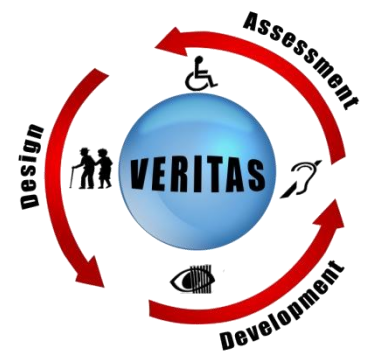




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## Examples from the developers



# LMS, empowering car manufacturers by improving driver and passenger comfort



**driver and passenger  
comfort**



**handling and driving  
pleasure**



**crash resistance  
passive / active safety**



**lightweight  
vehicles**

## Engineering the passion



**“Zero-mizing, Maxi-mizing”**

**Develop  
sound quality  
pass-by-noise**

**power consumption  
emissions**

**durability and  
reliability**

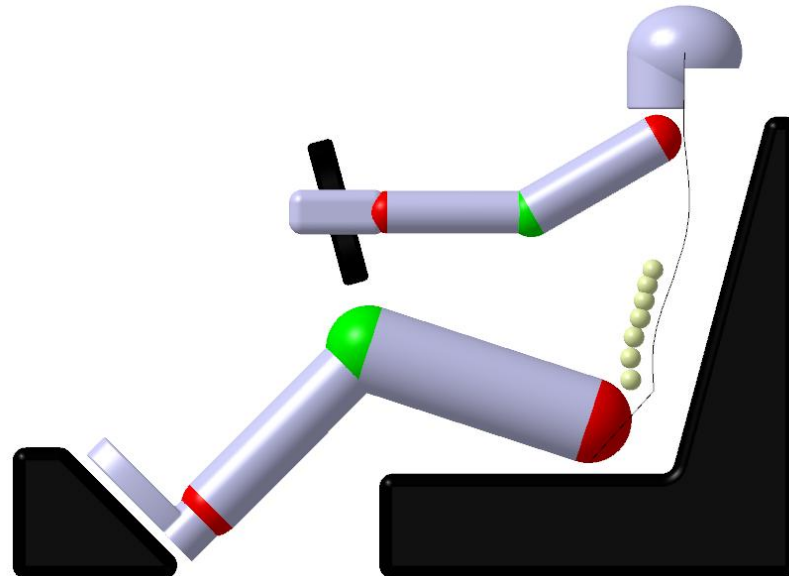
**driver productivity**



# WHOLE BODY VIBRATION ASSESSMENT BY USING MBS HUMAN MODEL

## APPLICATION EXAMPLE

1. Development of 3D MBS model of virtual human dummy to represent the biomechanical response due to whole body vibration.
2. Realistically represent human physical behavior for elderly and disabled people (i.e. modified human joint characteristics)



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# HUMAN BODY REPRESENTATION BY USING MBS METHODOLOGY

## SPINE

Vertebra considered as rigid bodies.

## ARMS STRUCTURE (LEFT AND RIGHT)

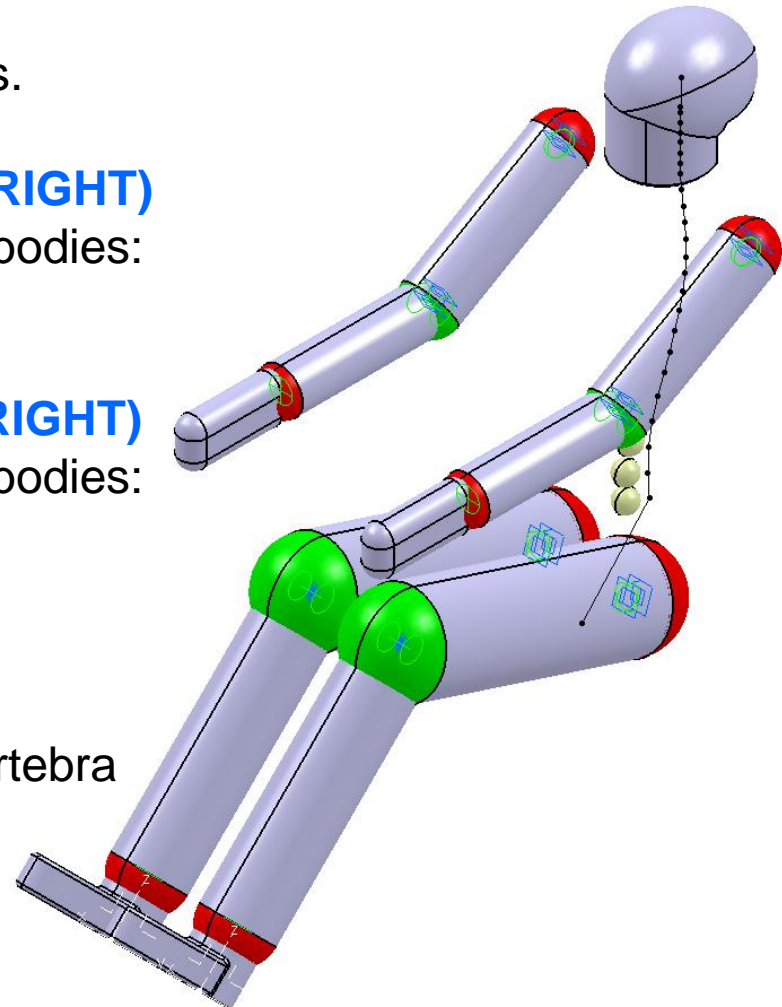
The sub-system is composed of 3 bodies: upper arm, lower arm, hand.

## LEGS STRUCTURE (LEFT AND RIGHT)

The sub-system is composed of 3 bodies: upper leg, lower leg, foot.

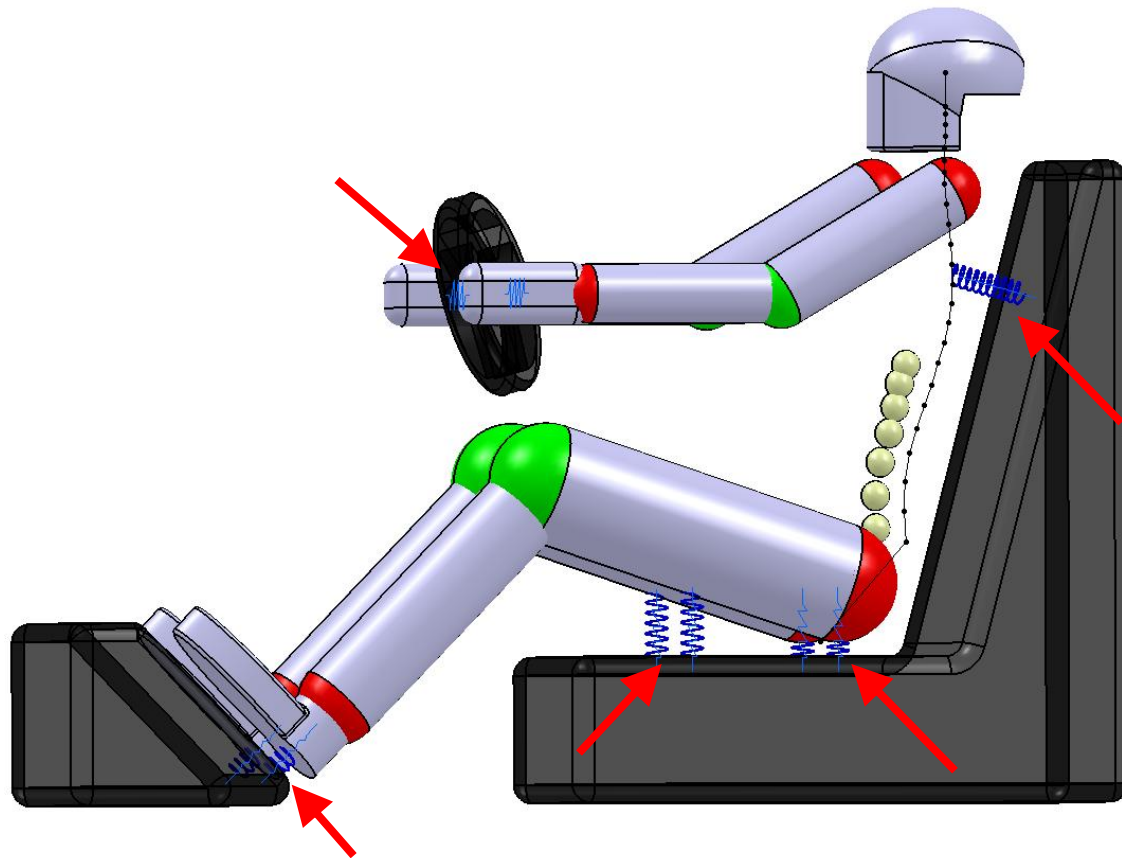
## JOINTS

- spherical joints: shoulders, hips
- revolute joints: elbows, knees, vertebra
- rigidly connected: wrists, ankles



# COMFORT STUDY WITHIN THE AUTOMOTIVE ENVIRONMENT

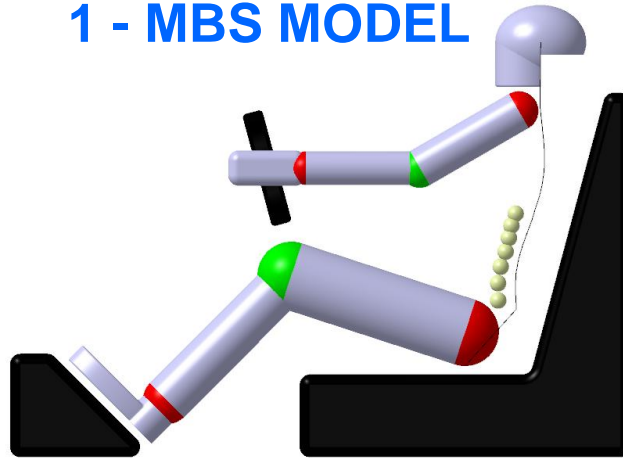
## CONNECTIONS BETWEEN CAR AND DUMMY



5

# FREQUENCY DOMAIN SIMULATION – MODAL ANALYSIS

## 1 - MBS MODEL



## 2 - LINEARIZATION

Motion equations



Solution of Eigenvalues-  
eigenvectors problem



Natural frequencies



<b>MODAL FREQUENCY (HZ)</b>	<b>DESCRIPTION</b>
2.5	Bending mode of the spine
5.2	Principal Vertical seat-body mode
6.4	Horizontal seat-body mode
9.0	Visceral masses vertical mode





# NEXT CHALLENGE: REPRESENT ELDERLY & DISABLED DRIVER

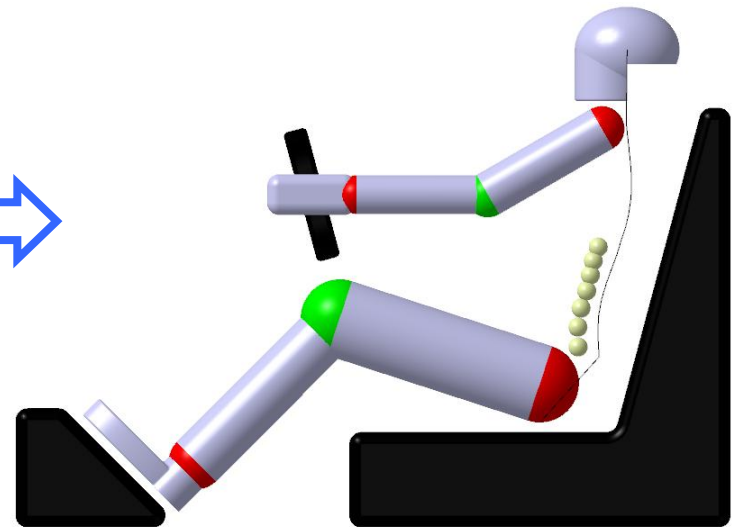
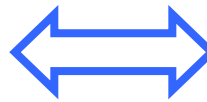
- Extended ergonomic simulation technologies in LMS Virtual.Lab
- Consider of elderly and disabled behavior within automotive scenario:
  - i.e. restricted joint motion range or stiffness



8



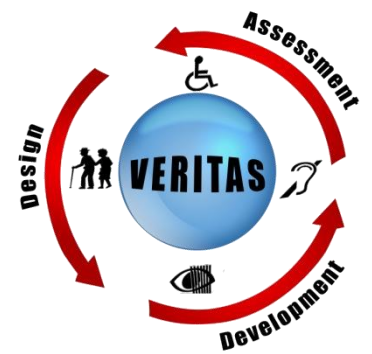
**FOCUS ON ELDERLY &  
IMPAIRED DRIVERS**





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Thank you for the attention!



For additional info, please feel free to contact:

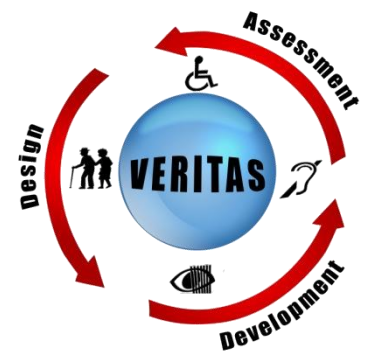
[Nicola.cofelice@lmsintl.com](mailto:Nicola.cofelice@lmsintl.com)

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## Examples from developers

Digital ergonomic product design



## Human Solutions

HUMAN SOLUTIONS

# Motivation



Low development costs

Large sales



Product quality



**Ergonomics**



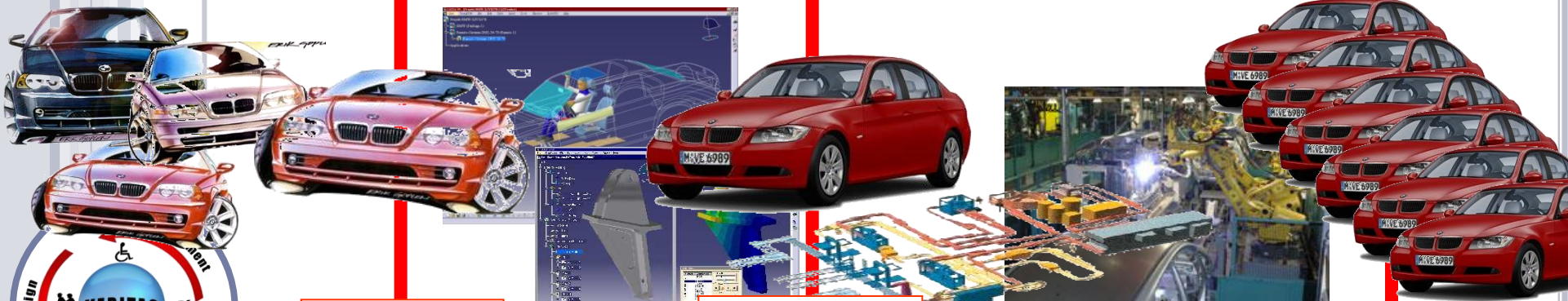
11

# Ergonomics in modern vehicle development

Strategy

Concept Phase

Production Design Phase



Styling Freeze

Virtual Model Freeze

SOP



12

Digital ergonomics

Physical ergonomics

Reduction



Quality



Efficiency



Quality

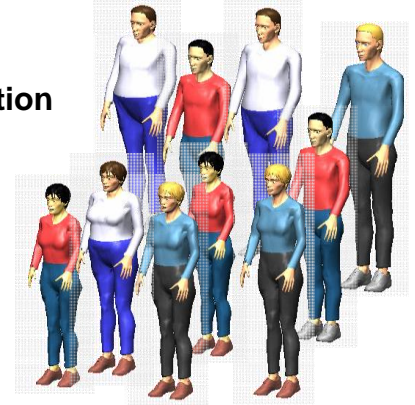
# Efficient ergonomic product design

Clearance

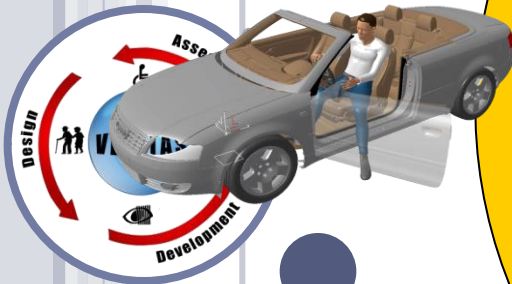


Seat belt

User representation



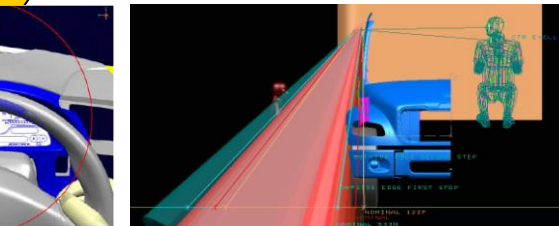
Ingress



Reachability



Visibility



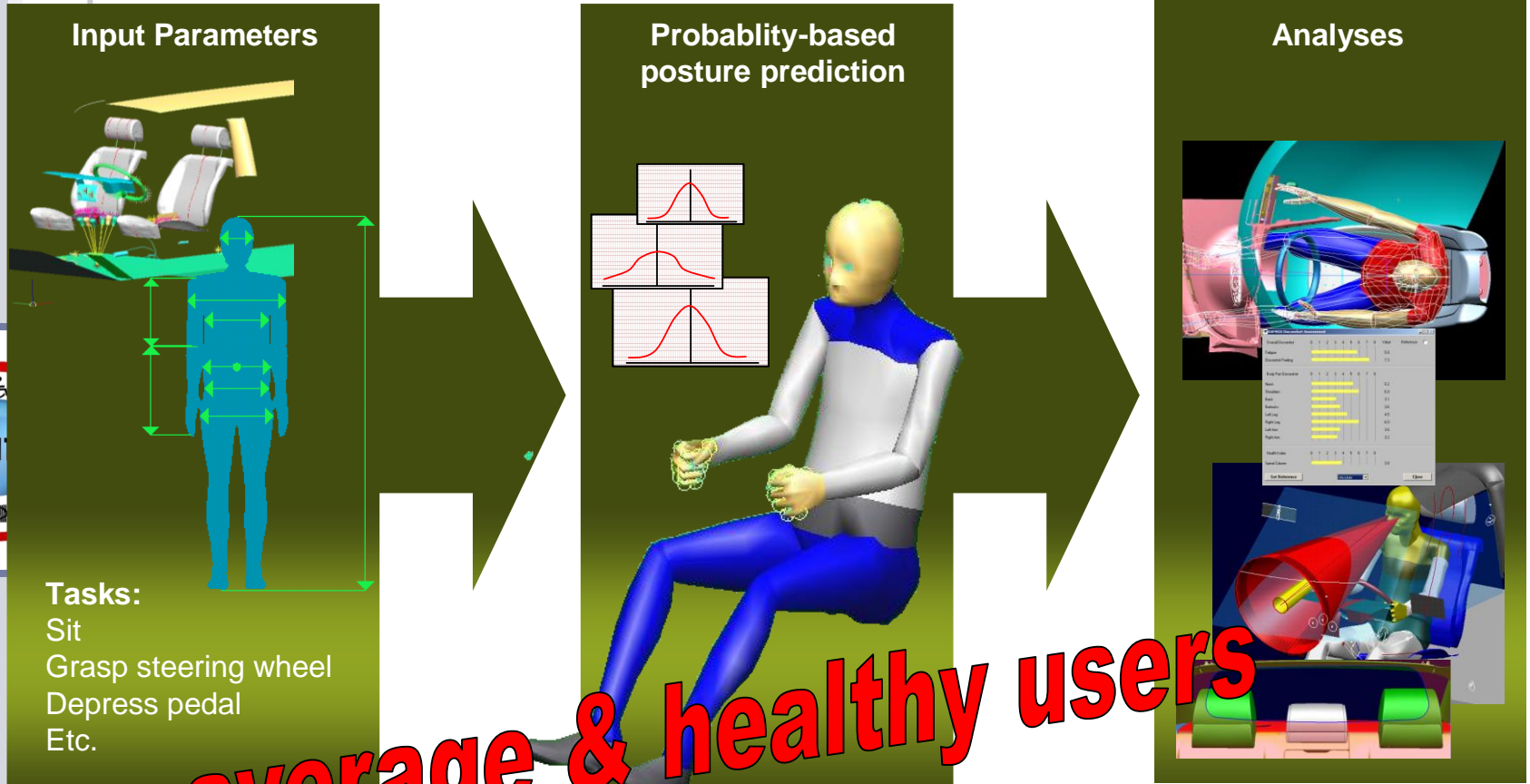
Feasibility



Roominess



# Technologies – Ergonomic design with digital human model RAMSIS



# Benefits from VERITAS project

- Extended ergonomic product design
- Consideration of demographic trend



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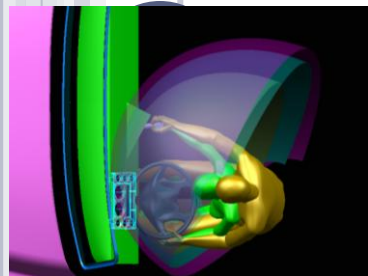
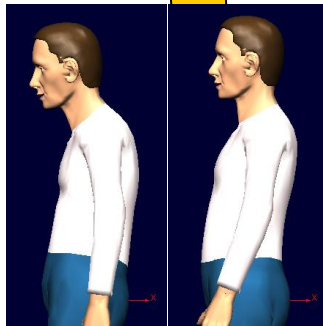
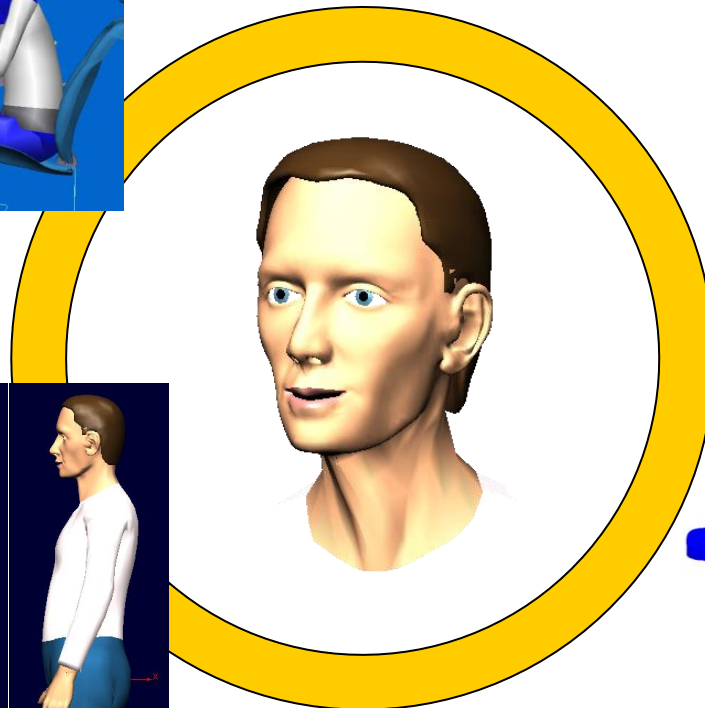
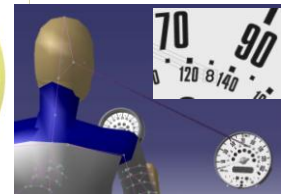
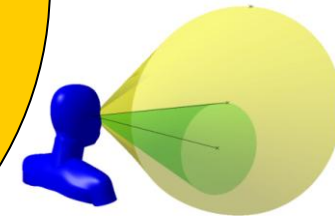
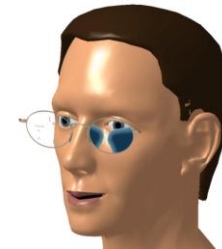
# Benefits from VERITAS project

- Extended ergonomic simulation technologies in RAMSIS
- Consideration of elderly and disabled behavior

Restricted force capabilities



Restricted visibility



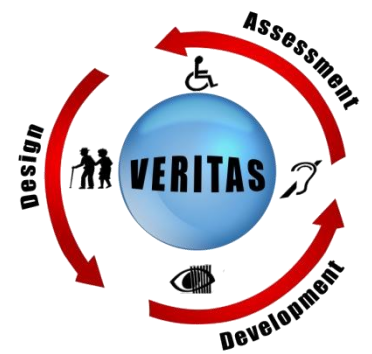
Restricted mobility





# VERITAS project

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Thank you for the attention!



## Human Solutions

HUMAN  SOLUTIONS