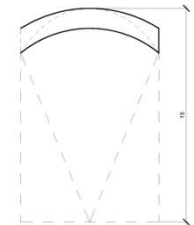
Top View



Perspective View

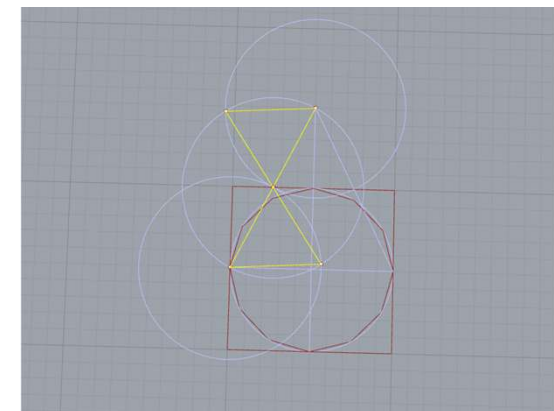
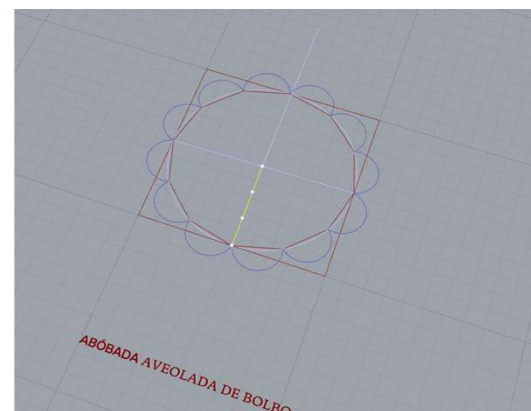
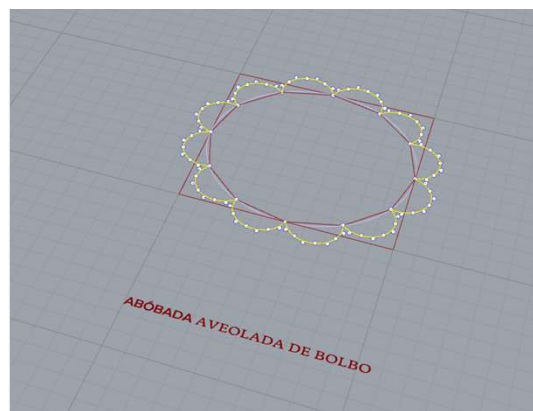
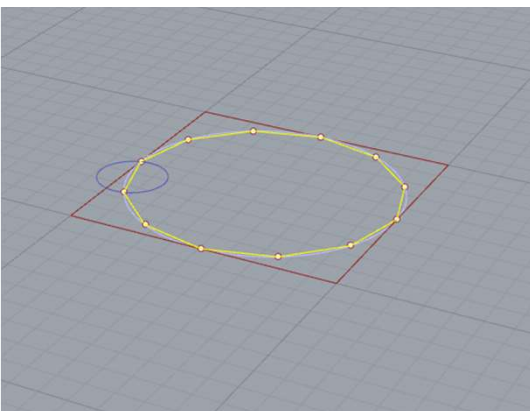


Front View



Right View

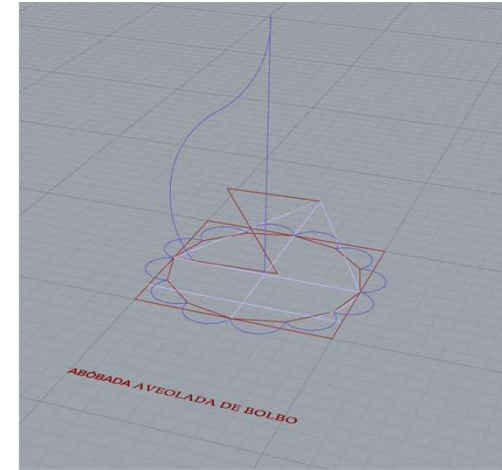
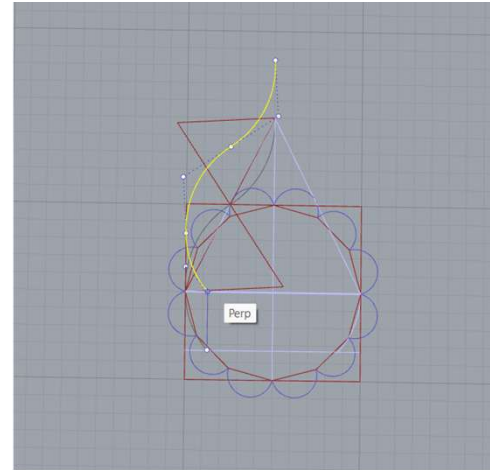
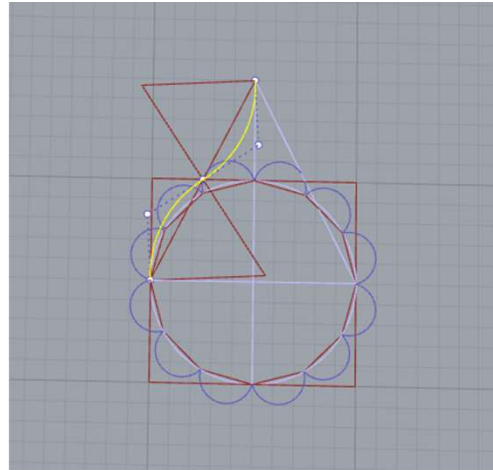
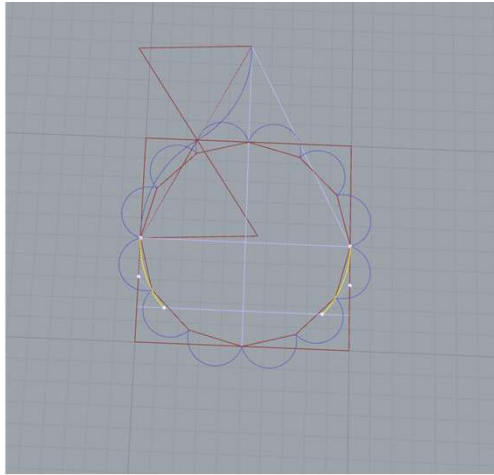
Trabalho 2.



ABÓBADA AVEOLADA DE BOLBO

- A base é formada a partir de um quadrado de 10 un por 10 un com um círculo e um dodecágono nele inseridos
- Num dos lados do polígono colocamos um semicírculo e utilizamos o ARRAYPOLAR para o repetir em todos os outros lados
- Traçamos uma linha que divide as formas ao meio, uma do seu centro para cima com 10 un e outra do seu centro para baixo com 5 un
 - Usamos DIVIDE para dividir a linha de baixo em 3
 - Ligamos a linha horizontal a linha no topo formando um triângulo
- Criamos 3 círculos, o primeiro a passar na ponta em 2 vértices do triângulo, o segundo como centro num dos vértices e a passar pelo centro do primeiro e o terceiro com o centro no topo do triângulo e a passar pelo centro do primeiro
- Formamos triângulos nas interseções destes círculos

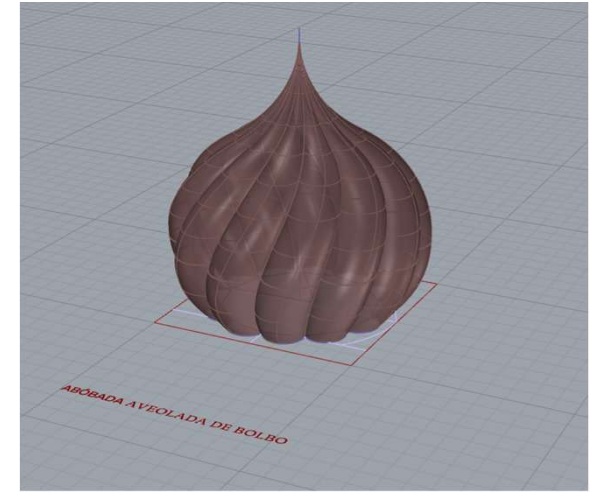
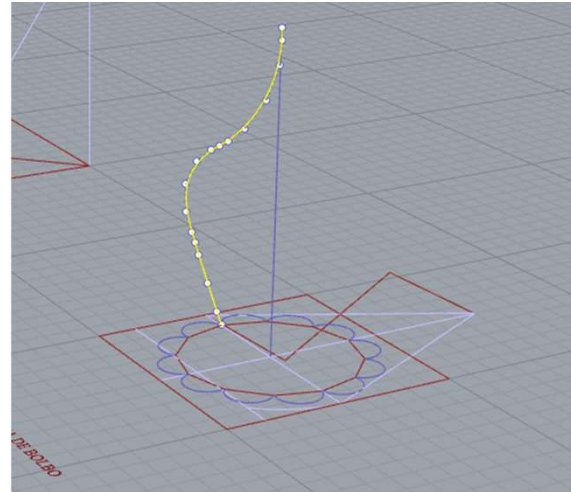
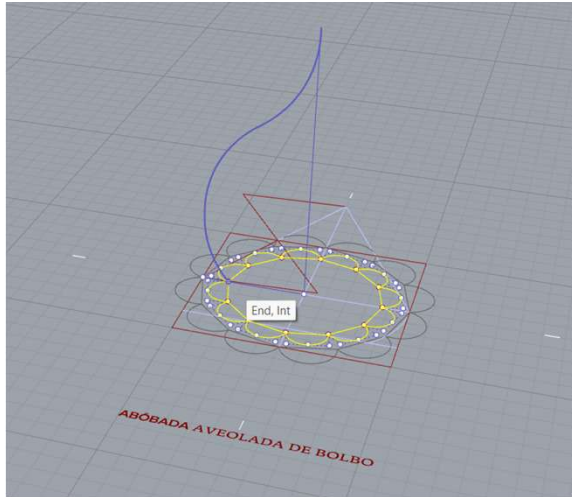
Trabalho 2.



ABÓBADA AVEOLADA DE BOLBO

- Neste triângulos podemos usar o comando ARC para criar arcos num dos seus lados que são unidos com uma parte do círculo cortado a partir da divisão da linha de baixo
- Arrastamos esta nova curva para a linha central e usamos o ROTATE 3D para a colocar na vertical

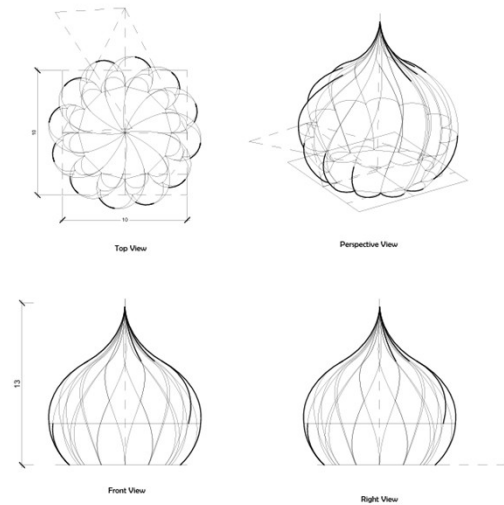
Trabalho 2.



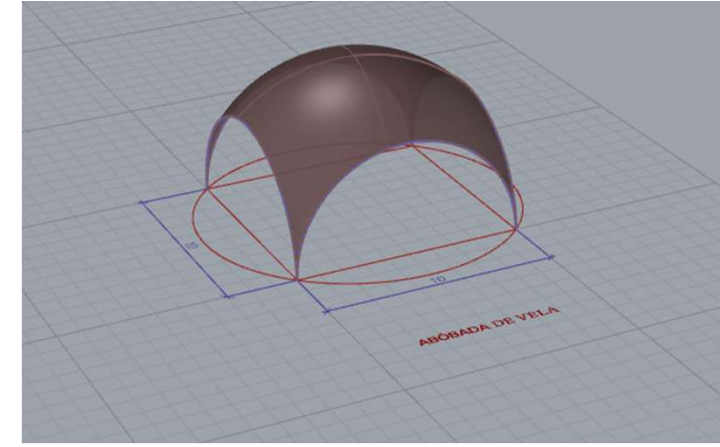
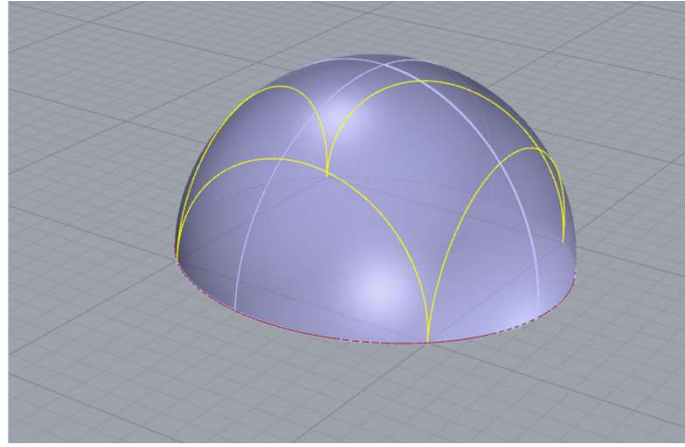
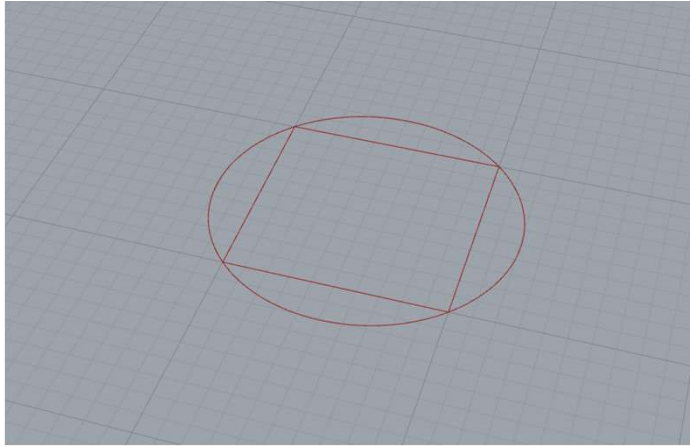
ABÓBADA AVEOLADA DE BOLBO

Utilizamos o comando SCALE para diminuir o dodecágono e os arcos para se interceta com a curva

- Usamos TWIST de 45° para dar a curvatura certa
- Executamos RAILREVOLVE para finalizar a abóbada alveolada de bolbo



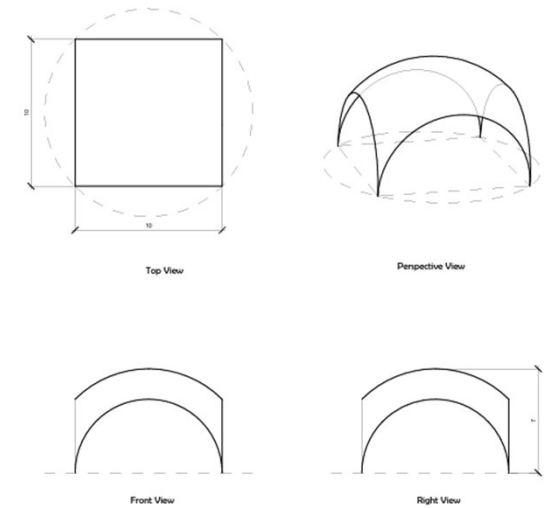
Trabalho 2.



ABÓBADA DE VELA

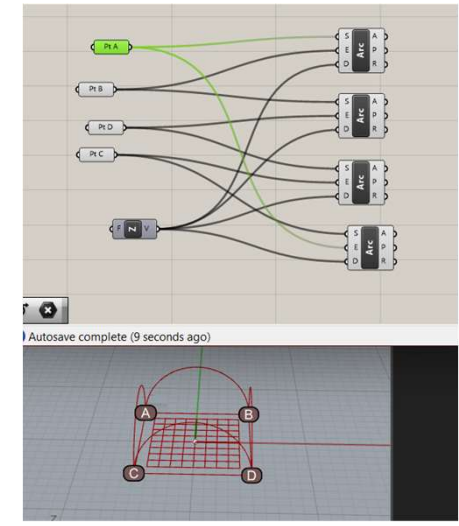
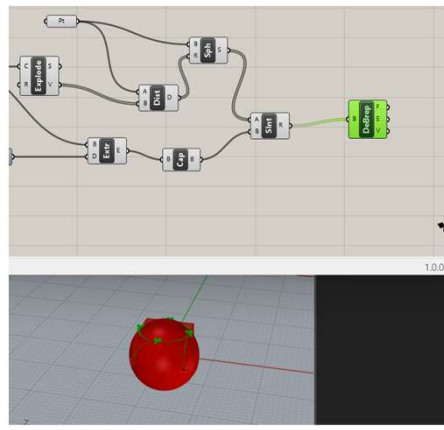
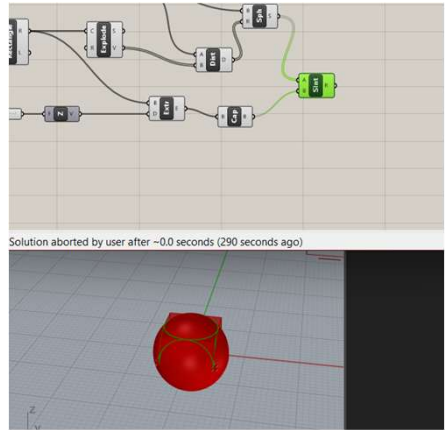
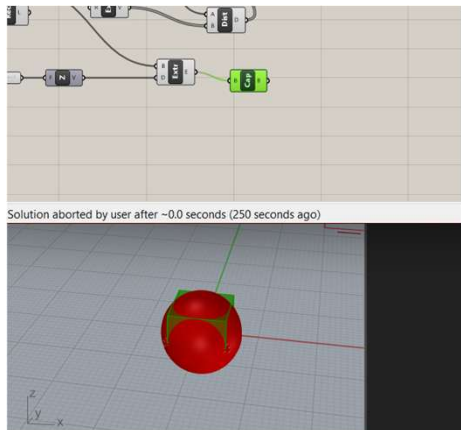
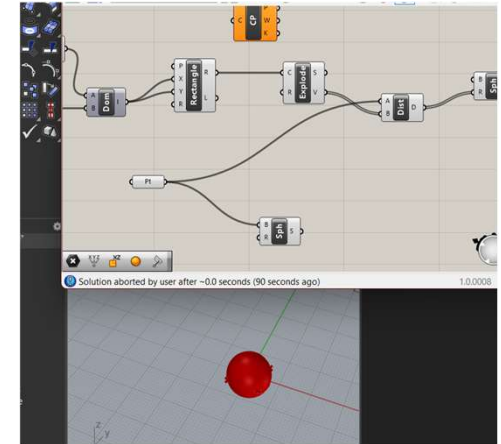
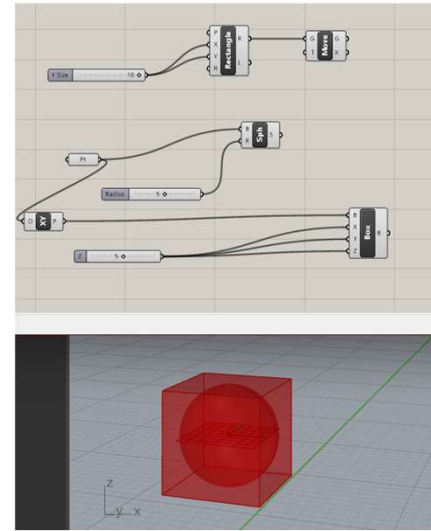
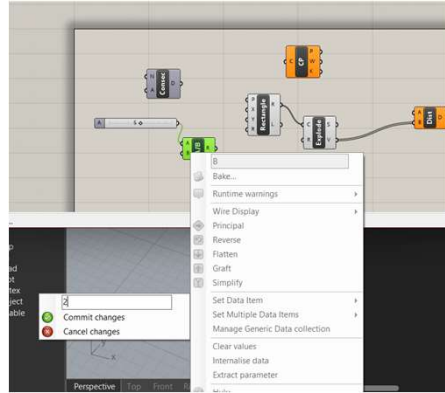
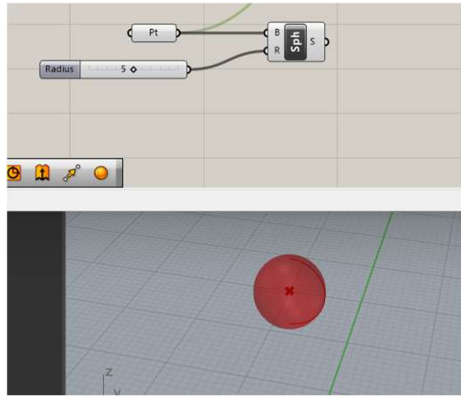
Iniciamos com um quadrado no interior de um círculo

- Na dimensão desse círculo fazemos uma esfera
- Fazemos o PROJECT do quadrado nesta esfera
- Retiramos o excesso com TRIM
- Obtemos uma abóbada de vela



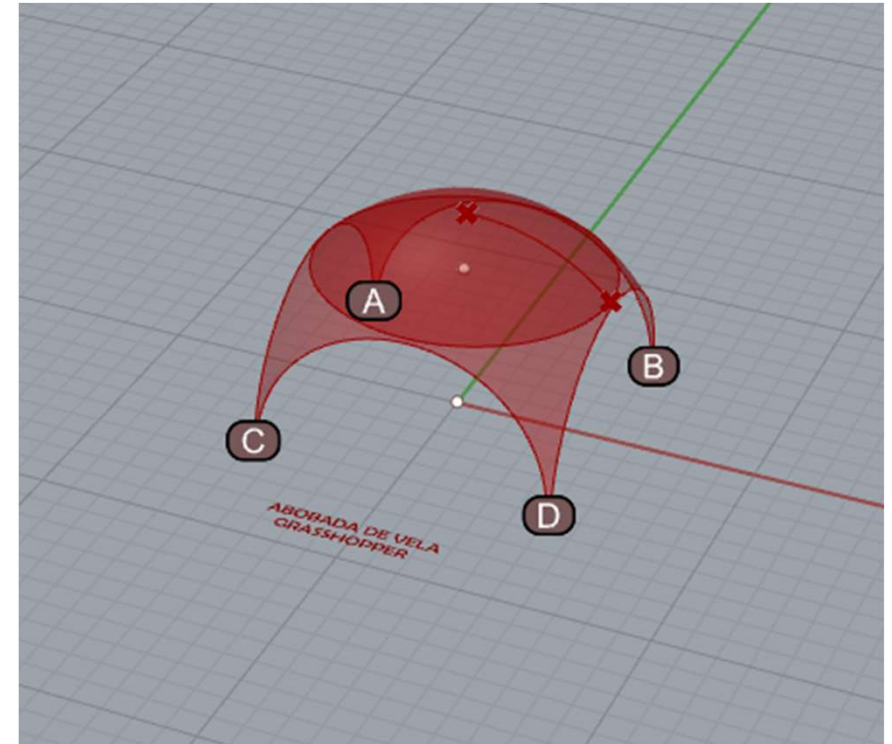
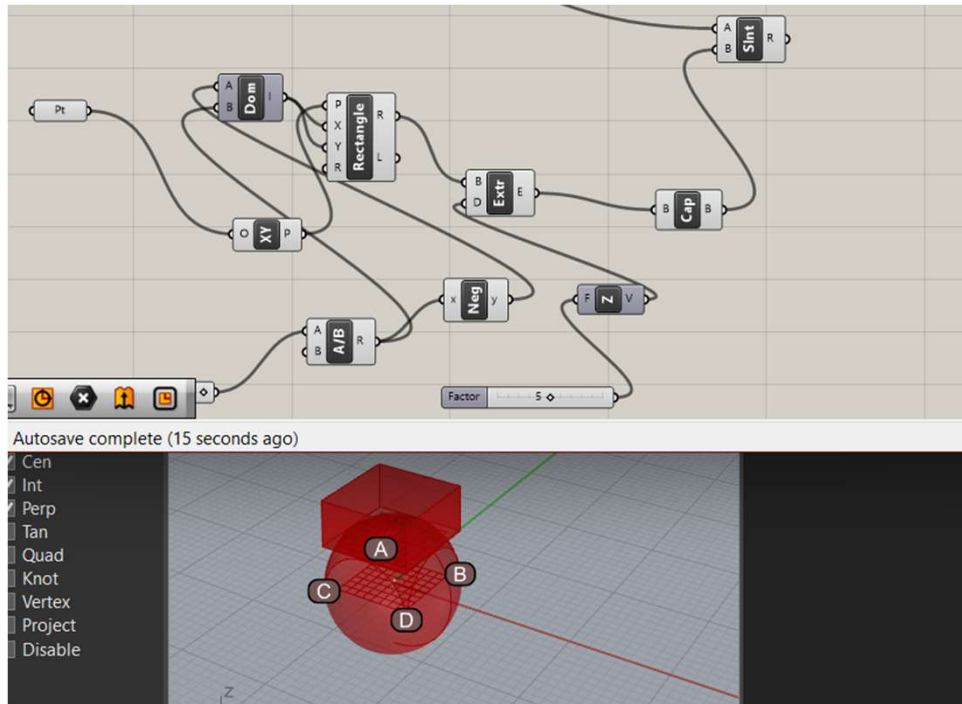
Trabalho 2.

GRASSHOPPER – TENTATIVA E ERRO



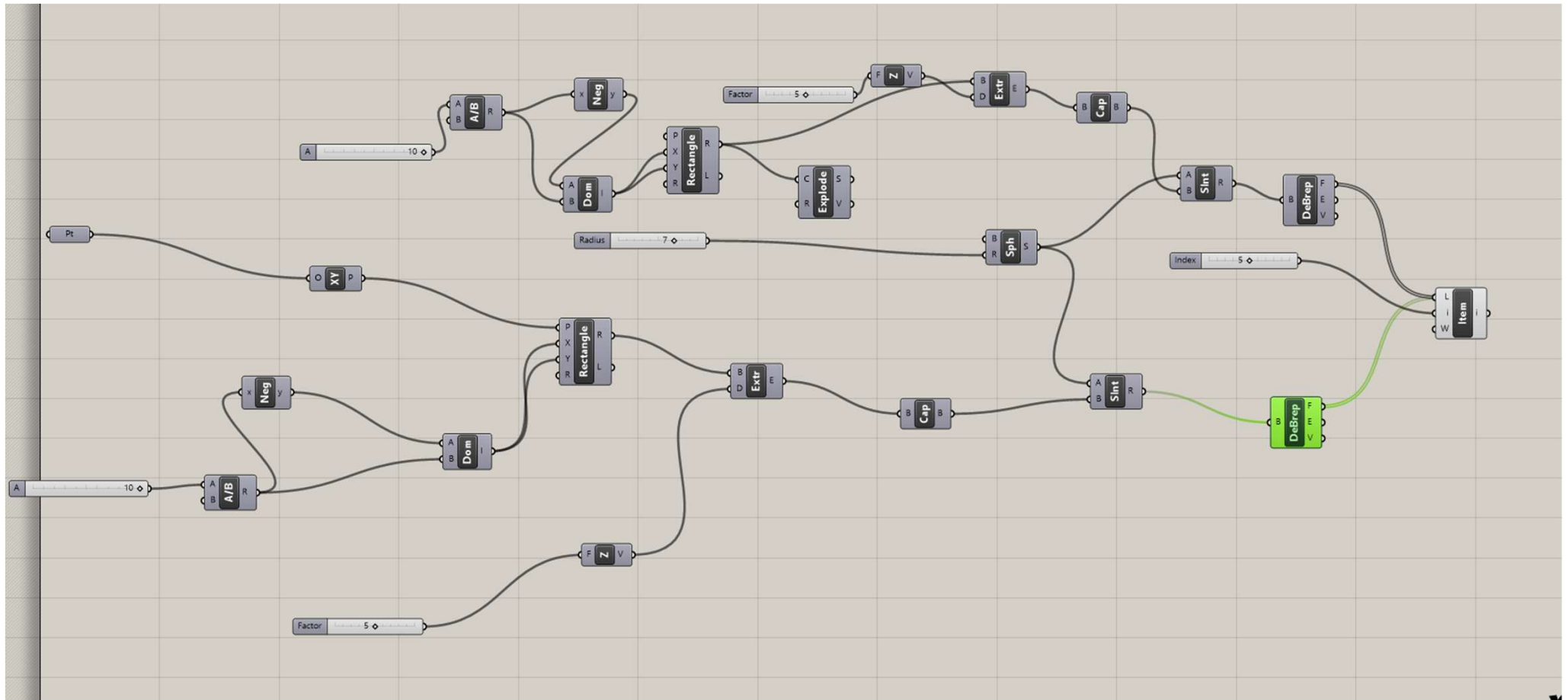
Trabalho 2.

GRASSHOPPER – ABÓBADA DE VELA



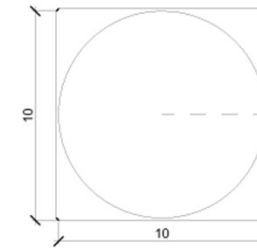
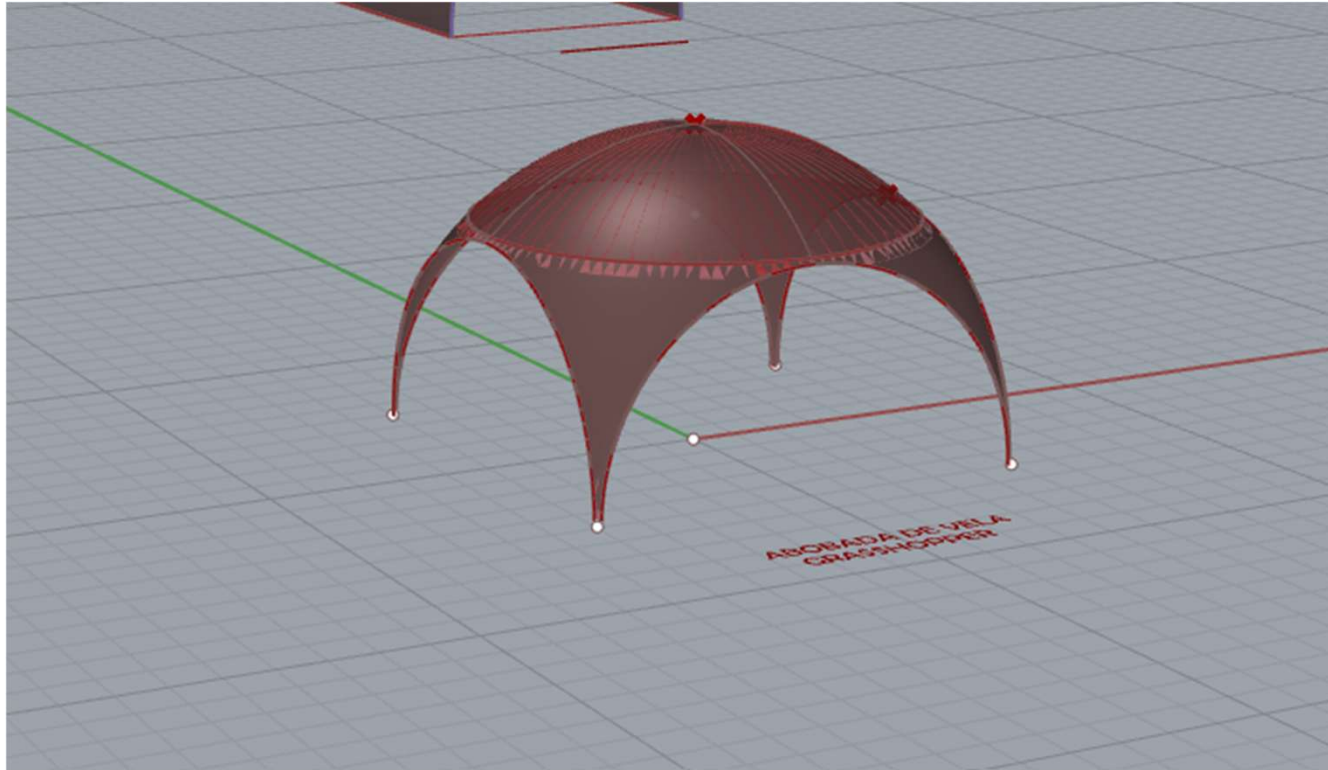
Trabalho 2.

GRASSHOPPER – ABÓBADA DE VELA

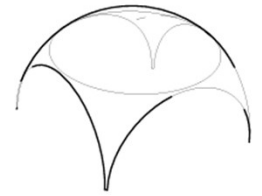


Trabalho 2.

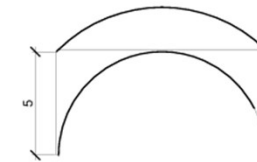
GRASSHOPPER – ABÓBADA DE VELA



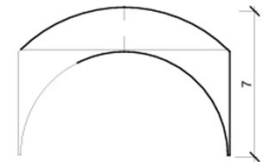
Top View



Perspective View



Front View



Right View

Trabalho 2.

GRASSHOPPER – ABÓBADA DE VELA

BASE: arcos / pendent

ESFERA

CUPULA

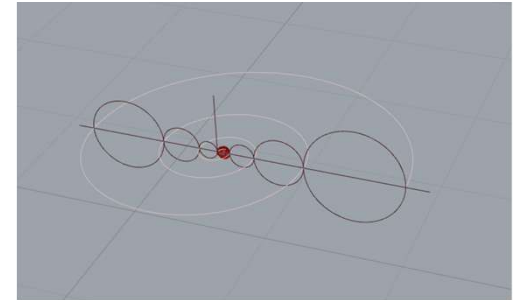
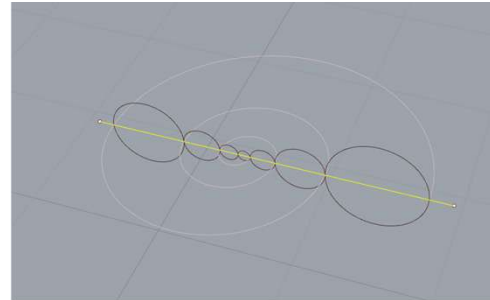
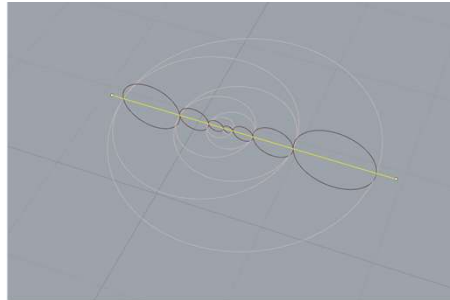
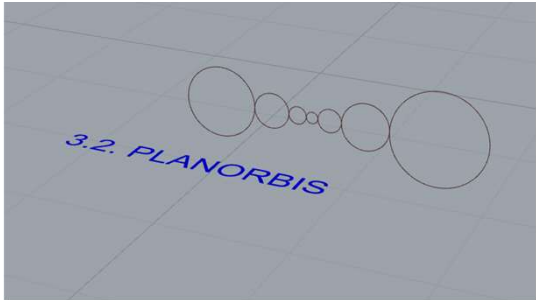
RESULTADO FINAL

Fim do Trabalho 2.

-

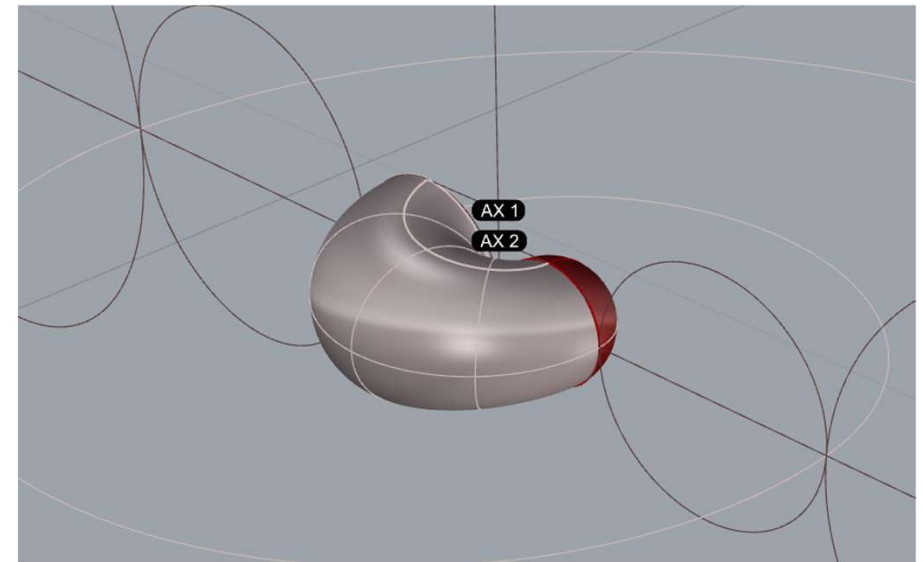
GRASSHOPPER – SUPERFÍCIE DE ABÓBADAS
CONSTRUÇÃO DO MODELO DE UM TORO EM SCRIPT

Aula. 9 – Sumário.

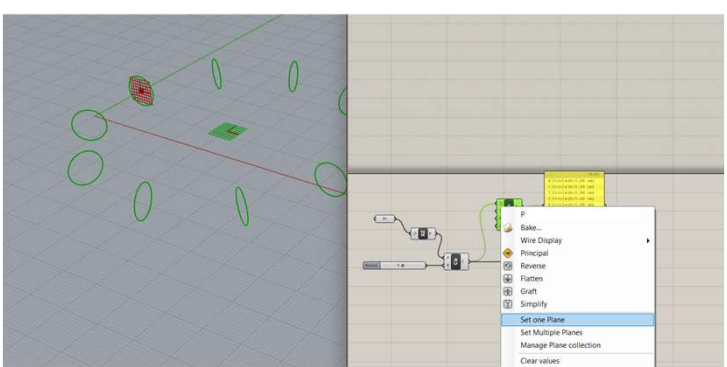
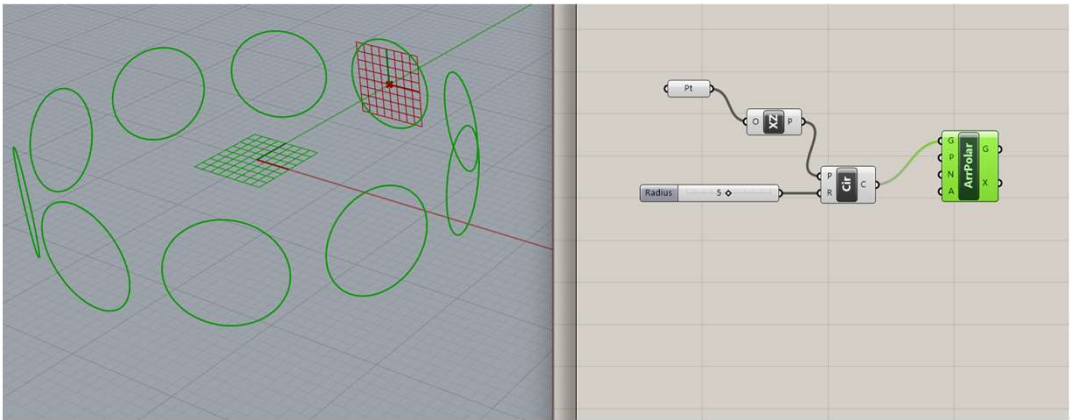
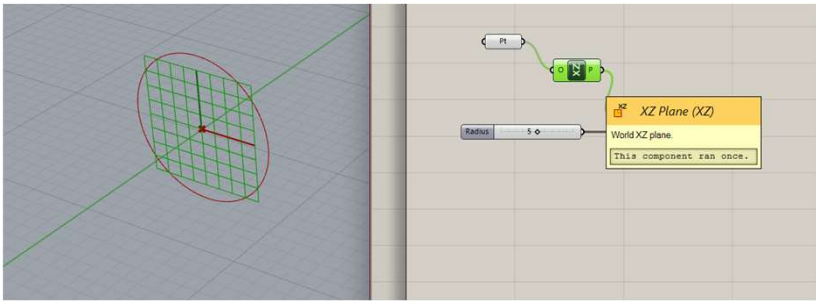
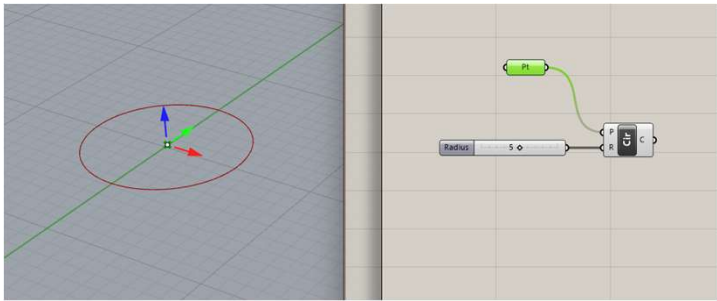
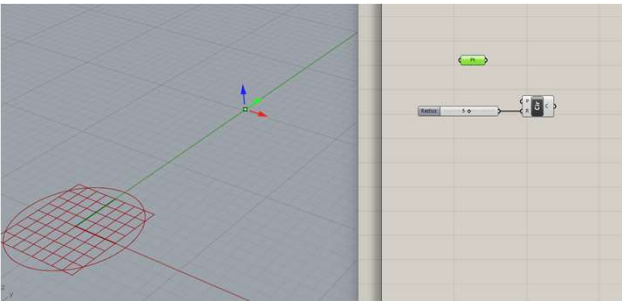


SPIRAL

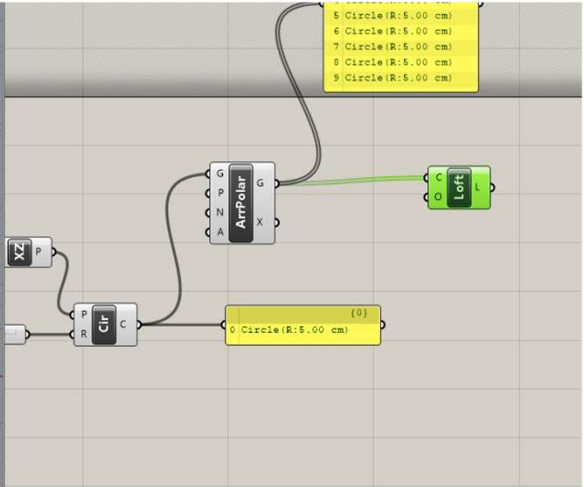
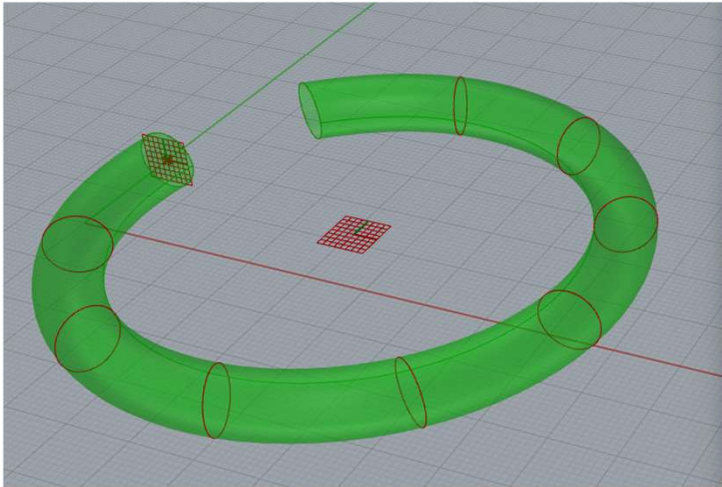
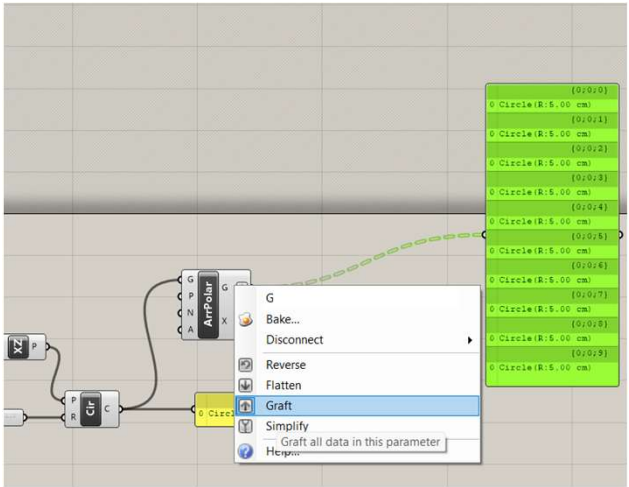
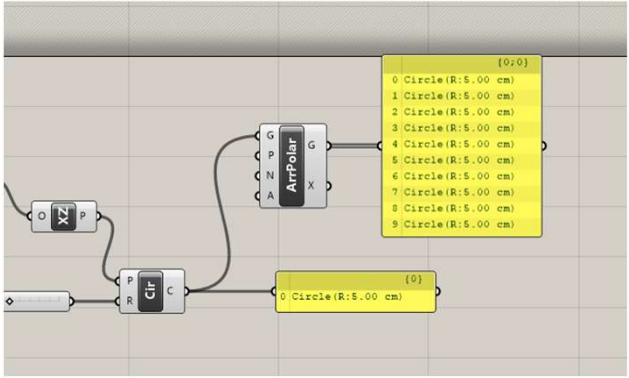
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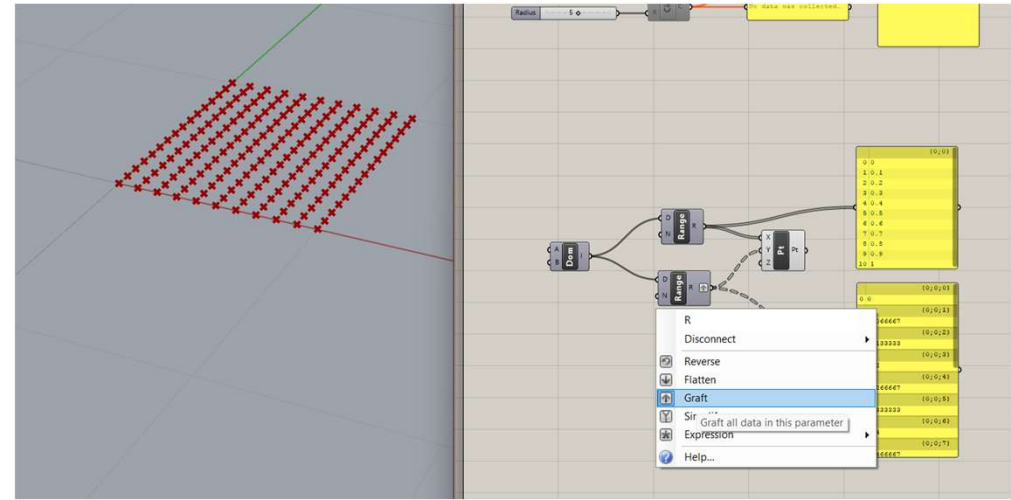
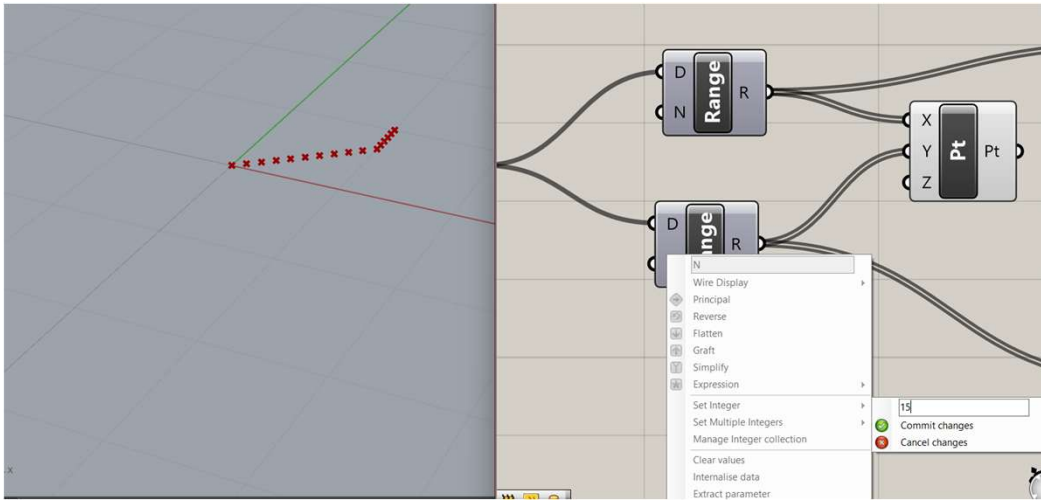
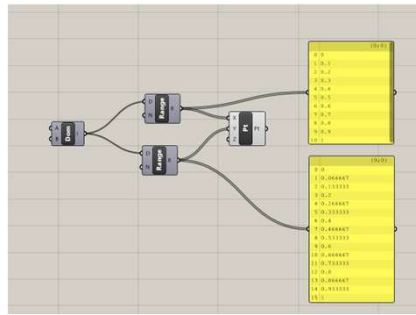
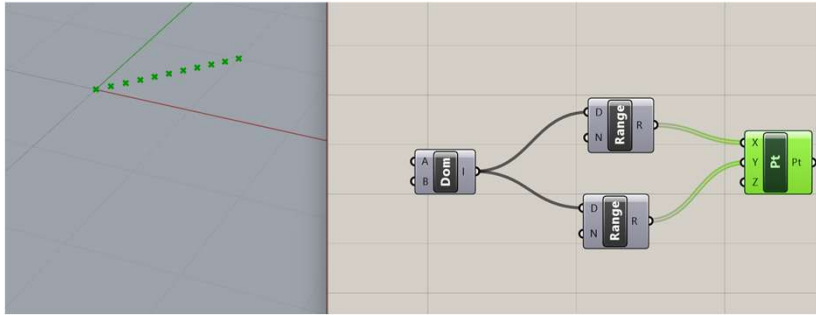
Aula. 9.



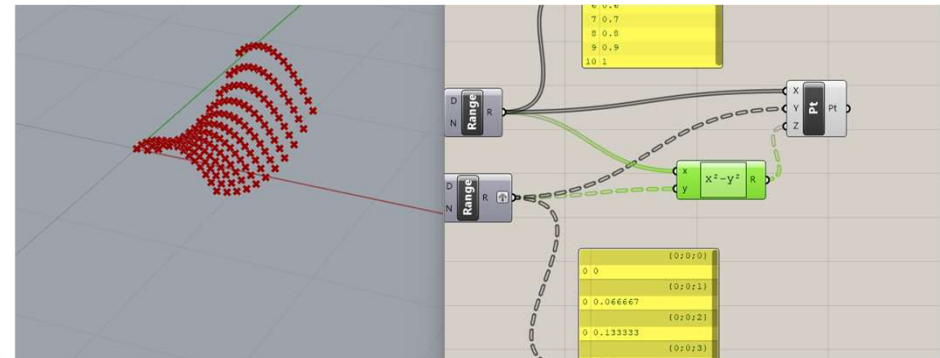
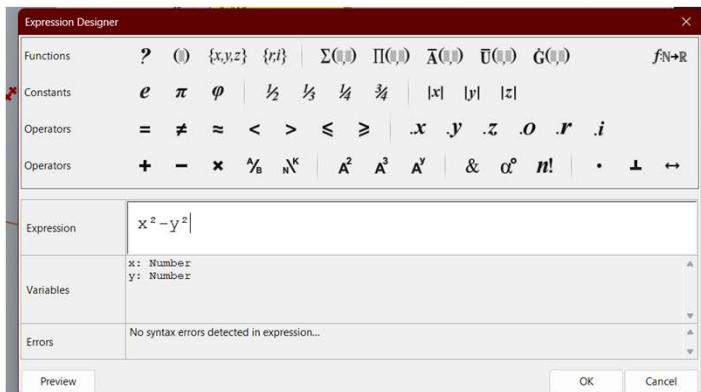
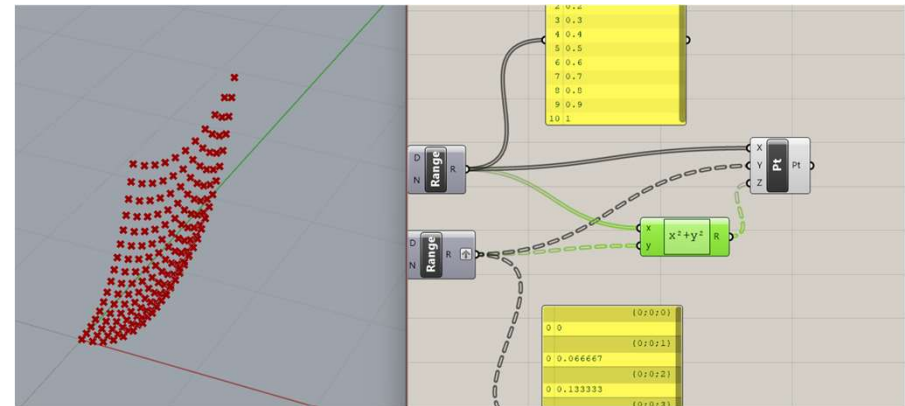
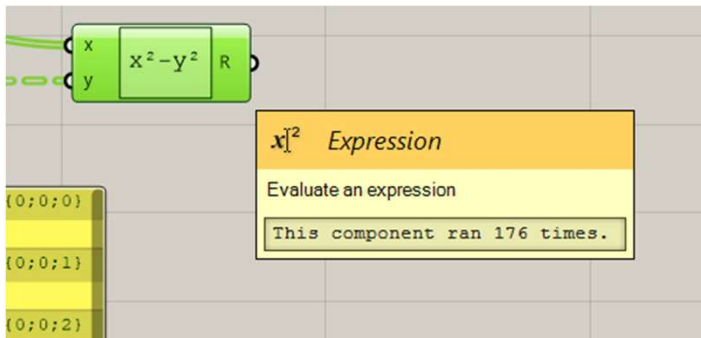
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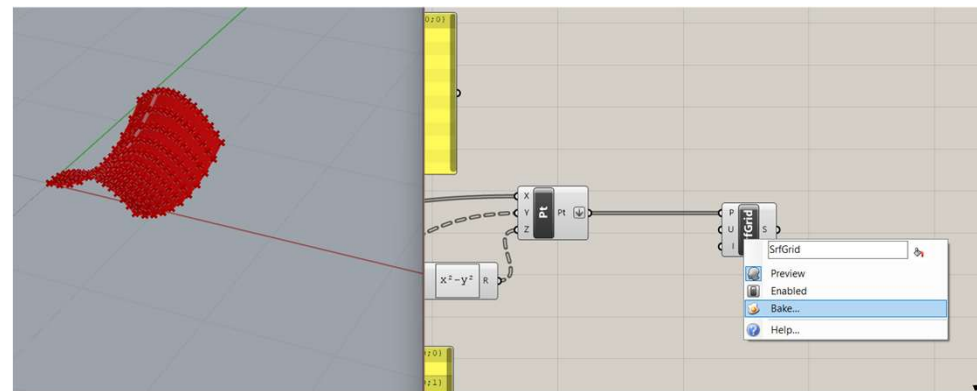
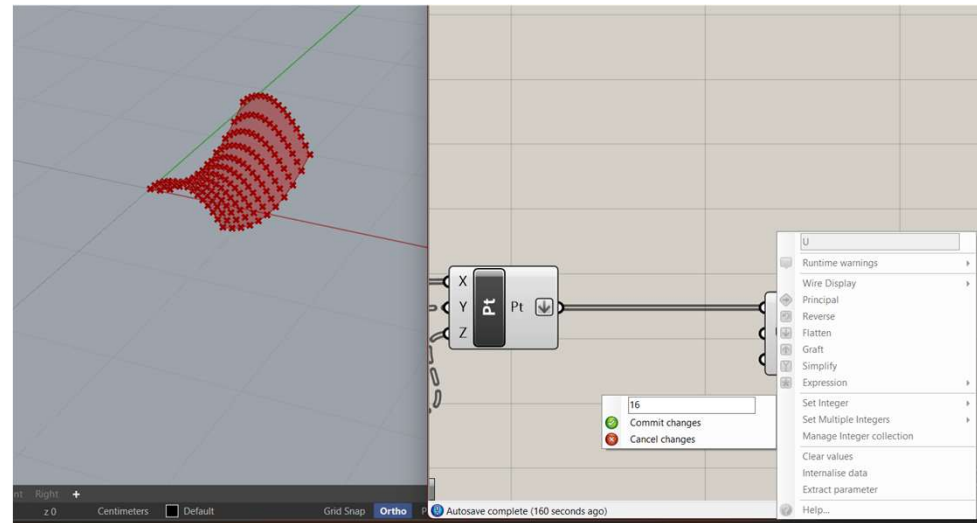
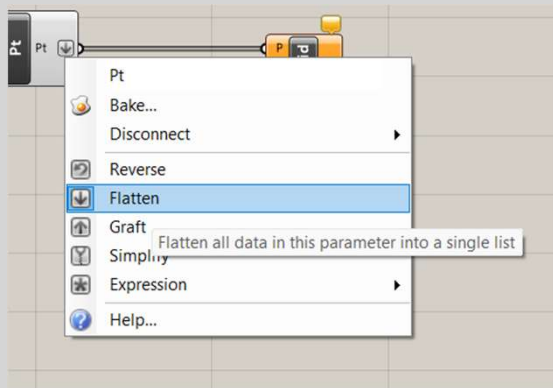
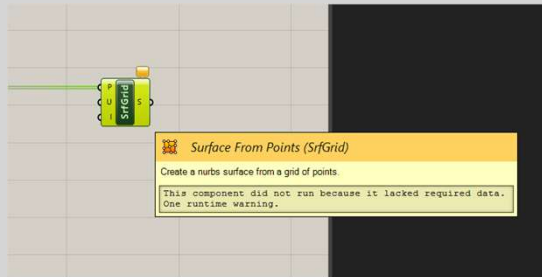
Aula. 9.



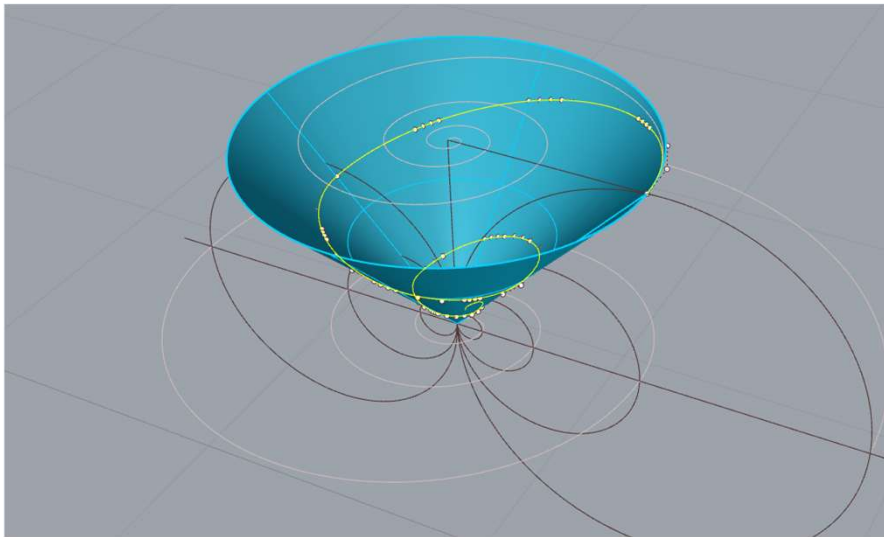
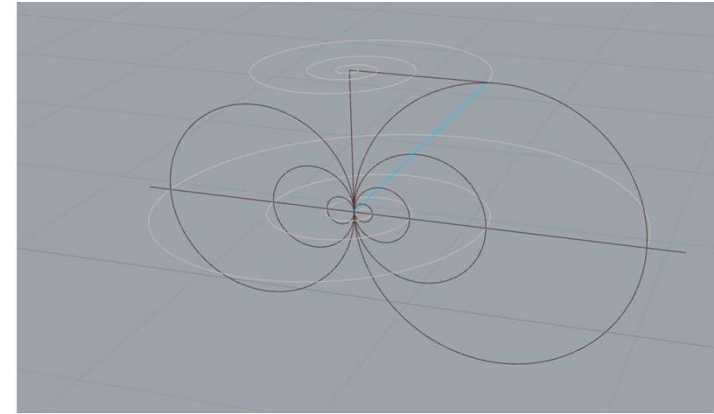
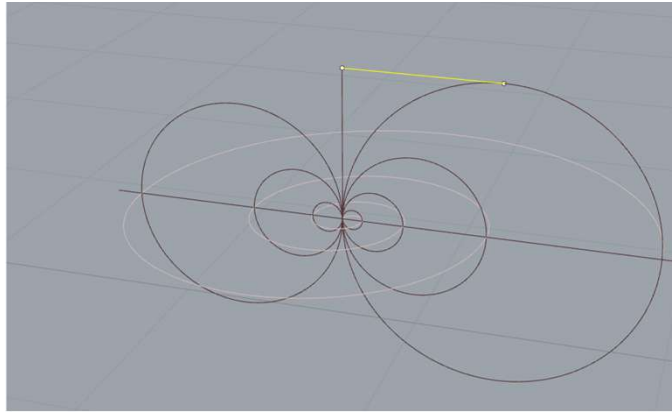
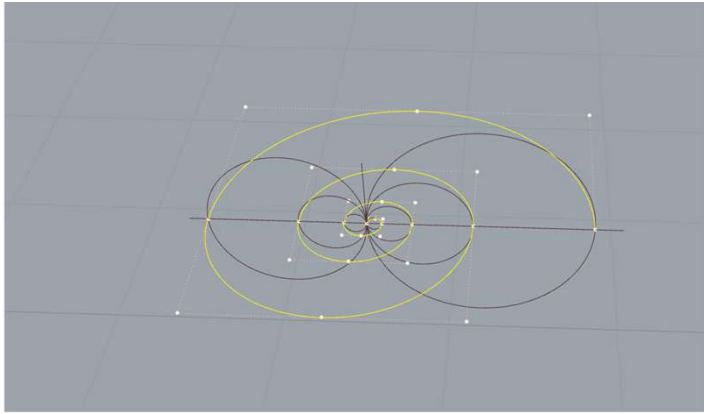
Aula. 9.



Aula. 9.



Aula. 9.



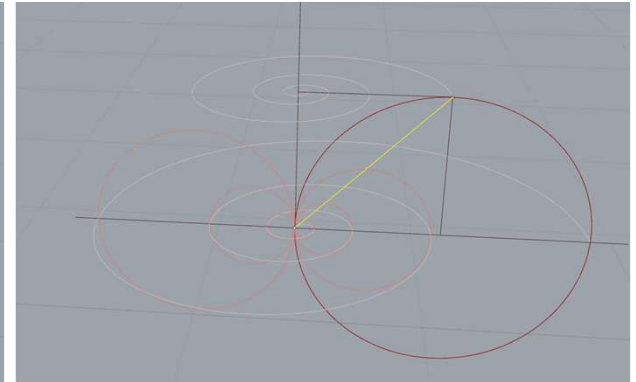
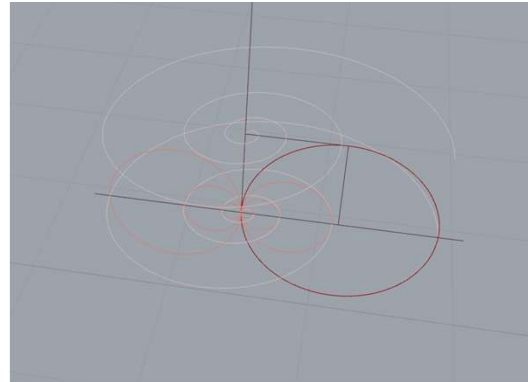
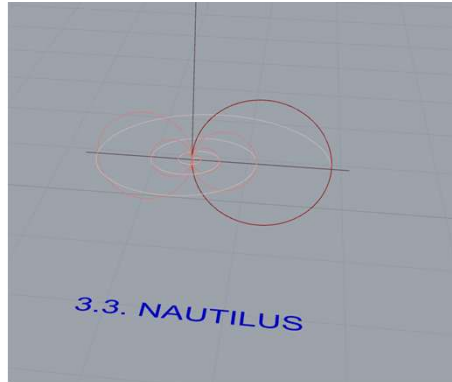
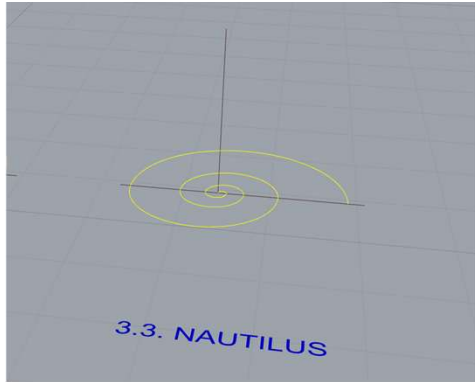
- SCALE

Aula. 9.

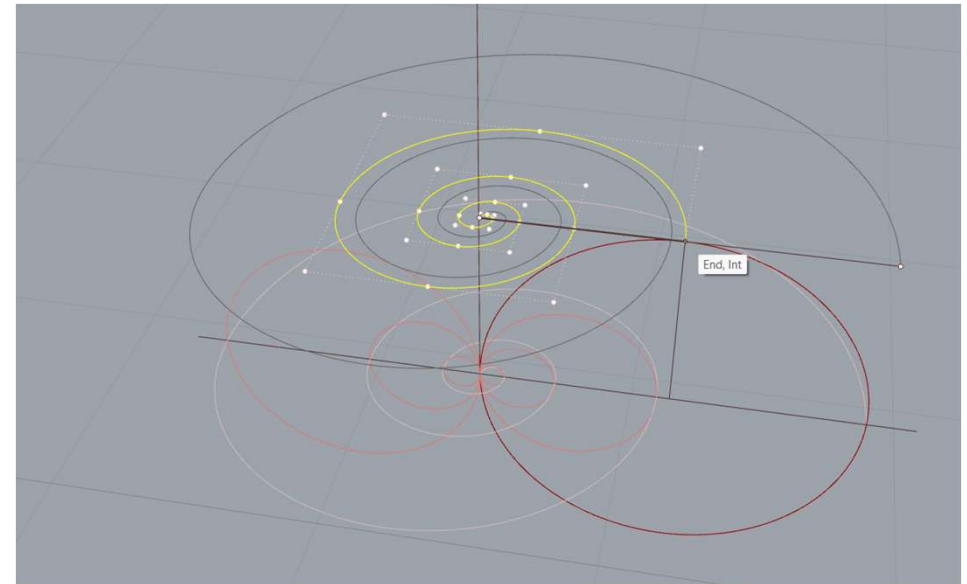
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RHINO - CONSTRUÇÃO DE SUPERFÍCIES CURVAS (MOLUSCOS)

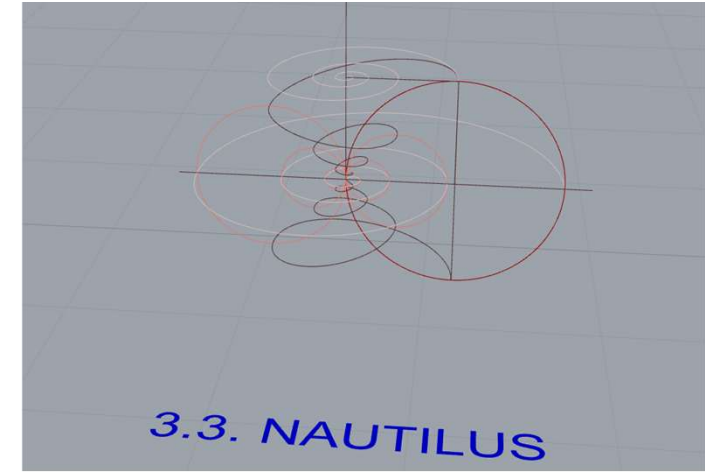
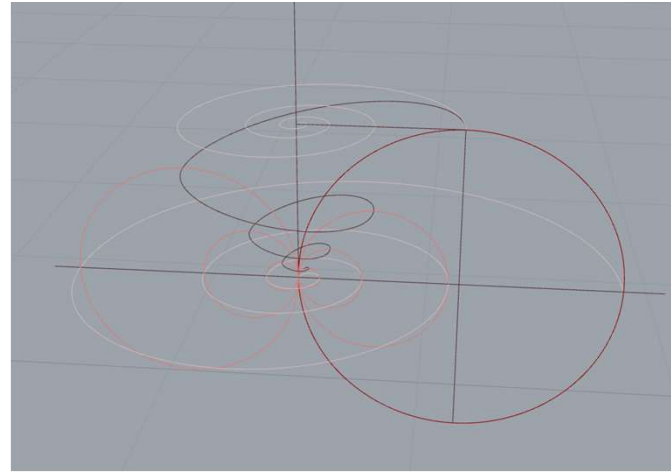
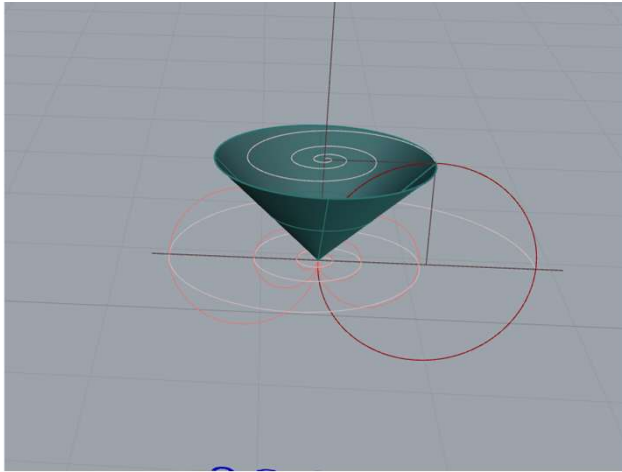
Aula. 10 – Sumário.



EXTEND – line
 JOIN – expiral
 CIRCLE – vertical - do centro aos locais em que
 Copiar espiral
 SCALE -



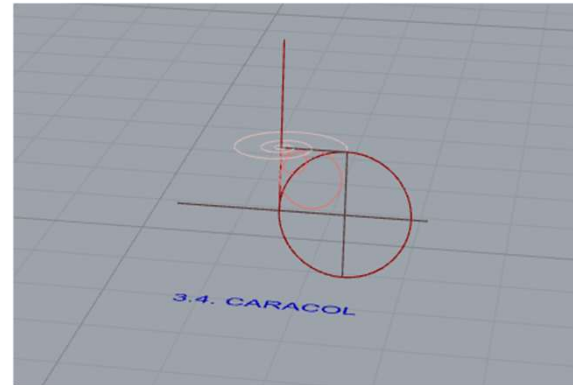
Aula. 10.



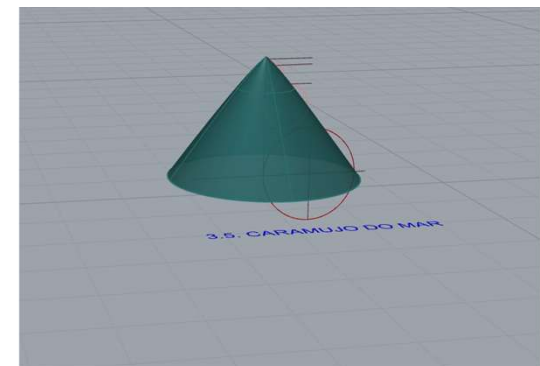
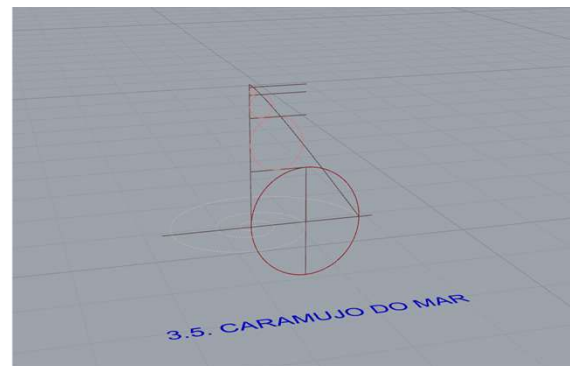
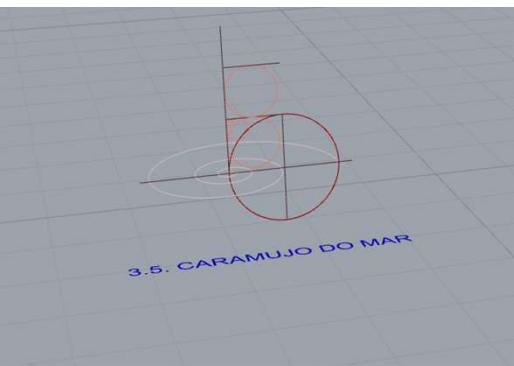
EXTEND – line
 JOIN – expiral
 CIRCLE – vertical - do centro aos locais em que
 Copiar espiral
 SCALE –
 Line
 RAILREVOLVE – cone
 PROJECT
 MIRROR – z axis

Aula. 10.

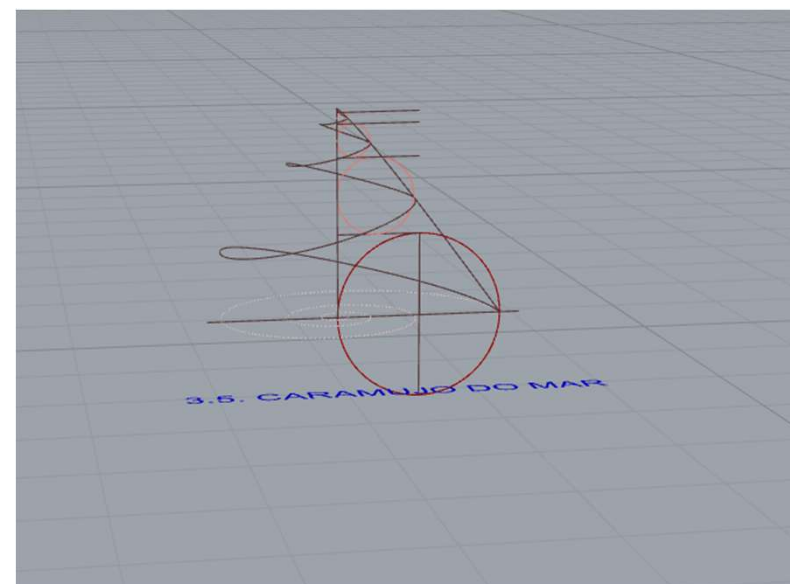
~MIRROR -



Aula. 10.



CONTROL POINT CURVE – nos quadrantes dos
 círculos
 EXTEND – até á linha vertical
 REVOLVE
 PROJECT
 SWEEP 2 .-

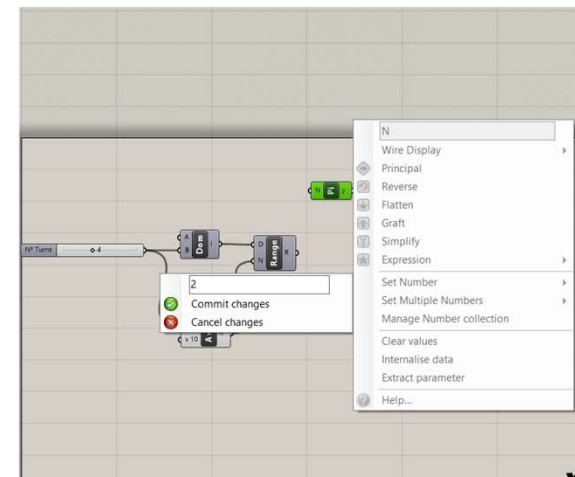
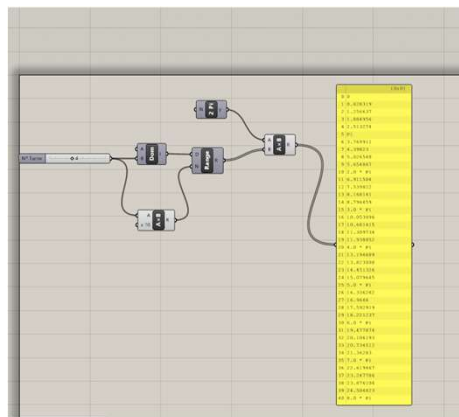
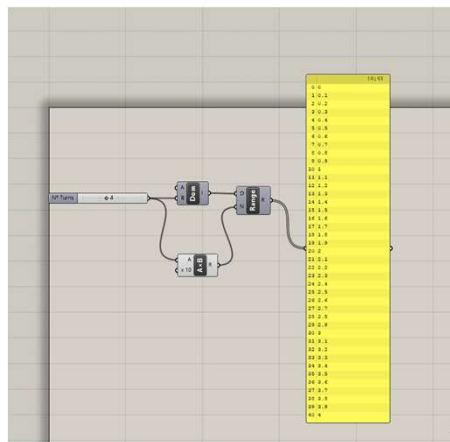
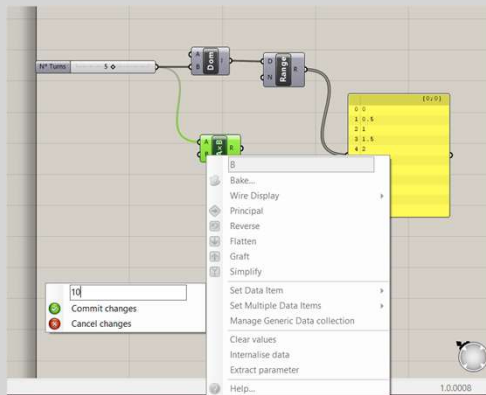
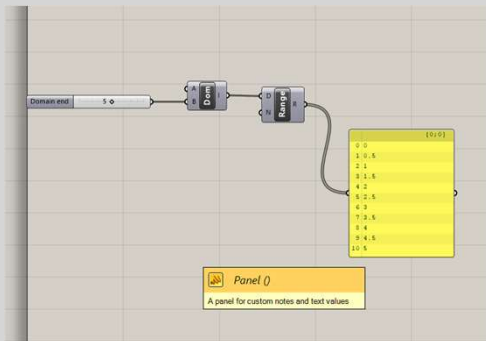
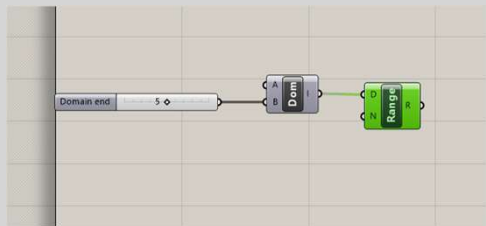


Aula. 10.

-

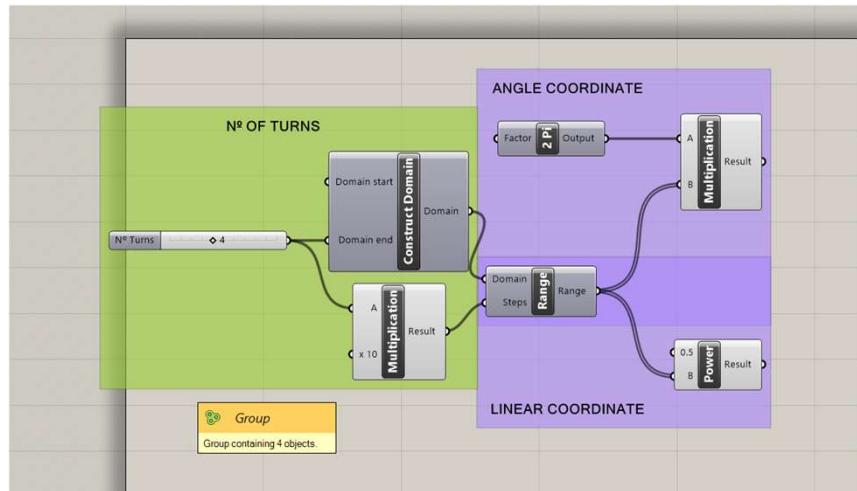
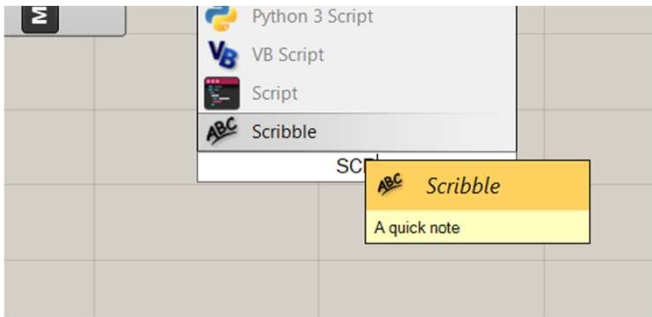
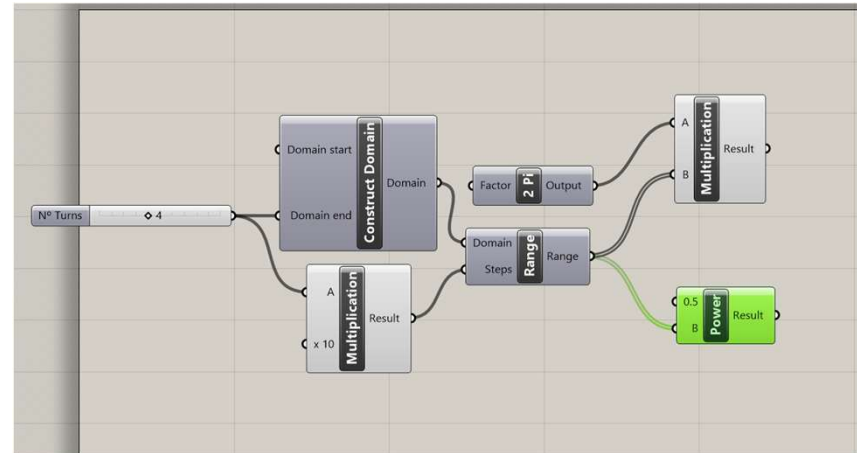
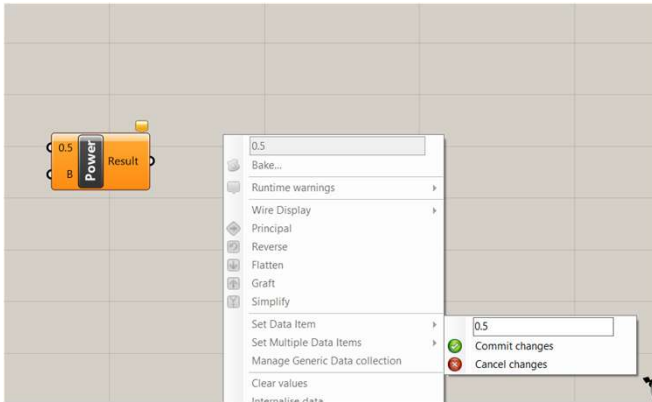
GRASSHOPPER - CONSTRUÇÃO DE SUPERFÍCIES CURVAS
(MOLUSCOS)

Aula. 11 – Sumário.

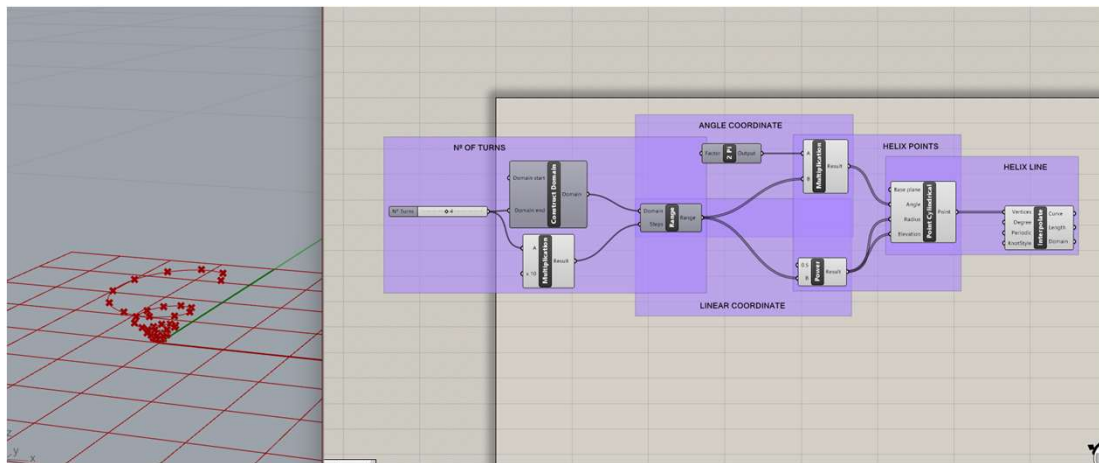


MULTIPLICATION (A x B)

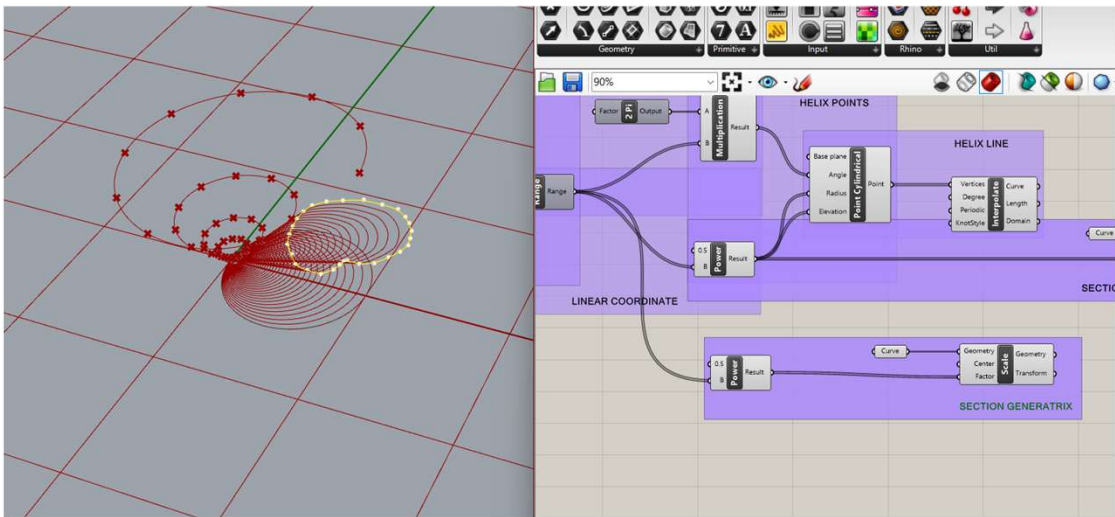
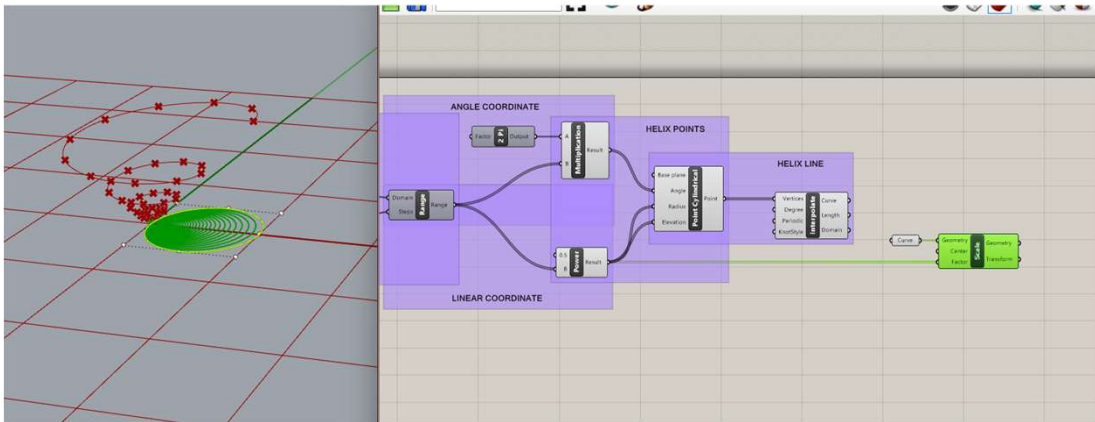
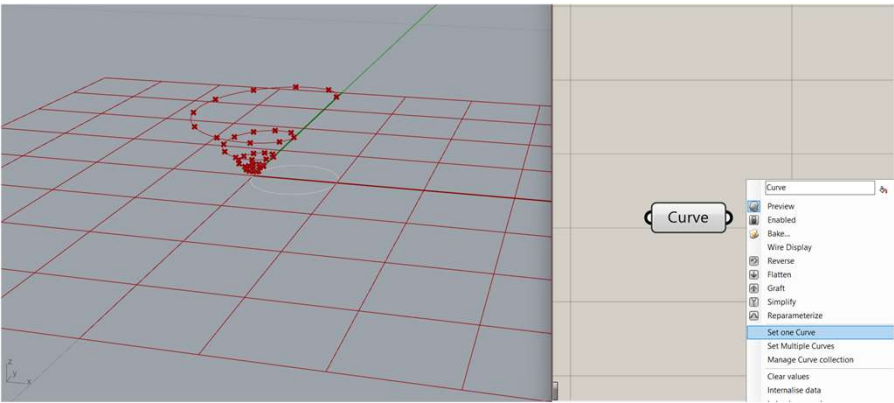
Aula. 11.



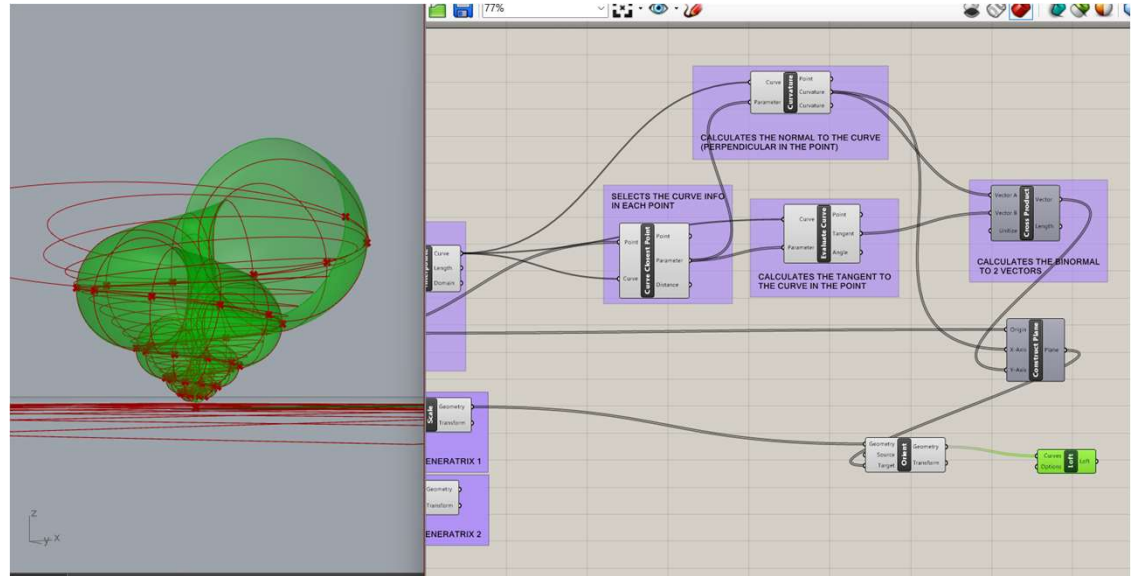
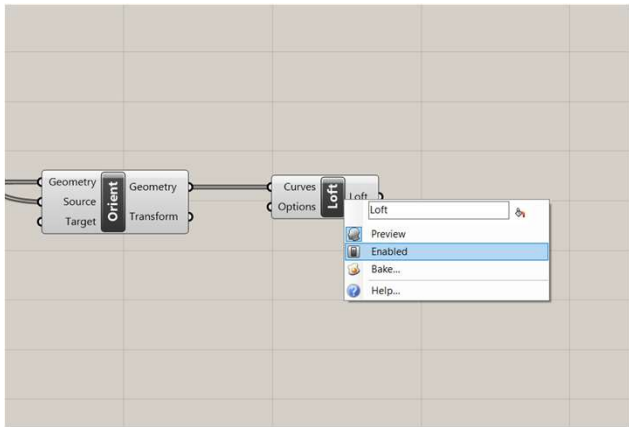
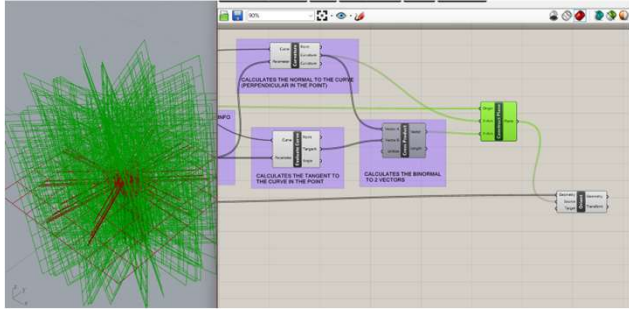
Aula. 11.



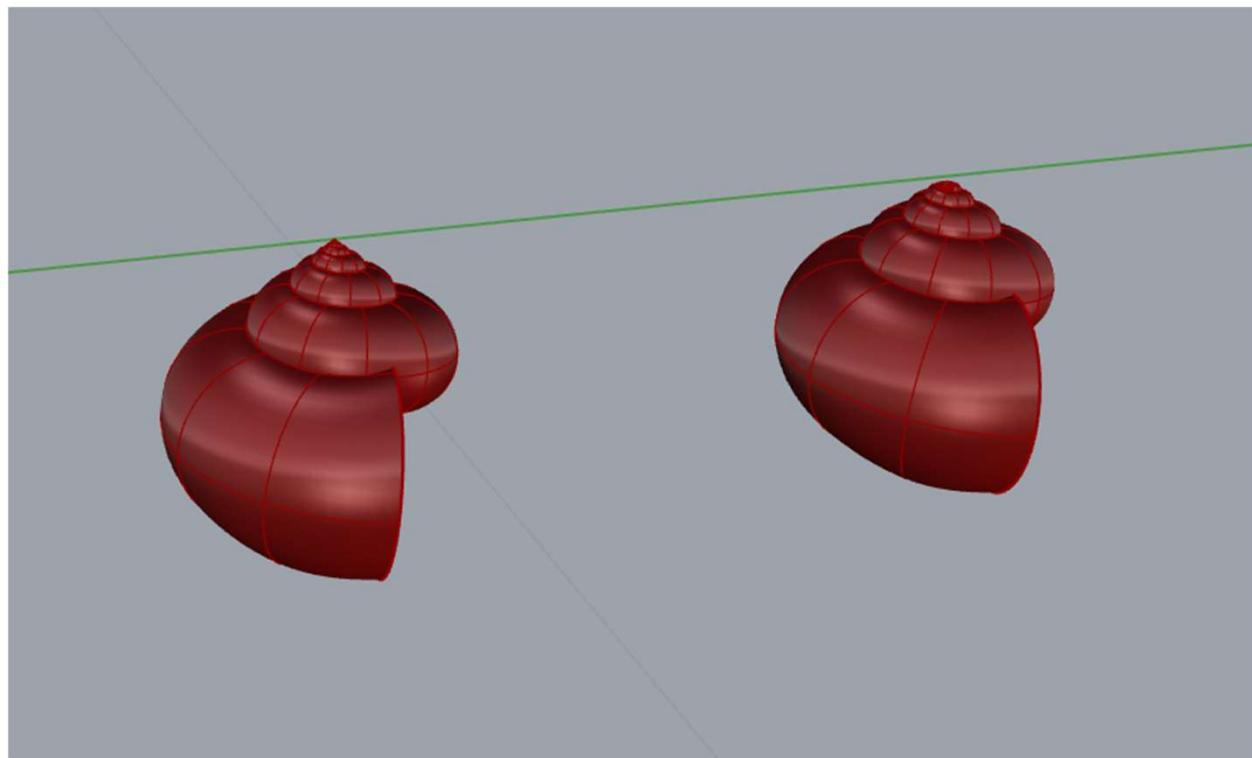
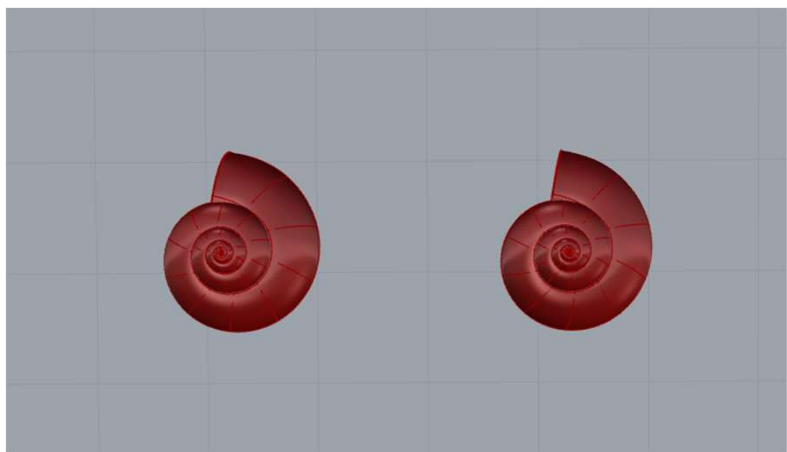
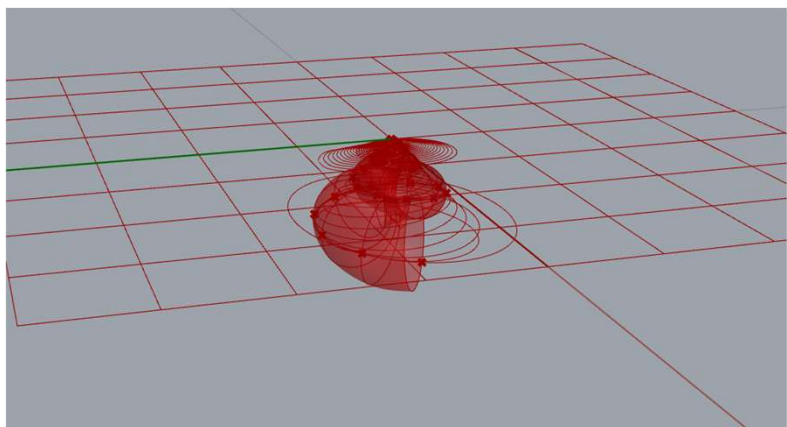
Aula. 11.



Aula. 11.



Aula. 11.



Aula. 11.

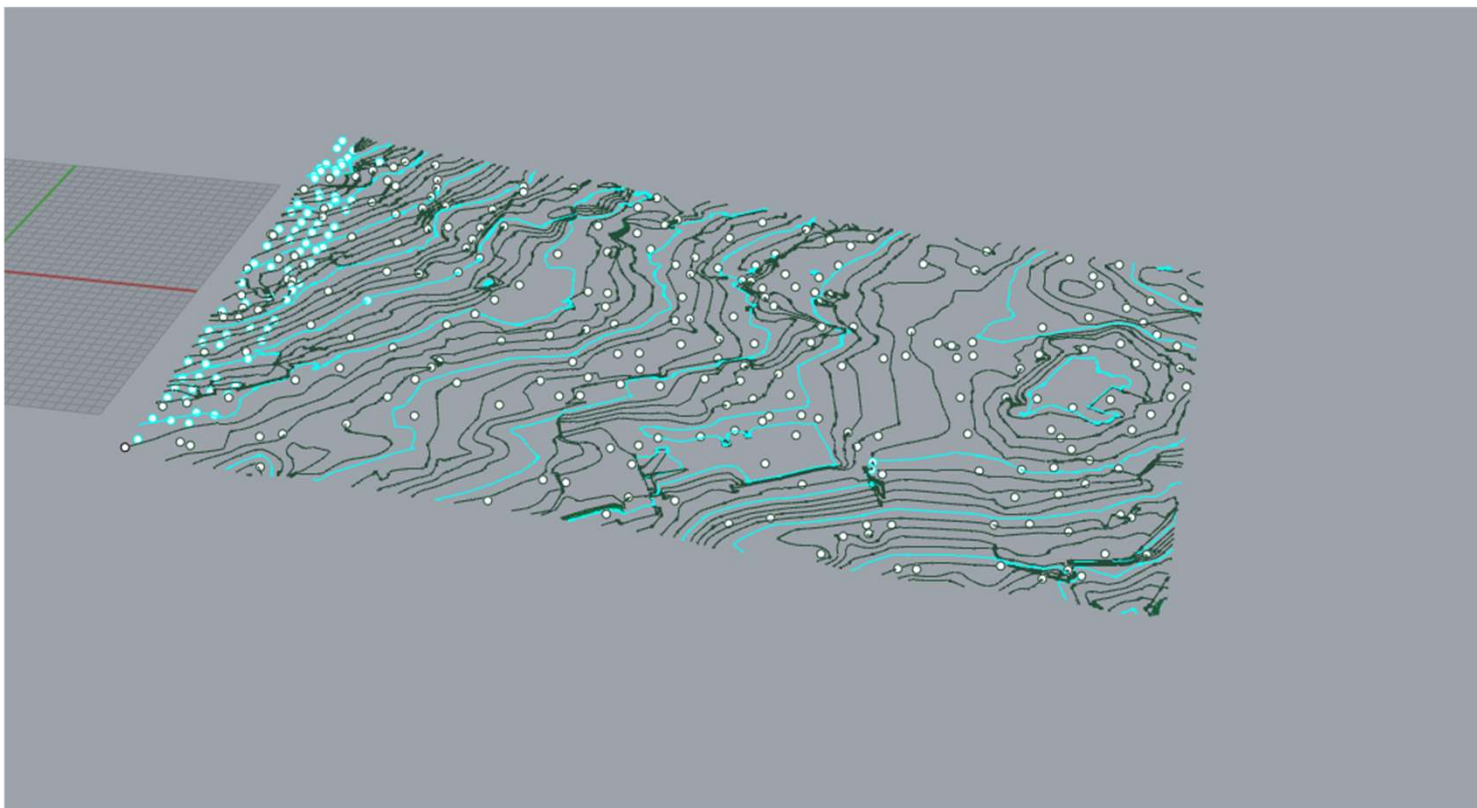
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GRASSHOPPER – CONSTRUÇÃO 3D DO TERRENO

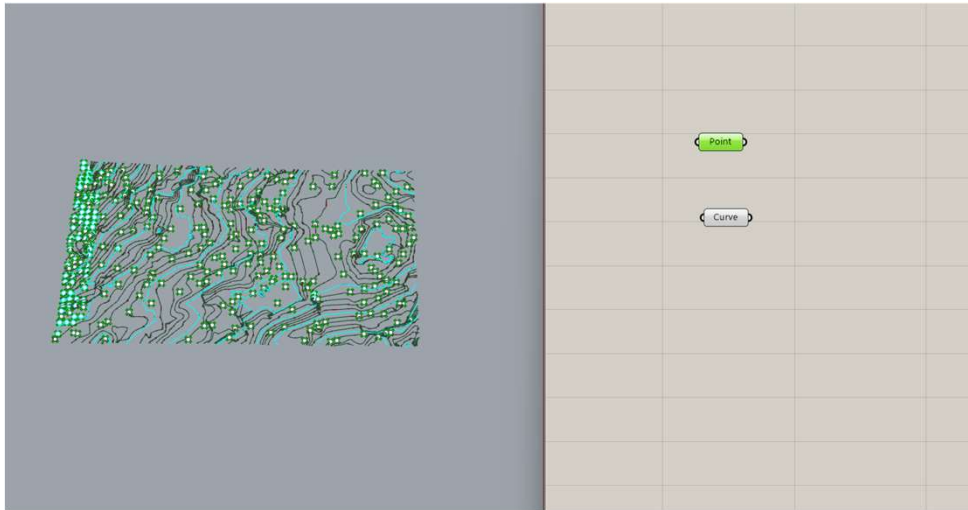
Aula. 12 – Sumário.

PLANTA TOPOGRÁFICA

IMPORT – planta topográfica.dwg



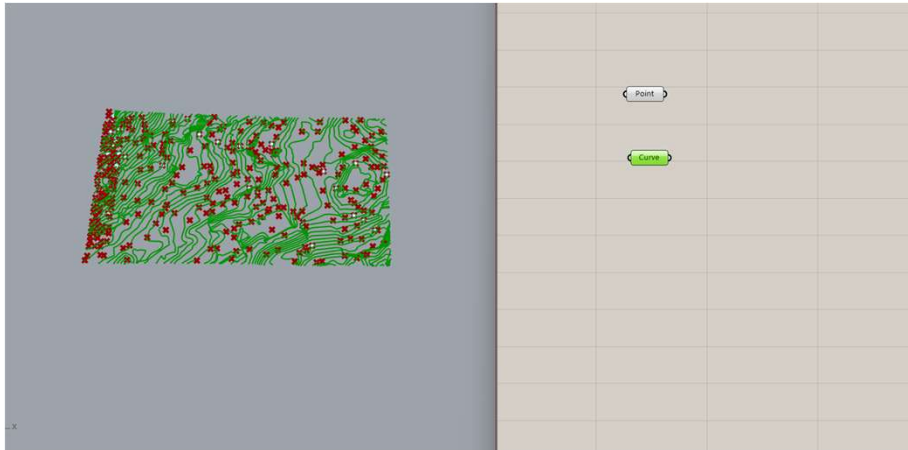
Aula. 12.



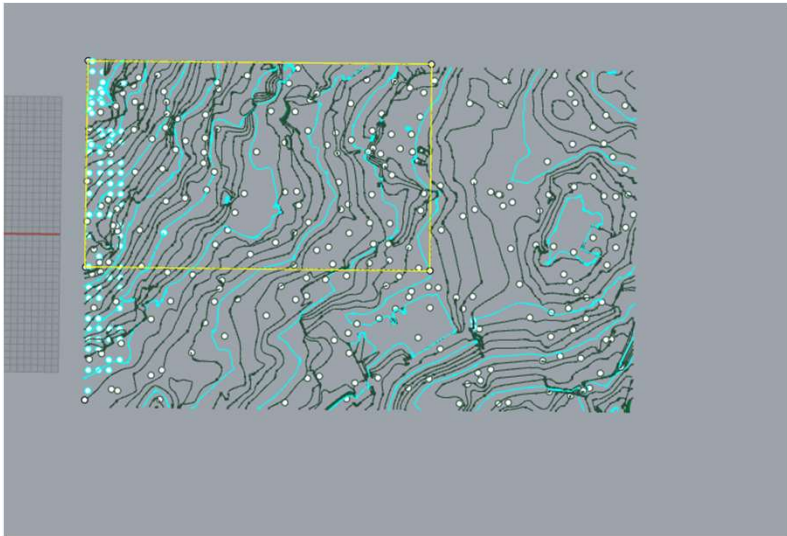
GRASSHOPPER

POINT – set multiple points
CURVES – set multiple curves

-



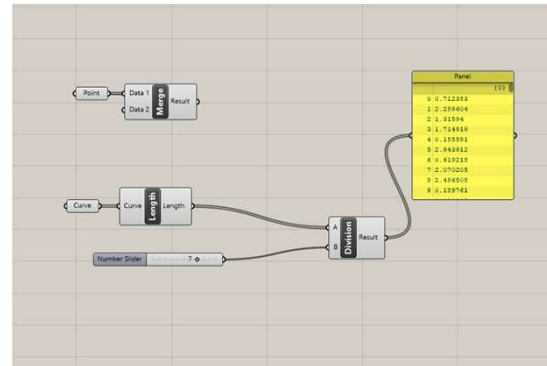
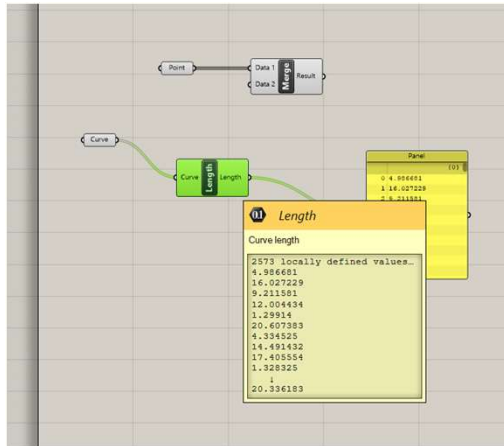
Aula. 12.



RECTANGLE – de 500 por 300 – define a partet do terreno que vamos trabalhar

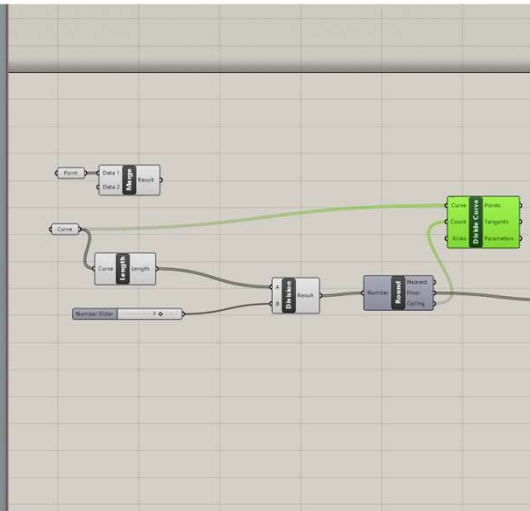
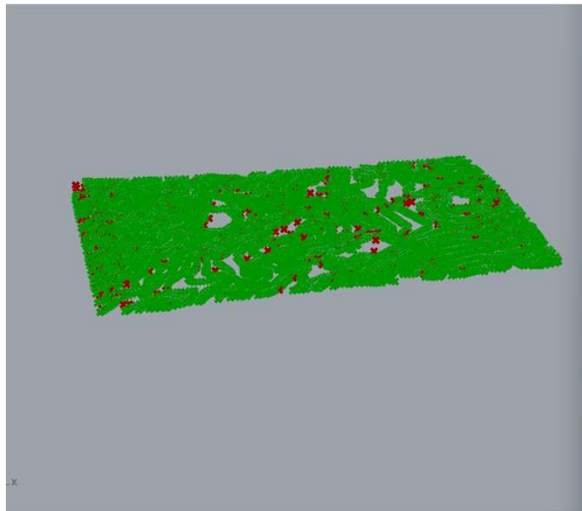
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Aula. 12.

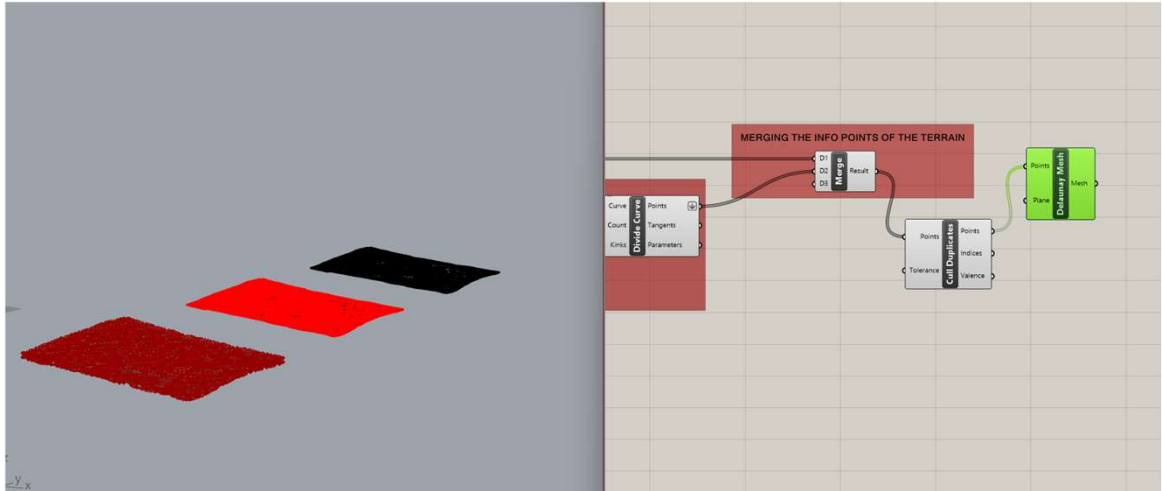


GRASSHOPPER

MERGE –
LENGTH –
DIVISION –



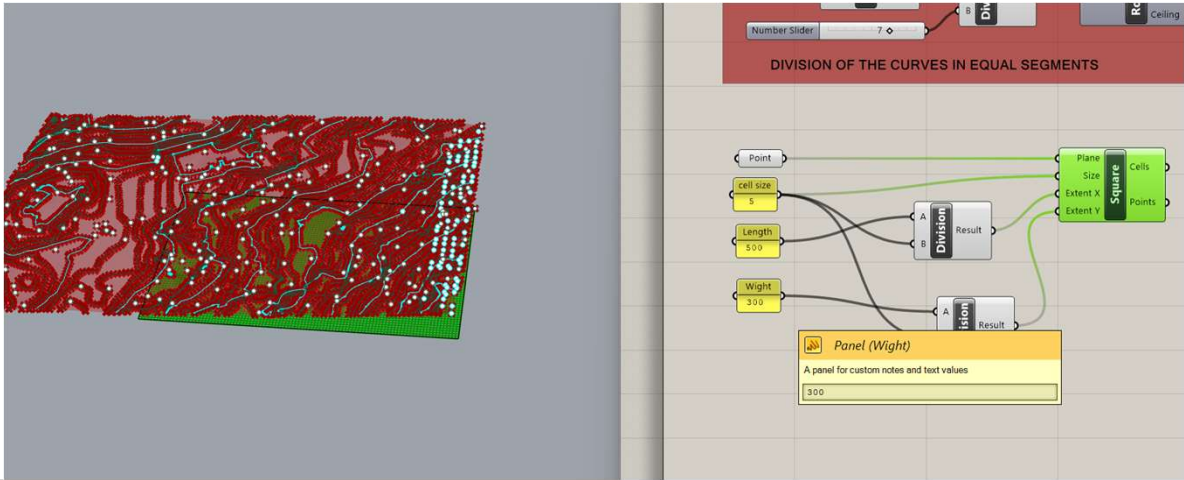
Aula. 12.

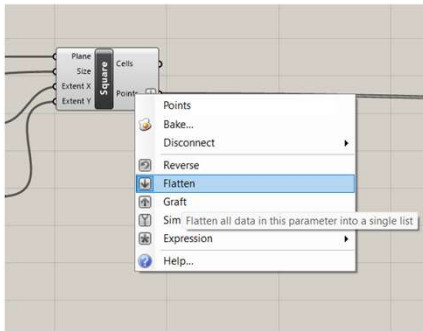


GRASSHOPPER

BAKE

-

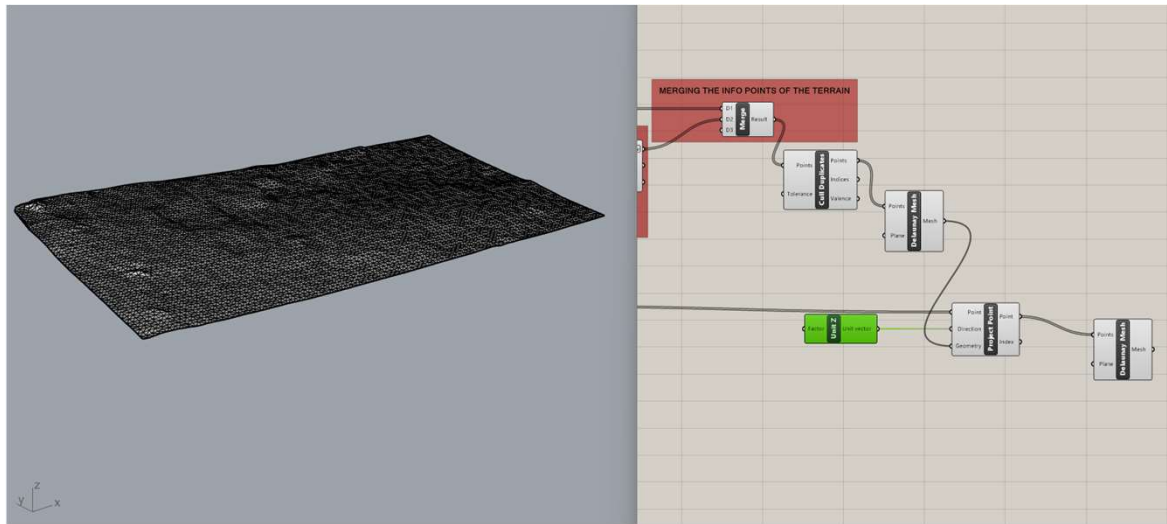




GRASSHOPPER

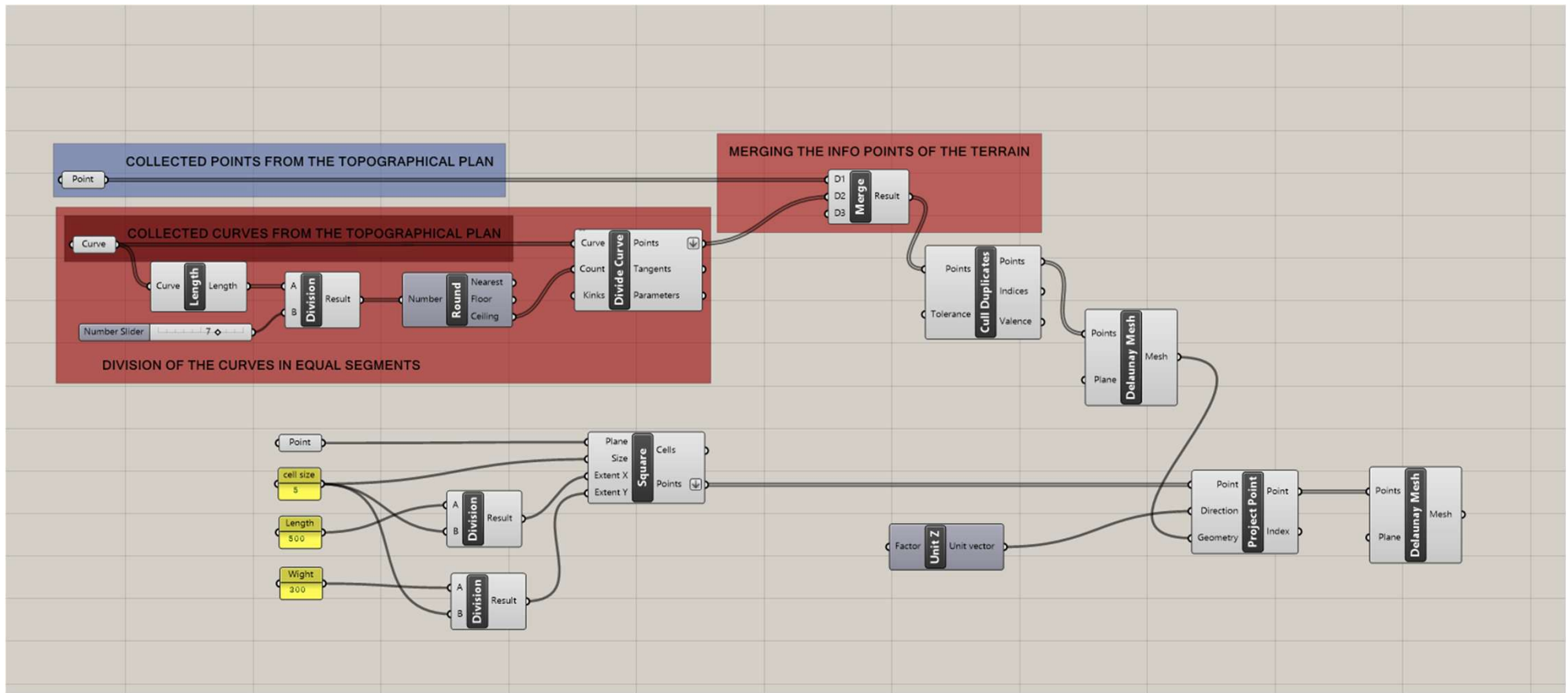
BAKE

-



Aula. 12.

GRASSHOPPER



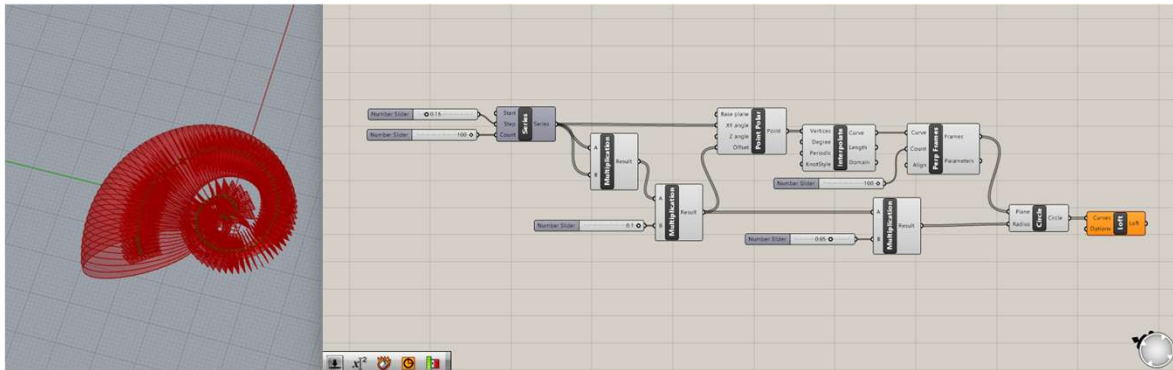
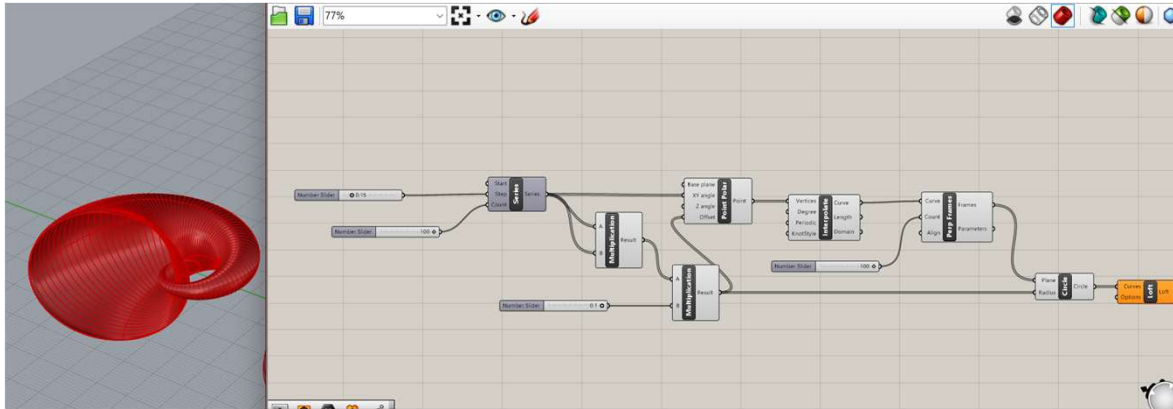
Aula. 12.

TRABALHO 3

MODELAÇÃO E ESTRUTURAÇÃO DE SUPERFÍCIES

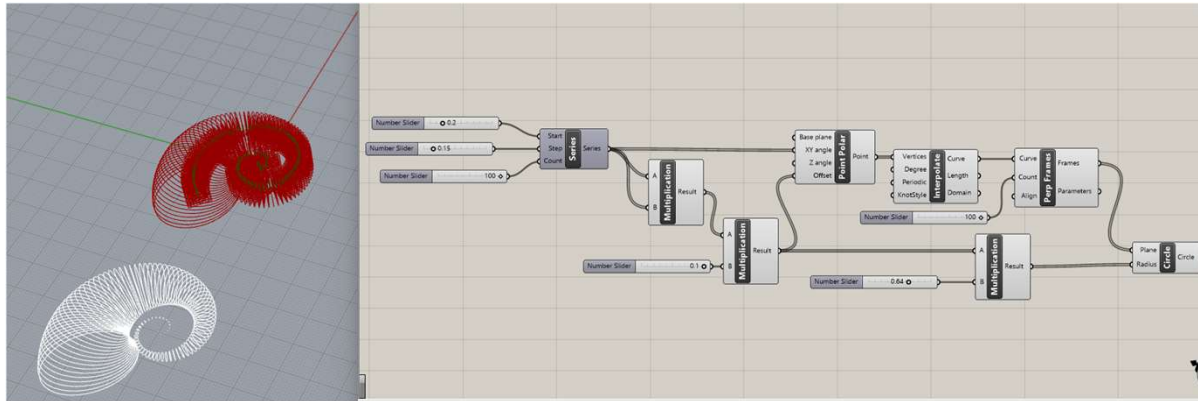
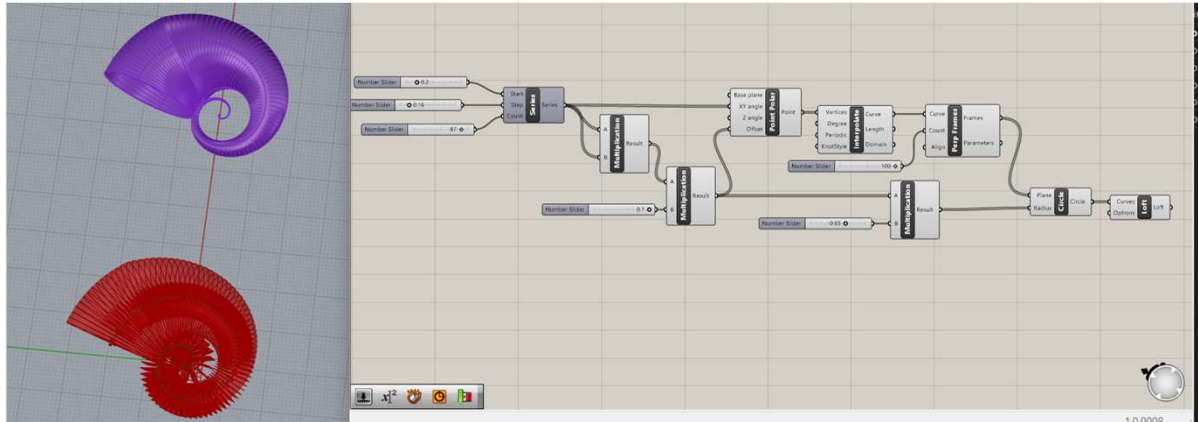
Trabalho 3.

GRASSHOPPER - SPIRULA



Trabalho 3.

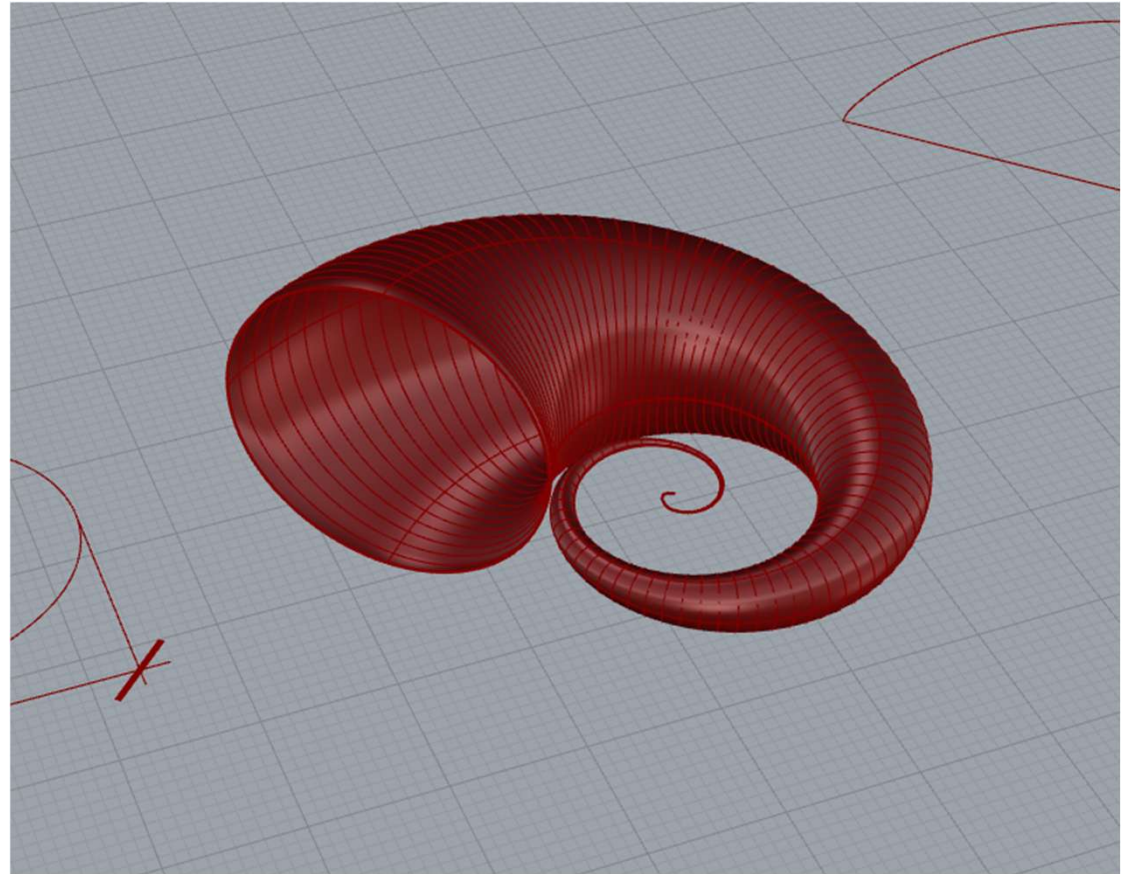
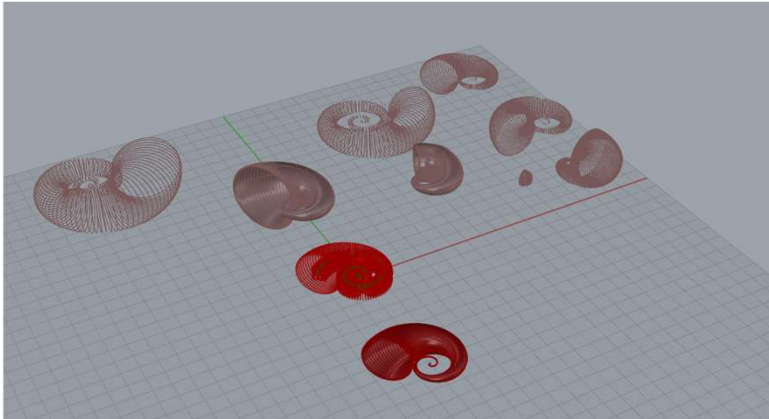
GRASSHOPPER - SPIRULA



Trabalho 3.

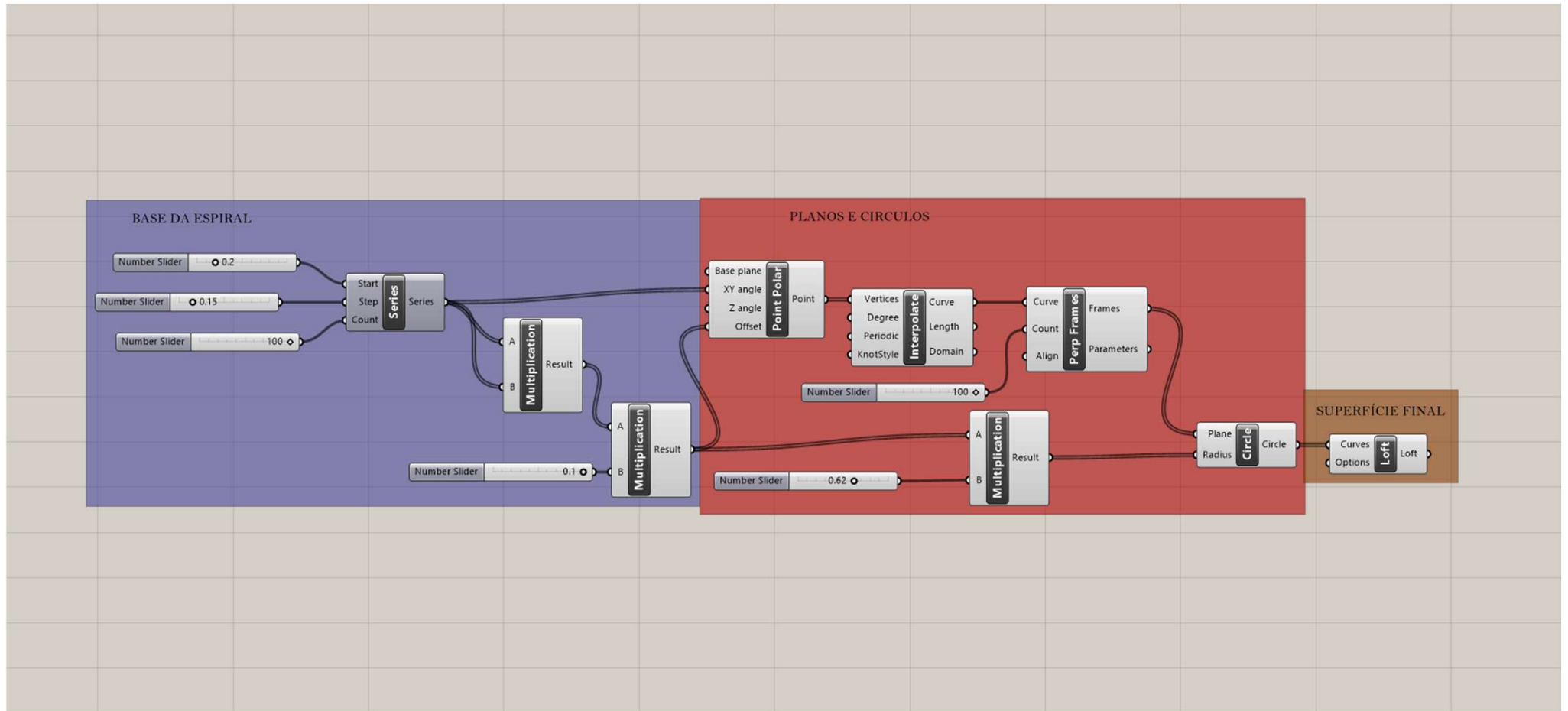
GRASSHOPPER - SPIRULA

Tentativa e erro



Trabalho 3.

GRASSHOPPER - SPIRULA



Fim do Trabalho 3.