# Generative Shape Design

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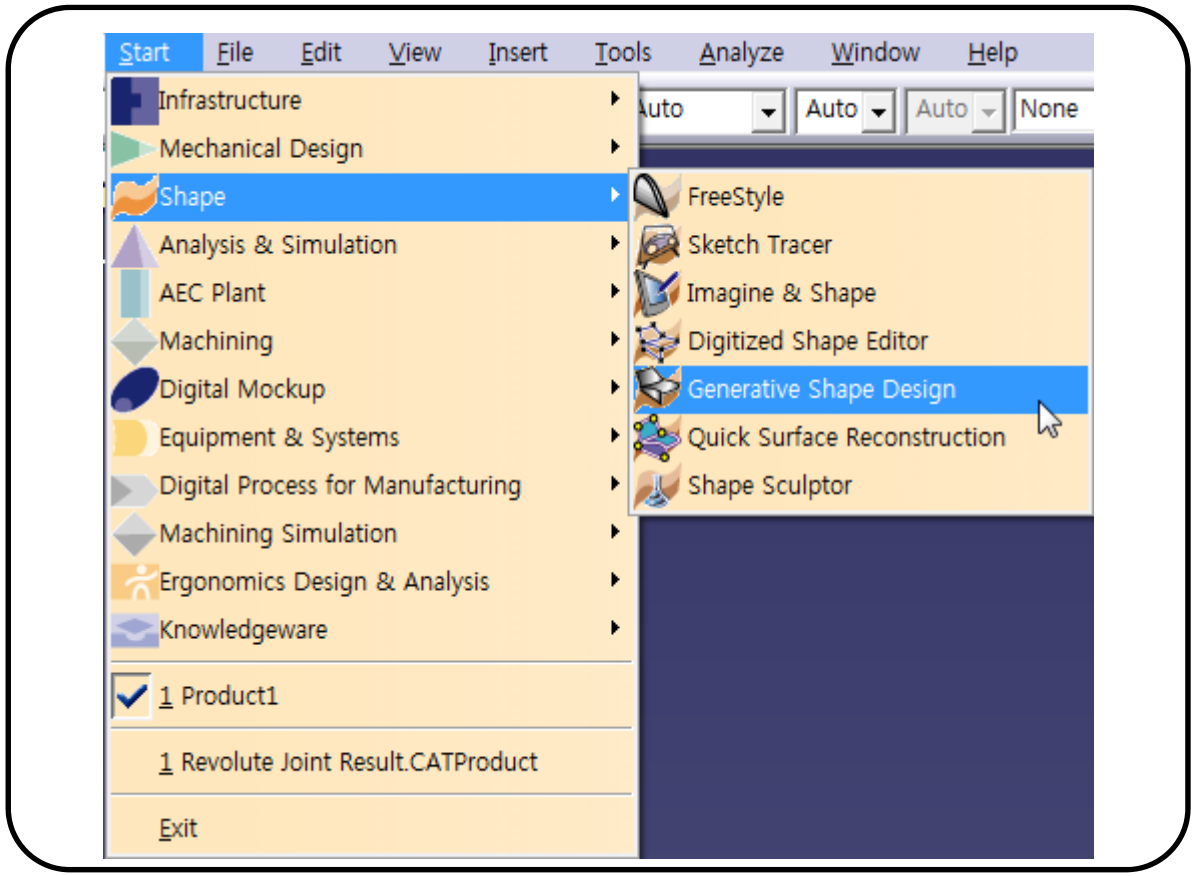
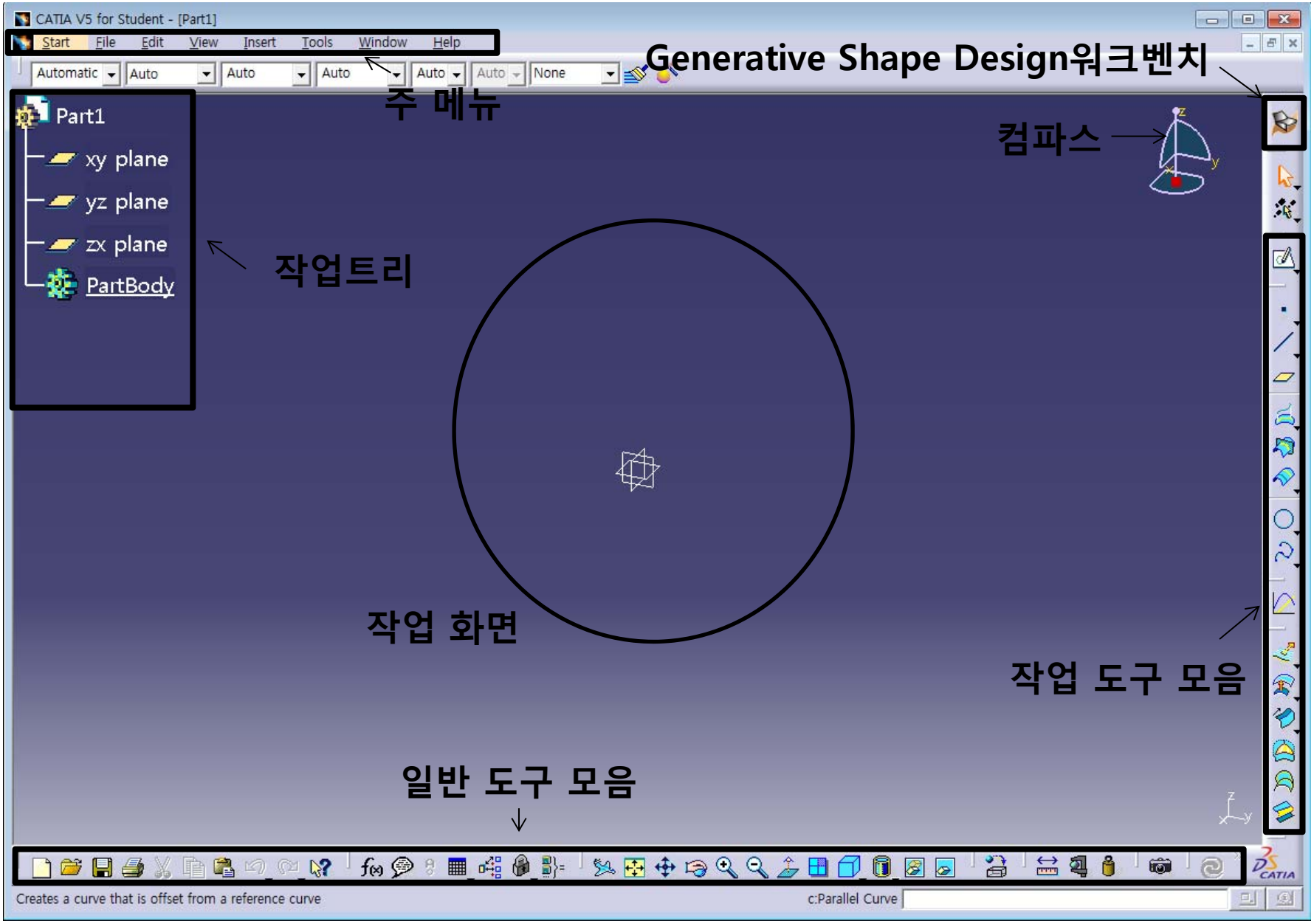
# GENERATIVE SHAPE DESIGN 시작하기

Start 메뉴에서 Shape → Generative Shape Design 선택



# GENERATIVE SHAPE DESIGN 작업화면

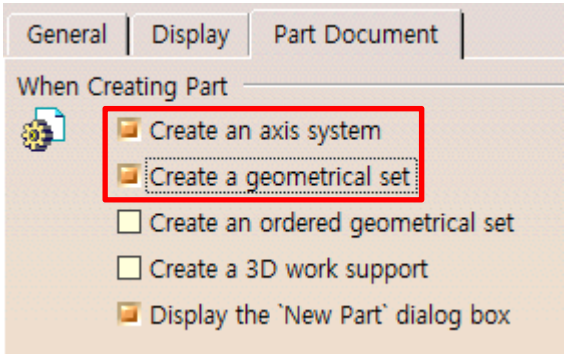


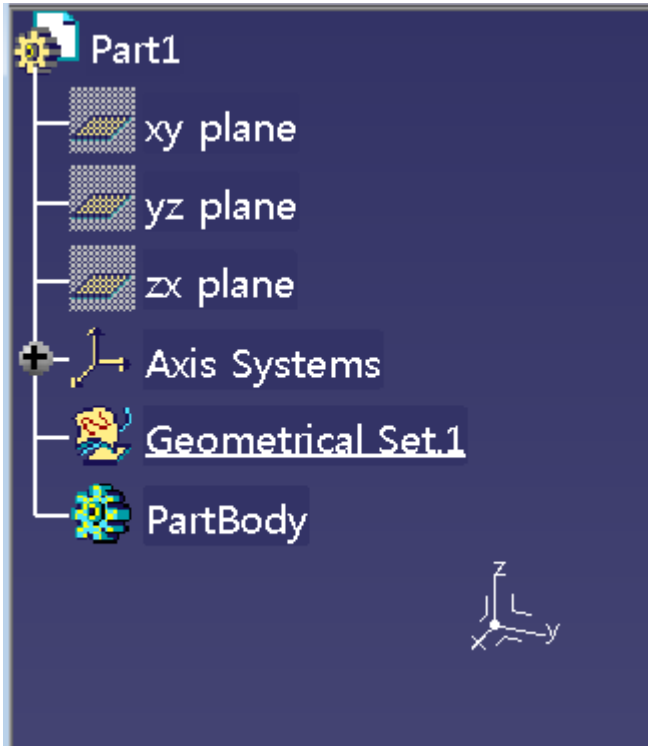
# GENERATIVE SHAPE DESIGN 기본설정

## 기본 설정

GSD 작업에 앞서 Geometrical set  과 Axis system  Option 설정을 해두면 작업이 수월해짐

· Tools → Options → Infrastructure → Part Infrastructure




Geometrical set:

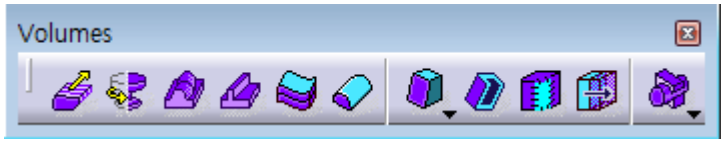
Wireframe 및 Surface 형상 요소에 대해 정렬 및 구분을 짓기 위한 세트

# GENERATIVE SHAPE DESIGN 툴바 종류


Reference Element와 Wireframe을 생성


Wireframe or Sketch 로부터 Surface 생성


생성한 Surface를 조립, 분할, 연결 등을 하는 기능




Surface에 Volume을 부여하는 기능

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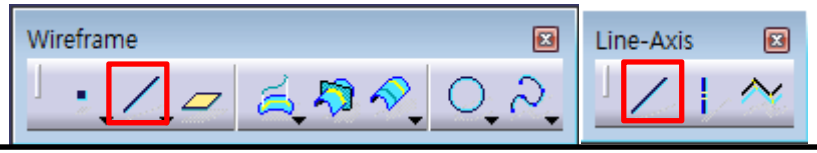
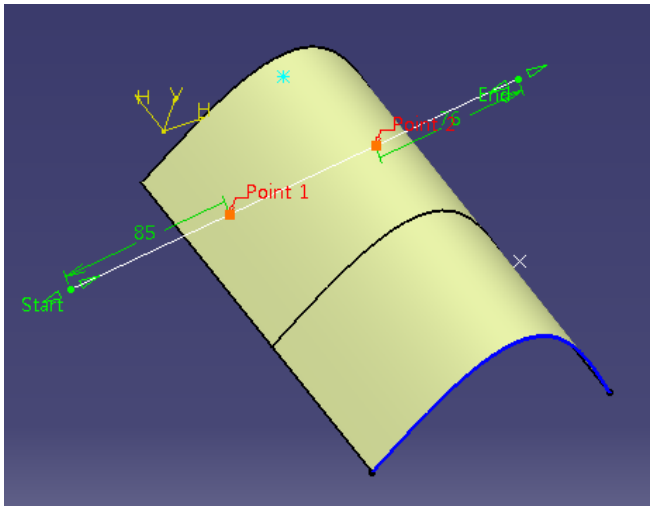
# GENERATIVE SHAPE DESIGN TOOL

Wireframe

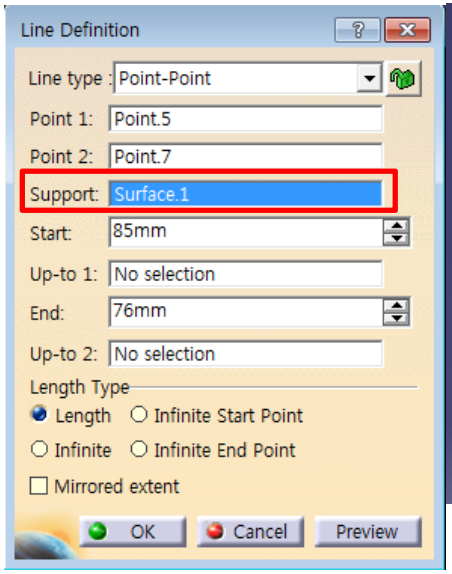


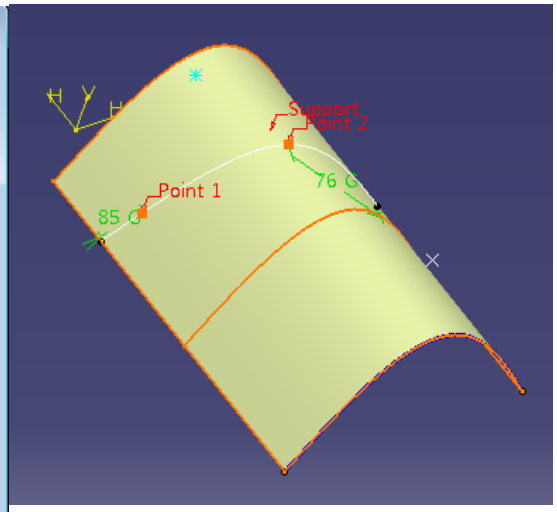

Line

기존의 Line 생성 결과



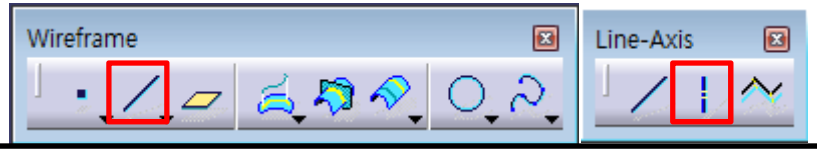

Surface를 Support로 선택 후 Line을 생성한 결과



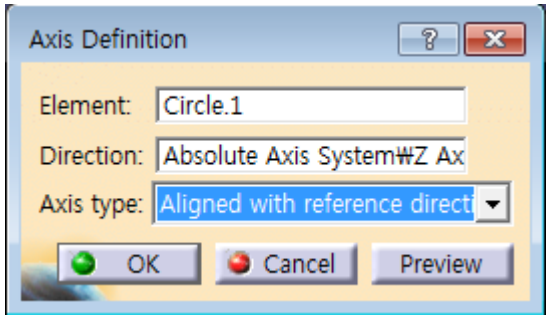
# GENERATIVE SHAPE DESIGN TOOL

Wireframe

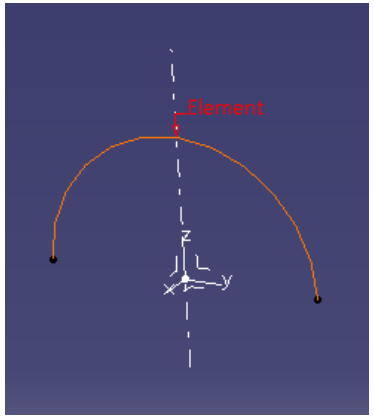



Axis

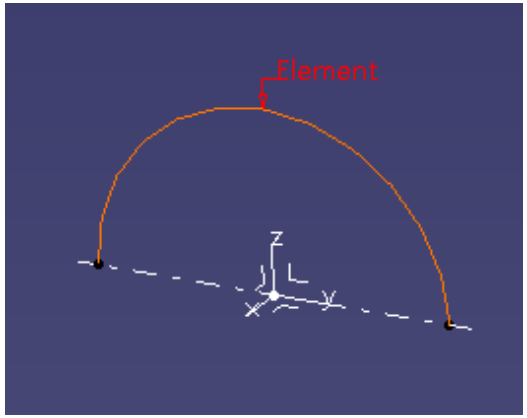
- 3차원 상에서 Axis를 생성




Aligned direction



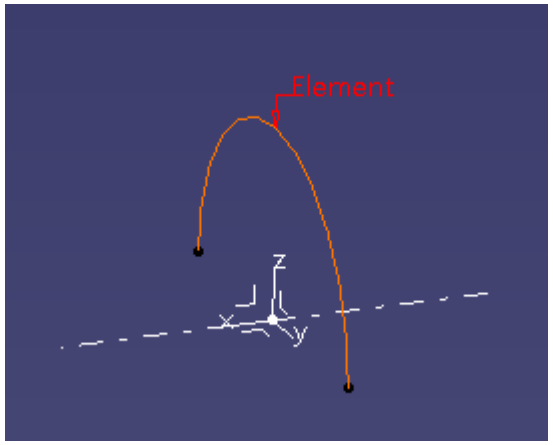

Normal to direction




Axis type :

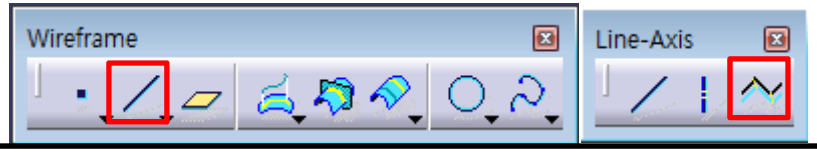
- Aligned with reference direction
- Normal to reference direction
- Normal to 'Element Type'

Normal to circle



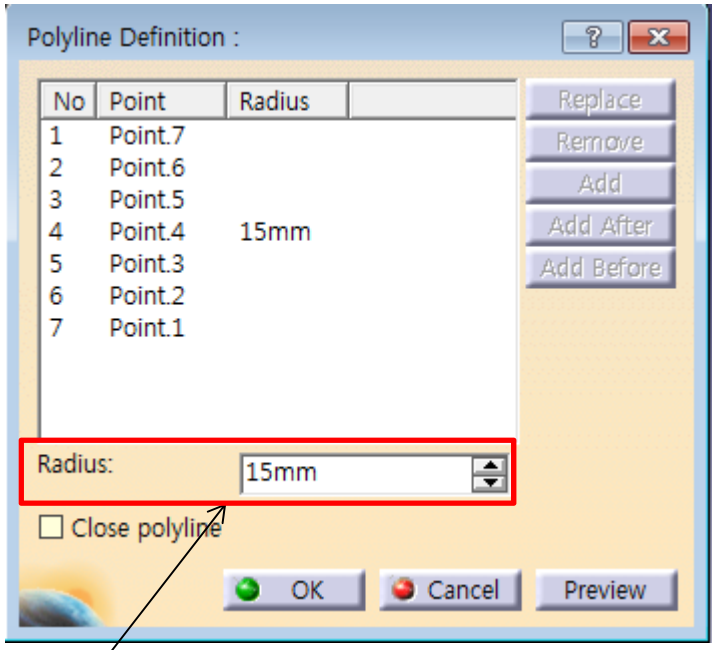
# GENERATIVE SHAPE DESIGN TOOL

Wireframe

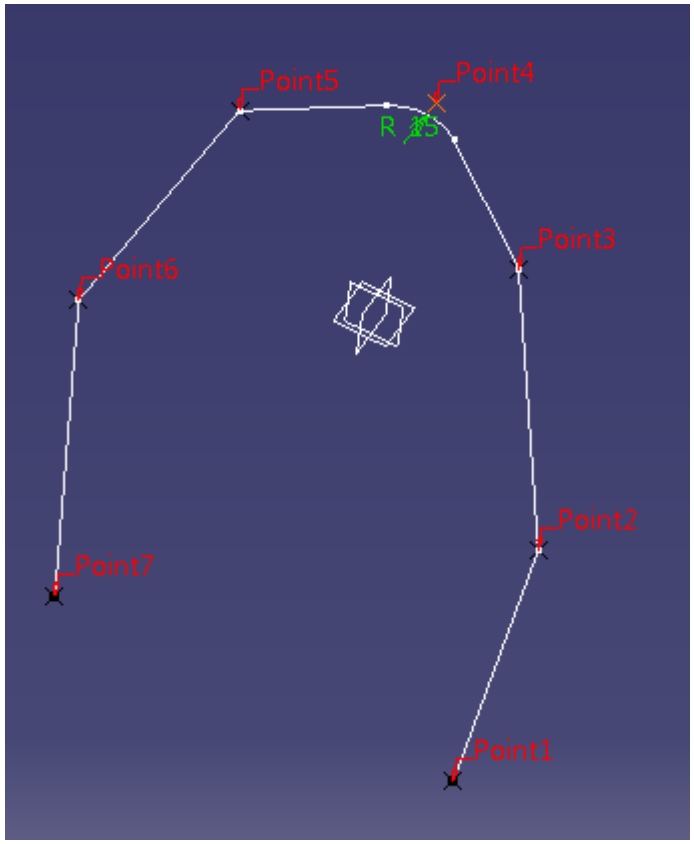



Polyline 

- 3차원 상의 points를 연결하여 직선을 만드는 기능.

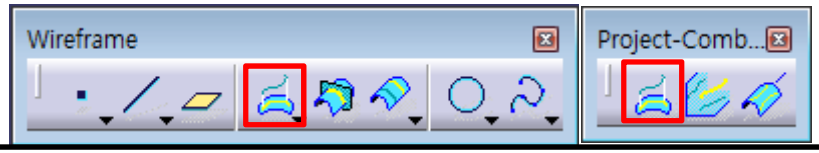



포인트 위치의 radius를 조절하여 반경 부여 가능



# GENERATIVE SHAPE DESIGN TOOL

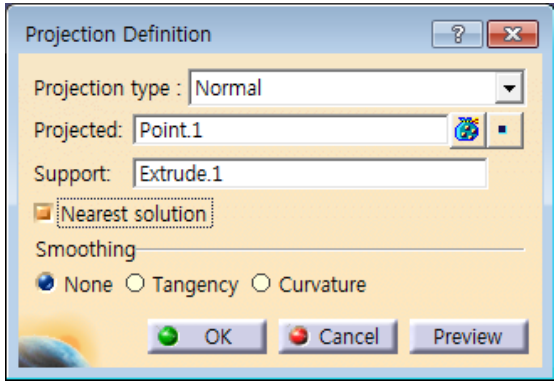
Wireframe

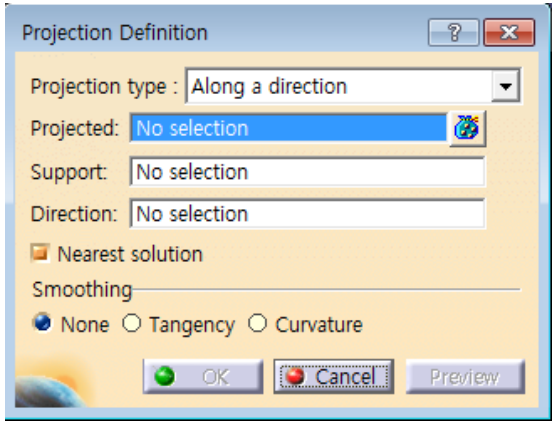



Projection 

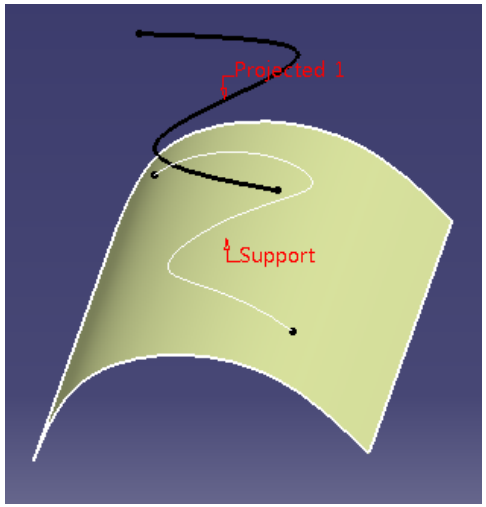
- 3차원 상의 points를 연결하여 직선을 만드는 기능.

Surface의 곡률을 따라 투영

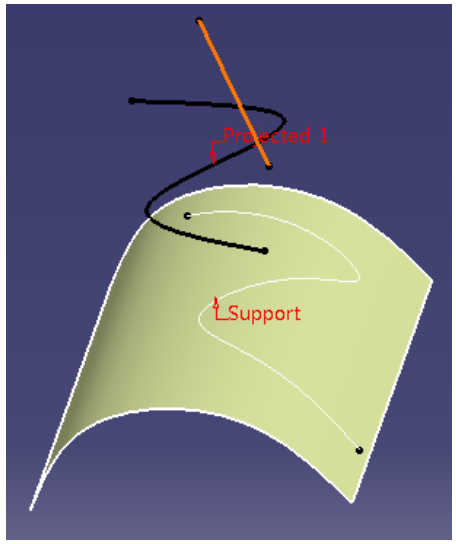



Z-direction

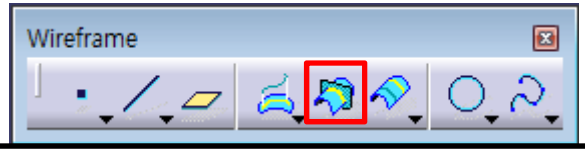



Line-direction



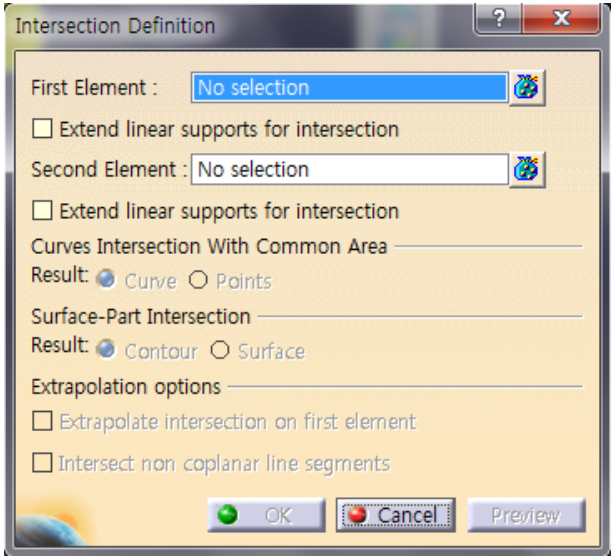
# GENERATIVE SHAPE DESIGN TOOL

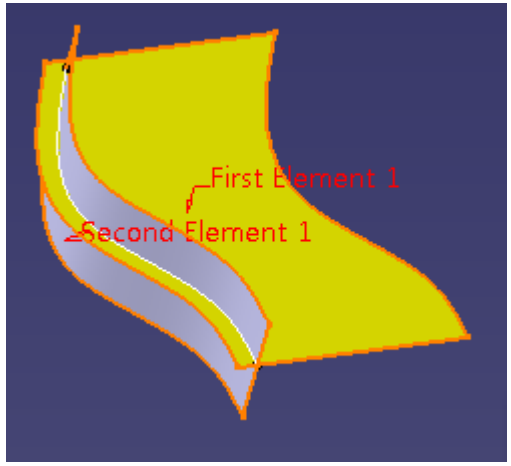
## Wireframe

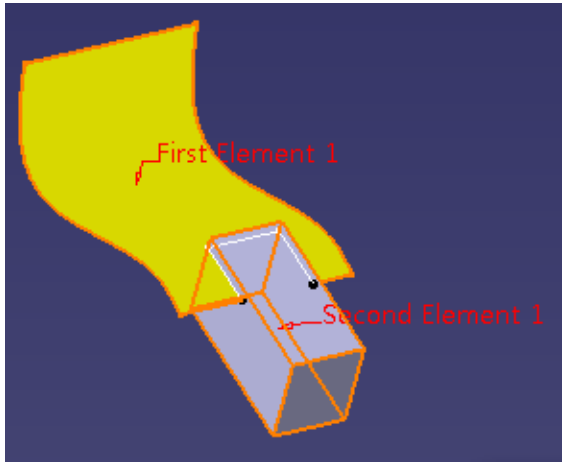



### Intersection 

- 형상과 형상 사이를 교차하는 요소를 생성

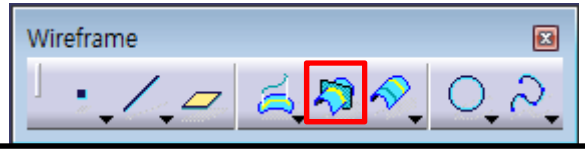


# GENERATIVE SHAPE DESIGN TOOL

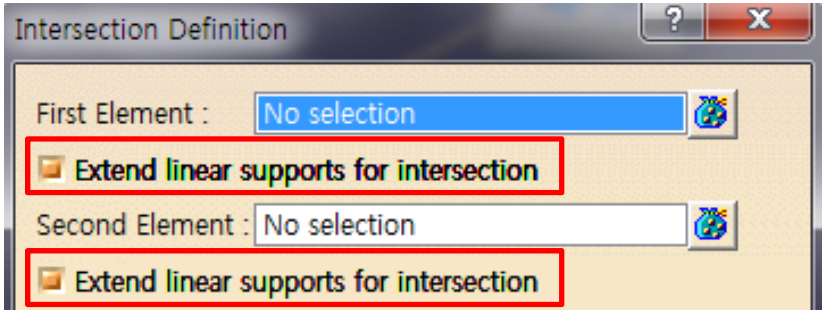
Wireframe

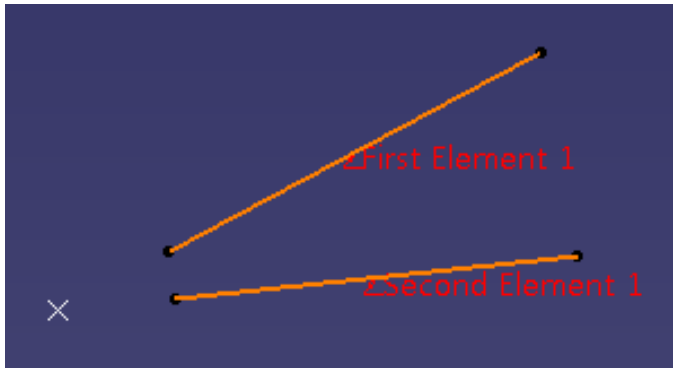



Intersection 

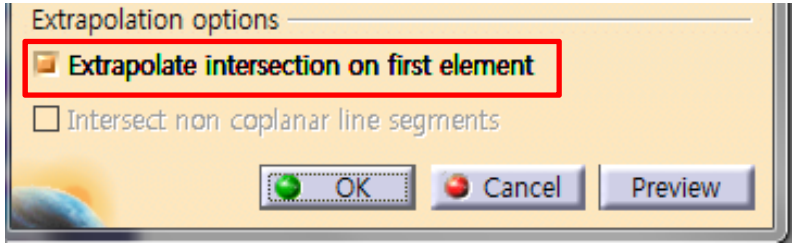
- 형상과 형상 사이를 교차하는 요소를 생성

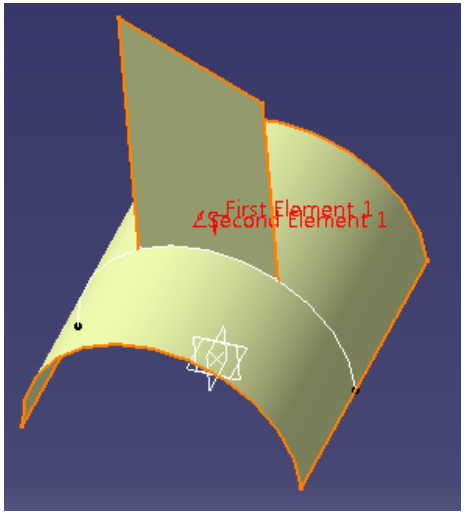
Extend linear supports for intersection



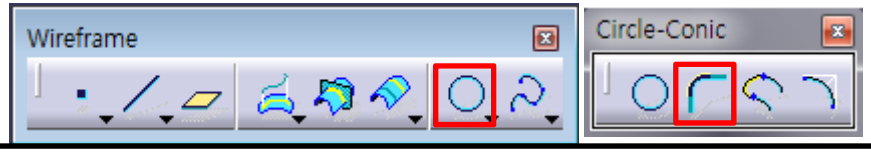

Extrapolate intersection on first element



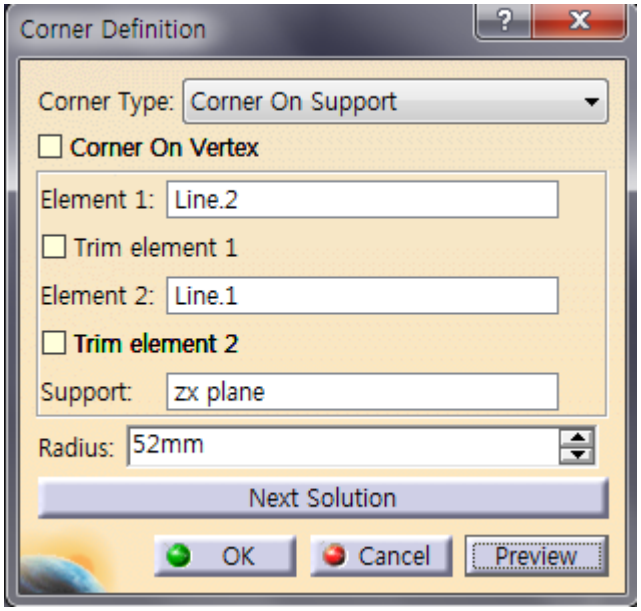
# GENERATIVE SHAPE DESIGN TOOL

Wireframe

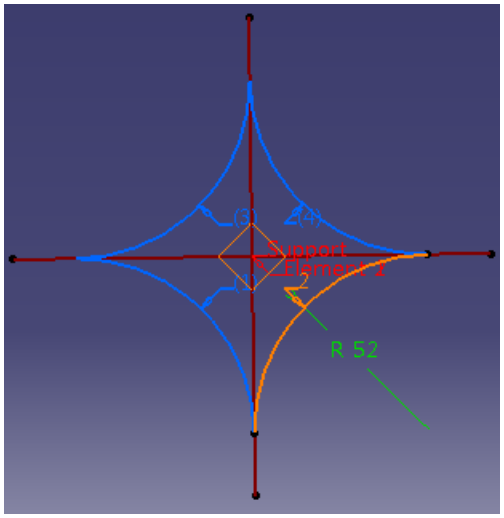



Corner 

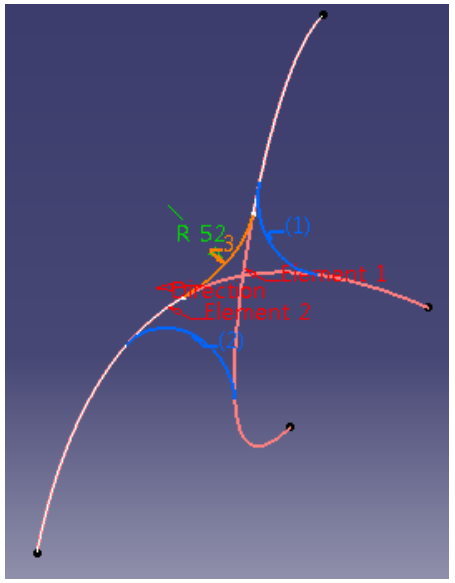
- 3차원상에 Corner를 생성




Corner On Support



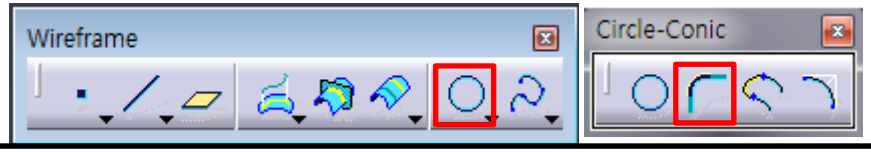

3D Corner




Corner Type의 3D Corner의 경우 element가 같은 평면상에 있지 않은 경우에 사용된다.

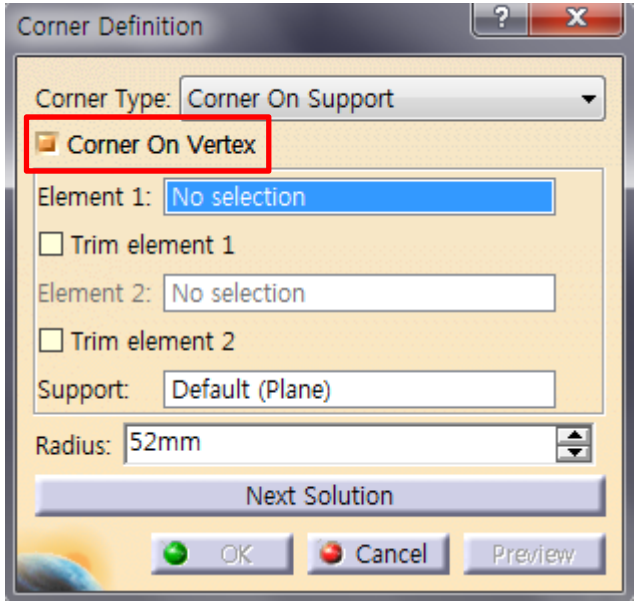
# GENERATIVE SHAPE DESIGN TOOL

Wireframe

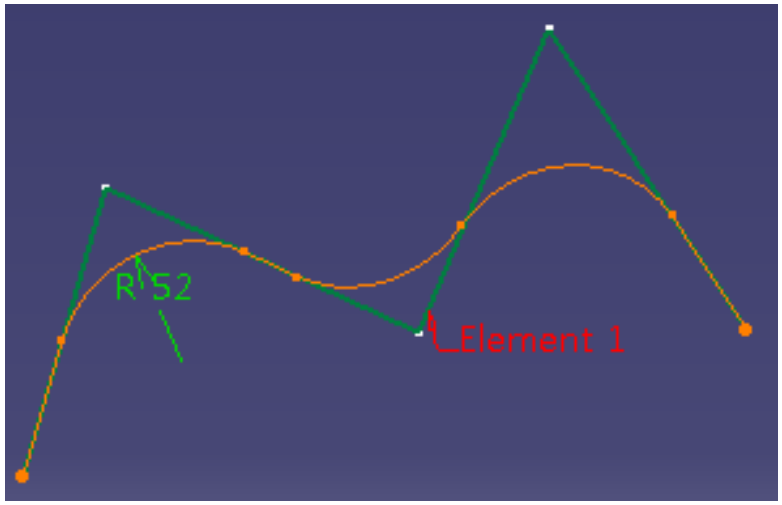



Corner 

- 3차원상에 Corner를 생성

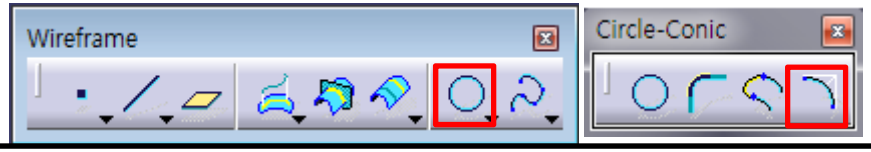



Corner On Vertex



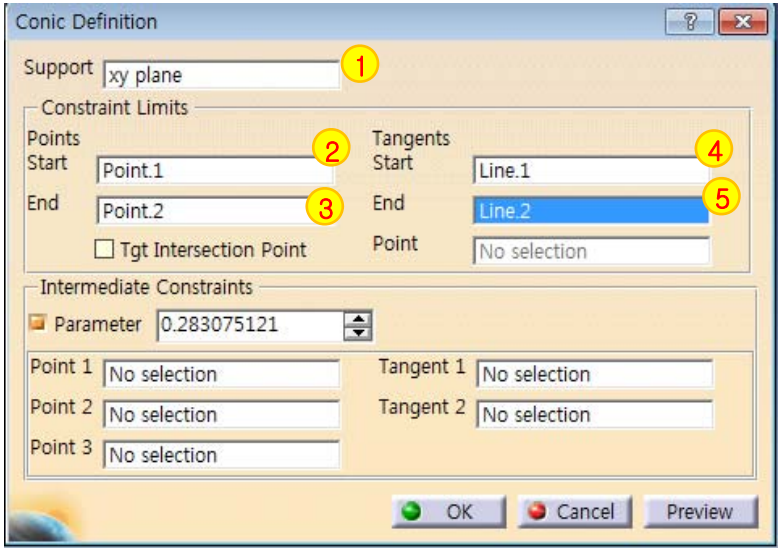
# GENERATIVE SHAPE DESIGN TOOL

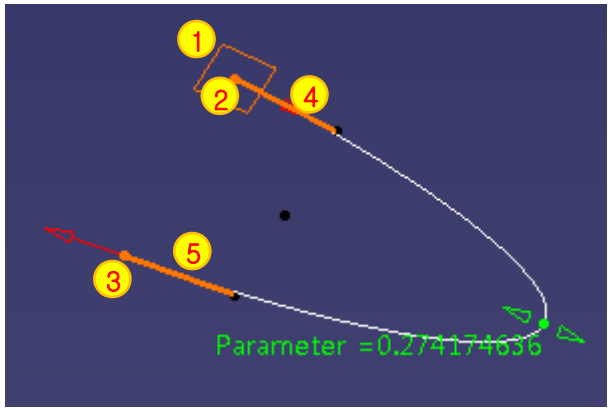
Wireframe



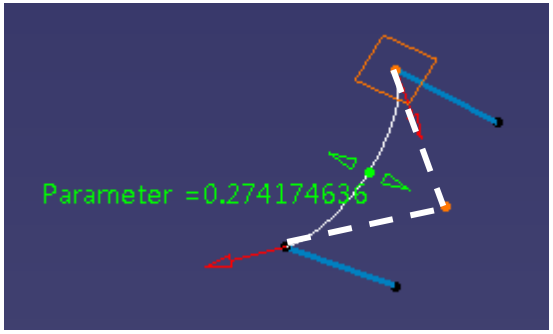

Conic 

- 3차원상에 Conic 생성



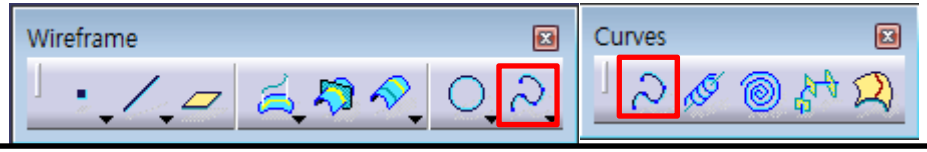




Tgt Intersection Point



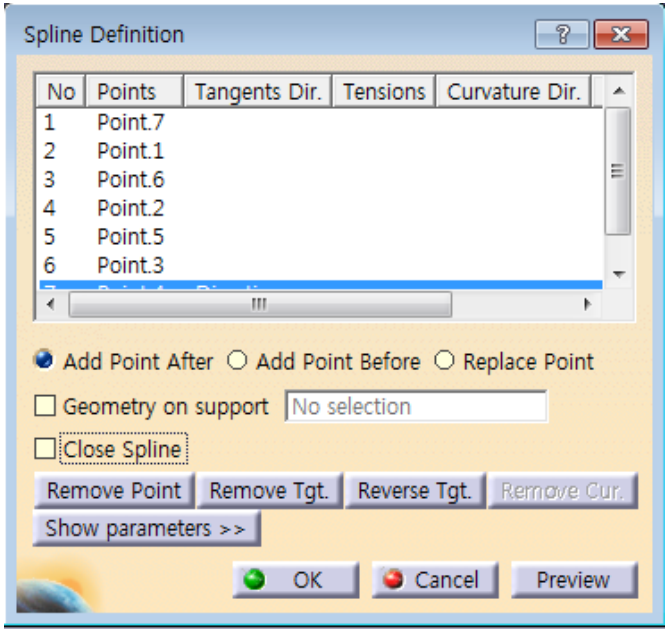
# GENERATIVE SHAPE DESIGN TOOL

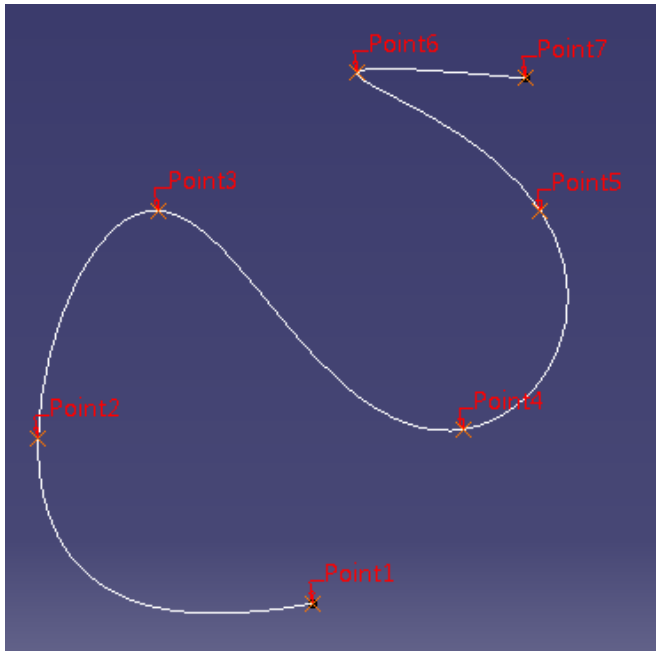
Wireframe




Spline 

- 3차원상의 Points를 이용하여 Spline Curve 생성



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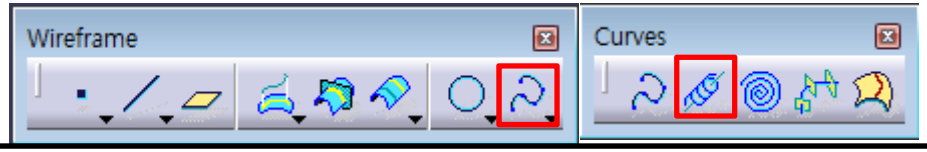
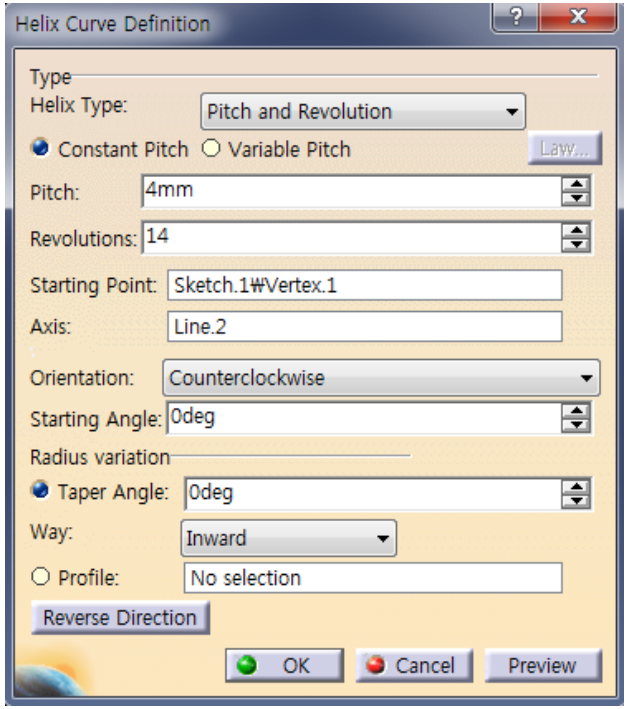
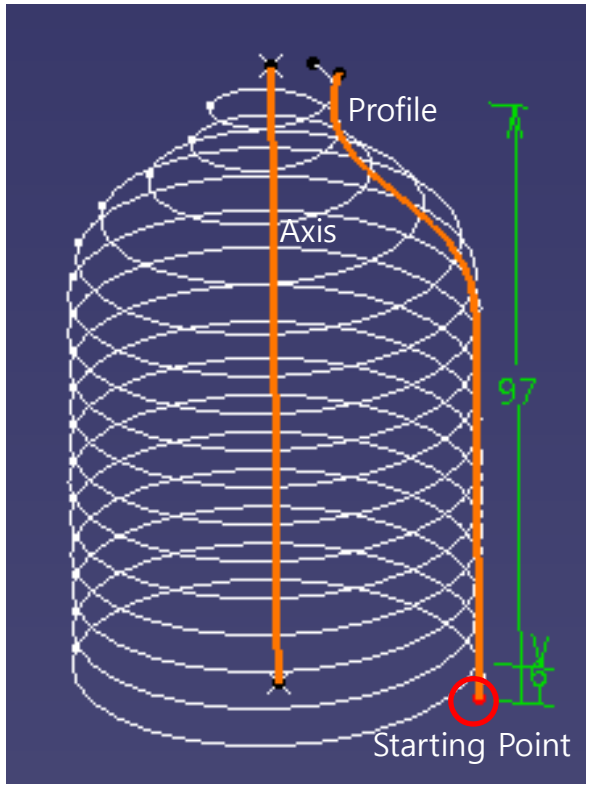
Wireframe



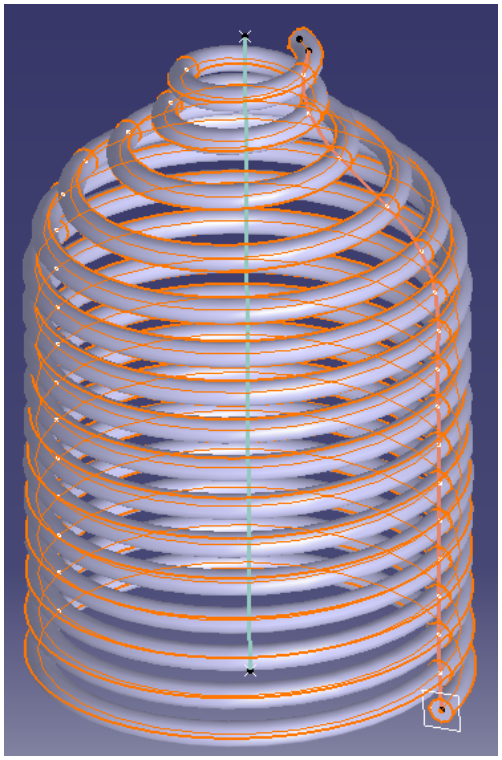

Helix 

- 스프링 같은 형상 생성




Part Design의 Rib 적용



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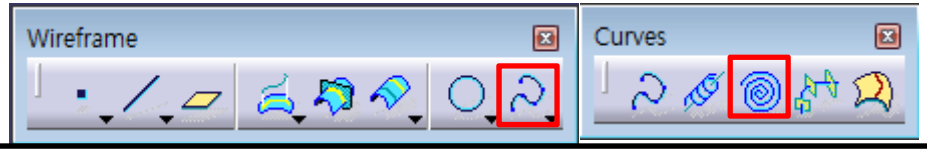
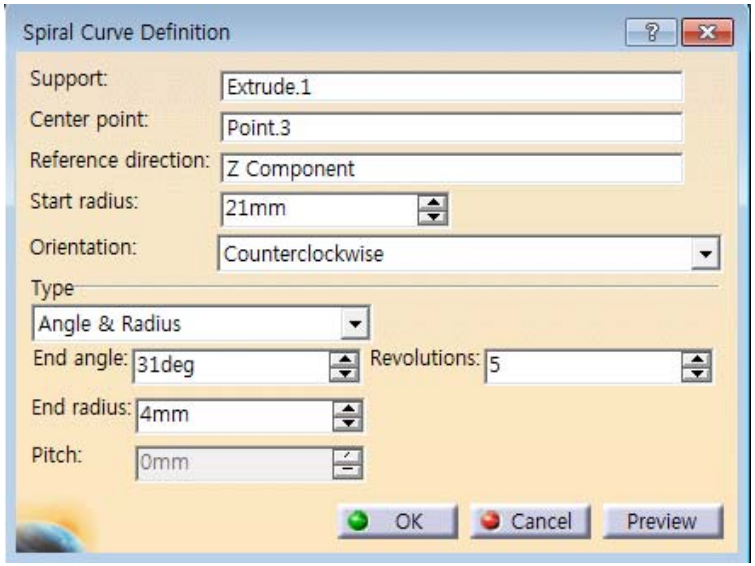
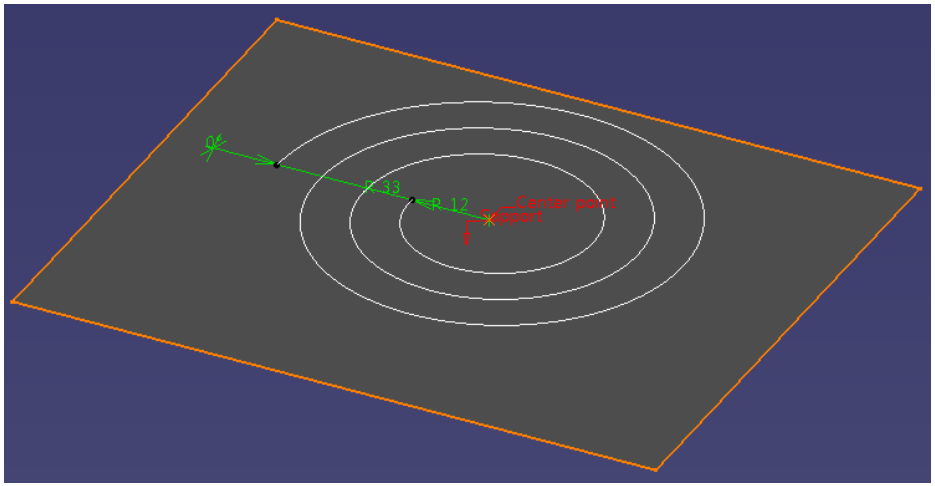
Wireframe




Spiral 

- 기준점으로 부터 나선 형태의 Curve 생성



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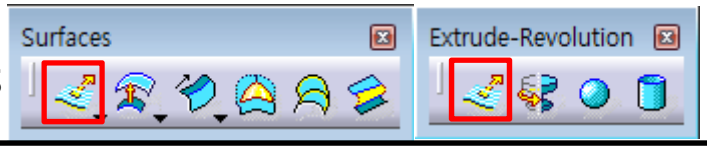
- ✓ Wireframe
- ✓ **Surfaces**
- ✓ Operation

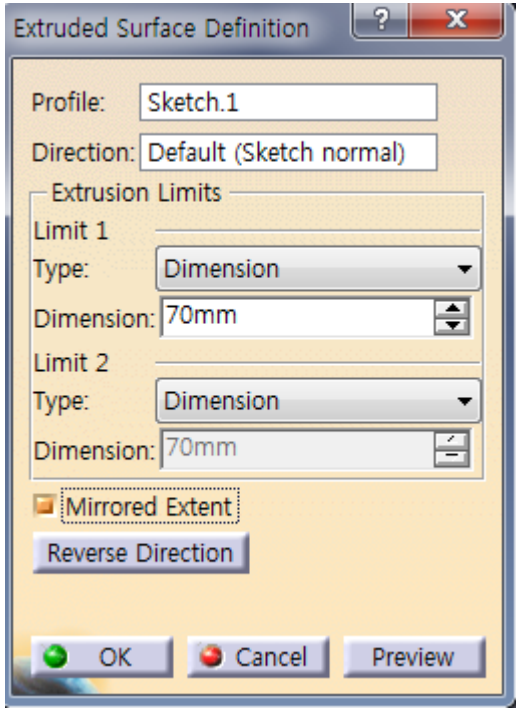
# GENERATIVE SHAPE DESIGN TOOL

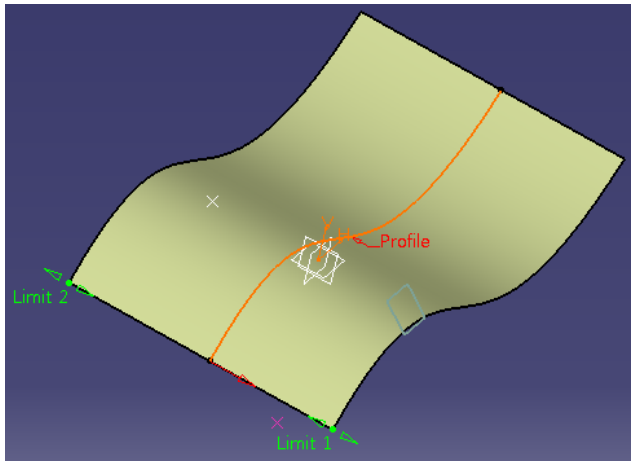
Surfaces



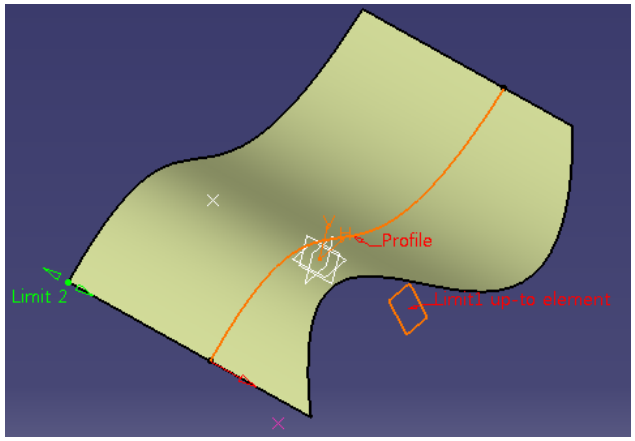

Extrude 

- Wireframe/Sketch를 길이방향으로 늘려 Surface 생성



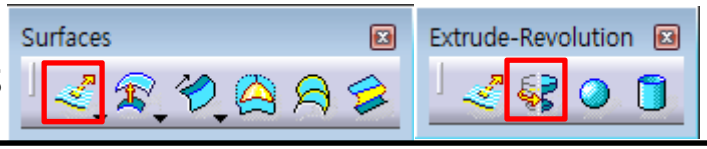




Plane을 이용한 Limit 설정 (Up-to element)



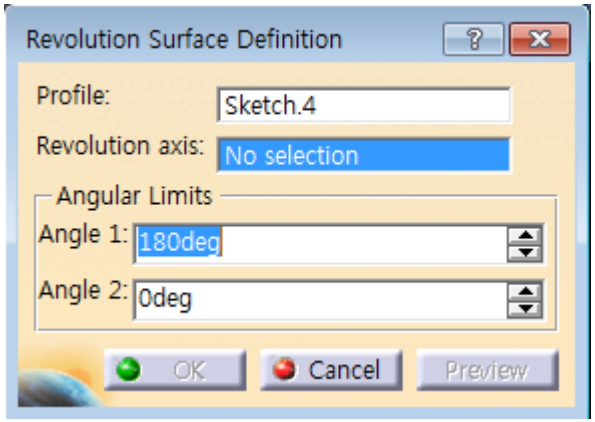
# GENERATIVE SHAPE DESIGN TOOL

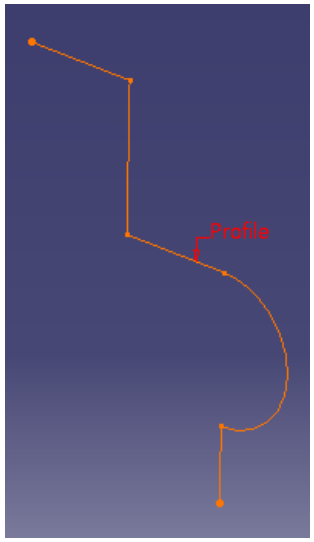
Surfaces

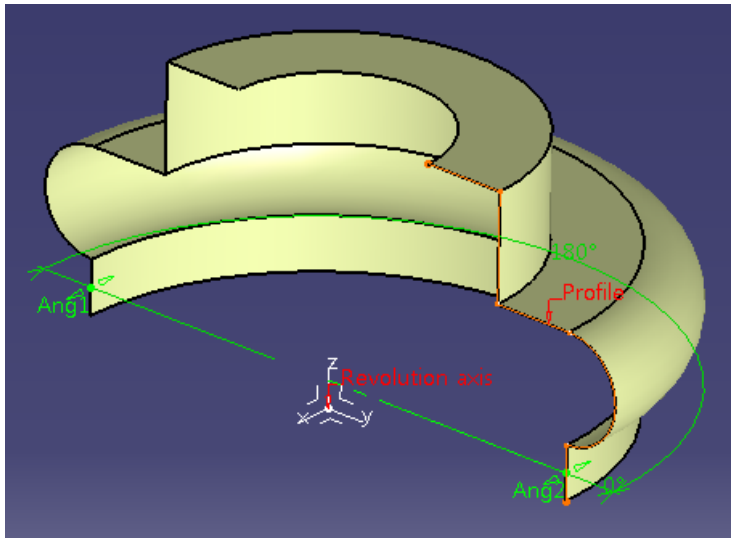



Revolute 

- Wireframe/Sketch를 회전시켜 Surface 생성

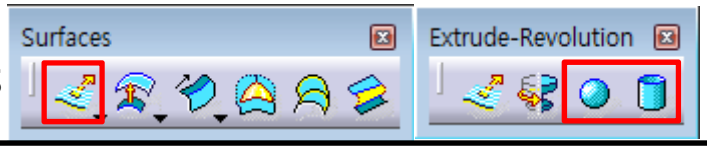


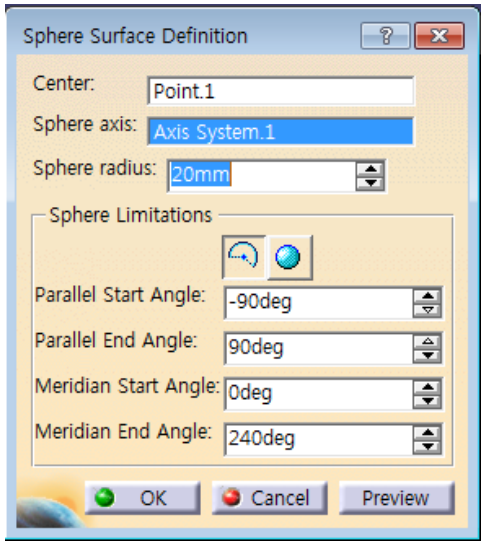
# GENERATIVE SHAPE DESIGN TOOL

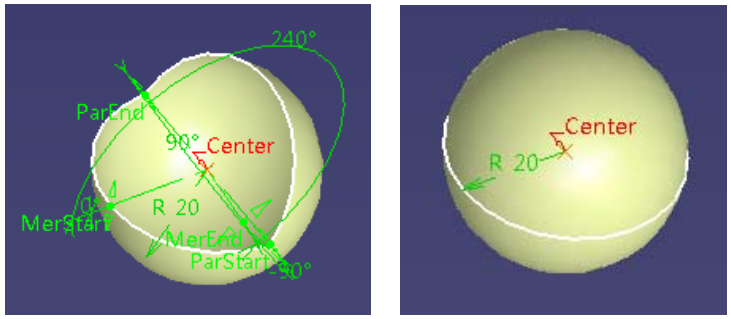
Surfaces




Sphere

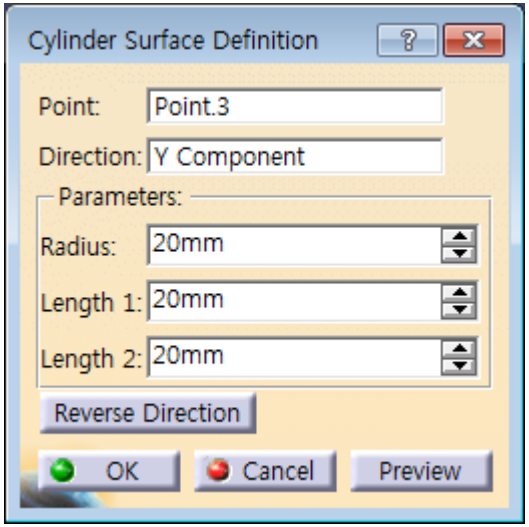
- Center를 기준으로 구 형태의 Surface 생성

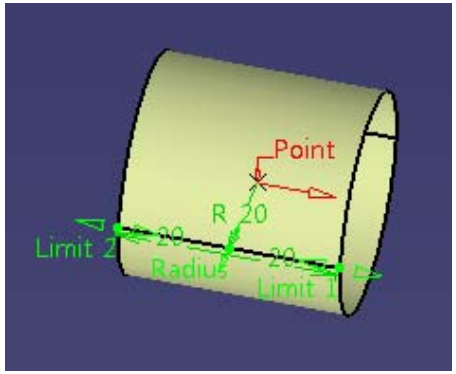



Cylinder

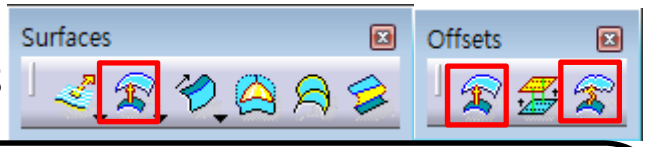
- Center를 기준으로 실린더 형태의 Surface 생성



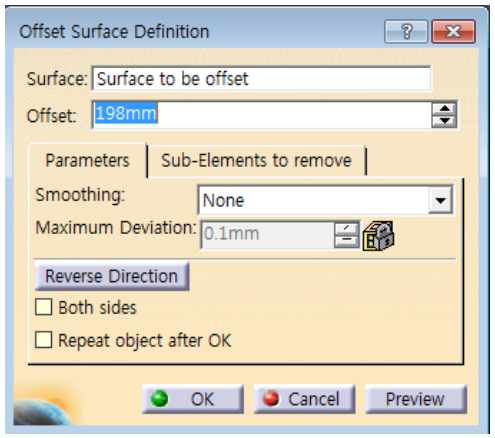
# GENERATIVE SHAPE DESIGN TOOL

Surfaces

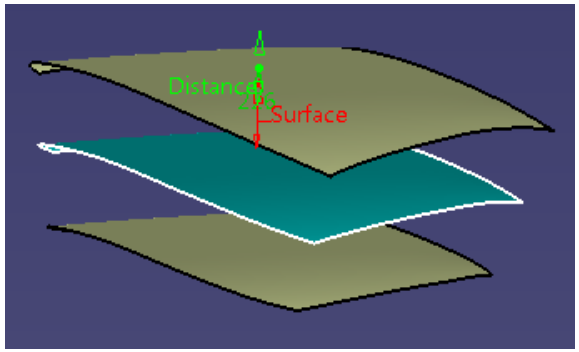



## Offset

- Surface의 Offset 생성

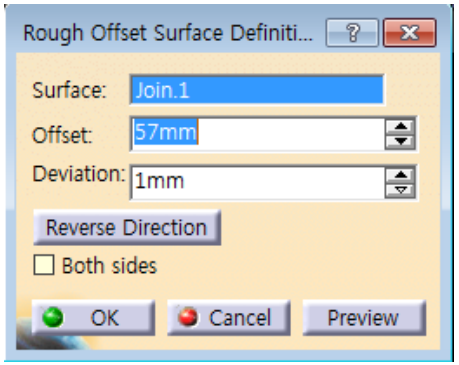


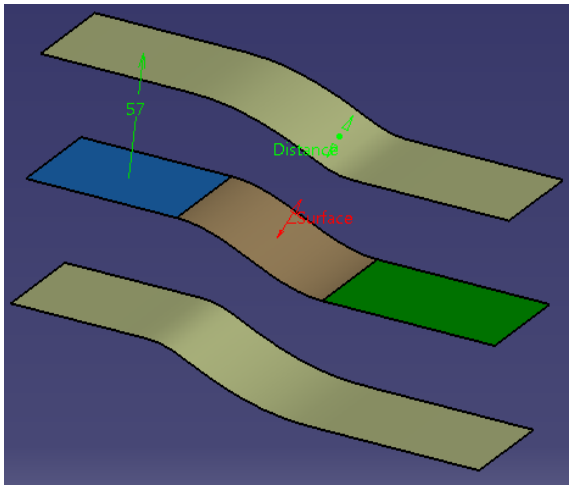

Both sides Offset




## Rough Offset

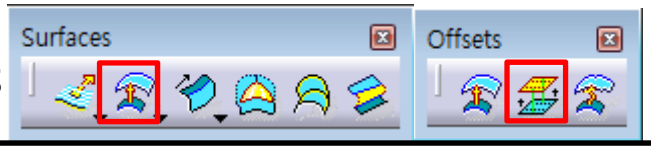
- 근사적인 Surface Offset 생성



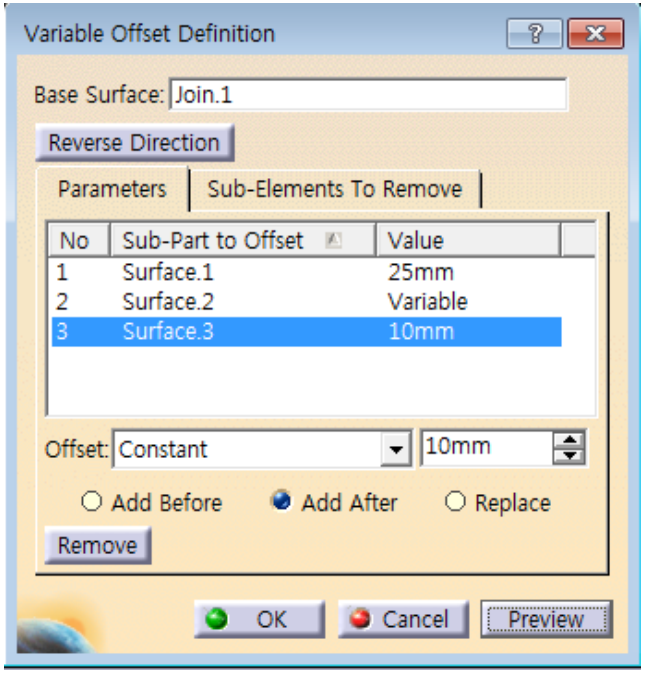
# GENERATIVE SHAPE DESIGN TOOL

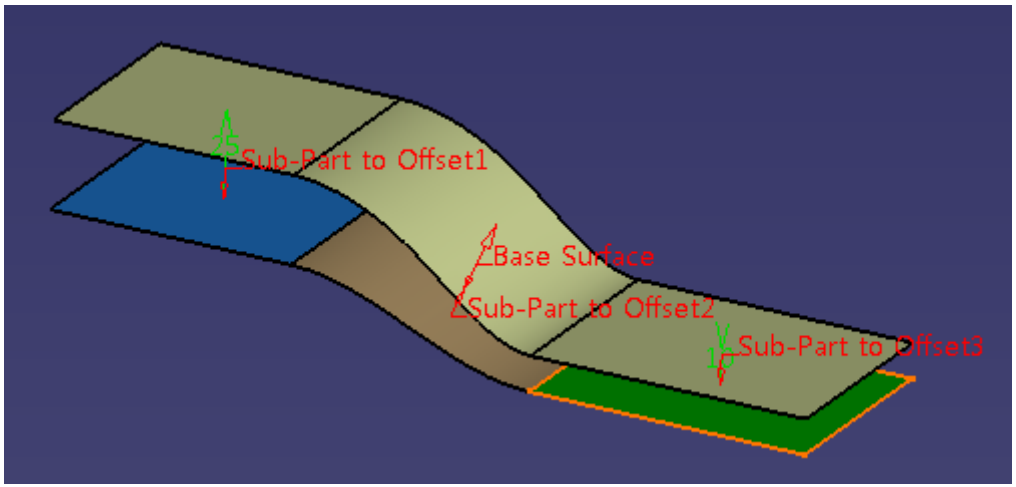
Surfaces



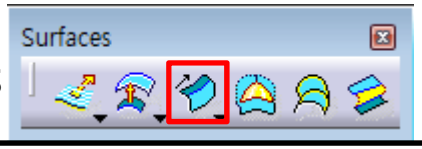

## Variable Offset

- 서로 다른 값을 가지는 Surface Offset 생성



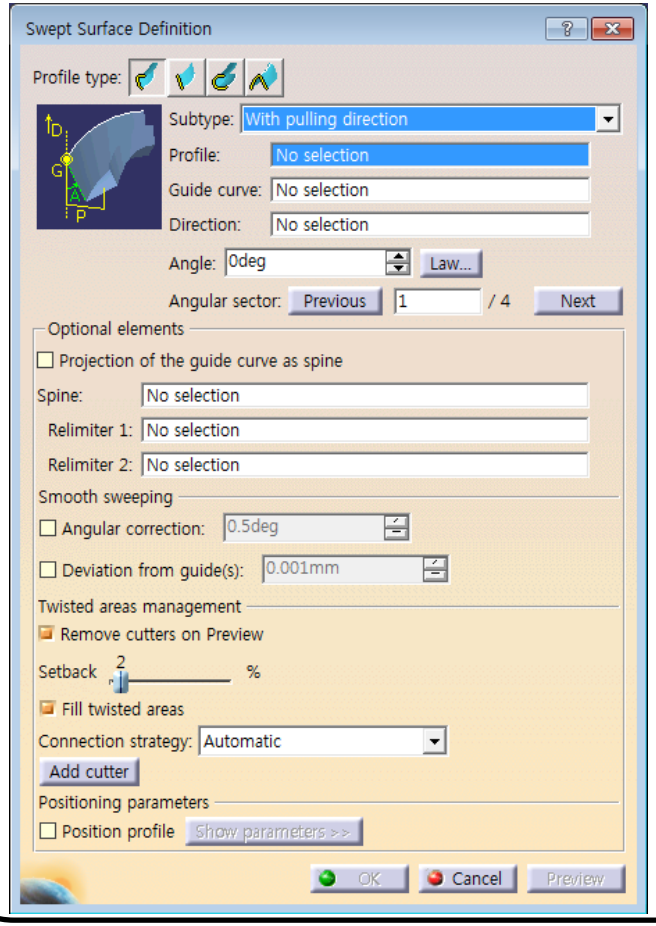



# GENERATIVE SHAPE DESIGN TOOL

Surfaces 


Sweeps 

- 여러 elements를 이용한 Surface 생성




 Explicit : Profile과 Guideline을 이용하여 Surface 생성

With reference surface
With two guide curves
With pulling direction

 Line : Profile을 따로 사용하지 않고 Guideline등을 이용하여 Surface 생성

Two limits
Limit and middle
With reference surface
With reference curve
With tangency surface
With draft direction
With two tangency surfaces

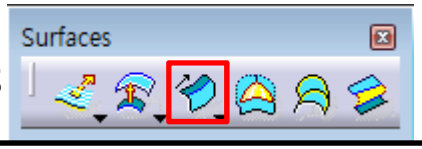
 Circle : Profile의 형상이 원형이 되도록 Surface 생성

Three guides
Two guides and radius
Center and two angles
Center and radius
Two guides and tangency surface
One guide and tangency surface
Limit curve and tangency surface

 Conic : Profile의 형상이 원뿔 모양이 되도록 Surface 생성

Two guide curves
Three guide curves
Four guide curves
Five guide curves

# GENERATIVE SHAPE DESIGN TOOL

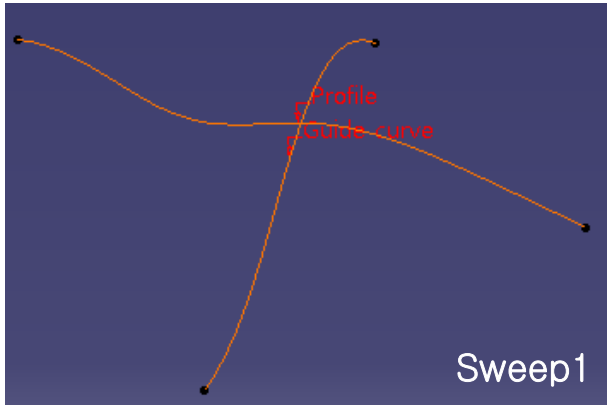
Surfaces 

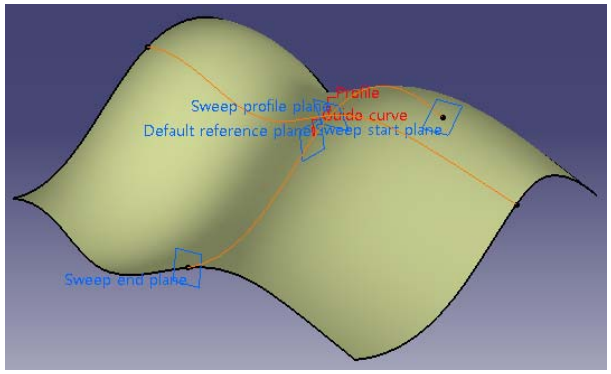

Sweeps 


Explicit

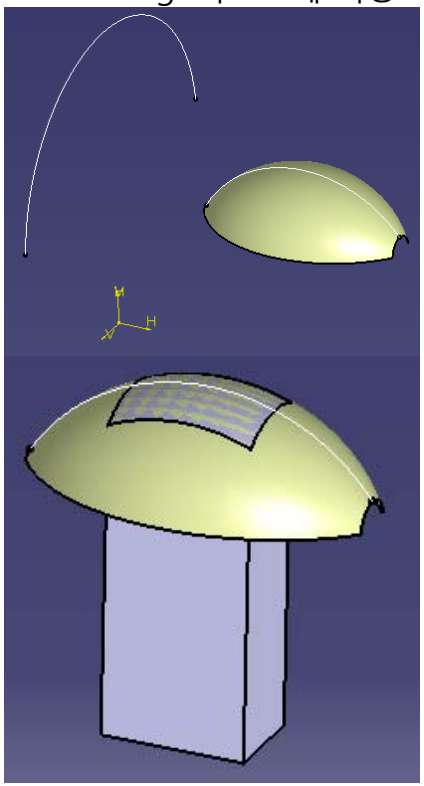
With reference surface
With two guide curves
With pulling direction

With reference surface
- Profile과 하나의 Guide curve를 이용하여 Guide를 따라가는 Surface 생성



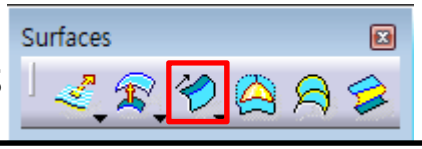




Part Design의 Pad에 적용



# GENERATIVE SHAPE DESIGN TOOL

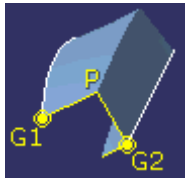
Surfaces

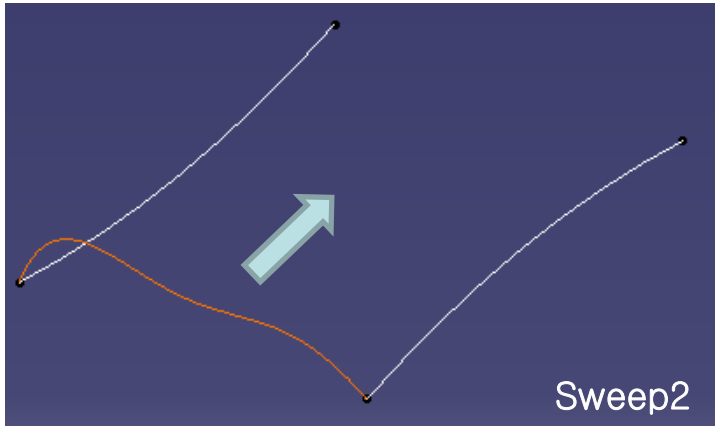



Sweeps

Explicit

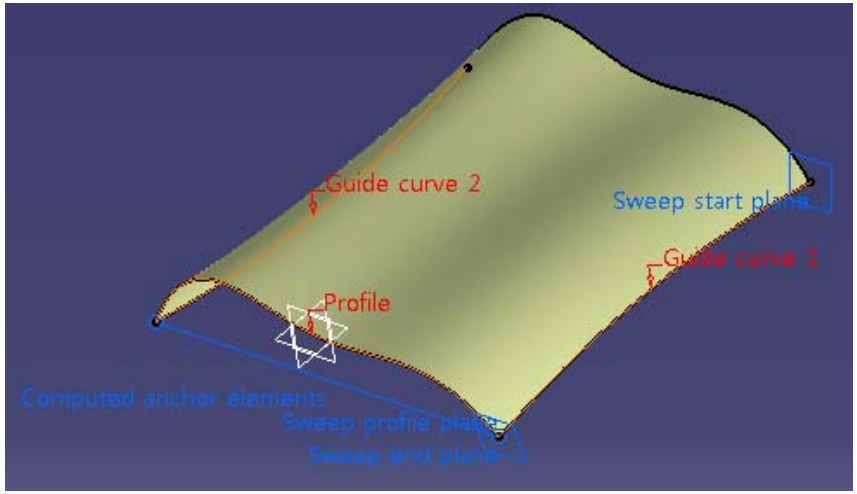
With reference surface
With two guide curves
With pulling direction



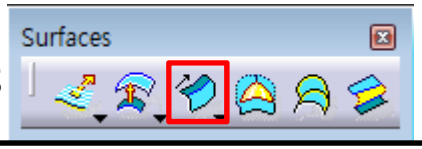




With two guide curves

- Profile과 두 개의 Guide curve를 이용하여 Surface 생성



# GENERATIVE SHAPE DESIGN TOOL

Surfaces 

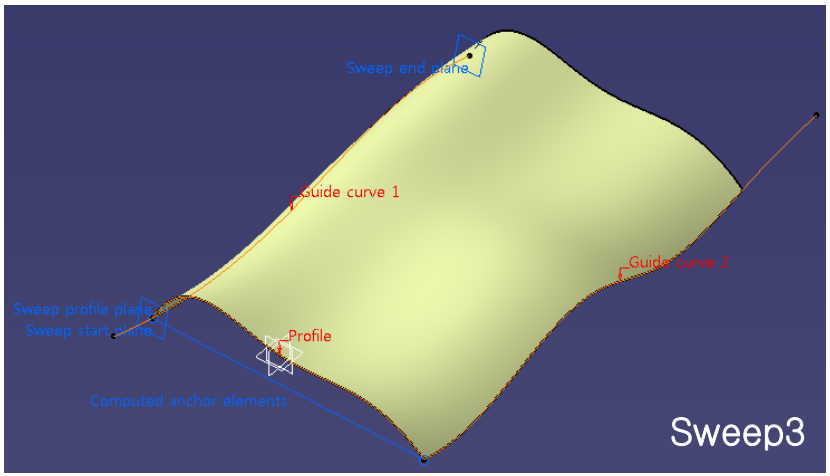

Sweeps 


Explicit

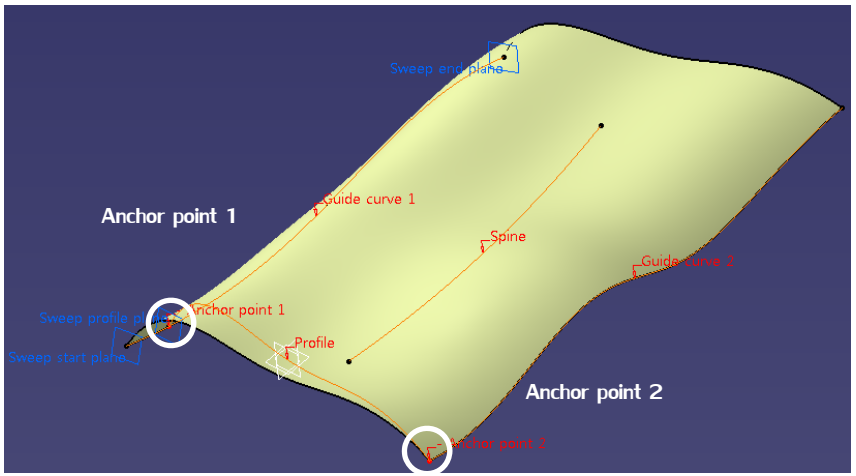
With reference surface
With two guide curves
With pulling direction

With two guide curves
- Profile과 두 개의 Guide curve를 이용하여 Surface 생성

Guide curve의 길이가 다른 경우

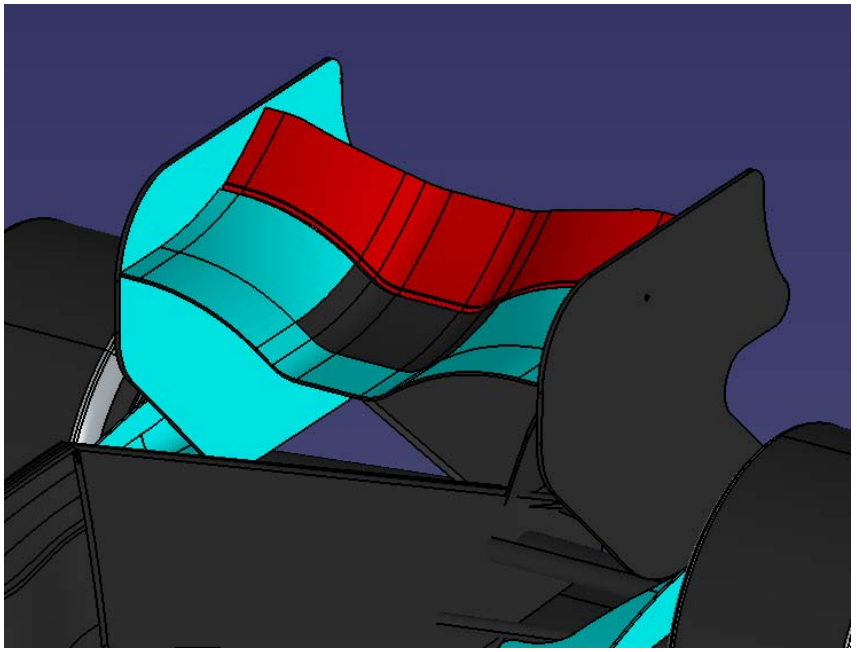


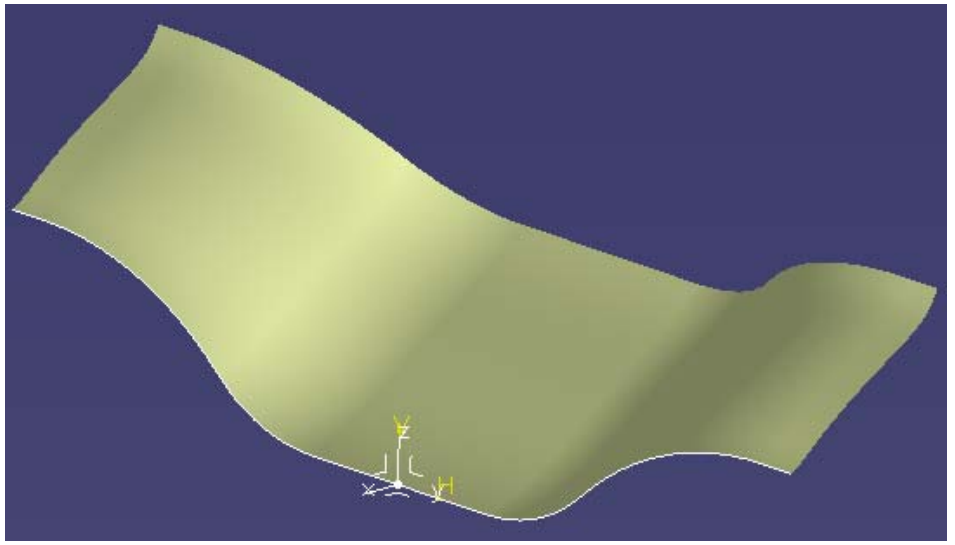

Spine 생성: Spine → Create Spine → Guide 선택



# 실습 예제

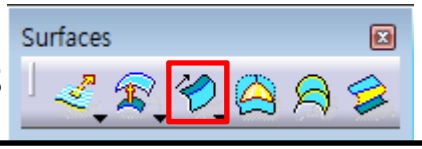
Sweep 기능을 이용하여 아래 그림과 유사하도록 surface 생성



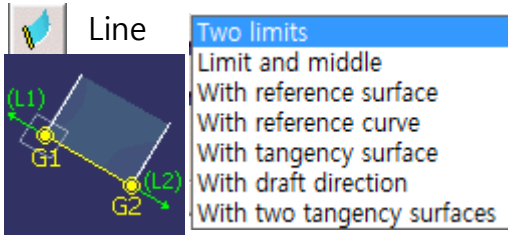


# GENERATIVE SHAPE DESIGN TOOL

Surfaces

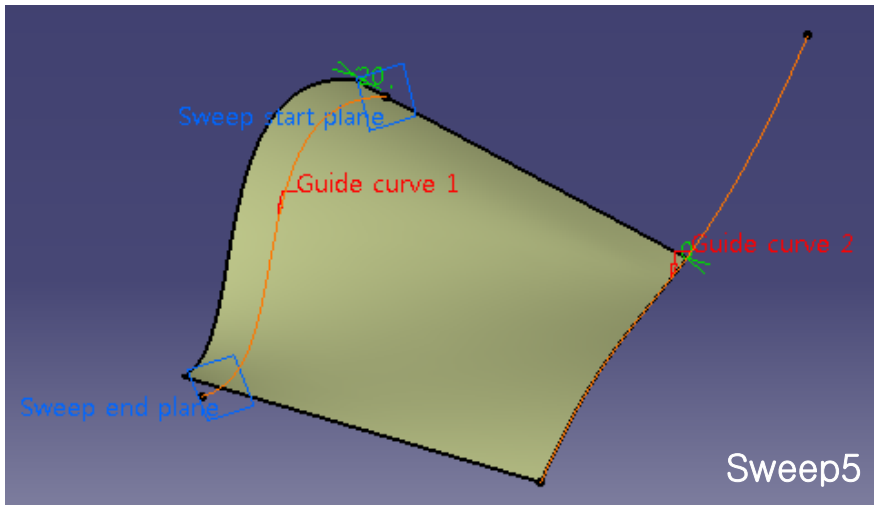



Sweeps

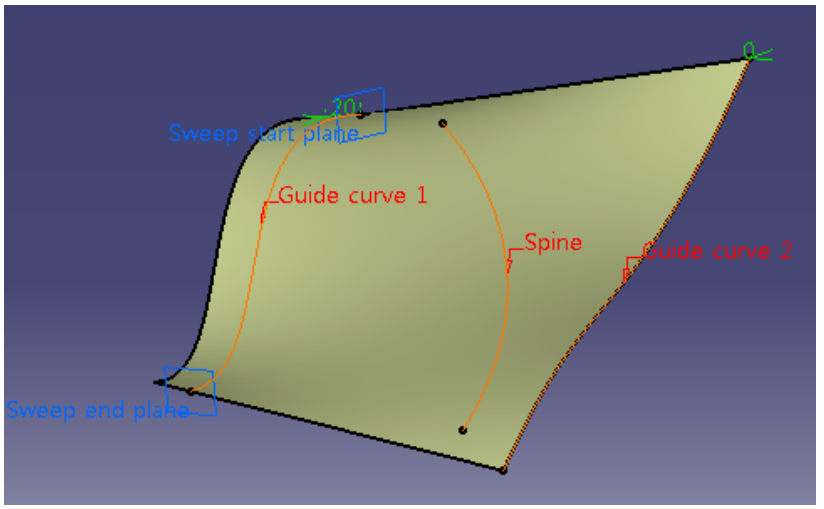



Two limits

- 두 개의 Guide Curve를 사용하여 Surface 생성

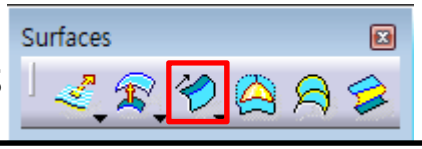



Using spine curve

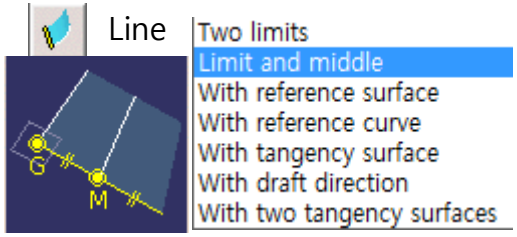


# GENERATIVE SHAPE DESIGN TOOL

Surfaces

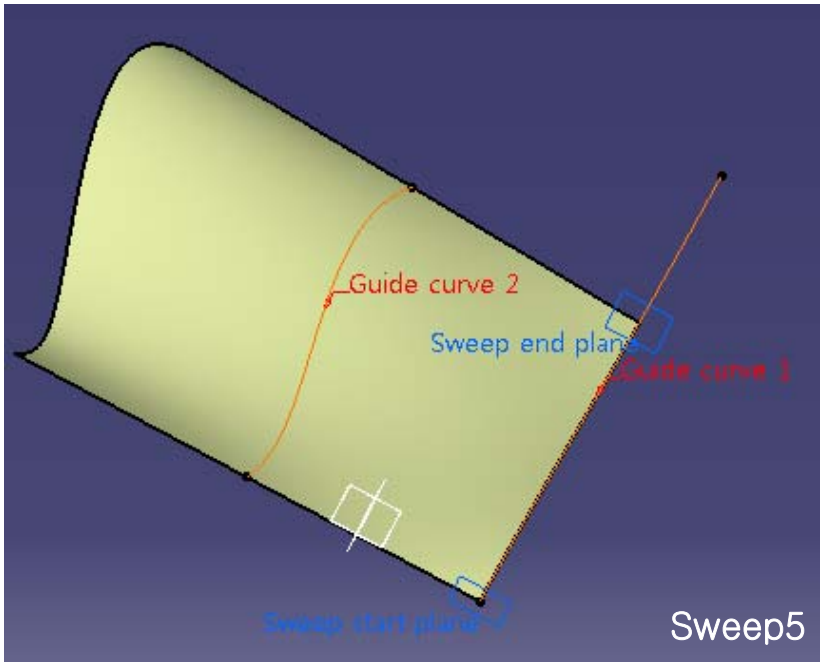



Sweeps 



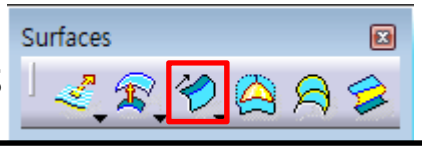

## Limit and middle

- 하나의 Guide Curve 1는 경계선, 나머지 하나는 Surface의 중간에 위치하도록 설정



# GENERATIVE SHAPE DESIGN TOOL

Surfaces



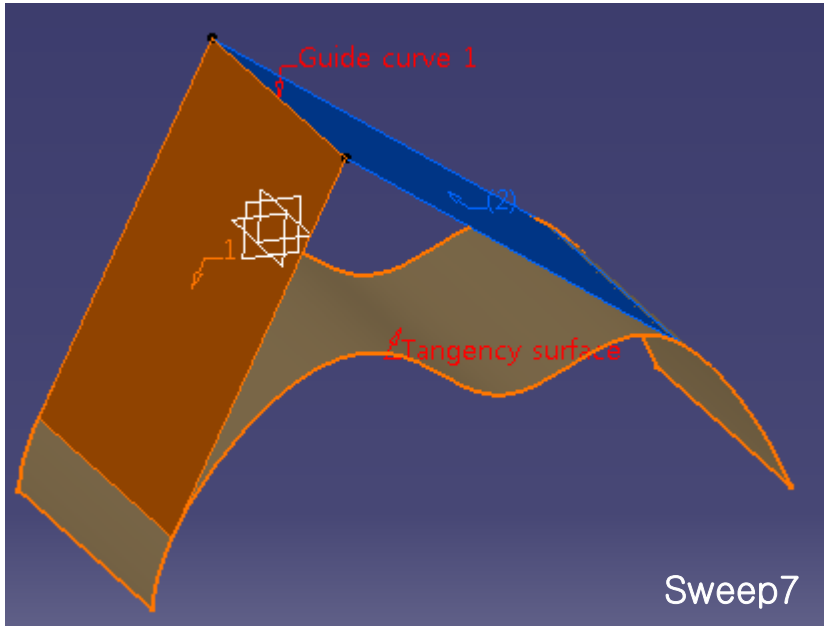

Sweeps

Line


Two limits
Limit and middle
With reference surface
With reference curve
With tangency surface
With draft direction
With two tangency surfaces

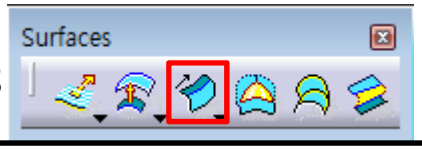
With tangency surface

- Guide Curve에서 특정 Surface에 접하는 surface를 생성



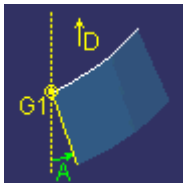
# GENERATIVE SHAPE DESIGN TOOL

Surfaces




Sweeps 

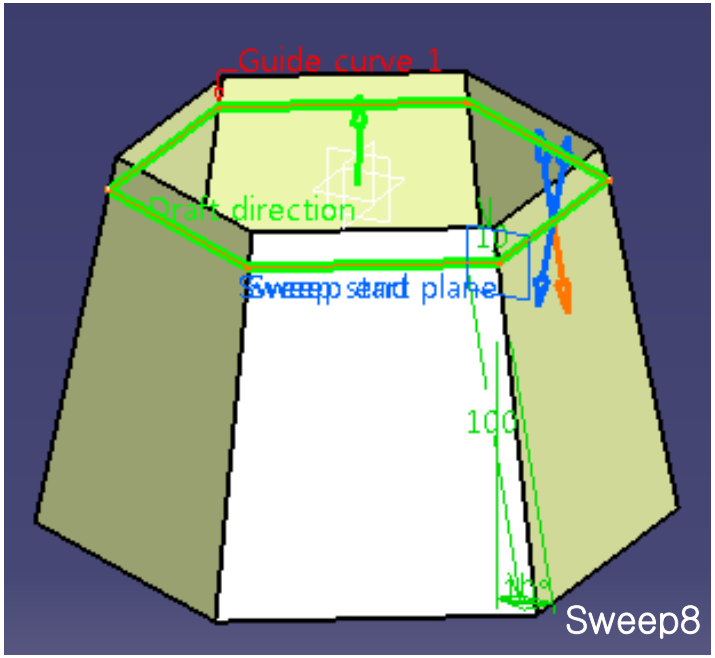
Line



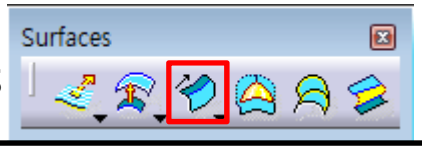

Two limits
Limit and middle
With reference surface
With reference curve
With tangency surface
With draft direction
With two tangency surfaces

With draft direction

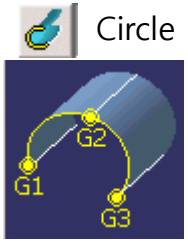
- Guide Curve를 선택한 Pulling direction 기준으로 각도를 부여하여 surface 생성



# GENERATIVE SHAPE DESIGN TOOL

Surfaces 

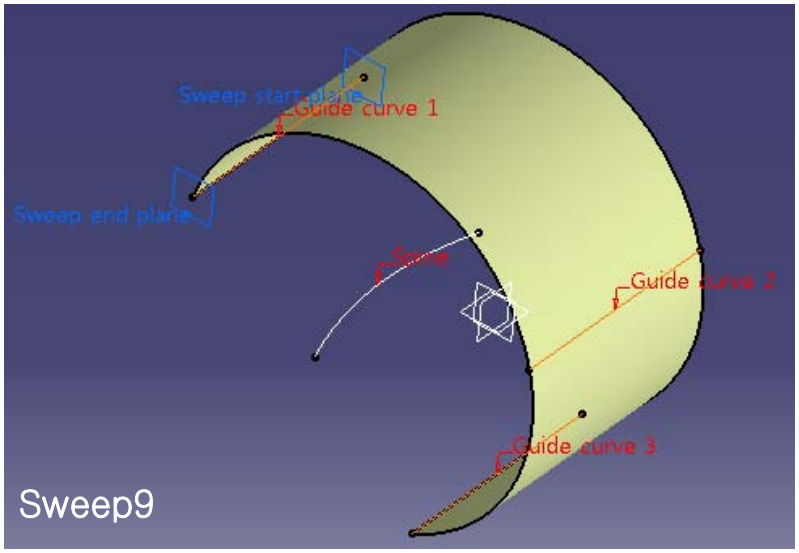

Sweeps 



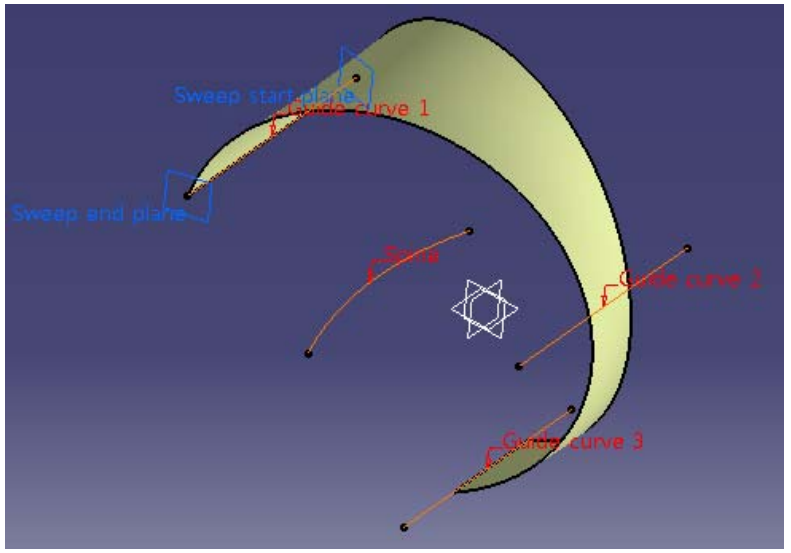

Circle

- Three guides
- Two guides and radius
- Center and two angles
- Center and radius
- Two guides and tangency surface
- One guide and tangency surface
- Limit curve and tangency surface

Three guides
- 3개의 Guide line을 이용해 생성

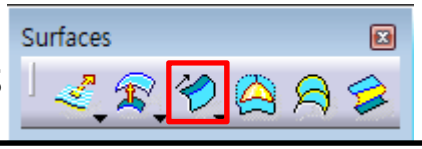



Spine 이용 (이 경우 Guides와는 별도)

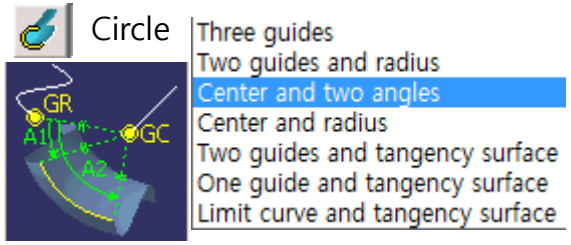


# GENERATIVE SHAPE DESIGN TOOL

Surfaces

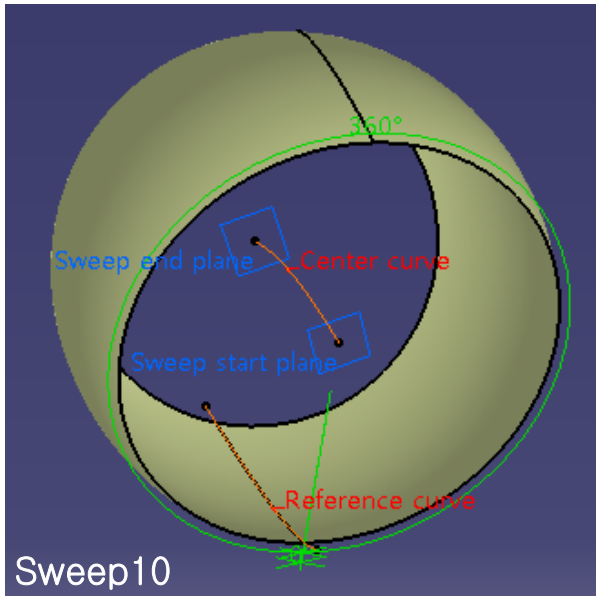


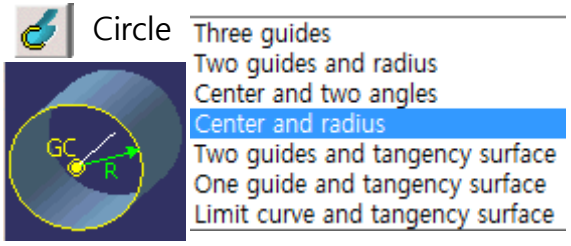

Sweeps 




Center and two angles

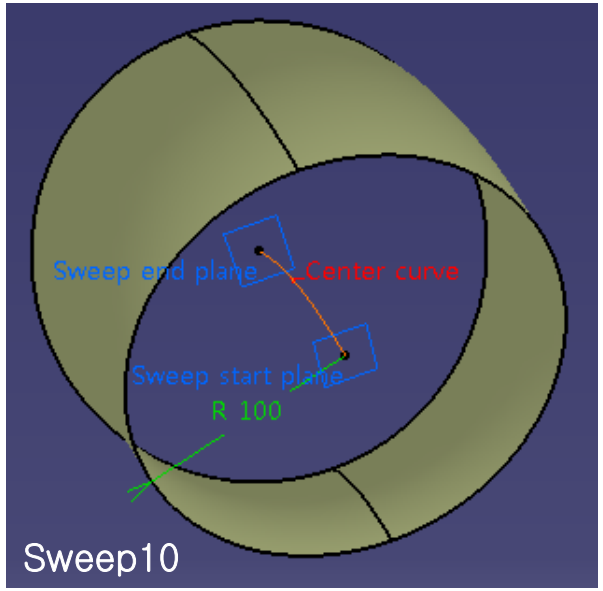
- 원의 중심을 지나는 Curve와 반경을 지나는 Curve를 이용



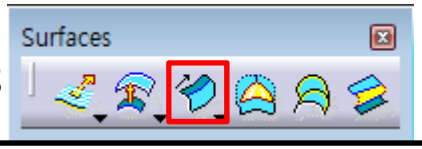

Center and radius

- 원의 중심을 지나는 Curve와 반경 값(radius) 사용

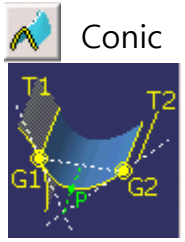


# GENERATIVE SHAPE DESIGN TOOL

Surfaces

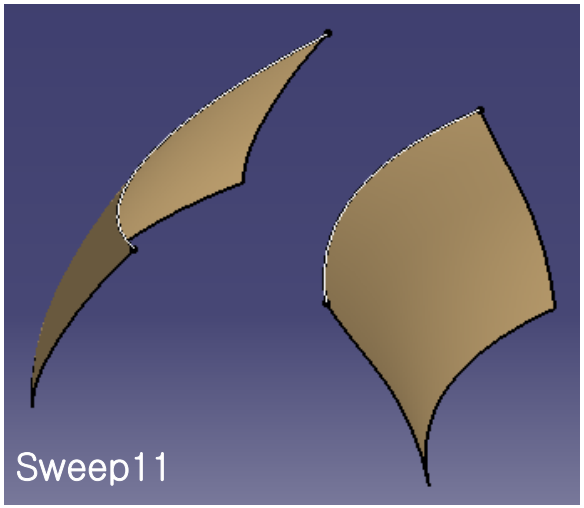


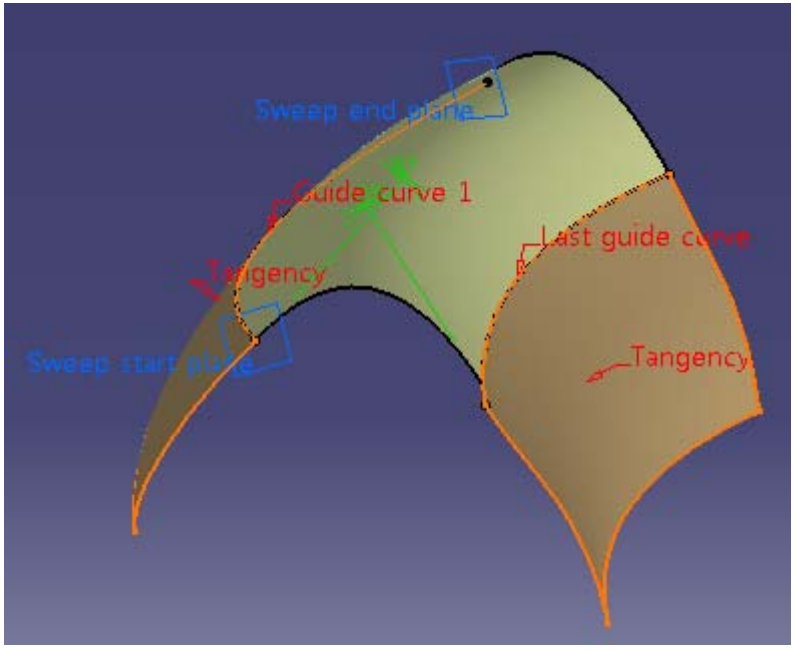

Sweeps 




Two guide curves

- 두 개의 Guide Curve와 Surface를 이용하여 생성



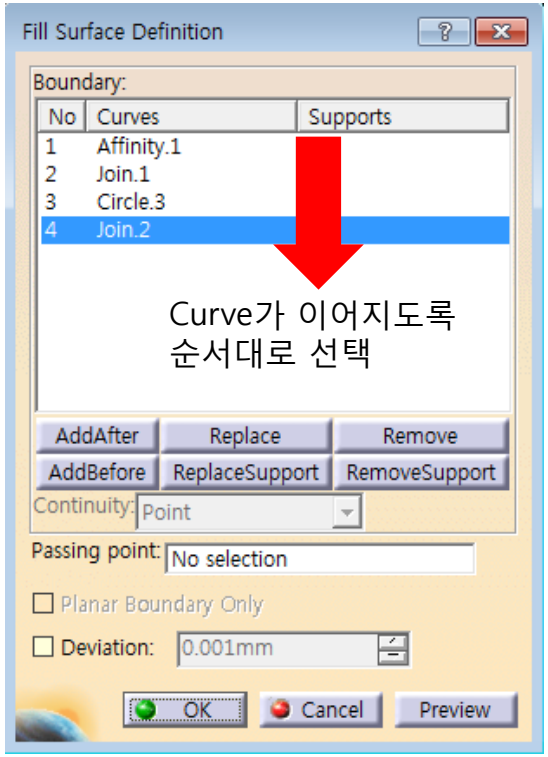



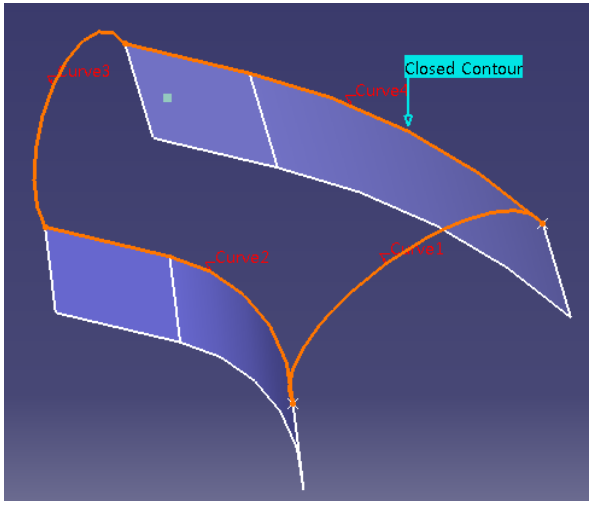
# GENERATIVE SHAPE DESIGN TOOL

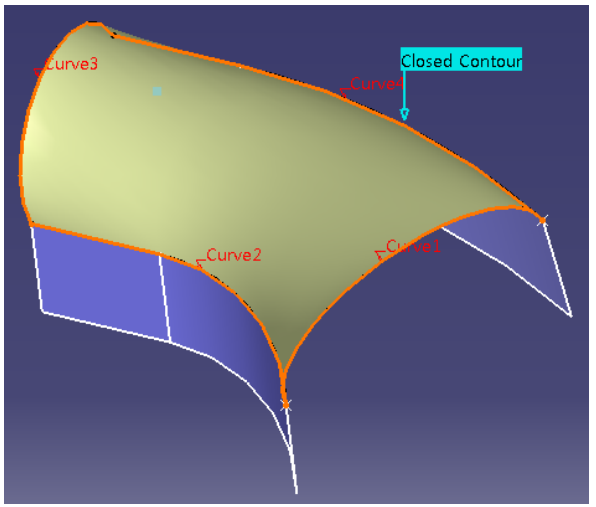
Surfaces


Fill 

- Curve로 이루어진 닫힌 형상을 Surface로 채워줌



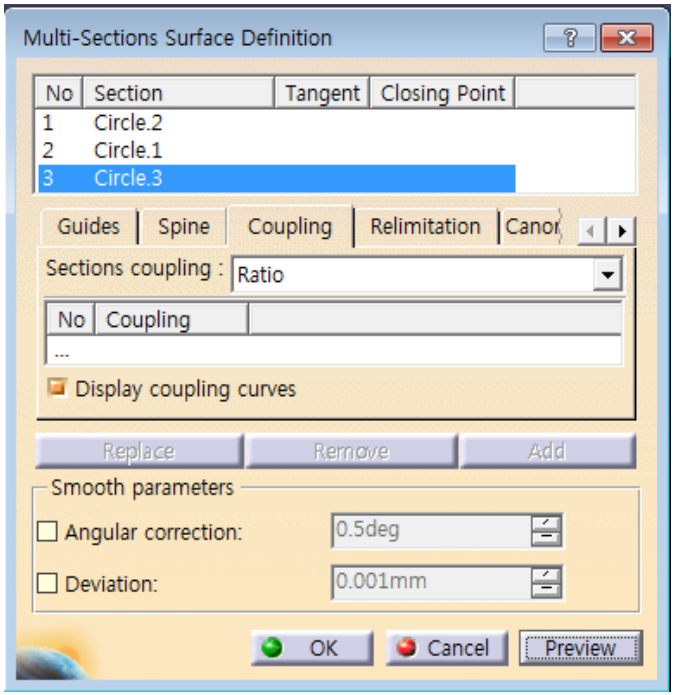



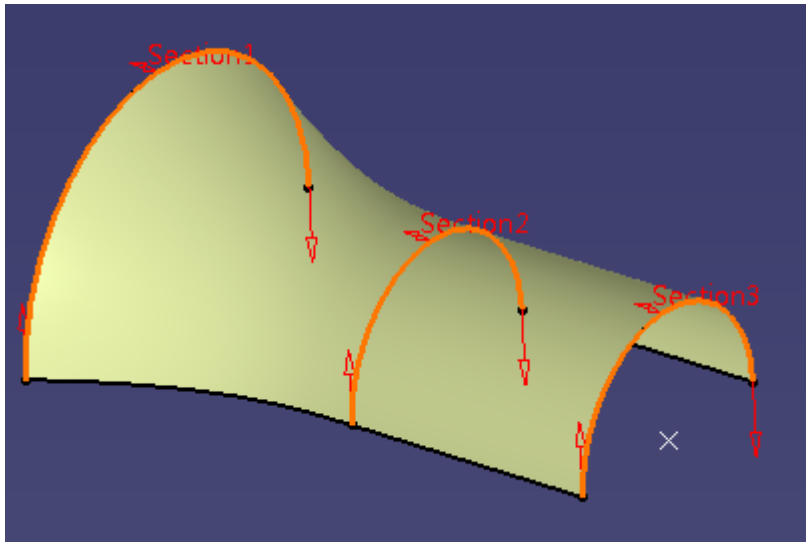
# GENERATIVE SHAPE DESIGN TOOL

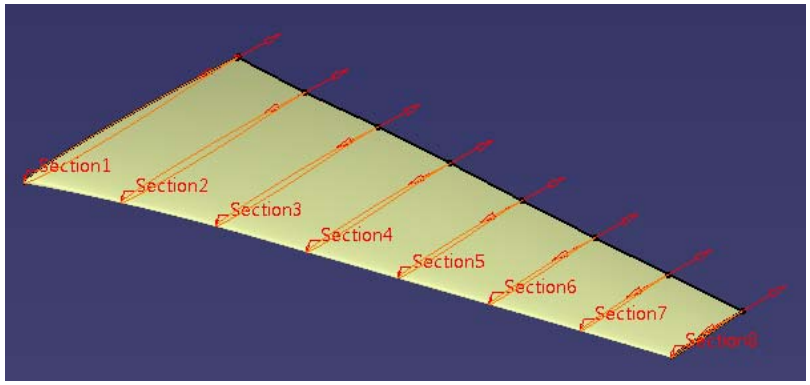
Surfaces


## Multi-Sections Surface

- 여러 개의 단면 profile을 연결한 surface 생성



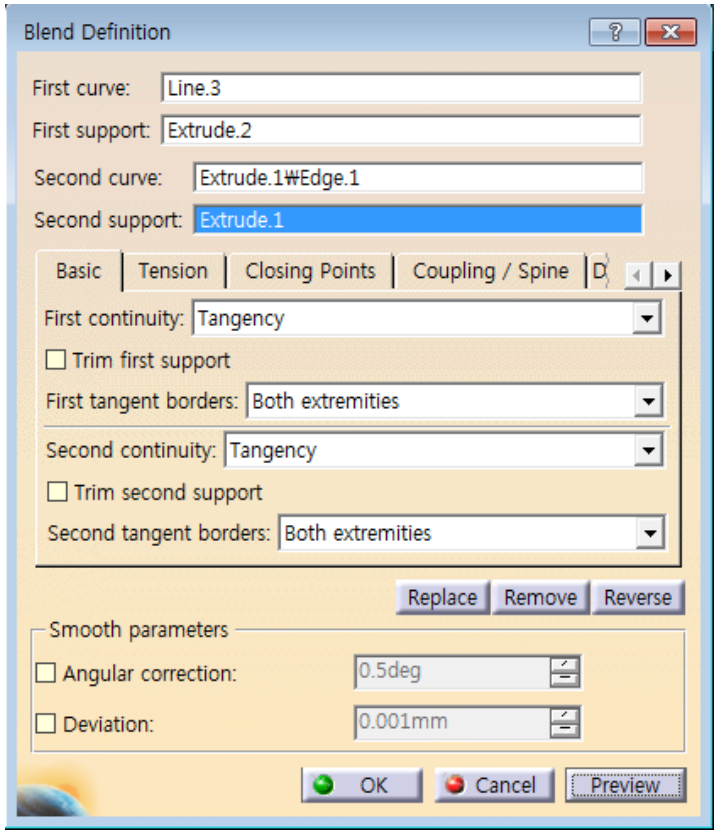



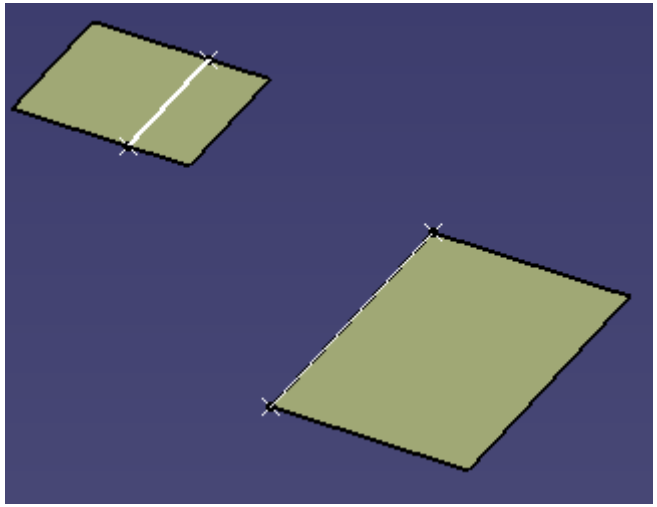
# GENERATIVE SHAPE DESIGN TOOL

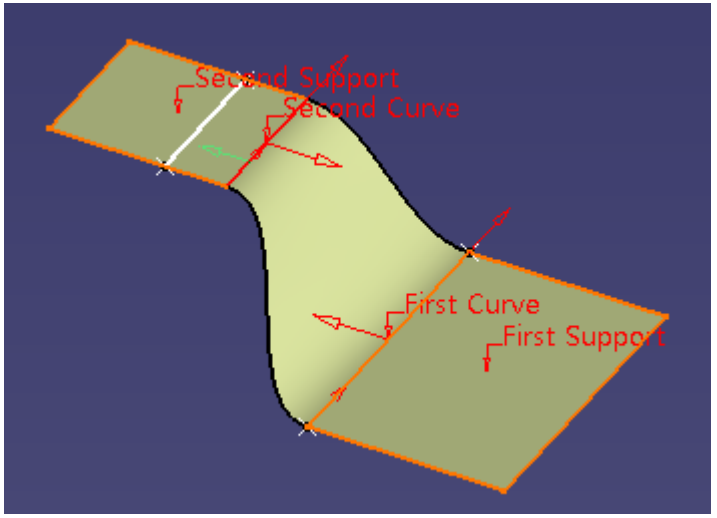
Surfaces


Blends 

- Curve와 Curve의 사이를 연결하는 Surface 생성

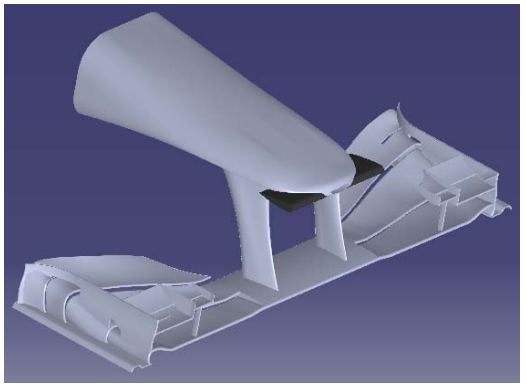


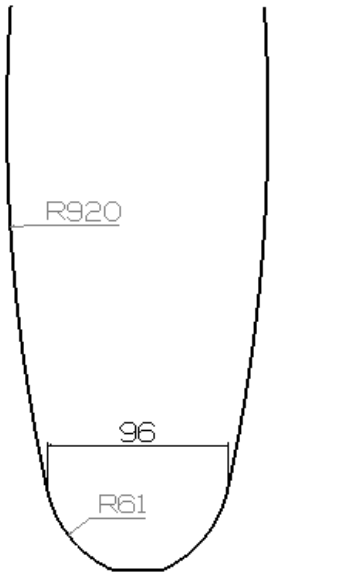





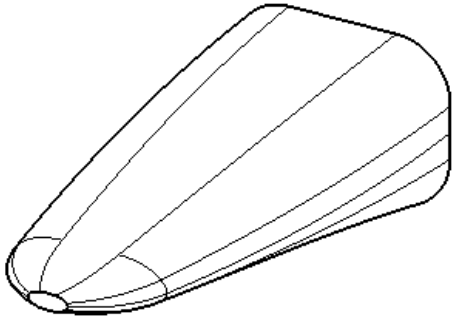
# 실습 예제

- Multi-sections surface 기능 사용

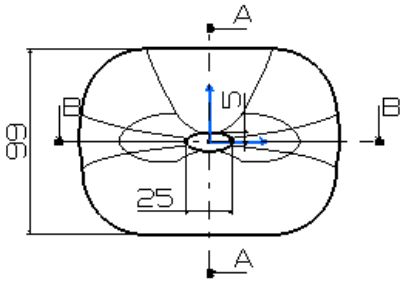





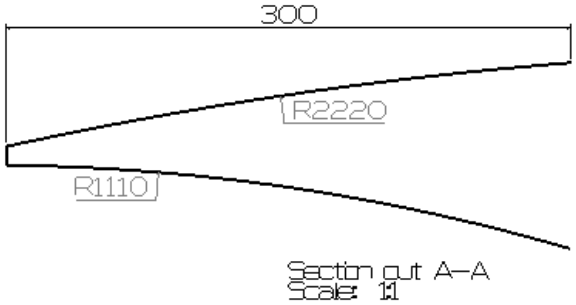

Section cut B–B
Scale: 1:1



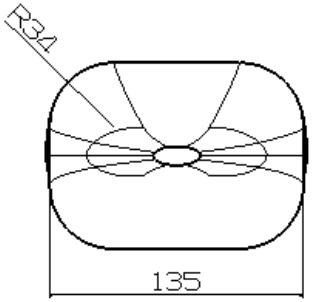
Isometric view
Scale: 1:1




Front view
Scale: 1:1




Section cut A–A
Scale: 1:1



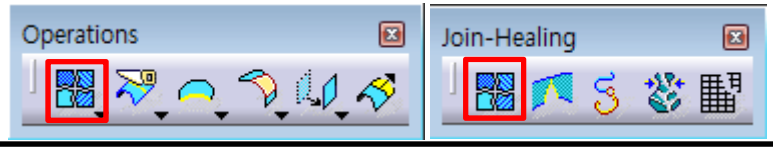

Rear view
Scale: 1:1

# CONTENTS

- ✓ 시작하기
- ✓ Wireframe
- ✓ Surfaces
- ✓ **Operation**

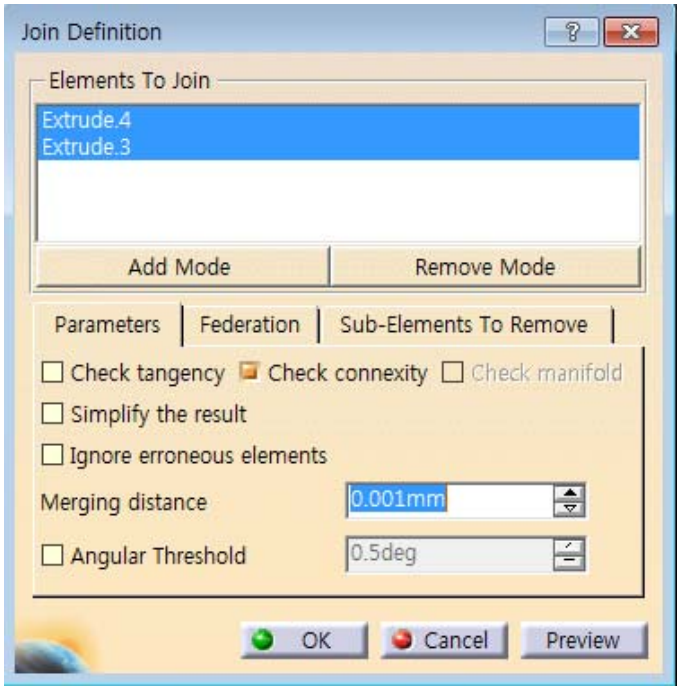
# GENERATIVE SHAPE DESIGN TOOL

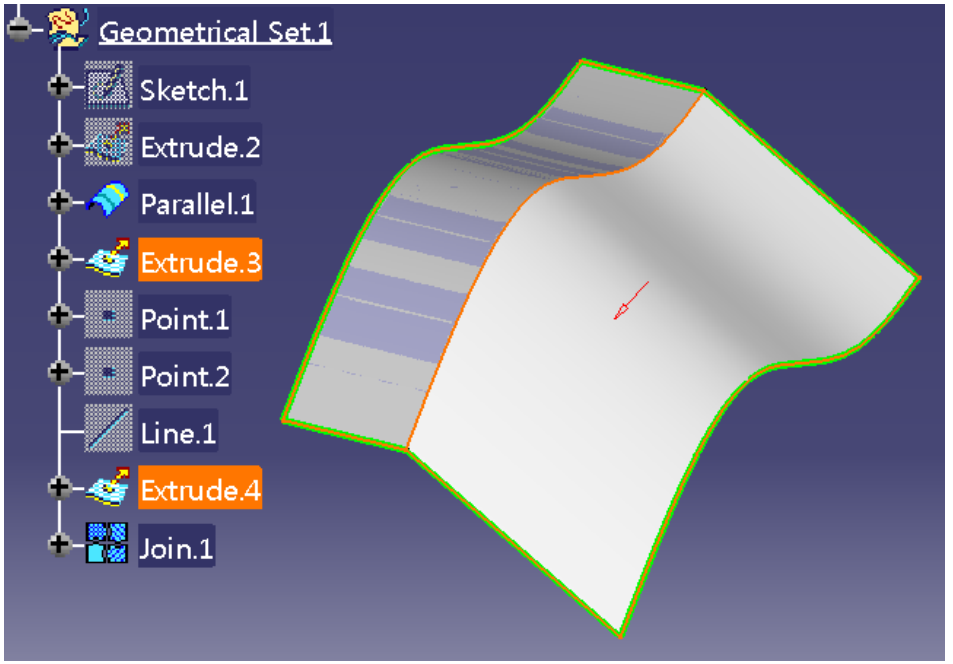
Operations




Join 

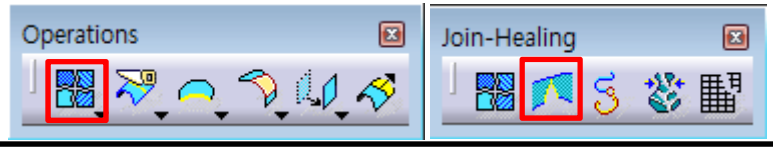
- 여러 개의 Surface/Curve들을 하나로 묶는 기능



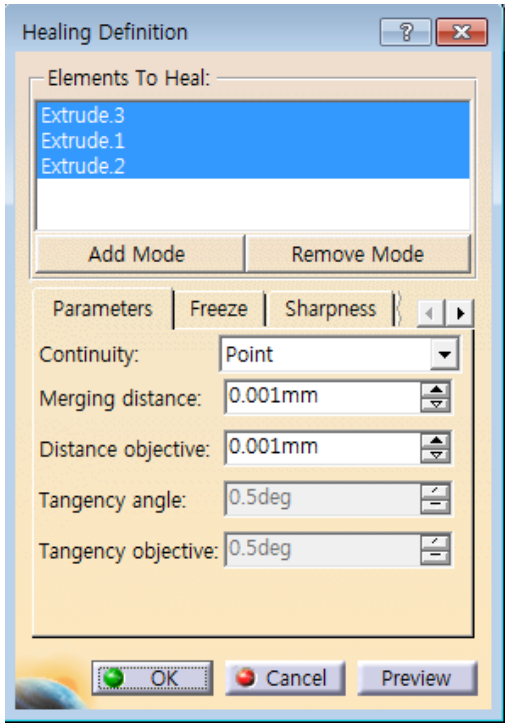
# GENERATIVE SHAPE DESIGN TOOL

Operations

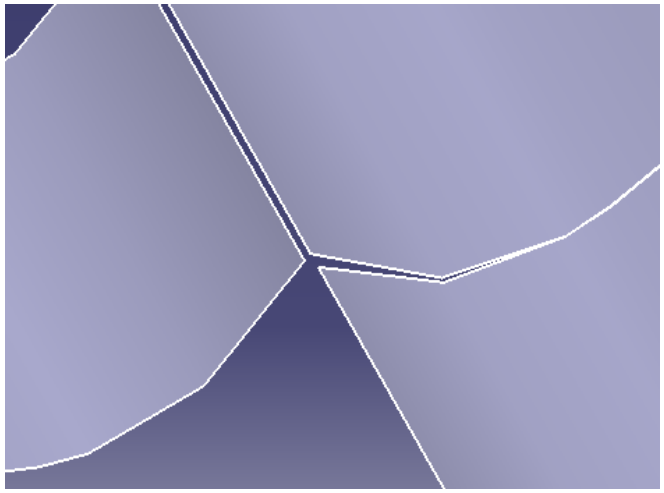


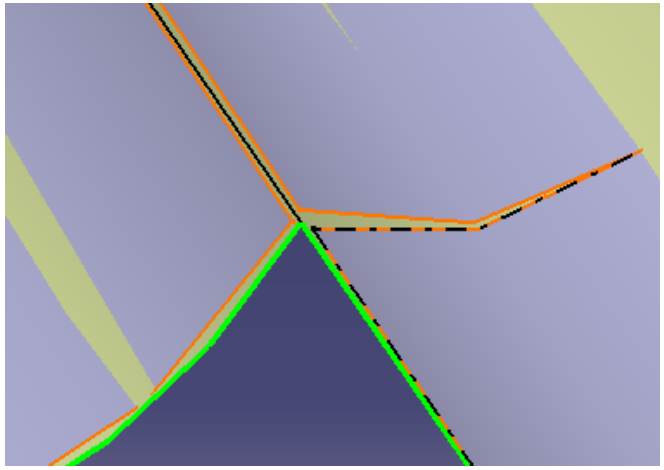

Healing 

- 여러 개의 Surface를 하나로 묶고
  큰 공차를 가진 부분을 연결함



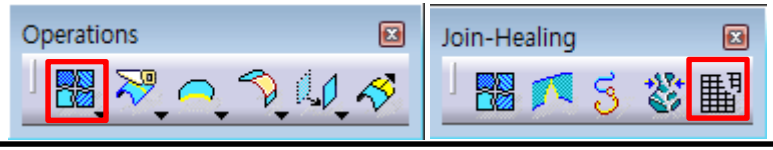

Distance objective : Merging distance의 허용오차





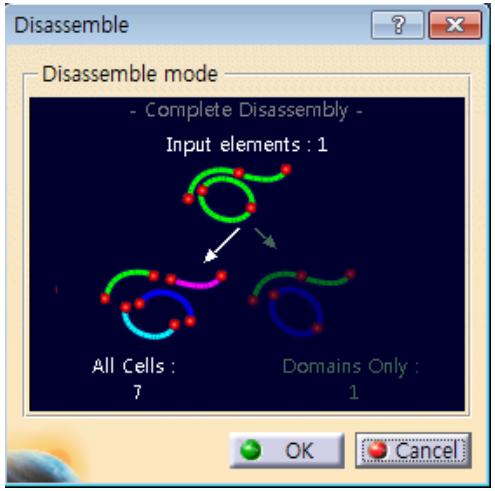
# GENERATIVE SHAPE DESIGN TOOL

Operations

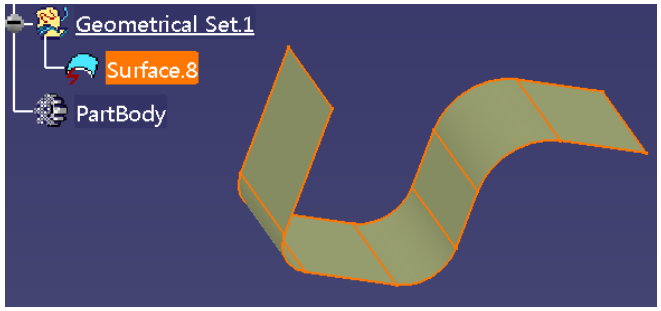


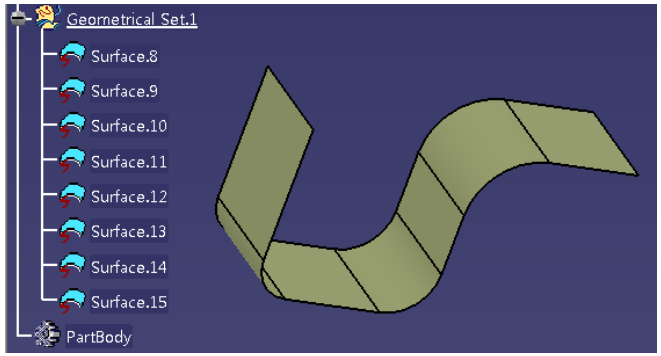

Disassemble

- 여러 개의 sub element로 이루어진 Surface나 Curve를 분해함

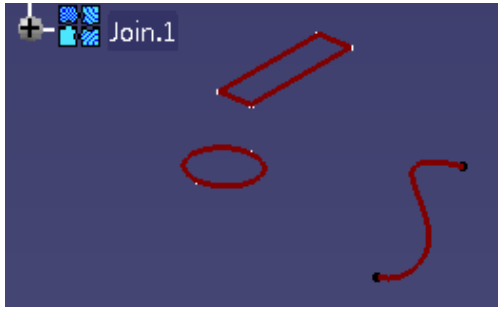


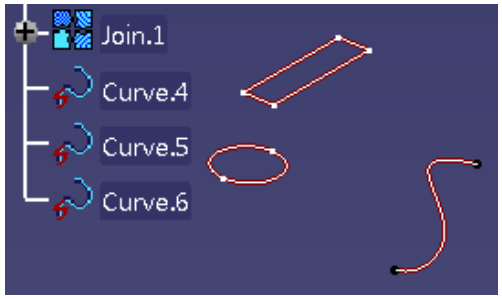

Surface



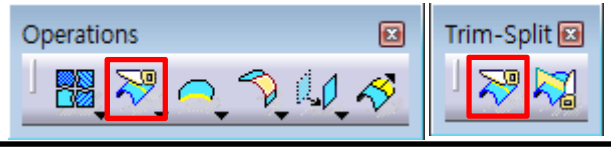

Wireframe



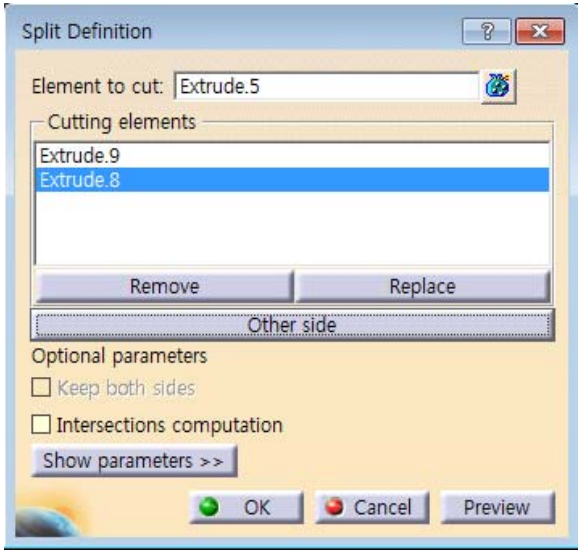
# GENERATIVE SHAPE DESIGN TOOL

## Operations

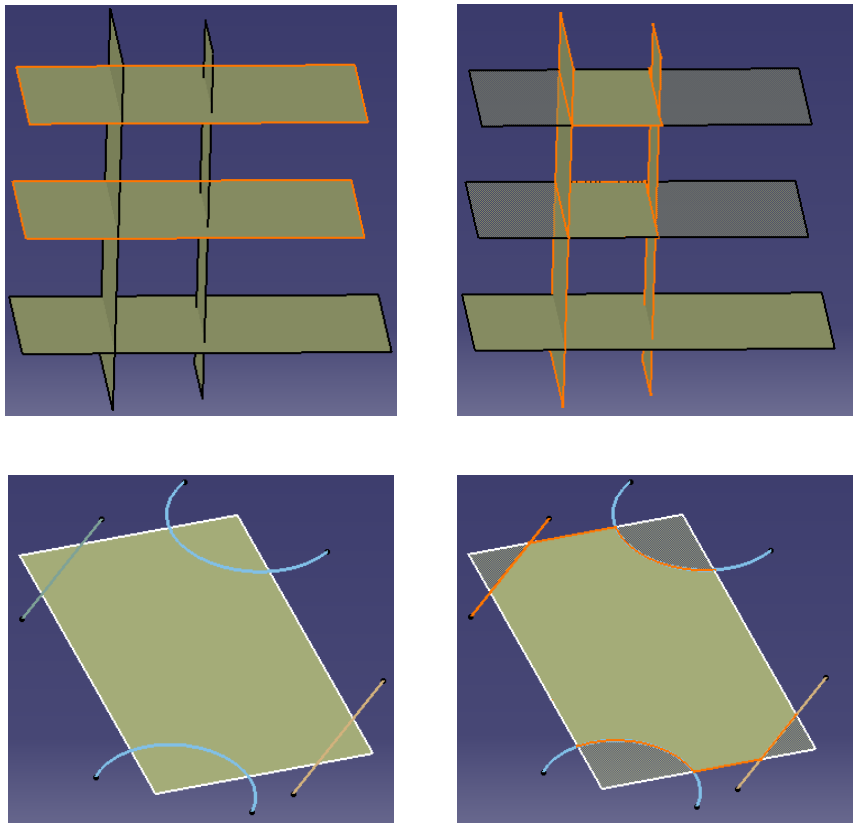



### Split

- Surface/Curve 형상을 임의의 요소를 기준으로 절단함




Keep both sides: Split으로 제거되는 요소도 남김

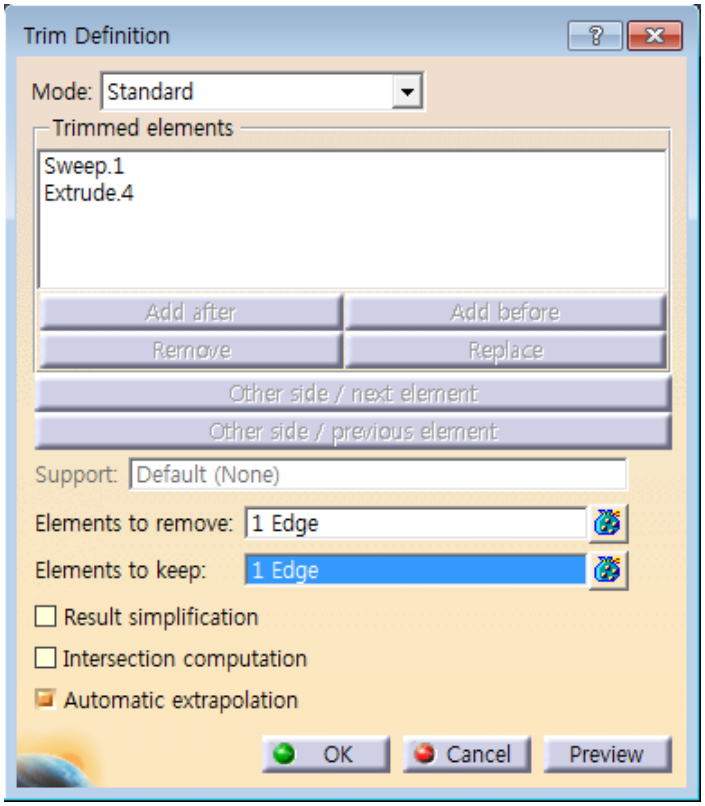


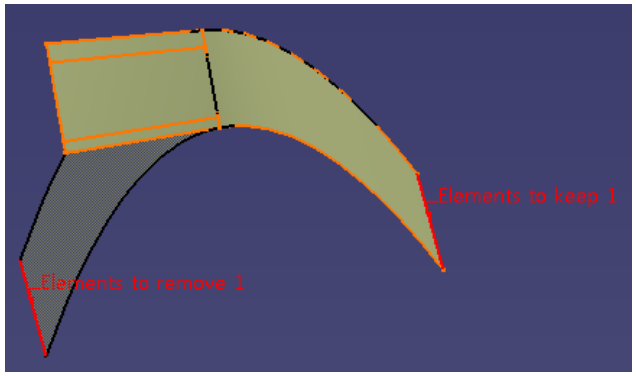
# GENERATIVE SHAPE DESIGN TOOL

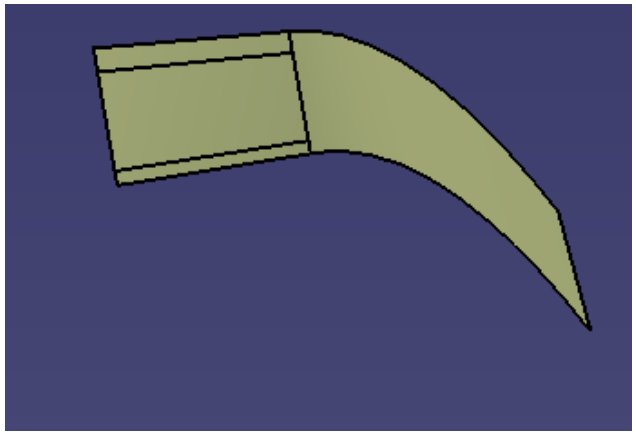
Operations


Trim 

- Surface/Curve 형상을 임의의 요소를 기준으로 Trim을 진행함

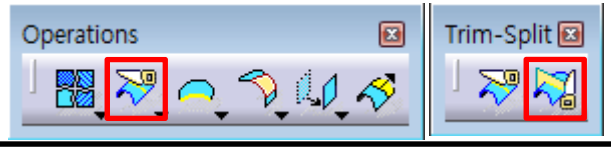


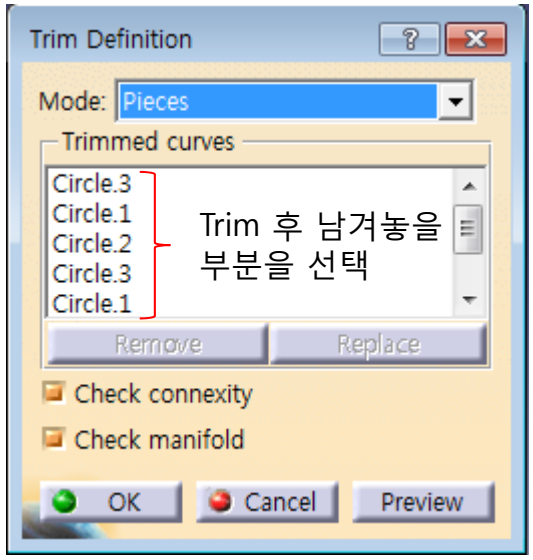
# GENERATIVE SHAPE DESIGN TOOL

## Operations

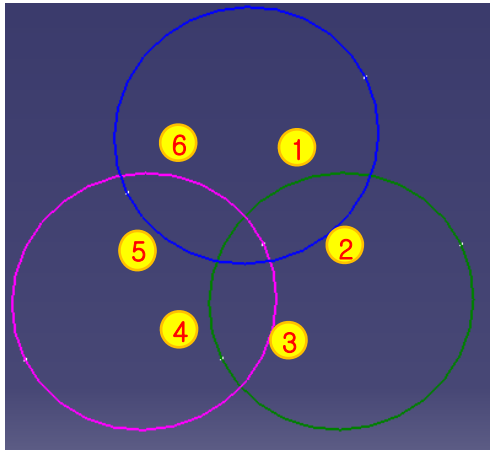


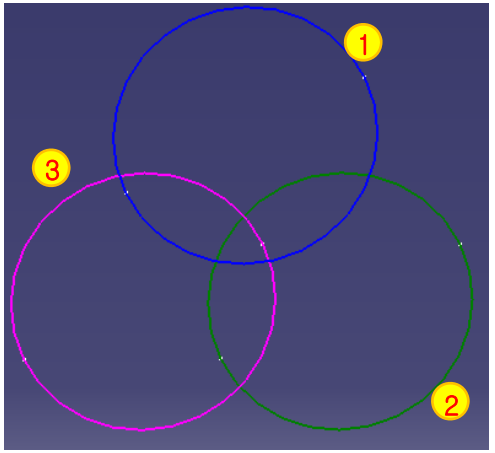

### Trim

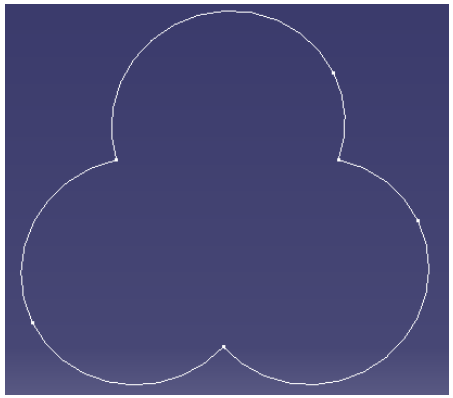
- Surface/Curve 형상을 임의의 요소를 기준으로 Trim을 진행함




Pieces Mode : Curve 요소에만 적용 가능

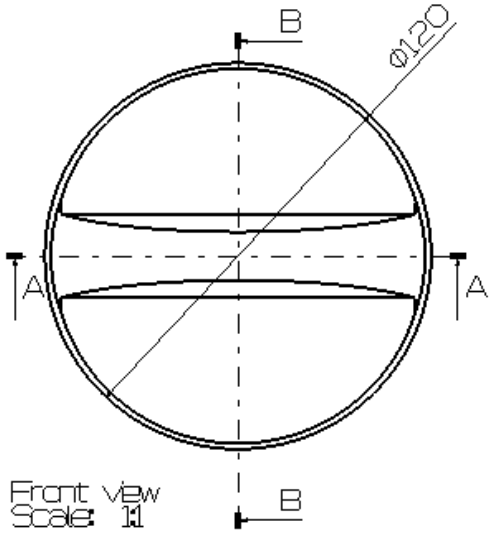


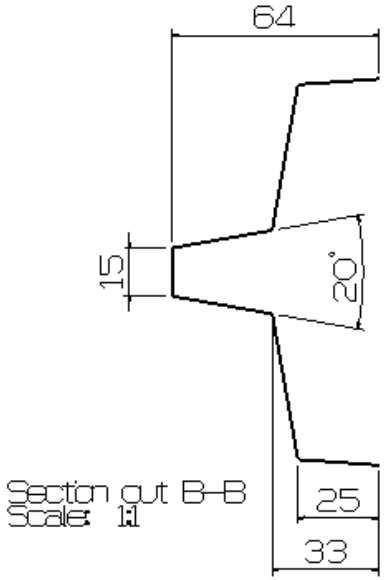



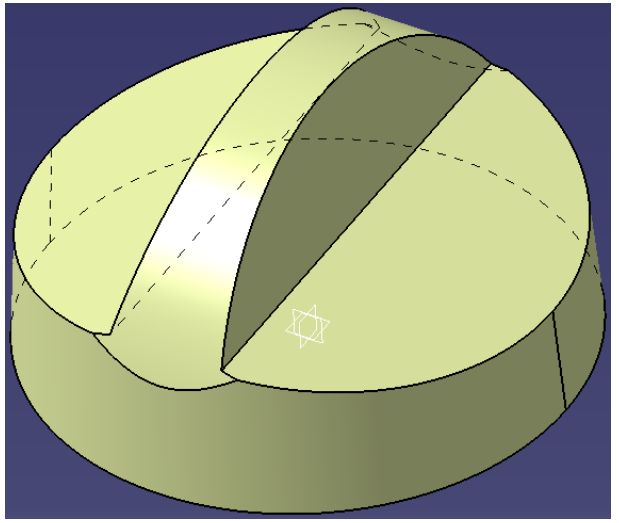



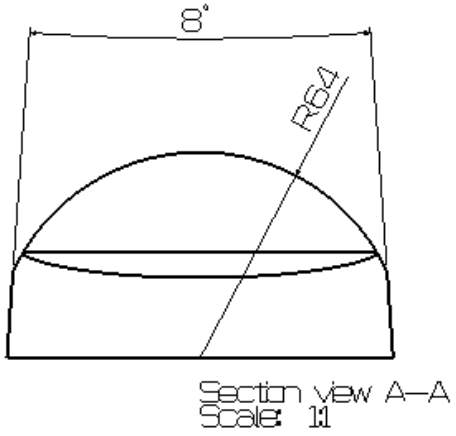
# 실습 예제

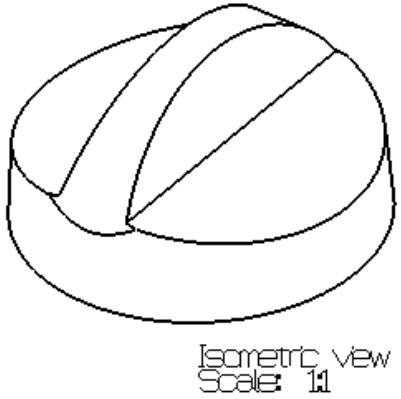
Generative Shape Design을 이용하여 모델링



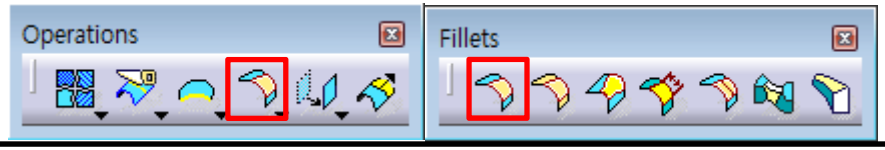





# GENERATIVE SHAPE DESIGN TOOL

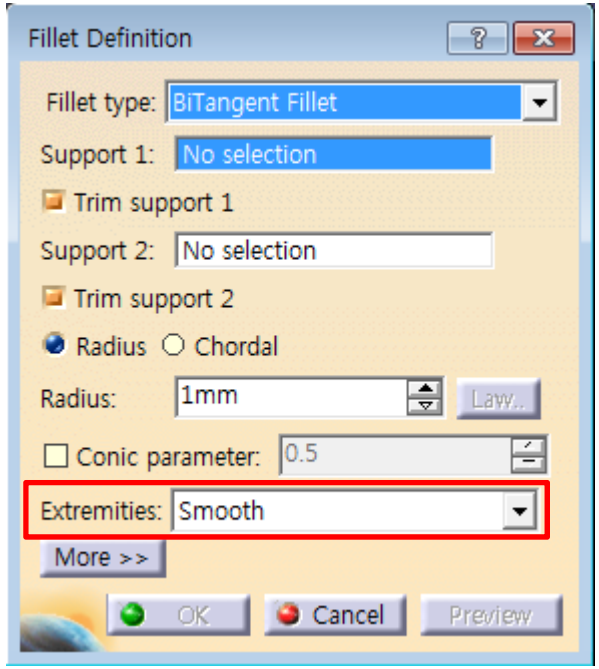
Operations



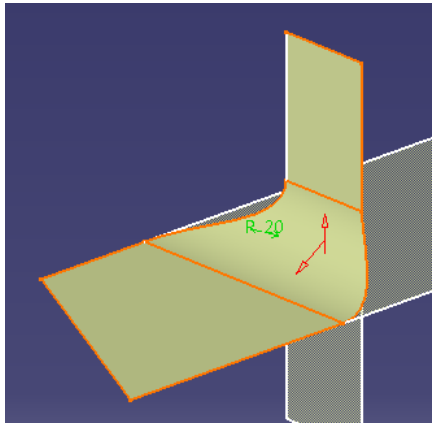

Shape Fillet

- Surface 사이에 Fillet을 부여함

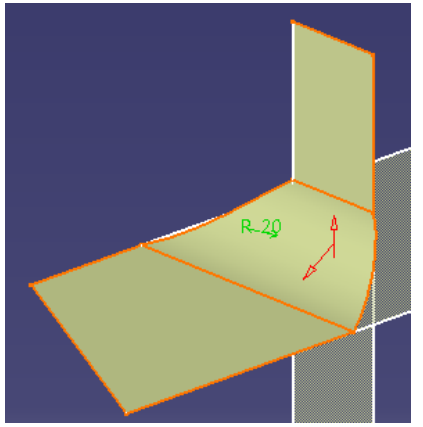
<BiTangent Fillet>



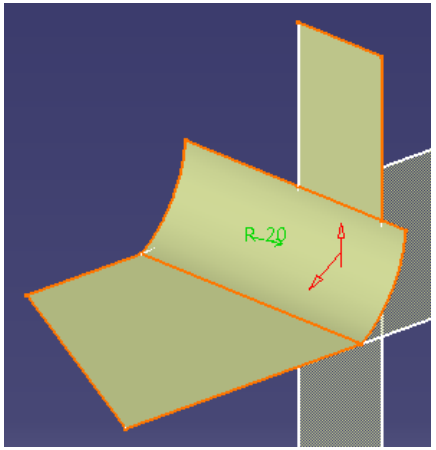

Smooth



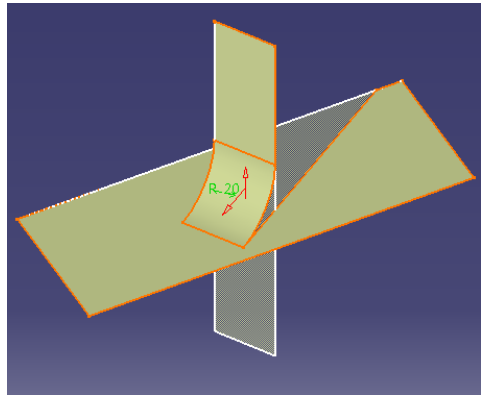

Straight




Maximum

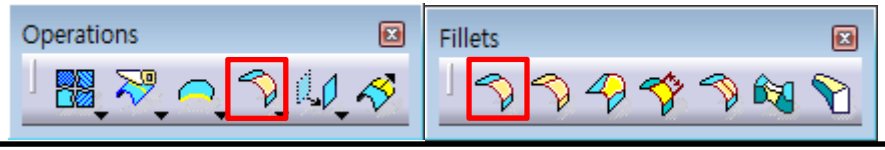



Minimum



# GENERATIVE SHAPE DESIGN TOOL

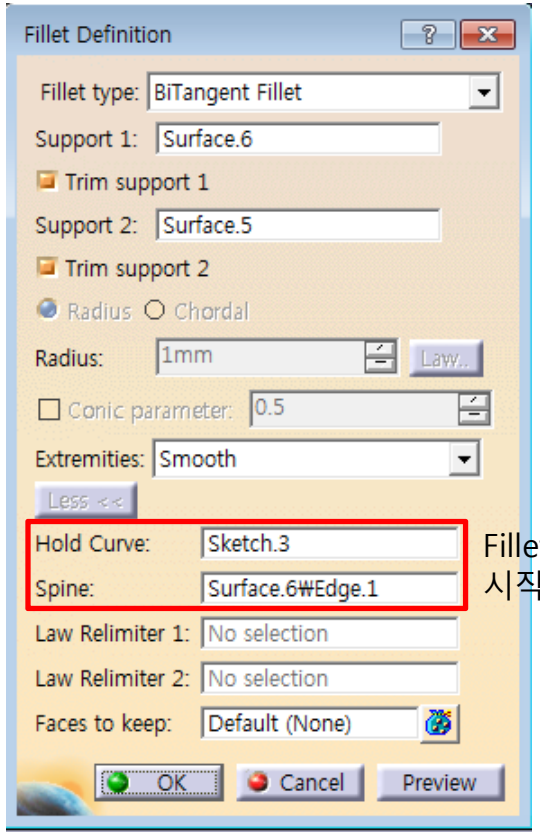
Operations



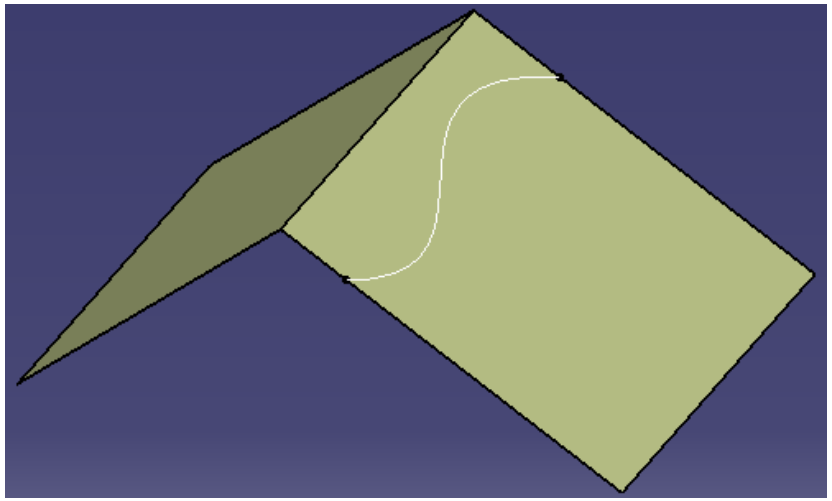

Shape Fillet

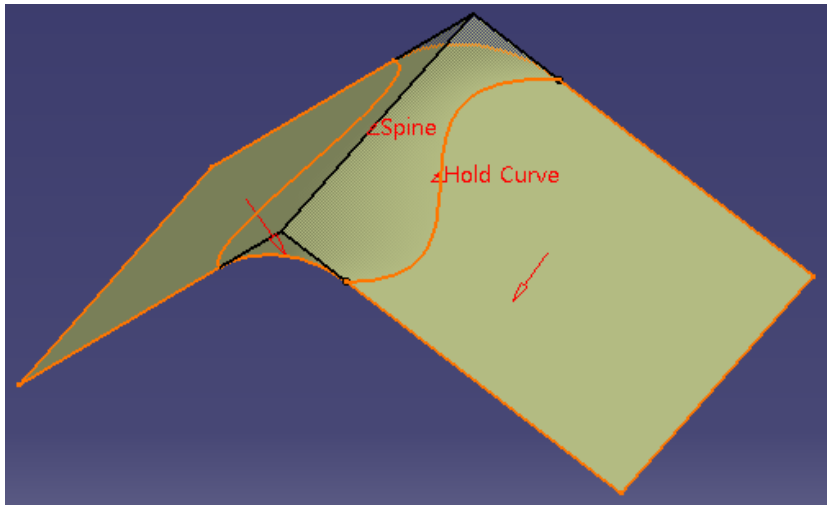
- Surface 사이에 Fillet을 부여함

<BiTangent Fillet>



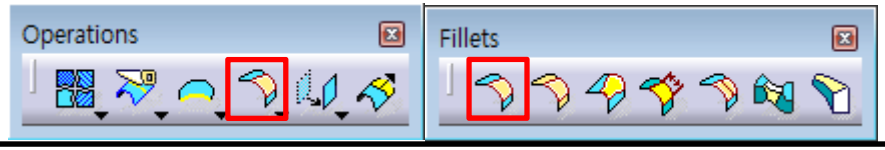

Fillet이 적용되는 시작부분을 정의





# GENERATIVE SHAPE DESIGN TOOL

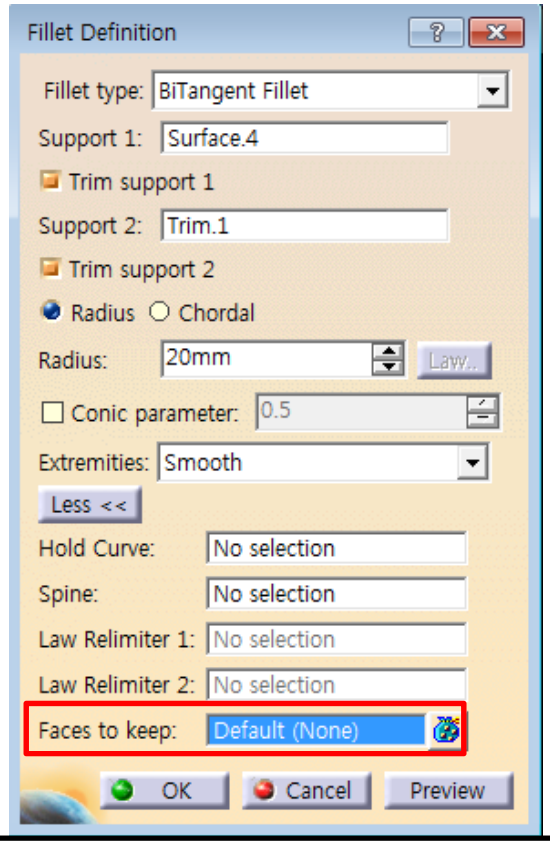
Operations

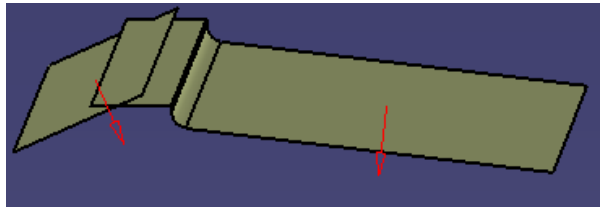


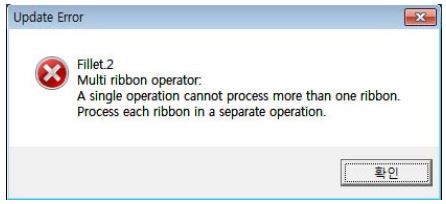

Shape Fillet

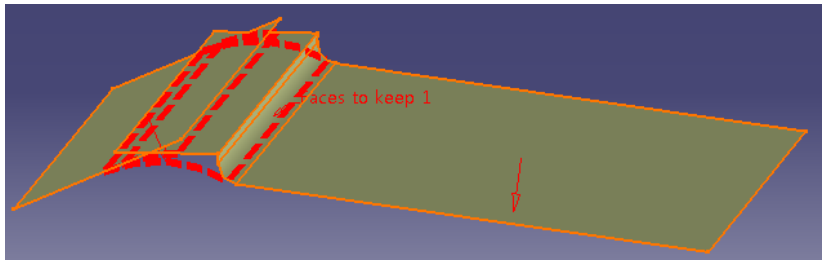
- Surface 사이에 Fillet을 부여함

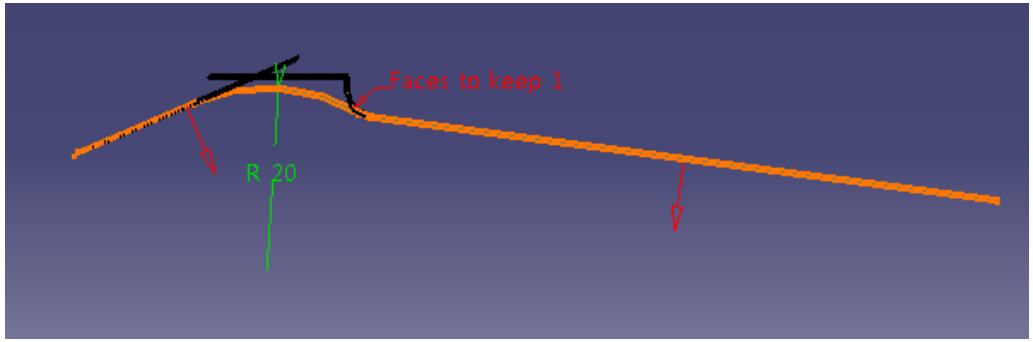
<BiTangent Fillet>



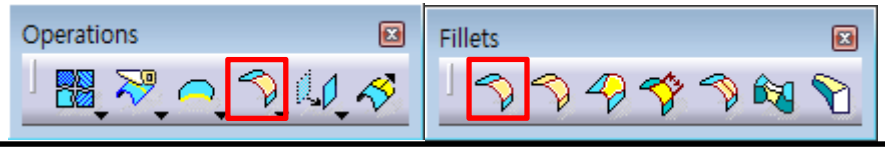


# GENERATIVE SHAPE DESIGN TOOL

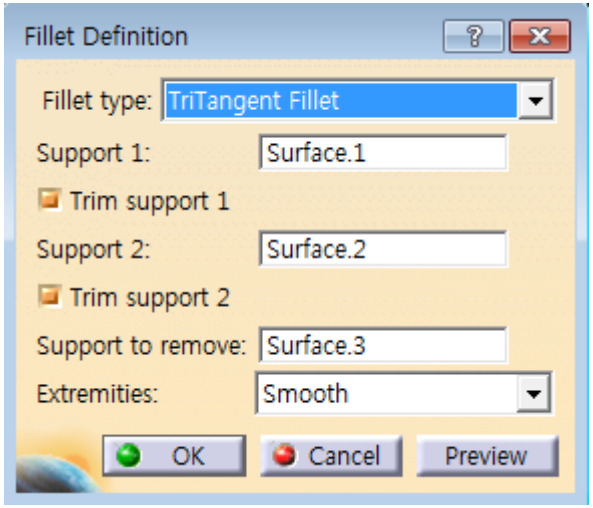
Operations



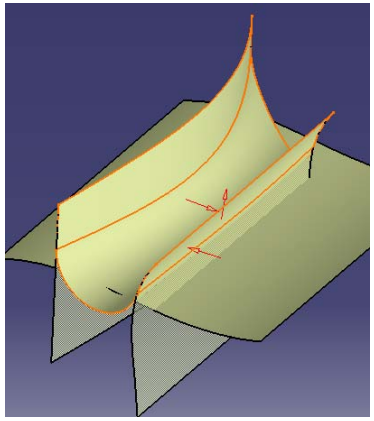

Shape Fillet 

- Surface 사이에 Fillet을 부여함

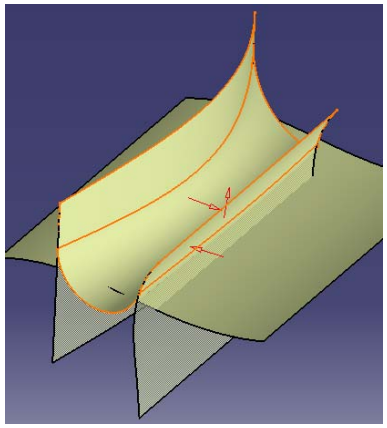
<TriTangent Fillet>



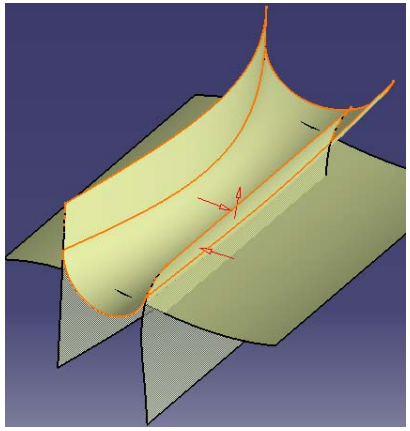

Smooth



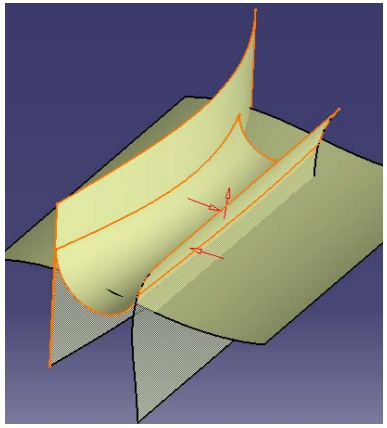
Straight



Maximum

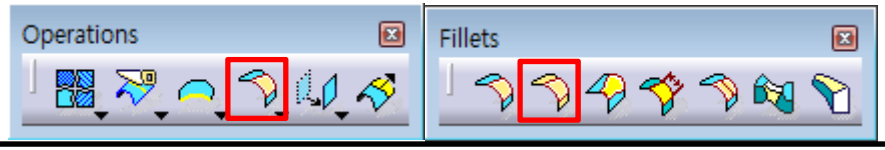


Minimum



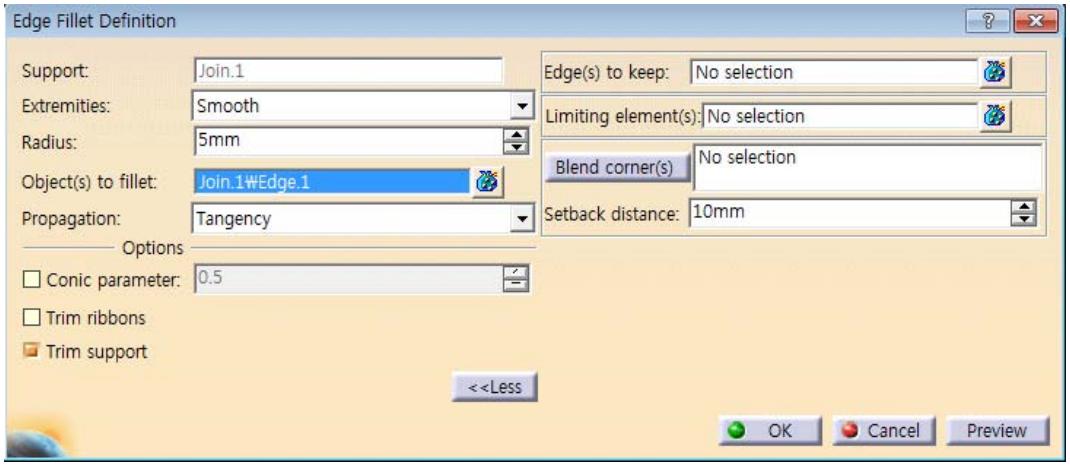
# GENERATIVE SHAPE DESIGN TOOL

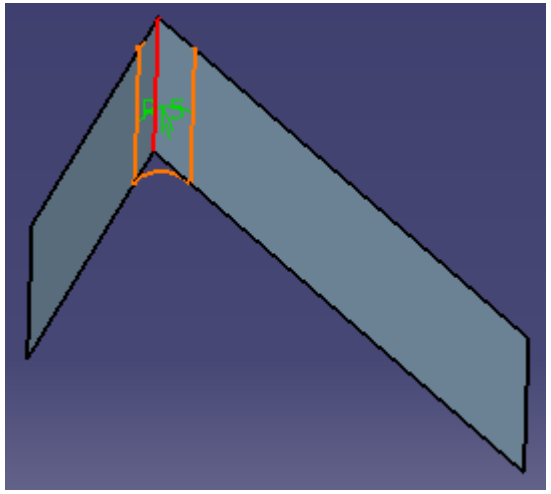
Operations




## Edge Fillet

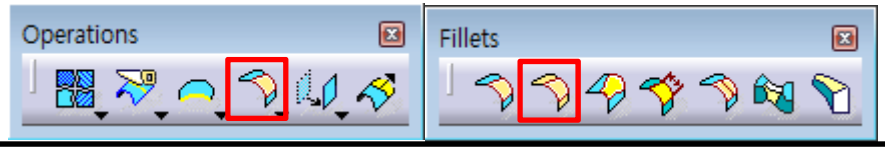
- Join된 Surface와 같이 하나의 Surface 상의 모서리에 Fillet을 부여함



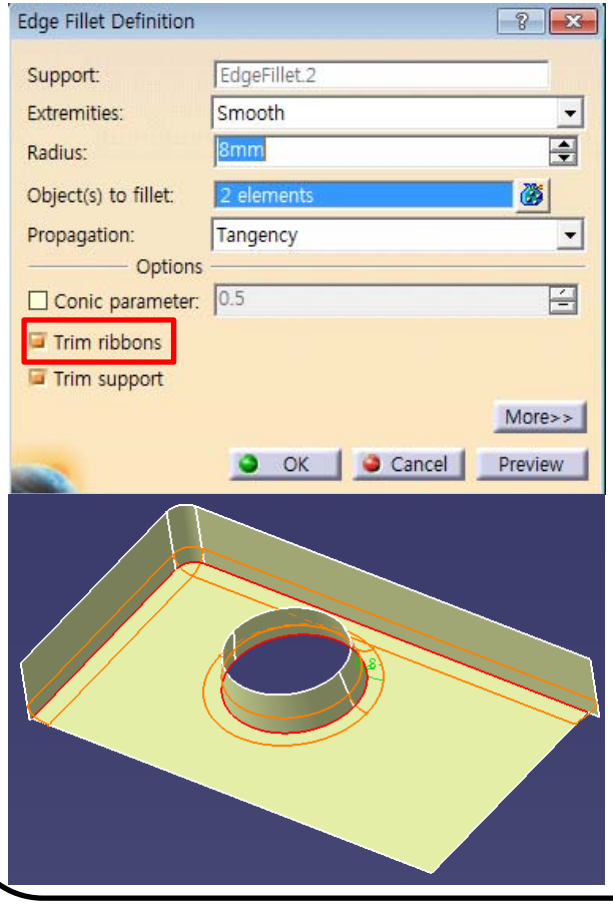
# GENERATIVE SHAPE DESIGN TOOL

Operations

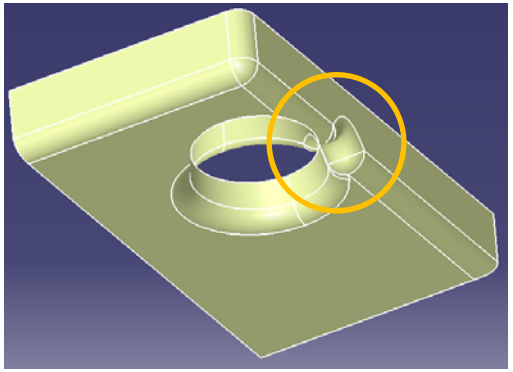



## Edge Fillet

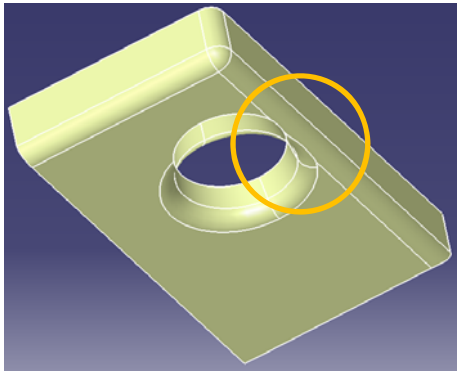
- Trim ribbons: Fillet이 겹치는 부분의 꼬임 형상을 방지

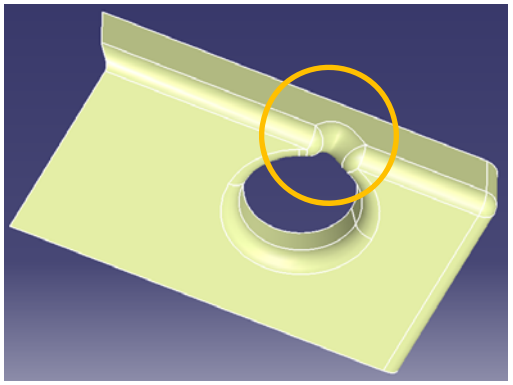


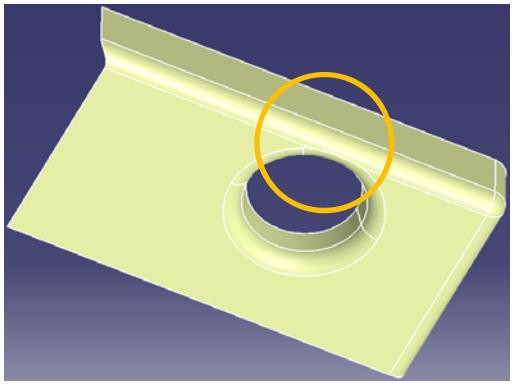

No Trim ribbons



Trim ribbons

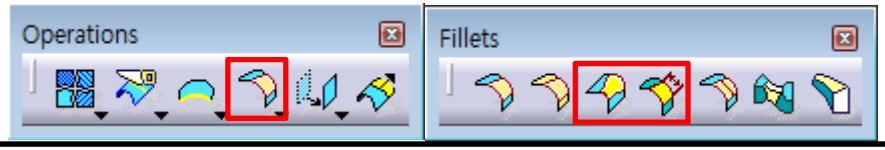






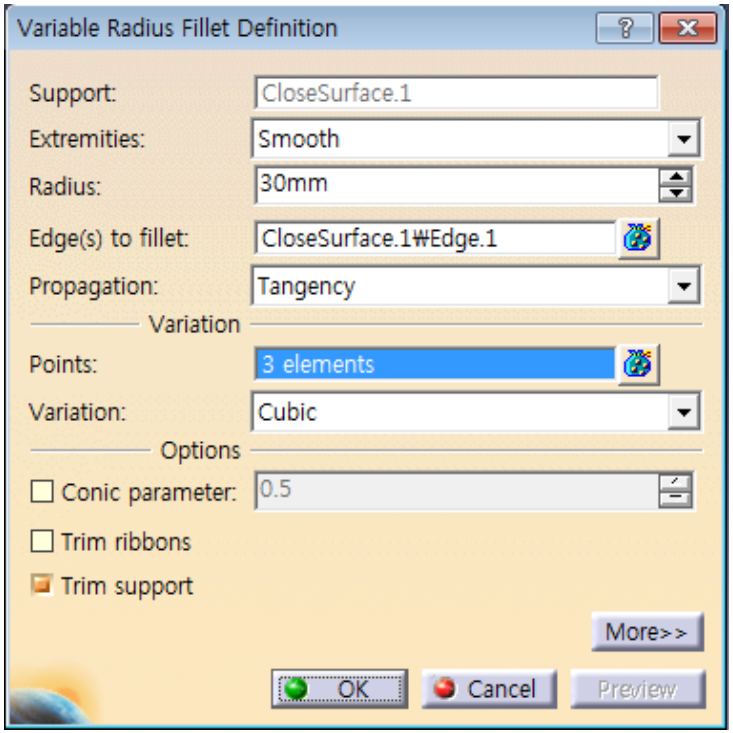
# GENERATIVE SHAPE DESIGN TOOL

Operations

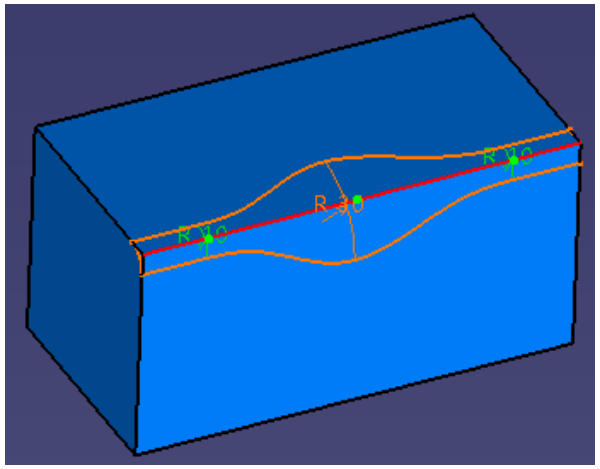



Variable Fillet / Chordal Fillet

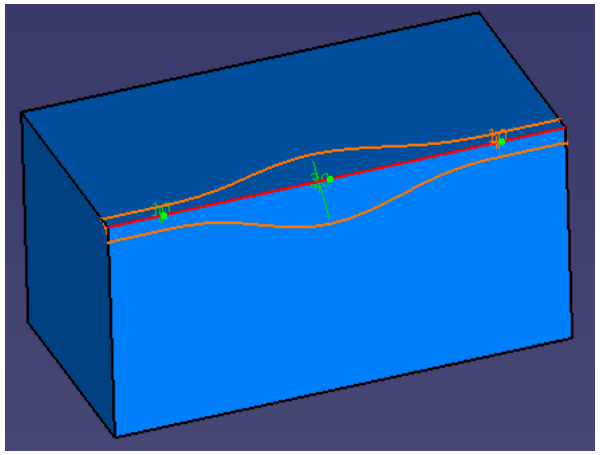
- 여러 개의 곡률/길이 값을 이용하여 Fillet 생성




Variable Fillet

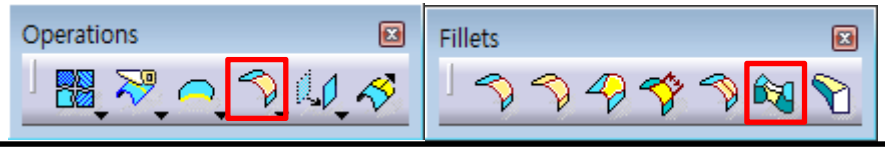


Chordal Fillet



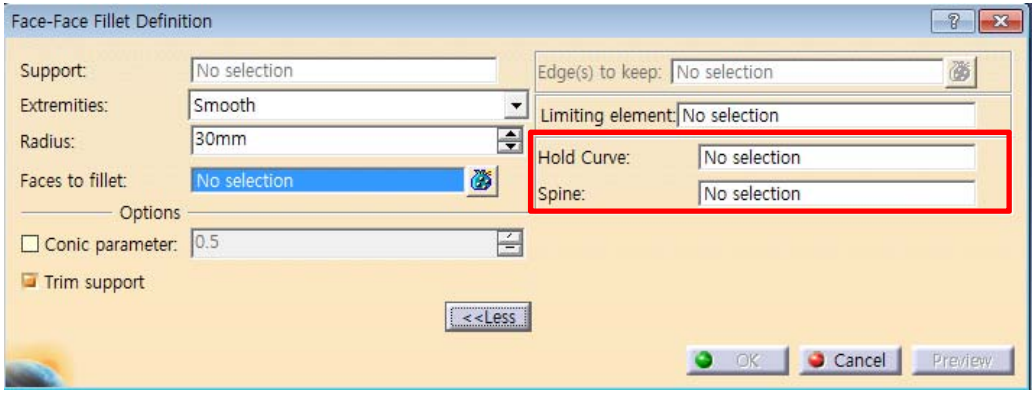
# GENERATIVE SHAPE DESIGN TOOL

Operations

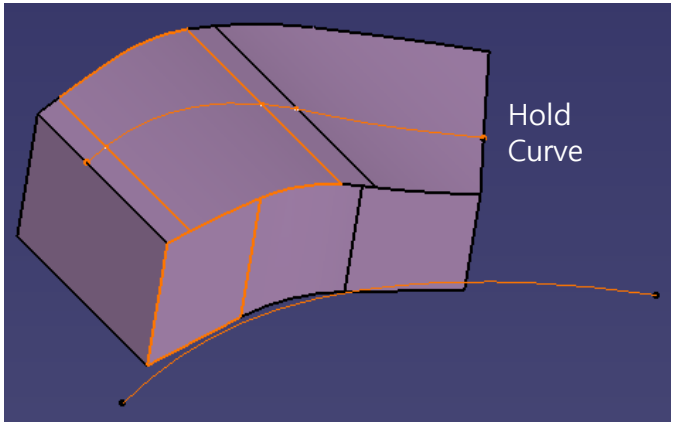



## Face-Face Fillet

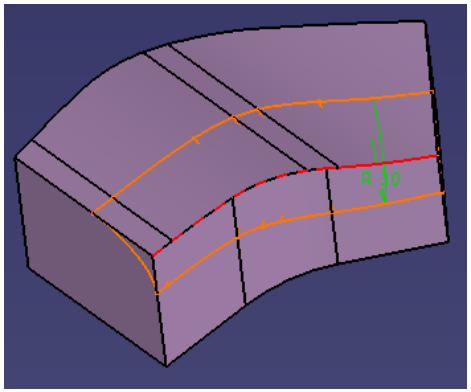
- 두 개의 Surface면과 Tangent하게 Fillet을 생성



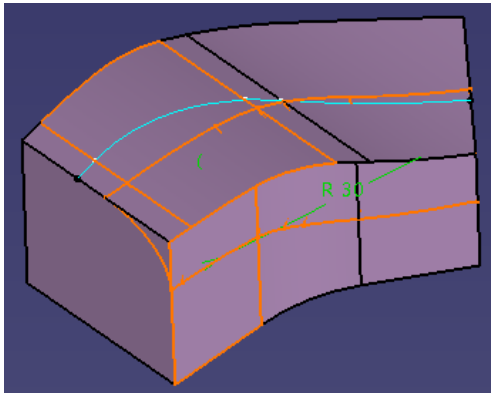

Hold Curve/Spine을 사용할 경우

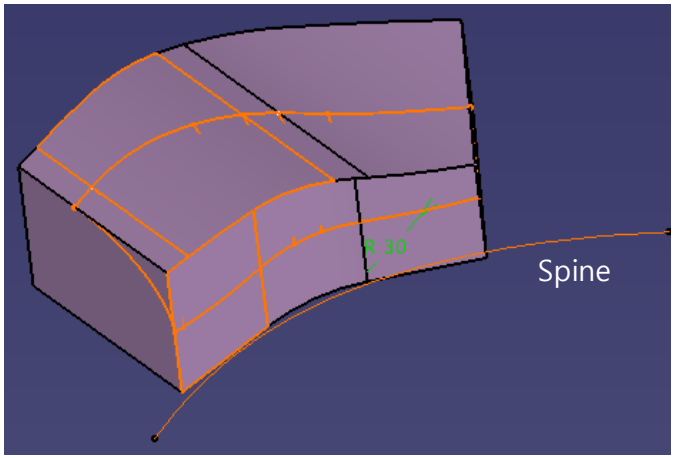



이전의 Edge Fillet을 사용할 경우



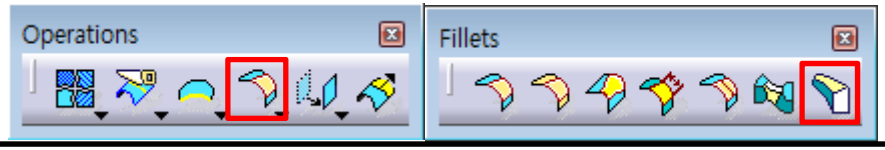

Face만 선택할 경우



# GENERATIVE SHAPE DESIGN TOOL

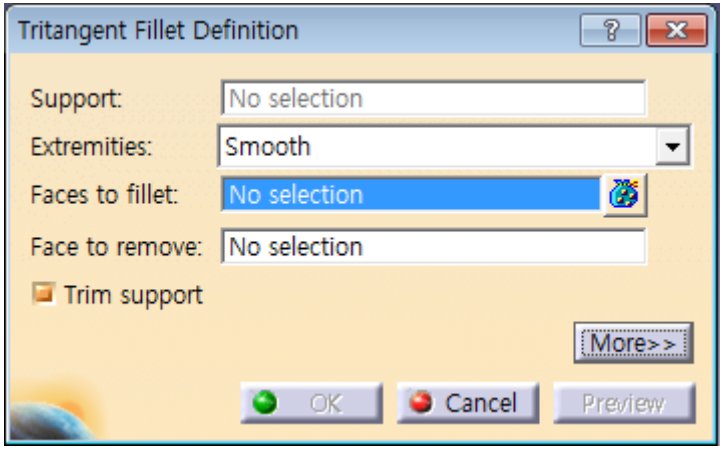
Operations

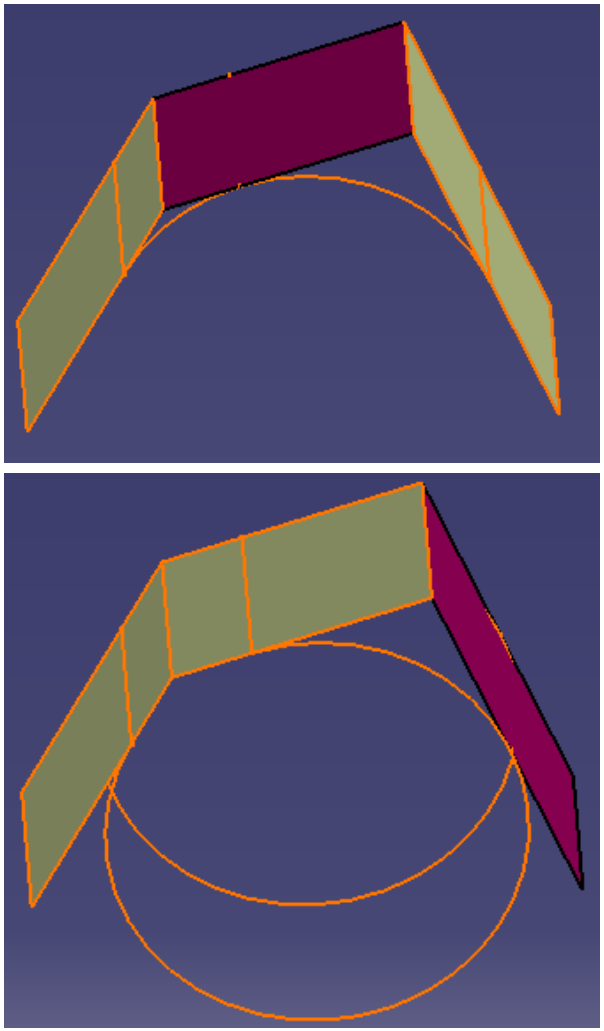



Tritangent Fillet 

- 세 개의 Surface면과 Tangent하게 Fillet을 생성

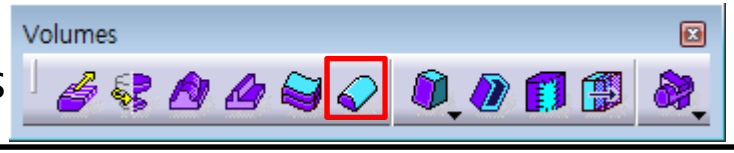
(세 개의 surface과 하나로 인식되는 경우에만 사용 가능.
독립적으로 떨어진 surface 간에는 사용 불가.)



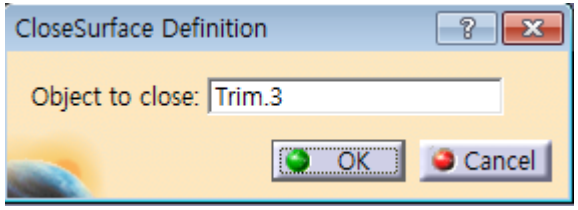
# GENERATIVE SHAPE DESIGN TOOL

Volumes

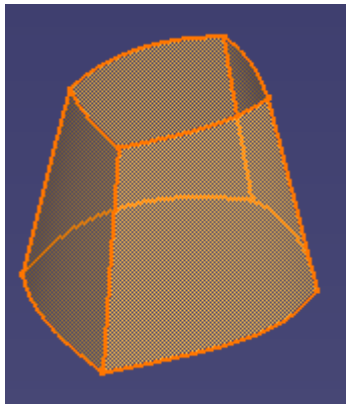



Close Surface 

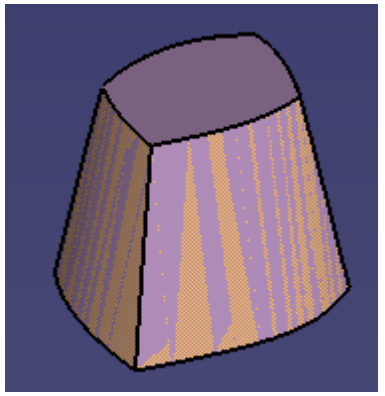
- 닫혀있는 구조의 Surface를 이용해 Volume을 생성




Open Surface



Volume

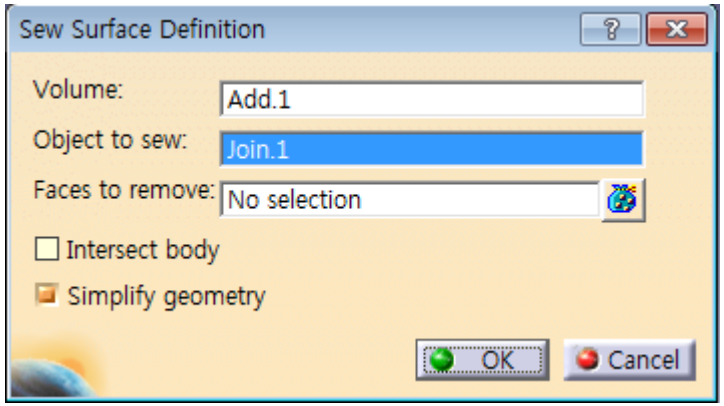


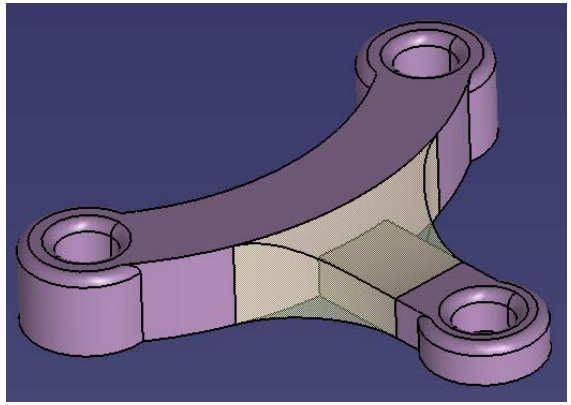
# GENERATIVE SHAPE DESIGN TOOL

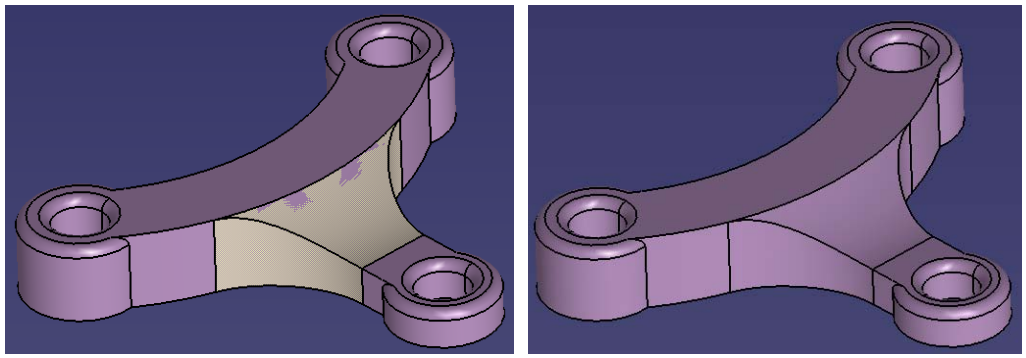
Volumes


Sew Surface 

- Volume과 연결된 닫힌 형태의 Surface 내부에 Volume을 생성





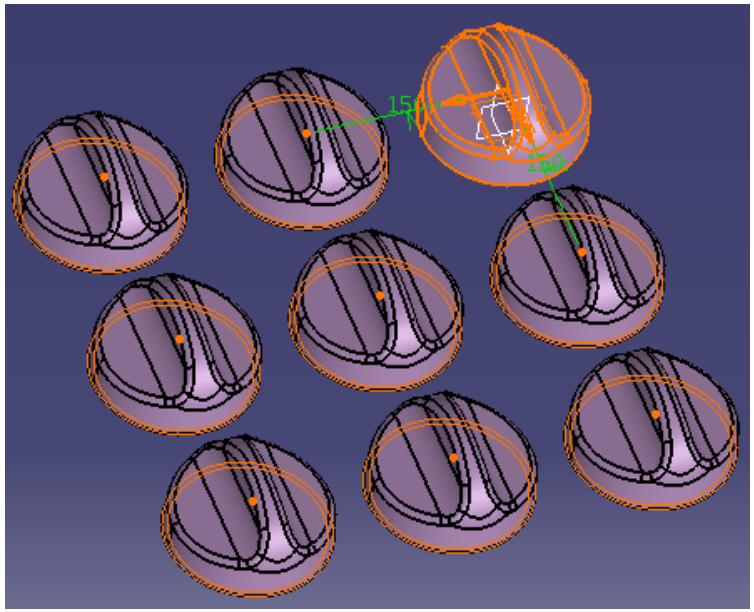
# GENERATIVE SHAPE DESIGN TOOL

## Replication

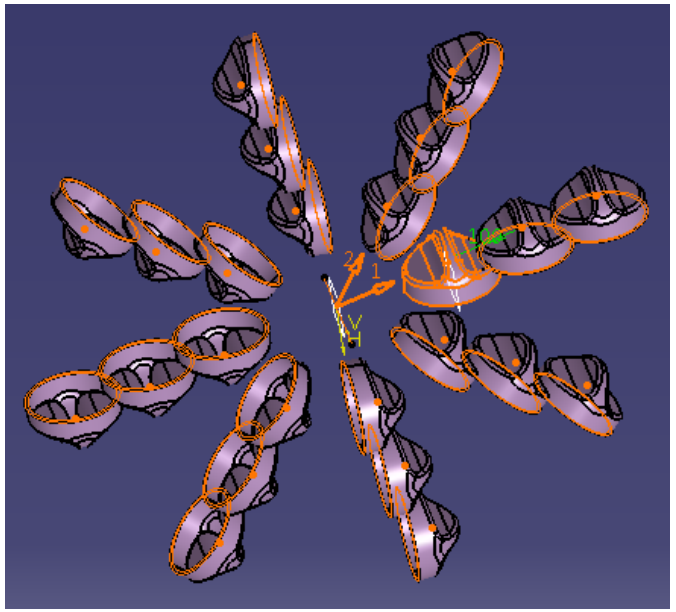

Patterns

- Part Design에서와 마찬가지로 반복되는 형상 생성을 도와줌

Rectangular Pattern

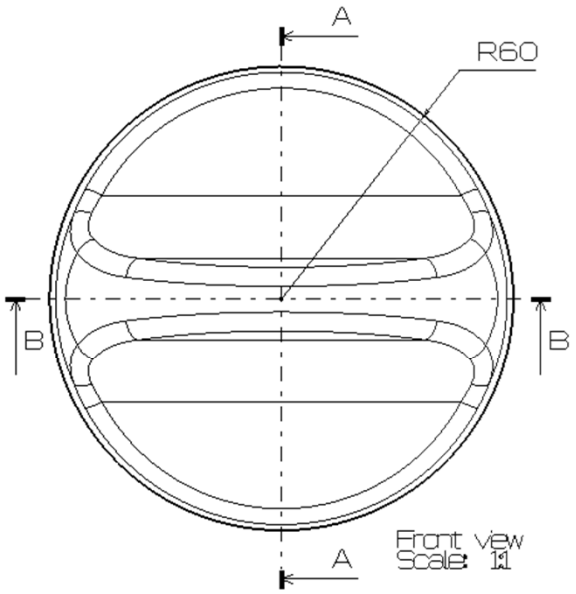


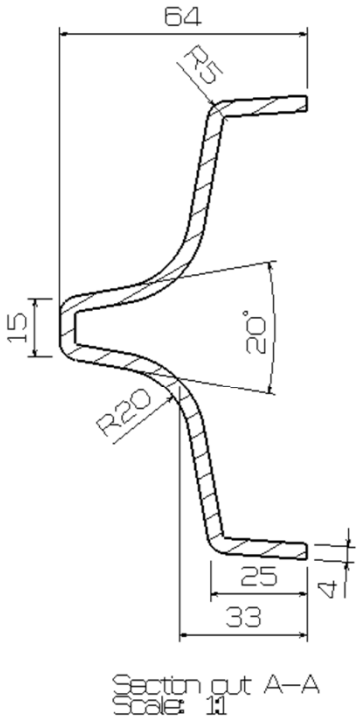
Circular Pattern

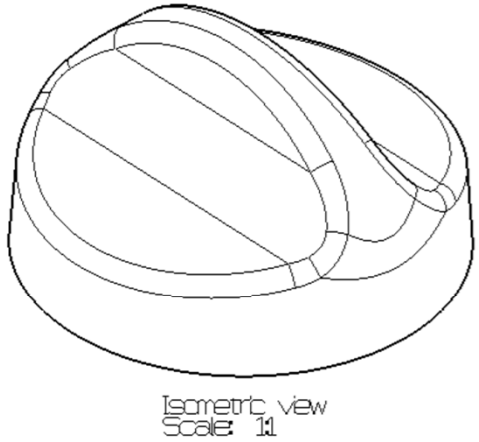


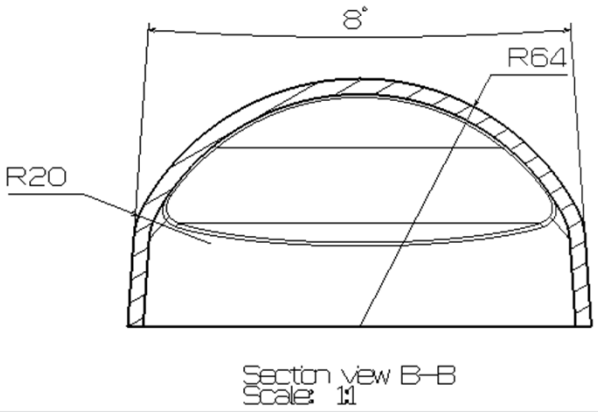
# 실습 예제

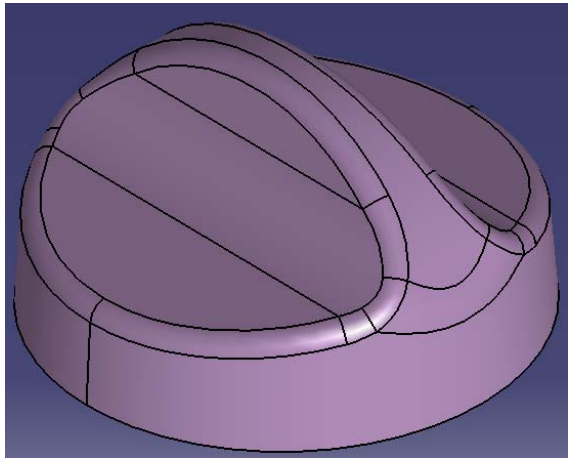
Generative Shape Design을 이용하여 모델링 (Volume툴은 Thick Surface 만 이용)



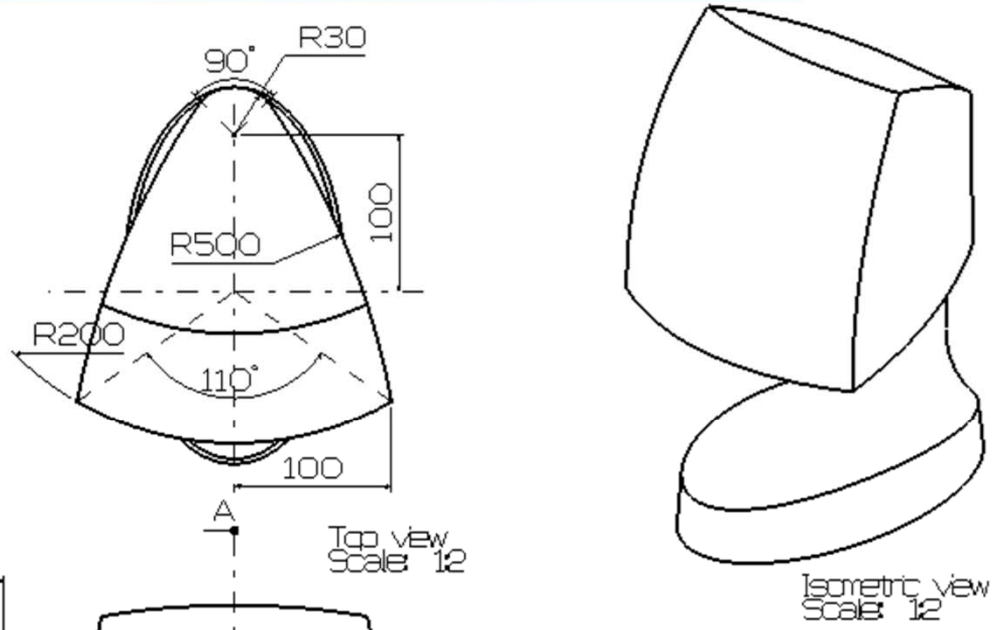



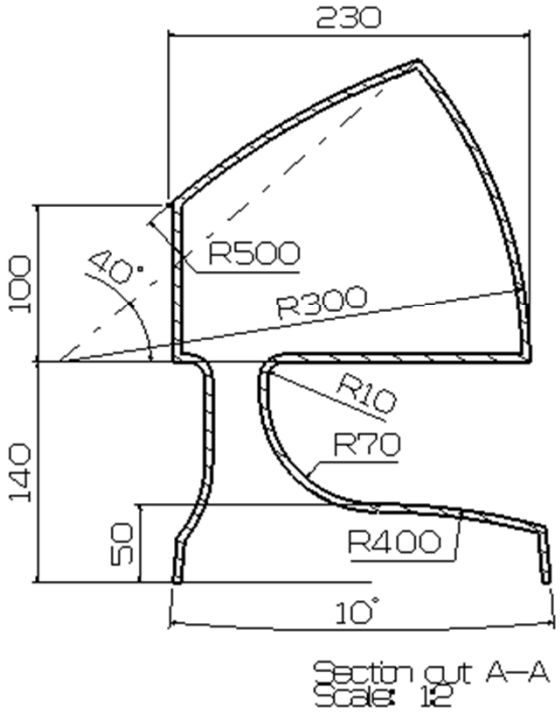
# 실습 과제

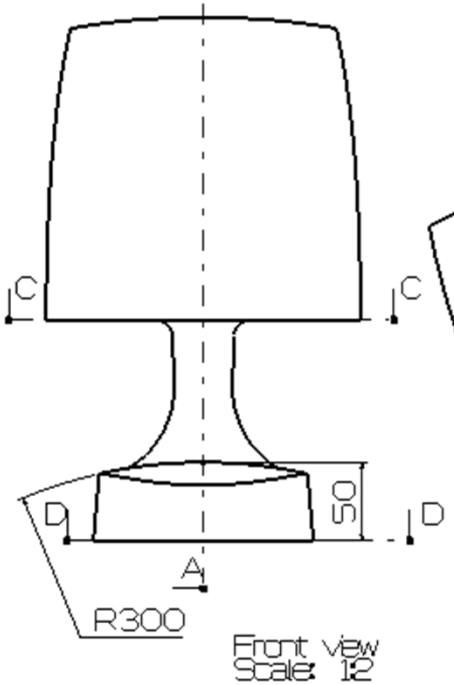
Note
1. Thickness 5mm

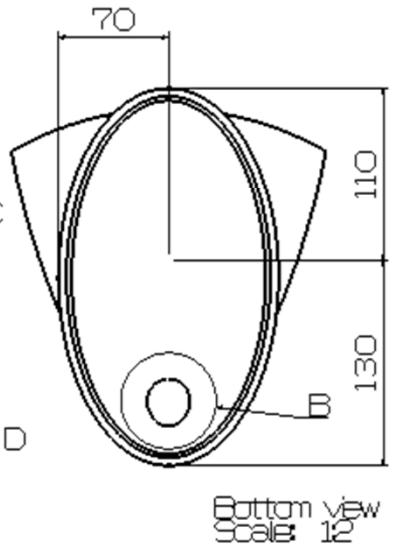









Multi-Section Surface