Socio-Technical Requirements for the System Dynamics Modeling of Driving Actions in Cooperative Traffic Systems

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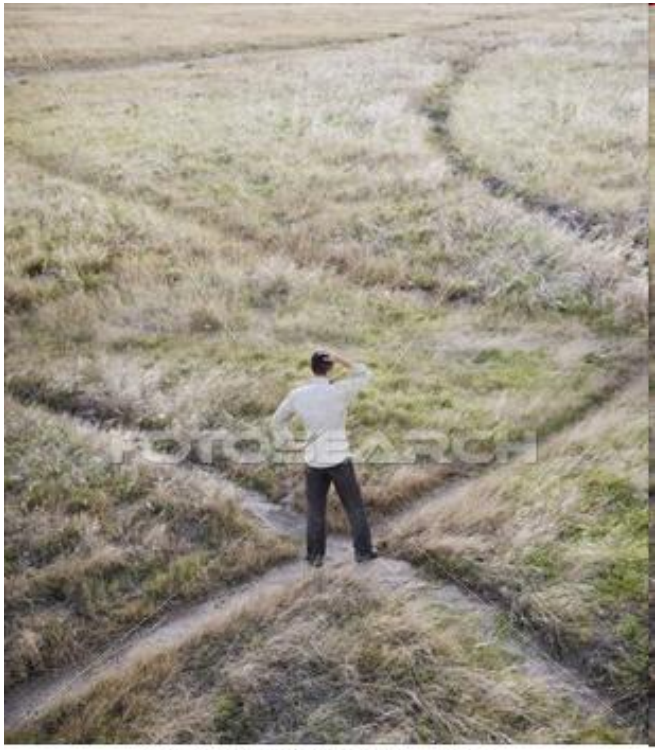

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Presentation Outline

- Three Modeling Problems
- How contribute?
- Conclusion

Three Problems with Humans and “Smart” Systems

- The consequences of humans‘ interaction with smart technologies (*from strategical to adaptative agency*)
- *Humans and society should also become/remain smart* - Human- and social-centered design
- Prediction of the short and long-term acceptance

~~„Humans act, machines can only function“~~

Rammert, Werner und Ingo Schulz-Schaeffer (2002): Technik und Handeln. Wenn soziales Handeln sich auf menschliches und Verhalten und technische Abläufe verteilt, in: dies. (Hg.): Können Maschinen handeln? Soziologische Beiträge zum Verhältnis von Mensch und Technik, Frankfurt a.M. und New York: Campus, S. 7-64.

HCI (Human Computer Interaction)

- Definition (SIGHCI* - ACM): „*Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them*.“(Hewett *et al*. 1992)
- Classical situation: „a person using an interactive graphics program on a workstation“ Static
  - (Quite) Predictible
  - (Quite) Perceptible

- * Special Interest Group on Human Computer Interaction

From *human love for computers* to *the dissapearing computers*

Source: http://www.livelypic.com/portrait-humor-about-human-love-for-computer.html

Computing systems will appear partially to dissolve into the environment and become much more intimately associated with their users' activities (Hewett *et al*. 1992)

„If multi-agent systems (MAS) are released into the real world, a new type of socio-technical system emerges which can be labelled "hybrid system", since it consists of human and nonhuman decision makers.“ (Weyer 2005)

HCI – Smart Technologies

Different type of interactivity

- Dynamic
- Difficult to predict
- Below perception

Understanding

- How include this interactivity in human models (driver models)?
- What are the implications for the acceptance of smart technologies?

System Dynamics Modeling

Presentation Outline

- Three Modeling Problems
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How contribute?

Conducting requirements analysis to determine conditions to be met for new intelligent systems:

- The humans' interaction with smart (agent) technologies
  - Distributiveness of actions on human, technical and social instances (Rammert 2007)
  - Consequences of unbalanced distributiveness
- Its embedding in socio-technical constellations

Empirical „Dynamic“ Questions for System Dynamics Modeling

- How do human and non-human elements interact and co-evolve? (Rammert/Schulz-Schaeffer 2002: 22)
- How do some consequences of this interaction (like for instance short-time adaptativity and reactive-passivity Weyer 2009) propagate through the system?

Levels of contribution

- Problem description: the selection of the most relevant human and social variables involved in the model
- System Dynamics Modeling: the specification of relations between variables, at the qualitative level of the mental model
- Simulation
- Analysis (relation of the model with the real world)

Ex: Traffic coordination at the intersection

Hierarchical control (traffic policeman)
Source: Bundesarchiv_Bild_102-00326A,_Verkehrspolizist.jpg, http://de.wikipedia.org/wiki/Verkehrspolizei

Hierarchical control (traffic lights):
Source: Roundabouts Versus Traffic Intersections: http://www.squidoo.com/roundabouts-versus-traffic-intersections

Cooperative intersection control

Hierarchical/decentralized control Source: Ball & Dulay 2010, Enhancing traffic and intersection control with intelligent objects: http://www.slideshare.net/rudiball/enhancing-intersection-control

Important contribution: Weyer 2009

The cooperative intersection control (Ball & Dulay 2010)

- Better control the intersection through the cooperation of intelligent objects (customized virtual „traffic light“ to each driver)
- Hypothesis: Intelligent objects are capable of adapting and influencing mobility. Vehicles are constrained but capable of speeding up or slowing down
- Dynamical adaptation to vehicle flow and failures
- Included in model: human actors, mobile devices, vehicle, and road rules
- Not included: other objects, weather, road surface conditions

Source Ball & Dulay 2010, *Enhancing traffic and intersection control with intelligent objects*: http://www.slideshare.net/rudiball/enhancing-intersection-control

How contribute?

- Describe the variables relevant for humans' dynamic interaction with smart objects in the intersection,
- De-construct the distributiveness of actions on human, technical and social instances
- Show ways of "socialization" of the agents and formulate scenarios
- Clarify the relation between the technology acceptance and the distributiveness of activities, respectively the dyachronic evolution of human reactivity

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Requirements for the System Dynamic Modeling of the Human Component

Capturing:

- Structure: social and human variables that undergo dynamic variations
- Relations: showing dynamic interdependencies between human-vehicle system and the environment, respectively between the system driver-vehicle-environment and the socio-technical constellation of the traffic system

Continuous Interaction between Humans and Smart Cooperative Objects

- Decisions and actions (tactical, strategical, and operational)?
- How are the sequences of actions distributed? On what instances?
- How do humans assess inputs, real-time recommendations from the cooperative traffic system? How do they respond in real-time to them?
- What happens in time with the humans' capacity to plan and anticipate their actions (predictive, strategic thinking) under the real-time condition?
- To what extent are voluntary decisions, human autonomy, and their ability to recognize situations in the cooperative traffic preserved?
- How do humans react in time to system failure and false alarms, distraction, cognitive overload, unintended consequences of actions?
- How do perceptions about the *ease of use* the *usefullness* of applications (acceptance) evolve in time?

Requirements for the Macroscopic Modeling

Variables at the aggregate level- modeling the emergence of the collective behaviour of communicative mobility

- Collective actors involved? Their perspectives and objectives?
- How do actors and elements adapt to each other in time?
- How is the social behavior of humans in the intelligent traffic shaped through their real-time interaction and coordination of mobility?
- Which pattern follow the changes?
- What are the unintended consequences of yesterday's solutions at the societal level?

Aknowledgements

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