PRODEC: A METHOD AND PLATFORM

FOR MODEL-BASED HUMAN SYSTEMS INTEGRATION OF HUMAN-AI TEAMS

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

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WHAT DO WE MEAN BY ARTIFICIAL INTELLIGENCE?

A Human Systems Integration (HSI) Approach

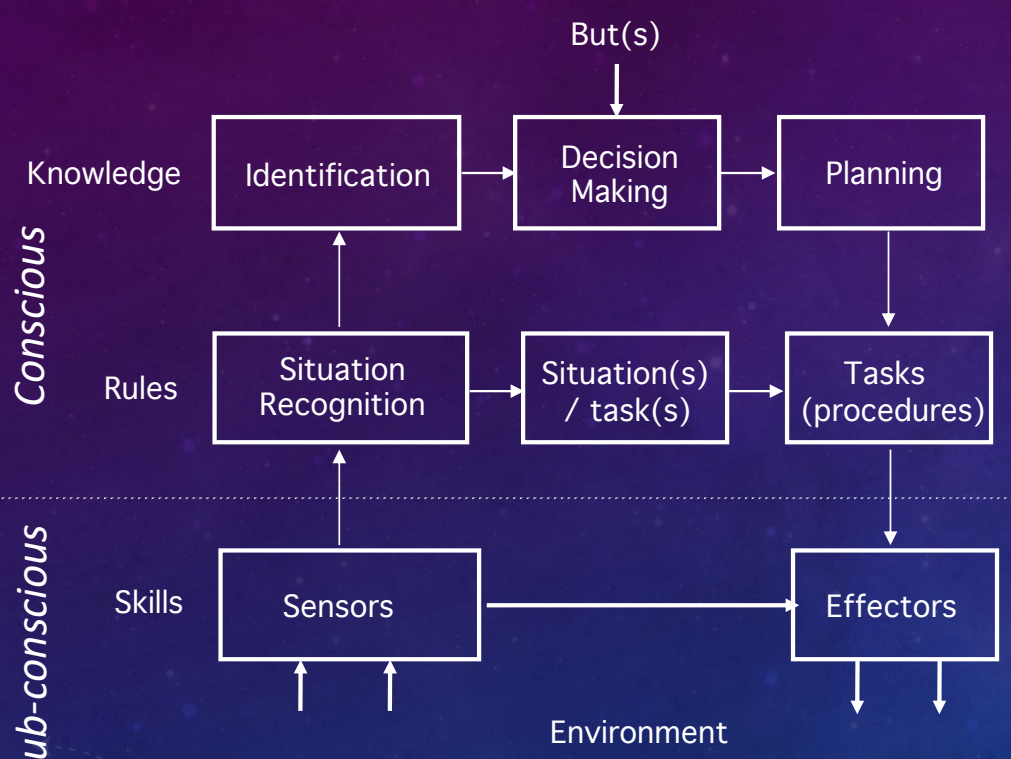
A REAL-WORLD RAILWAY OPERATIONAL SYSTEM

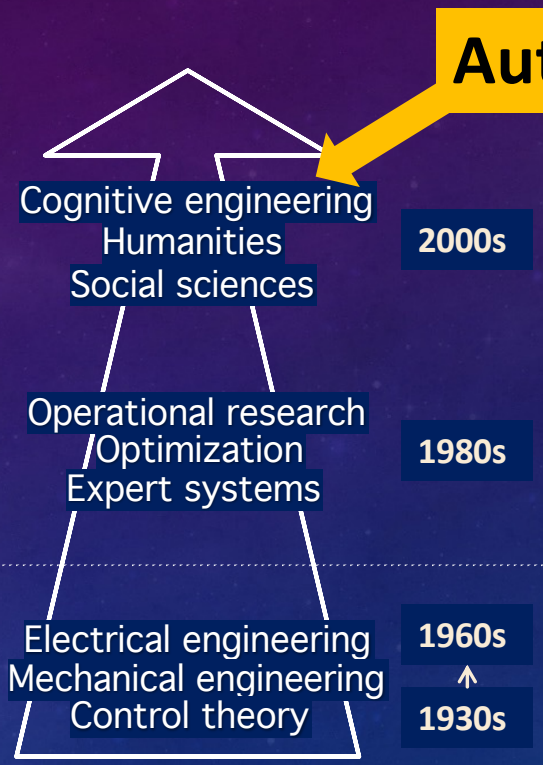
DESIGNED & DEVELOPED USING MODEL-BASED HUMAN SYSTEMS INTEGRATION (MB-HSI)

INGESCAPE – PRODEC

- RATP RER A in Paris
  - Largest urban train line in Europe (1.2M pax/day, more than 250 trains/day)
  - New system deployed in January 2024
- 64 systems orchestrated with Ingescape
  - Field equipment command & control, alerting, authentication, archiving, itineraries, trains parking, missions/trains/drivers management, etc.
  - 598 inputs/outputs
  - 438 services
  - 6664 monitored field equipment
  - 1580 messages/second
- 21 real-time gateways to external systems
- 9000+ applicable requirements
- 16 workstations and an 18-meters wide LED display (5 x UHD)

WHAT DO WE MEAN BY ARTIFICIAL INTELLIGENCE?

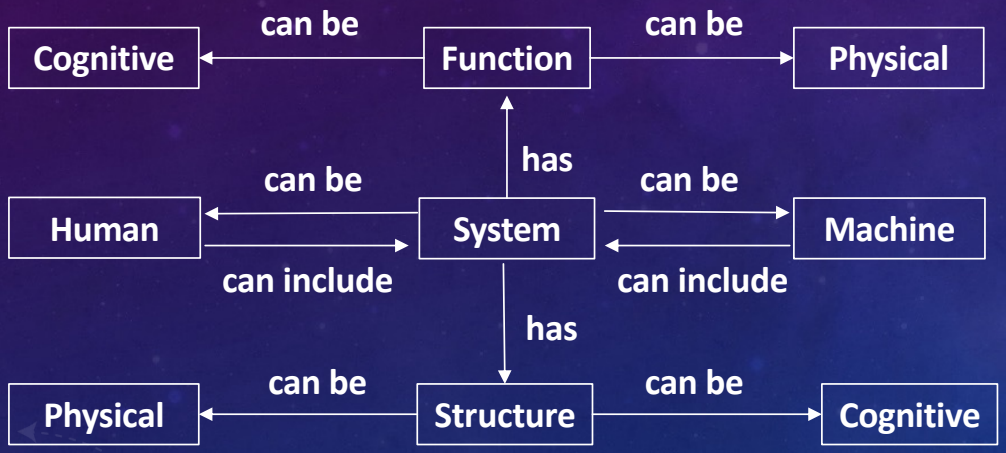




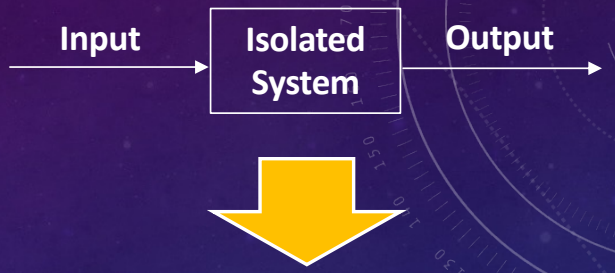
HUMAN | MACHINE | SE/HSI 4 AI

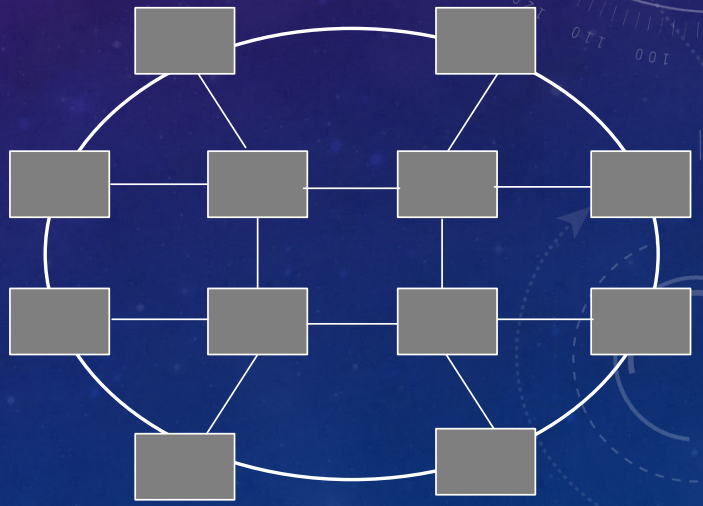
SE4AI & AI4SE

- AGENT VS. SYSTEM
- MULTI-AGENT (AN AGENT AS A SOCIETY OF AGENTS) VS. SYSTEM OF SYSTEMS
- AGENT/SYSTEM → STRUCTURE & FUNCTION (ROLE, CONTEXT, RESOURCES (SUB-SYSTEMS))
- AGENT/SYSTEM CAN HUMAN AND/OR MACHINE (HARDWARE & SOFTWARE)



Systems represent Humans and Machines…





Interconnected System of Systems

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HSI principles:

- **Shared Situation Awareness**
- **Trust & Collaboration**
- **Speed & Precision**
- **Resilience**
- **…**

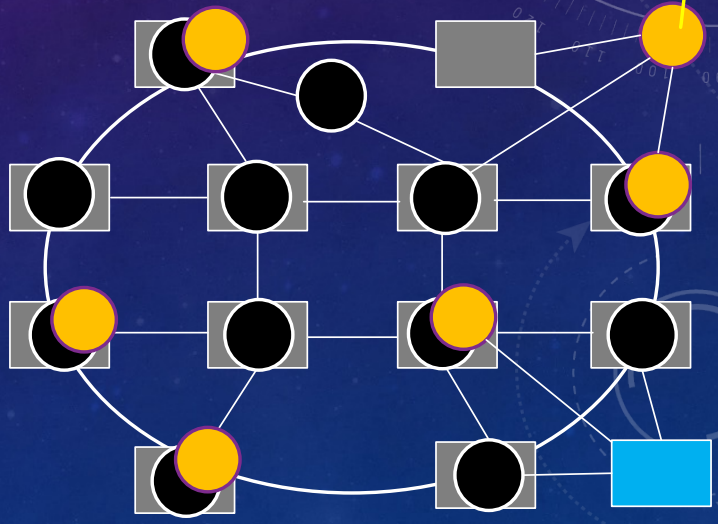
Interconnected Functions of Functions

Potentially, creating new people's jobs

Emergent Structures

Emergent Functions

Overlapping Functions of Functions



Interconnected Structures of Structures

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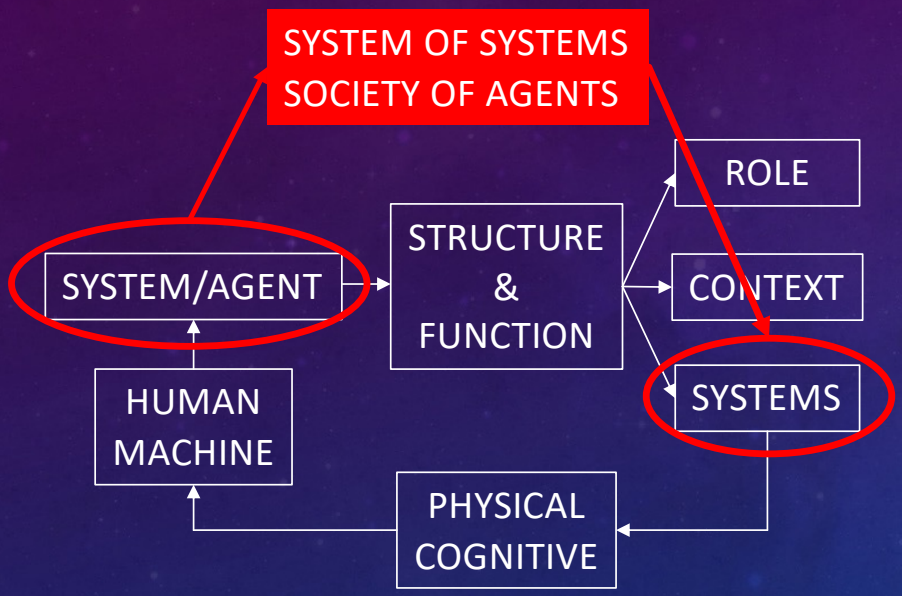
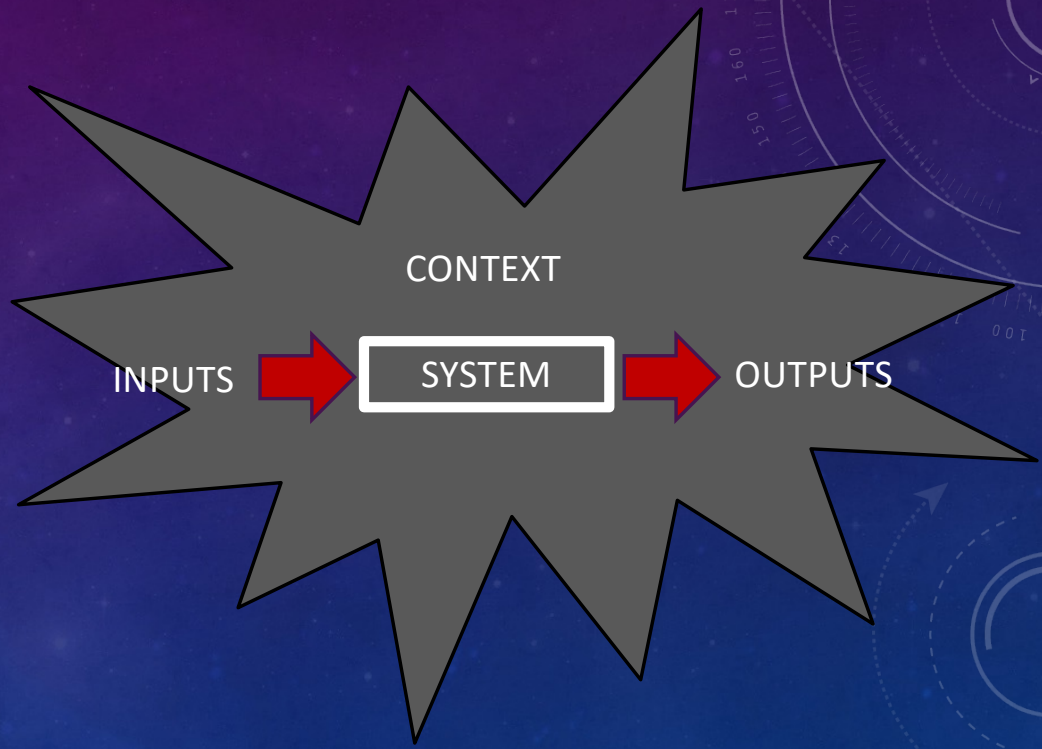
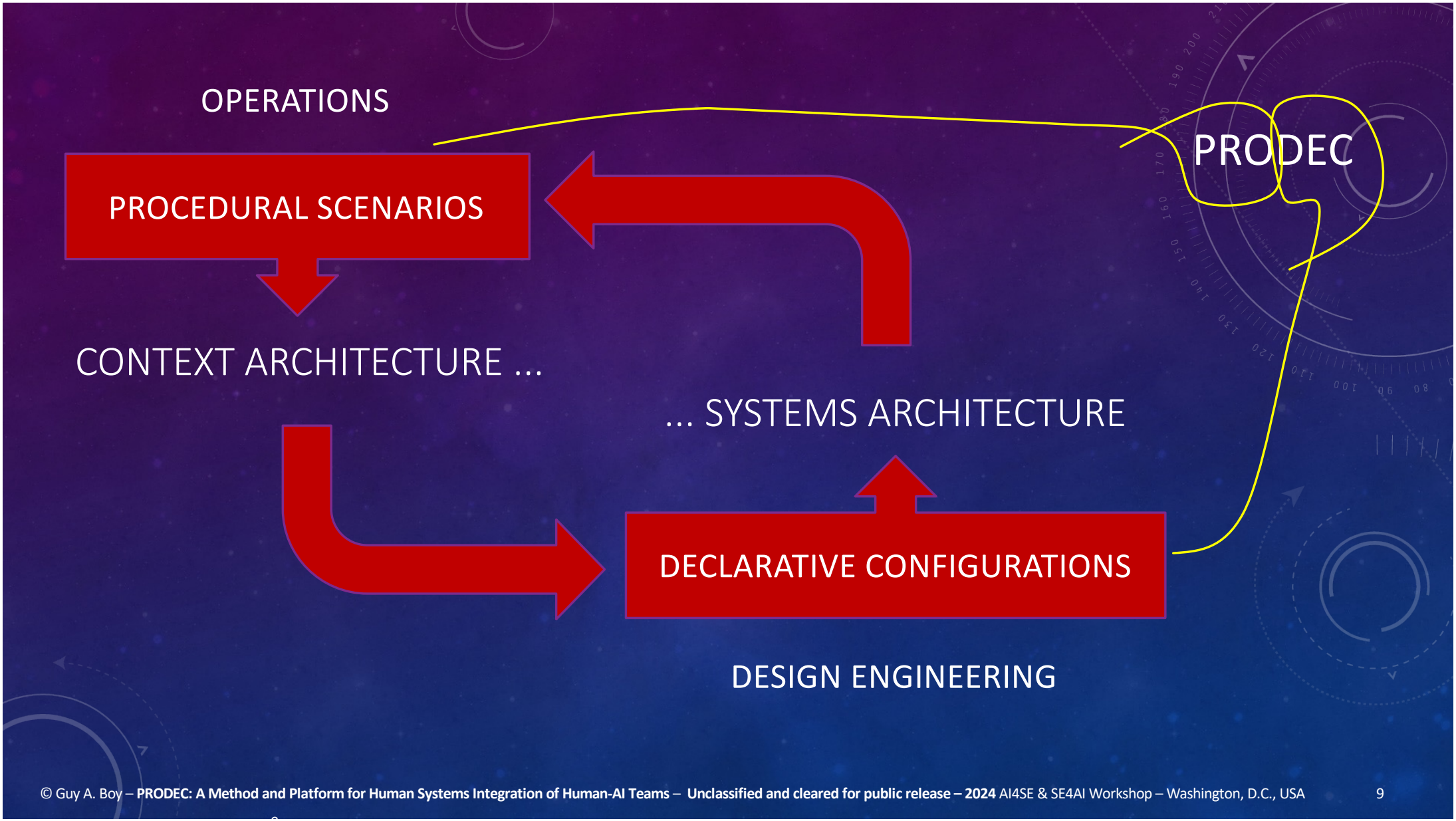
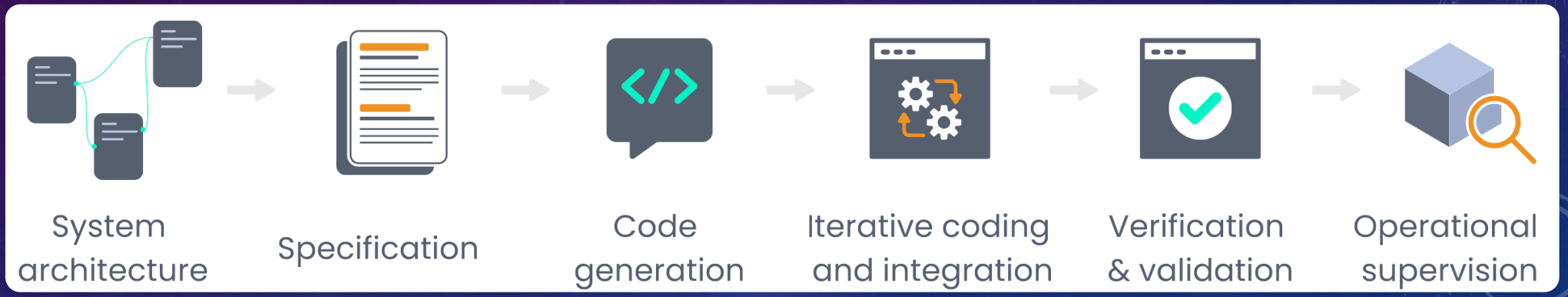




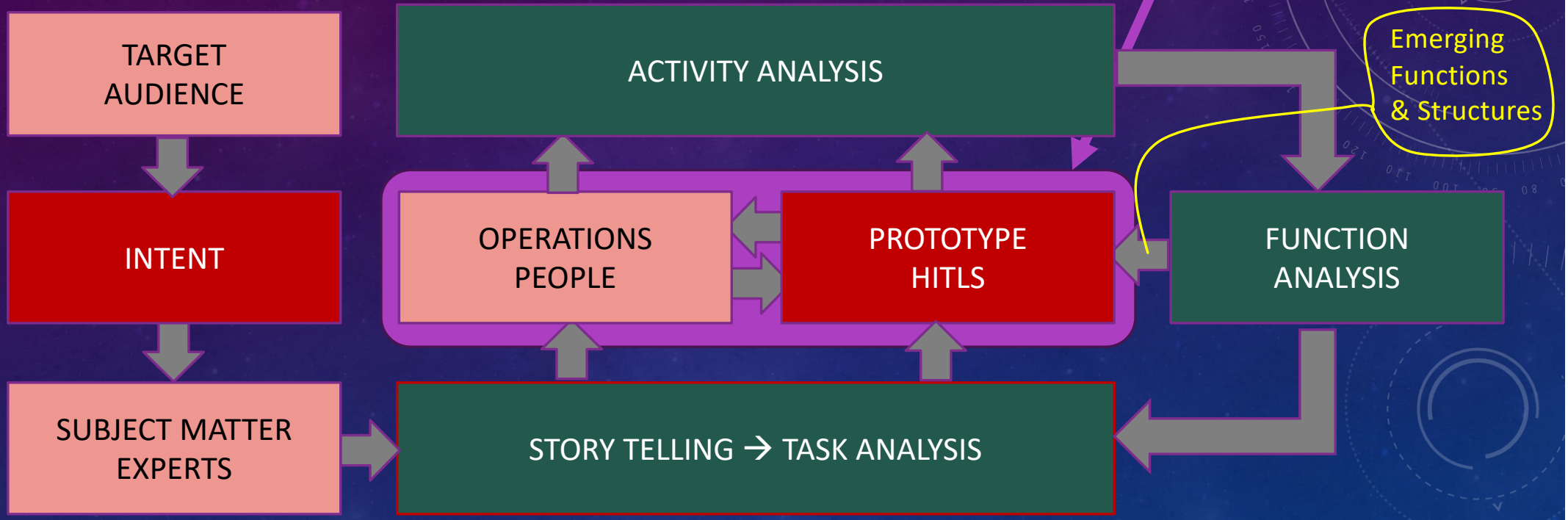
SYSTEMIC SPACE ⟷ CONTEXTUAL SPACE


OPERATIONS
PRODEC
PROCEDURAL SCENARIOS
CONTEXT ARCHITECTURE ...
... SYSTEMS ARCHITECTURE
DECLARATIVE CONFIGURATIONS
DESIGN ENGINEERING

INGESCAPE: A PLATFORM FOR PRODEC PROCESSING



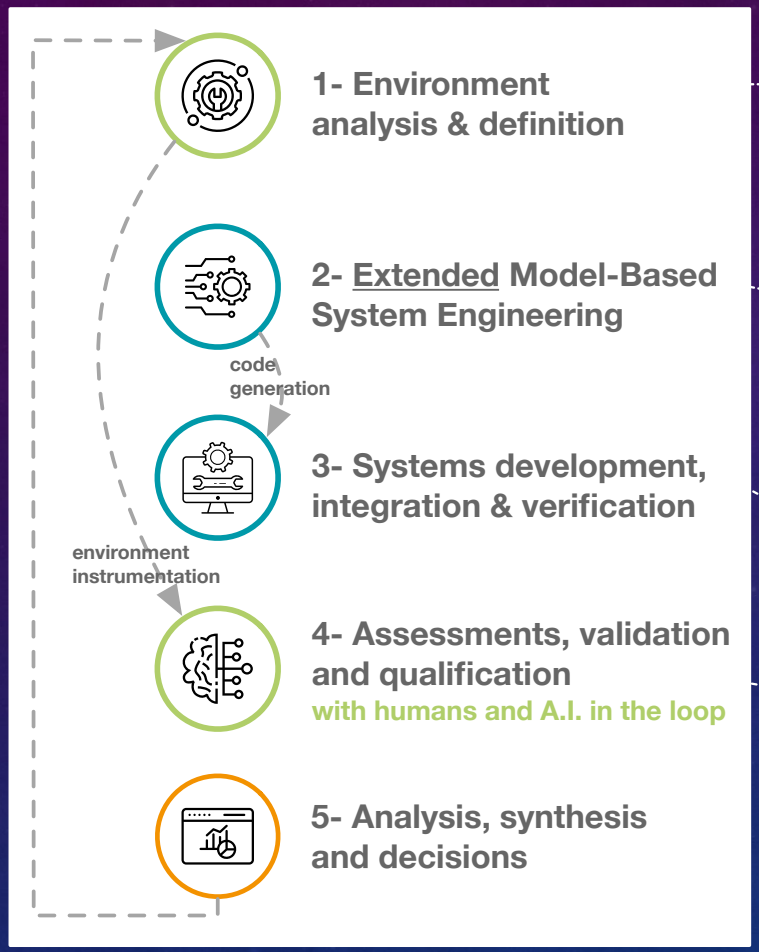
PRODEC: SCENARIO-BASED DESIGN & HUMAN-IN-THE-LOOP SIMULATION



A MULTIDISCIPLINARY & ITERATIVE PROCESS

FOR SOCIOTECHNICAL SYSTEMS OF SYSTEMS ENGINEERING

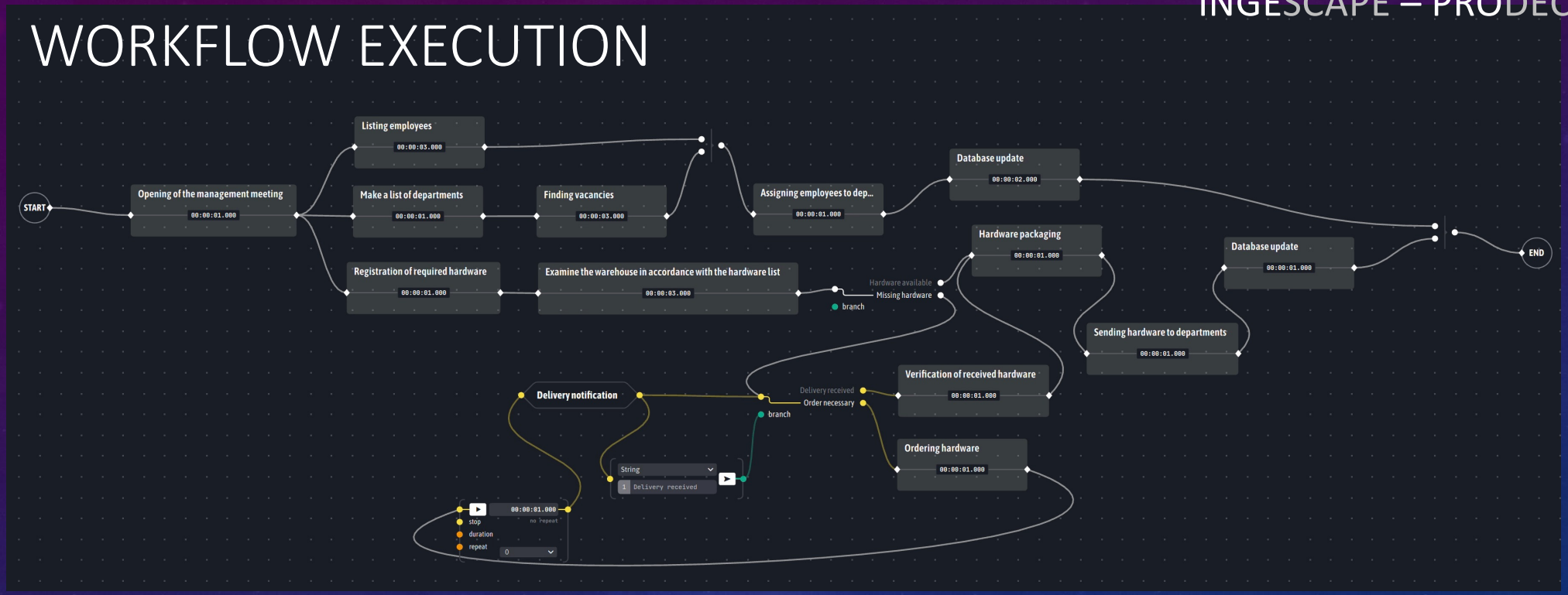
INGESCAPE – PRODEC

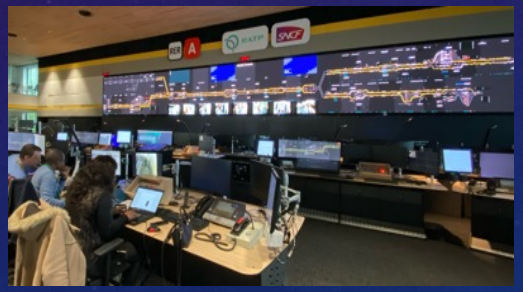


- Target audience, intent, subject matter experts
- Seamlessly iterate on models for
  - Tasks, organizations & scenarios
  - Requirements & metrics
  - Systems structure, functions, behaviors and urbanization
  - Data formats & protocols
- Continuously use models & simulations to make systems
  - Human-in-the-loop simulations → emergent behaviors
  - Observable
  - Actionable
  - Measurable
  - Verifiable

  From task to activity analysis
- Keep the models useful and up-to-date at all times

WORKFLOW EXECUTION



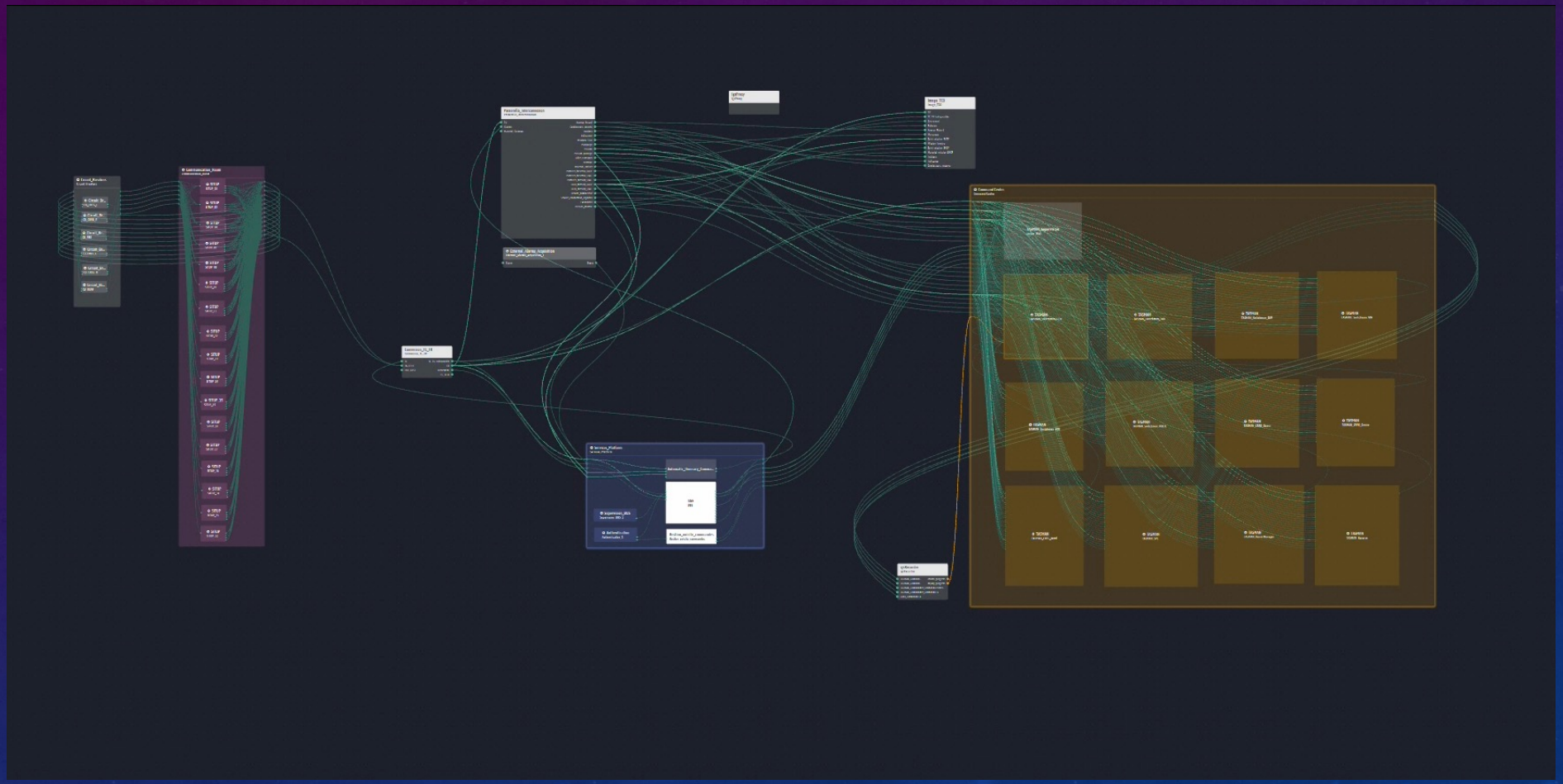


MOHICAN: TRUST, COLLABORATION & PERFORMANCE

Human-in-the-loop simulations
of an Air Combat system

COMPLEX LIVE MODEL
(MB-HSI AND ACTIVE DOCUMENTATION)

INGESCAPE – PRODEC

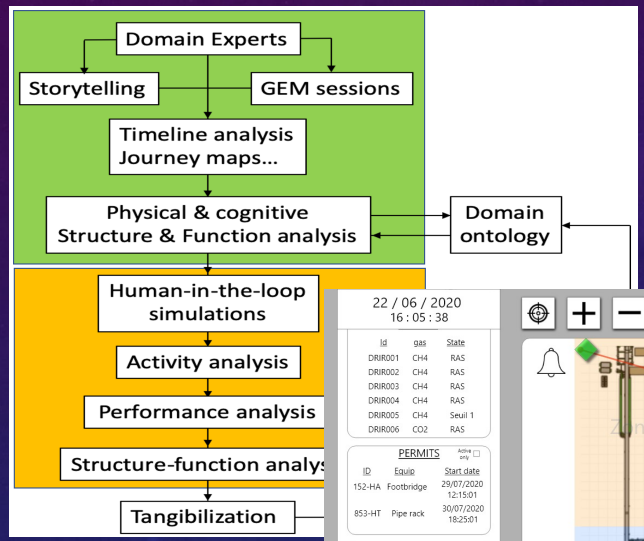


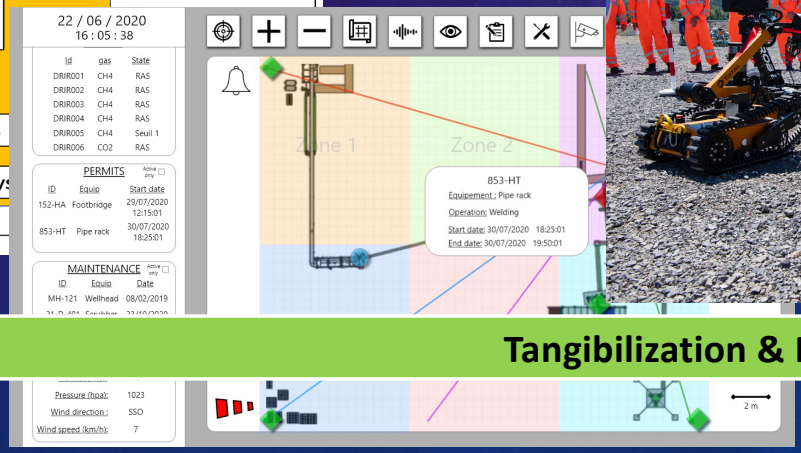
OFF-SHORE OIL & GAS MULTI-AGENT TELEROBOTIC SYSTEMS

Another example…

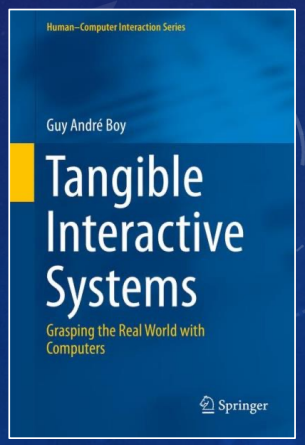
Situation awareness, Decision-making & Risk-taking → Human-AI Tangibility & Maturity

Using the PRODEC method (SBD & HITLS)





Tangibilization & Maturity



COLLABORATIVE WORK IN DESIGN TEAMS

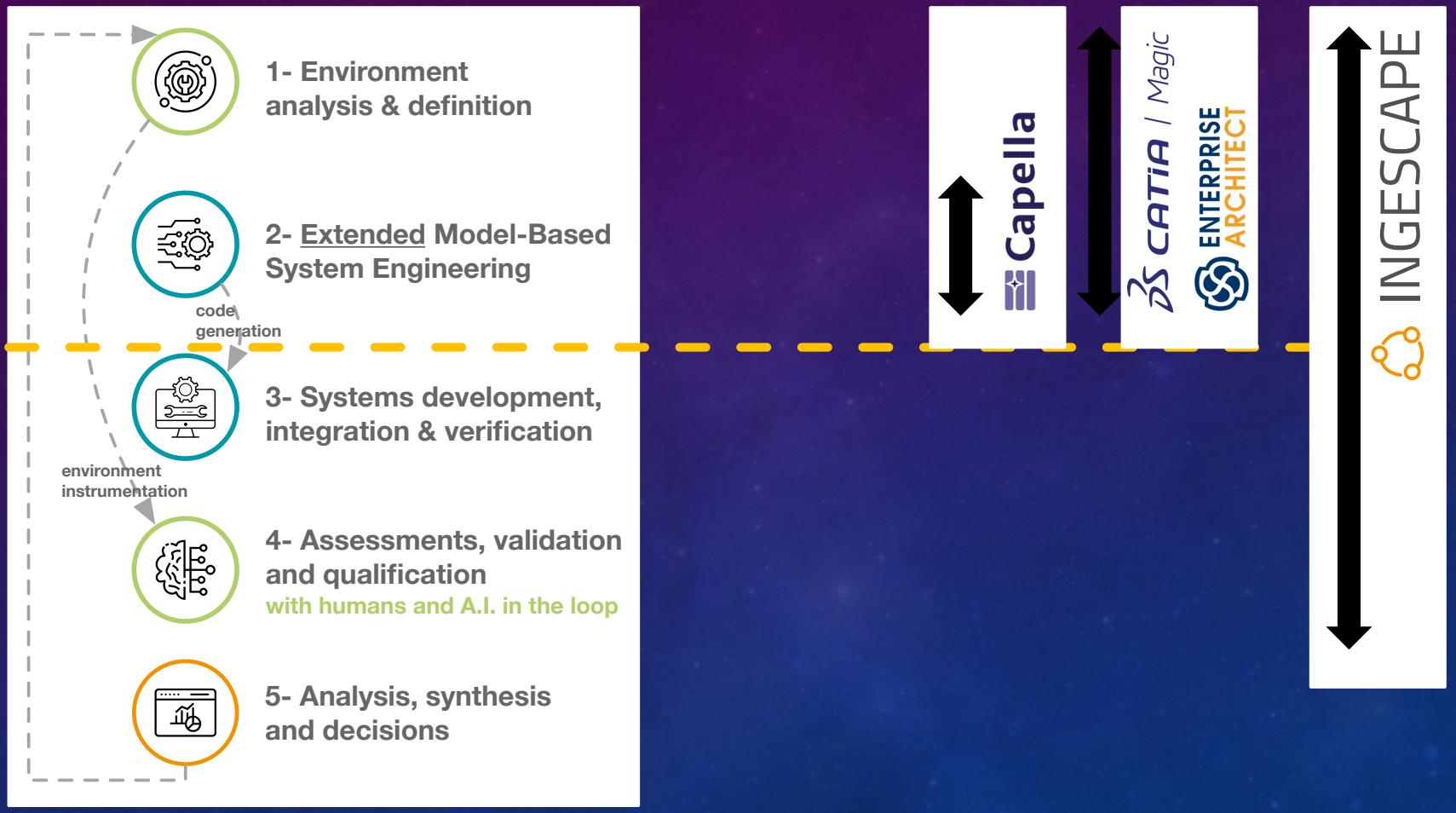
- Graphical visualization → **Mediating tool for Collaborative Work**
- Linking Logical models (LM) & Operational models (OM) → improved **Tangibility/Maturity** assessment & design **Flexibility**
- Documenting the design process and its solutions → **Active Sociotechnical Documents for Design & Operations**
- Toward **Model-Based Human Systems Integration** (MB-HSI)

Boy, G.A. (2023). Model-Based Human Systems Integration.
In the Handbook of Model-Based Systems Engineering,
A.M. Madni & N. Augustine (Eds.). Springer, USA, pp. 471-499. DOI
https://doi.org/10.1007/978-3-030-27486-3_28-1.

A MULTIDISCIPLINARY & ITERATIVE PROCESS

FOR SOCIO-TECHNICAL SYSTEMS OF SYSTEMS ENGINEERING → MB-HSI

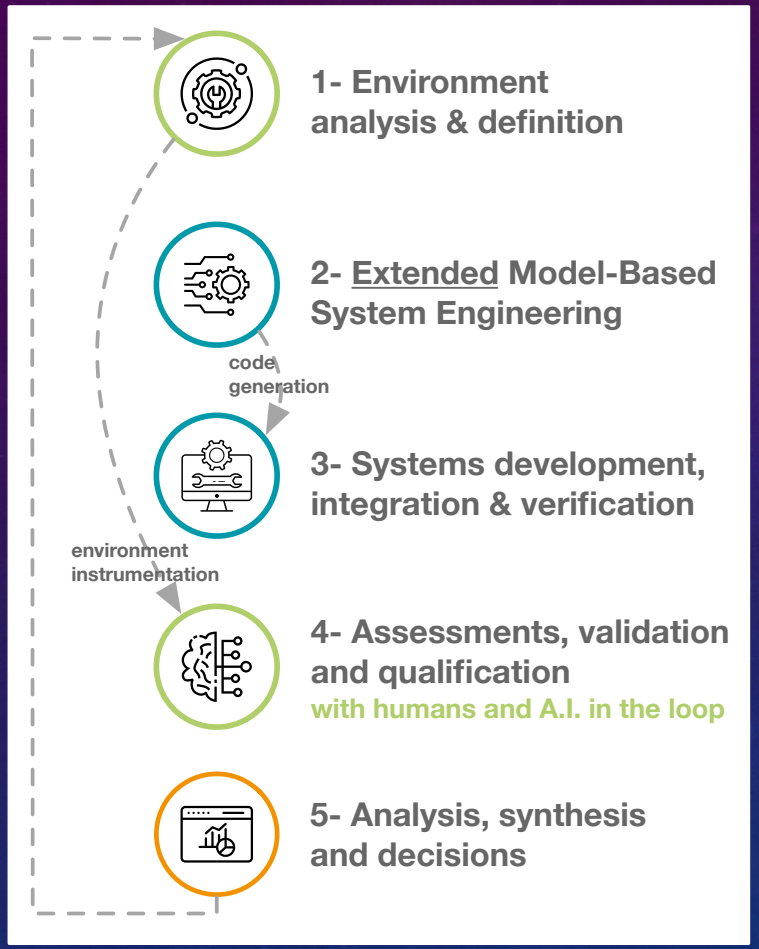
INGESCAPE – PRODEC



LEVERAGE AND COMBINE

ALL THE RELEVANT MODELS AND STANDARDS

INGESCAPE – PRODEC



OMG SYSTEMS MODELING LANGUAGE SysML v2

ARCADIA

BPMN

UAF OMG UNIFIED ARCHITECTURE FRAMEWORK

SVG

UNIFIED MODELING LANGUAGE UML

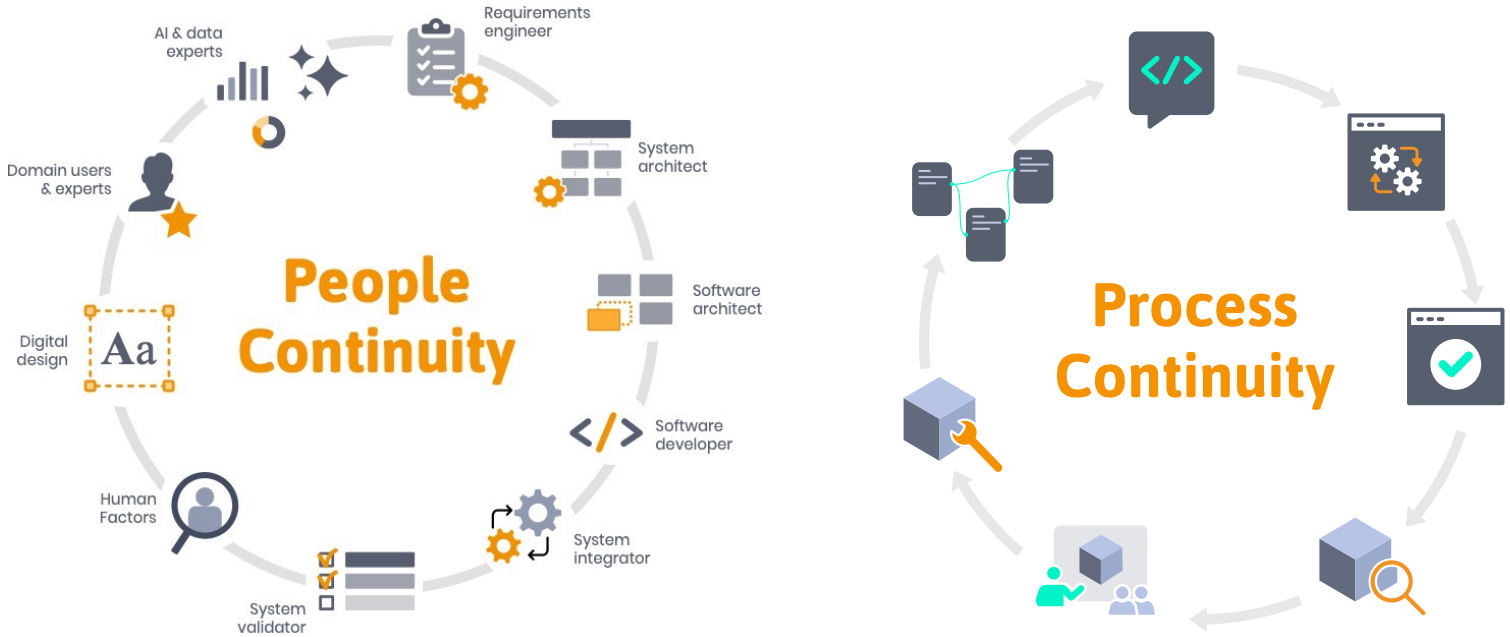
OpenAPI

protobuf Protocol Buffers

Etc.

INGESCAPE: A PLATFORM FOR PRODEC PROCESSING

The continuity principle…



- People continuity
- Process continuity
- Digital continuity

Digital Continuity of the **models & requirements** during the whole lifecycle

REFERENCES

- 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.
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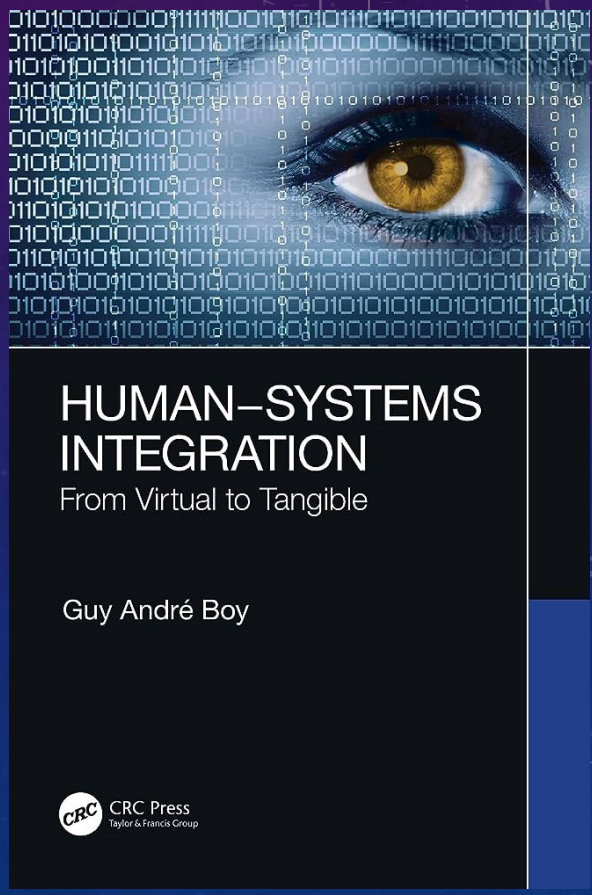
… and others: https://www.flextechchair.org/publications.html

THANK YOU!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