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OMICS Group International is a pioneer and leading science event organizer, which publishes around 400 open access journals and conducts over 300 Medical, Clinical, Engineering, Life Sciences, Pharma scientific conferences all over the globe annually with the support of more than 1000 scientific associations and 30,000 editorial board members and 3.5 million followers to its credit.

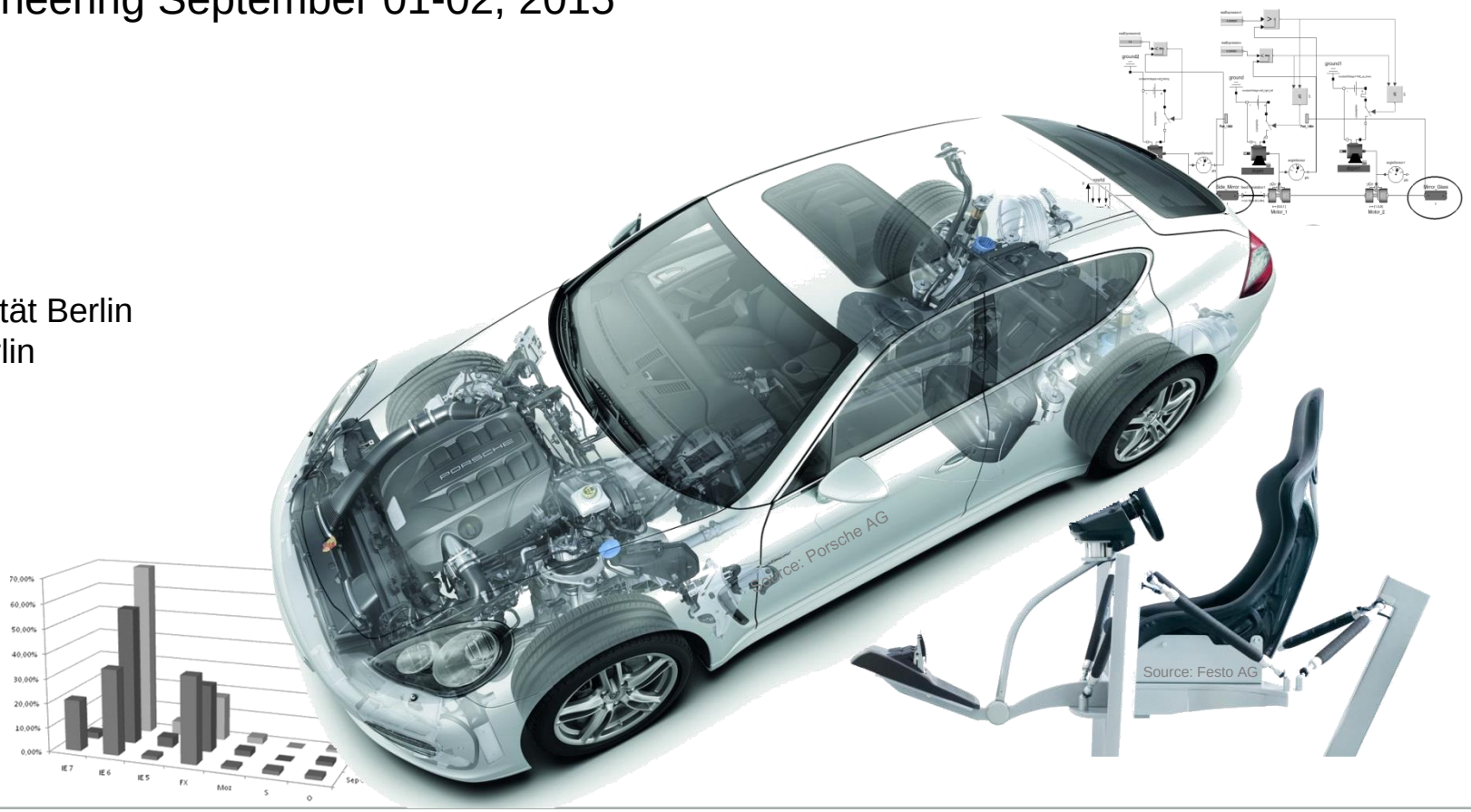
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MEASURING USER EXPERIENCE DURING A DRIVING SIMULATION WITH MINARGUS

Automobile Engineering September 01-02, 2015
Valencia, Spain

Maik Auricht[1]
Rainer Stark[2]

[1] Technische Universität Berlin
[2] Fraunhofer IPK, Berlin



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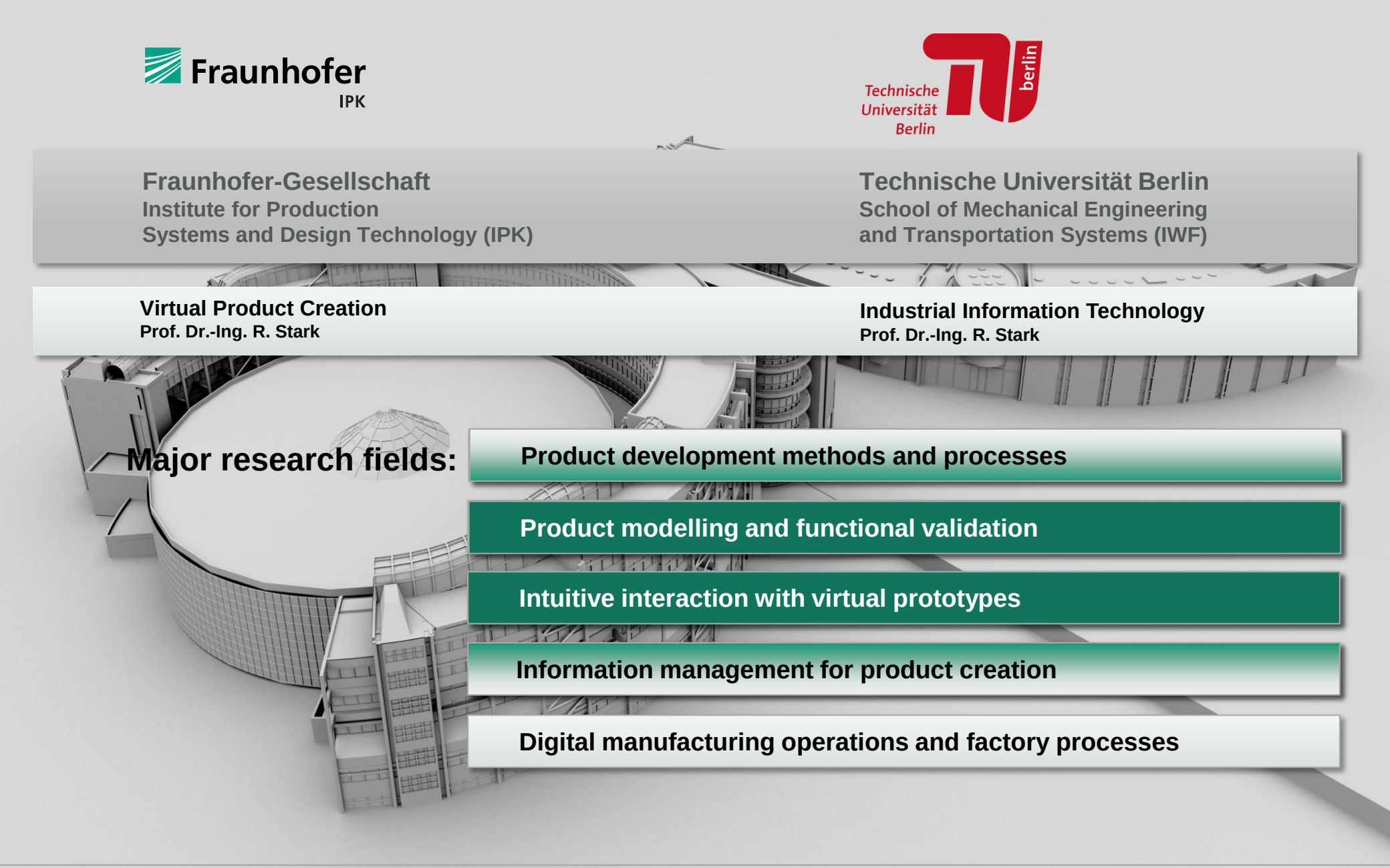
Technische Universität Berlin

Fraunhofer-Gesellschaft
Institute for Production
Systems and Design Technology (IPK)

Technische Universität Berlin
School of Mechanical Engineering
and Transportation Systems (IWF)

Virtual Product Creation
Prof. Dr.-Ing. R. Stark

Industrial Information Technology
Prof. Dr.-Ing. R. Stark



Major research fields:

- Product development methods and processes
- Product modelling and functional validation
- Intuitive interaction with virtual prototypes
- Information management for product creation
- Digital manufacturing operations and factory processes

Source of Picture: Fraunhofer IPK, Alina Goldberg

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Motivation

„With its analysis of more than 300 innovations Oliver Wyman shows that, among other hybrid drives, sequential multi-stage turbocharger, LEDs, intelligent driver-machine interface and electromagnetic brake technologies have the potential to success. **Electronics continues to be the central 'enabler' and drivers for 60 percent of all innovations, with the focus shifted from individual applications to system applications that combine multiple components. As new features are often created by an intelligent combination of existing components and modules**. Almost all the core features of the car will improve: Fuel efficiency (up to 30 percent), emissions, active and passive safety, connectivity and infotainment, vehicle dynamics and performance characteristics, comfort, flexibility and space - while improving cost-benefit ratio for buyers . “

DANNENBERG, J.; BURGARD, J. (2007): 2015 car innovation - Innovationsmanagement in der Automobilindustrie, Oliver Wyman (Hg.)

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Motivation

- Almost every car is equipped with Advanced Driver Assistance Systems (ADAS)
- It occurs, that drivers are not satisfied with the system
- That can have different reasons:
  - A: Usability aspects (such as Effectiveness or Efficiency)
  - B: System does not work correctly (technical aspects)
  - C: System has interdependencies with other assistance systems (similar to B)
  - D: User experience issues (such as subjective feelings, motivational aspects)
- There are different validation methods for the reason A-C in the early phases of the product development process
- However, there are no running validation methods for reason D
- Reason D is more a validation problem rather than a verification problem*

*Verification: Are we building the system right? | Validation: Are we building the right system?

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Structure of the presentation

State of the art

Validation methods for Advanced Driver Assistance Systems

User Experience

Driving Simulators

Results of the questionnaire

Pilot questionnaire

Development of a new tool to perform User Experience tests

MINARGUS: A new tool to measure UX and control the simulation

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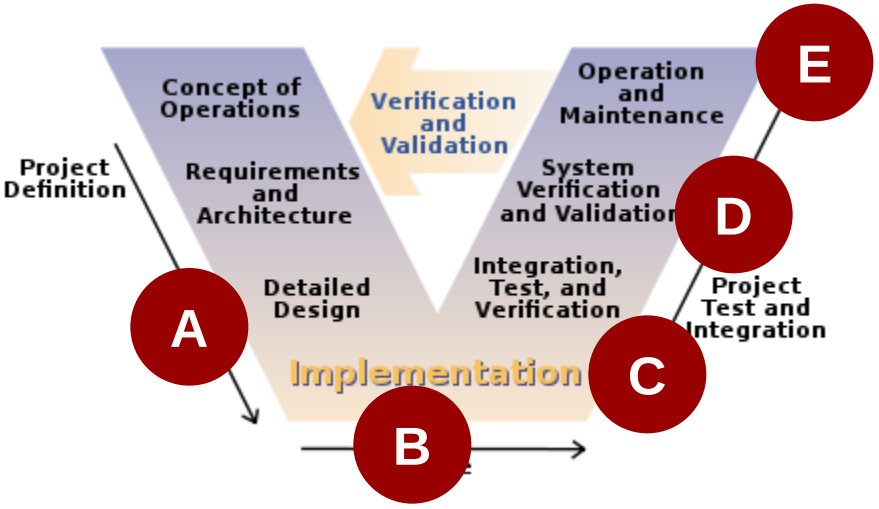
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MINARGUS: A new tool to measure UX and control the simulation

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State of the art

Validation methods for Advanced Driver Assistance Systems (ADAS)



- During development ADAS are tested with different validation methods:
  - A: Model-in-the-Loop (MiL)*
  - B: Software-in-the-Loop (SiL)
  - C: Hardware-in-the-Loop (HiL)
  - D: Vehicle-in-the-Loop (ViL)
  - E: Field tests
- During all tests, driving simulators are used in different maturity levels

* Model in the Loop (MiL) is the simulation of an embedded system in an early development phase.

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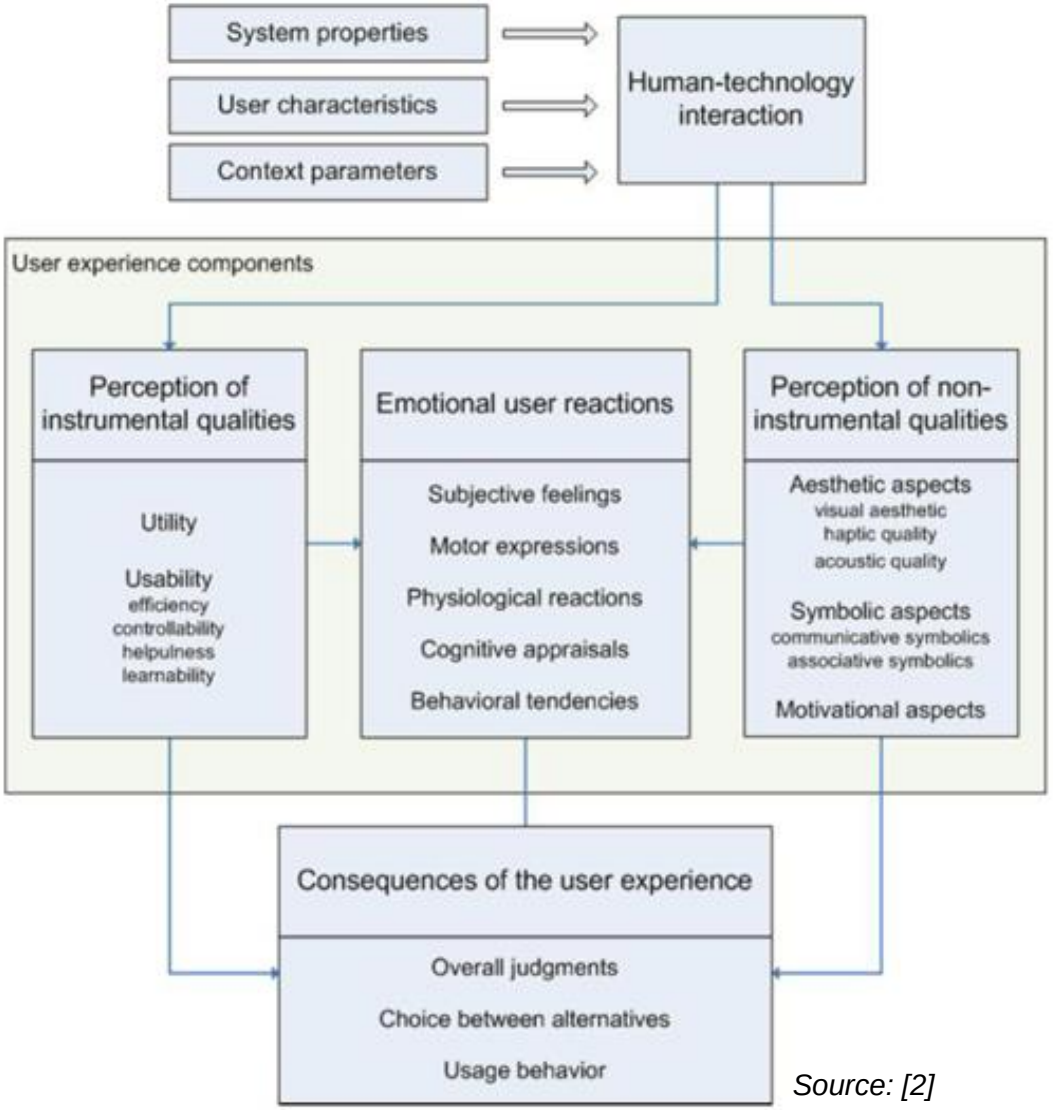
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State of the art

User Experience

"By "experience" we mean all the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it." [1]

- User Experience is more than Usability
- It consideres emotions, subjective feelings, aesthetic aspects, etc.
- Questionnaires to measure the UX:
  - AttrakDiff
  - Affect Grid
  - mDES
  - VisAwi
  - Etc.



Source: [2]

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State of the art

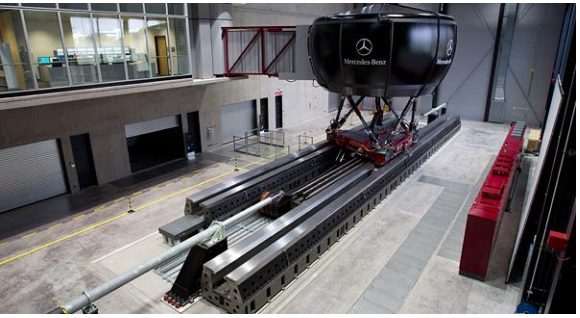
Driving simulators



Source: Daimler



Source: DLR



Source: Festo

- Separation in static and dynamic simulators
- Static simulators are often use in early phases (MiL)
- Dynamic simulators provide G-forces and thus enhance the user feeling
- There are different price ranges depending on the maturity:
  - Small driving seats (e.g. Festo Airmotion Ride 50k€)
  - Hydraulic hexapod-systems (e.g. DLR driving simulator 2M€)
  - Full range simulators (e.g. Daimler 40M€)
- The visualisation reaches from simple monitors up to 360° projection

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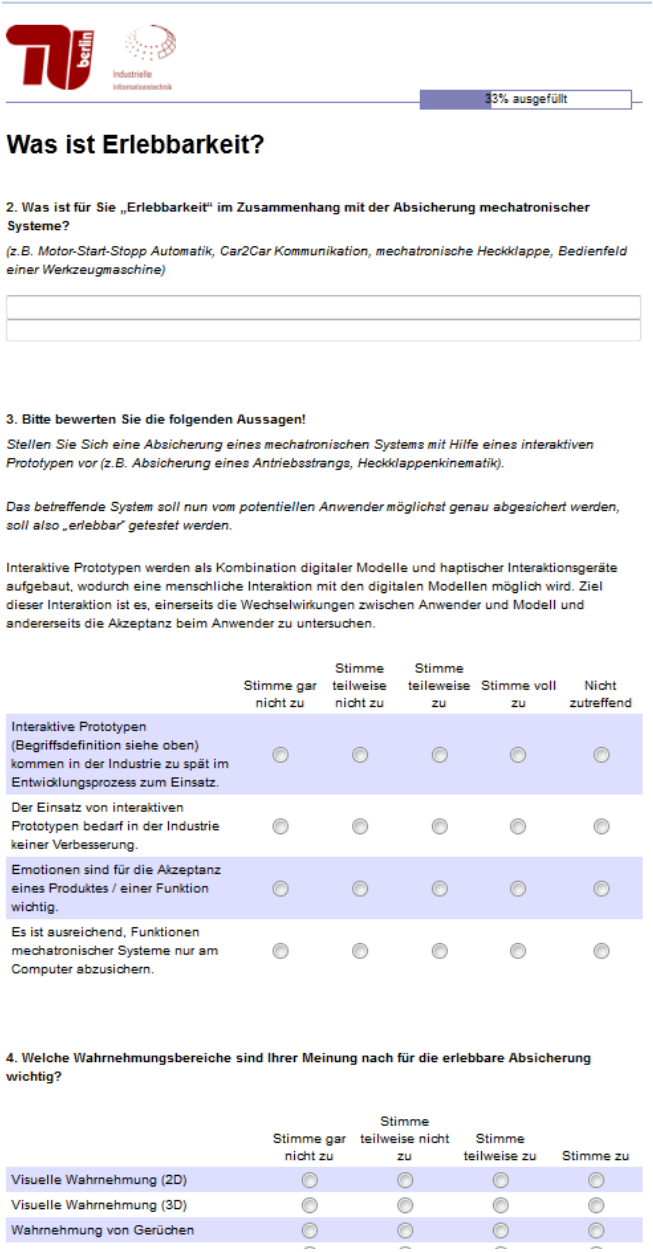
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Pilot study

Setup

- First pilot study
- Exploratory questionnaire
- 5 closed questions
- 15 open questions
- Participants:
  - 36 experts (Virtual Product Creation)
  - Average age: 31
- 8 weeks duration



33% ausgefüllt

Was ist Erlebbarkeit?

2. Was ist für Sie „Erlebbarkeit" im Zusammenhang mit der Absicherung mechatronischer Systeme?

(z.B. Motor-Start-Stopp Automatik, Car2Car Kommunikation, mechatronische Heckklappe, Bedienfeld einer Werkzeugmaschine)

3. Bitte bewerten Sie die folgenden Aussagen!

Stellen Sie Sich eine Absicherung eines mechatronischen Systems mit Hilfe eines interaktiven Prototypen vor (z.B. Absicherung eines Antriebsstrangs, Heckklappenkinematik).

Das betreffende System soll nun vom potentiellen Anwender möglichst genau abgesichert werden, soll also „erlebbar" getestet werden.

Interaktive Prototypen werden als Kombination digitaler Modelle und haptischer Interaktionsgeräte aufgebaut, wodurch eine menschliche Interaktion mit den digitalen Modellen möglich wird. Ziel dieser Interaktion ist es, einerseits die Wechselwirkungen zwischen Anwender und Modell und andererseits die Akzeptanz beim Anwender zu untersuchen.

	Stimme gar nicht zu	Stimme teilweise nicht zu	Stimme teilweise zu	Stimme voll zu	Nicht zutreffend
Interaktive Prototypen (Begriffsdefinition siehe oben) kommen in der Industrie zu spät im Entwicklungsprozess zum Einsatz.					
Der Einsatz von interaktiven Prototypen bedarf in der Industrie keiner Verbesserung.					
Emotionen sind für die Akzeptanz eines Produktes / einer Funktion wichtig.					
Es ist ausreichend, Funktionen mechatronischer Systeme nur am Computer abzusichern.					

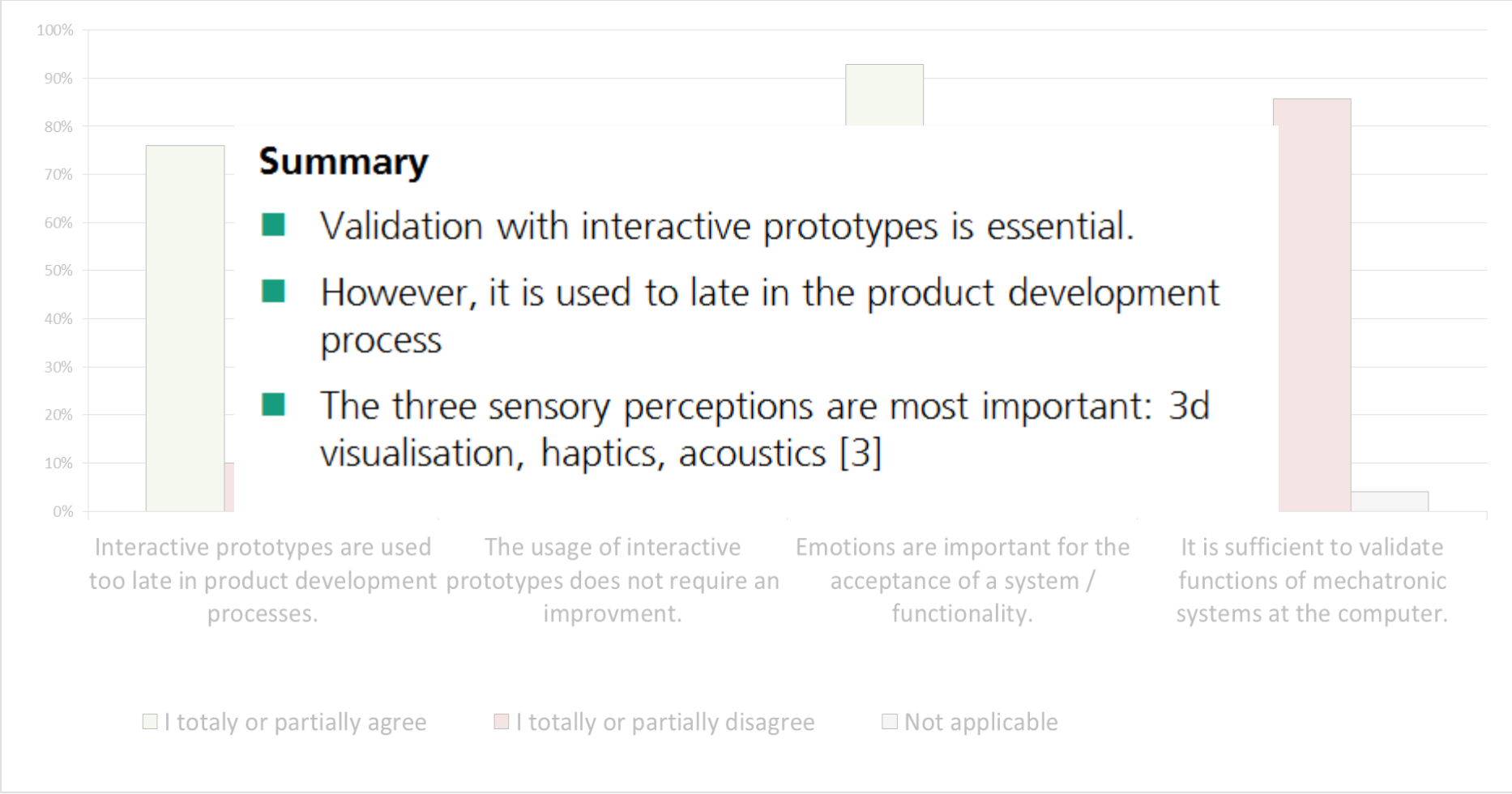
4. Welche Wahrnehmungsbereiche sind Ihrer Meinung nach für die erlebbare Absicherung wichtig?

	Stimme gar nicht zu	Stimme teilweise nicht zu	Stimme teilweise zu	Stimme zu
Visuelle Wahrnehmung (2D)				
Visuelle Wahrnehmung (3D)				
Wahrnehmung von Gerüchen				

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Pilot study

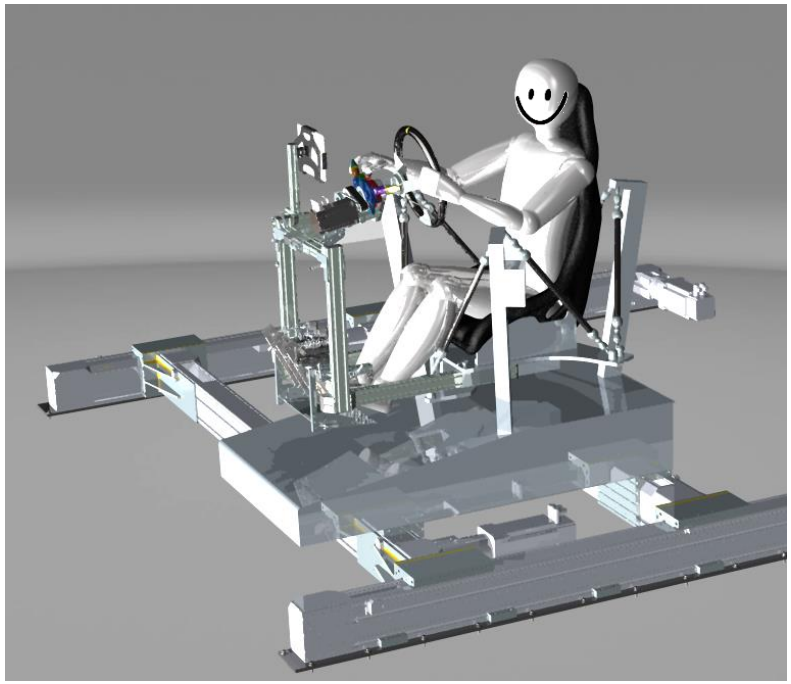
Results

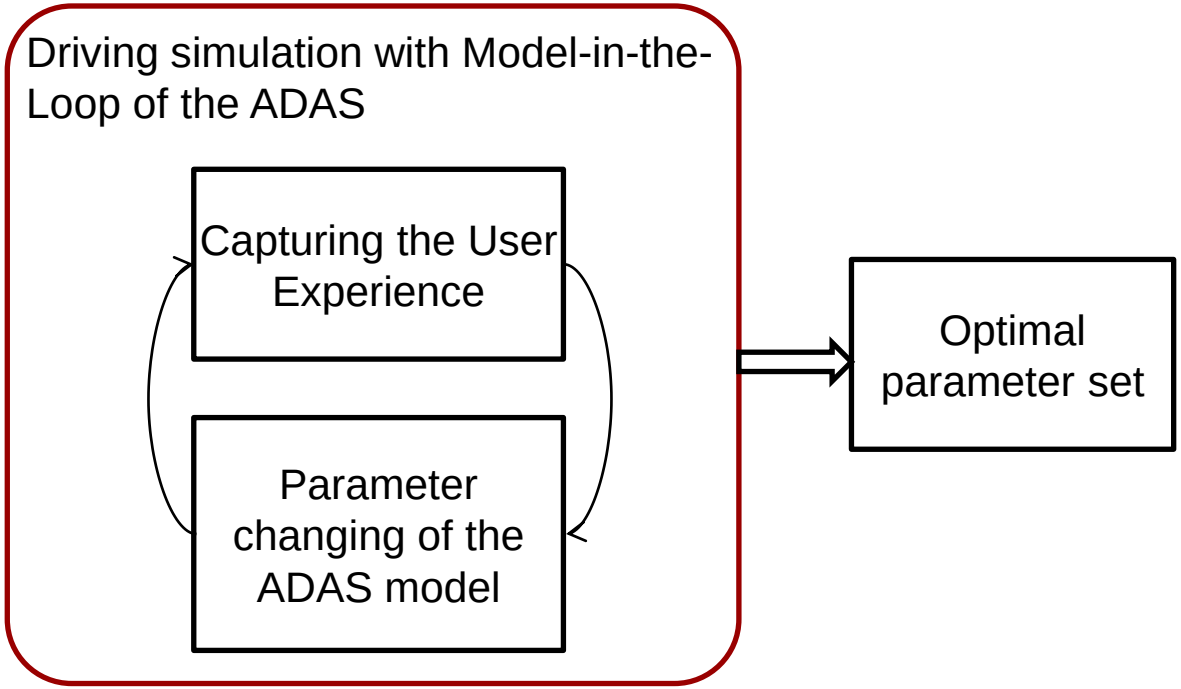


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What is the big aim? Why do I need a new tool?

- The aim is to change parameter during a driving simulation
- Dependent variables are the components of UX
- Configuration is complete if you have best UX-values





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MINARGUS

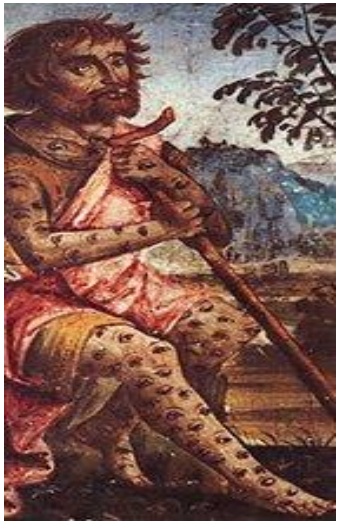


What is MINARGUS?

- A tool which brings together the Engineering part and the Physiological measurement

Why is it called MINARGUS?

- MINARGUS = Minerva (Roman goddes of wisdom) + Argus Panoptes (Greek mythology: 100-eyed giant)



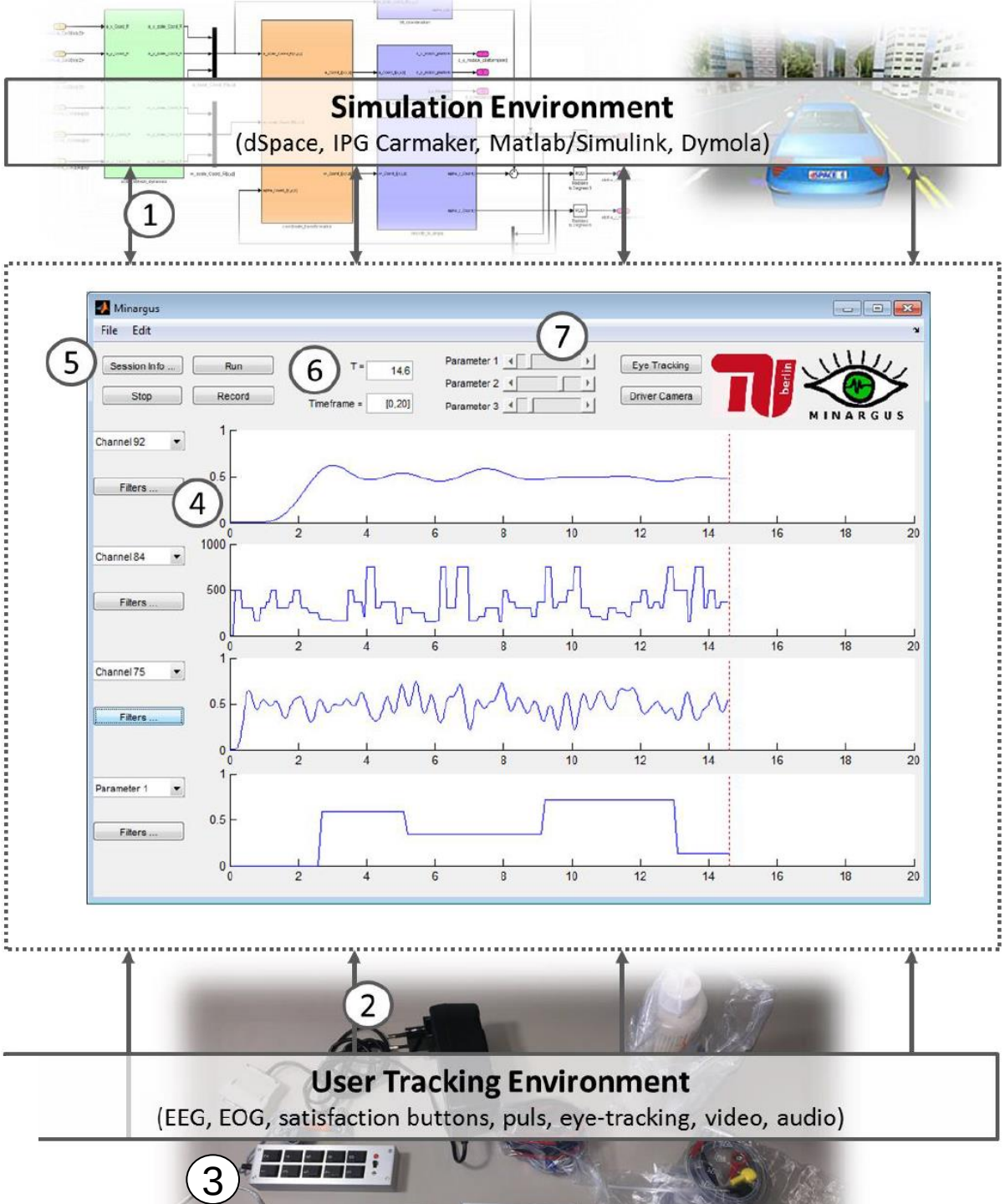
What is MINARGUS capable of?

- It allows the visualization of all measured data and allows the direct parameter sweep within the simulation model

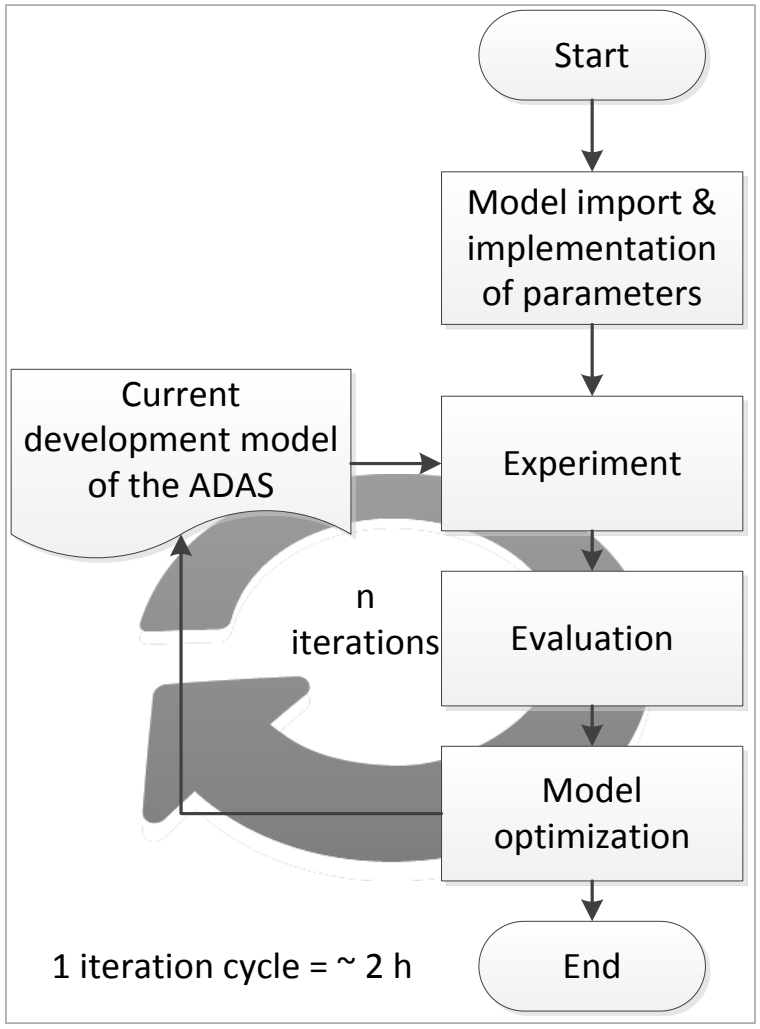
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MINARGUS

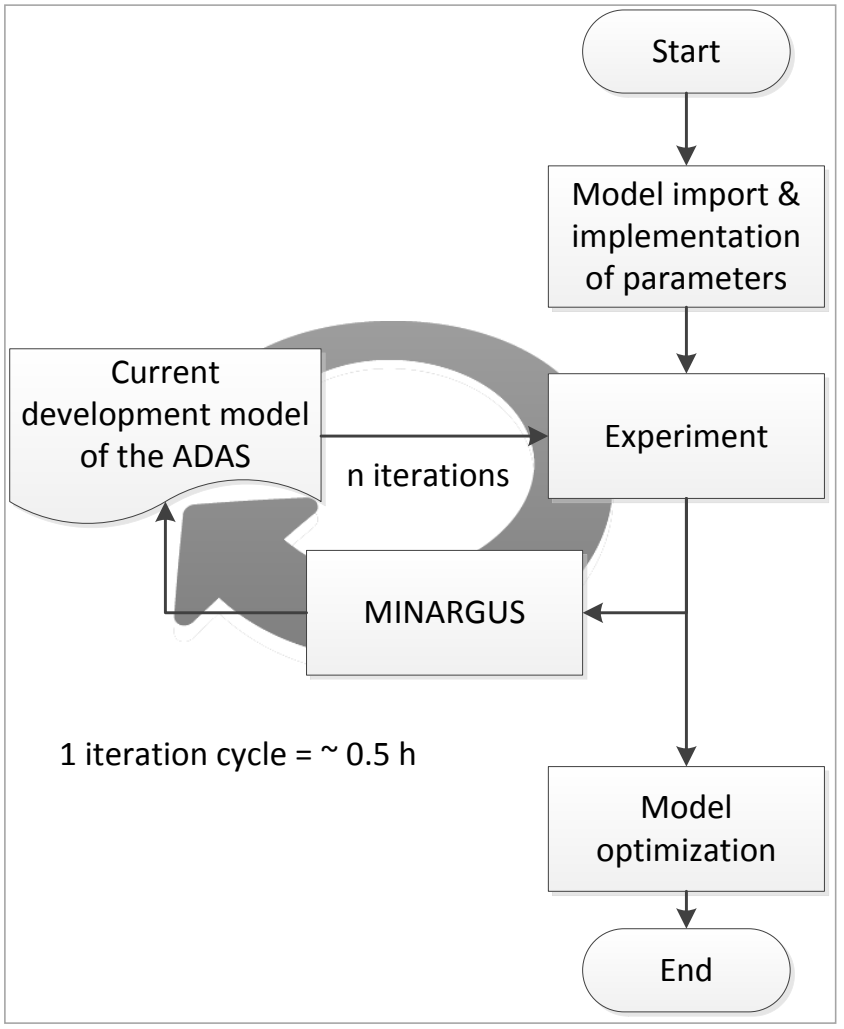
- 1: Direct connection to Matlab
- 2: Connection the User Tracking Environment
- 3: Physiological measurement system (PAR-PORT)
- 4: Visualization of the channels (e.g. EEG, EKG)
- 5,6: Standard functionalities (save, jump to times etc)
- 7: Parameter changes of the simulation model



Change of validation process



The current process

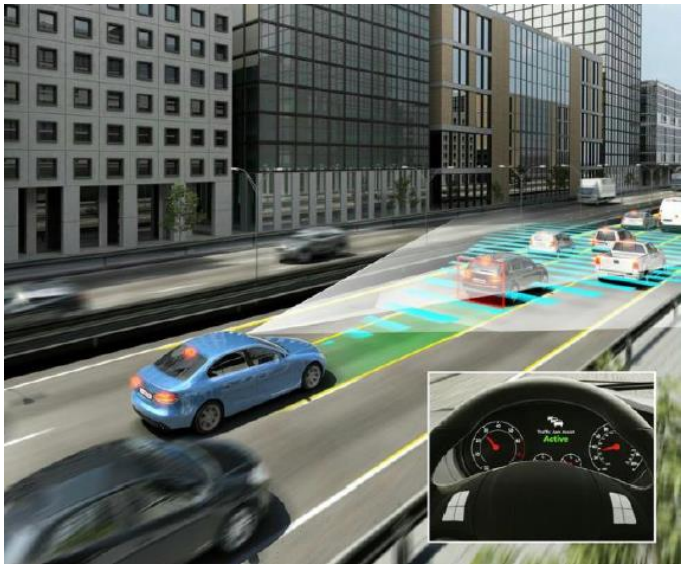


The improved process with MINARGUS

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MINARGUS: An example (1/2)

- The developer defines the test and the parameters, which need to be optimized
  - Using the example of the Traffic Jam Assist, defined parameters can be the starting acceleration or the starting delay
  - Both parameters are highly important for the UX: A high starting acceleration and a short delay indicate an aggressive driving behavior of the system and could cause discomfort
  - Whereas a small starting acceleration and a long delay could cause discomfort in terms of being forced to interact because of the behind driving cars
- These parameters are defined together with the experimental designer
- The experimental designer now builds up the UX test with all its constraints (test procedure, test design, questionnaires, etc.)



Traffic Jam Assist, Source: Bosch, 2014



Emotions, Source: KIT, 2014

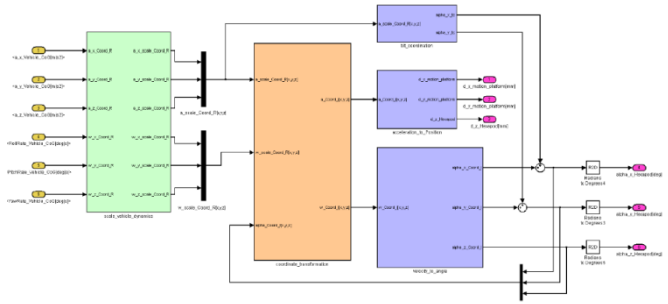
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MINARGUS: An example (2/2)

- After defining the parameters, they are then integrated in the simulation model
- The model and the simulation environment must allow real-time simulation because of adjustments to the parameters
- In most cases there is a complete model of the car and the environment (streets, other cars, etc.)
- In this stage testing can be conducted
- The test subject drives a virtual car in a simulator, which ideally covers all important sense areas
- Once the test has been performed, the results can be evaluated. The model optimization is the final step



Motion Desk, Source: dSpace, 2014



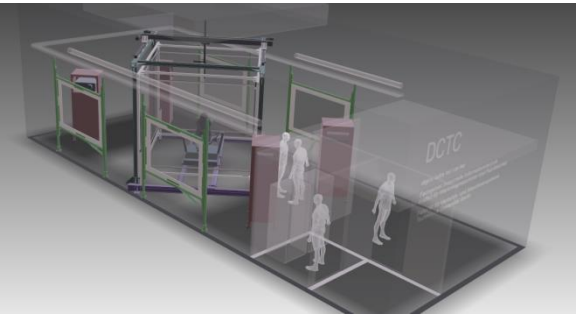
Automotive Simulation Model, Source: dSpace, 2014

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Outlook



Digital Cube Test Center



Digital Cube Test Center



Festo Airmotion Ride

- The presented tool shows a possible integration of psychological measurement methods into existing engineering validation methods
- The usage of the tool can reduce the validation cycle time by ~1,5h
- Developers, validation engineers and human factor experts work now more closer
- Nevertheless the tool needs to be evaluated
- In 2015 there will be a study to prove the functionalities of the tool
- The new tool will be evaluated within the Digital Cube Test Center (DCTC) at the Technische Universität Berlin

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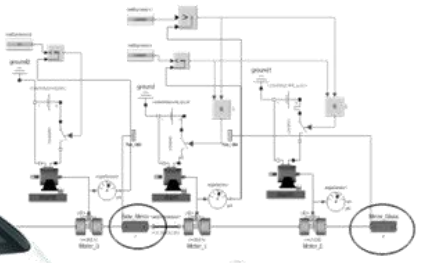
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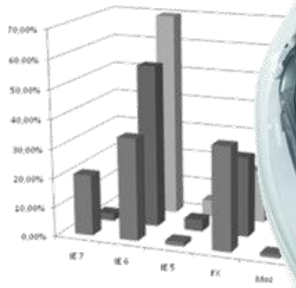


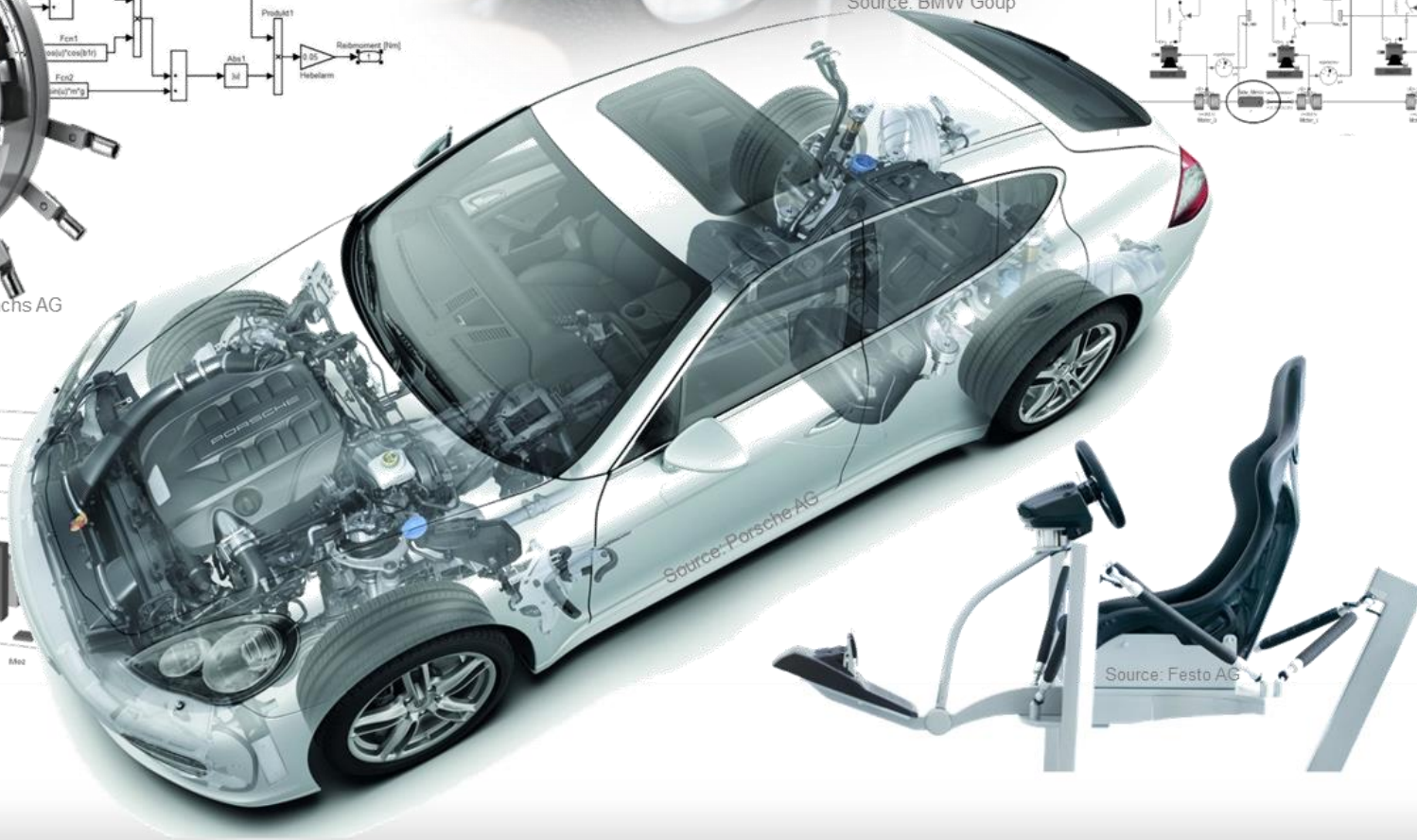
Source: Sachs AG



Source: BMW Goup







Source: Porsche AG

Source: Festo AG

EXPERIENCE & VALIDATE

MAIK AURICHT

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[3] Auricht M, Dittrich E, Brandenburg S, Stark R. Engineering meet UX: Ingenieurstechnische Absicherungsmethoden treffen auf User Experience Forschung. In: Dittrich E, Doria L, Gross A, Günzler T, Smieszek H, editors. Proceedings of the 10. Berliner Werkstatt Mensch-Maschine-Systeme: Grundlagen und Anwendungen der Mensch-Maschine-Interaktion. 10. Berliner Werkstatt Mensch-Maschine-Systeme, 10th ed. Berlin: TU Berlin; 2013.

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