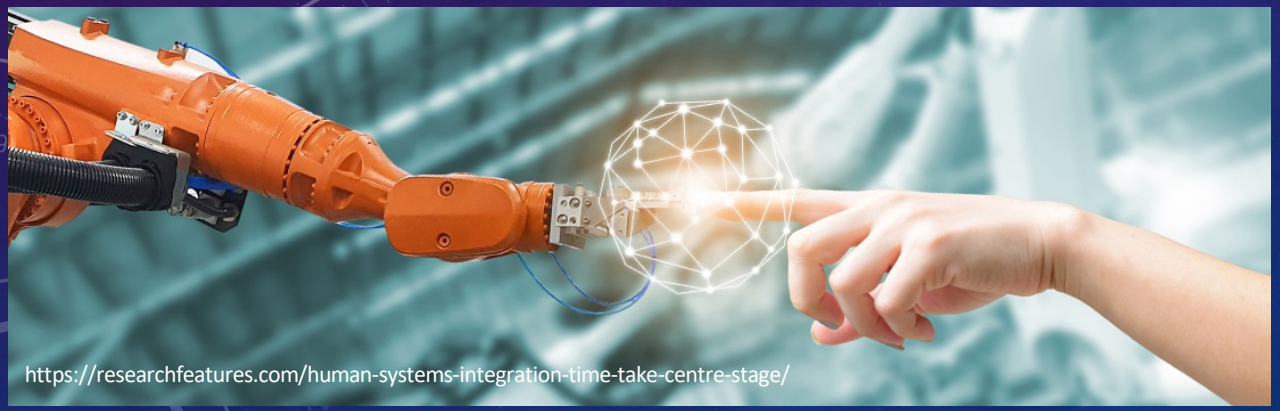
AI4SE & SE4AI Workshop 2022
Washington, D.C., U.SA..
September 21-22, 2022

IS THE MACHINE A PARTNER OR A TOOL?
A MAJOR ISSUE OF HUMAN-AI TEAMING



https://researchfeatures.com/human-systems-integration-time-take-centre-stage/

GUY ANDRÉ BOY

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ARTIFICIAL INTELLIGENCE (AI)…

Knowledge-based systems
Vision
Speech
Natural language processing
Robotics
Machine learning
Planning
…

AI demonstrates intelligent behavior

- analyzes its environment
- acts to achieve specific goals with some degree of autonomy

AI performs tasks that usually require human intelligence

e.g., perception, conversation, and decision-making

(Kanaan, 2020)

Human-AI Teaming is a matter of **Human Systems Integration** (HSI)

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

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

Integrated Logistics Support & Maintenance

Workforce Planning

Safety

Environment

Human Factors Engineering

Competences & Professionalism

People

Organization

HSI

HSI Planning

Sustainability

Training

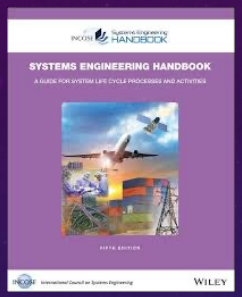
Habitability

Technology

Social, Cultural & Organizational Factors

UX/Usability

Occupational Health



SEH5E

HSI Primer

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

https://www.incose.org/incose-member-resources/working-groups/analytic/human-systems-integration

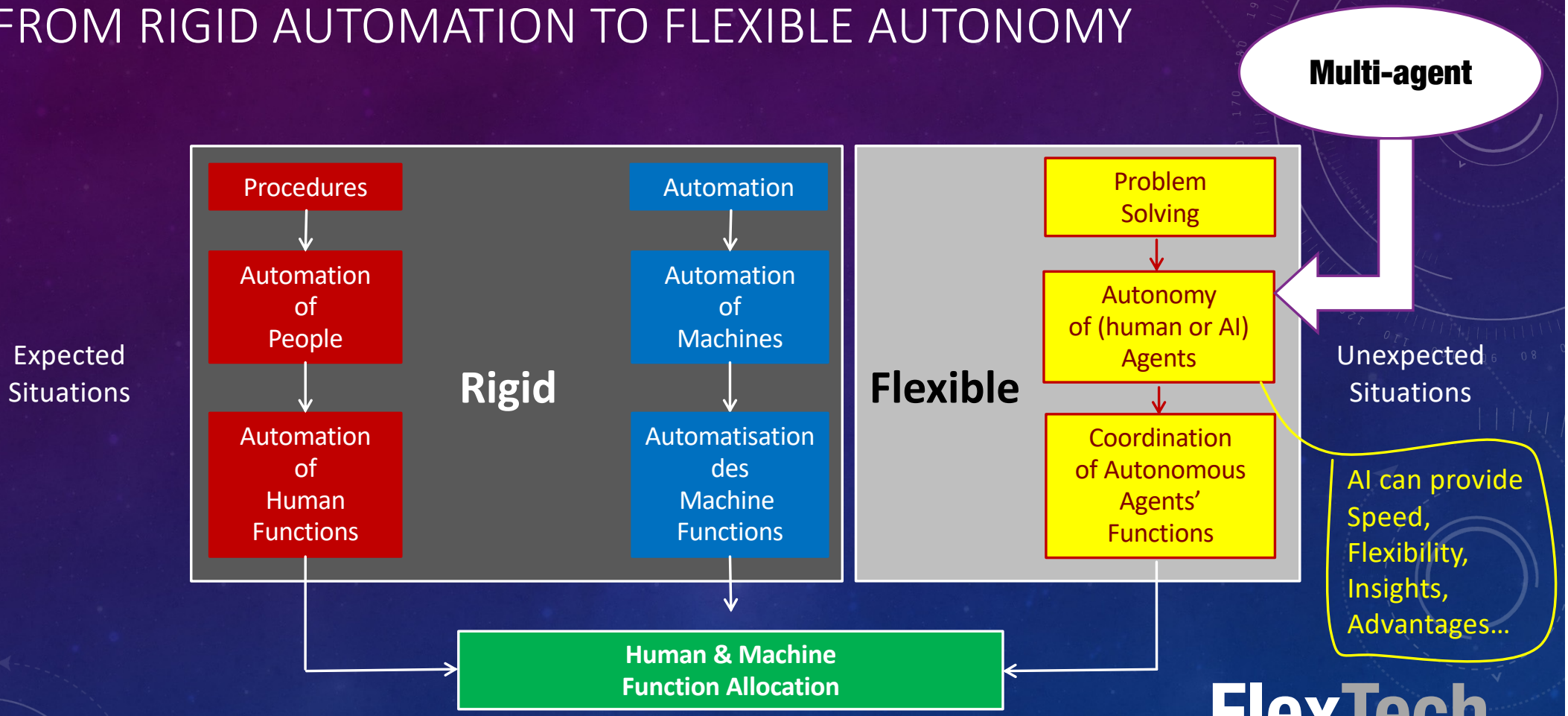
HUMAN-AI TEAMING…

Procedures: Automation of people

Monitoring of automated machines

Problem solving otherwise…

FROM RIGID AUTOMATION TO FLEXIBLE AUTONOMY



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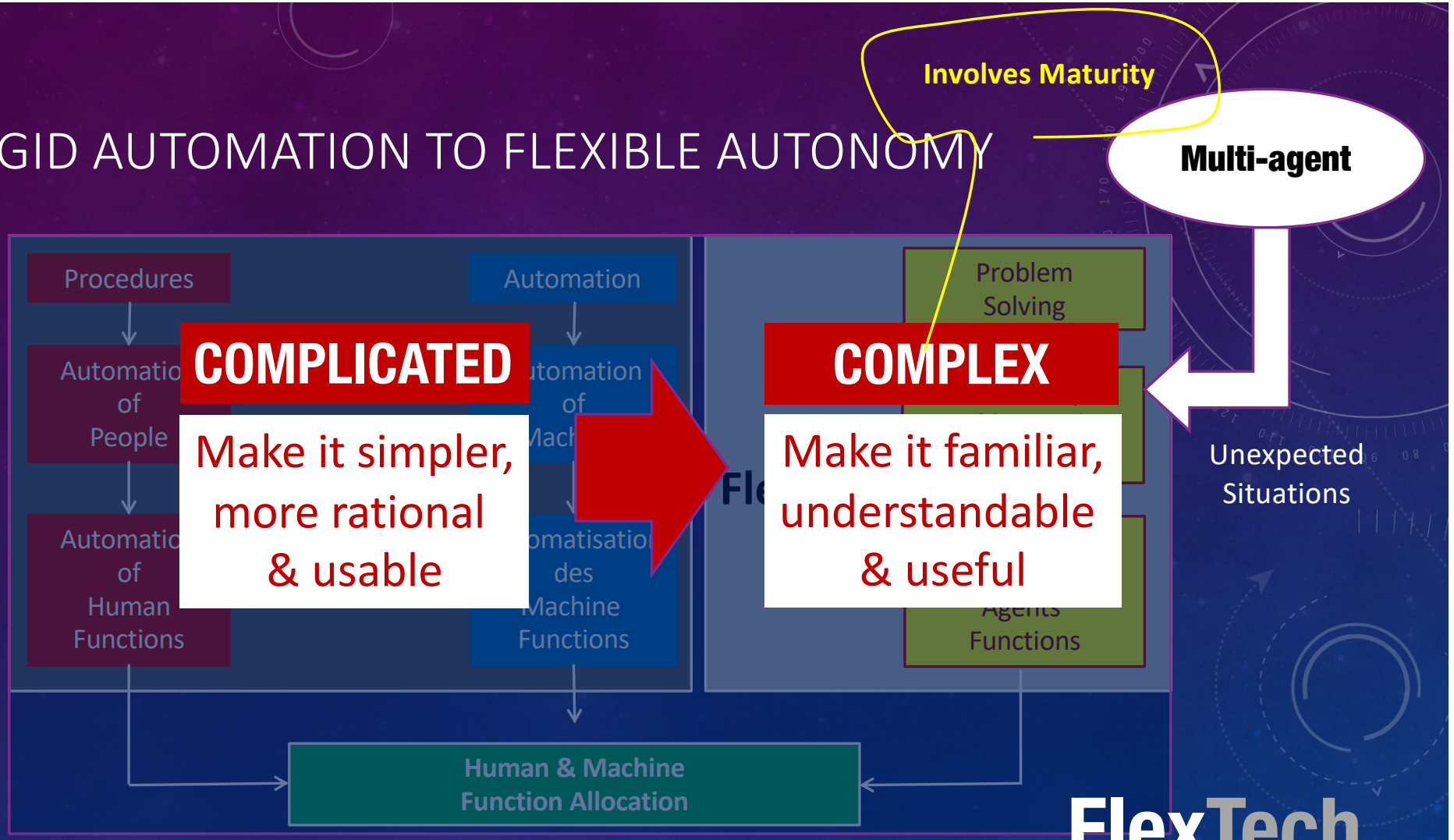
FROM RIGID AUTOMATION TO FLEXIBLE AUTONOMY



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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

FLEXIBILITY?

COMPLICATED

Make it simpler, more rational & usable

RIGID

COMPLEX

Make it familiar, understandable & useful

FLEXIBLE

FOR OPERATIONS & ENGINEERING DESIGN

→ Need for a systemic representation that covers both humans and machines

Including AI

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

MOHICAN

A HUMAN-AUTONOMY TEAMING (HAT) PROJECT

HAT performance evaluation in combat aircraft cockpit

- **A model of trust and collaboration**

  Level 1: Identification of trust & collaboration metrics (approaches and tools state of the art)

  Level 2: Definition of intermediate criteria contextualized with the operational environment.

  Level 3: Selection of objective and subjective measures using physiological methods & sensors

- **Design of a tangible virtual assistant prototype**

A research effort sponsored by DGA

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MONITORING HUMAN-MACHINE PERFORMANCE BY ANALYZING TRUST AND COOPERATION

Objectives

- Propose and test a method to evaluate the performance of pilot–virtual assistant teaming…

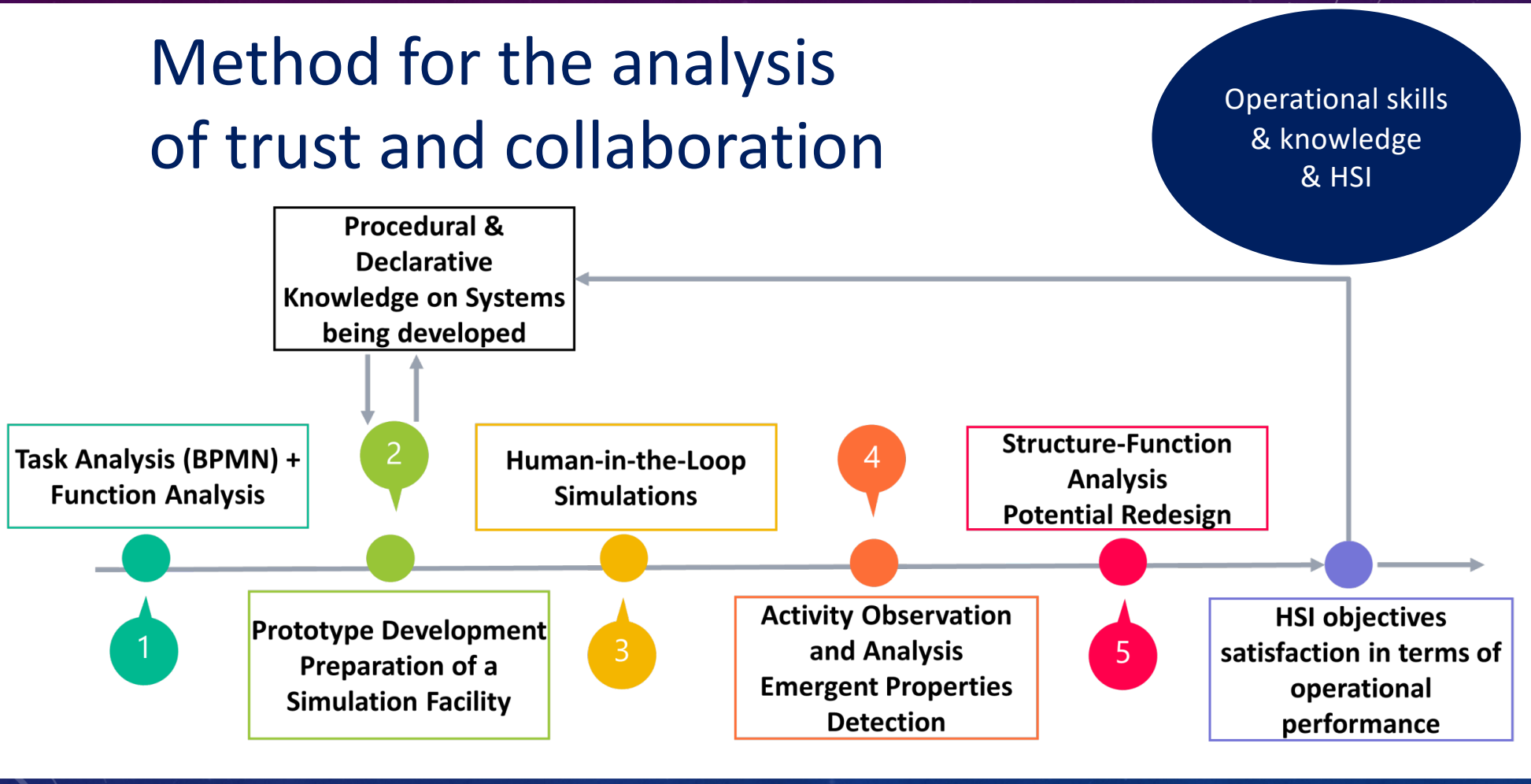
  … in the cockpit of a simulated fighter aircraft

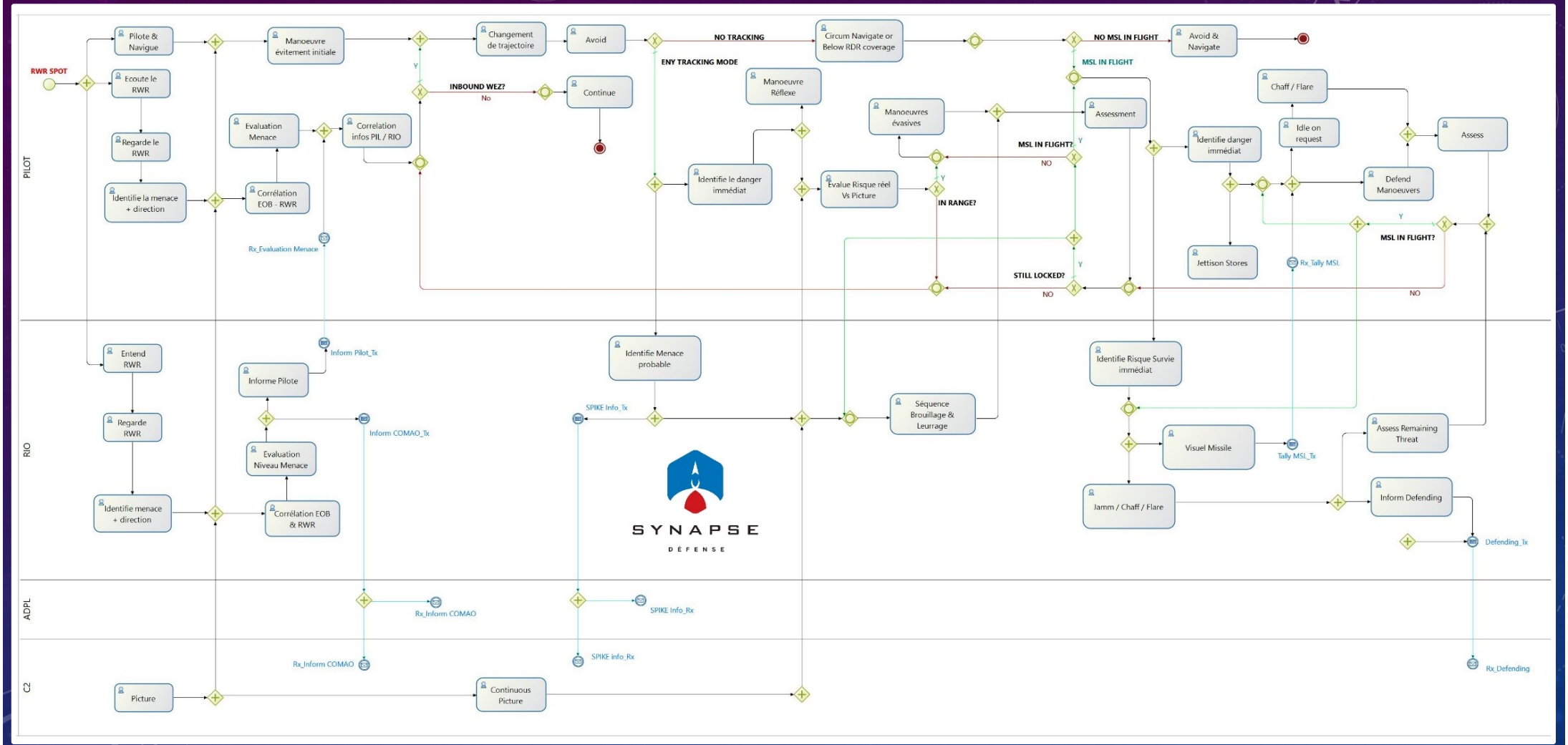
- Define trust and collaboration models & metrics by
  - Considering pilot's context and environment
  - Building indicators based on operational experience
  - Building metrics based on tangible virtual prototypes
  - Developing virtual prototypes (virtual assistant) and experiments

Including AI

Human-Machine Teaming

Method for the analysis of trust and collaboration

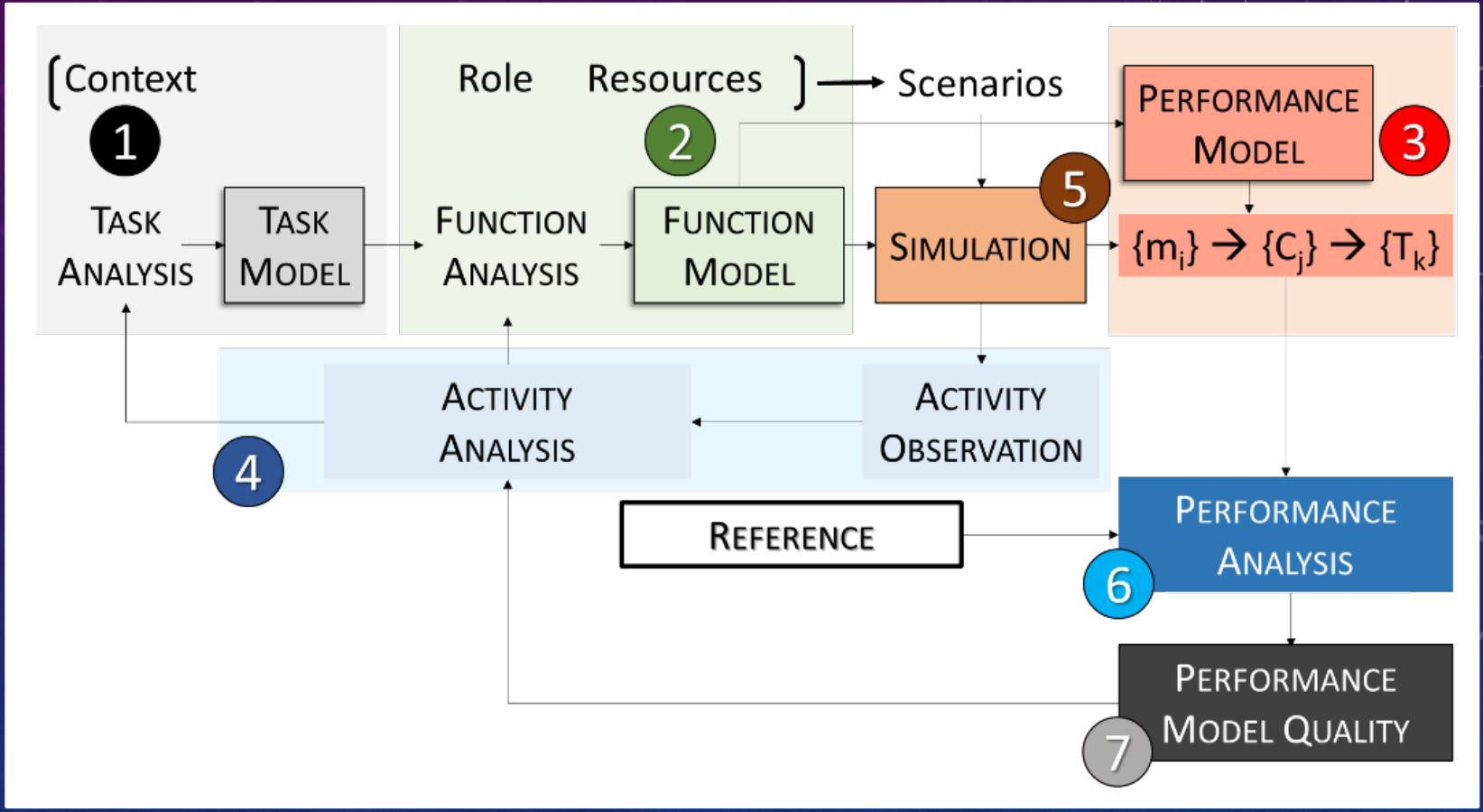



PILOT
RIO
ADPL
C2
RWR SPOT
Pilote & Navigue
Ecoute le RWR
Regarde le RWR
Identifie la menace + direction
Manoeuvre évitement initiale
Evaluation Menace
Corrélation EOB - RWR
Correlation infos PIL / RIO
Rx_Evaluation Menace
Changement de trajectoire
INBOUND WEZ?
No
Continue
Avoid
NO TRACKING
ENY TRACKING MODE
Circum Navigate or Below RDR coverage
Manoeuvre Réflexe
Identifie le danger immédiat
Evalue Risque réel Vs Picture
IN RANGE?
Manoeuvres évasives
MSL IN FLIGHT?
NO
NO MSL IN FLIGHT
Avoid & Navigate
MSL IN FLIGHT
Assessment
Identifie danger immédiat
Chaff / Flare
Idle on request
Assess
Defend Manoeuvers
Jettison Stores
Rx_Tally MSL
MSL IN FLIGHT?
STILL LOCKED?
Entend RWR
Regarde RWR
Identifie menace + direction
Corrélation EOB & RWR
Evaluation Niveau Menace
Informe Pilote
Inform Pilot_Tx
Inform COMAO_Tx
Identifie Menace probable
SPIKE Info_Tx
Séquence Brouillage & Leurrage
Identifie Risque Survie immédiat
Visuel Missile
Tally MSL_Tx
Jamm / Chaff / Flare
Assess Remaining Threat
Inform Defending
Defending_Tx
SYNAPSE DÉFENSE
Rx_Inform COMAO
SPIKE Info_Rx
Rx_Inform COMAO
SPIKE info_Rx
Rx_Defending
Picture
Continuous Picture

PRODEC METHOD USED IN MOHICAN

Task vs Activity

Procedural vs Declarative Knowledge



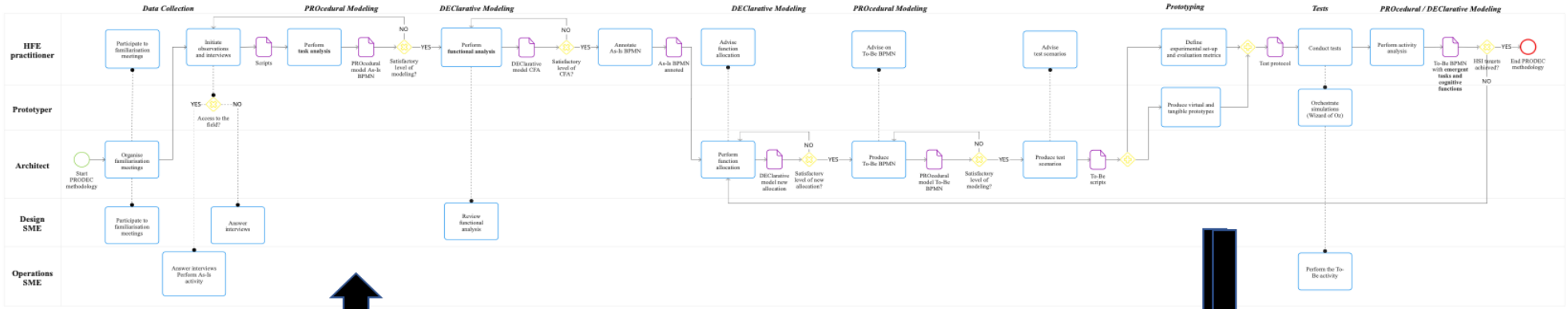
Boy, G.A. & Morel, C. (2022). The Machine as a Partner: Human-Machine Teaming Design using the PRODEC Method. *WORK: A Journal of Prevention, Assessment & Rehabilitation*. Vol. 73, no. S1, pp S15-S30. DOI: 10.3233/WOR-220268

Task-based Procedural Knowledge → Task-based Declarative Knowledge → Emergence & Activity Analysis

AS-IS

TO-BE

Human-in-the-loop simulations



TO-BE becomes AS-IS ← TO-BE

Activity-based Procedural Knowledge

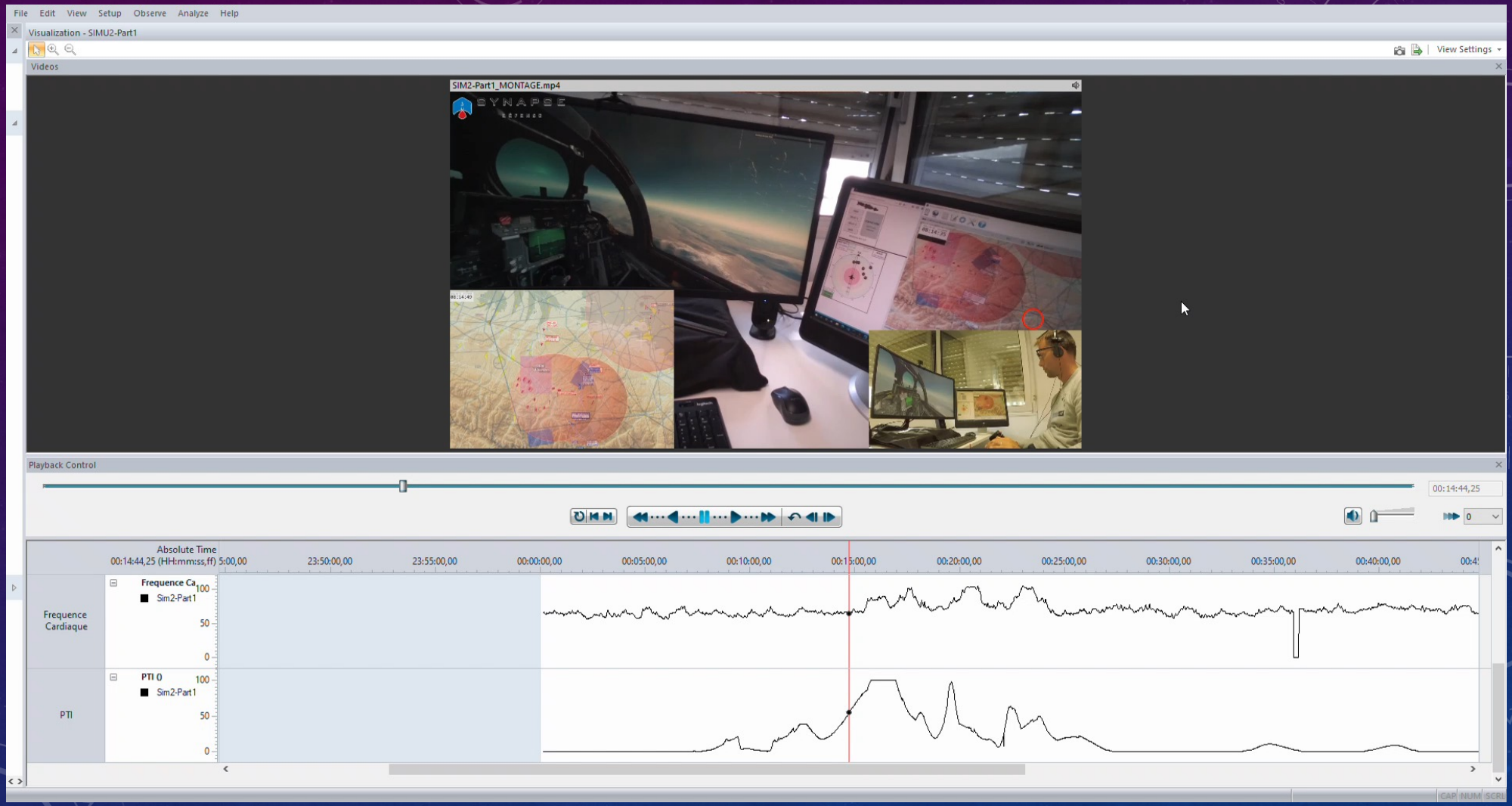
+

+

ADD – ON DECISION SUPPORT JOBS

SIMULATION SET-UP


SYNAPSE
DÉFENSE
TGT1 245°/7Nm
POSIT MDHS
16°/77Nm
INST
DELAY 1
DELAY 2
SAFE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Visualization - SIMU2-Part1
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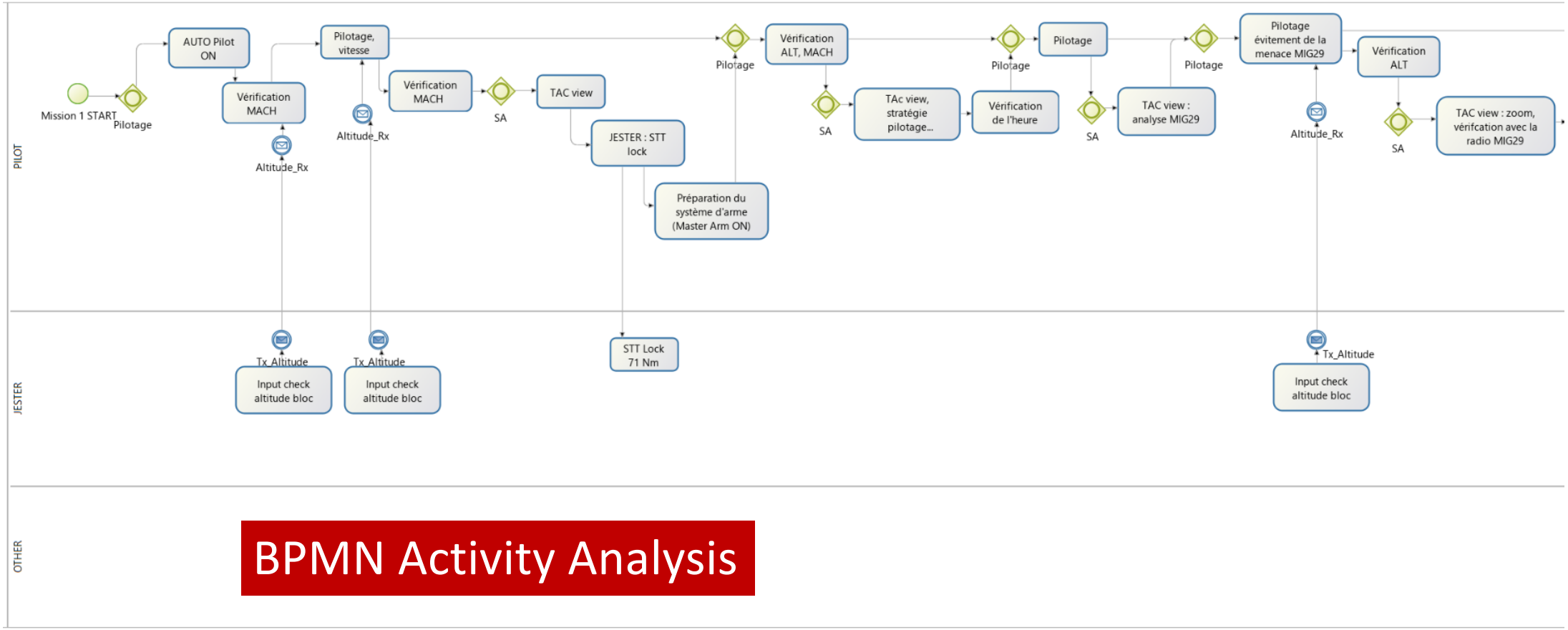
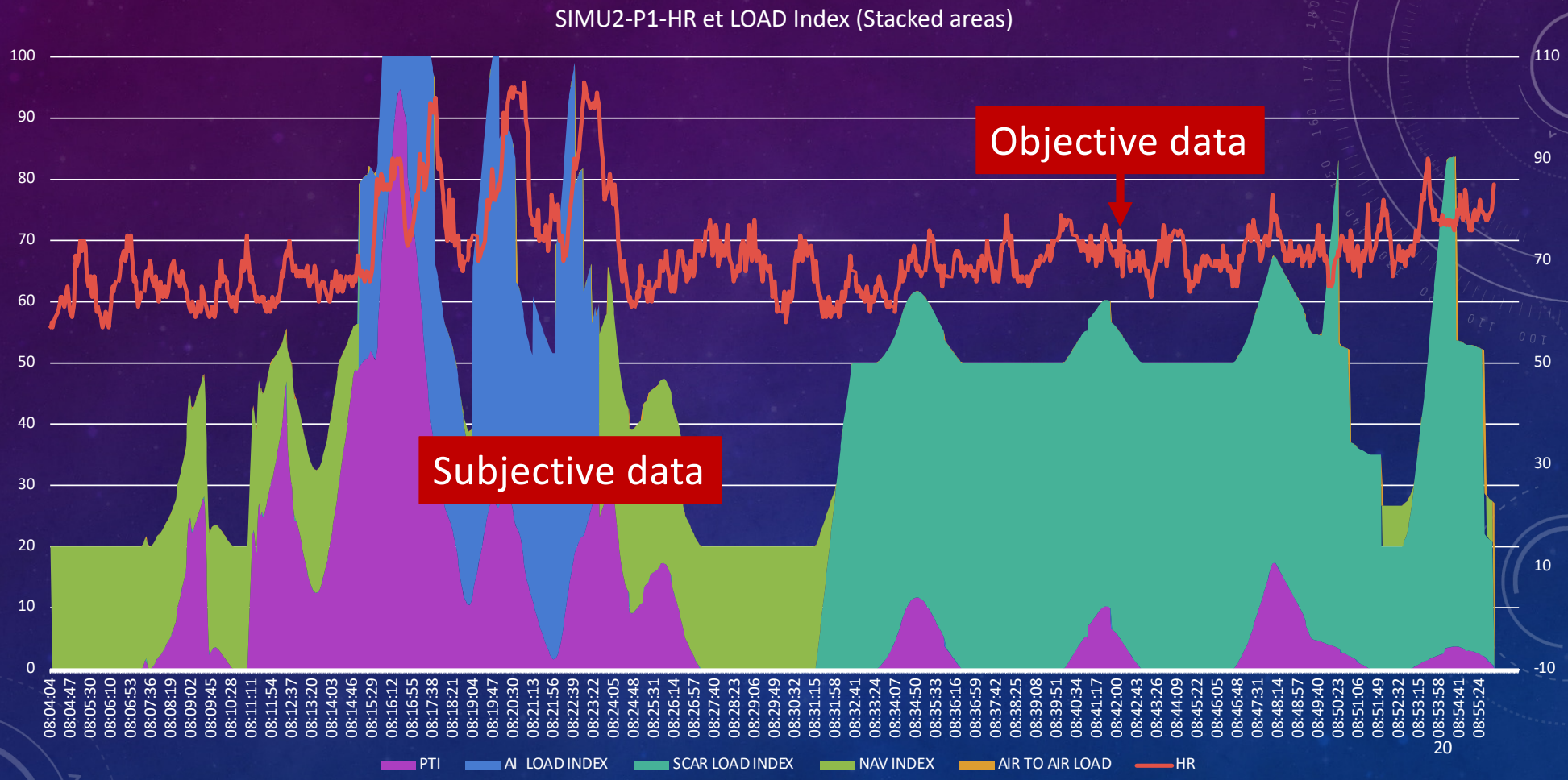


BPMN Activity Analysis

BPMN ACTIVITY ANALYSIS +

CORRELATION BETWEEN PILOT LOAD INDEX AND CFA RESULTS



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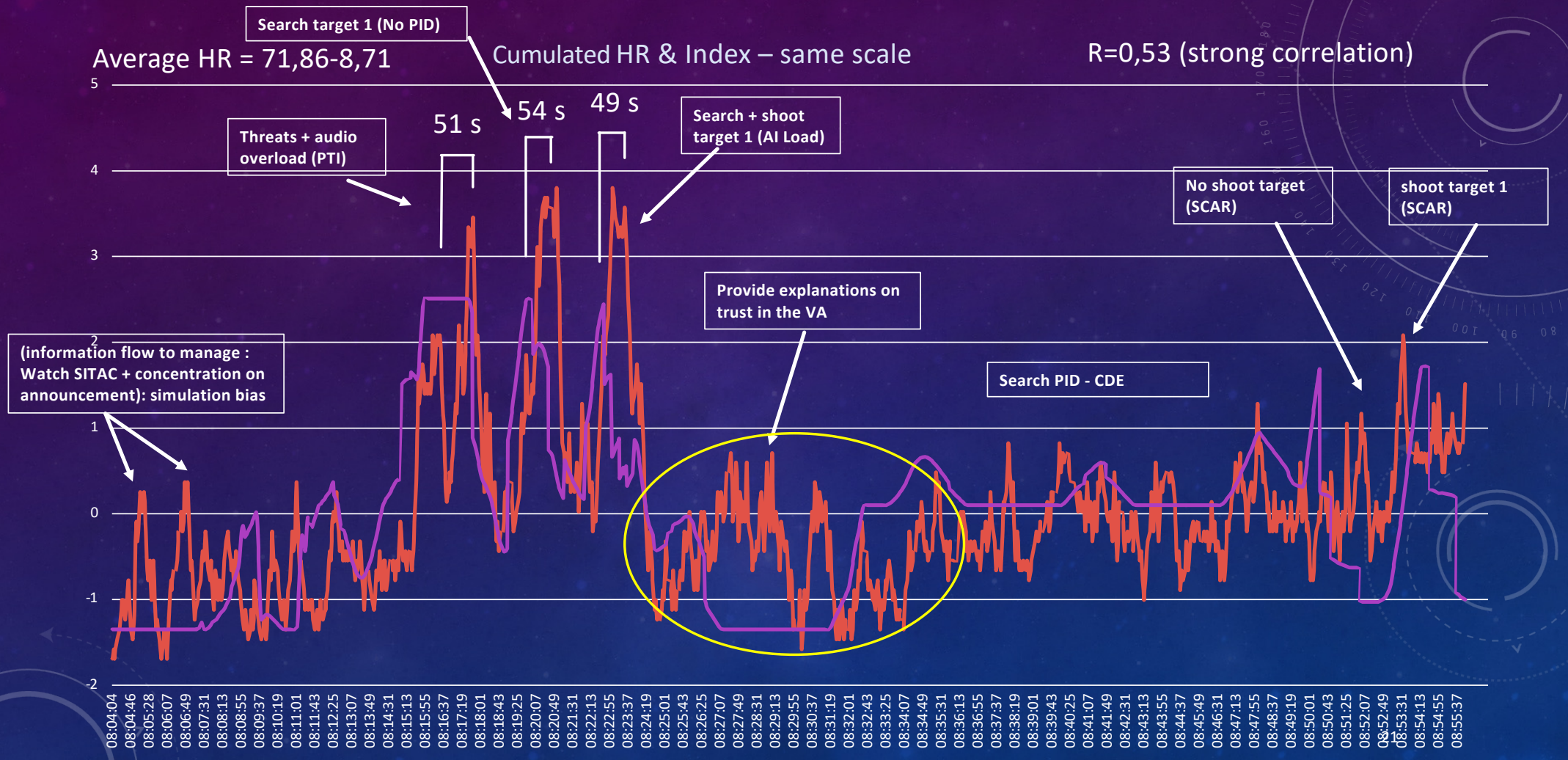
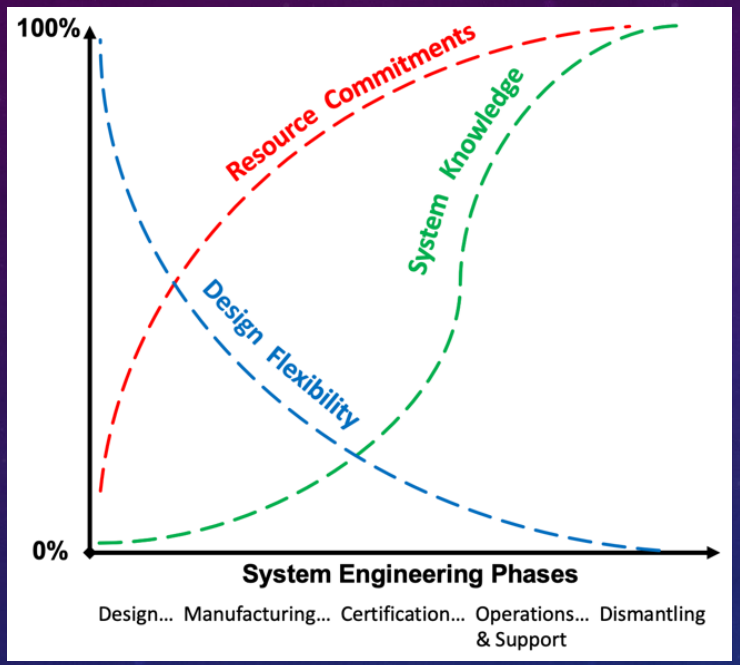


ELICITATION & VALIDATION OF EVALUATION CRITERIA

Metrics	Criteria	Measures
Trust	Efficiency	Proce[illegible]nation (pilot actions)
		V[illegible]ed information (eye tracking)
	Effectivity	[illegible]nteraction time (Raw data - The Observer XT)
	Reliability/Robustness	Bug or functional default (experimenter)
	Relevance	Added value (pilot)
	[illegible]sparency	Perceived information (pilot)
		Interpretated/comprehended information (pilot)
	Flexibility/Adaptability	Adaptability to the pilot or to context (pilot)
Collaboration	Feedback quality	Quantity & nature of VA feedback (pilot)
	Perceived relief of the task	Perceived relief of pilot's workload (pilot)
	No discomfort	Discomfort introduced by usage/announcement (pilot)

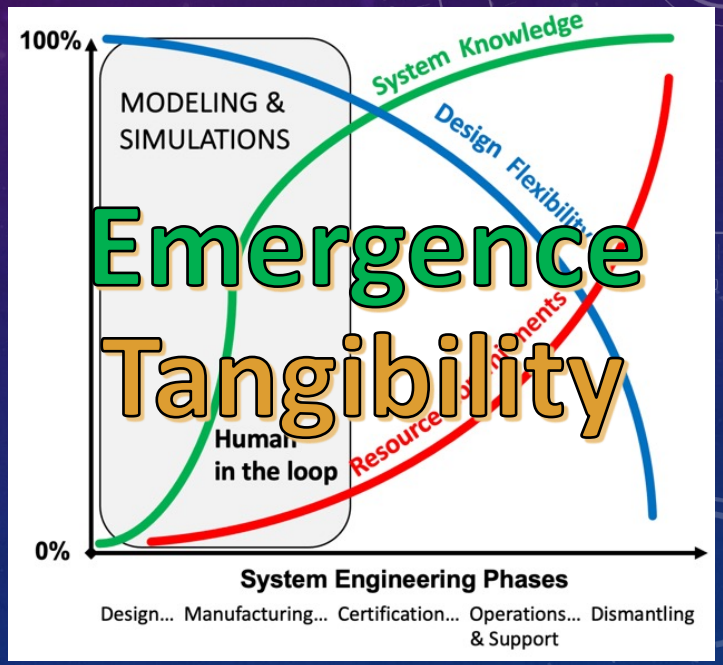
Certification vs. Qualification…

TECHNOLOGY-CENTERED
ENGINEERING:
LATE IN LIFE CYCLE



Maturity…

HUMAN-CENTERED
DESIGN:
WHAT WE REALLY WANT



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- Boy, G.A. (2020). *Human Systems Integration: From Virtual to Tangible*. CRC Press – Taylor & Francis Group, USA (https://www.taylorfrancis.com/books/9780429351686).

2024 FlexTech Spring School on **Human-AI Teaming (HAT)**

A Human Systems Integration Approach

27-31 May 2024 - Radisson Blu, Biarritz, Basque Country, France

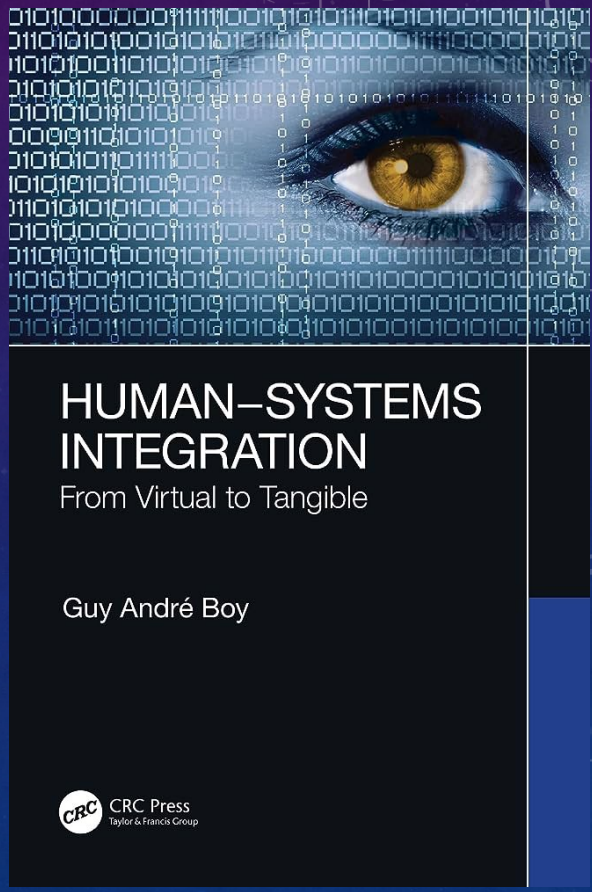
Purpose

- intensive week-long training and exchange seminar
- introduction to Human Systems Integration
- integrating artificial intelligence (AI), systems engineering, human factors & ergonomics, and human-computer interaction
- through incremental tangibilization of virtual prototypes

Logistics

- Radisson Blu Hotel, Biarritz, France
- with the best senior scientists and practionners
- limited to 60 participants worldwide
- arrival Sunday evening & departure Friday afternoon

THANK YOU!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