

**SDPS 2023**

**TOWARDS A SUPRA-DISCIPLINARY DESIGN AND PROCESS SCIENCE**

**Workshop Session: Intellectualized Cyber-physical Systems**

# **ARE THE CYBER-PHYSICAL SYSTEMS ONLY “CYBER- PHYSICAL”?**

Position statement by:

Assoc. Prof. Dr. Zühal Erden



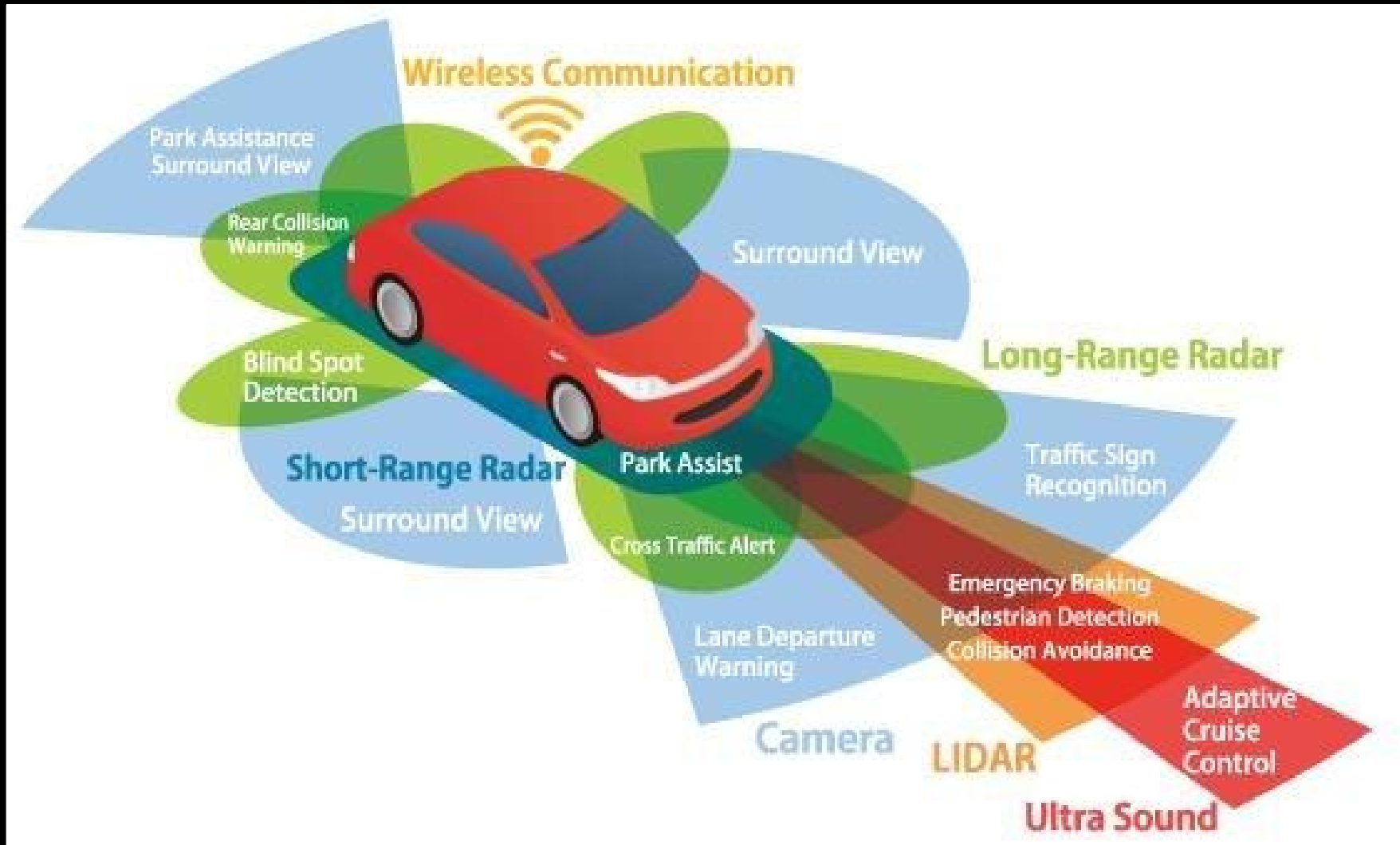
# Position Statement

- Intellectualization of CPS tends towards autonomy with a trajectory of interacting with human and environment consciously.
- Conscious design, whether natural or artificial, needs “conscious AI” leading to I\*CPS interacting with nature and the real world.
- Design, implementation and application of autonomous, socialized and personalized I\*CPS highly depend on mechanisms which blend technological and cognitive abilities with human- and society-related concepts.
- I\*CPS should be designed as compatible with the natural infrastructure for integration into the fabric of society and industry.
- The relationships between I\*CPS and humans/other systems will evolve to assure two-sided consciousness.

# Intellectualization of CPS tends

- Developing cutting-edge technologies for transition from “automation” to “autonomy” resulted in Cyber-Physical Systems (CPS).
- CPS are emerged from and evolved mainly within the scientific, industrial and technological domains.
- They are now penetrating into the daily life of people and society being beyond “Cyber-Physical” only...

# towards autonomy...



Source: Chehri, A., & Mouftah, H. T. (2019). Autonomous vehicles in the sustainable cities, the beginning of a green adventure. *Sustainable Cities and Society*, 51, 101751.

## with a trajectory of

- interacting more with people fulfilling various roles by responding to human/society's behaviors, patterns, and social norms.
- This type of interaction will be possible, if CPS have communication skills and social skills through perceptual and learning systems.

# interacting with human and environment...

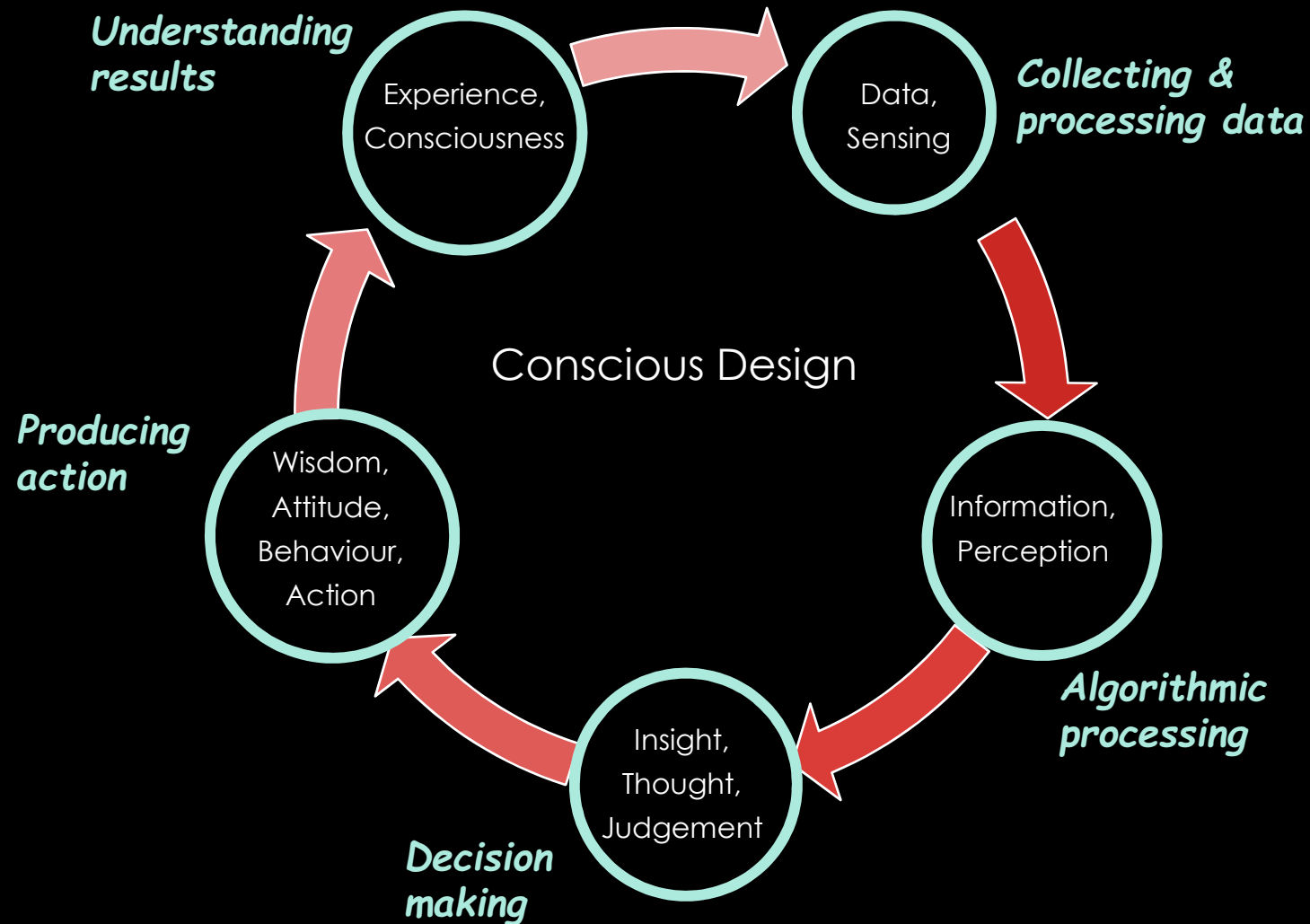


Source: <https://www.cubiclecom.com/blog/self-driving-cars-future-of-autonomous-vehicles-automotive-vehicles-2030/> (accessed:26.04.2022)

## consciously...

- CPS are becoming integrated in a natural/artificial sustainable environment/ecosystem
- Resulting in the developments of Intellectualized CPS (I\*CPS) with the trajectory of conscious design
- Intellectualization of CPS addresses mainly a fundamental adaptation process for the diffusion of CPS into the society.

# Conscious design, whether natural or artificial,

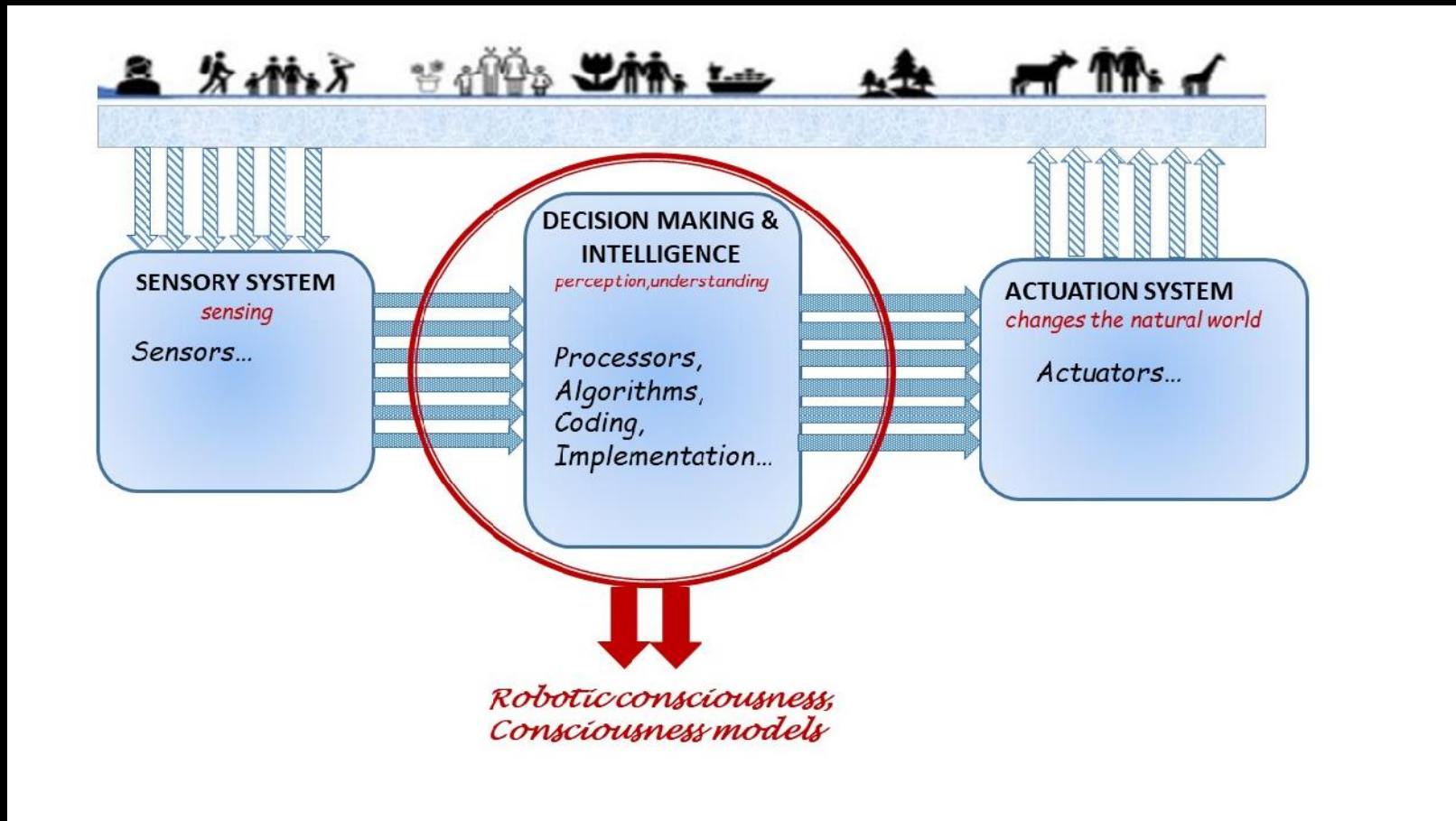


## needs “conscious AI”

- to model and forecast potential consequences of its actions, and
- to change them appropriately using bio-inspired learning and reasoning mechanisms

# leading to I\*CPS

- interacting with nature and the real world



Source: Erden, A. (2023). The Conscious Engineer, The Engineering Consciousness (unpublished book in Turkish, in print)

# I\*CPS – A conceptual overview

	Design	Implementation	Application
<i>Autonomous</i>	Human needs Science&technology Critical thinking Imagination Creativity Consciousness Multidisciplinarity Holistic design Education	Tools&techniques Availability Infrastructures Artificial Intelligence Control Communication Open-source (for design and software)	Economy Sustainability Healthcare Pollution Worldwide affordability Safety
<i>Socialized</i>	Social norms Social awareness Understanding human behavior (individual/group) Social interaction modalities	Human-machine cooperation Social acceptance	Laws/regulations Standards
<i>Personalized</i>	Stakeholder/end-user involvement Modularity User friendly design	Tools for user involvement	Usability Diversity

# What I\*CPS need?

Blending technological and cognitive abilities with human- and society-related concepts

- Learning mechanisms
- Modelling of natural systems
- Scenario based modelling
- Cognitive modelling at system level
- Ontological modelling
- Socio-economic modelling
- Modelling of robot's world
- Behavioral modelling
- Evolutionary mechanisms

# Integrating I\*CPS into society and industry

- The world we live in is an artificial collection of products built on natural infrastructure.
- I\*CPS should be designed compatible with this infrastructure,
- I\*CPS should produce economic, healthy, aesthetic and comfortable solutions with cultural extensions,
- Society should be involved in I\*CPS development,
- People should be educated for living with I\*CPS.

# I\*CPS and humans/other systems

Designing conscious I\*CPS with  
natural/biological/social compatibility



Increase in the consciousness  
level of human/society

*Thank you...*