ARTIFICIAL INTELLIGENCE, AEROSPACE & DEFENSE SYSTEMS, AND HUMAN-SYSTEM INTEGRATION

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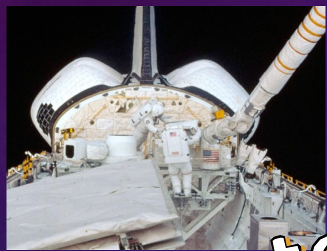
CHAIR OF AAE SCIENTIFIC AND TECHNICAL COMMITTEE ON HUMAN SYSTEMS INTEGRATION

MY WORLD FOR MORE THAN 45 YEARS ...



... in technical design
and operations

From correction to interaction to integration

Artificial Intelligence in Aerospace...
Human-Centered Design & Automation...
Human Systems Integration...

https://en.wikipedia.org/wiki/Guy_André_Boy

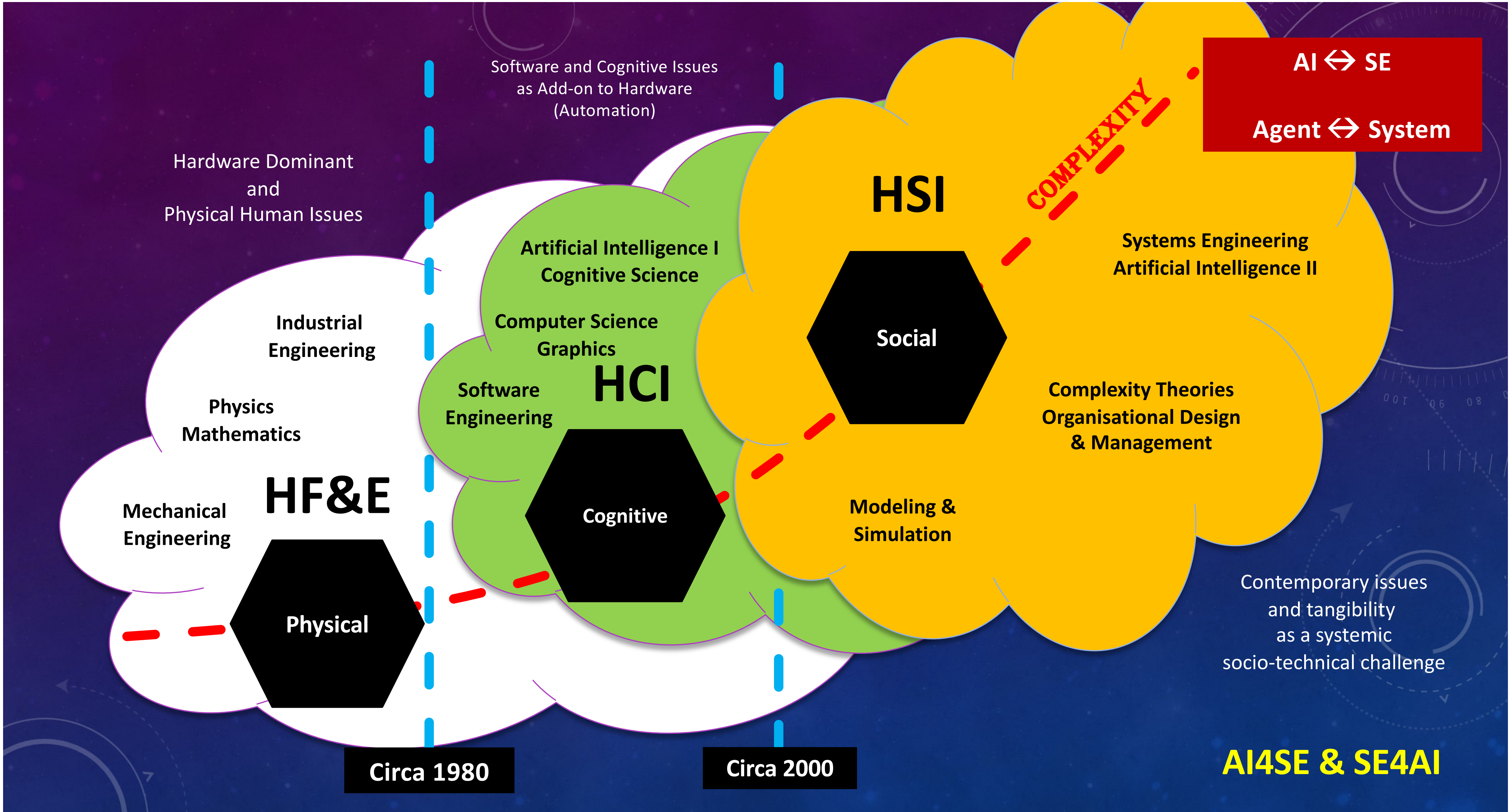
SOCIOTECHNICAL SYSTEMS

- Complex systems
- Technology, Organization & People Triptych
- Systems of Systems (Multi-Agent systems)
- Artificial Intelligence & Model-Based Human Systems Integration
- Life-Critical Systems
- Increasingly Autonomous Systems
- Digital twins
- …

The Handbook was officially out in the world in April 2026!

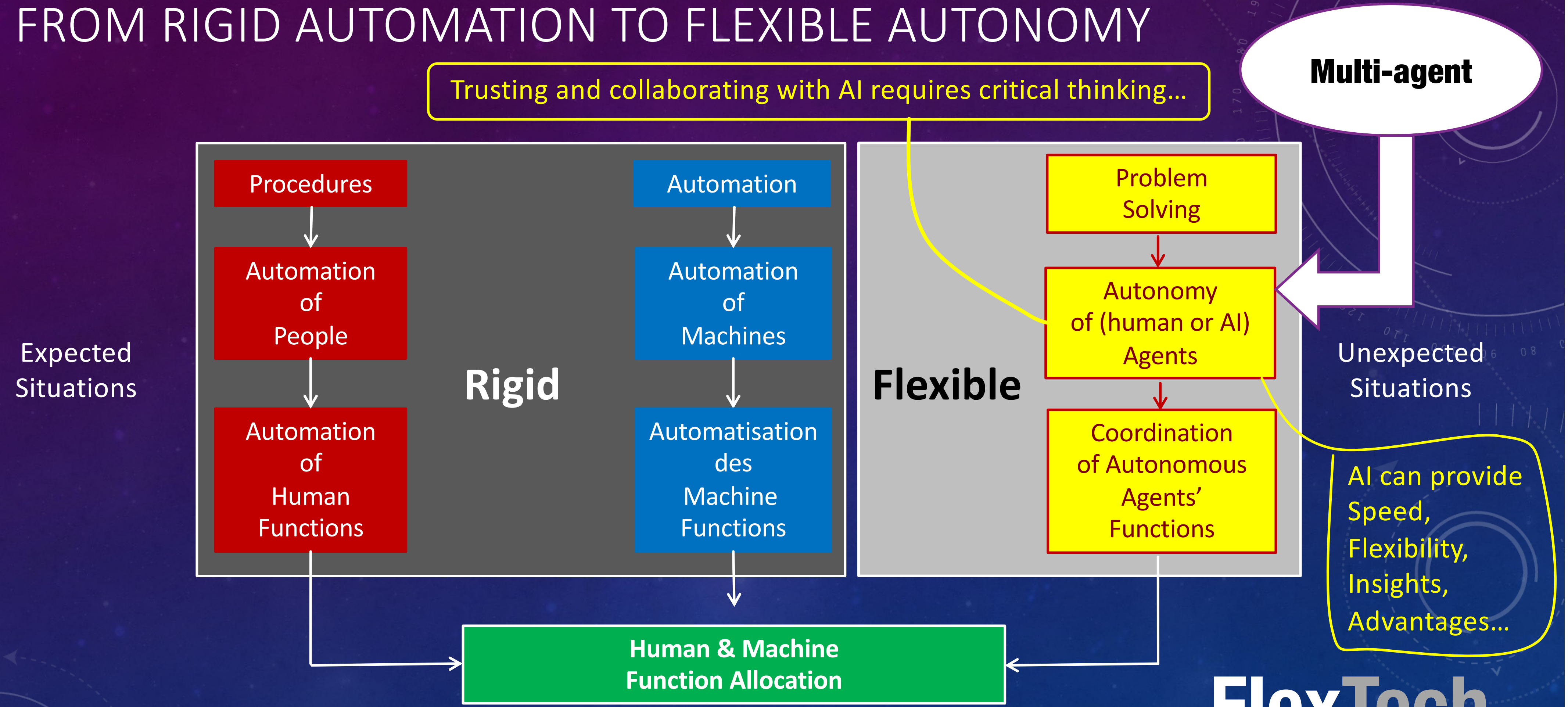
678 pages
45 chapters
87 authors
16 countries

https://www.routledge.com/Handbook-of-Sociotechnical-Systems-A-Human-Systems-Integration-Approach/AndreBoy/p/book/9781041122289



Software and Cognitive Issues
as Add-on to Hardware
(Automation)
AI ⇔ SE
Agent ⇔ System
Hardware Dominant
and
Physical Human Issues
COMPLEXITY
HSI
Systems Engineering
Artificial Intelligence II
Artificial Intelligence I
Cognitive Science
Social
Industrial
Engineering
Computer Science
Graphics
Software
Engineering
HCI
Complexity Theories
Organisational Design
& Management
Physics
Mathematics
HF&E
Cognitive
Modeling &
Simulation
Mechanical
Engineering
Physical
Contemporary issues
and tangibility
as a systemic
socio-technical challenge
Circa 1980
Circa 2000
AI4SE & SE4AI

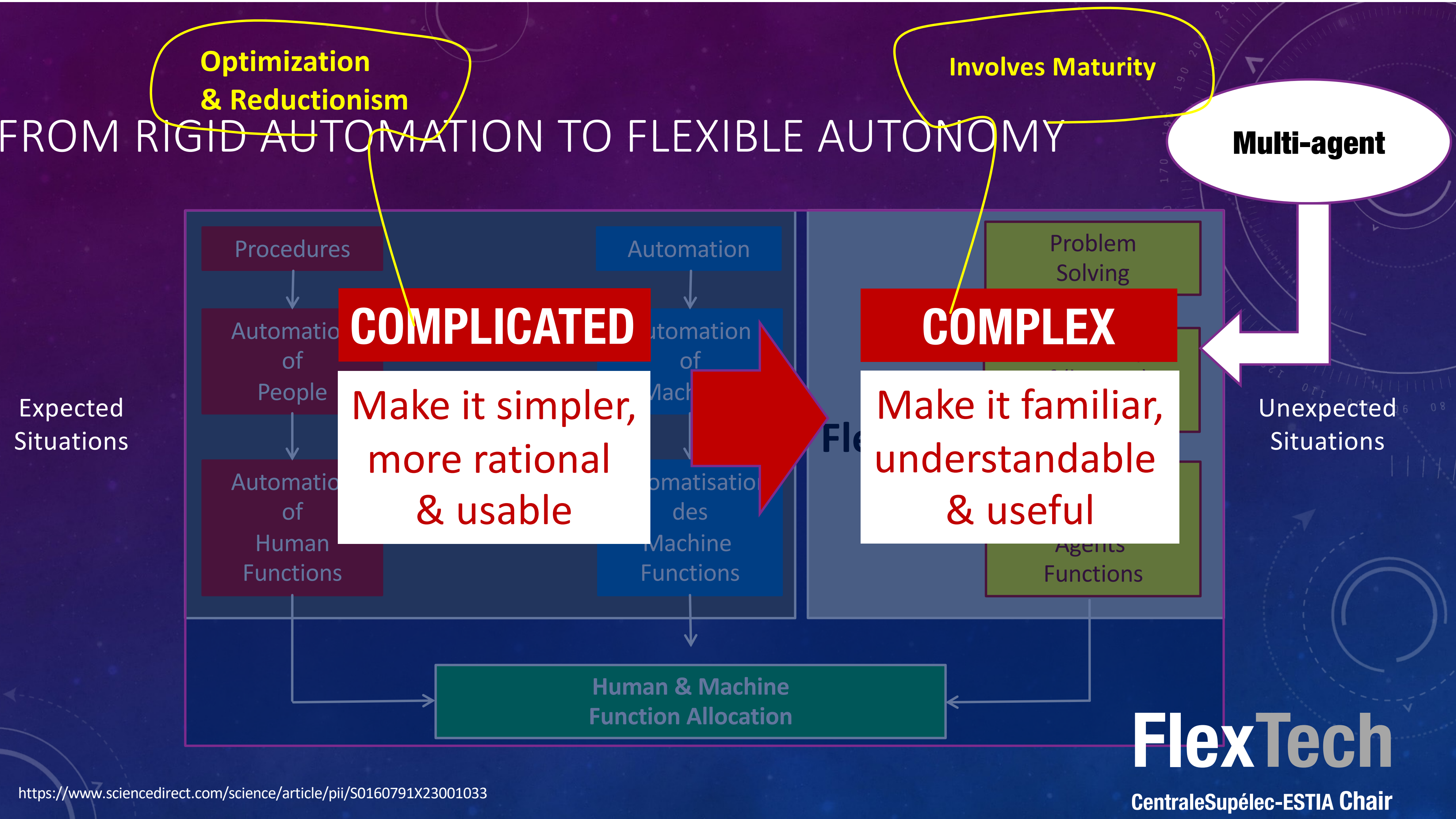
FROM RIGID AUTOMATION TO FLEXIBLE AUTONOMY



FlexTech
CentraleSupélec-ESTIA Chair

https://www.sciencedirect.com/science/article/pii/S0160791X23001033

FROM RIGID AUTOMATION TO FLEXIBLE AUTONOMY



https://www.sciencedirect.com/science/article/pii/S0160791X23001033

READINESS LEVELS

Technology (TRL)

Human (HRL)

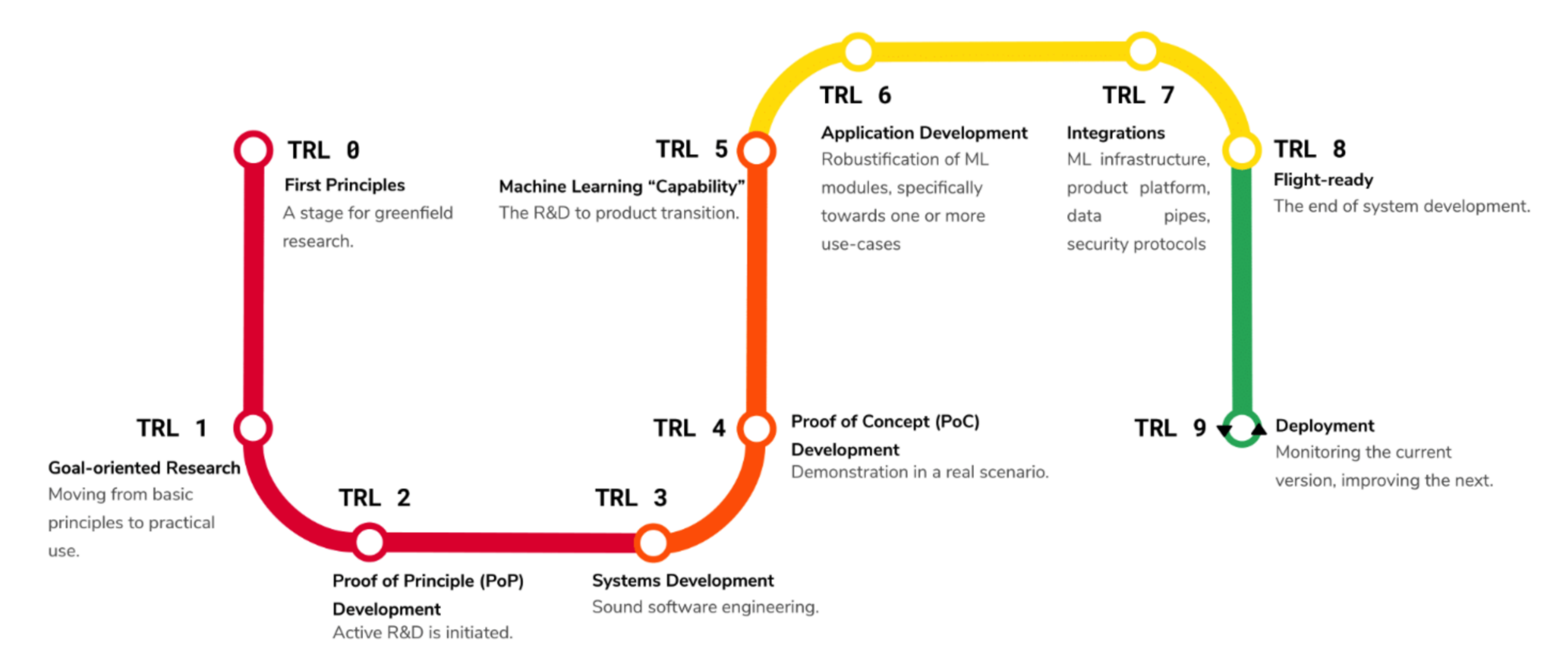
HRL	Description
1	Relevant human capabilities, limitations, and basic human performance issues and risks identified
2	Human-focused concept of operations defined and human performance design principles established
3	Analyses of human operational, environmental, functional, cognitive, and physical needs 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

Organization (ORL)

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

https://www.sciencedirect.com/science/article/pii/S0160791X23001033

TECHNOLOGY READINESS LEVELS FOR MACHINE LEARNING SYSTEMS



Lavin, A., Gilligan-Lee, C.M., Visnjic, A. *et al.* Technology readiness levels for machine learning systems. *Nat Commun* **13**, 6039 (2022). https://doi.org/10.1038/s41467-022-33128-9

Technology Readiness Levels for Machine Learning Systems

Alexander Lavin* Latent Sciences
Ciaràn M. Gilligan-Lee Spotify
Alessya Visnjic WhyLabs
Siddha Ganju Nvidia
Dava Newman MIT
Sujoy Ganguly Unity AI
Danny Lange Unity AI
Atılım Güneş Baydin Oxford University
Amit Sharma Microsoft Research
Adam Gibson Konduit
Yarin Gal Alan Turing Institute
Eric P. Xing Petuum
Chris Mattmann NASA Jet Propulsion Lab
James Parr NASA Frontier Development Lab

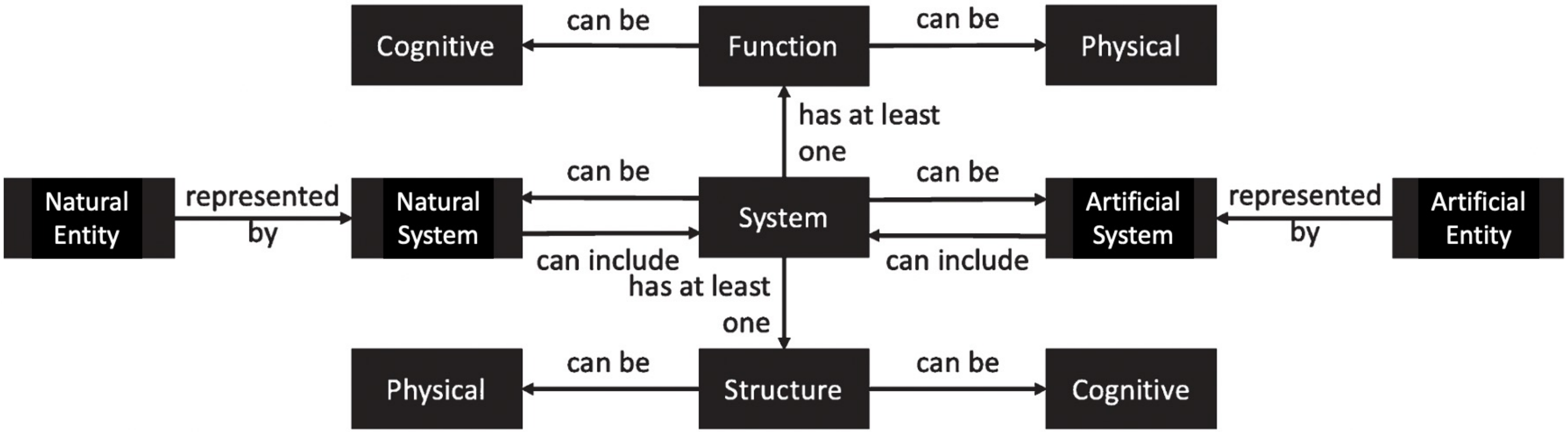
Abstract

The development and deployment of machine learning (ML) systems can be executed easily with modern tools, but the process is typically rushed and means-to-an-end. The lack of diligence can lead to technical debt, scope creep and misaligned objectives, model misuse and failures, and expensive consequences. Engineering systems, on the other hand, follow well-defined processes and testing standards to streamline development for high-quality, reliable results. The extreme is spacecraft systems, where mission critical measures and robustness are ingrained in the development process. Drawing on experience in both spacecraft engineering and ML (from research through product across domain areas), we have developed a proven systems engineering approach for machine learning development and deployment. Our *Machine Learning Technology Readiness Levels (MLTRL)* framework defines a principled process to ensure robust, reliable, and responsible systems while being streamlined for ML workflows, including key distinctions from traditional software engineering. Even more, MLTRL defines a lingua franca for people across teams and organizations to work collaboratively on artificial intelligence and machine learning technologies. Here we describe the framework and elucidate it with several real world use-cases of developing ML methods from basic research through productization and deployment, in areas such as medical diagnostics, consumer computer vision, satellite imagery, and particle physics.

Keywords: Machine Learning; Systems Engineering; AI Ethics; Medical AI; Space Sciences

Lavin, A., Gilligan-Lee, C.M., Visnjic, A. *et al.* Technology readiness levels for machine learning systems. *Nat Commun* **13**, 6039 (2022). https://doi.org/10.1038/s41467-022-33128-9

WHAT'S FUNDAMENTAL HERE?



MAKING SYSTEM COMPLEXITY EXPLICIT…

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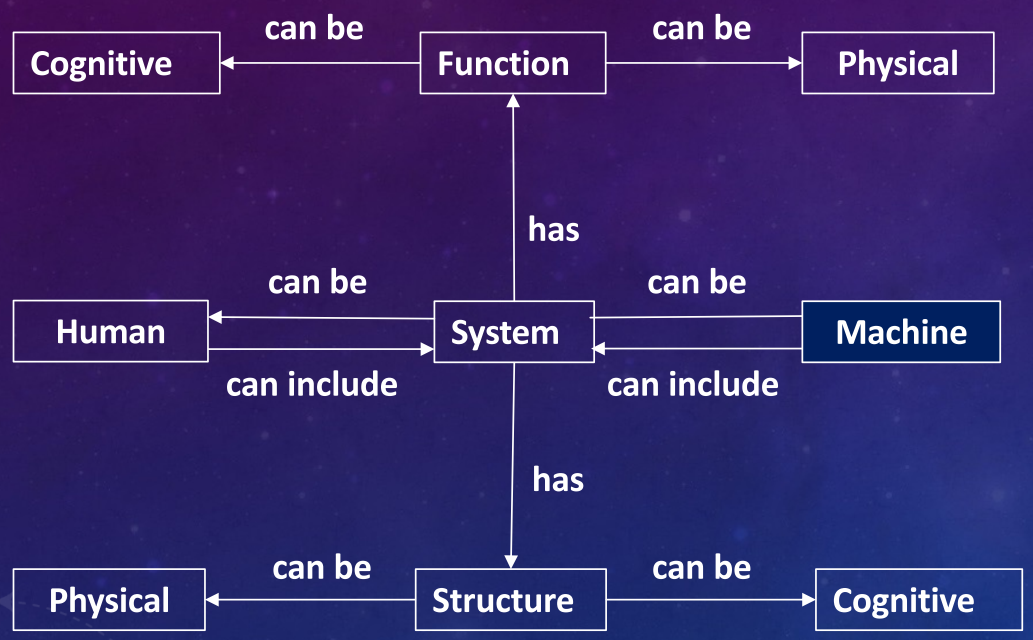
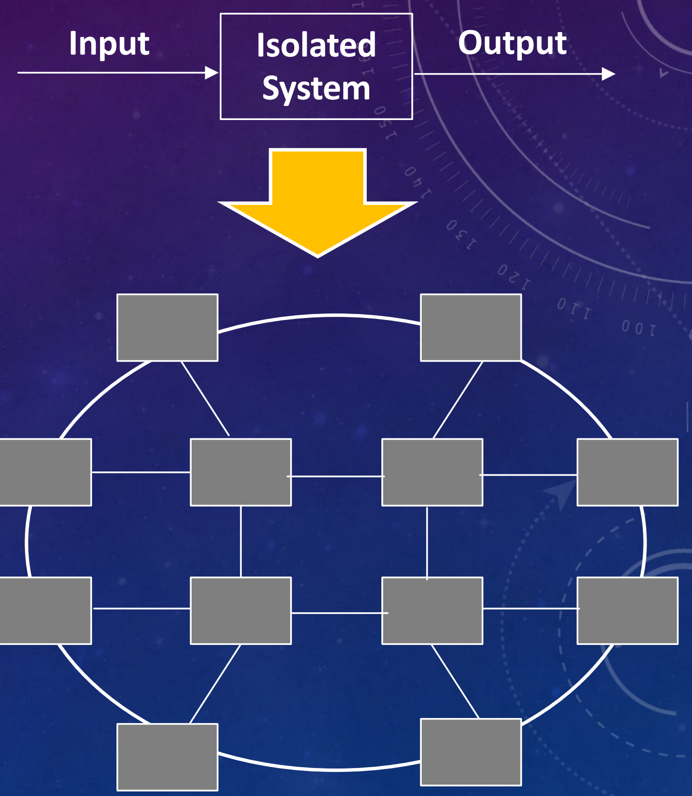


Systems include Humans and Machines…



Interconnected System of Systems

MAKING SYSTEM COMPLEXITY EXPLICIT…

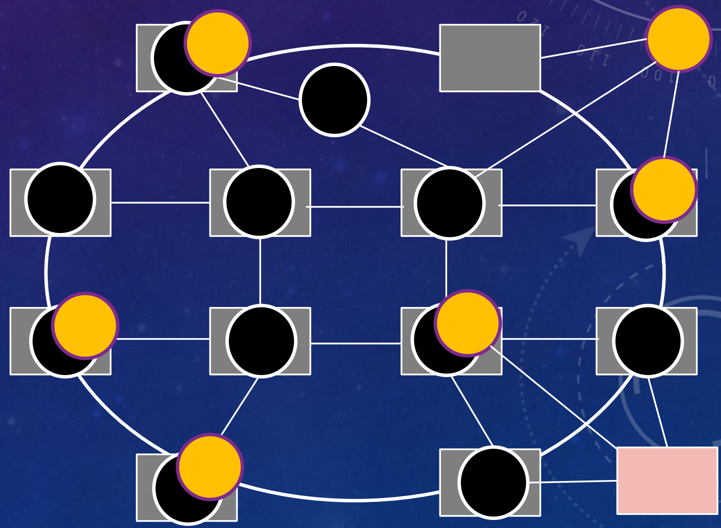
METRICS
- Shared situation awareness
- Speed & precision
- Resilience
- Trust & Collaboration

Interconnected Functions of Functions

Emergent Structures

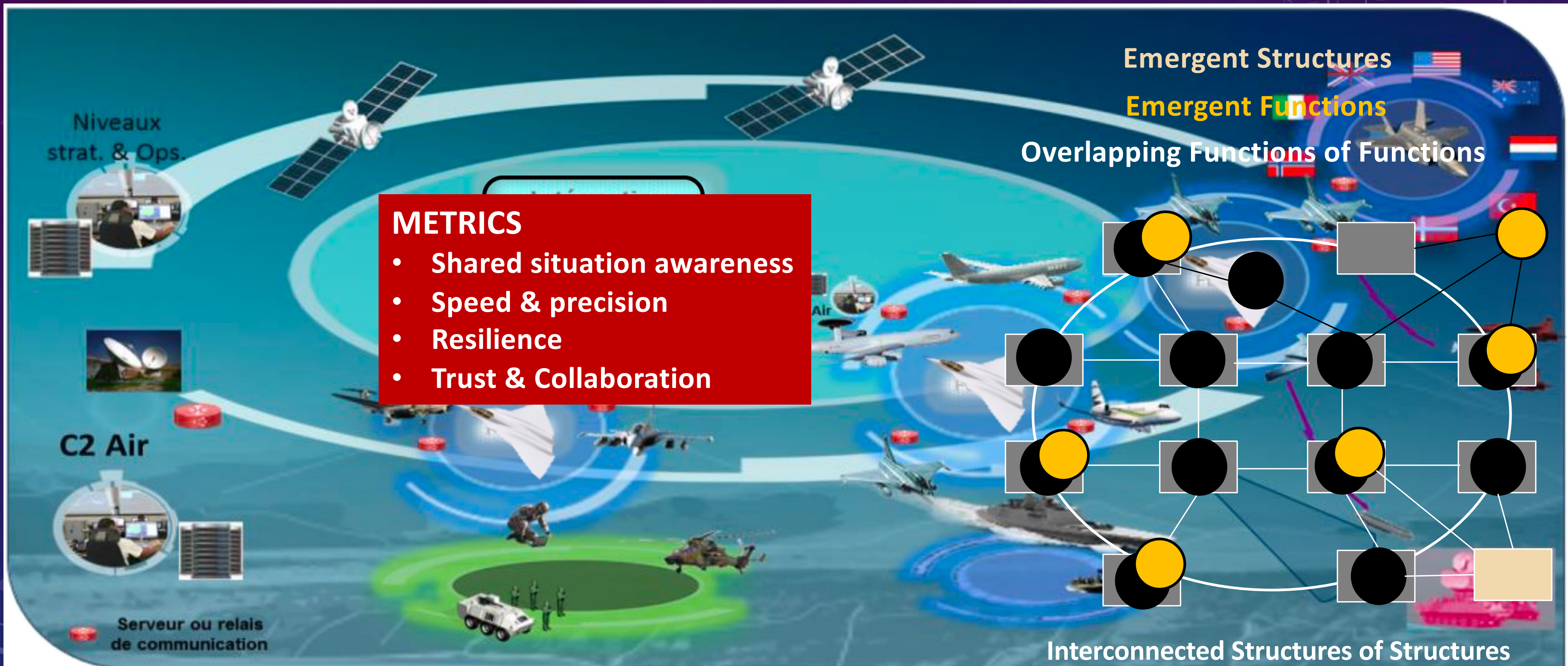
Emergent Functions

Overlapping Functions of Functions



Interconnected Structures of Structures

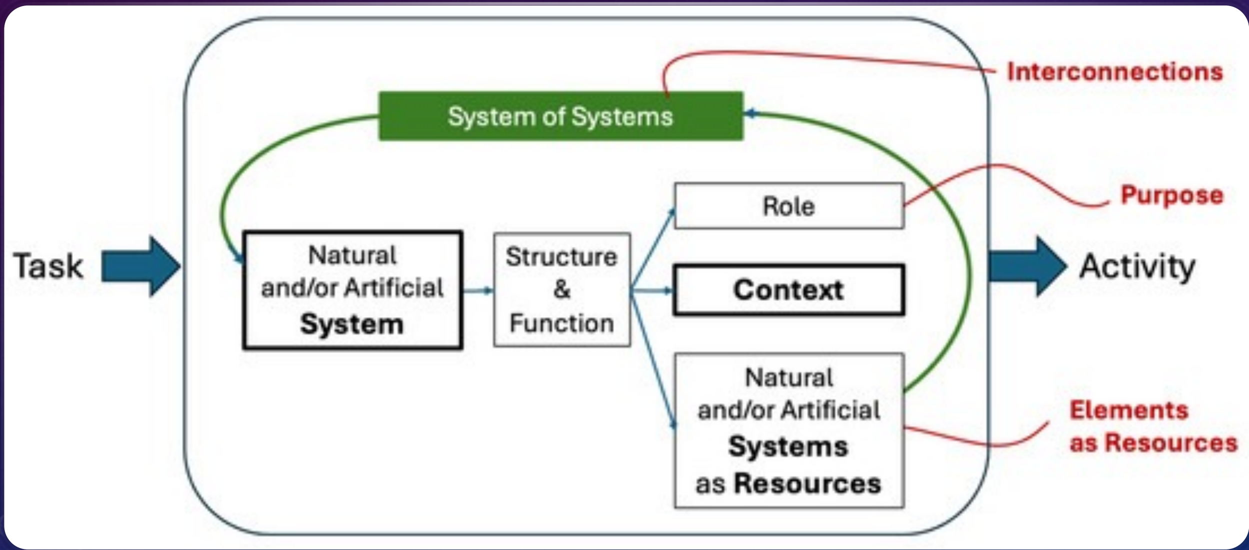
MAKING SYSTEM COMPLEXITY EXPLICIT…



SYSTEMIC COGNITION:

A CONSTRUCTIVIST APPROACH SUPPORTING HUMAN SYSTEMS INTEGRATION

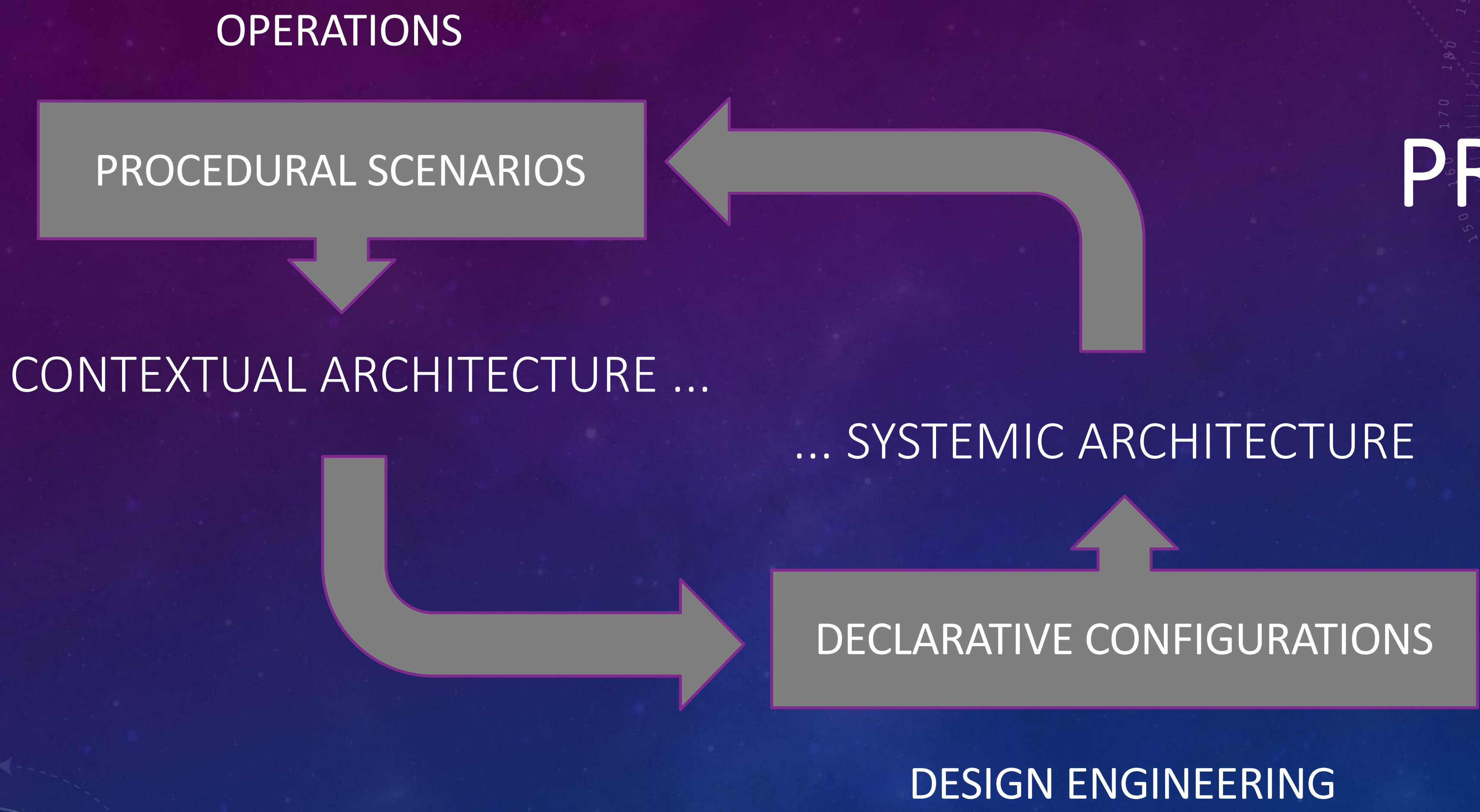
SYSTEMIC COGNITION



THE LOGICAL AND TELEOLOGICAL DEFINITION OF A SOCIOTECHNICAL SYSTEM

- The logical part
  - Prescribed task
  - Effective activity
- The teleological part
  - Structure & function
  - Role (goal-driven)
  - Context (event-driven)
  - Resources (systems)

PRODEC


OPERATIONS
PROCEDURAL SCENARIOS
CONTEXTUAL ARCHITECTURE ...
... SYSTEMIC ARCHITECTURE
DECLARATIVE CONFIGURATIONS
DESIGN ENGINEERING

TWO SYSTEMIC COGNITION PROJECTS:

1. PRODEC-INGESCAPE PLATFORM DEVELOPMENT

2. AEROSEC EUROPEAN PROJECT

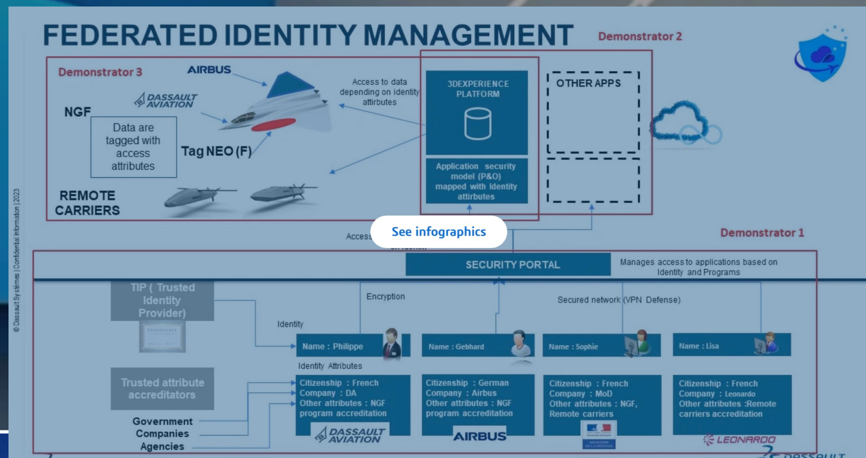
Systemic Cognition in Action…

Observe + Feed + Measure + Verify

DASSAULT SYSTEMES

AEROSEC

Delivering a sovereign Highly Secure Multi Cloud European platform for the co conception of military programs.



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THANK YOU!