



**2018**  
Annual **INCOSE**  
international workshop  
Jacksonville, FL, USA  
January 20 - 23, 2018

- Working Group on

## Human-Systems Integration

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# Agenda: January 2018

- Saturday
  - 13-17: Ongoing HSI WG agenda:
    1. keep writing new materials for SEBOK and SE Handbook;
    2. provide latest work in progress in HSI;
    3. plan for INCOSE IS 2018
    4. announcements: IEEE HSI WG + INCOSE Safety WG
- Tuesday
  - 09-12: HSI Roadmap



HSIWG

# Introduction

January 21, 2018

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Human-System Integration  
**= Human-Centered Design  
+ Systems Engineering**





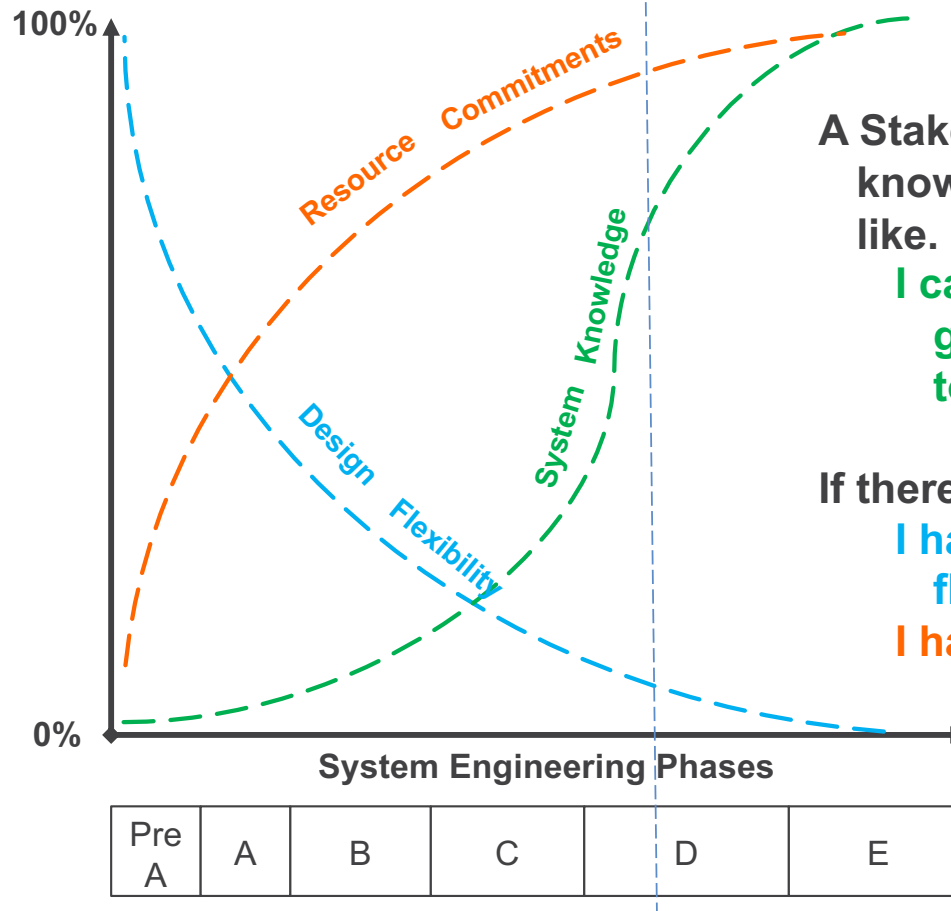
## e.g., NASA Lifecycle Phases

- **Pre-Phase A**, Concept, Studies
  - Feasible concepts, simulations, studies, models, mockups
- **Phase A**, Concept and Technology Development
  - Concept definition, simulations, analysis, models, trades
- **Phase B**, Preliminary Design & Technology Completion
  - Mockups, study results, specifications, interfaces, prototypes
- **Phase C**, Final Design, and Fabrication
  - Detailed designs, fabrication, software development
- **Phase D**, System Assembly, Integration and Test, Launch
  - Operations-ready system with related enabling products
- **Phase E - F**, Operations and Sustainment, Closeout





# Late in the Lifecycle...



A Stakeholder wants to know what “It” will look like.

I can show them pieces going together and tour the floor

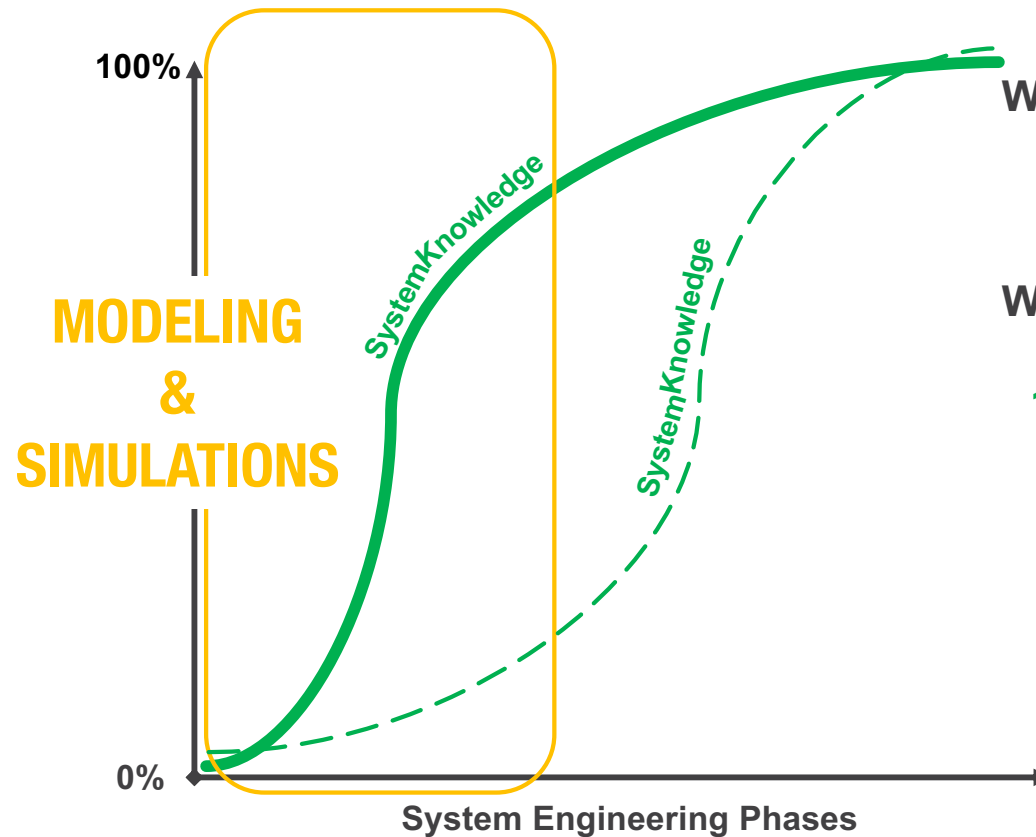
If there is a change:

I have no design flexibility

I have no money



# We Really Want ...



Pre A	A	B	C	D	E
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When Stakeholder asks  
“What will it look  
like?”

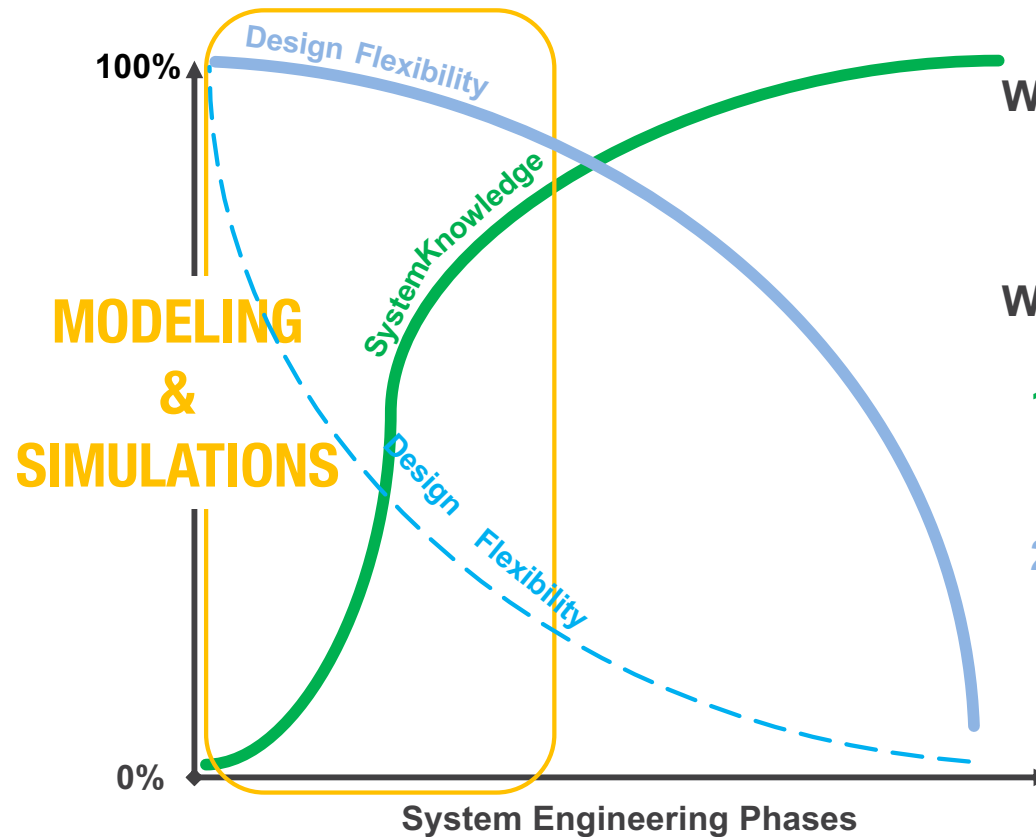
What “We” Really  
Want:

1. I can show you the  
Sim. (Early System  
Knowledge)





# We Really Want ...



When Stakeholder asks  
“What will it look  
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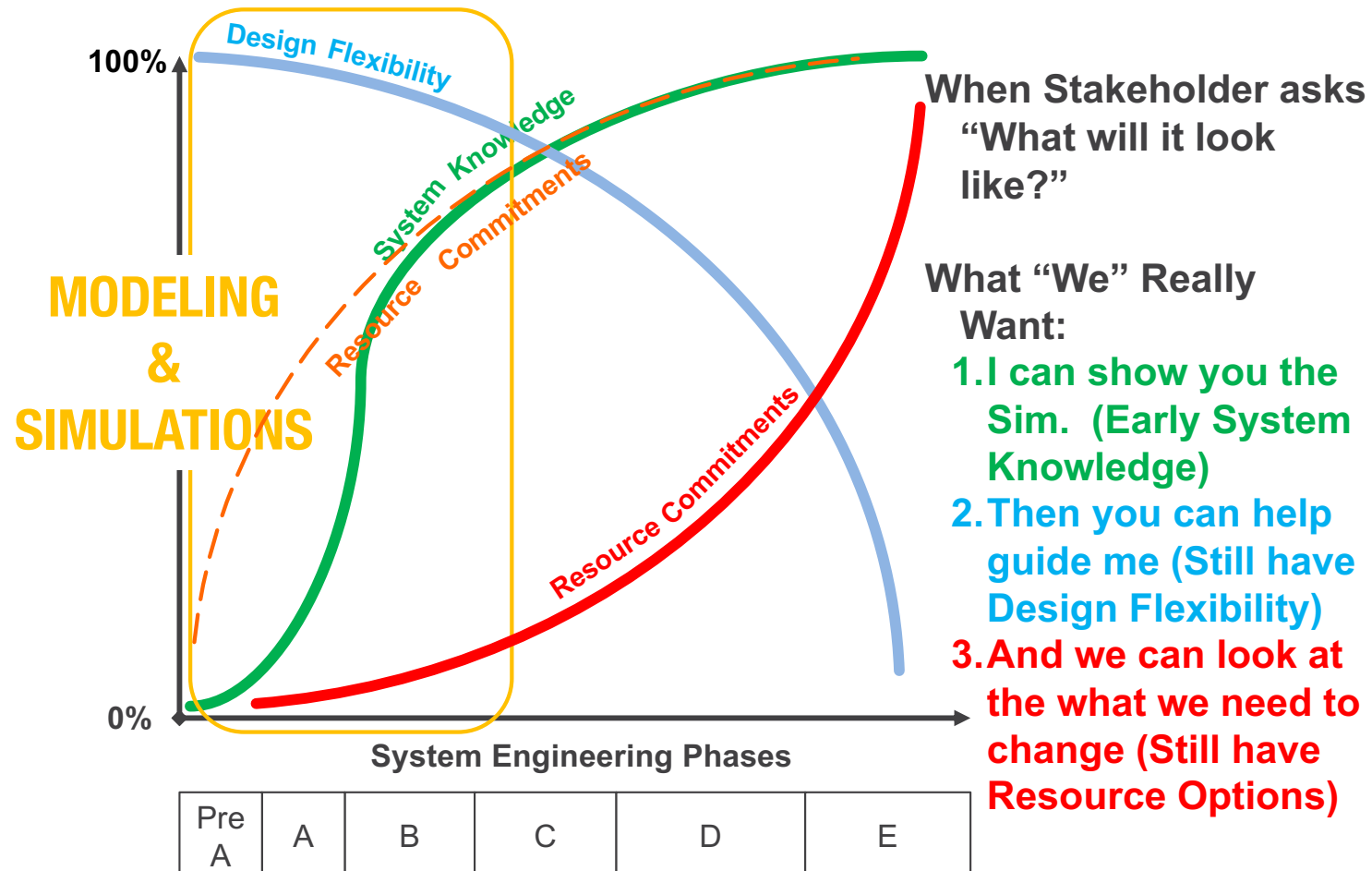
What “We” Really  
Want:

1. I can show you the  
Sim. (Early System  
Knowledge)
2. Then you can help  
guide me (Still have  
Design Flexibility)

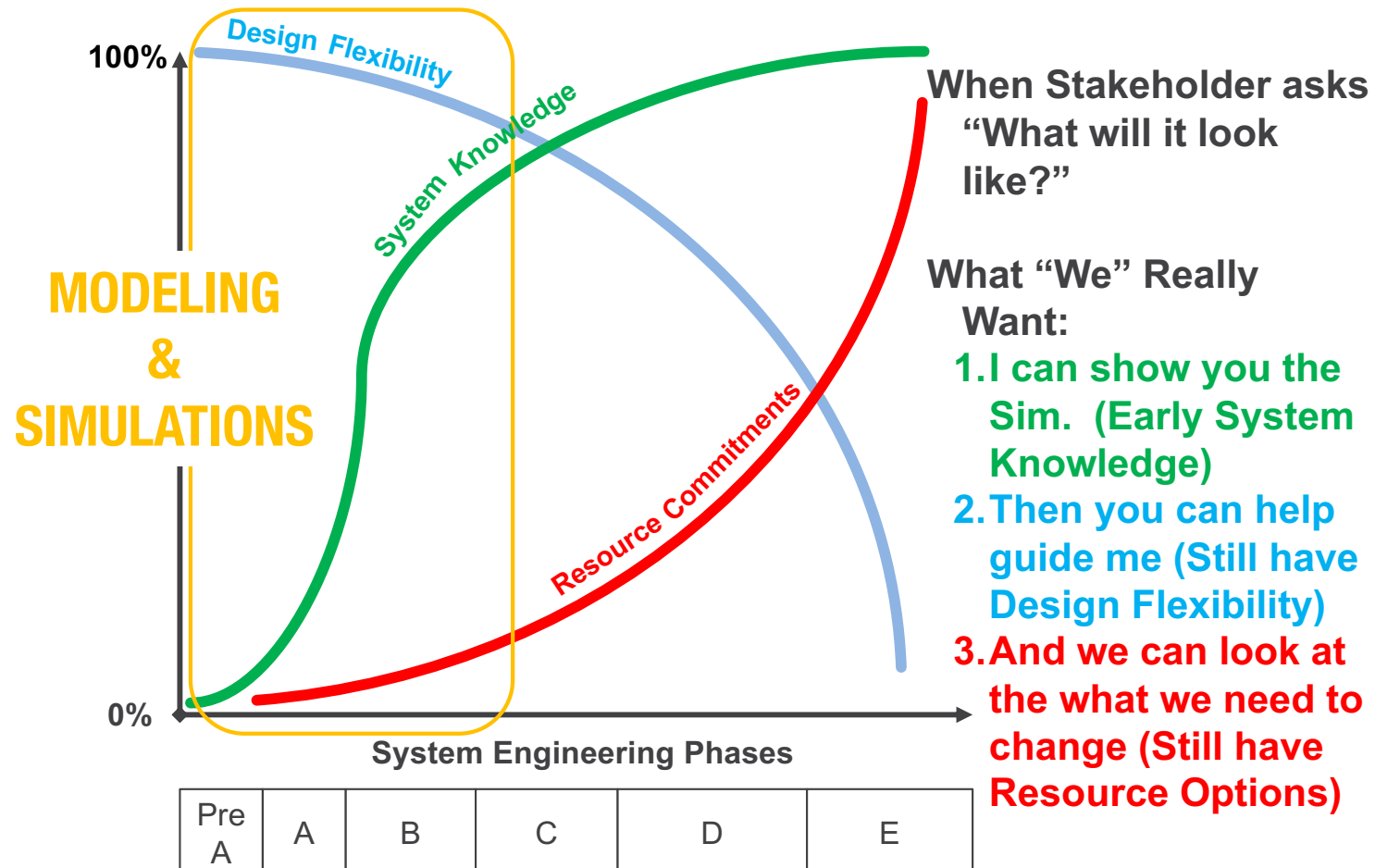




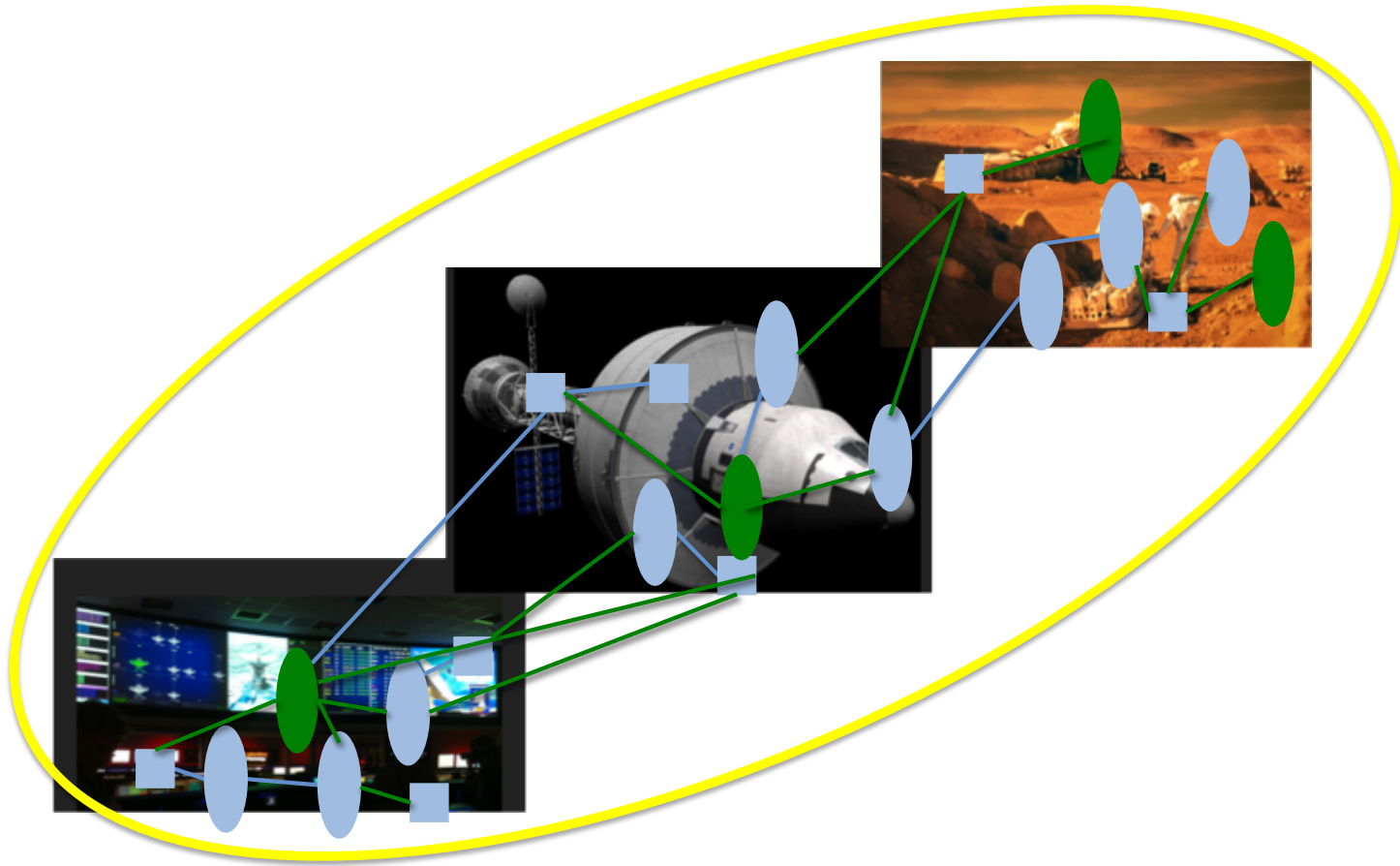
# We Really Want ...



# We Really Want ...









# Integration of HCD and engineering

Design vs. engineering

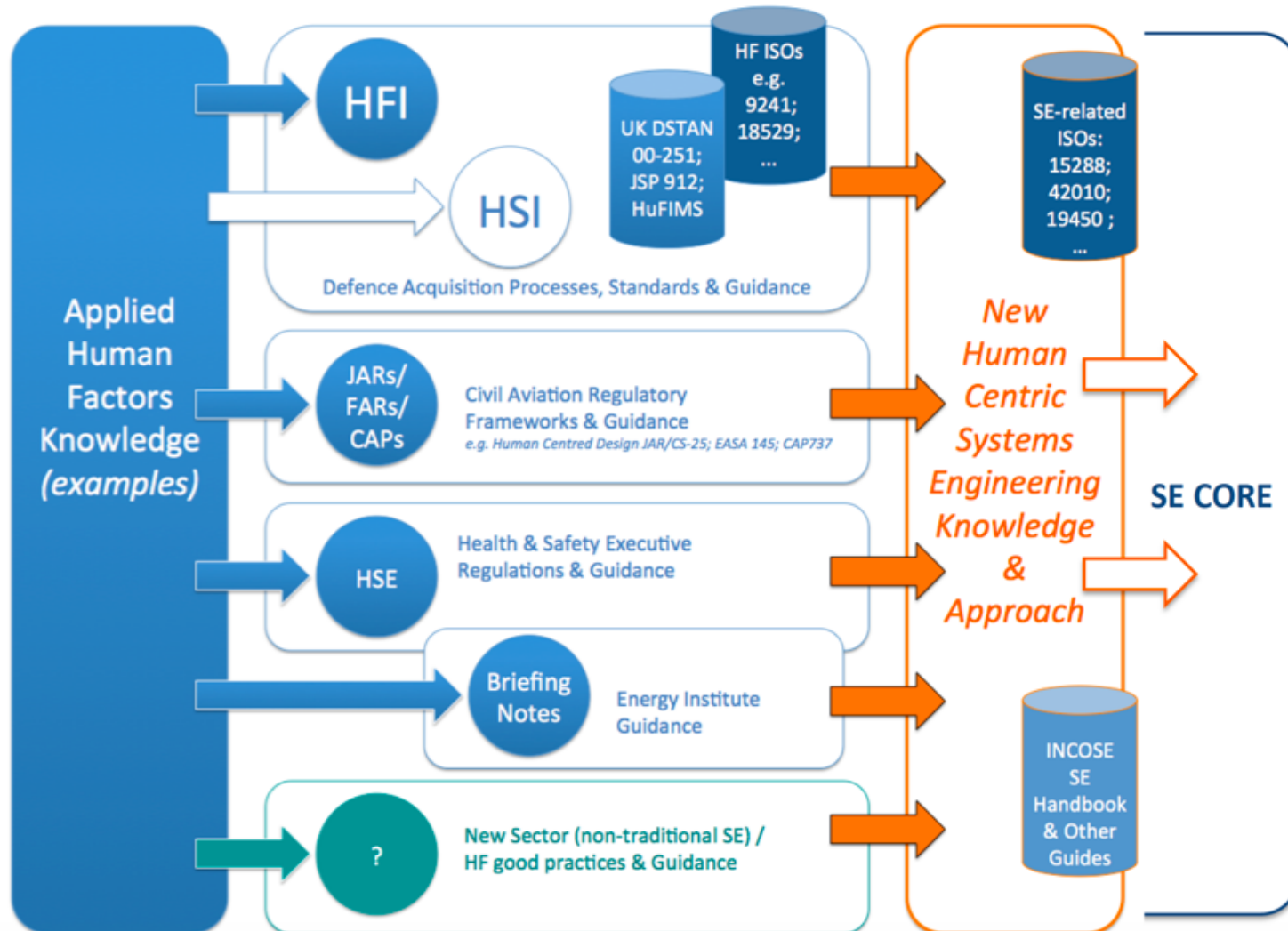
Human-centered design (HCD)

- ISO: ... focuses on usability and HFE
- Technology, organization and people during the whole life cycle of a system

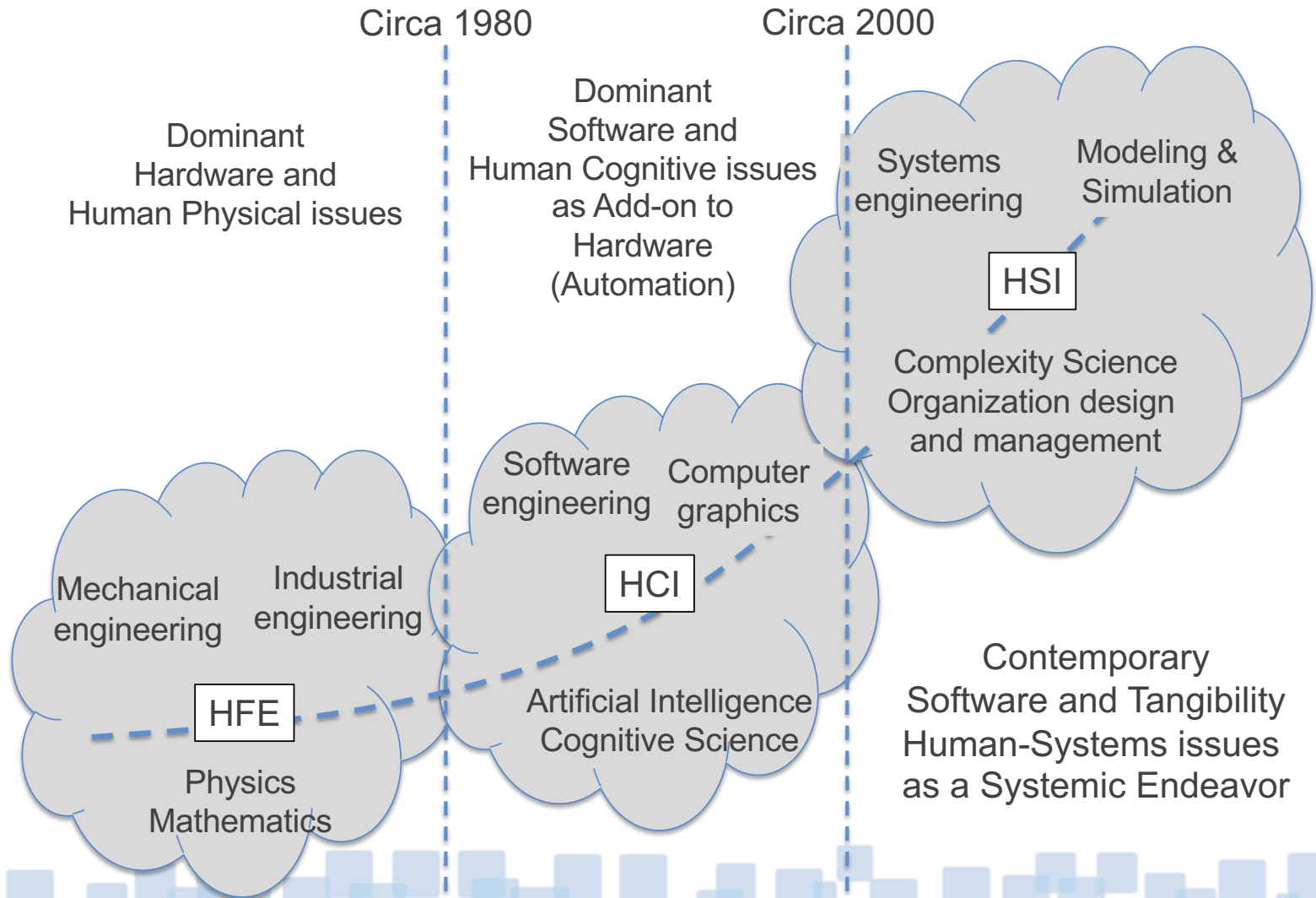
HCD supported by

- human-in-the-loop modeling and simulation
- complexity analysis and modeling (addressing messy and wicked problems)

# INCOSE UK: Human Centric Systems Engineering Working Group



INCOSE UK HCSEWG Presentation to HSI Workshop, Florida 04-5OCT 2016

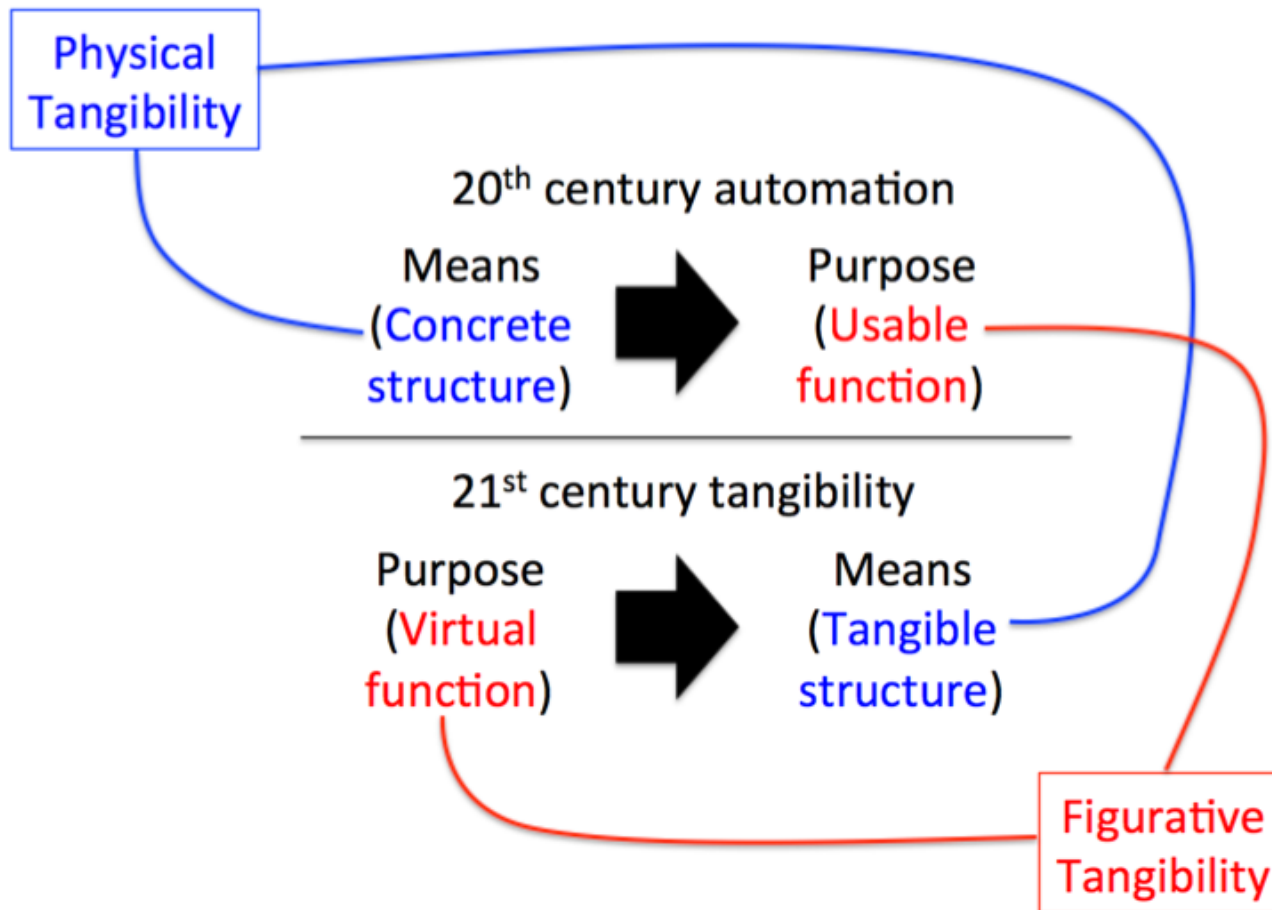




# Tangibility

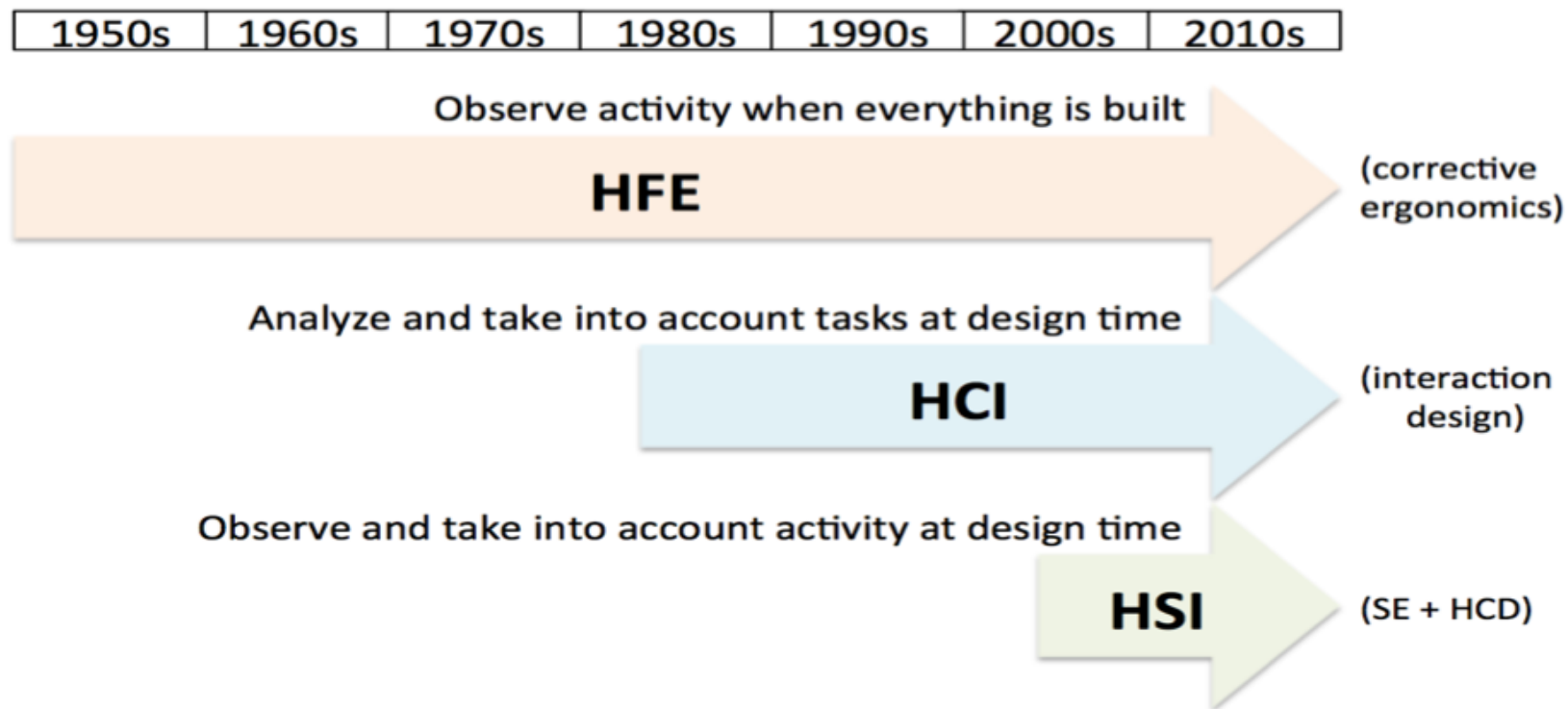
- Real, actual, material
- Opposite to imaginary or visionary
- Physical tangibility: touchable, graspable
- Figurative tangibility: acceptability, meaningfulness







## Activity-based HSI...





## Report: HSIWG Workshop at FIT (Oct 4-5, 2016)

- Questions
  - HSI semantics?
  - Human-system architect?
  - INCOSE's HSI charter?



## INCOSE HSI-WG

- Action items (short term):
  - Form an active INCOSE HSI steering committee
  - Organize teleconferences every two months
  - Organize a session during the next INCOSE IS

# Logo



# ?



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# Status of HSI

# A sequence for this afternoon (14:00-18:00)



What is HSI?

A few  
presentations by  
HSI WG  
participants

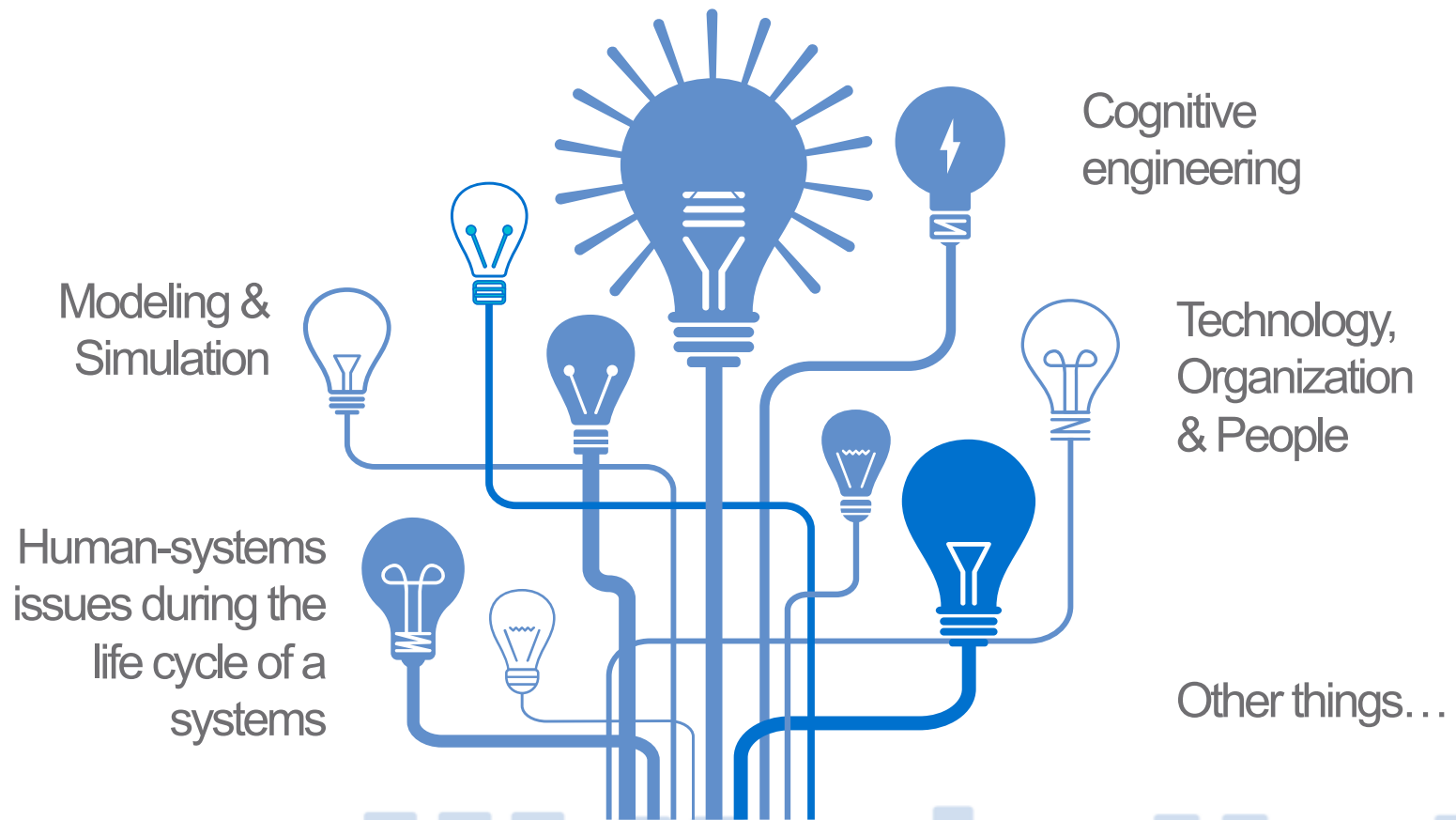
What is the  
difference  
between HFE,  
HCI, HSI and  
other human-  
technology  
disciplines?

What are the  
relationships  
between HSI &  
other SE disciplines  
(SoS, agile,  
systems science,  
healthcare, MBSE,  
etc.?

Synthesis and  
recommendations



# What is HSI?





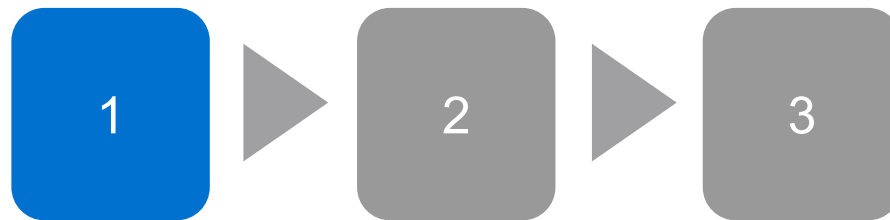


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# Terminology and perspectives



# A sequence for this afternoon (13:00-18:00)



Brainstorming  
on terminology  
and ontology  
supporting HSI

Compilation of  
perspectives on  
HSI terminology

Definition of a  
terminology for  
HSI



# A definition (proposed at IW 2017)

## **Human-systems integration**

- Interdisciplinary process (i.e., human and technological sciences together)
- Bring the human in the design process
- Not limited to user interface design
- Considers all stakeholders dealing with technology being developed
- Intent: increase total system performance
- Life cycle framework (i.e., from design to disposal)

Alternative term:

- human-centered systems integration
- human-centered systems engineering  
(condition is that SE would be a human-centered integrating discipline)

➤ The term “system” should be thought as a representation



# HSI key properties

Tangibility

Human-in-the-loop simulation

Fidelity

Complexity

Goal, task, activity... and user experience

Function

Integration

The social dimension: Multi-agent vs. single-agent

Autonomy

Context

Maturity



# Human-in-the-loop simulation

- Fidelity and realism in terms of technology, organization and people
- Enables to consider human factors at design time by observing activity
- Separability issue (complexity management)



# Fidelity

- Relation to the real world
- Realism
- May take several forms: physical, environmental, software, hardware, etc.
- Realistic scenarios (task fidelity)
- Degree of similarity with real world object, feature or condition (modeling)
- Levels of fidelity with respect to design and development phases
- Appropriateness: levels of abstraction with respect to system (or component) purpose and complexity
- Appropriately documented (e.g., for reuse)
- Fidelity from 3 viewpoints: technology, organization and people



# Complexity

- Problem understanding difficulty
- Difficulty in understanding relationships among component of a system to be designed
- Unpredictable
- Non-linear
- All systems with humans in them are complex adaptive systems
- Emergent properties and behaviors

## Competency of the design team

- Designing for idiots versus designing for experts
- Risk taking and management
- Human errors and human engagement



# Grounding concepts

## Goal

- End state that needs to be achieved
- Can be decomposed into sub-goals
- ISO 9241-11: intended outcome

## Task

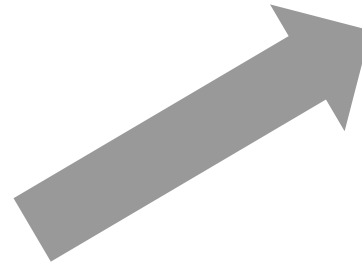
- Prescribed set of actions
- To achieve a goal
- ISO 9241-11 (1998)

## Activity

- Set of actions effectively executed
- Result of the application of a function executing a task
- Observable (HITLS and real practice)

## User experience

- ISO 9241
- Should be measurable
- Needs to be better defined







# Function

- Role of an agent
- A system outcomes which contribute to goals or objectives.
- To have a function, a system must be able to provide the outcome through two or more different combinations of elemental behavior. (Ackoff 1971)
- An action, a task, or an activity performed to achieve a desired outcome. (Hitchins 2007)
- A broad work area encompassing multiple related disciplines (e.g., Engineering, Finance, Human Resources, etc.). (Created for SEBoK)
- A function is defined by the transformation of input flows to output flows, with defined performance. (Created for SEBoK)



# Integration (human-centered)

- Structure and function (ontology)
- Intentional and reactive behavior
- Function allocation
- Architecture
- Where in the life cycle
- Minimalism, seamlessness, noise reduction, value added



# The social dimension

Multi-agent vs. single-agent

- Systems of systems
- Types and locus of control (hierarchical, heterarchical)
- Centralized versus distributed organizations
- Dependency versus autonomy
- 3C (communication, cooperation, coordination)
- Delegation, authority, responsibility, accountability
- Security
- Common frame of reference (language)
- Knowledge management



# Autonomy

- Self direction
- Levels of autonomy
- Autonomy validity boundaries (constraints)
- Coordination rules
- External information processing (consciousness and support)



# Context

- Environmental
- Social and historical
- Normal, abnormal and emergency (nominal and off-nominal)
- Expected versus unexpected
- Operations, maintenance, training, certification, decommissioning, design, manufacturing, etc.
- Culture and education
- Ethical values
- Legal and regulatory
- Economical and business



# Maturity

- Process-driven (CMMi, TRLs)
- Technology and product (usability, usefulness)
- Culture, practice and training (social and human readiness, ISO 9241/220)
- Organization



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# Future of HSI

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# A sequence for today (10:00-15:00)



Discussion topics:  
standardization,  
innovation, maturity,  
design, influence of  
data science,  
complexity science,  
organization science,  
etc.

Short-term HSI  
issues and action  
items

Longer-term  
HSI strategic  
initiatives

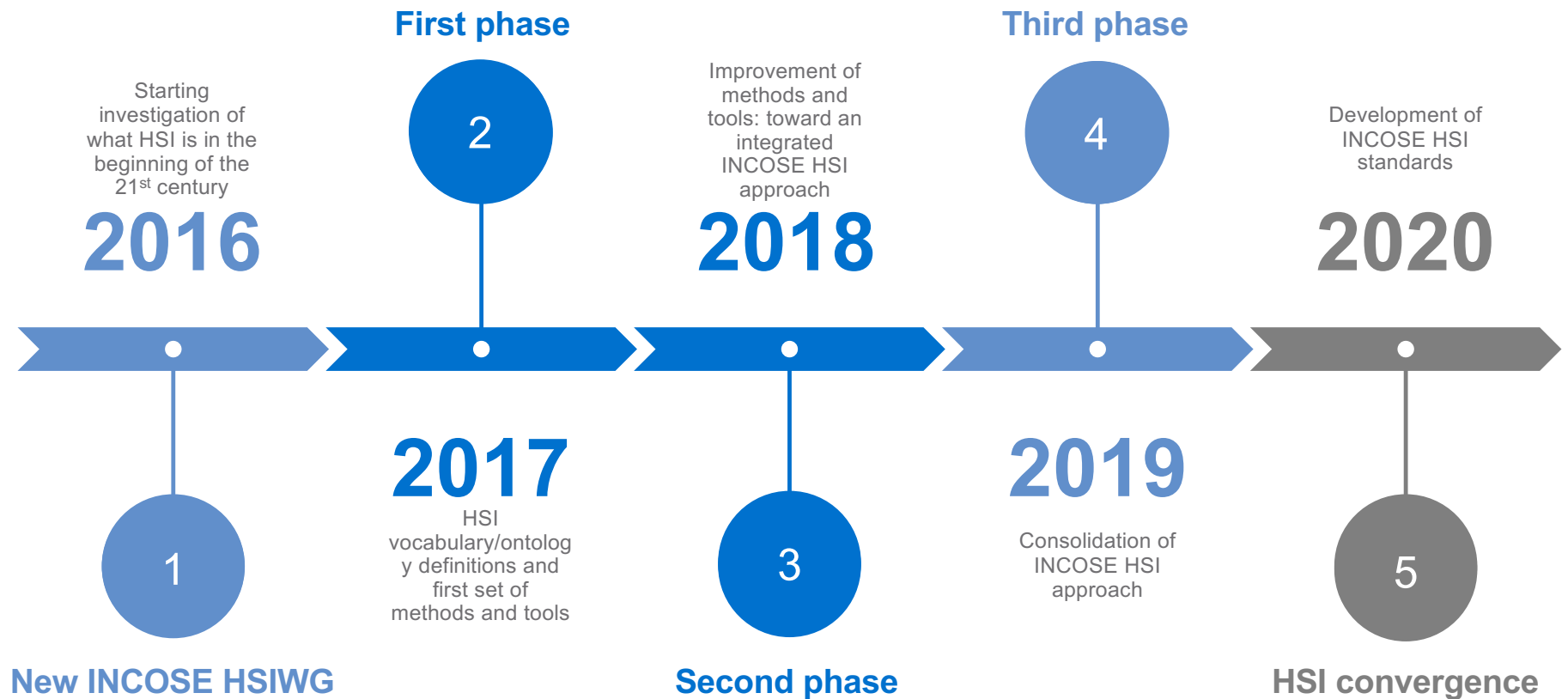
Nomination of a  
write up committee  
(for SE-BoK and  
SE-Handbook)

Wrap-up and  
decisions





# INCOSE HSI Roadmap



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