une plateforme d'innovation

ESTIA INSTITUTE OF TECHNOLOGY

CCI BAYONNE PAYS BASQUE
Euskal Herri

CentraleSupélec

FlexTech

Prof. Guy André Boy
FlexTech Chair Holder

MY BACKGROUND…

- Aerospace Advanced Automation, ISAE-SUPAERO (Master, Ph.D.)
- Cognitive & Computer Scientist, Sorbonne University, UPMC (HDR)

- ONERA + SUPAERO (Research Scientist + Group Lead + Associate Professor)
- NASA Ames Research Center (Group Lead, Advanced Interaction Media)
- EURISCO (Airbus + Thales) CEO & Chief Scientist (Cognitive Engineering)
- NASA Kennedy Space Center (Chief Scientist, Human-Centered Design)
- Florida Institute of Technology (Dean+ University Professor, Human-Centered Design)
- CentraleSupélec + ESTIA (Professor + FlexTech Chair Holder, Human Systems Integration)

- INCOSE (Fellow 2021 + HSI WG Chair: 2015-Present)
- Air & Space Academy (Fellow 2006)
- Association for Computing Machinery (Senior Member + ACM-SIGCHI Executive Vice President: 1995-1999)
- International Ergonomics Association (Aerospace TC Chair: 2018-Present)

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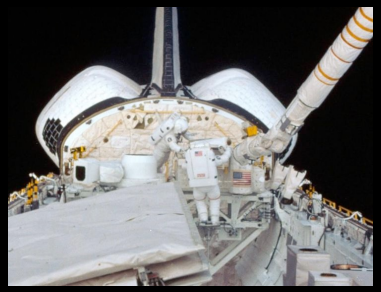
MY WORLD FOR ~40 YEARS…

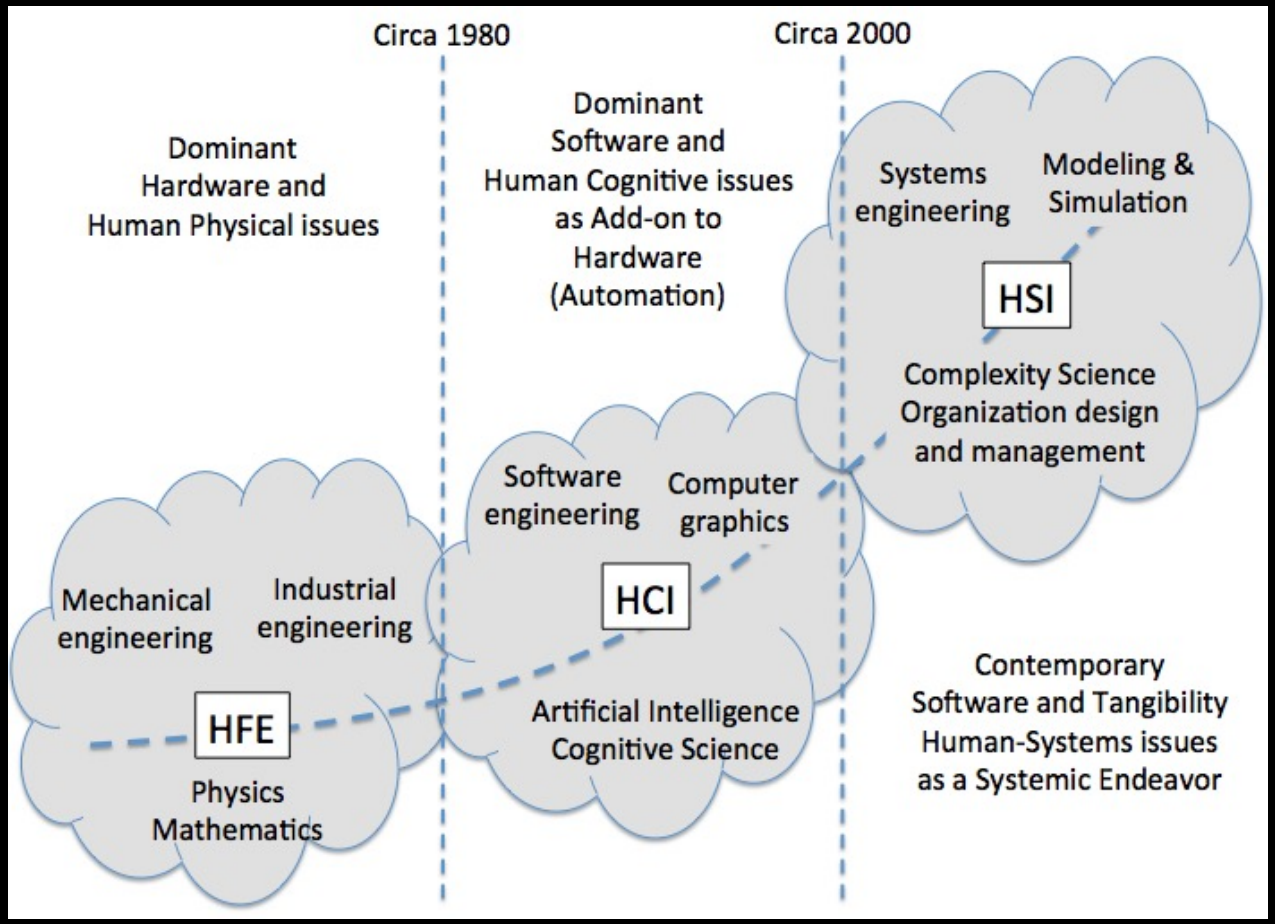


From correction…
… to interaction
… to integration

… and other things

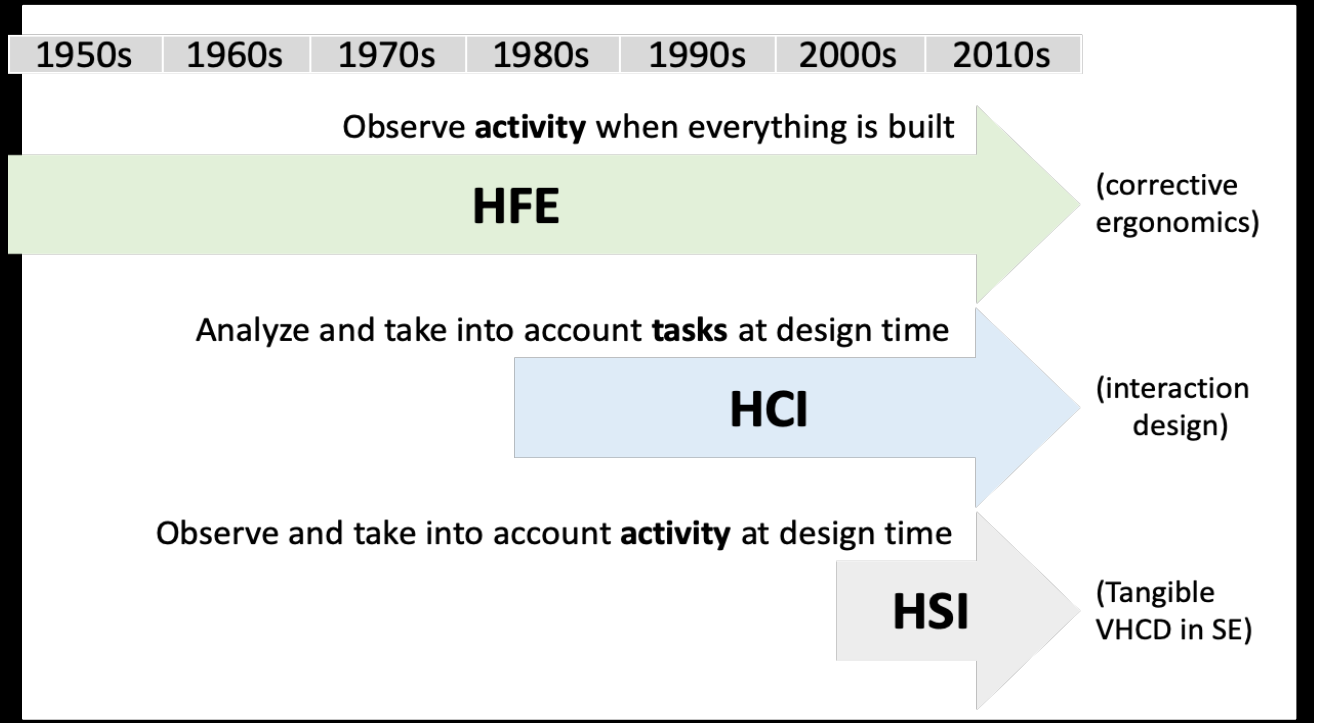
RECENT EVOLUTION OF ENGINEERING-ORIENTED HUMAN-CENTERED APPROACHES

- From cognition to socio-cognition
- Complexity science
- Organization design & management
- Modeling and simulation



RECENT EVOLUTION OF ENGINEERING-ORIENTED HUMAN-CENTERED APPROACHES

- Task vs. Activity Analysis
- From corrective ergonomics
  to interaction design
  to tangibilization
  of virtual prototypes



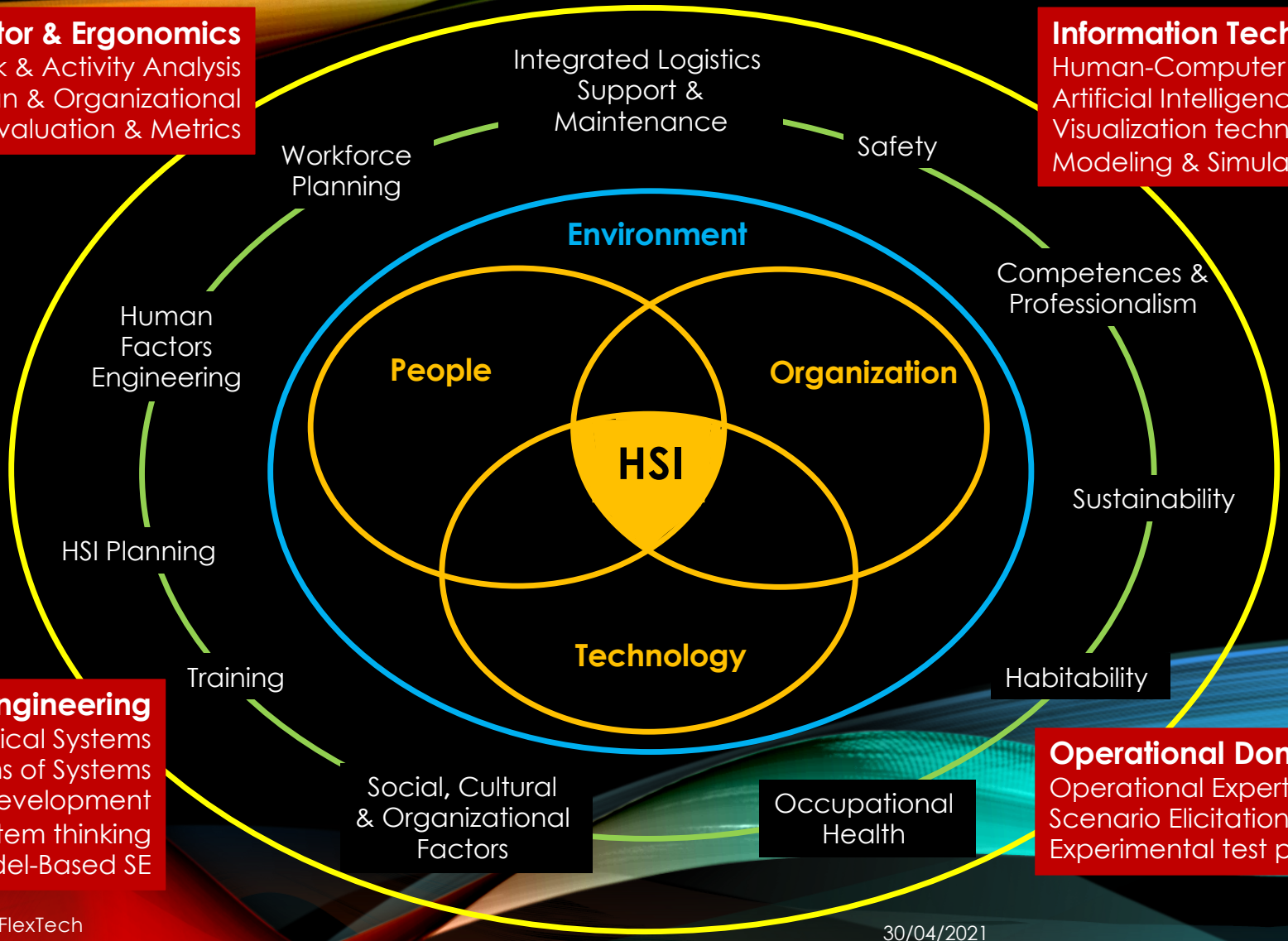
HUMAN SYSTEMS INTEGRATION (HSI)

= HUMAN-CENTERED DESIGN (HCD)

+ SYSTEMS ENGINEERING (SE)

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

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



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

Operational Domain
Operational Expertise & Experience
Scenario Elicitation
Experimental test personnel

FLEXTECH PURPOSE

Design, develop and refine
concepts, methods and tools
for Human Systems Integration (HSI)
of increasingly autonomous systems

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METHODOLOGY

1. Improve contemporary HSI theories and approaches
2. Carry out a series of real-world hard problems and incrementally induce models, methods and tools
3. Cross-fertilize fundamental HSI knowledge and practical problem-solving approaches to HSI (i.e., 1 + 2)

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CURRENT REAL-WORLD RESEARCH EFFORTS

- Human-Centered Design (HCD)/HSI of a telerobotic system for off-shore platform control and management [TOTAL]: Elise, Chloé, Dimitri & GAB
- HCD/HSI of an experience-feedback-based digital twin for oil-&-gas platform management [TOTAL]: Stélian, Eric, Dimitri & GAB
- HCD/HSI of a learning digital twin for helicopter engine maintenance [SAFRAN]: Quentin, Christophe, Eric & GAB
- HCD/HSI of a digital twin for energy performance: case of a hospital building, HS40 [Feder SUDOE]: Mohanad, Christophe & Audrey
- HCD/HSI of a virtual tower [CS Group]: Thomas, Marija & GAB
- MOHICAN [MMT DGA/Thales]: Chloé, Julien, Raymond & GAB

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Toward more Autonomy & Flexibility

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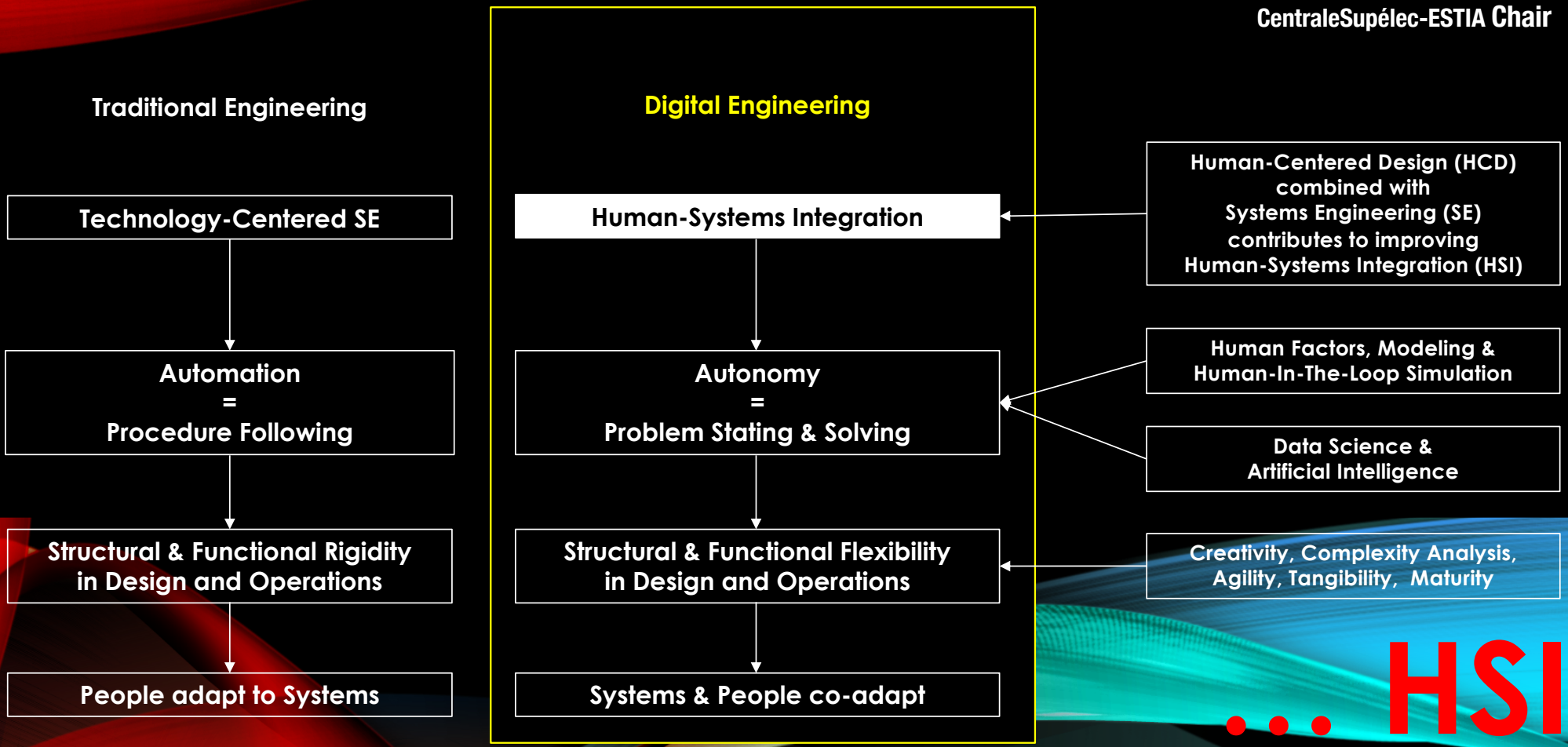
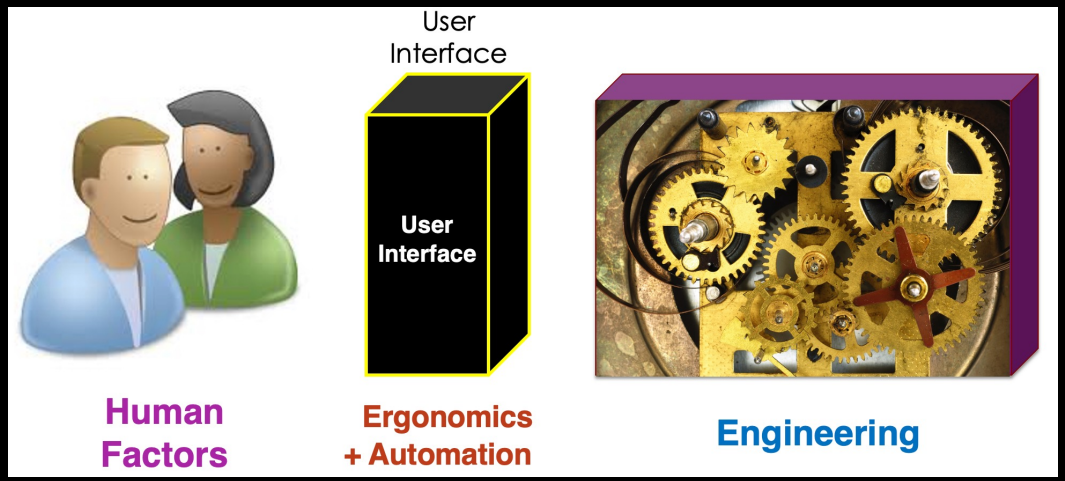
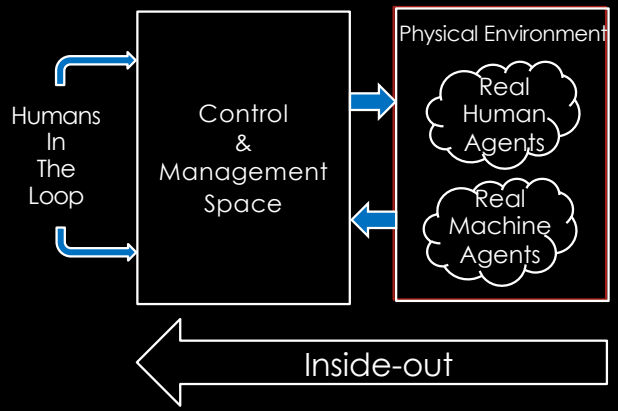




20th century approach



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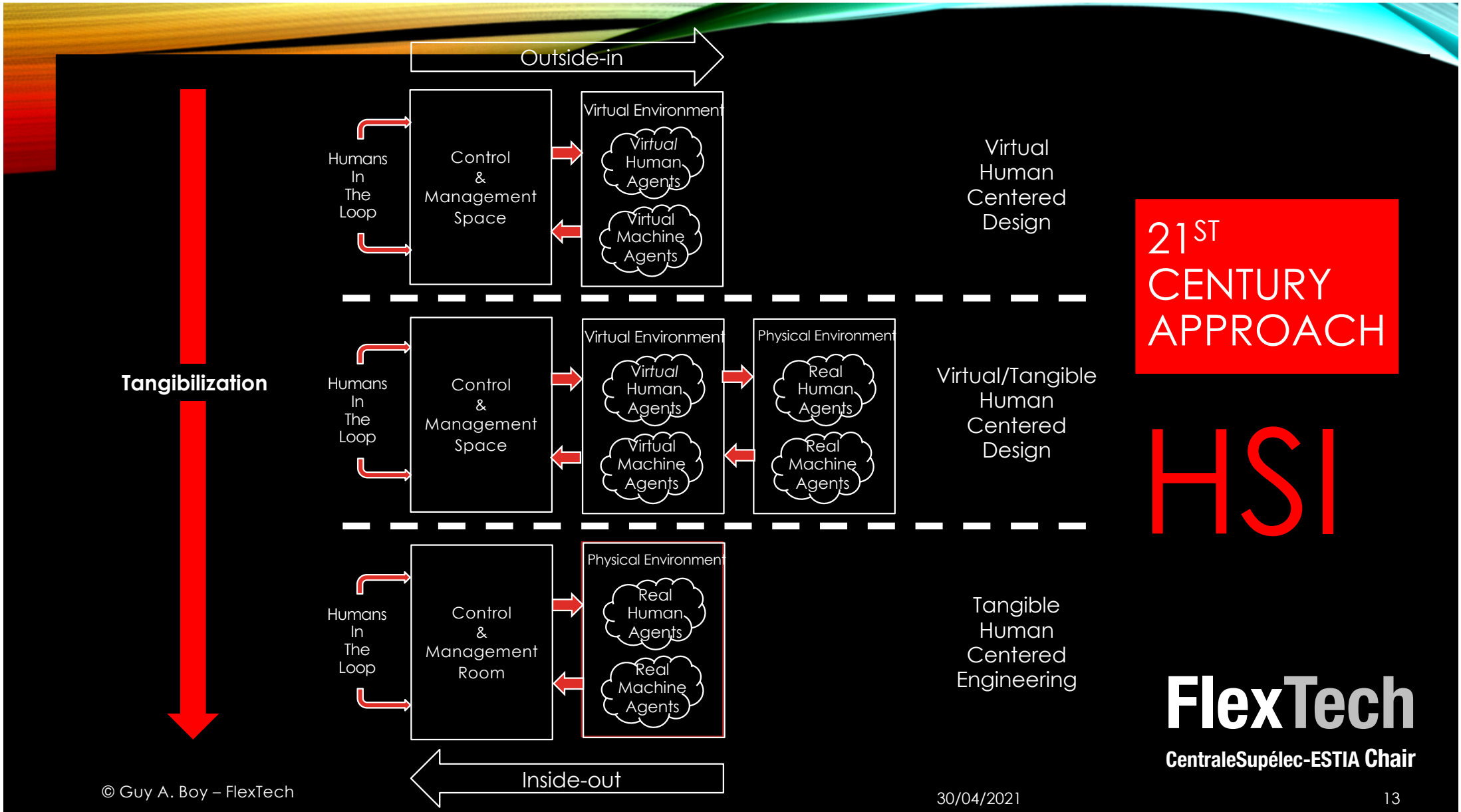

TANGIBILITY

- Physical vs. Figurative Tangibility
  - Grasping virtual things both physically and cognitively
  - Situation awareness at the center of Industry 4.0
- Virtual Prototyping and Human-In-The-Loop Simulation (HITLS)
  - Enabling Human-Centered Design (HCD)
  - Activity-based development
- From Purpose to Means instead of the usual opposite
  - The User Interface is a component of complex systems to be designed
  - Approach: Outside-In instead of Inside-Out
  - TOP Model (Technology-Organizations-People based concurrent design)

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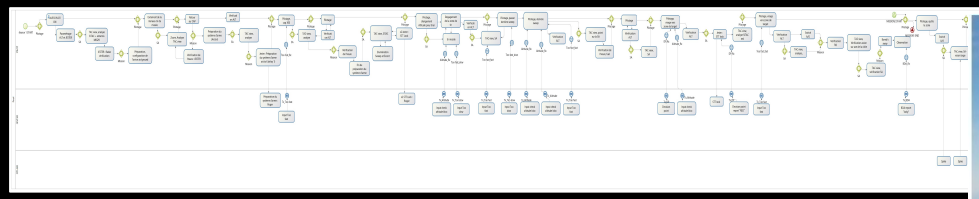
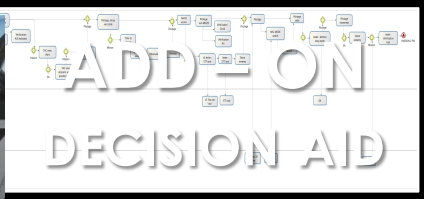
MMT MOHICAN
HUMAN-IN-THE-LOOP SIMULATION (HITLS)





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VIRTUAL ASSISTANTS

- From Rigid Automation to Flexible Autonomy
  - Technological, human and societal maturity
  - Multi-agent systems as human & machine systems of systems
- Human factors issues
  - Trust & collaboration between human & machine agents
  - Emergent human & machine system performance
- Rationalization of expertise & experience
  - Human modeling as a support for virtual assistant design and use
  - Knowledge representation and human-centered system science

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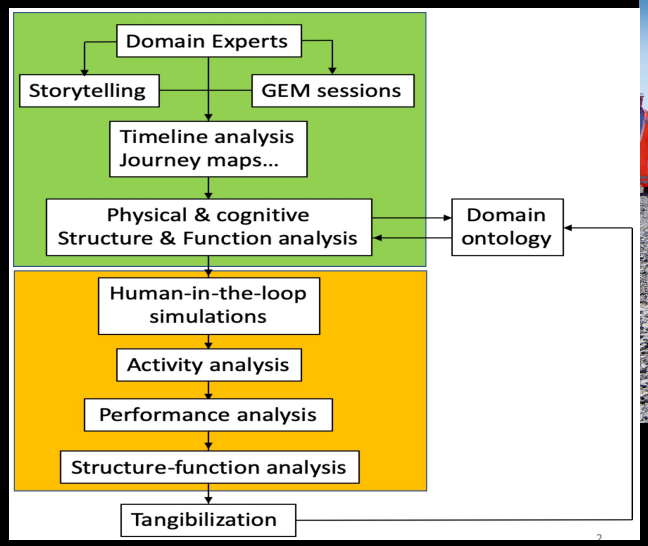
OFF-SHORE OIL & GAS MULTI-AGENT TELEROBITIC SYSTEMS

Using PRODEC method combined with HITLS



Tangibilization

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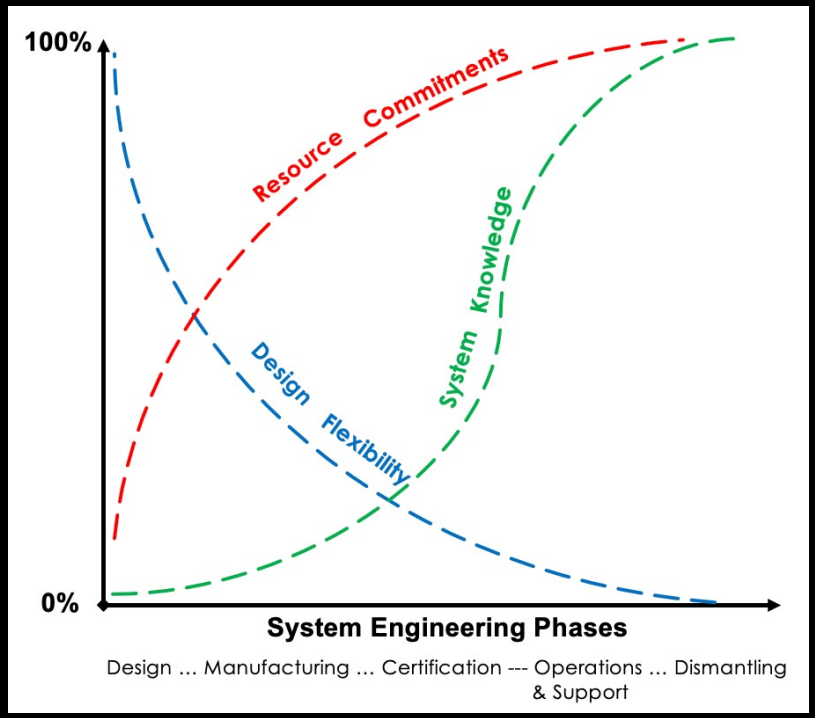
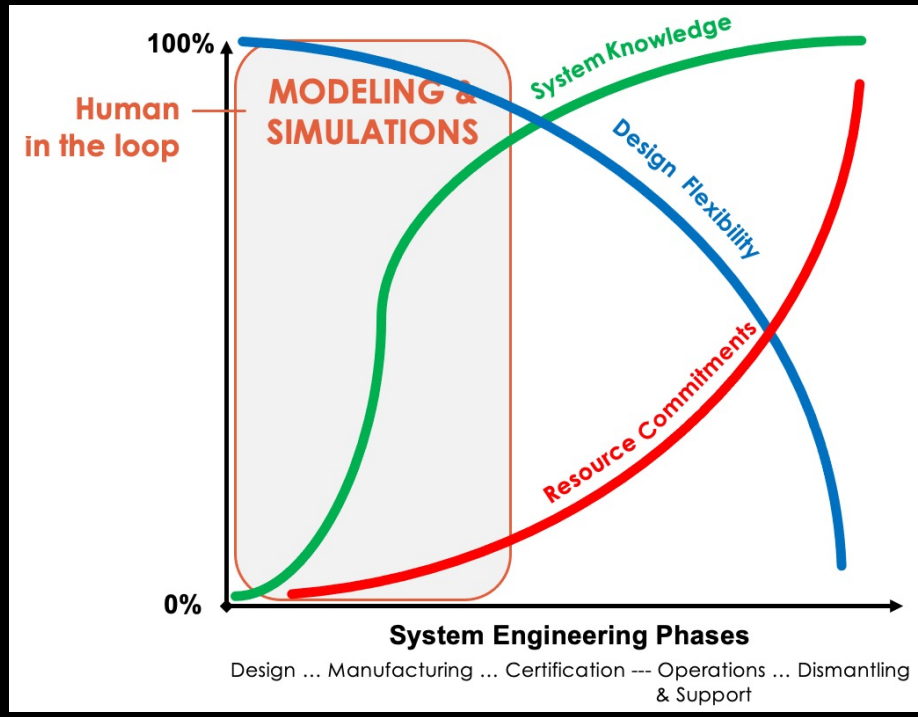
LIFE-CYCLED HUMAN SYSTEMS INTEGRATION

Technology-centered



Human-centered



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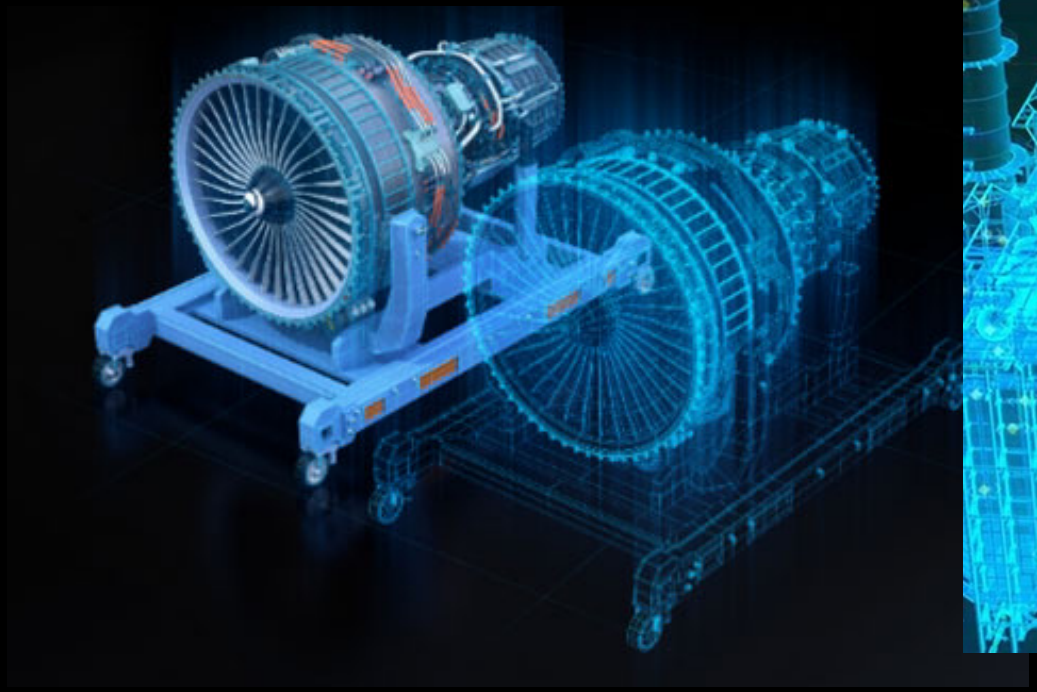
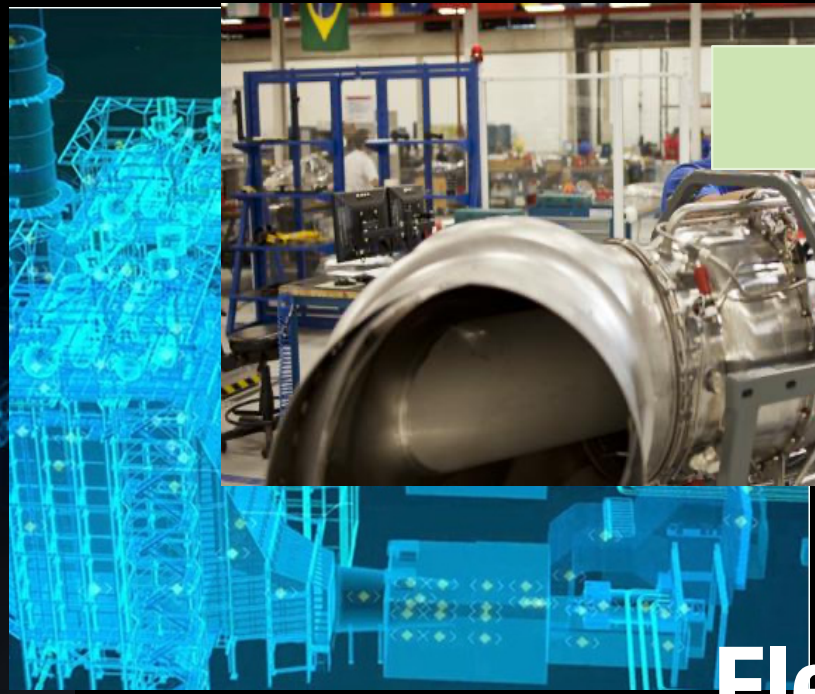
HUMAN-CENTERED DESIGN OF A DIGITAL TWIN FOR HELICOPTER ENGINE MAINTENANCE





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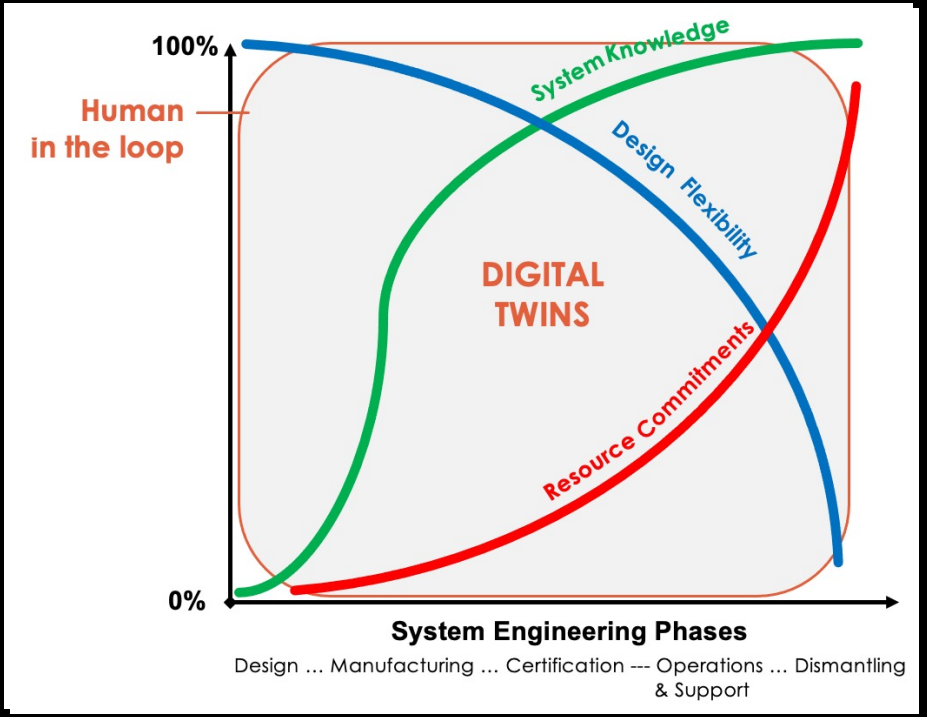
DIGITAL TWINS

- Expanding HITLS
  - During the whole life cycle
  - "what if?"
- Vivid documentation
  - Integration of experience feedback
  - Organizational memory
- DTs as virtual assistants
  - Multi-agent collaboration
  - Mediators for collaborative work



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FUNDAMENTAL RESEARCH EFFORTS

- PRODEC: knowledge elicitation & structure-function analysis method
- Digital twin HCD methods and tools (including human-in-the-loop simulation)
- Virtual HCD (VHCD) methodology
- Unexpected event processing
- Shared situation awareness
- Sociotechnical systems and socio-cognition
- Ethnographical approaches to HSI
- Shift from rigid automation to flexible autonomy
- SE4AI & AI4SE toward HSI readiness levels

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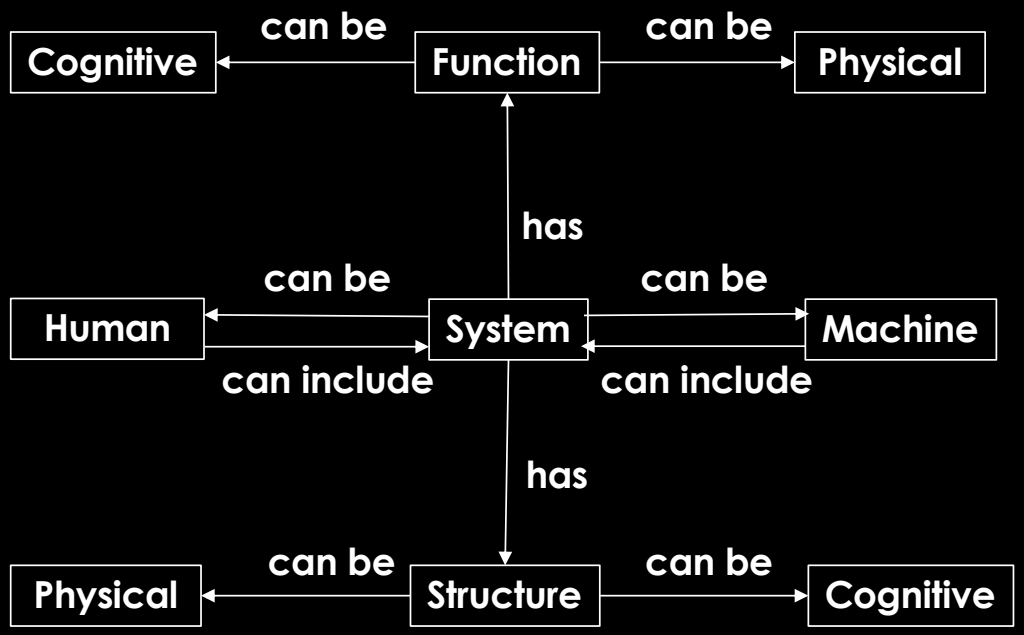
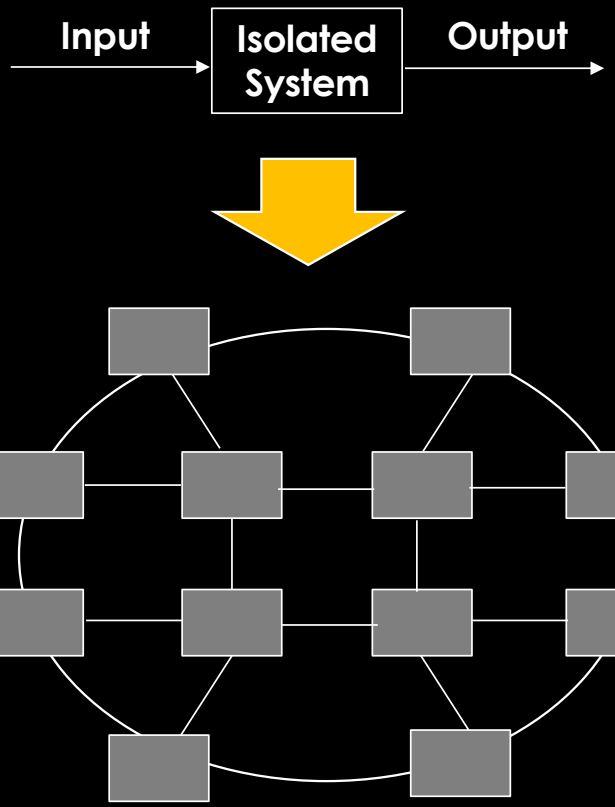
WHAT IS A SYSTEM?



Systems include Humans and Machines…



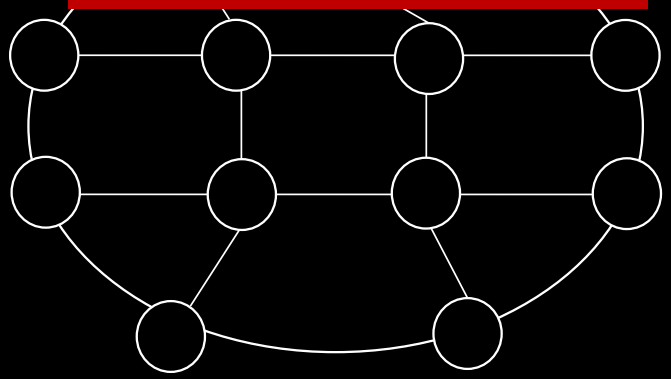
Interconnected System of Systems

SYSTEM = STRUCTURE + FUNCTION

Emergent Structures

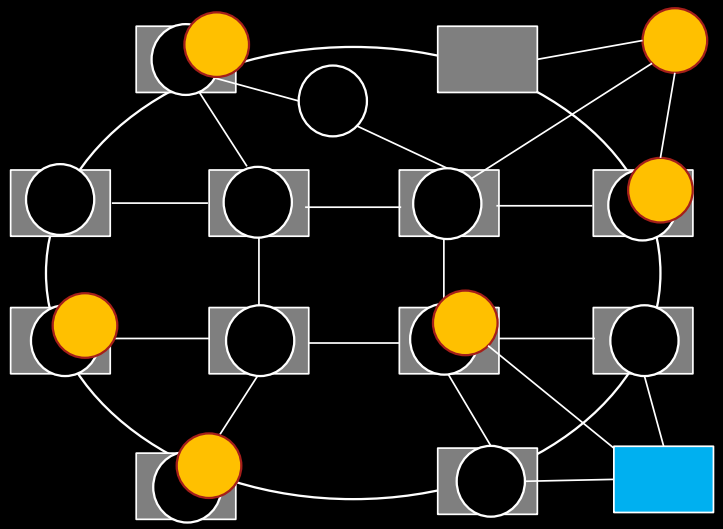
Emergent Functions

Shared situation awareness
Speed & precision
Resilience



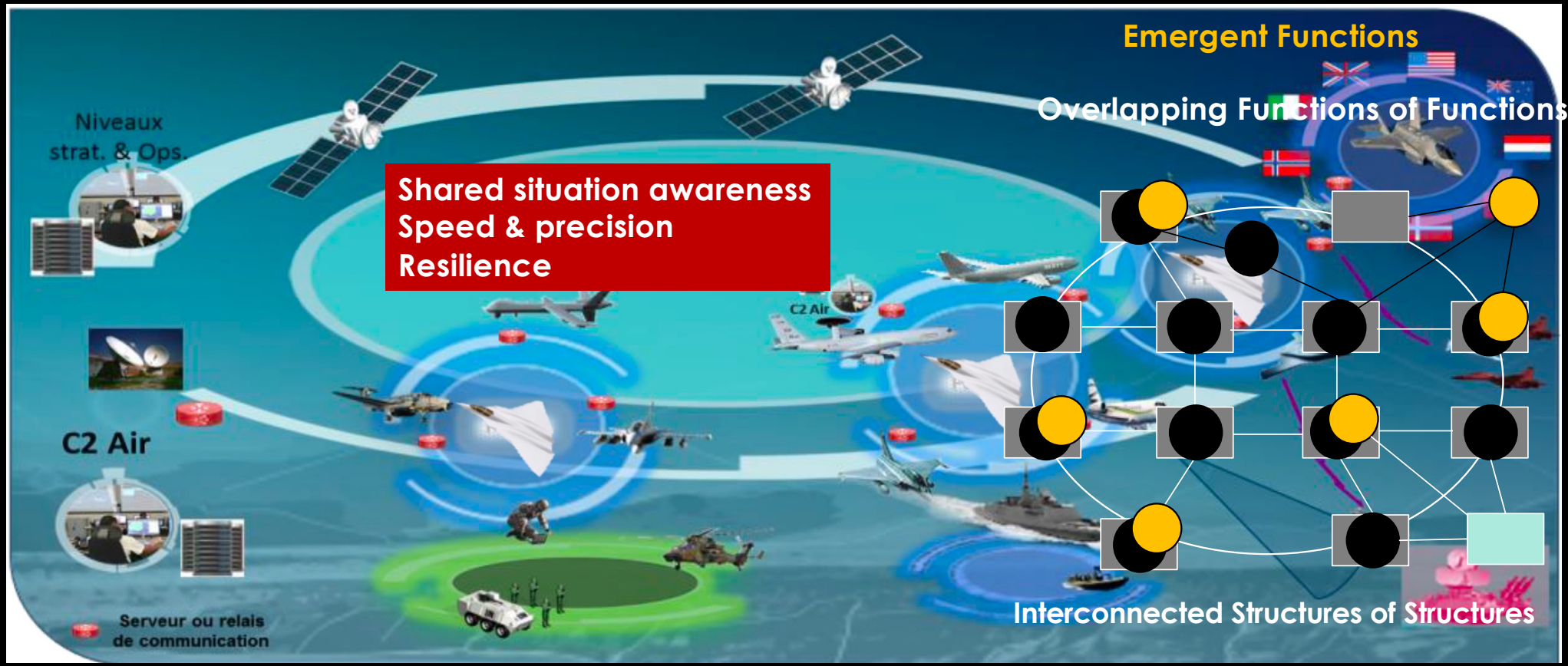
Interconnected Functions of Functions

Overlapping Functions of Functions

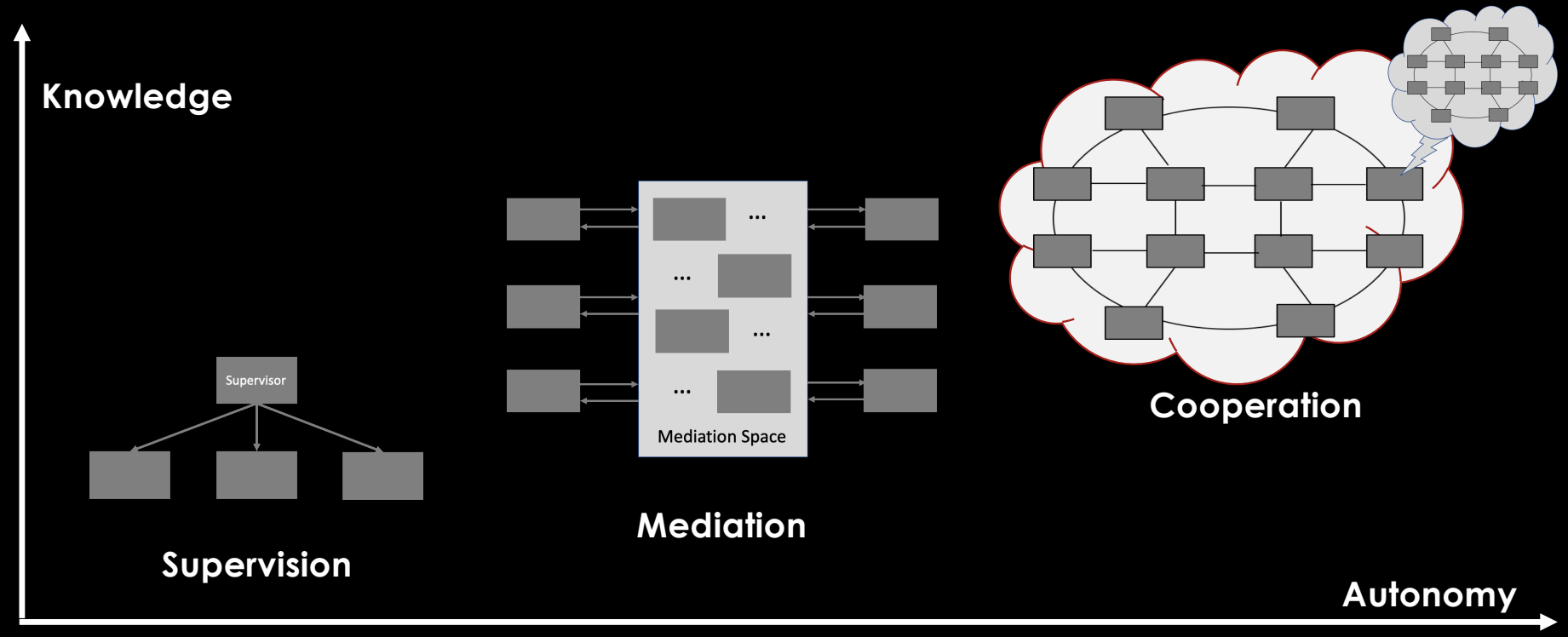


Interconnected Structures of Structures

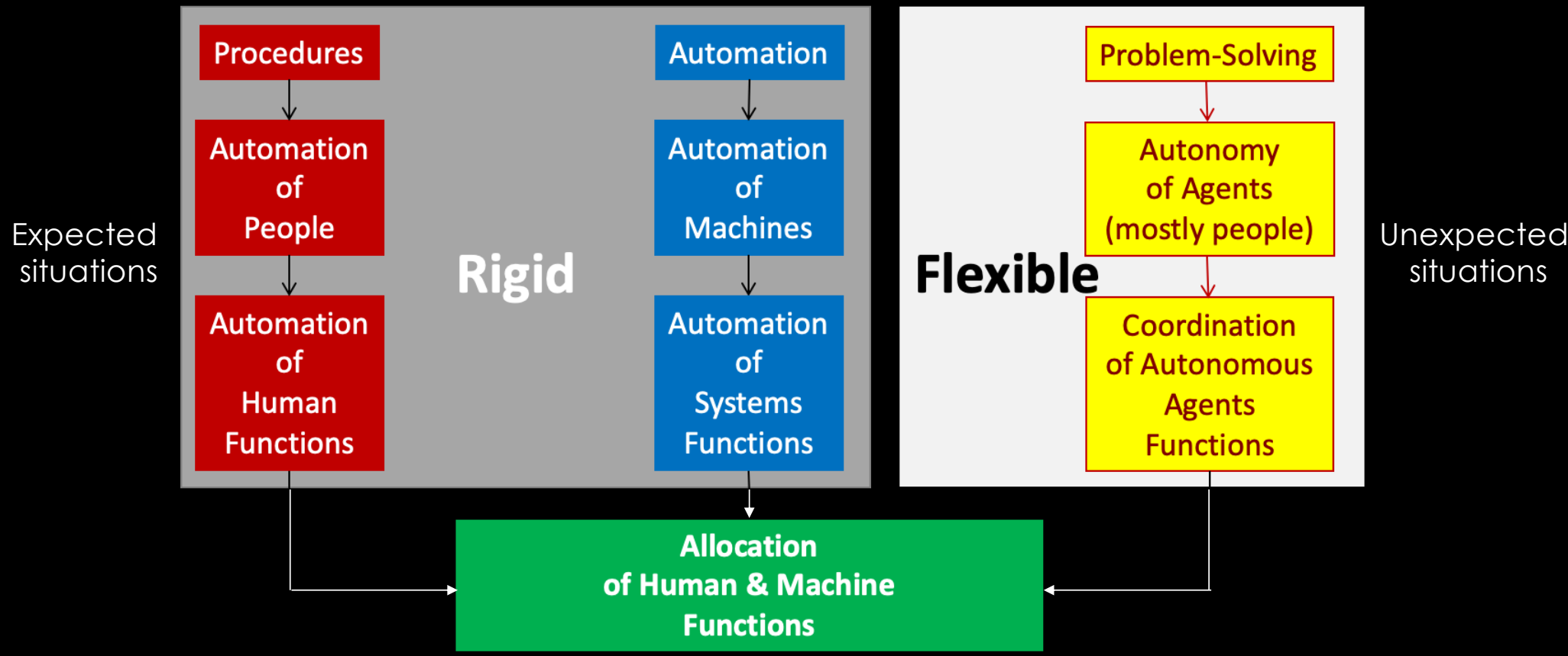
SYSTEM = STRUCTURE + FUNCTION



SYSTEMIC INTERACTION MODELS… … AND AUTHORITY SHARING



FROM RIGID AUTOMATION TO FLEXIBLE AUTONOMY



FLEXTECH IN THE WORLD…

- INCOSE (International Council on Systems Engineering)
  - HSI working group (Chair)
  - Coordinate HSI Chapter for SE Handbook 5th edition
  - Organize conferences (2019 in Biarritz; 2021 in San Diego, CA)
  - Organize workshops (2020: 350 participants/24 countries)
- IEA (International Ergonomics Association)
  - Aerospace technical committee worldwide (Chair)
  - Ambassador INCOSE to the IEA (MOU) worldwide
- ACM (Association for Computing Machinery)
  - SIGCHI in cooperation for HSI2021 (Digital Library)
  - CHI2021: SpaceCHI contributor

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PUBLICATIONS

- Boy, G.A. (2020). *Human Systems Integration: From Virtual to Tangible*. CRC Press – Taylor & Francis Group, USA
- Kolski, C., Boy, G.A., Melançon, G., Ochs, M. & Vanderdonckt, J. (2020). Cross-Fertilisation Between Human-Computer Interaction and Artificial Intelligence. In A Guided Tour of Artificial Intelligence Research. Springer Nature Switzerland AG, by P. Marquis et al. (eds.)
- Boy, G.A., Guegan, A., Vion, V. & Krob, D. (2019). *Complex Systems Design and Management*. Springer. Springer Nature Switzerland AG, ISBN-13: 9783030348427

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PUBLICATIONS

- Boy, G.A. (2021 to appear). Design for Flexibility. Springer, U.K.
- Boy, G.A. (2021 to appear). Conscience de la Situation. *Dictionnaire Encyclopédique de l'Ergonomie* - Dico Ergo. Dunod, Paris, France.
- Boy, G.A. (2021 to appear). Model-Based Human Systems Integration. In the *Handbook of Model-Based Systems Engineering*, A.M. Madni & N. Augustine (Eds.). Springer, USA.
- Boy, G.A. (2021 to appear). Uncertainty management in human systems integration of life-critical systems. In the Handbook of Uncertainty Management in Work Organizations, G. Grote & M. Griffin (Eds.). Oxford University Press, UK.
- Camara Dit Pinto, S., Masson, D., Villeneuve, E., Boy & Urfels. L. (2021). From requirements to prototyping: Application of human systems integration methodology to digital twin. in ICED 2021 proceedings
- Camara Dit Pinto, S., Villeneuve, E., Masson, D., Boy, G.A., Barron, T. & Urfels. L. (2021). Digital Twin Design Requirements in Downgraded Situations Management. in Incom 2021 proceedings

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COURSES

- ESTIA (January 2021)
  - 32 students (3rd year – Master level)
  - Participation of high standard speakers (Airbus, Air Force, EDF, Navy)
- CentraleSupélec (February & March 2021)
  - 38 students (3rd year – Master level)
  - Participation of high standard speakers (Airbus, Air Force, EDF, Navy)

…

- Next year, will be given at ISAE-SUPAERO

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COURSES (PROJECTS)

1. INNOMED: General Practitioner-centered Health system
2. FCAS (Future Combat Air Sys) shared situation awareness system
3. Digital aviation air traffic system
4. Small nuclear reactors system
5. Digital twin for helicopter engine diagnostic and repair system
6. Unexpected-event or wrong systemic decision-making process?
7. Offshore oil-&-gas platform telerobotic system
8. Integrative experience-feedback digital twin in process control

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WEBINARS & KEYNOTES

- 8 November 2021. Human Systems Integration. Plenary Speaker. Aerospace Engineering and Technology Conference. Frankfurt, Germany.
- 26 July 2021. Human Systems Integration: The FlexTech Challenge. Keynote at the 12th International Conference on Applied Human Factors and Ergonomics (AHFE 2021). New York City, USA.
- 13-18 June 2021. Human Systems Integration: The right Mix of Technology, Organization and People. Keynote. 21st Triennial Congress of the International Ergonomics Association, Vancouver, Canada – online
- 2 March 2021. Human Machine Teaming: A Human Systems Integration Approach. Invited Guest Speaker at the Pentagon Trilateral Strategic Steering Group (US-UK-France) Workshop on "How should our trilateral air forces better employ, integrate and introduce Human Machine Teaming (HMT) to ensure our advantage against adversaries?"

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WEBINARS & KEYNOTES(CONT.)

- 11 June 2020. Human Systems Integration. Aersopace Valley Seminar, with a panel with Dassault Aviation, Thales and Synapse Défense (80 participants)
- 27 May 2020. Human Systems Integration: From Virtual to Tangible. AFIS Webinar (120 participants)
- 15 April 2020. Human Systems Integration: From Virtual to Tangible. INCOSE Webinar (250 participants)
- 23 January 2020. Architecting for Operations Autonomy. Jet Propulsion Laboratory, NASA, California Institute of Technology, Pasadena, California, USA (150 participants)

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THE NEXT STEP…

- Hire a Deputy Chair Holder for FlexTech to continue good work
- New research work (Ph.D. program)
  - ***C****ollaborative* ***H****uman* ***A****nd* ***M****achine* ***P****latform and* ***I****ntelligence t****O****ward a value* ***N****etwork, DGA, IRT SystemX, collaboration with Sorbonne University*
  - Model-based HSI in the rail domain, SNCF, collaboration with Prof. A. Barros
  - HSI & AI in Air Force personnel training, CEAM, CS Group, collaboration with ENSC
  - Dealing with the unexpected, potentially with Dassault Aviation
- FlexTech HSI Professional Course (3 to 5 days)
- Community service
  - INCOSE HSI WG: next SE Handbook + HSI Primer + HSI2021 Conf. + IEA MOU
  - FlexTech HSI recurring workshops + 2022 Summer School
- FlexTech Website
  - https://www.flextechchair.org/home/index.html

This book is a follow-up of previous contributions in Human-Centered Design and practice in the development of virtual prototypes that requires progressive operational tangibility toward Human-Systems Integration (HSI). The book discusses flexibility in design and operations, tangibility of software-intensive systems, virtual human-centered design, increasingly-autonomous complex systems, Human-Factors and Ergonomics of sociotechnical systems, and systems of systems integration.

This is an attempt to better formalize a systemic approach to HSI. Good HSI is a matter of maturity… it takes time to mature. It takes time for a human being to become autonomous, and then mature! HSI is a matter of human-machine teaming, where human-machine cooperation and coordination are crucial. We cannot think engineering design without considering people and organizations that go with it. We also cannot think new technology, new organizations and new jobs without considering change management, especially in digital organizations.

The book will be of interest to industry, academia, those involved with systems engineering, human factors and the broader public.

Features:

- Discusses flexibility in design and operations of complex systems
- Offers tangibility of software-intensive systems
- Presents virtual human-centered design
- Covers autonomous complex systems
- Provides human factors and ergonomics of sociotechnical systems

About the Author:

Guy André Boy is one of the pioneers and a world leader in the study and applications of human centered design and human systems integration. He is also the Chair of INCOSE Human Systems Integration Working Group worldwide.

Ergonomics and Human Factors

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HUMAN-SYSTEMS INTEGRATION

Guy Andre Boy

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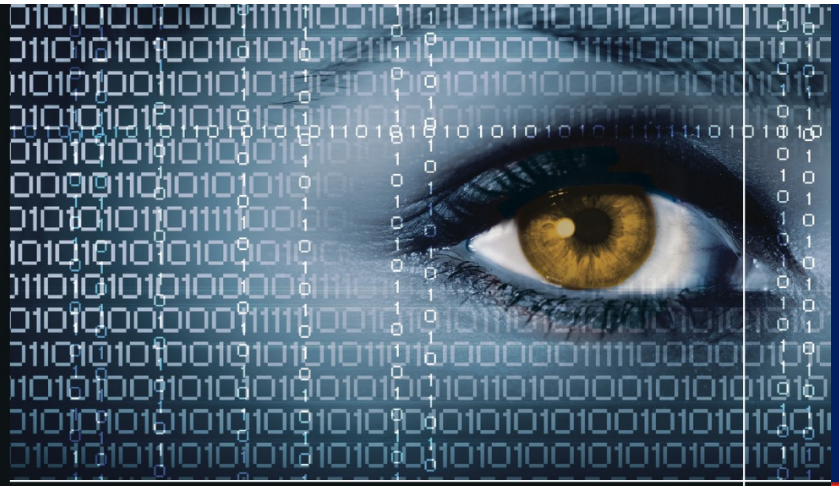

HUMAN-SYSTEMS INTEGRATION

From Virtual to Tangible

Guy Andre Boy

CRC Press
Taylor & Francis Group