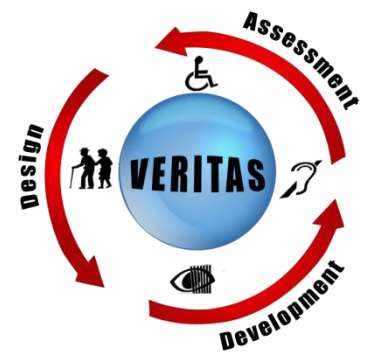




VERITAS project

FP7 247765



User requirements: Benchmarking of existing tools



Nicola Cofelice (LMS)



BENCHMARKING OF EXISTING MODELS, STANDARDS AND PROBLEMS

MAIN ACTIVITY

- Identify initial framework regarding the **existing approaches towards the modeling** of the targeted beneficiaries:
 - older people
 - people with disabilities user groups
- Modeling of physical impairments:
 - Motor impairments
 - Visual impairments
 - Speech and hearing impairments
- Modeling of cognitive impairments
- Modeling of behavioral and psychological states



2

COLLECT INFORMATIONS

LMS PROPOSED A TEMPLATE (ACCEPTED BY INVOLVED PARTNERS)

- **A1.1.2.** Benchmark of existing models, standards and problems
- **A1.3.1.** Report on the study of the state of the art of physical models
- **A1.4.1.** Report on the study of the state of the art of cognitive models
- **A1.5.1.** Report on the study of the state of the art of behav. and psyc. models

STRUCTURE OF THE DOCUMENT

- General information about the model
 - (name, modeling methodology, experience of the reviewer with it, etc...)
- Description of the model for each targeted domain
 - (automotive, workplace, etc..)
- Reported use in state-of-the-art and application papers
 - (journal, user manual, thesis, etc...)
- Use of the model for elderly & disabled user groups
 - (strong points & bottleneck)
- Reference standard and simulation algorithm
- Principle for physical, cognitive, behavioral and psychological modeling

The image shows two screenshots of a questionnaire form. The left screenshot is the title page, titled "Benchmarking of Existing User Models and Physical Driver Modeling". It includes the project name "H2020 project VERITAS, the VERIS-7 idea", the acronym "Fuzzy Finite Element Method", and the logo of the University of Leuven (ULB). It also provides contact information for the project manager, including a name, email, and phone number. The right screenshot shows the "Personal Data" section, which includes fields for name, email, and phone number, and a section for "Section A: 'Benchmarking of Existing Models' (part of A1.1.2)". This section contains several checkboxes for selecting the model type (Physical, Cognitive, Behavioral, Psychological) and the domain (Automotive, Workplace, etc.).



BENCHMARK OF EXISTING TOOLS FOR MOTOR & VISION IMPAIRMENTS

Motor and Vision Impairment

24 models analyzed

Almost 100 references analyzed

		Model name	Automotive	Smart Living Space	Workplace	Infotainment	Healthcare	Other	
VR	Graphic render	ARGOSY					•		
		BLENDER				•			
		MAKE HUMAN				•			
	FK + IK	RAMSIS	•						
		DELMIA	•		•	•			•
		ENOVIA	•		•	•			•
		MAYA	•			•			•
NX HUMAN		•	•	•				•	
JACK	•	•	•				•		
VIDEO CAPTURE		MOTEK				•	•		
		CONTEMPLAS					•		
		VISUAL 3D					•		
		VICON	•	•		•	•	•	
MBS	ID	ANYBODY	•		•		•	•	
		OPENSIM				•	•		
	FD + ID	SIMM				•	•		
		MODEL from University CALIFORNIA				•	•		
		LIFE MODELER	•	•	•	•	•	•	
	FD	MADYMO	•						
		VL VIRTUAL DUMMY	•						
FE	FK + FD	ALTAIR	•						
		ABAQUS	•						
		LS-DYNA	•						
		PAM SAFE	•						

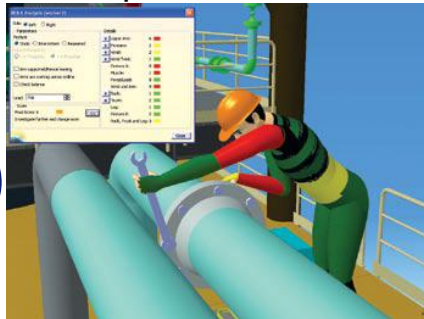


PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (1)

Virtual Reality

- Ergonomic studies & Posture prediction
- Anthropometric database

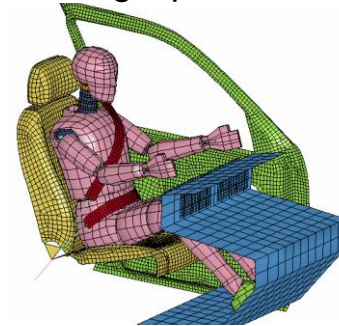
3D



Finite Element Modeling (FEM)

- Crash test & comfort assessment
- Complete or single part human body model

3D



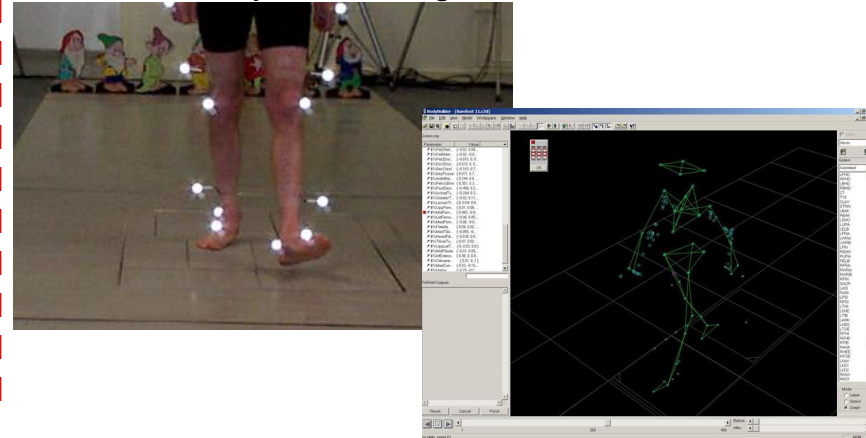
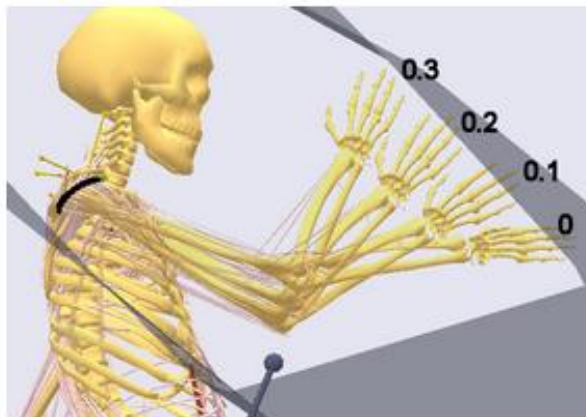
Multi-body Simulation (MBS)

- Forward/Inverse Kinematic/Dynamics Simulation

Techniques

Motion capture + post-process

- acquisition with cameras & kinematic and dynamic magnitude evaluation



5

3D

PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (2)

Virtual reality models - IK/ID (i.e. RAMSIS)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
<ul style="list-style-type: none"> • The simulations are based on forward and inverse kinematics • Allows the user to create advanced, user-defined manikins using a number of advanced anthropometric tools 	<ul style="list-style-type: none"> • No possibility of evaluation of muscle reaction forces • No elderly and disabled people database implemented • No possibility to perform forward and inverse dynamics analysis

Motion capture + post-processing (i.e. VICON)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
<ul style="list-style-type: none"> • Video capture system allows to analyse elder and disabled people gait • It is possible to perform inverse dynamics analysis 	<ul style="list-style-type: none"> • There is not available a data base which contains anthropometrics information • Evaluation of kinematics and dynamics magnitudes are based on acquired data



6

PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (3)

Multibody models –FK / FD (i.e. VL Dummy)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
<ul style="list-style-type: none"> • The simulations are based on forward kinematics • It is possible to perform forward dynamics analysis • Allows the user to create advanced 3D manikins using an anthropometric database 	<ul style="list-style-type: none"> • No elderly and disabled people database implemented • No possibility to perform inverse kinematics and inverse dynamics analysis

Multibody models - FK / FD & IK / ID (i.e. ANYBODY)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
<ul style="list-style-type: none"> • The simulations are based on forward and inverse kinematics • It is possible to perform forward and inverse dynamics analysis • Allows the user to create advanced 3D manikins using an anthropometric database 	<ul style="list-style-type: none"> • Simulation and model data for elderly and disabled people are not available



PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (4)

Finite Element Models (i.e. PAM-safe)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
<ul style="list-style-type: none"> • Real experimental dummies are available in FE analyzed software. The models take into account kinematic magnitudes and biomechanical parameters (i.e. full and detailed model of the spine, internal organs, ribs) • The simulations are oriented to crash test and pedestrian impact test. It is possible to perform forward kinematics and dynamics analysis 	<ul style="list-style-type: none"> • The dummies don't take into account elderly and disabled people • The simulations are very time consuming due to model and methodology complexity • It is not possible to perform inverse kinematics and inverse dynamics analysis

Virtual reality – only render (i.e. Argosy)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
<ul style="list-style-type: none"> • Anthropometric database available 	<ul style="list-style-type: none"> • Only for rendering (no possibilities of any simulation)



8

BENCHMARK OF EXISTING TOOLS FOR SPEECH AND HEARING IMPAIRMENTS

Speech and hearing impairment

12 models analyzed

15 references analyzed

Hearing loss simulators/models	Speech simulators/models
Inclusive Design toolkit simulator	sim.sagepub
HeLPS	Thomas & Hummel model
HearLoss	Robel & Rodet model
Inspire 2010.2, Starkey simulator	TRACE
Surround Town	
Cochlear Implant Simulator	
HELOS Hearing Loss Simulator	
NIOSH Hearing Loss Simulator	



CONCLUSIONS PHYSICAL TOOLS

- Review of 36 models for human physical modeling and more than 100 references analyzed
 - Virtual Reality + Video Motion Capture suitable to analyze kinematic quantitative metrics
 - Multibody Systems + Video Motion Capture suitable to analyze kinematic & dynamic quantitative metrics
 - FEM methodology not suitable
- Analysis of the interrelation with the cognitive, motor and perceptive tasks needed.



10

BENCHMARK OF EXISTING TOOLS FOR COGNITIVE IMPAIRMENTS

- 17 cognitive models have been studied and analysed until now

Modelling approach	Brief Descriptions	Primary Strengths	Primary Weakness

COGNITIVES MODELS ANALIZED

ACT-IF
 ACT-R
 ADAPT
 AMBR
 Artificial neural networks (ANNs)
 COGENT
 CoLiDeS
 DOKGETT
 DUAL
 EPIC
 GLEAN
 IDA
 MESA
 MIDAS (CORE/AIR)
 SNIF-ACT
 SOAR
 Task Network



CONCLUSIONS COGNITIVE TOOLS

- Analysis of 17 cognitive models
 - ACT-R
- Definition of 13 cognitive functions:
 - Functions considered as cognitive attributes
 - Independent attributes: reaction time
 - Dependent attributes: decision making
 - Functions considered as cognitive tasks
 - Primitive tasks: visual perception
 - Complex tasks: orientation
- Quantitative disability metrics can be extracted from the cognitive function analysis



12

BENCHMARK OF EXISTING TOOLS FOR BEHAVIORAL & PSYCHOLOGICAL STATES

- 14 Behavioral & Psychological tools have been studied and analysed until now

Behav. & Psycol. MODELS

ACT-R

ACT-Simple

EPIC

ANN

Models based on Fuzzy Logic

GOMS

KLM-GOMS

GOMS & Markov Model

Models based on Markov Model

PUM

Motor-Behavior models

IPG driver

CORE

AVANTI



13

CONCLUSIONS BEHAVIORAL & PSYCHOLOGICAL TOOLS

- Analysis of 14 Behavioral & psychological models
 - ACT-R
- From a behavioral point of view there are no impairments defined
 - Better to speak about **Psychological states**.
- Analysis of the **interconnection** of the P&B models, with the **Cognitive and Physical models** needed.

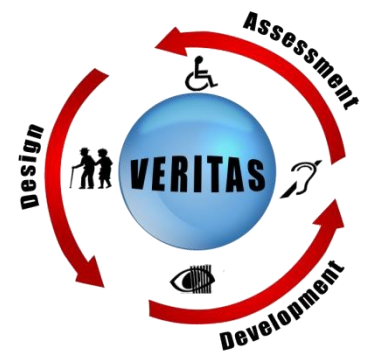


14



VERITAS project

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Thank you for the attention!



For additional info, please feel free to contact:

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15