

# Tesla optimus gen2

## (테슬라)

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2020043445 김영훈

2023018504 이현승



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  - 2. 디자인 과정
  - 3. 어려웠던 점 및 고찰
  - 4. 질의응답
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# 팀 소개



2020043445 김영훈

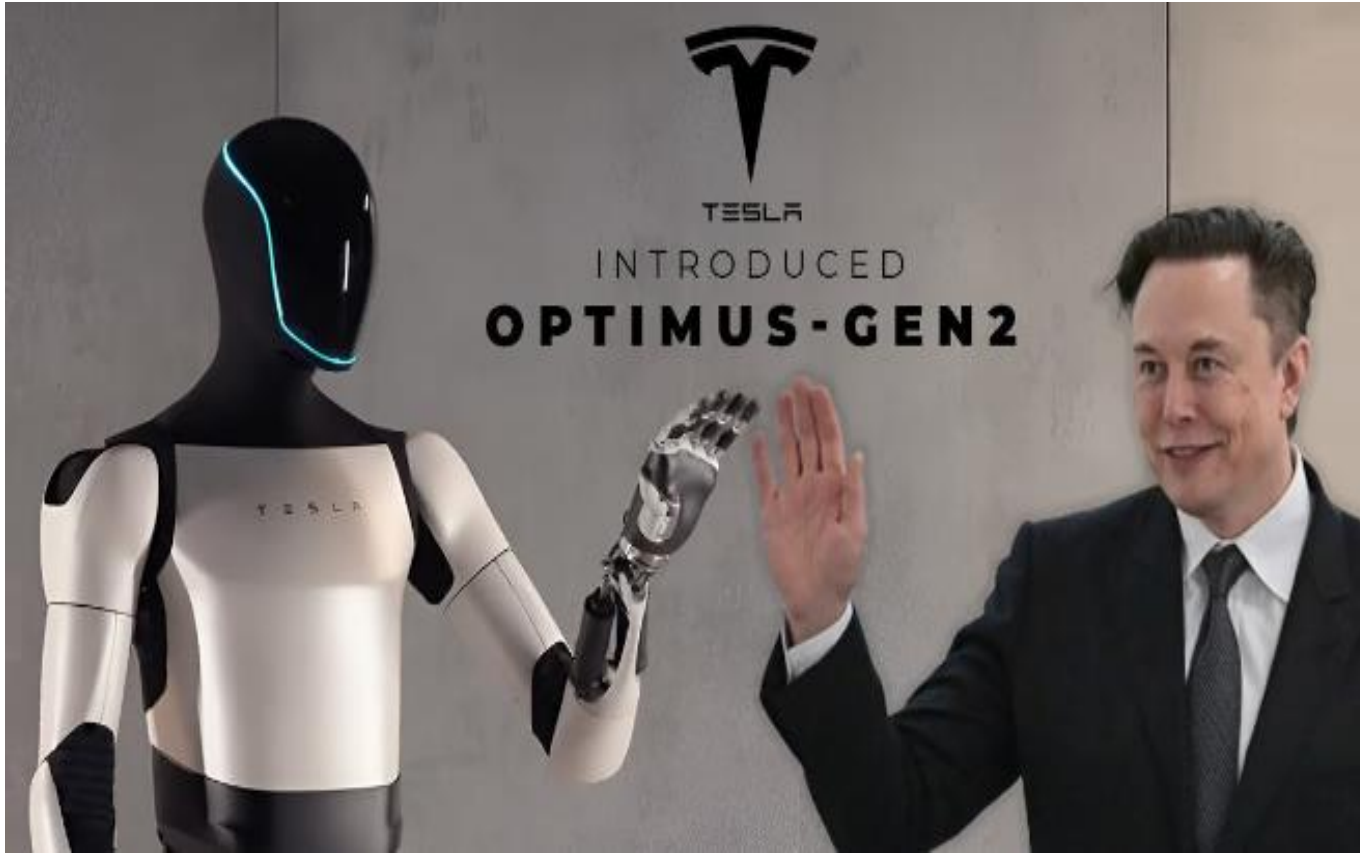
상반신 외형 및 뼈대 Modeling  
(머리, 몸, 어깨, 팔)  
Assembly  
Kinematics



2023018504 이현승

하반신 외형 및 뼈대 Modeling  
(골반, 다리, 발, 손)  
Assembly  
Kinematics / simulation /  
sequence

# 주제: Tesla optimus gen2



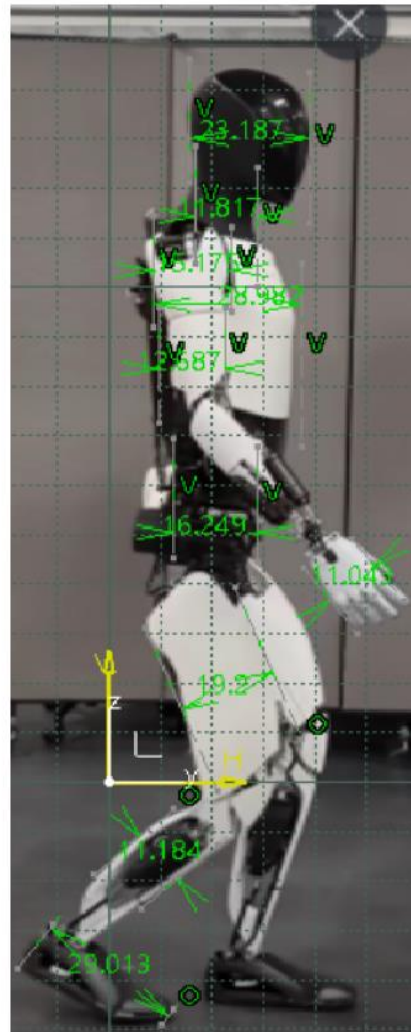
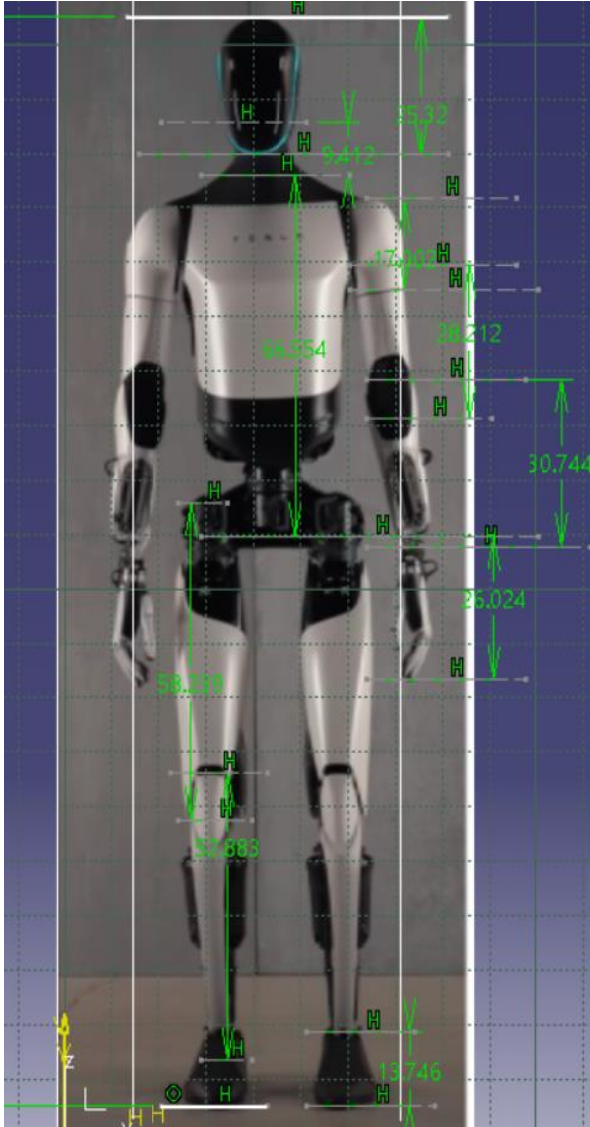
- <https://youtu.be/cpraXaw7dyc?si=fja6Pxxg9SdtILYcN> (참고 영상)



# Kinematics

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# 모델링 준비 단계 : 외부



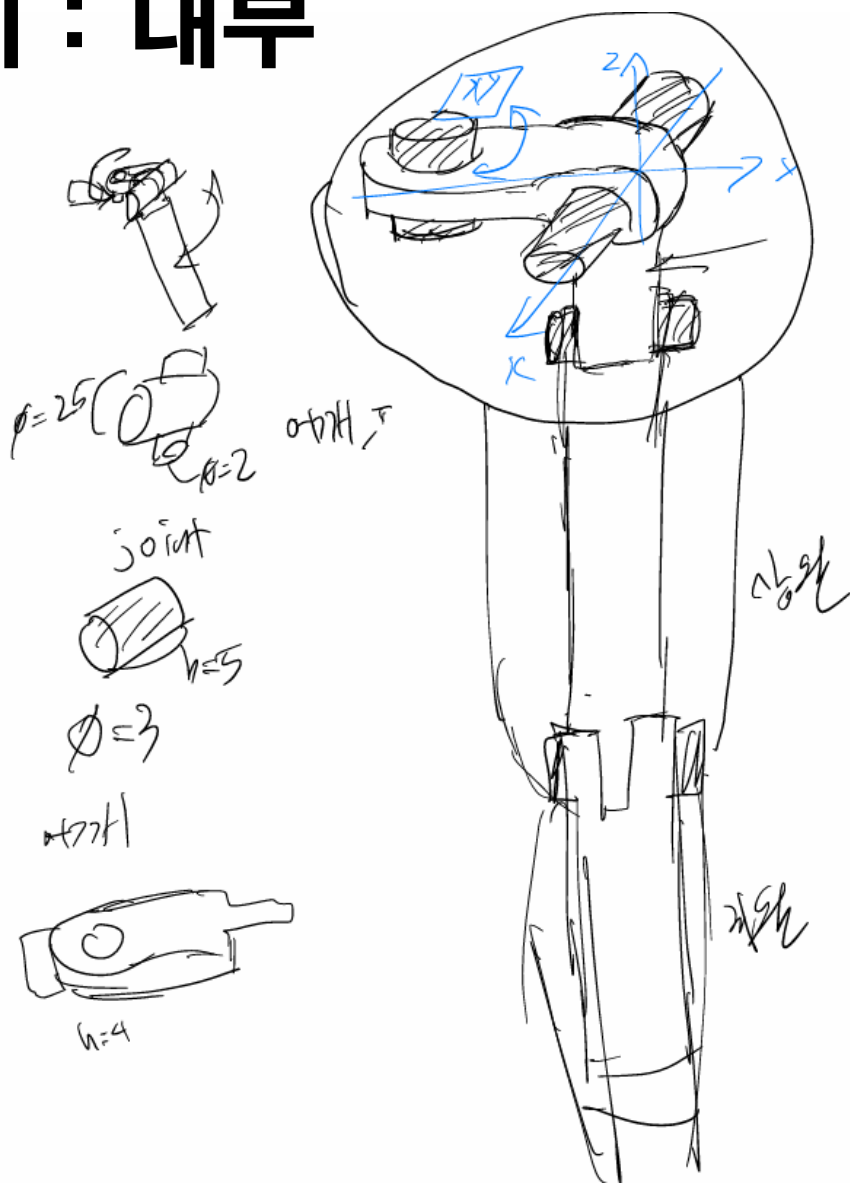
- 공개된 치수가 없어 캡처를 통해 Sketch tracer 기능으로 x,y,z 방향의 치수를 부여함

# 모델링 준비 단계 : 내부

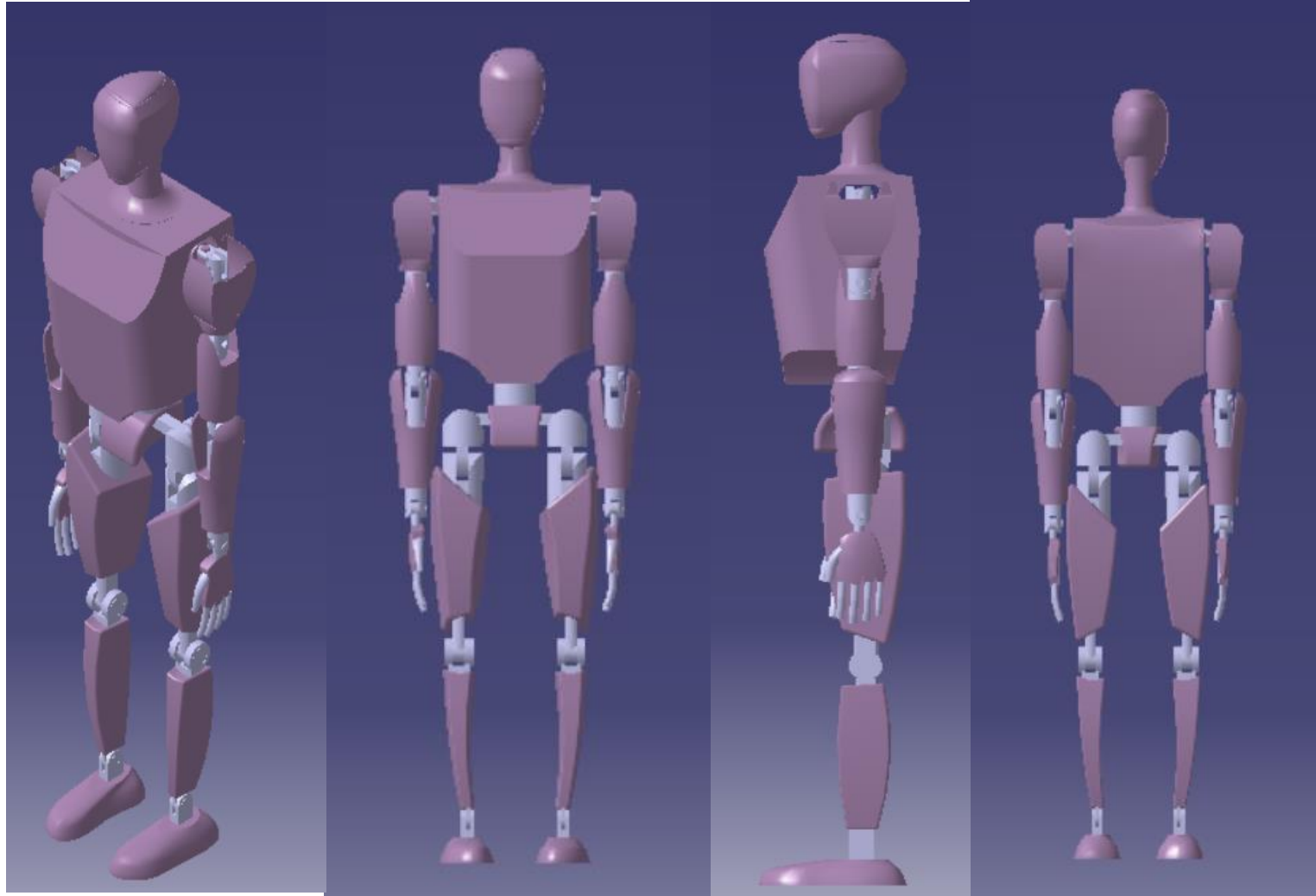
내부 뼈대 및 조인트 설계

외부: GSD를 통해 디자인

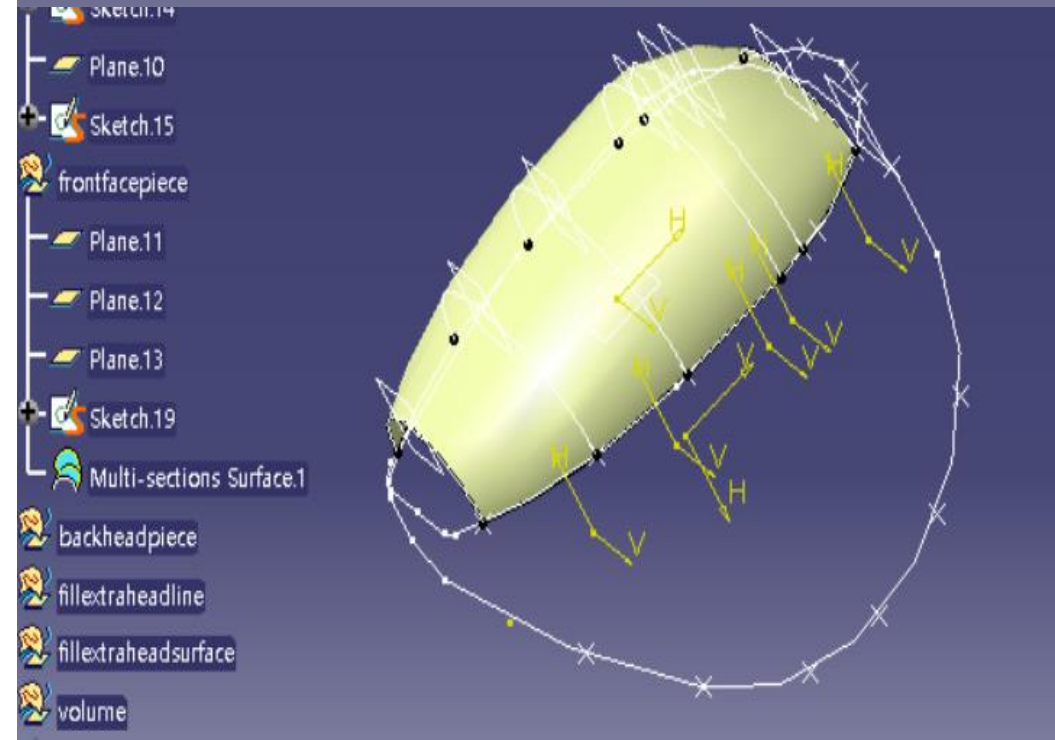
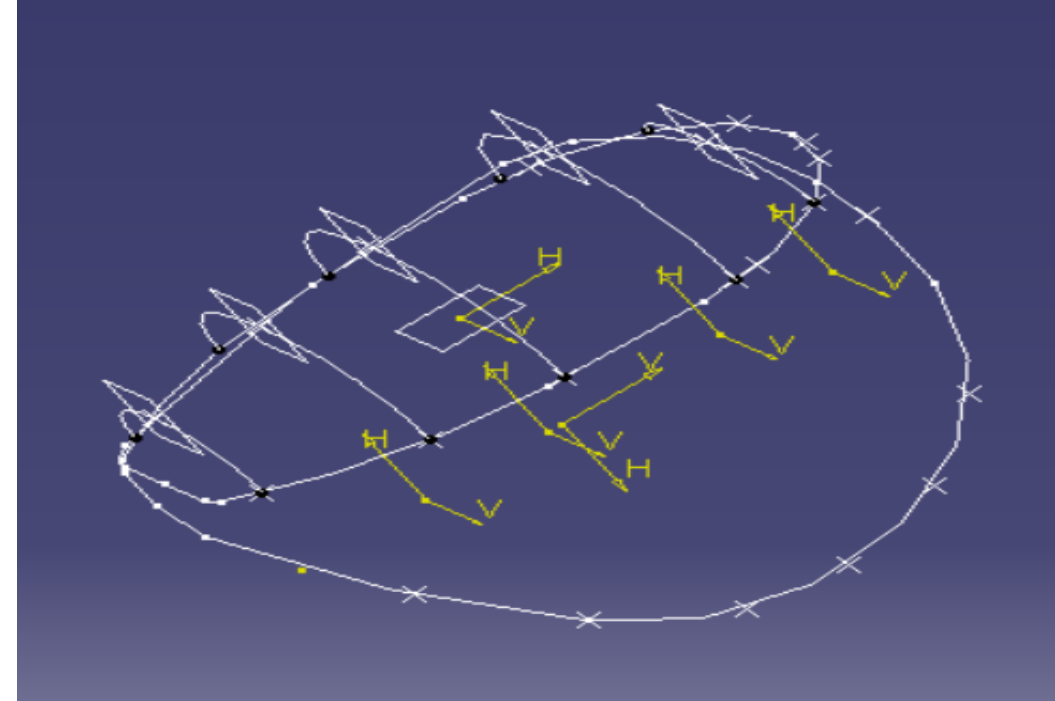
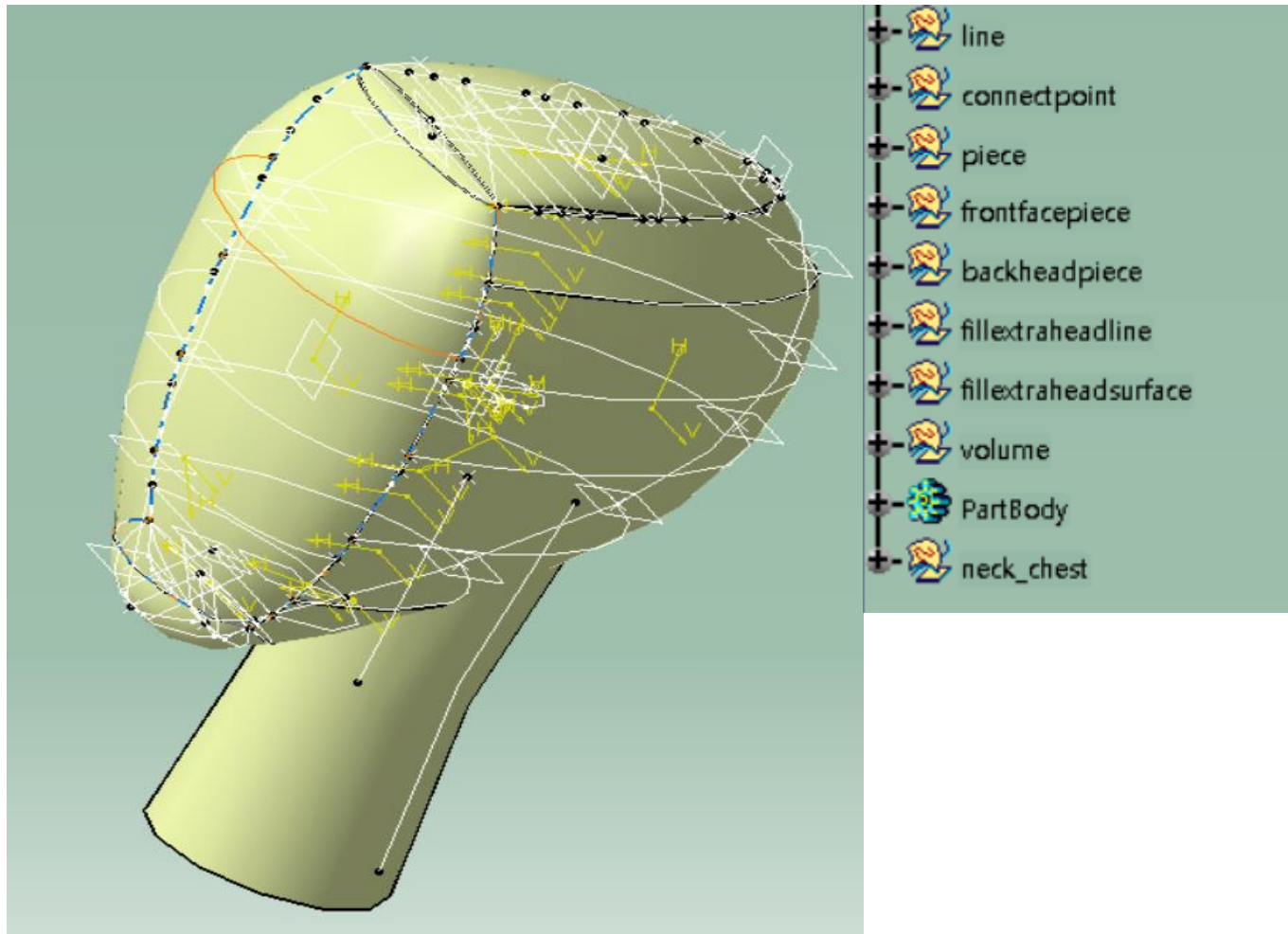
내부: Part Design을 통해 디자인

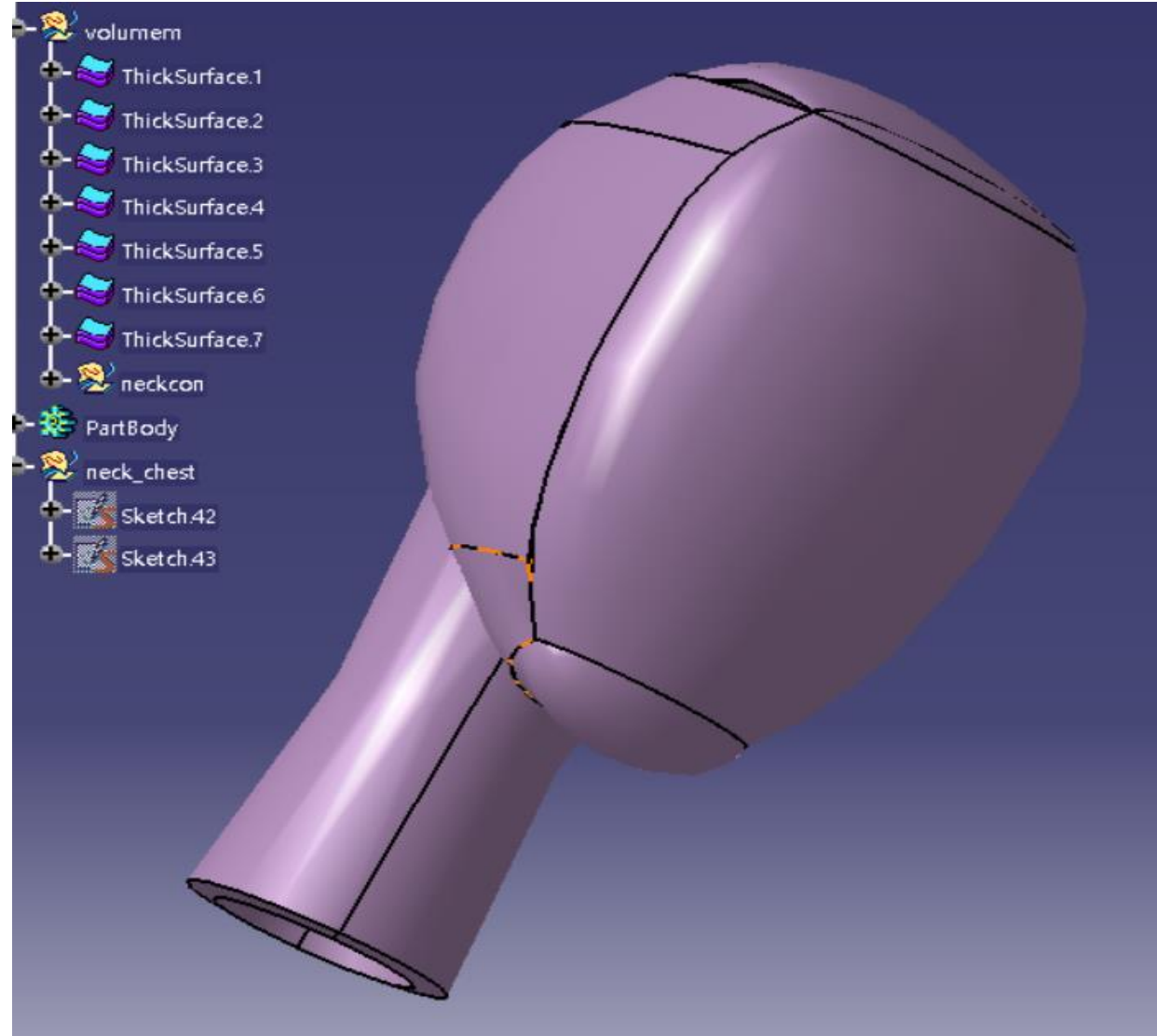


# 모델링 결과

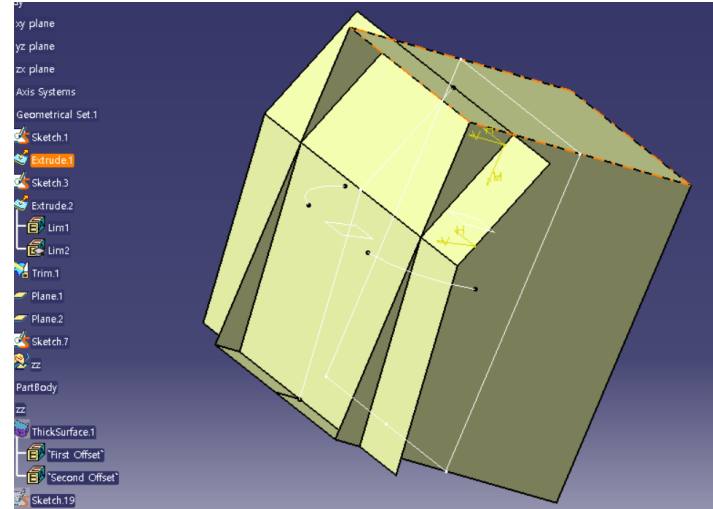


# 모델링 과정 : 머리

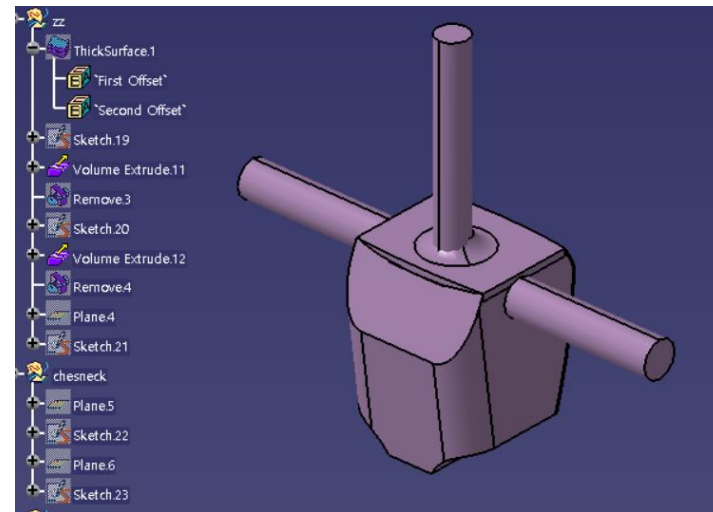




# 모델링 과정 : 몸

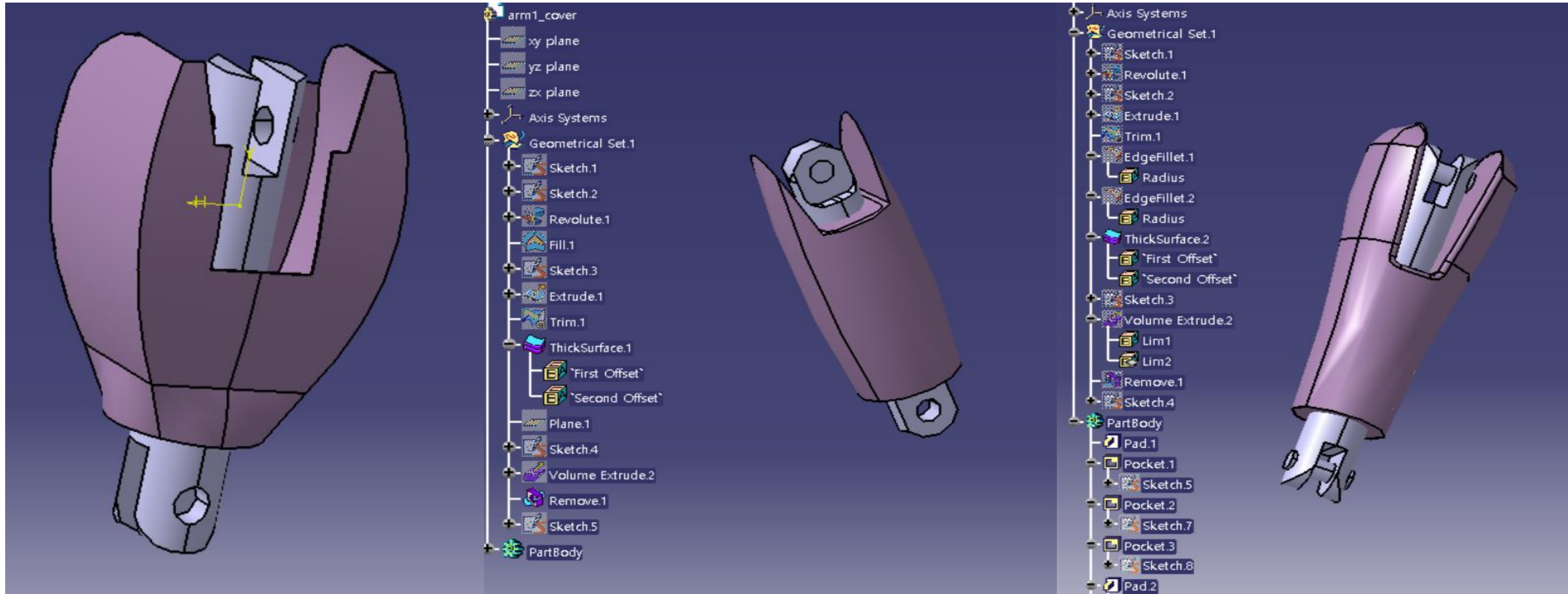


Trim 기능 이용

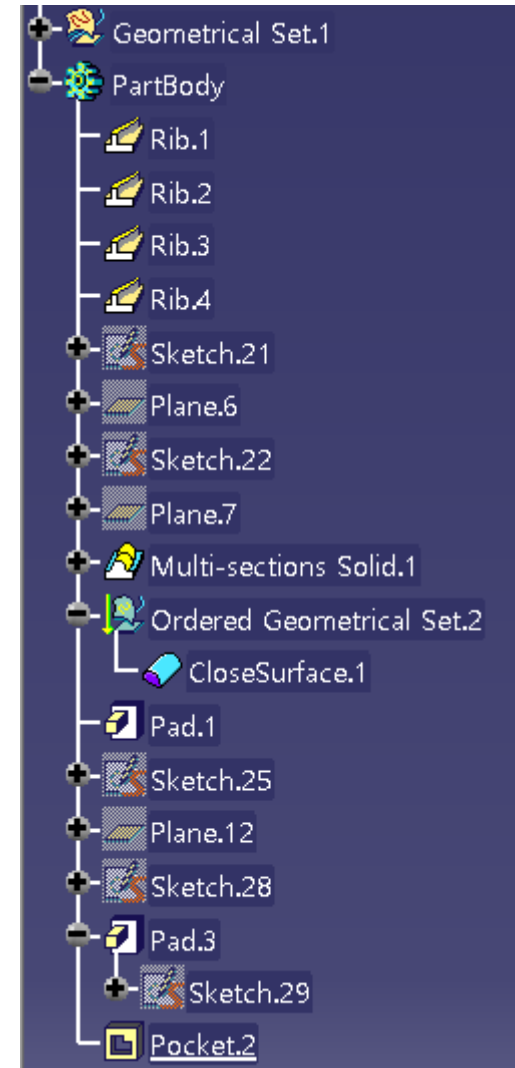
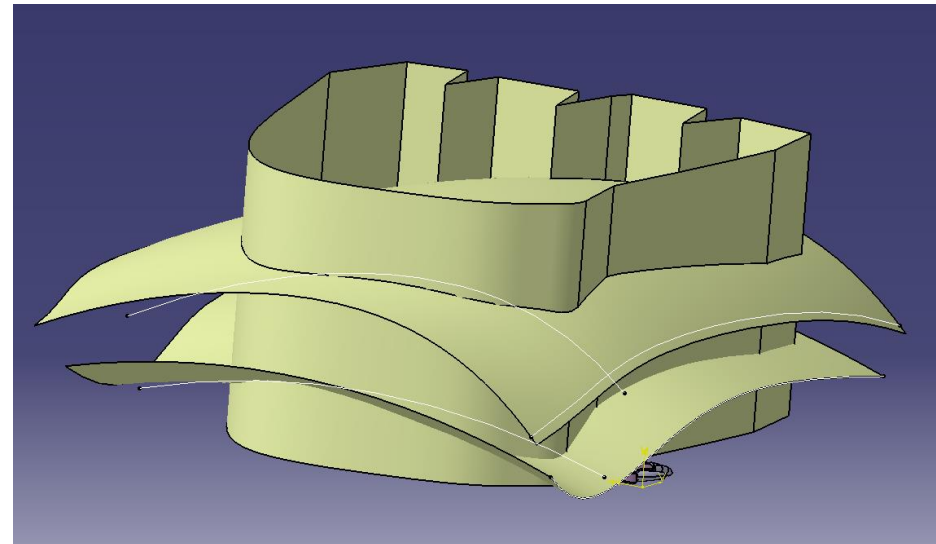
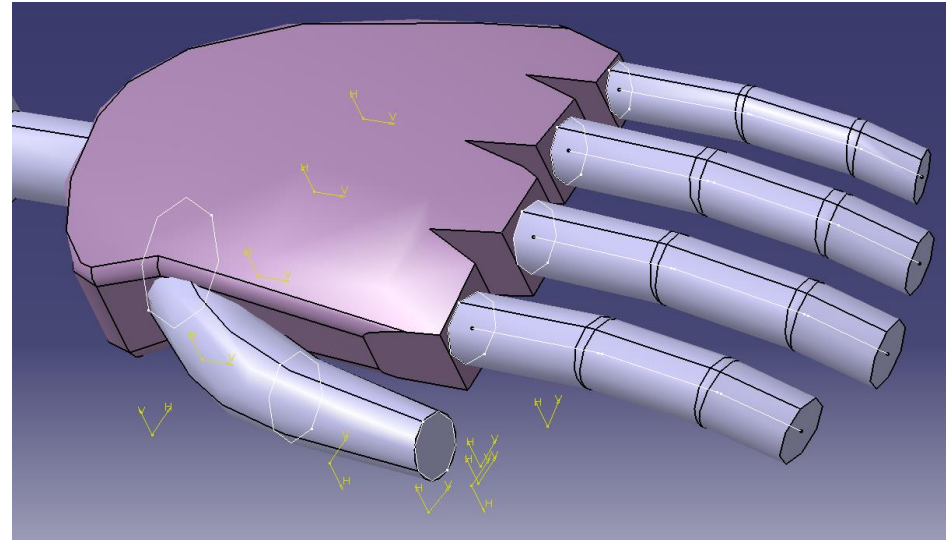
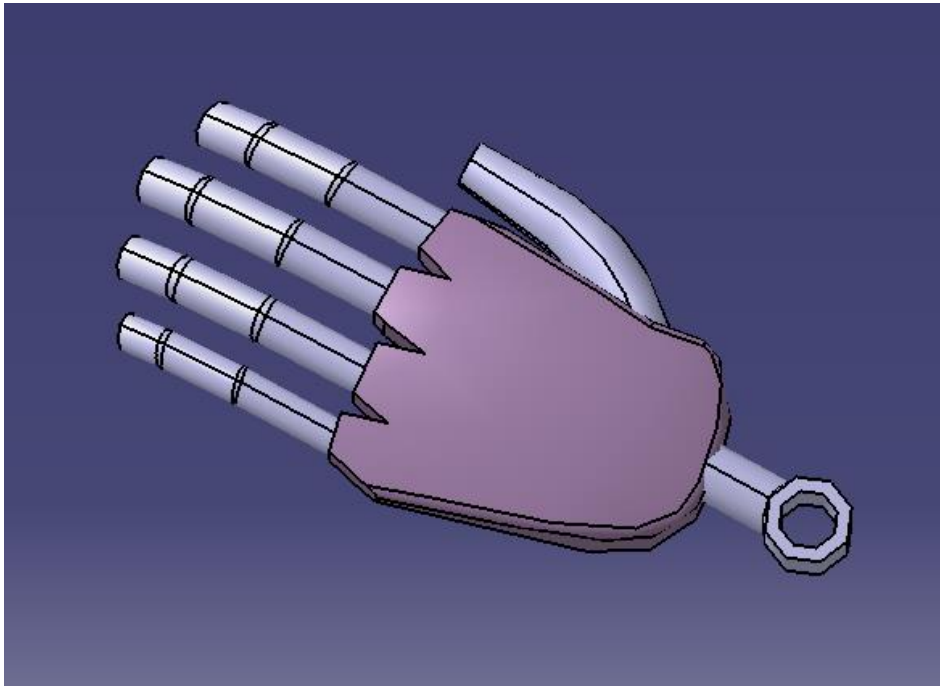


Boolean 연산이용

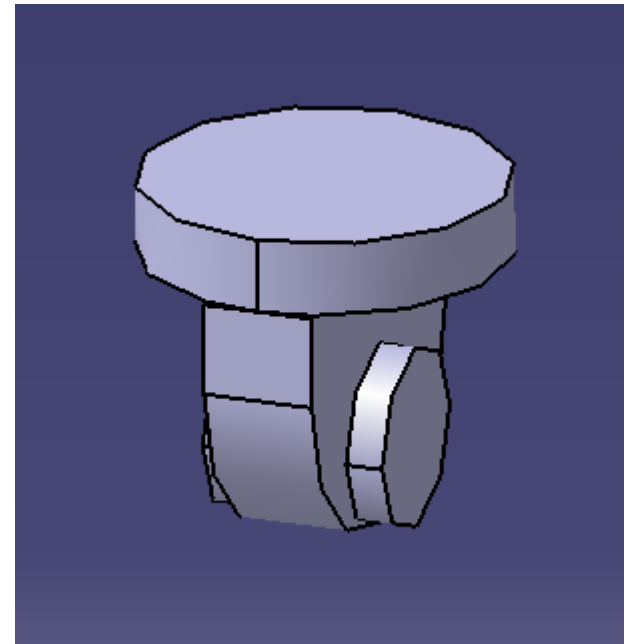
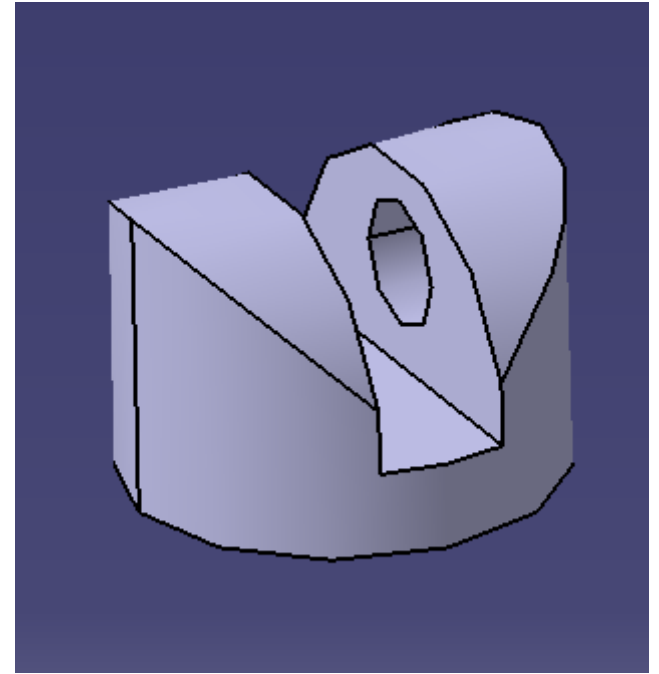
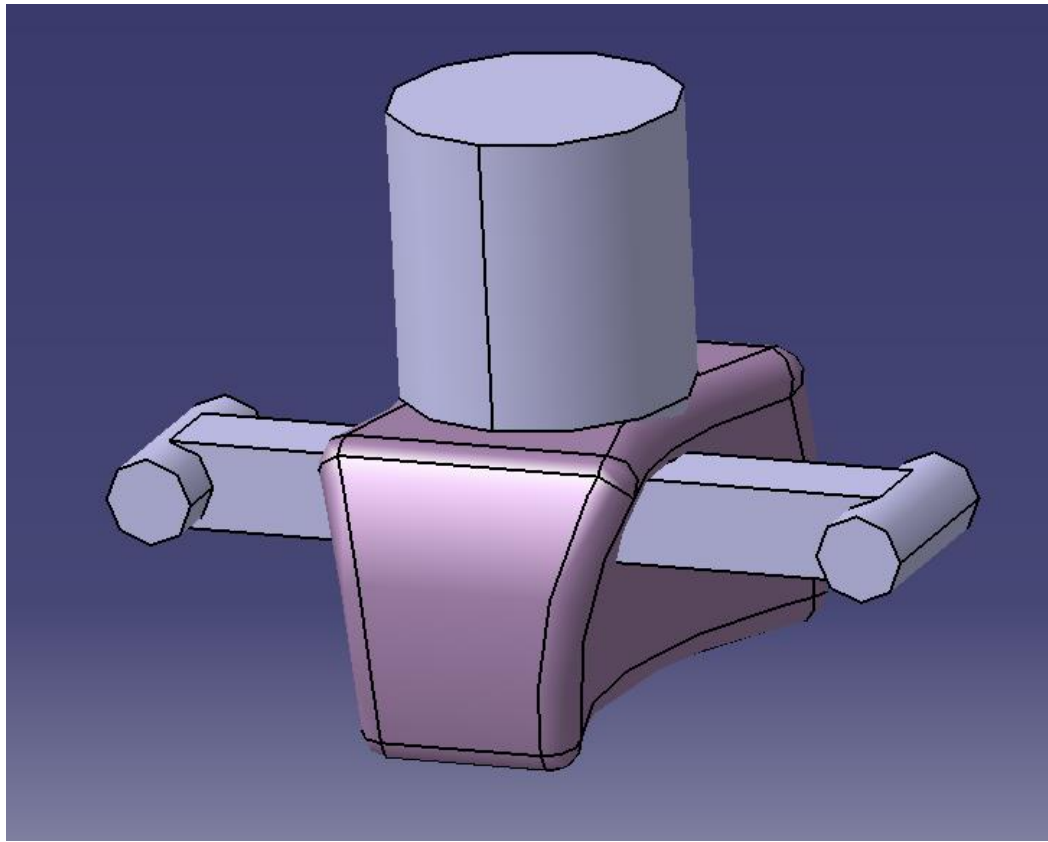
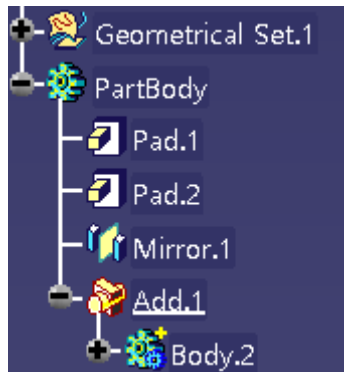
# 모델링 과정 : 어깨-팔



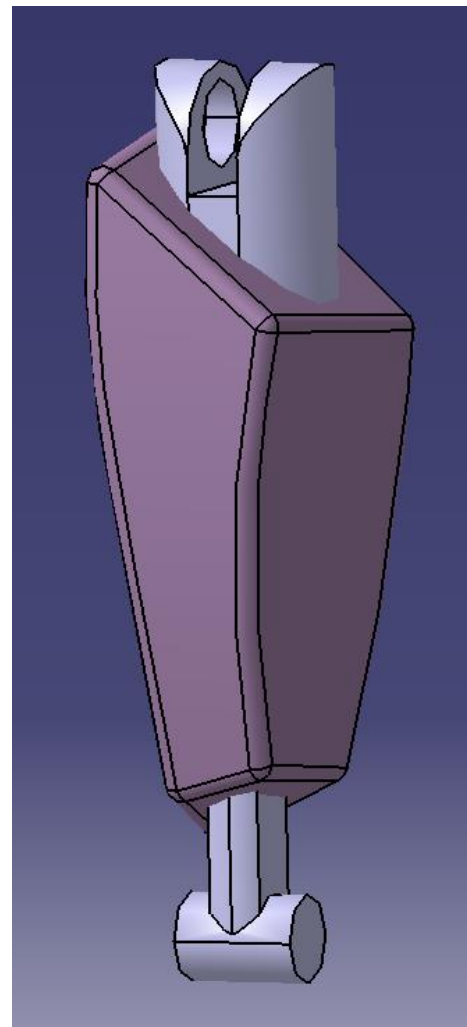
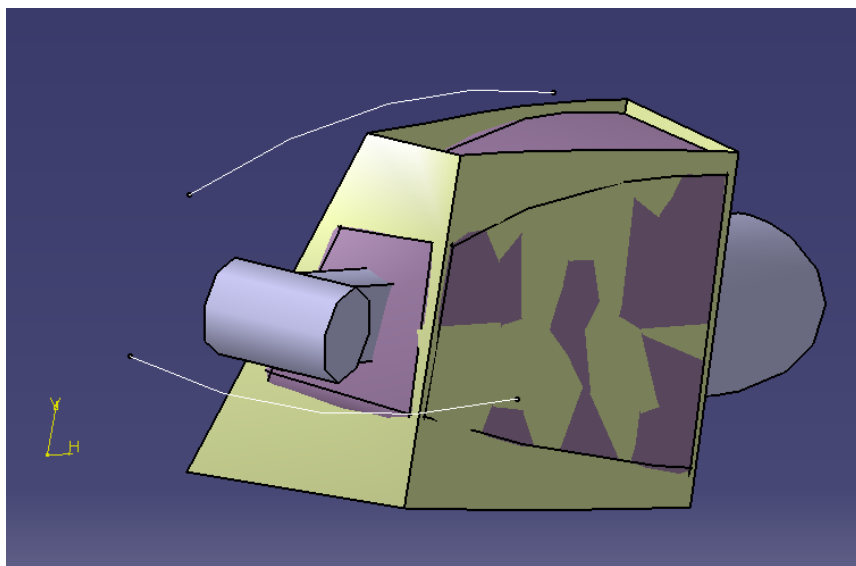
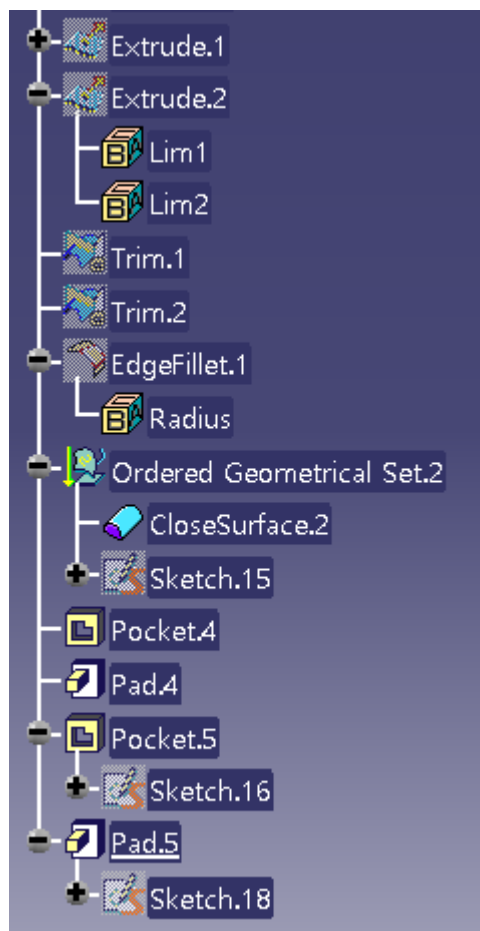
# 모델링 과정 : 손



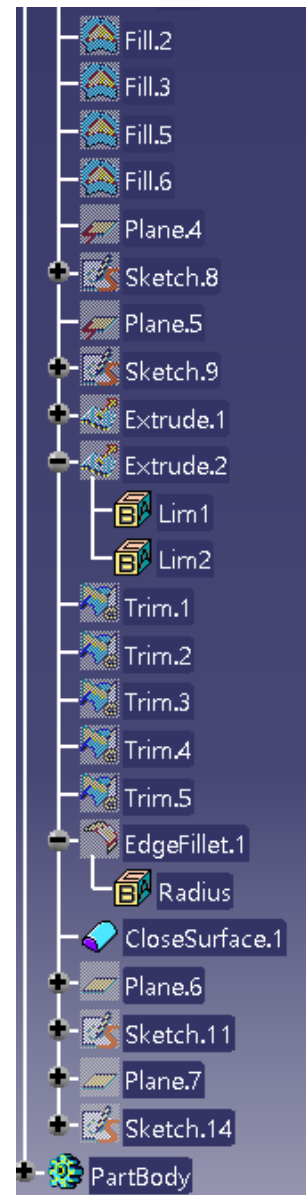
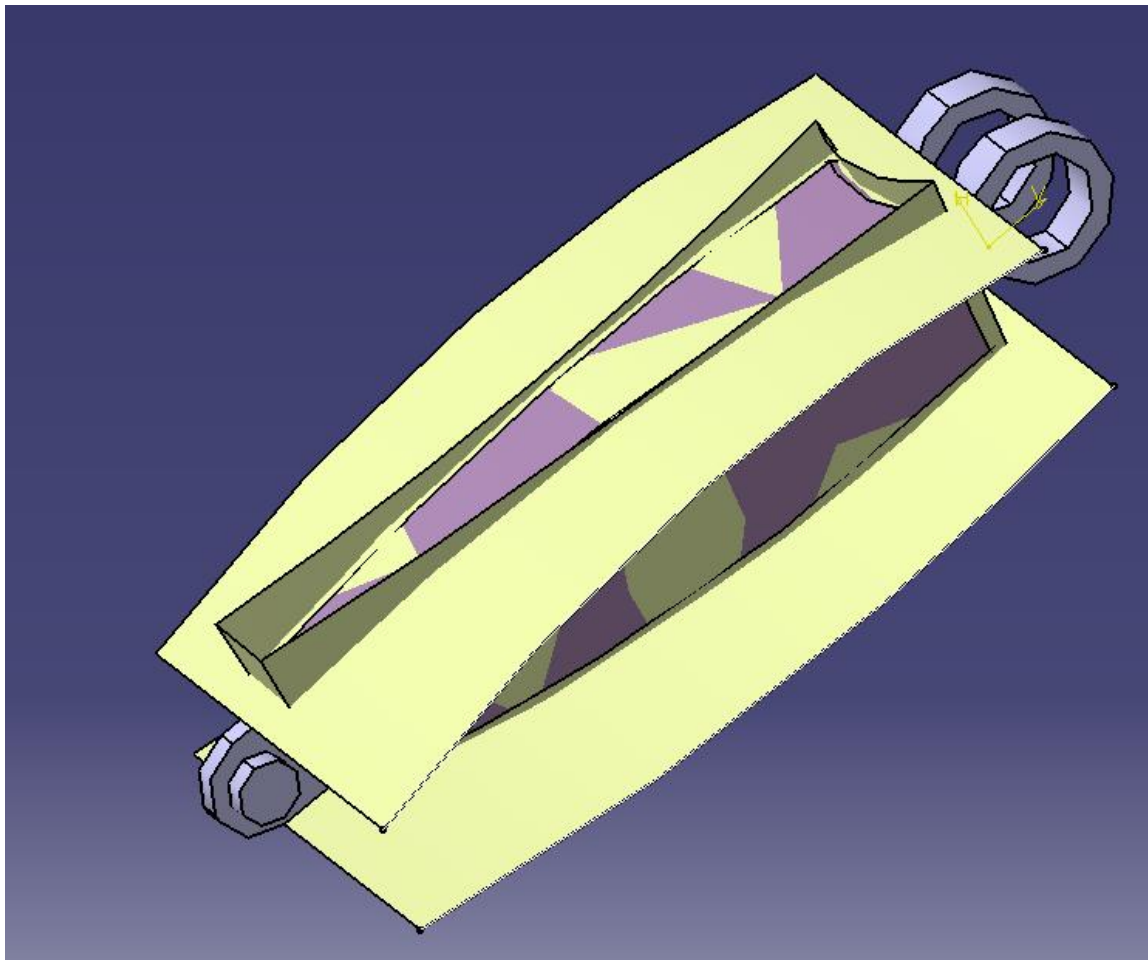
# 모델링 과정 : 고관절



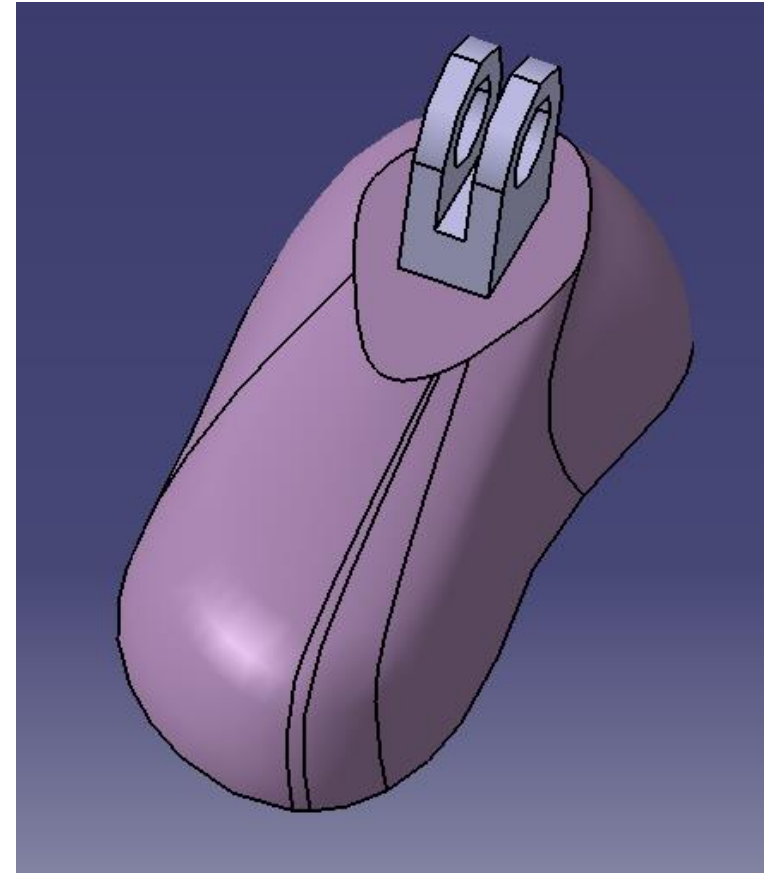
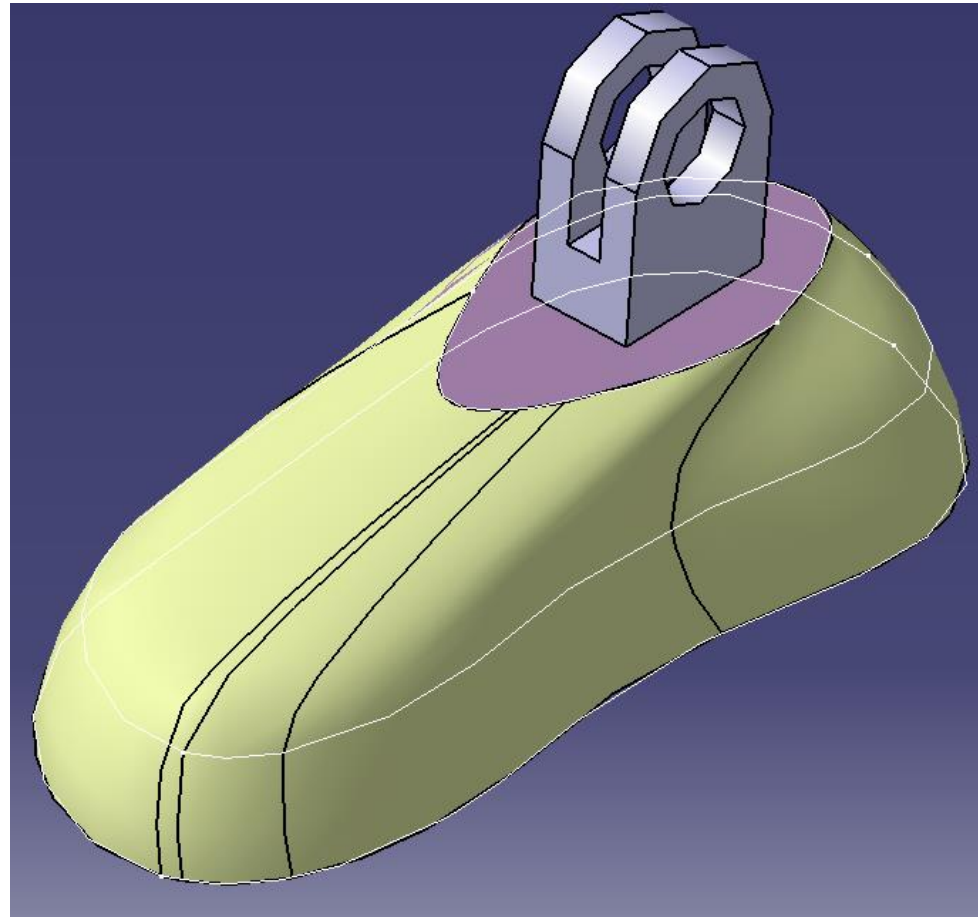
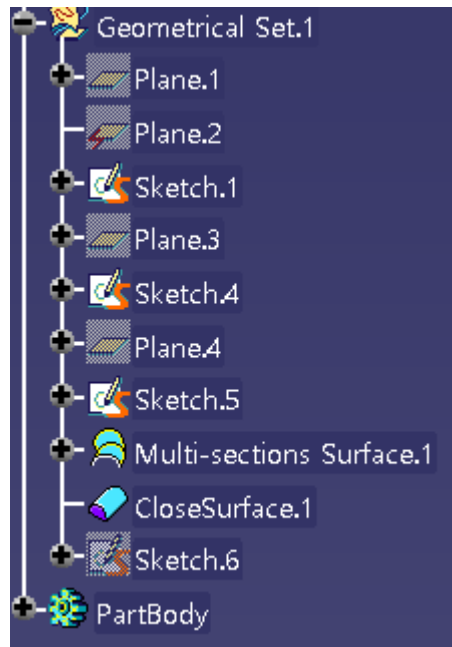
# 모델링 과정 : 허벅지 부



# 모델링 과정 : 종아리 부

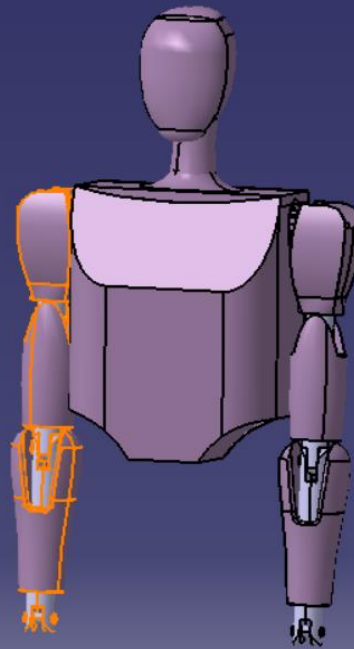


# 모델링 과정 : 발



# 어셈블리

- Assembly의 symmetry 기능을 이용해 대칭되는 부분을 assembly 처리



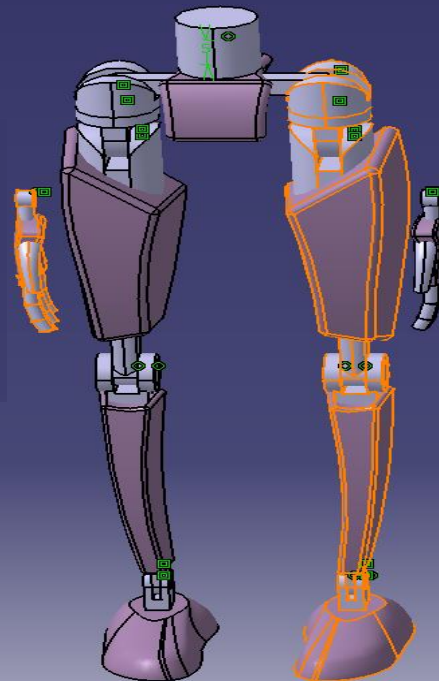
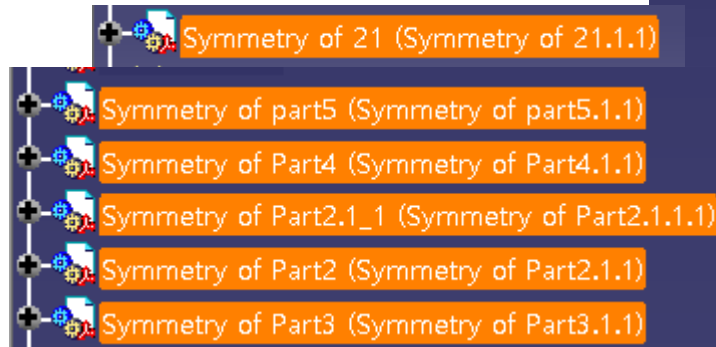
ry of part5.1.1)

ry of Part4.1.1)

metry of Part2.1.1.1)

ry of Part2.1.1)

ry of Part3.1.1)



ry of Part20.1.1)

y of Part1.2.1)

mmetry of Part2.4.1)

f Part3.3.1)

f 21.1.1)

# 키네마틱스

## Applications

### Mechanisms

- Eokkea\_FB, DOF=0
- Hip, DOF=0
- R\_Ankle, DOF=0
- L\_Ankle, DOF=0
- R\_Knee, DOF=0
- L\_Knee, DOF=0
- R\_TLeg, DOF=0
- L\_TLeg, DOF=0
- R\_HipHinge, DOF=0
- L\_HipHinge, DOF=0
- L\_Eokkea\_UD, DOF=0
- R\_Eokkea\_UD, DOF=0
- L\_Shorder, DOF=0
- R\_Shorder, DOF=0
- L\_Elbow, DOF=0
- R\_Elbow, DOF=0

### Joints

- R\_Ankle (Part3.1,Part2.1)
- L\_Ankle (Symmetry of Part3.1.1,Symmetry of Part2.1.1)
- R\_Knee (Part2.1,Part2.1.1)
- L\_Knee (Symmetry of Part2.1.1,Symmetry of Part2.1.1.1)
- R\_TLeg (Part4.1,Part2.1.1)
- L\_TLeg (Symmetry of Part4.1.1,Symmetry of Part2.1.1.1)
- R\_HipHinge (Part4.1,part5.1)
- L\_HipHinge (Symmetry of part5.1.1,Symmetry of Part4.1.1)
- HeoLi (part6.1,body.1)
- L\_Eokkea\_UD (Part1.2,Part20.1)
- R\_Eokkea\_UD (Symmetry of Part20.1.1,Symmetry of Part1.2.1)
- L\_Shorder (Part2.4,Part1.2)
- R\_Shorder (Symmetry of Part2.4.1,Symmetry of Part1.2.1)
- L\_Elbow (Part3.3,Part2.4)
- R\_Elbow (Symmetry of Part2.4.1,Symmetry of Part3.3.1)
- L\_Hand (Part3.3,21.1)
- R\_Hand (Symmetry of Part3.3.1,Symmetry of 21.1.1)
- Head (head.1,body.1)
- Eokkea\_FB (Part20.1,Symmetry of Part20.1.1,body.1)
  - L\_Eokkea\_FB.1 (Part20.1,body.1)
  - R\_Eokkea\_FB.1 (body.1,Symmetry of Part20.1.1)
- Hip (part5.1,Symmetry of part5.1.1,part6.1)
  - R\_Hip.1 (part6.1,part5.1)
  - L\_Hip.1 (part6.1,Symmetry of part5.1.1)

### Sequences

#### Sequence.1

### Simulation

- Eokkea\_FB
- Hip
- R\_Ankle
- L\_Ankle
- R\_Knee
- L\_Knee
- R\_TLeg
- L\_TLeg
- R\_HipHinge
- L\_HipHinge
- L\_Eokkea\_UD
- R\_Eokkea\_UD
- L\_Shorder
- R\_Shorder
- L\_Elbow
- R\_Elbow

Edit Sequence

Edit Action

Edit Analysis

Action in session

Eokkea\_FB

Hip

R\_Ankle

L\_Knee

R\_Knee

L\_TLeg

R\_TLeg

L\_TLeg

R\_HipHinge

L\_HipHinge

L\_Eokkea\_UD

R\_Eokkea\_UD

L\_Shorder

R\_Shorder

L\_Elbow

R\_Elbow

Action in Sequence

| Step | Action      | Duration (s) | Delay (s) |
|------|-------------|--------------|-----------|
| 1    | R_Ankle     | 45           | 20        |
| 1    | L_Knee      | 45           | 20        |
| 1    | R_HipHinge  | 20           | 0         |
| 1    | R_Eokkea_UD | 45           | 20        |
| 1    | Eokkea_FB   | 45           | 20        |
| 1    | L_Elbow     | 44           | 20        |
| 1    | L_Ankle     | 45           | 20        |
| 1    | R_TLeg      | 45           | 20        |
| 1    | L_HipHinge  | 20           | 0         |
| 1    | L_Shorder   | 45           | 20        |
| 1    | Hip         | 45           | 20        |
| 1    | R_Elbow     | 44           | 20        |
| 1    | R_Knee      | 45           | 20        |
| 1    | L_TLeg      | 45           | 20        |
| 1    | L_Eokkea_UD | 45           | 20        |
| 1    | R_Shorder   | 45           | 20        |

Move Up

Merge Up

Move Down

Merge Down

Action duration (s) 0

Reset duration

Action delay (s) 20

Action add mode

☒ Create last step and add
 ☐ Add in last step
 ☐ Iterative create last step and add

☒ Highlight the simulated action(s)

OK

Cancel

Kinematics Simulation - R\_Ankle

|             |      |  |     |        |  |     |
|-------------|------|--|-----|--------|--|-----|
| Eokkea_FB   | -45  |  | 45  | 0.0000 |  | ... |
| Hip         | -70  |  | 10  | 0.0000 |  | ... |
| R_Ankle     | 0    |  | 30  | 0.0000 |  | ... |
| L_Ankle     | 0    |  | 30  | 0.0000 |  | ... |
| R_Knee      | 0    |  | 110 | 0.0000 |  | ... |
| L_Knee      | 0    |  | 110 | 0.0000 |  | ... |
| R_TLeg      | 0    |  | 110 | 0.0000 |  | ... |
| L_TLeg      | 0    |  | 110 | 0.0000 |  | ... |
| R_HipHinge  | 0    |  | 20  | 0.0000 |  | ... |
| L_HipHinge  | 0    |  | 20  | 0.0000 |  | ... |
| HeoLi       | -360 |  | 360 | 0.0000 |  | ... |
| L_Eokkea_UD | 0    |  | 135 | 0.0000 |  | ... |
| R_Eokkea_UD | 0    |  | 135 | 0.0000 |  | ... |
| L_Shorder   | 0    |  | 40  | 0.0000 |  | ... |
| R_Shorder   | 0    |  | 40  | 0.0000 |  | ... |
| L_Elbow     | 0    |  | 90  | 0.0000 |  | ... |
| R_Elbow     | 0    |  | 90  | 0.0000 |  | ... |

☐ Check joint limits

Reset

☐ Keep position on exit

Edit Simulation

Name: R\_Ankle



0.00 1

☐ Animate viewpoint

Insert

Modify

Delete

Skip

☐ Automatic insert

Interference

Off

Distance

Off

Edit analysis

Edit simulation objects

Edit sensors

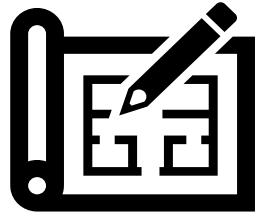
OK

Cancel

# 시뮬레이션 영상

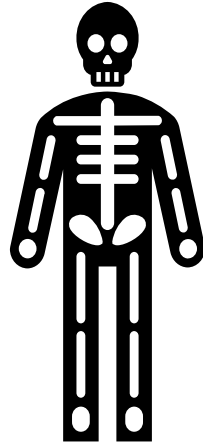
<https://youtu.be/Fa91ZRH-WtQ>

# 어려웠던 부분



계획:

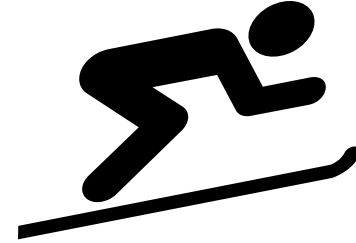
모델링 대상의 정보 부족



모델링 :

쉽지 않은 연속적으로 변화하는  
곡률의 모델링

모델링 대상의 부정확한 치수  
부여를 통한 과정에서 생기는  
모델링 오류



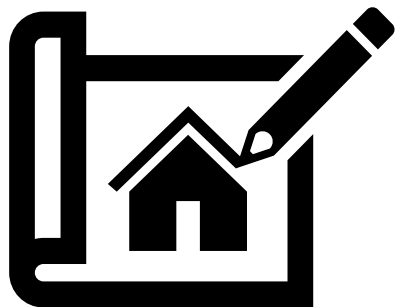
키네마틱:

동시다발적으로 운동해야 하는 많은  
조인트의 개수

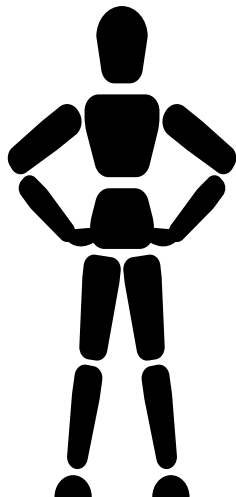
자연스러운 운동을 만들기 위한 각도  
설정 및 부여

메커니즘의 충돌로 인한 시뮬레이션  
중단 현상

# 해결방법



영상 캡처와 비례식을 이  
용해 최대한 유사한 치수  
비유



적극적인 Multi-surface  
의 활용

관절부분(꺾이는 부)을  
드러내는 형상의 디자인  
을 통해 겹침 방지



모든 관절에 대해 다른  
Mechanism을 부여한 후  
animation 구성 이후  
Sequence작업 진행

# Q&A

