

SocioErgonomics

A FEW CLARIFICATIONS ON THE
TECHNOLOGY-ORGANIZATIONS-PEOPLE TRIPTYCH

Prof. Guy A. Boy

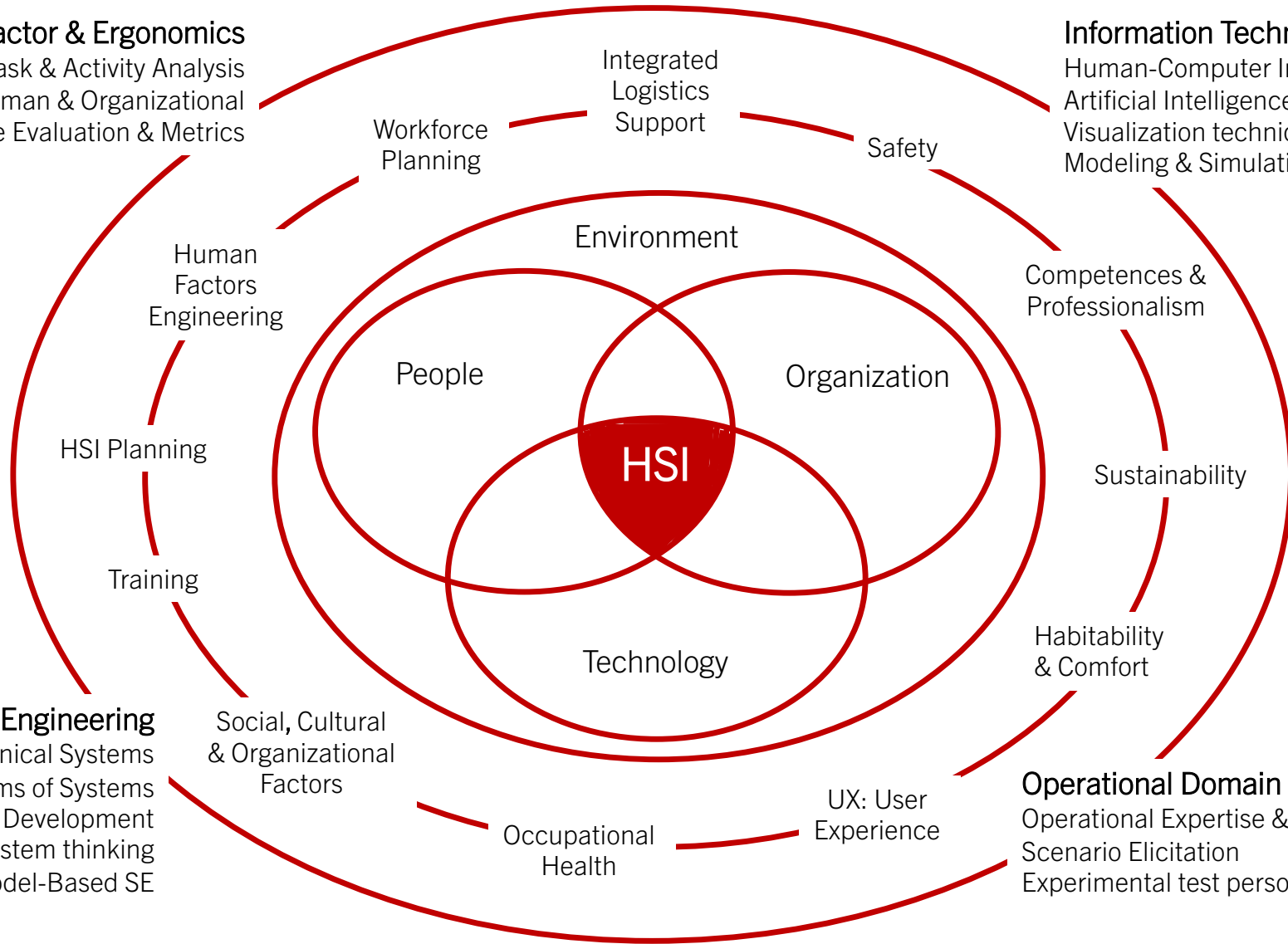
IEA HSI TC Co-Chair





Human-Factor & Ergonomics
Task & Activity Analysis
Human & Organizational
Performance Evaluation & Metrics

Information Technology
Human-Computer Interaction
Artificial Intelligence
Visualization techniques
Modeling & Simulation



Workforce Planning
Integrated Logistics Support
Safety

Human Factors Engineering
HSI Planning
Training

Competences & Professionalism
Sustainability
Habitability & Comfort

Systems Engineering
Sociotechnical Systems
Systems of Systems
Agile Development
Design & System thinking
Model-Based SE

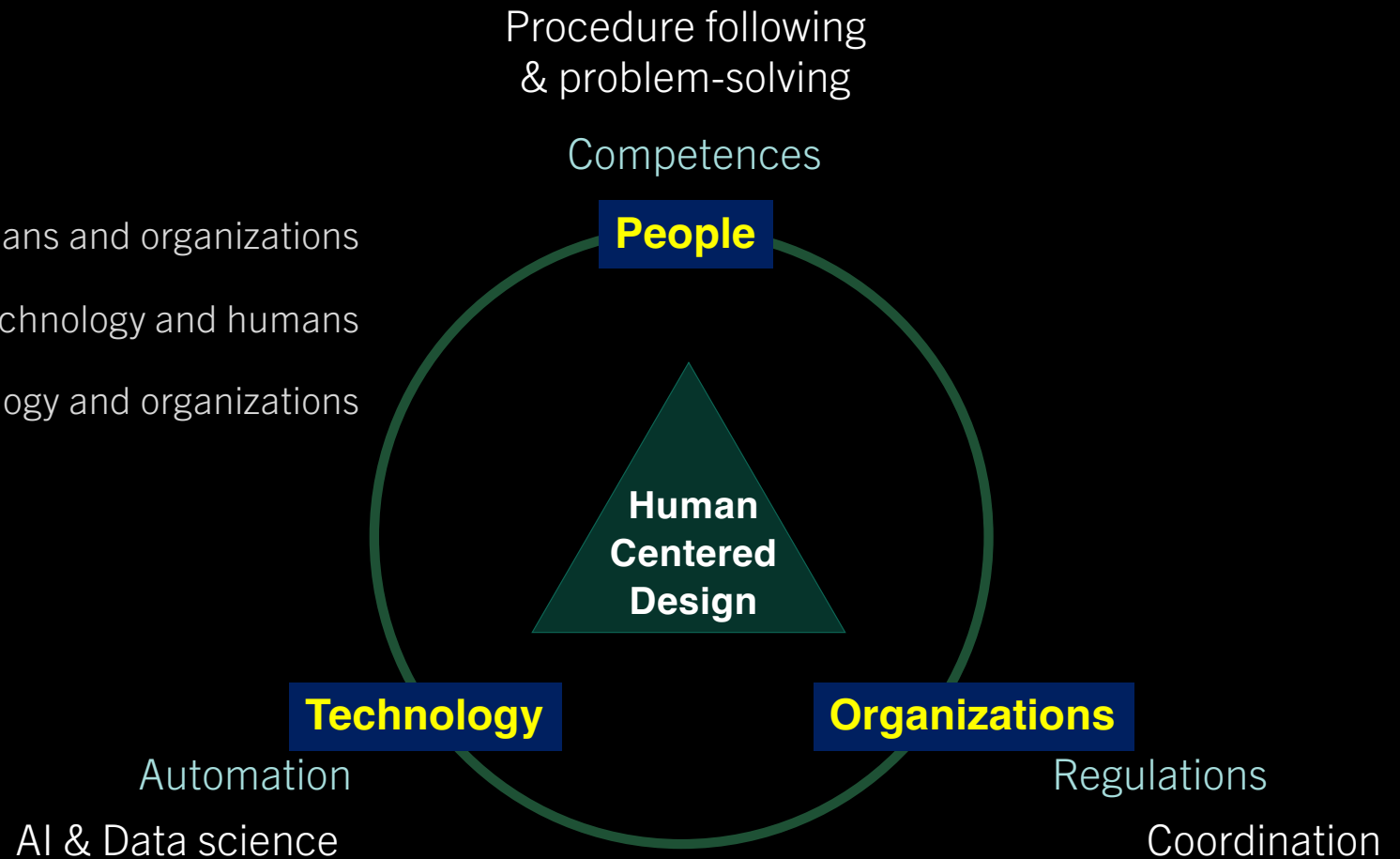
Social, Cultural & Organizational Factors

Occupational Health
UX: User Experience

Operational Domain
Operational Expertise & Experience
Scenario Elicitation
Experimental test personnel

HSI: A MATTER OF ADAPTATION

- Adaptation of technology to humans and organizations
- Adaptation of organizations to technology and humans
- Adaptation of humans to technology and organizations

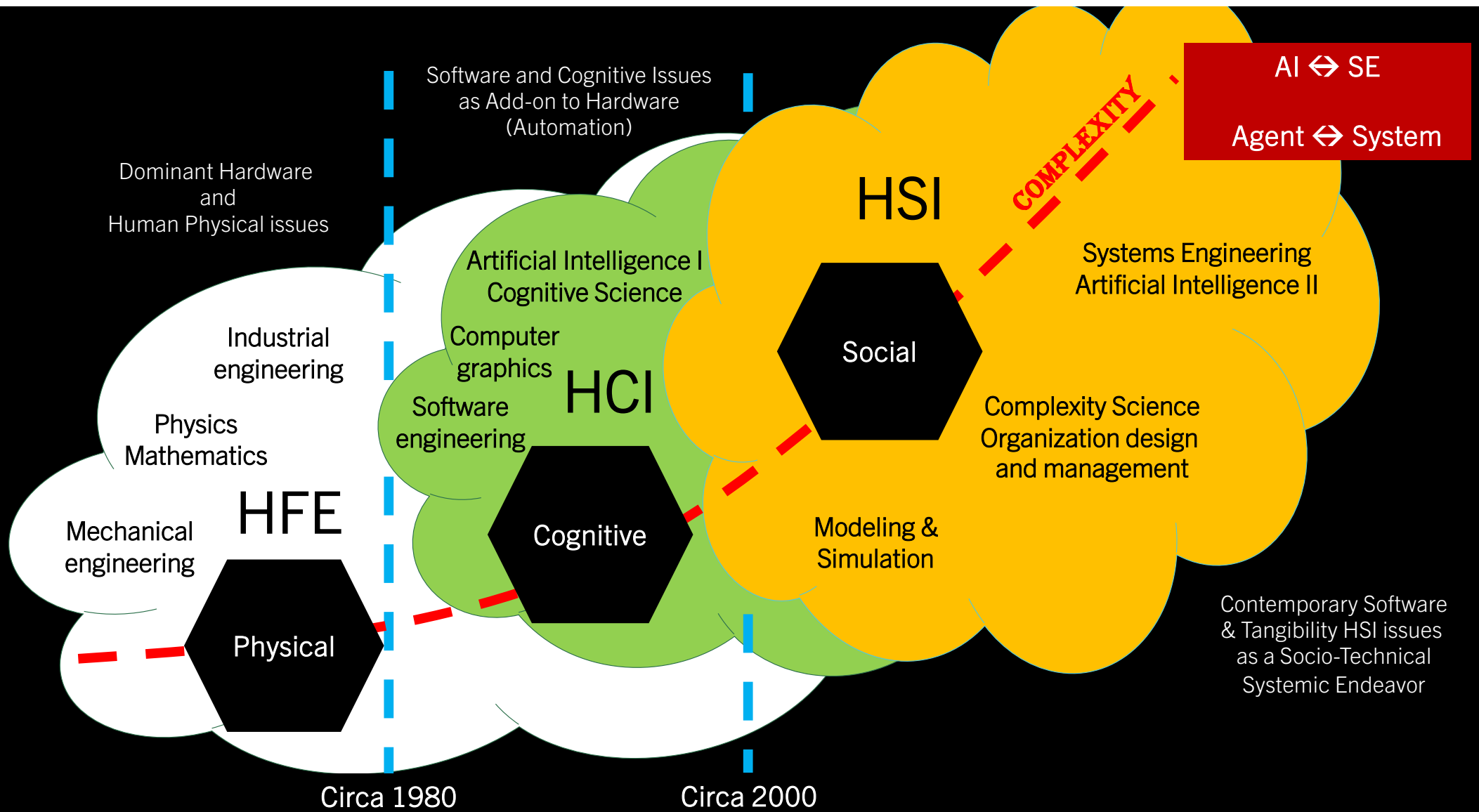


SOCIOLOGY

A social science

- Studies human societies, their interactions, and the processes that preserve and change them.
- Examines the dynamics of constituent parts of societies such as institutions, communities, populations, and gender, racial, or age groups.
- Studies communities and organizations to better understand their internal and external interdependencies and properties.

Encyclopædia Britannica, 2021



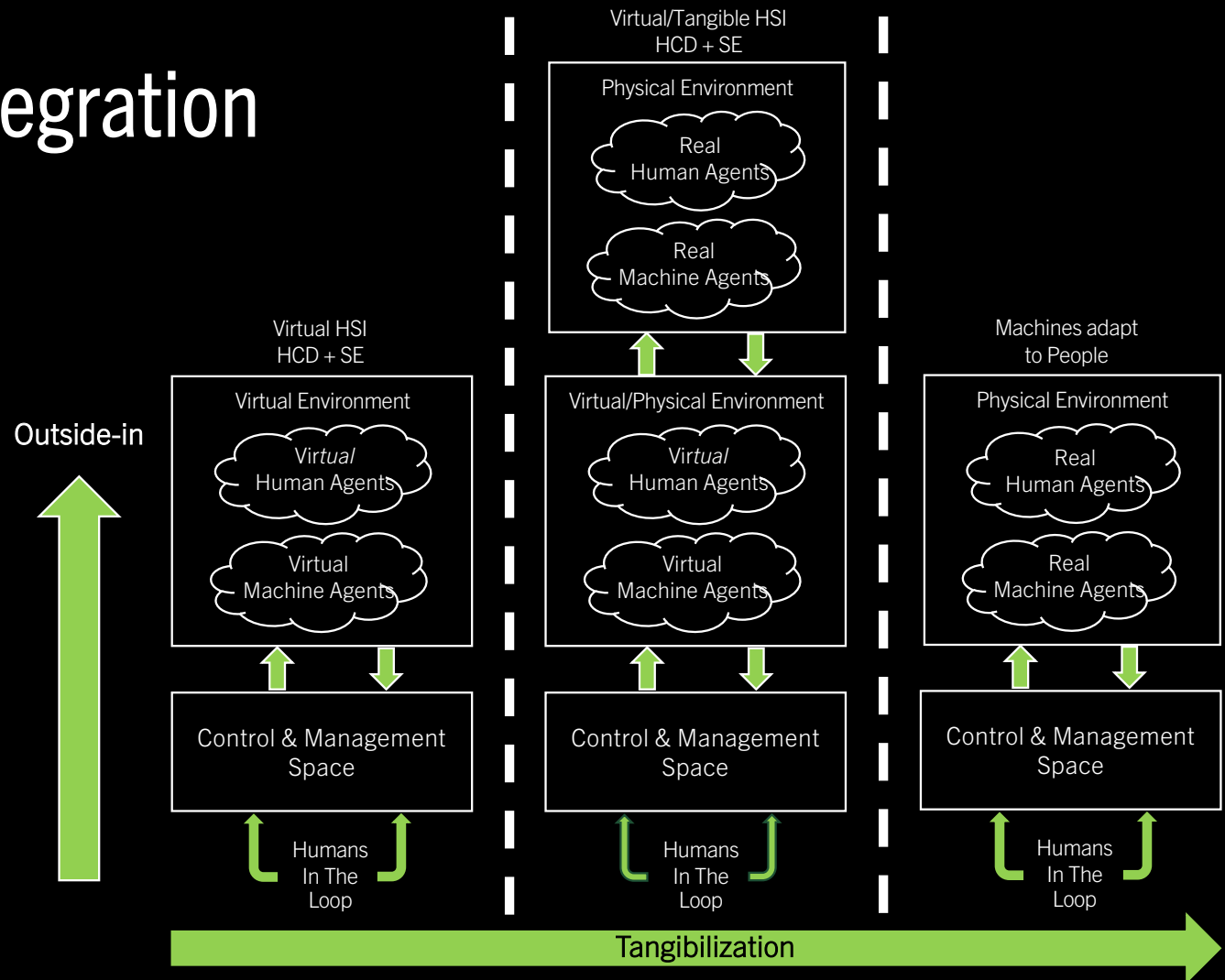
THE SHIFT FROM SINGLE AGENT...

... TO MULTI-AGENT

Human Systems Integration

21ST CENTURY APPROACH

Human-Centered Design (HCD)
Systems Engineering (SE)
Digital Human-in-the-loop Simulation
Artificial Intelligence & Data Science
Organization Sciences

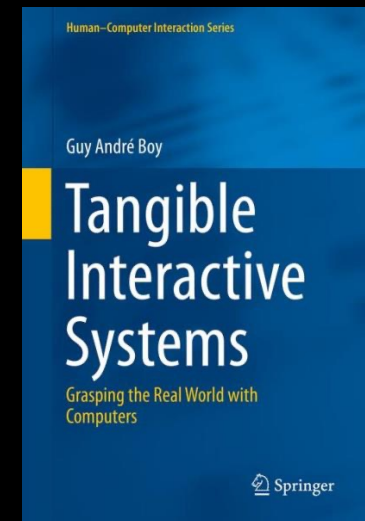


TANGIBILITY: SYSTEMIC ATTRIBUTES

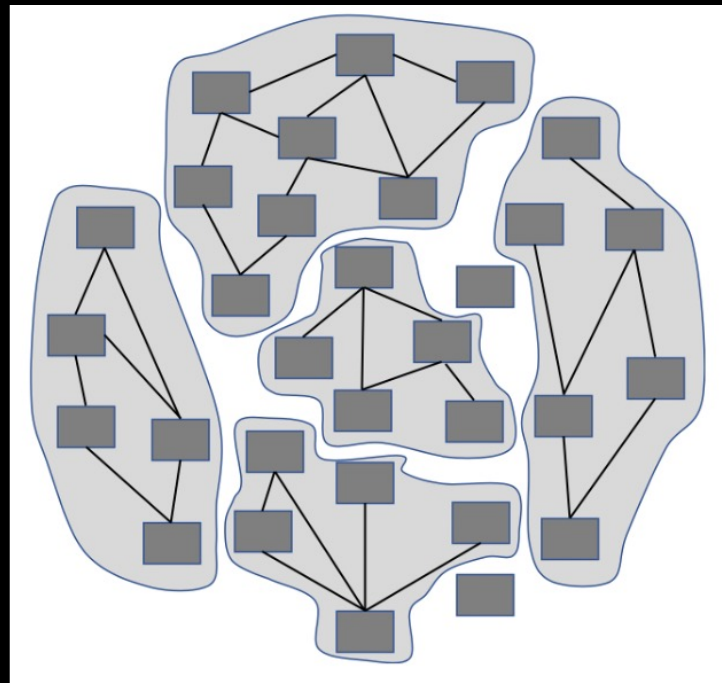
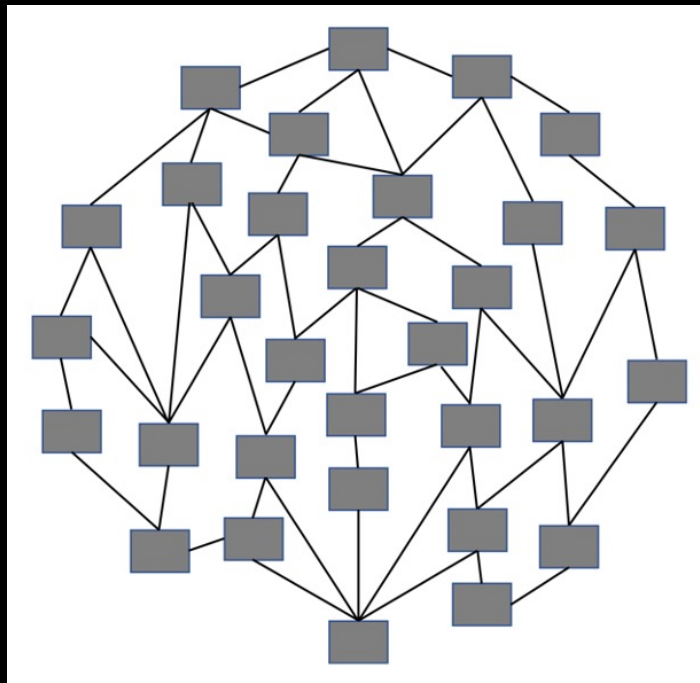
- Complexity → separability, interconnectivity, collaboration, trust, ...
- Maturity → TRLs & HRLs & ORLs
- Flexibility (design & operations) → safety nodes, reversibility, FlexTech, ...
- Stability/Resilience → passive vs. active, resilience, crisis management, ...
- Sustainability → design rationale, knowledge management, ...

+ Social Factors

Shared situation awareness
Cooperative decision-making
Harmonized risk taking
Trust and collaboration



SEPARABILITY



READINESS LEVELS

Technology



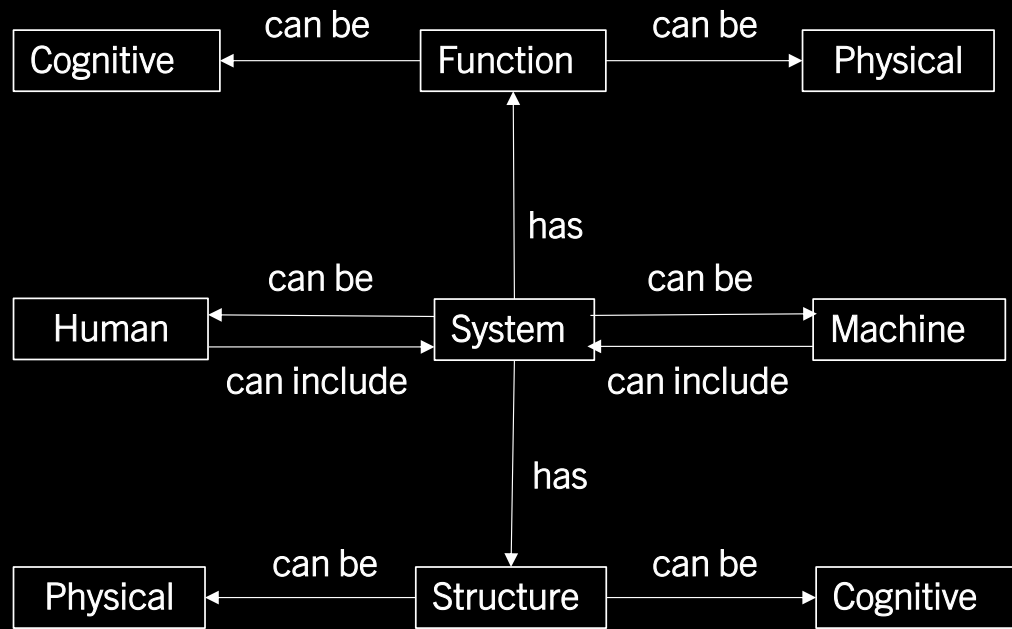
Human

HRL	Description
1	Relevant human capabilities, limitations, and basic human performance issues and risks identified
2	Human-focused concept of operations defined and human performance design principles established
3	Analyses of human operational, environmental, functional, cognitive, and physical needs completed, based on proof of concept
4	Modeling, part-task testing, and trade studies of user interface design concepts completed
5	User evaluation of prototypes in mission-relevant simulations completed to inform design
6	Human-system interfaces fully matured as influenced by human performance analyses, metrics, prototyping, and high-fidelity simulations
7	Human-system interfaces fully tested and verified in operational environment with system hardware and software and representative users
8	Total human-system performance fully tested, validated, and approved in mission operations, using completed system hardware and software and representative users
9	System successfully used in operations across the operational envelope with systematic monitoring of human-system performance

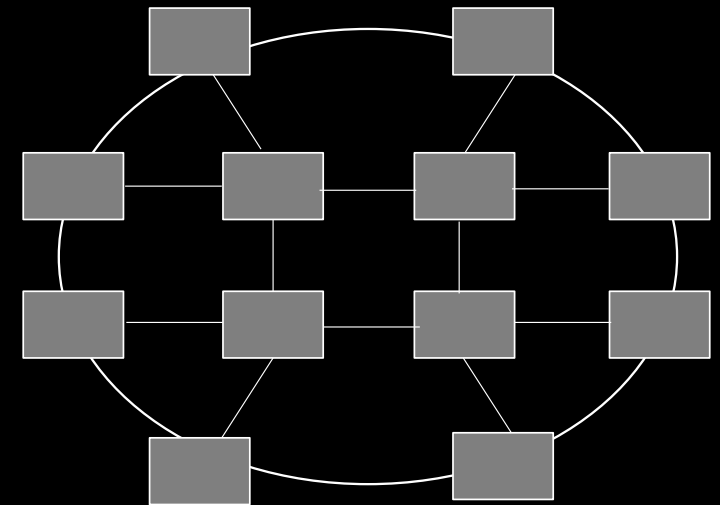
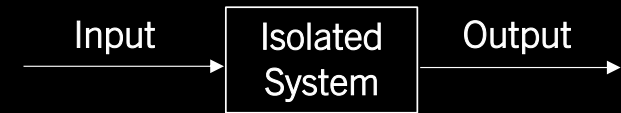
Organizations

ORL-0	First principles where potential organizational models are explored.
ORL-1	Goal-oriented research that requires making choices from first principles to practical fully digital organizational setups
ORL-2	Proof of principle development, and active R&D is started in a virtual environment
ORL-3	Virtual agile organizational prototype development and first HITLS (virtual HCD)
ORL-4	Proof of organizational concept development using concrete scenario-based design from fully virtual to more tangible environments
ORL-5	Assessing organization capability in terms of authority sharing (responsibility, accountability and control), trust, collaboration and coordination, for example
ORL-6	Real-world use-case tests in a wider variety of situations - tangibilization continues
ORL-7	Practical integration with respect to criteria such as safety, efficiency and comfort, at various levels of granularity of the organization – tangibilization continues
ORL-8	Readiness for effective implementation on a real site (fully tangible) based on personnel feedback for deployment approval
ORL-9	Deployment involving both personnel and real machines

WHAT IS A SYSTEM?



Systems include Humans and Machines...

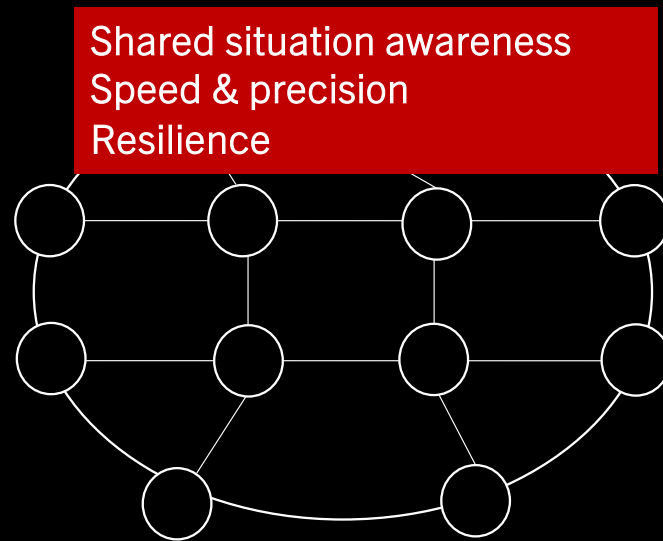


Interconnected System of Systems

SYSTEM = STRUCTURE + FUNCTION

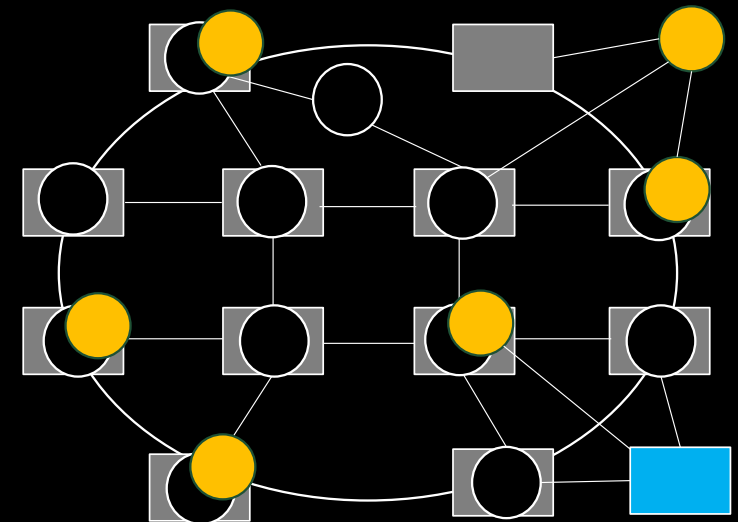
Emergent Structures

Emergent Functions



Interconnected Functions of Functions

Overlapping Functions of Functions

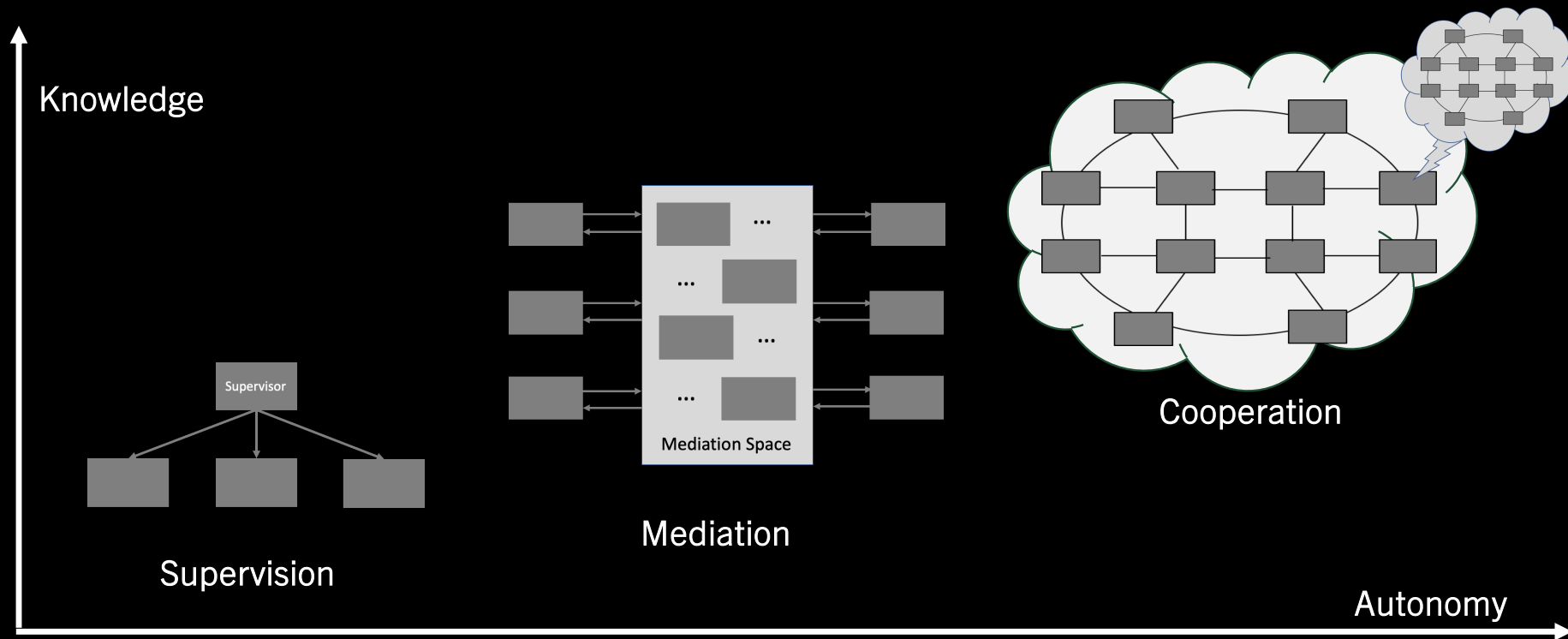


Interconnected Structures of Structures

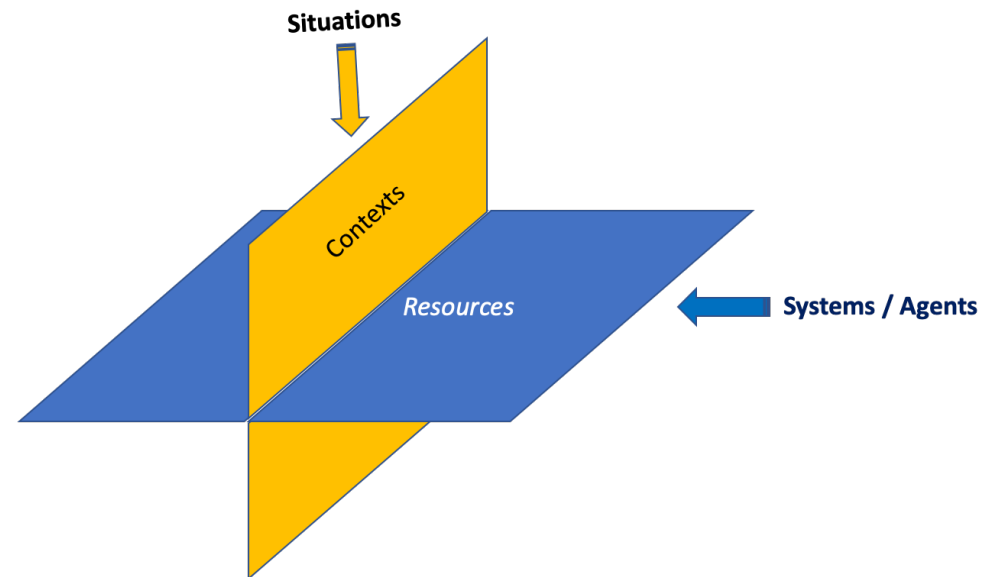
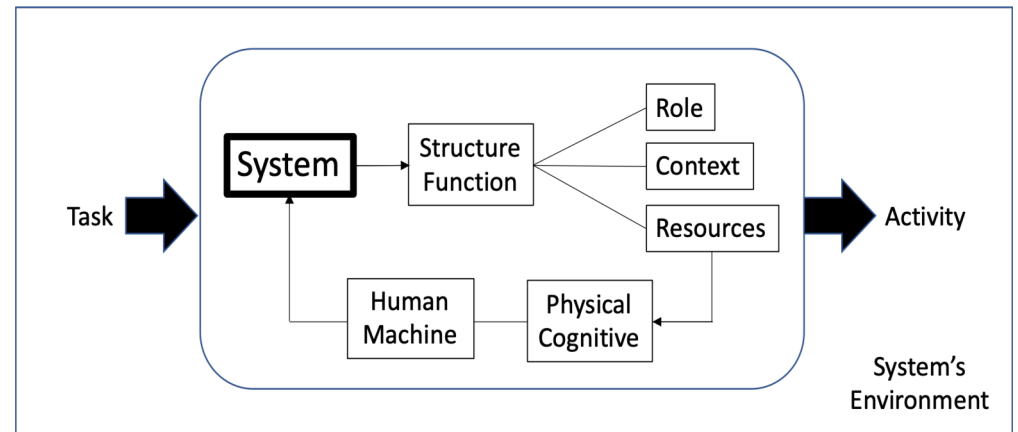
SYSTEM = STRUCTURE + FUNCTION



SYSTEMIC INTERACTION MODELS... ... AND AUTHORITY SHARING

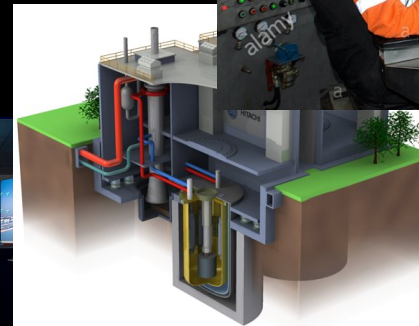


TOWARD AN ONTOLOGY FOR SOCIOERGONOMICS



A FEW EXAMPLES OF SOCIOERGONOMICS RESEARCH

- Health sociotechnical system
- Future combat air system
- Virtual air traffic control tower
- Small nuclear reactor
- Oil-and-gas telerobotic systems
- ...



SOCIOERGONOMICS... A FEW TAKEAWAYS

- Strongly based on social science disciplines and HSI
 - Expands traditional corrective ergonomics
 - Longer-term sociotechnical systems sustainability than short-term quick gains optimization
- Investigates human or machine agents' social behavior and interactions in work environments
 - Personality, trust, collaboration, individual and collective performance in a real-world sociotechnical environment
 - Group dynamics, social performance, change management, and organizational safety, performance & well-being
- Informs engineering stakeholders during the whole life cycle of a sociotechnical system (STS)
 - Considers holistic STS evolution, continuously or disruptively
 - Adapts systems' structures and functions toward sustainable HSI validity (i.e., economically, environmentally, and societally)
 - Focuses on collaborative work environments, shared situation awareness, group decision making, organization design and management, life-critical systems, cooperative and competitive agencies, mutual trust (intersubjectivity), human machine teaming, etc.

MAJOR ARTICLES ...

FlexTech

CentraleSupélec-ESTIA Chair

- Boy, G.A. (2025). Systemic Cognition: A Few Epistemological Clarifications. *Systems*, 14(1), 15; <https://doi.org/10.3390/systems14010015>.
- Boy, G.A., Masson, D., Durnerin, E. & Morel C. (2024). PRODEC for Human Systems Integration of Increasingly Autonomous Systems. *Systems Engineering Journal*. Wiley, USA. DOI:10.1002/sys.21751.
- Boy, G.A. (2023). An epistemological approach to human systems integration. *Technology in Society Journal*, 102298. <https://doi.org/10.1016/j.techsoc.2023.102298>
- Boy, G.A. (2023). Uncertainty management in human systems integration of life-critical systems. In Griffin, Mark A., and Gudela Grote (eds). The Oxford Handbook of Uncertainty Management in Work Organizations (online edn, Oxford Academic, 20 Oct. 2022), Oxford University Press, UK, accessed 6 Dec. 2022.
- Boy, G.A. (2022). Model-Based Human Systems Integration. In the Handbook of Model-Based Systems Engineering, A.M. Madni & N. Augustine (Eds.). Springer, USA. DOI: https://doi.org/10.1007/978-3-030-27486-3_28-1.
- Boy, G.A. (2021). Design for Flexibility - A Human Systems Integration Approach. Springer Nature, Switzerland. ISBN: 978-3-030-76391-6.
- Boy, G.A. (2021). Socioergonomics: A few clarifications on the Technology-Organizations-People Tryptic. Proceedings of INCOSE HSI2021 International Conference, Wiley Online Lib.
- Boy, G.A. (2020). *Human Systems Integration: From Virtual to Tangible*. CRC Press – Taylor & Francis Group, USA (<https://www.taylorfrancis.com/books/9780429351686>).

REFERENCES FOR THIS PRESENTATION

- Cognitive Function Analysis
- The Handbook of Human-Machine Interaction
- Orchestrating Human Centered Design
- Human Systems Integration
- Design for Flexibility
- Risk taking, Prevention & Design
- ... be curious!



- To appear in April 2026
- About 45 chapters ([link](#))
- 16 countries
- 630 pages



THANK YOU...