THUMS (Total Human Model for Safety) in der Fußgängerschutz-Simulation

Using THUMS (Total Human Model for Safety) for Pedestrian Safety Simulation

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Fig. 1

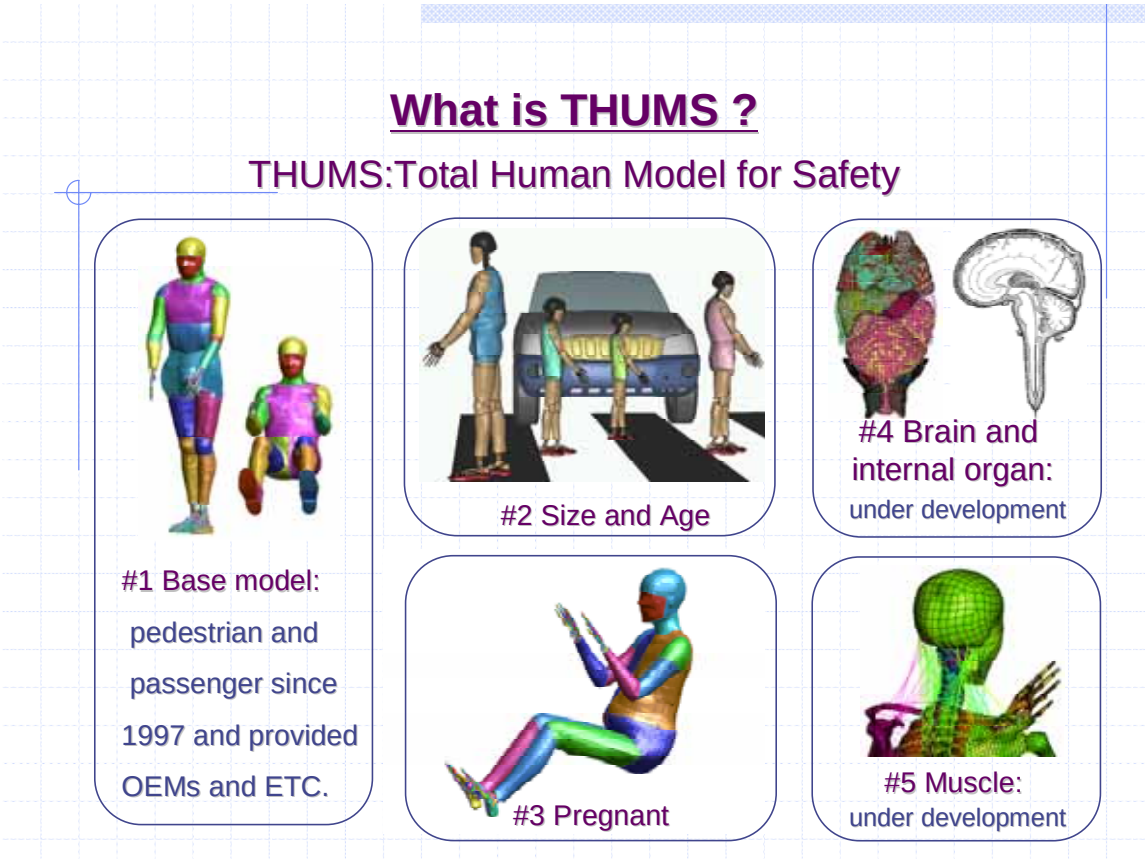

What is THUMS ?
THUMS:Total Human Model for Safety
#1 Base model:
pedestrian and
passenger since
1997 and provided
OEMs and ETC.
#2 Size and Age
#3 Pregnant
#4 Brain and
internal organ:
under development
#5 Muscle:
under development

Fig. 2

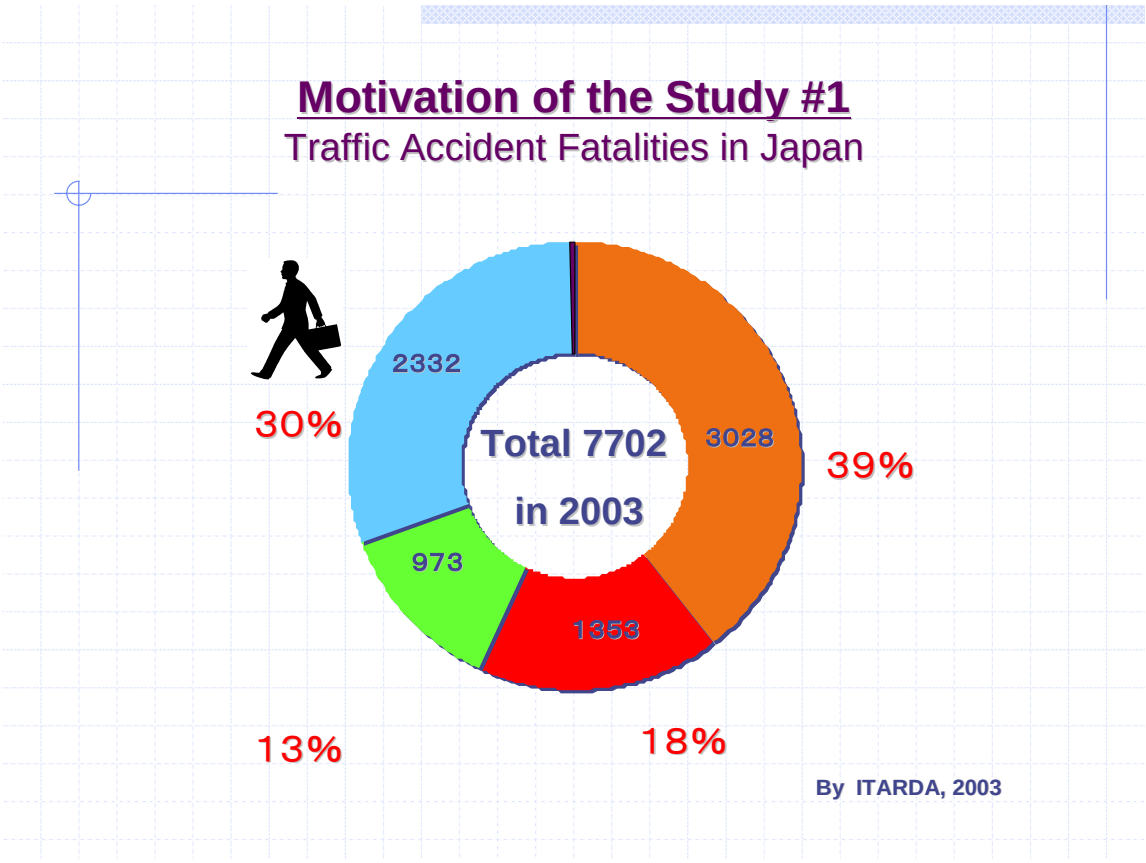

Motivation of the Study #1
Traffic Accident Fatalities in Japan
2332
30%
Total 7702
in 2003
3028
39%
973
1353
13%
18%
By ITARDA, 2003

Fig. 3

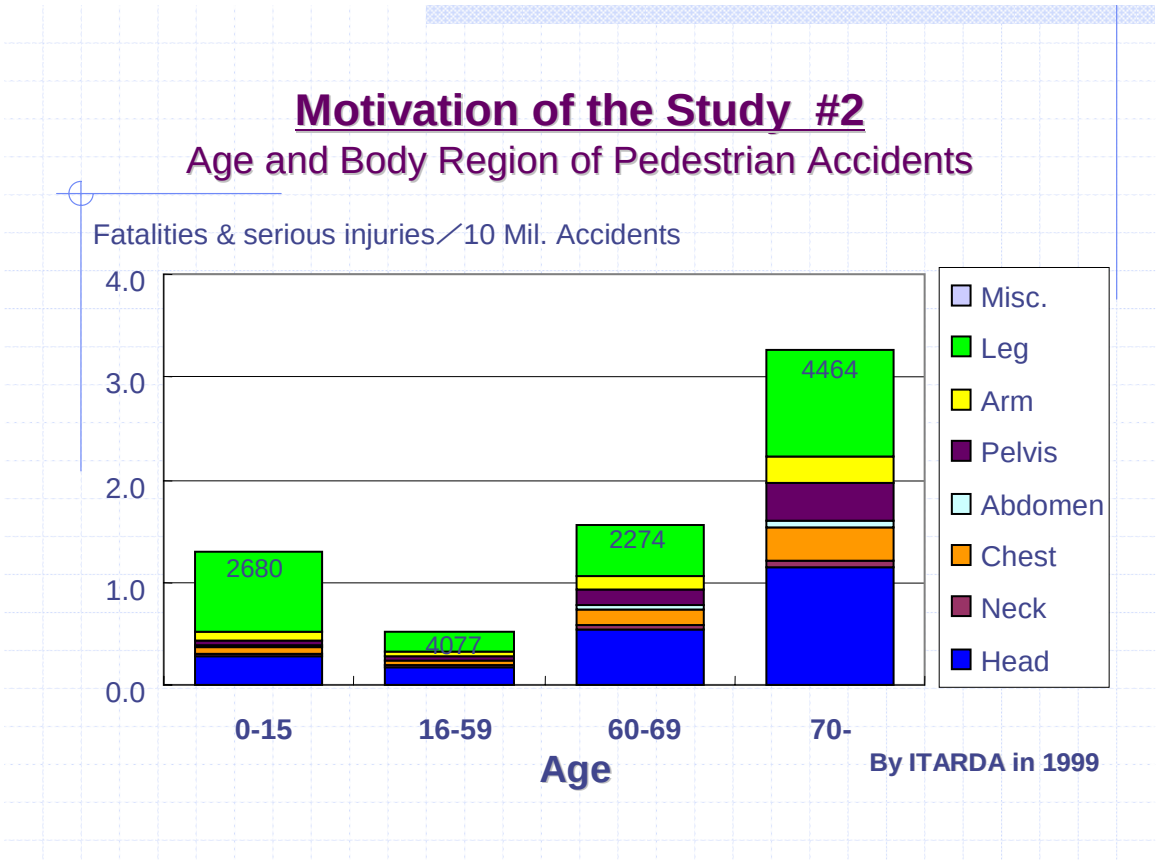

Motivation of the Study #2
Age and Body Region of Pedestrian Accidents
Fatalities & serious injuries／10 Mil. Accidents
4.0
3.0
2.0
1.0
0.0
2680
4077
2274
4464
Misc.
Leg
Arm
Pelvis
Abdomen
Chest
Neck
Head
0-15
16-59
60-69
70-
Age
By ITARDA in 1999

Fig. 4

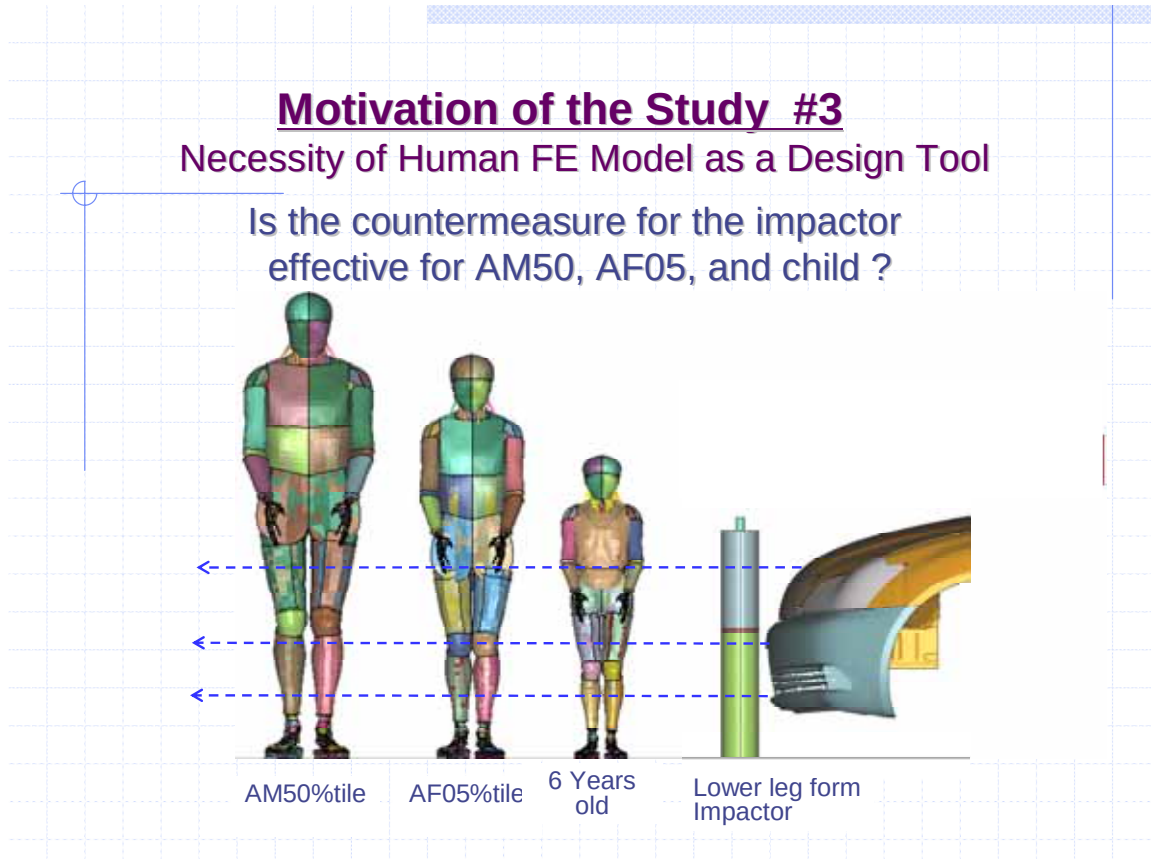

Motivation of the Study #3
Necessity of Human FE Model as a Design Tool
Is the countermeasure for the impactor
effective for AM50, AF05, and child ?
AM50%tile
AF05%tile
6 Years old
Lower leg form Impactor

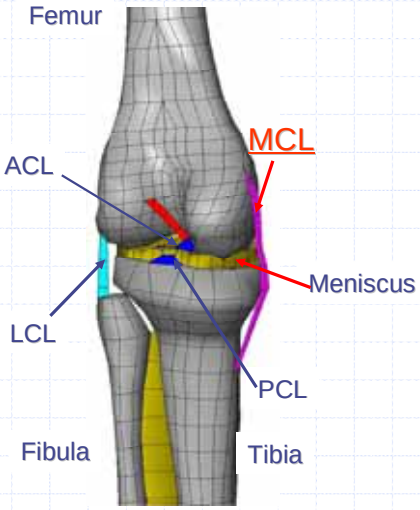
Fig. 5

Bio–fidelity of THUMS

Fig. 6

Knee Structure

Lower leg foam impactor



THUMS

Fig. 7

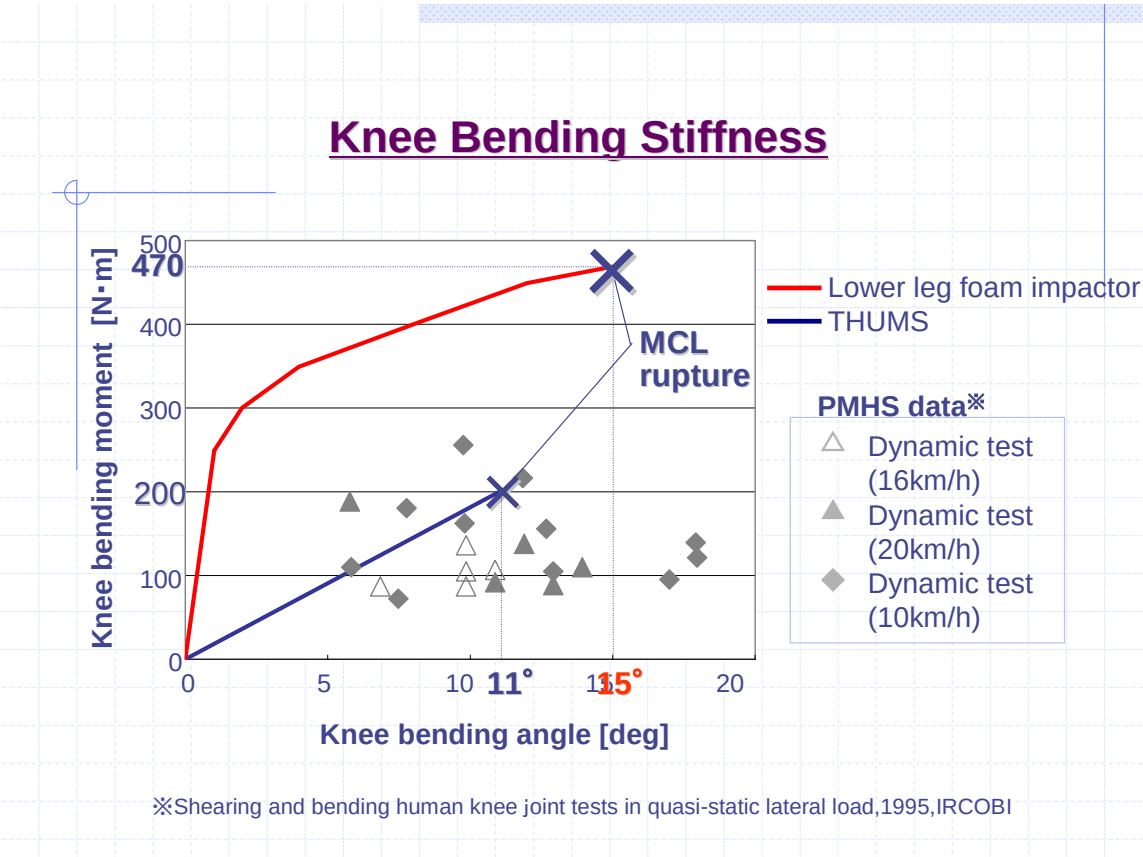

Knee Bending Stiffness
Knee bending moment [N・m]
500
470
400
300
200
100
0
0
5
10
11°
15°
20
Knee bending angle [deg]
MCL rupture
Lower leg foam impactor
THUMS
PMHS data※
Dynamic test (16km/h)
Dynamic test (20km/h)
Dynamic test (10km/h)
※Shearing and bending human knee joint tests in quasi-static lateral load,1995,IRCOBI

Fig. 8

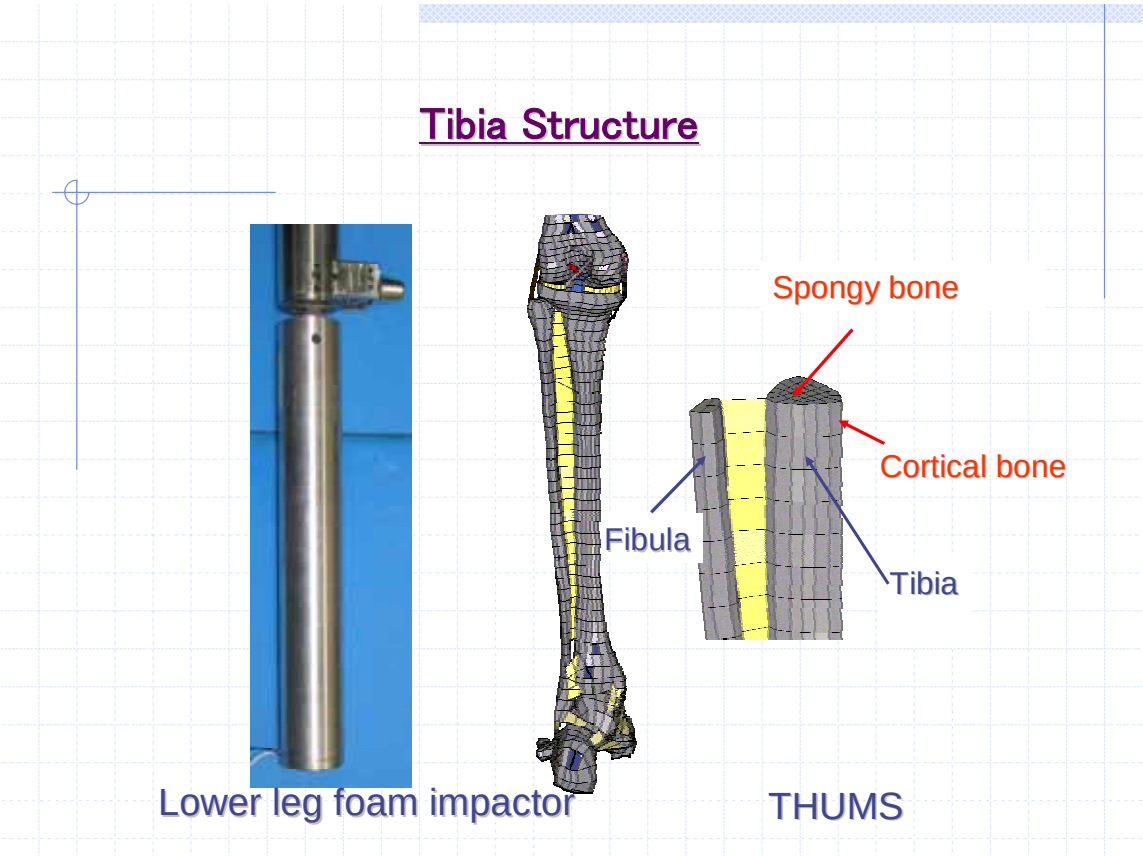

Tibia Structure
Spongy bone
Cortical bone
Fibula
Tibia
Lower leg foam impactor
THUMS

Fig. 9

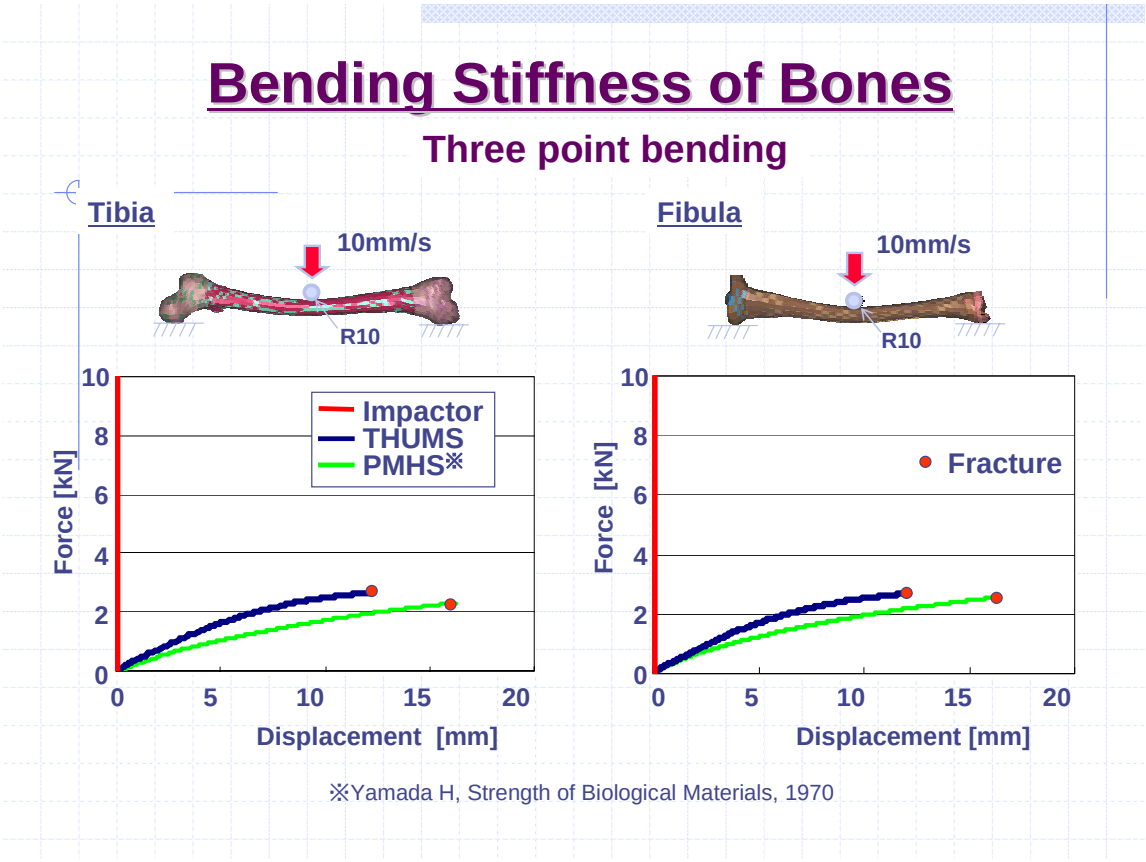

Bending Stiffness of Bones
Three point bending
Tibia
10mm/s
R10
Fibula
10mm/s
R10
Force [kN]
Impactor
THUMS
PMHS※
Displacement [mm]
Force [kN]
Fracture
Displacement [mm]
※Yamada H, Strength of Biological Materials, 1970

Fig. 10


THUMS as a Design Tool

Fig. 11

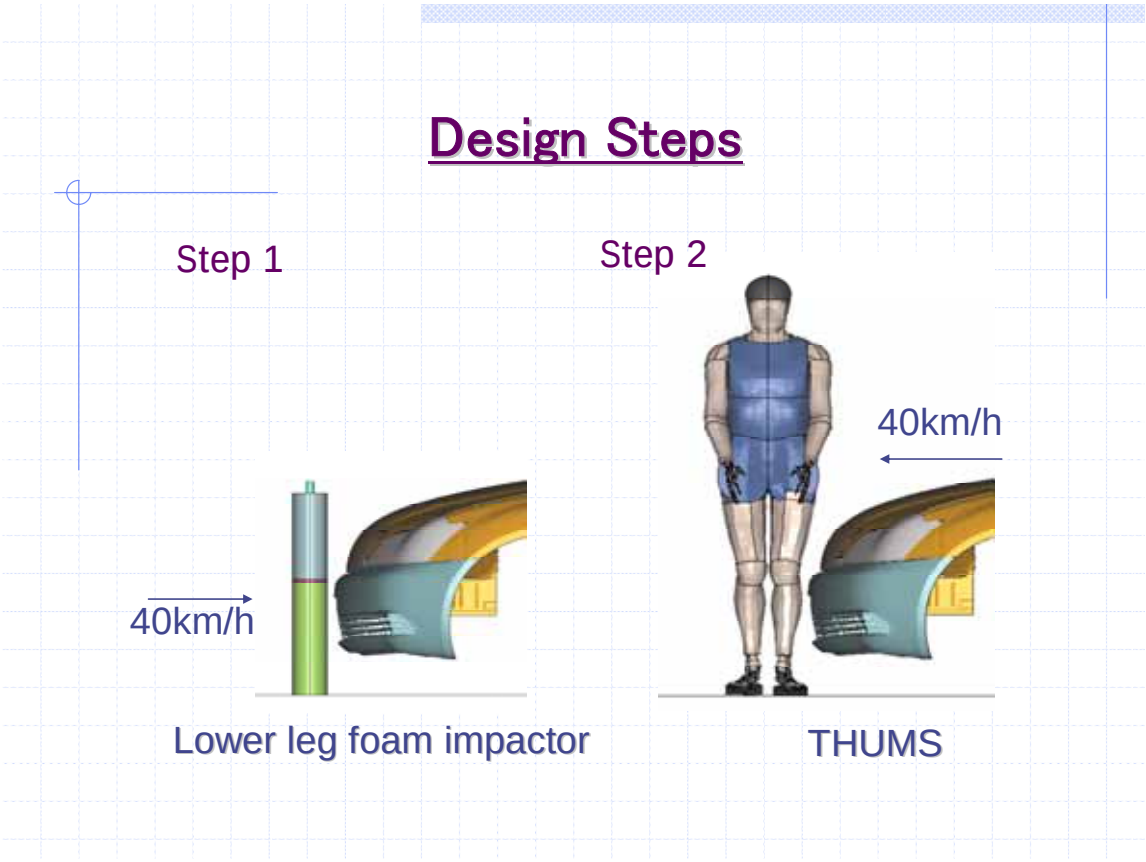

Design Steps
Step 1
Step 2
40km/h
40km/h
Lower leg foam impactor
THUMS

Fig. 12

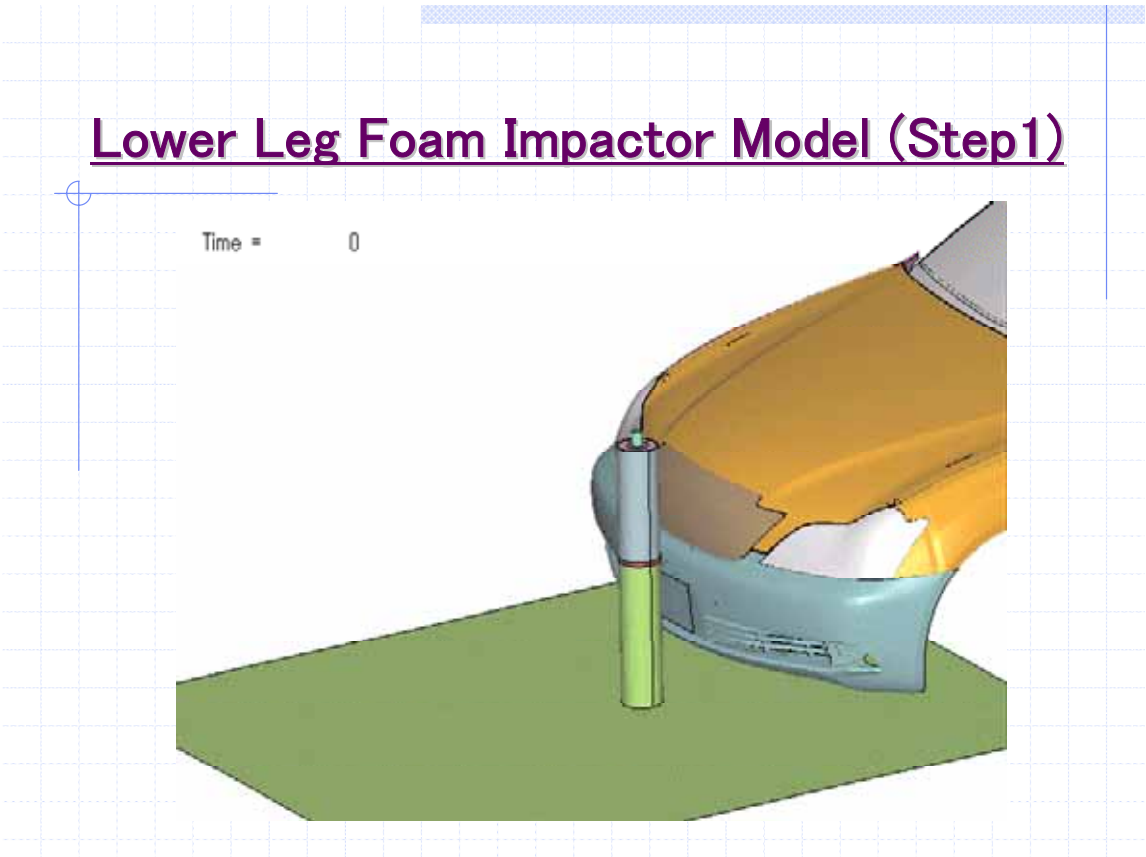

Lower Leg Foam Impactor Model (Step1)
Time = 0

Fig. 13

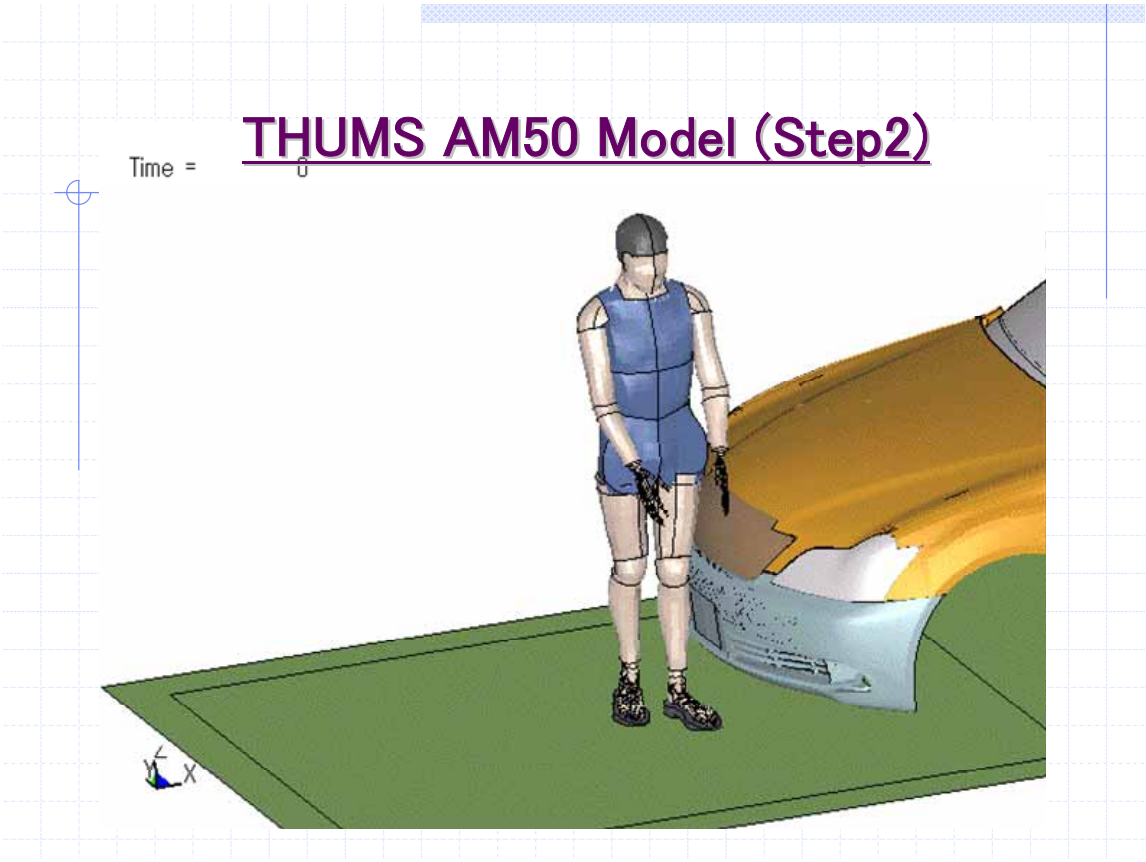


Fig. 14

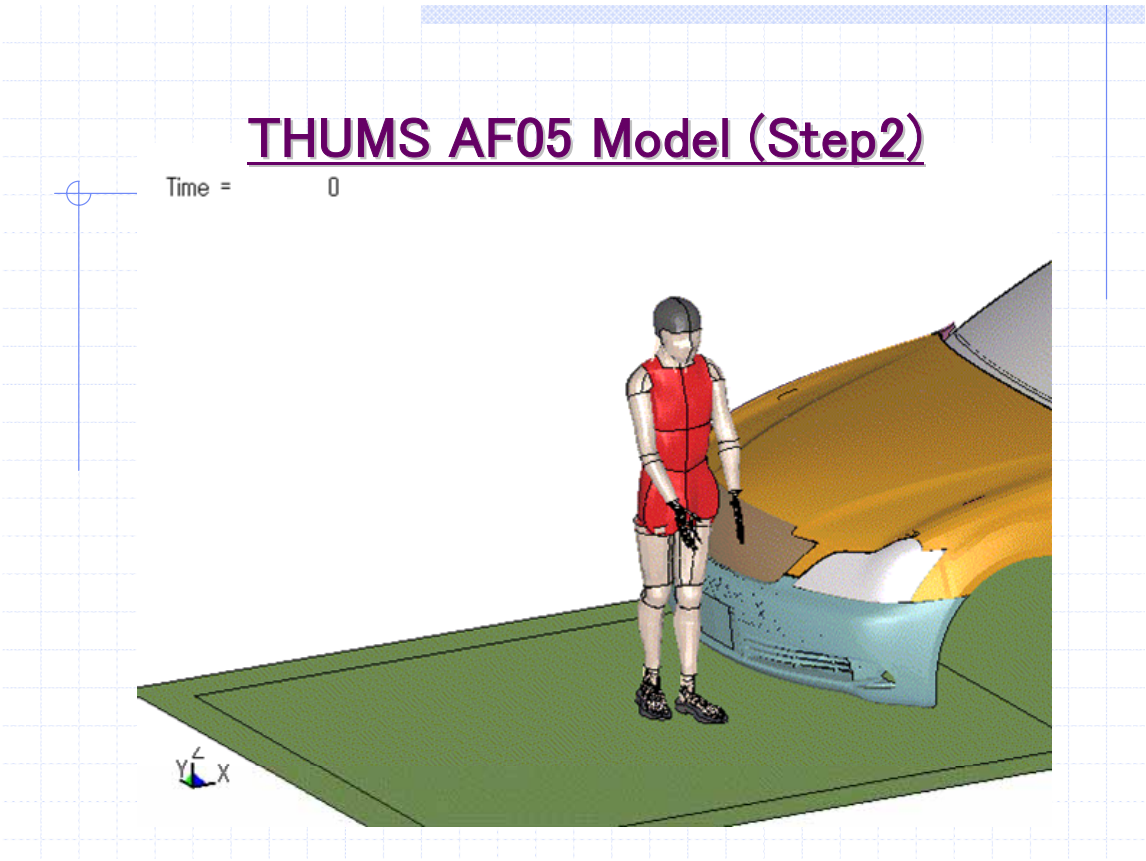


Fig. 15


6YO
Time
THUMS 6 years Old Model (Step2)

Fig. 16

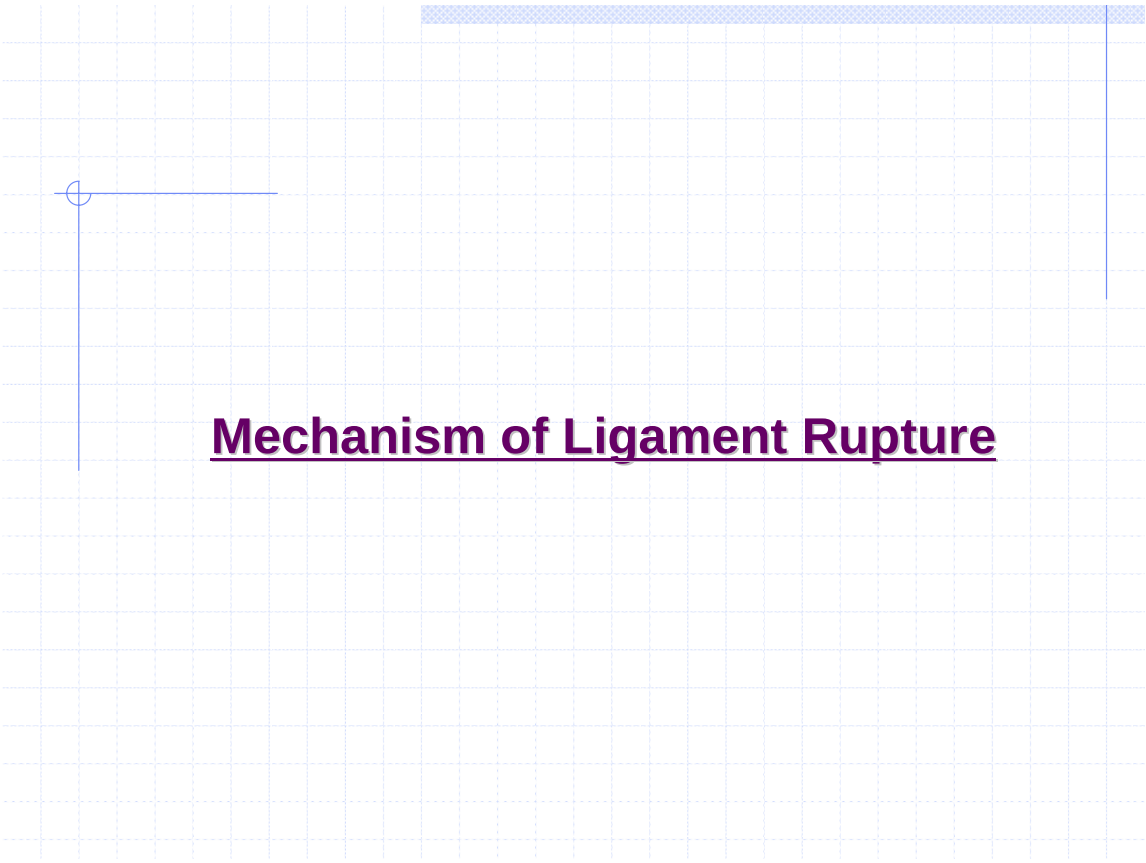

Mechanism of Ligament Rupture

Fig. 17

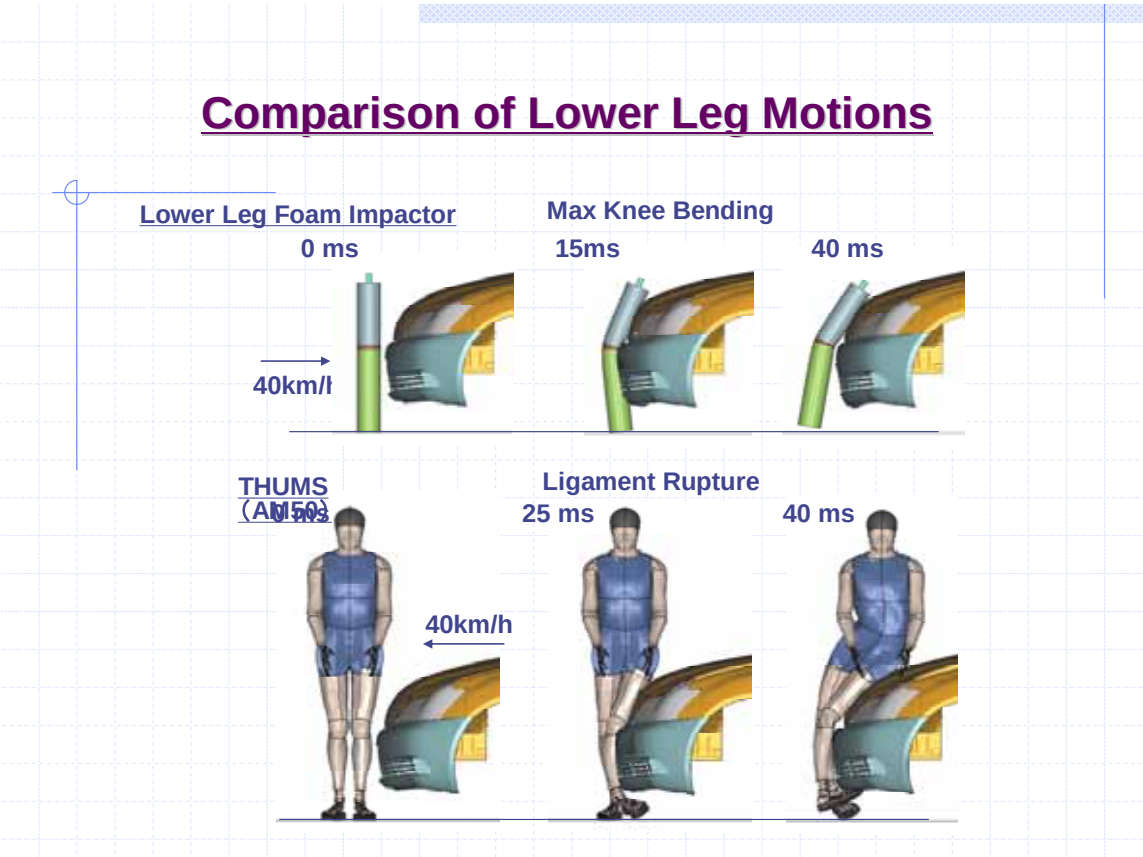

Comparison of Lower Leg Motions
Lower Leg Foam Impactor
0 ms
Max Knee Bending
15ms
40 ms
40km/h
THUMS
(AM50)
0 ms
Ligament Rupture
25 ms
40 ms
40km/h

Fig. 18

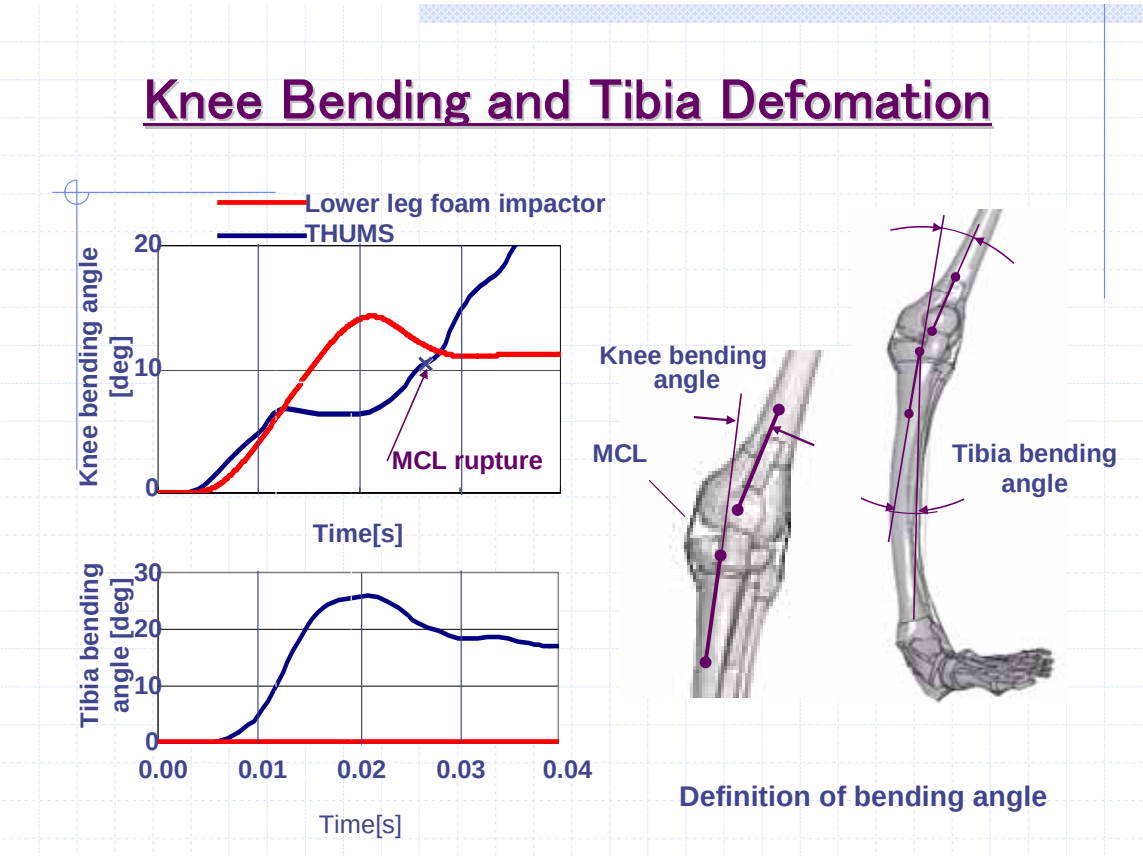

Knee Bending and Tibia Defomation
Lower leg foam impactor
THUMS
Knee bending angle [deg]
20
10
0
MCL rupture
Time[s]
Tibia bending angle [deg]
30
20
10
0
0.00
0.01
0.02
0.03
0.04
Time[s]
Knee bending angle
MCL
Tibia bending angle
Definition of bending angle

Fig. 19

Fig. 20

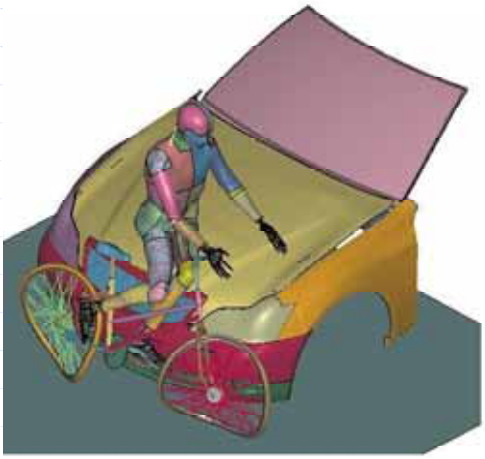
Pros and Cons of the Method

Full scale dummy is good for accident reconstruction.
Impactor is good for car assessment.
Human FE model is good for accident reconstructions and vehicle development.

	Full scale dummy	Impactor	Human FE model
Bio-fidelity	Good	Marginal	Good
Injury mechanism research	Marginal	Poor	Good
Cost	Poor	Marginal	Good
Vehicle development	Poor	Good	Good

Fig. 21

Outlook



Cyclist safety simulation

Detailed brain model

Fig. 22

Conclusion

THUMS has been provided to universities, parts suppliers, and OEMs.

Actually, THUMS is a design tool for pedestrian safety. A lower leg impactor simulation FE model can be replaced by THUMS

By using THUMS for pedestrian safety simulation, knee ligament rupture and bone fracture can be estimated at design stage of vehicle development.

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Fig. 23

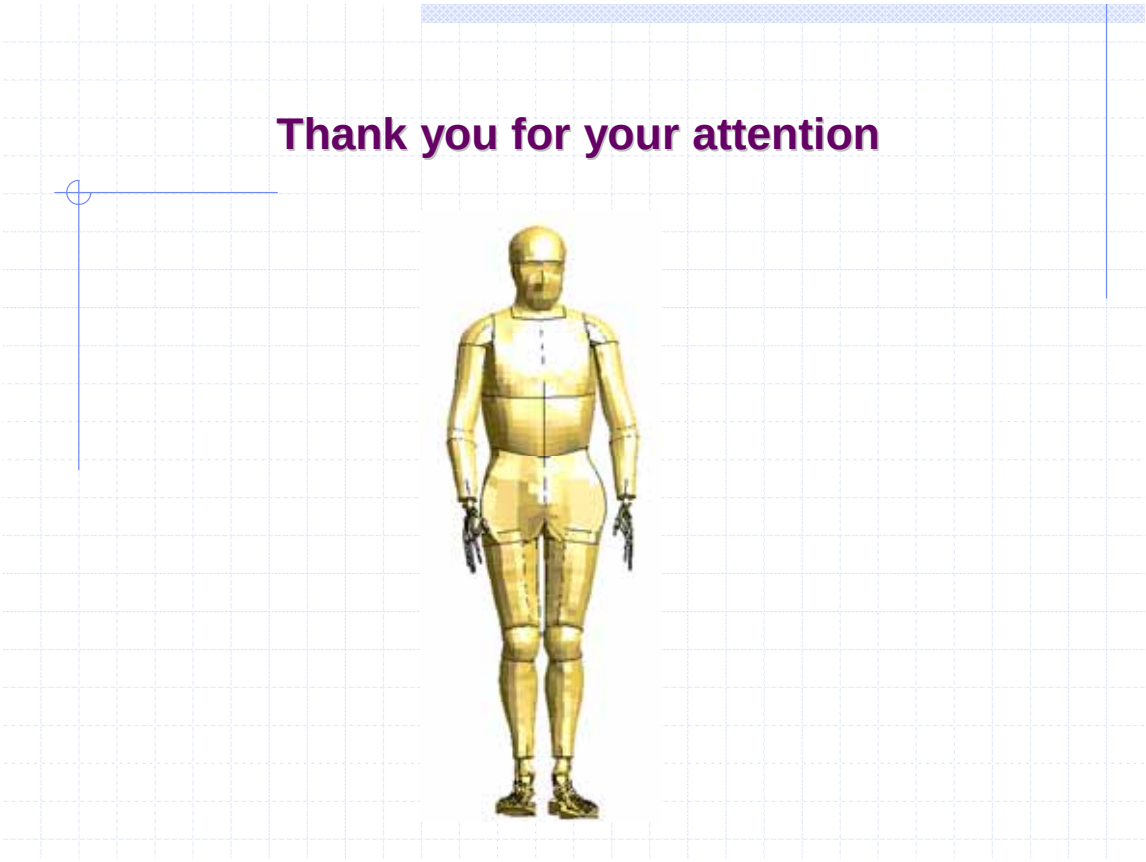

Fig. 24