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INCOSE Webinar: Human-Systems Integration: An Evolution

Guy Andre Boy

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INCOSE Webinar Series

Thursday 26th July 2018– Webinar 114

**Human – Systems Integration –
An Evolution**



Guy André Boy





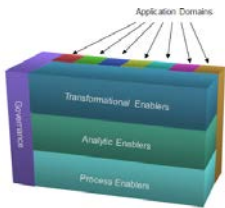
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annual **INCOSE**
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Los Angeles, CA, USA
January 28 - 31, 2017

- To provide a forum for experts in the field of Systems Engineering to present information on the “State of the Art”
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Choreography

1. Andy Pickard (your host) will introduce the Webinar and the speaker
2. Guy will speak for about 40 to 45 minutes
3. During their talk, participants can write questions using the Webex Q&A window
4. After Guy completes his talk, he will spend 10 minutes answering questions that Andy selects from those submitted by the audience
5. Andy Pickard will provide information about upcoming Webinars and then end this session
6. This Webinar is being recorded and will be made available on the INCOSE website to members and employees of CAB organizations

WEBINAR



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Chair, INCOSE HSI WG
g.boy@estia.fr

Human-Systems Integration: An Evolution...

26 July 2018



INCOSE HSI Definition

“... the interdisciplinary technical and management processes for integrating human considerations within and across all system elements. It is an essential enabler to systems engineering.”

SE Handbook Working Group, 2007.

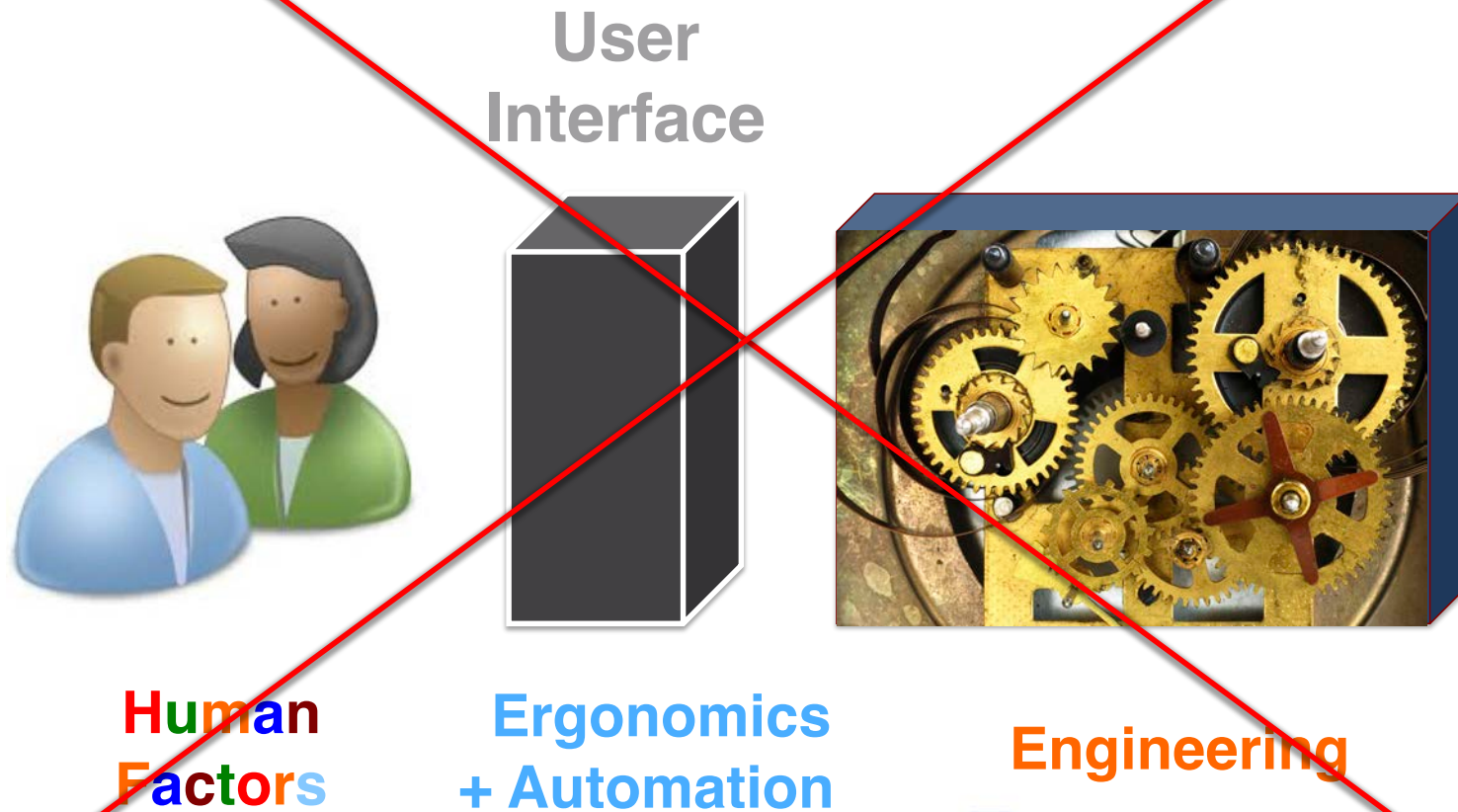


Outline

- From HFE to HCI to HSI...
- The issue of tangibility in our growing virtual world...
- HSI as Human-Centered Design + Systems Engineering
- Systemic knowledge, resources and flexibility
- Technology, Organizations and People (TOP Model)
- INCOSE HSI Working Group update
- Q&A



What is the traditional approach?





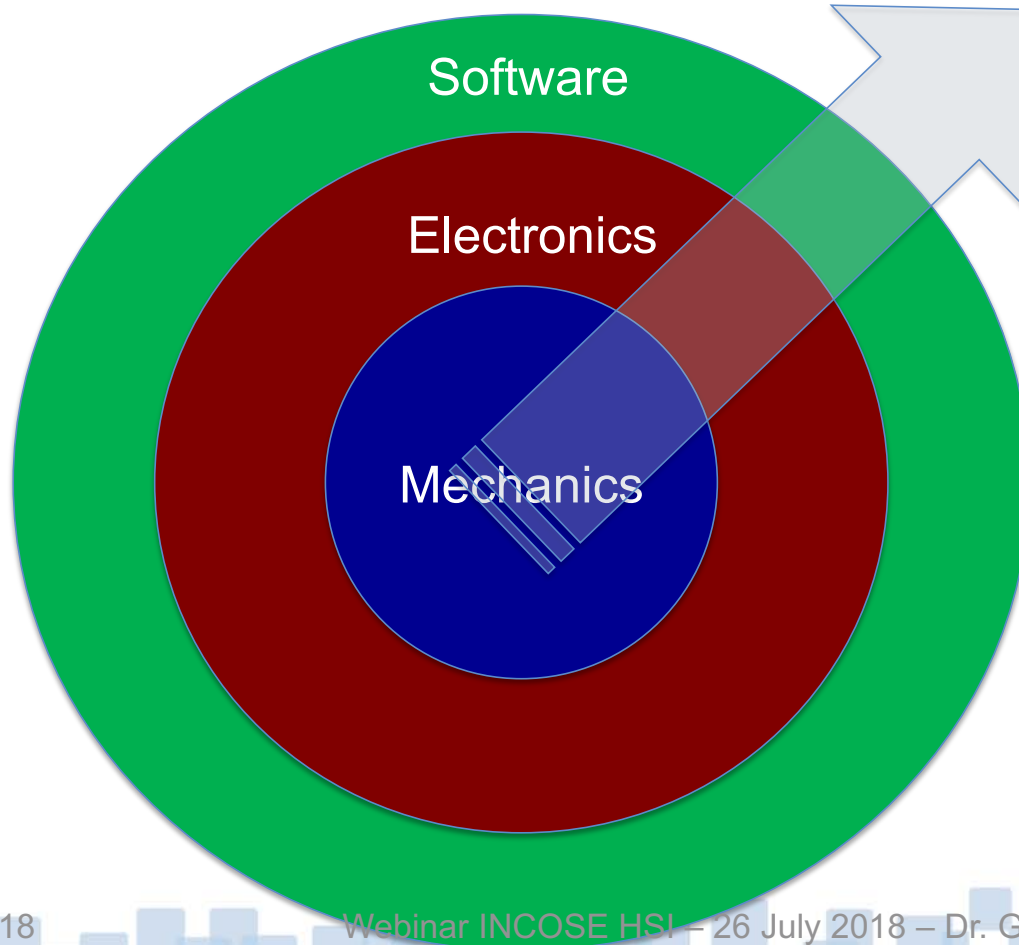
Why is Human-Centered Design possible now?

- Let's provide a historical evolution...



20th century

From Hardware to Software



Incremental
Accumulation
of Artificial
Functions
into Structure

...



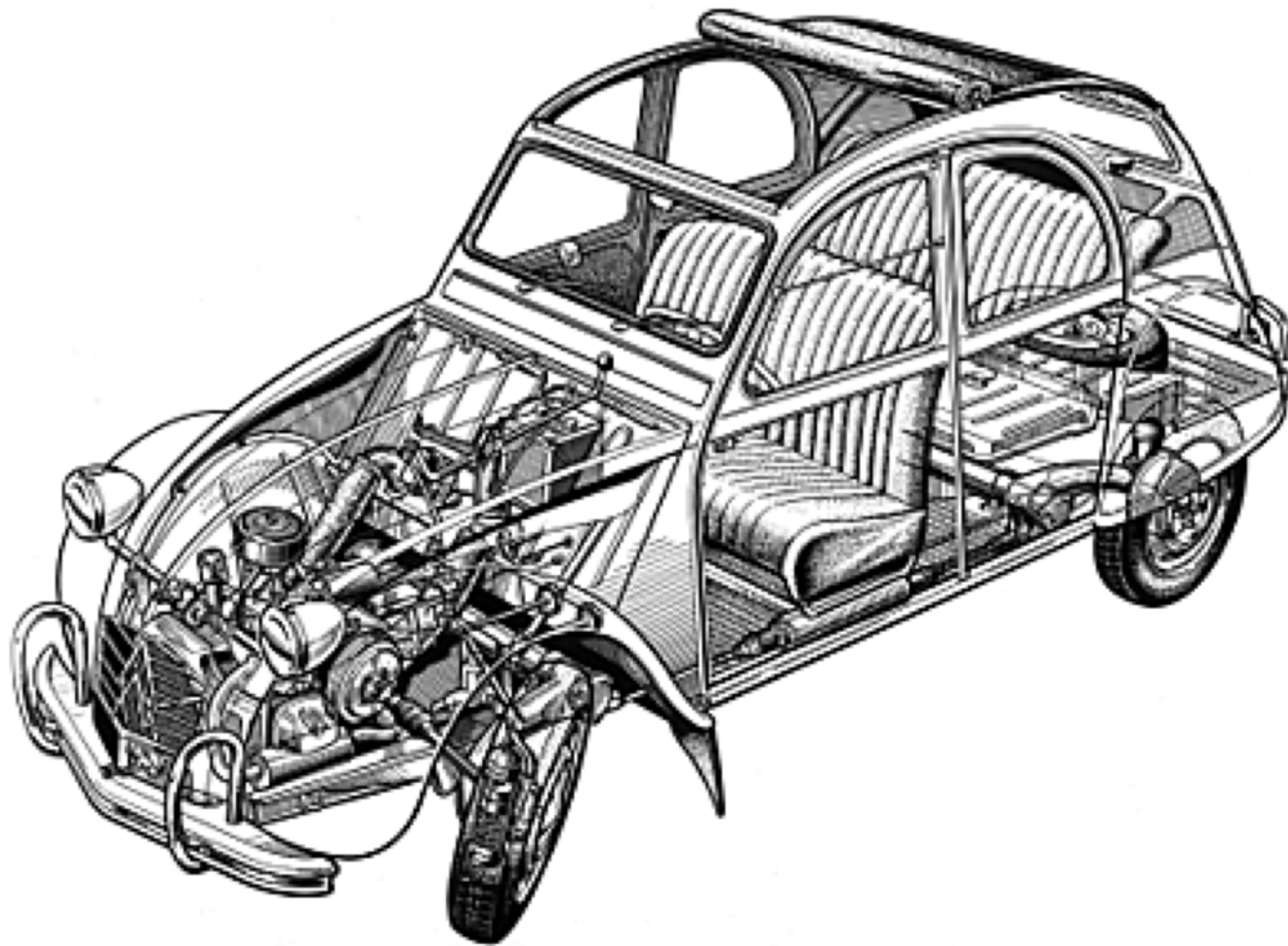
**Automation
&
HCI**



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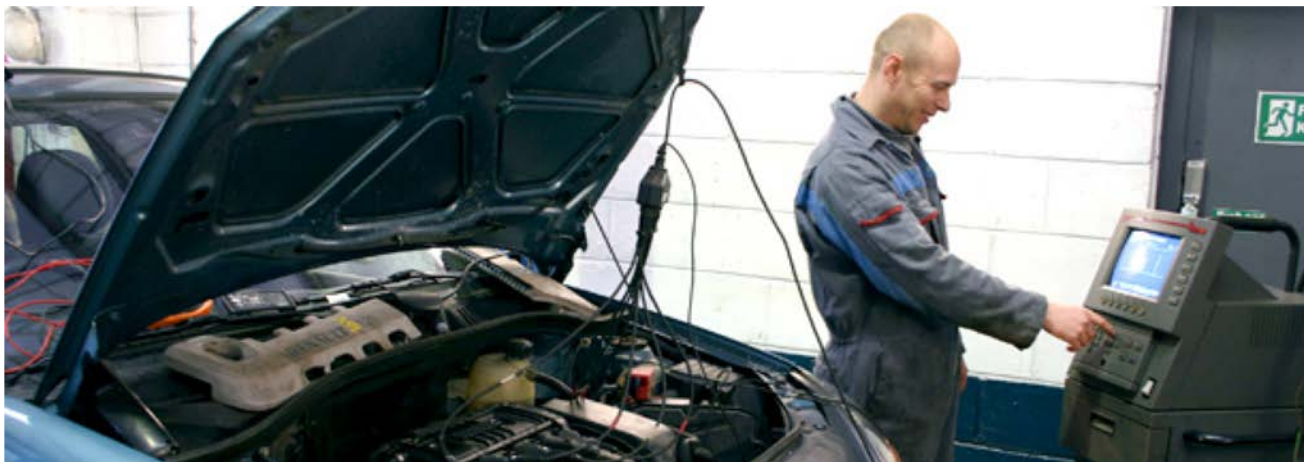




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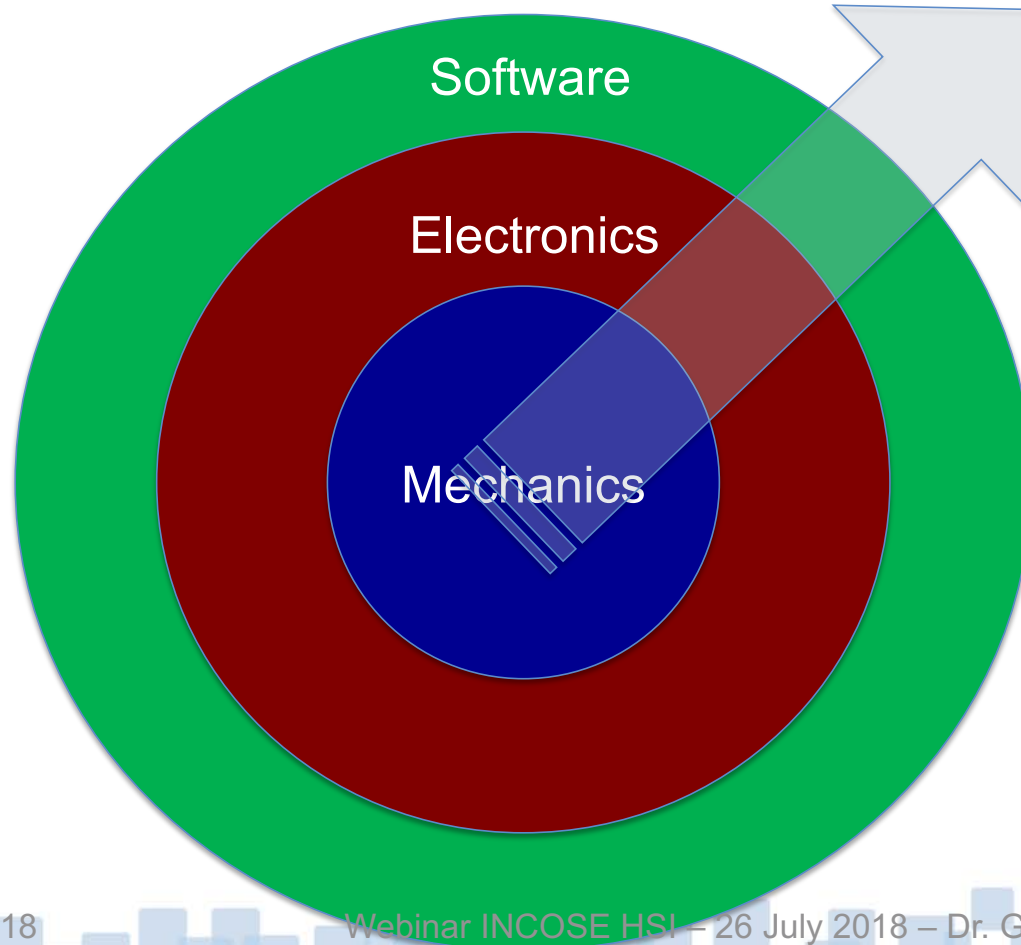
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20th century

From Hardware to Software



Incremental
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...



**Automation
&
HCI**

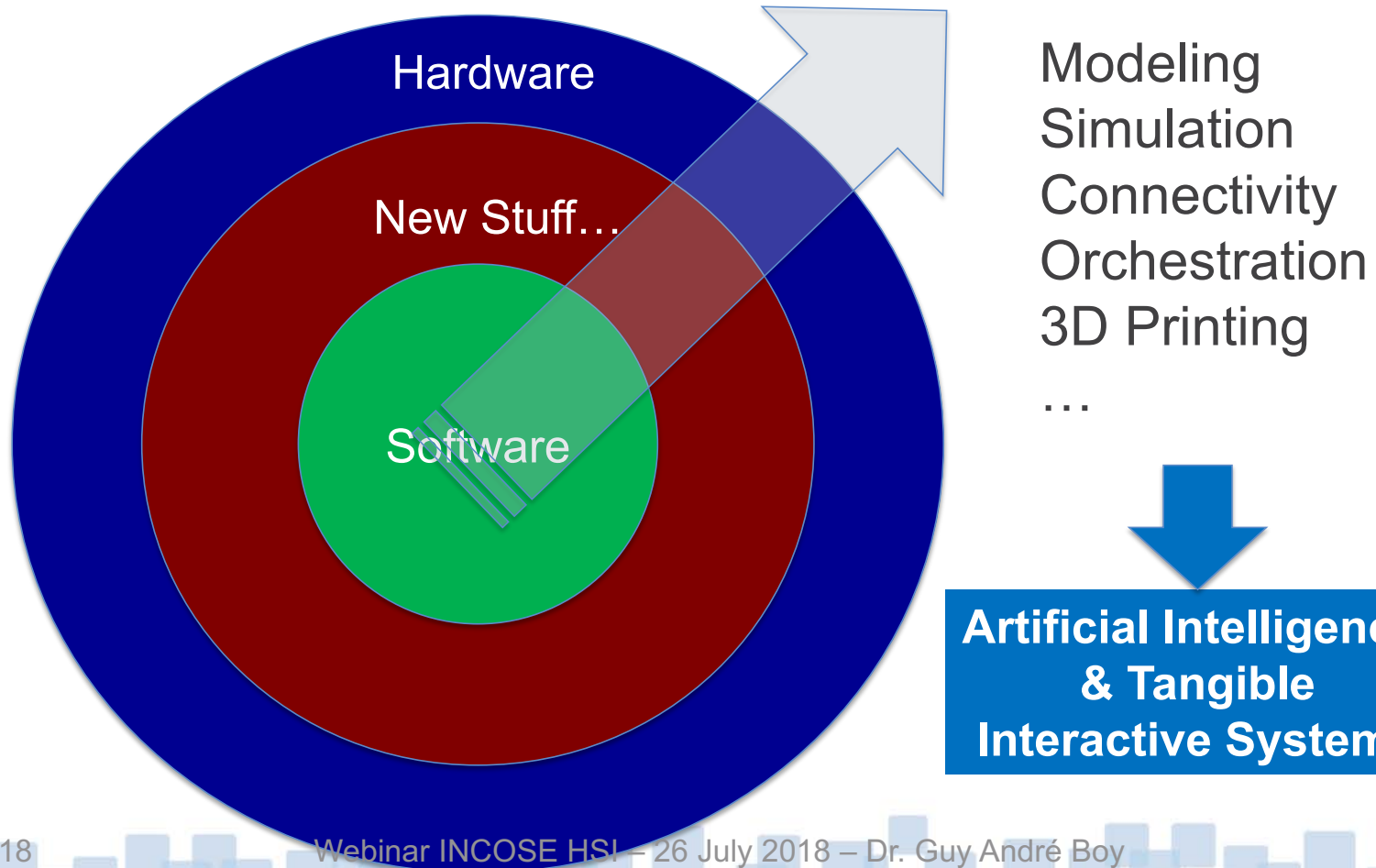


Why is HCD now possible?



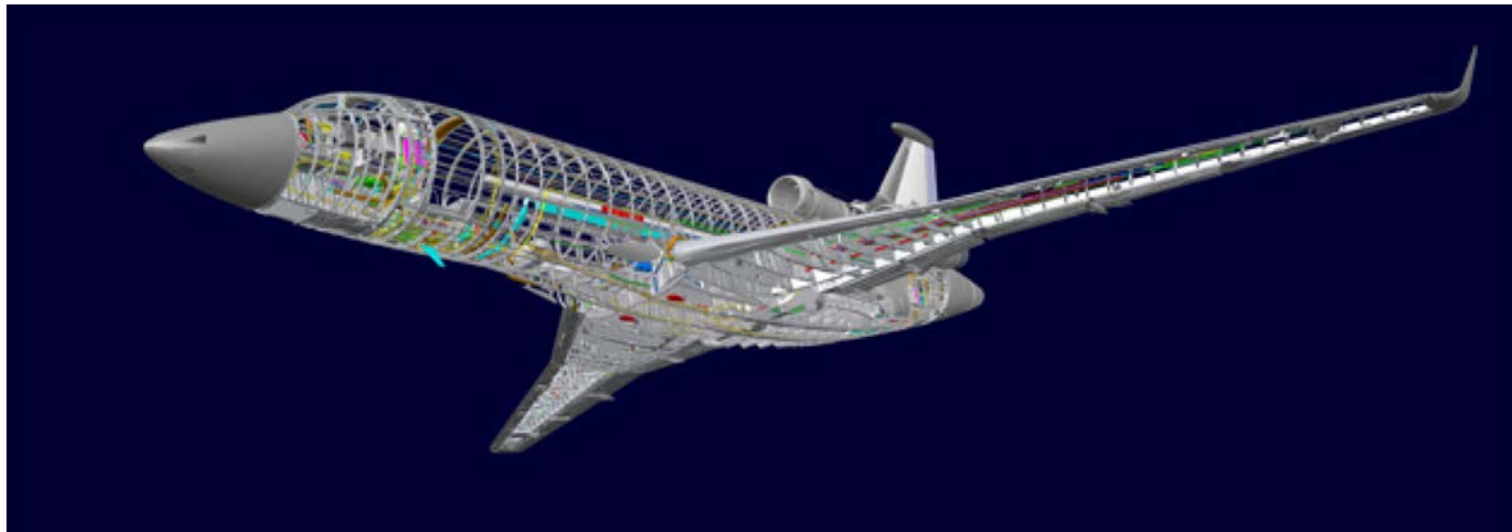
21st century

From Software to Hardware





Why HCD is now possible?







Digital/tangible human-in-the-loop simulation

at design time...

... more accurate physics models → fidelity & realism

... explore emergent behaviors and properties → during the whole life cycle

... explore human-systems function allocation → separability issue & complexity management



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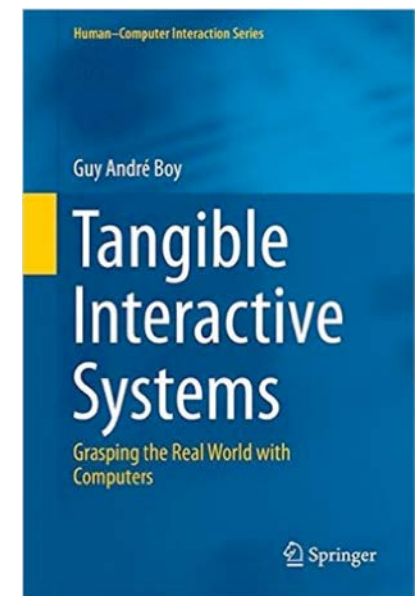
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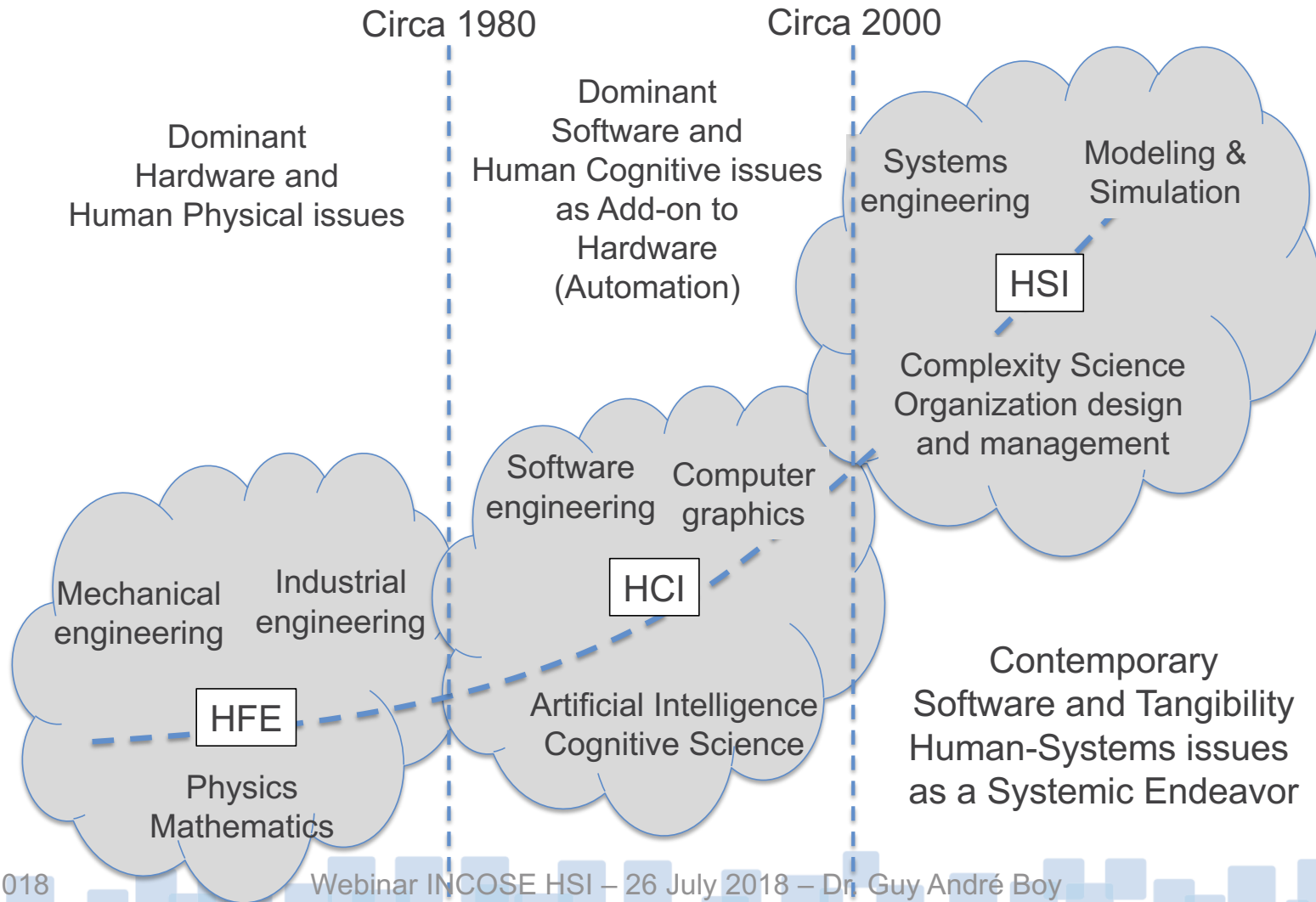


Tangible: What do we mean?

Something is tangible when it is **graspable** in the **physical** sense, but also in the **figurative** sense.

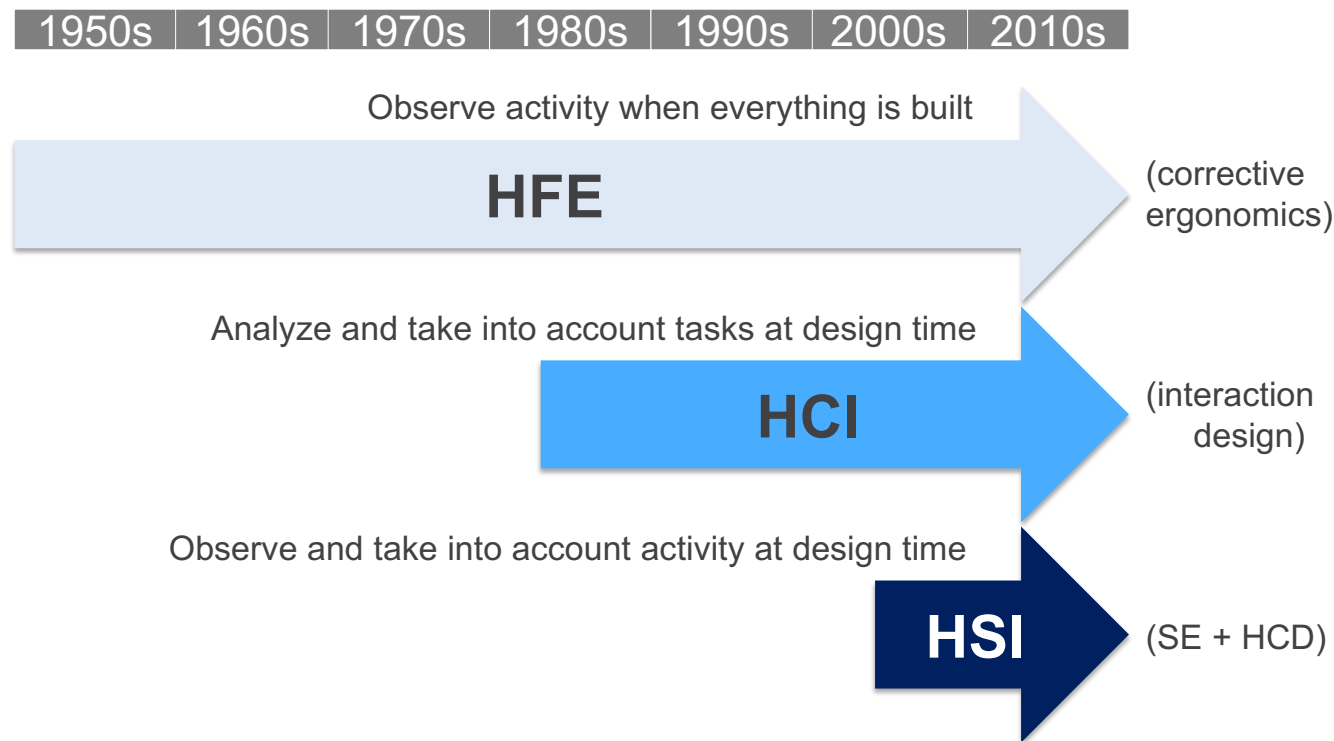
- Real, actual, material
- Opposite to imaginary or visionary
- Physical tangibility: touchable, graspable
- Figurative tangibility: acceptability, meaningfulness







Activity-based HSI...



HFE: Human Factors and Ergonomics
HCI: Human Computer Interaction
HSI: Human Systems Integration
SE: Systems Engineering

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Human-Systems Integration (HSI)?

Human-Centered Design + Systems Engineering



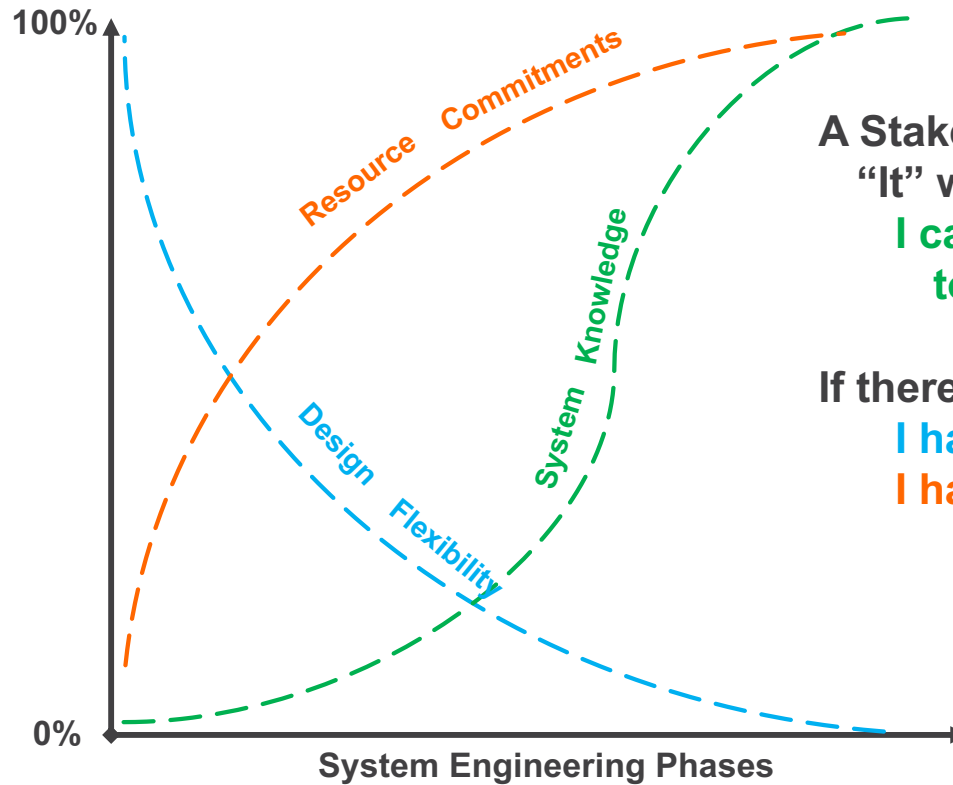


e.g., NASA Lifecycle Phases

- **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 life cycle ...



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

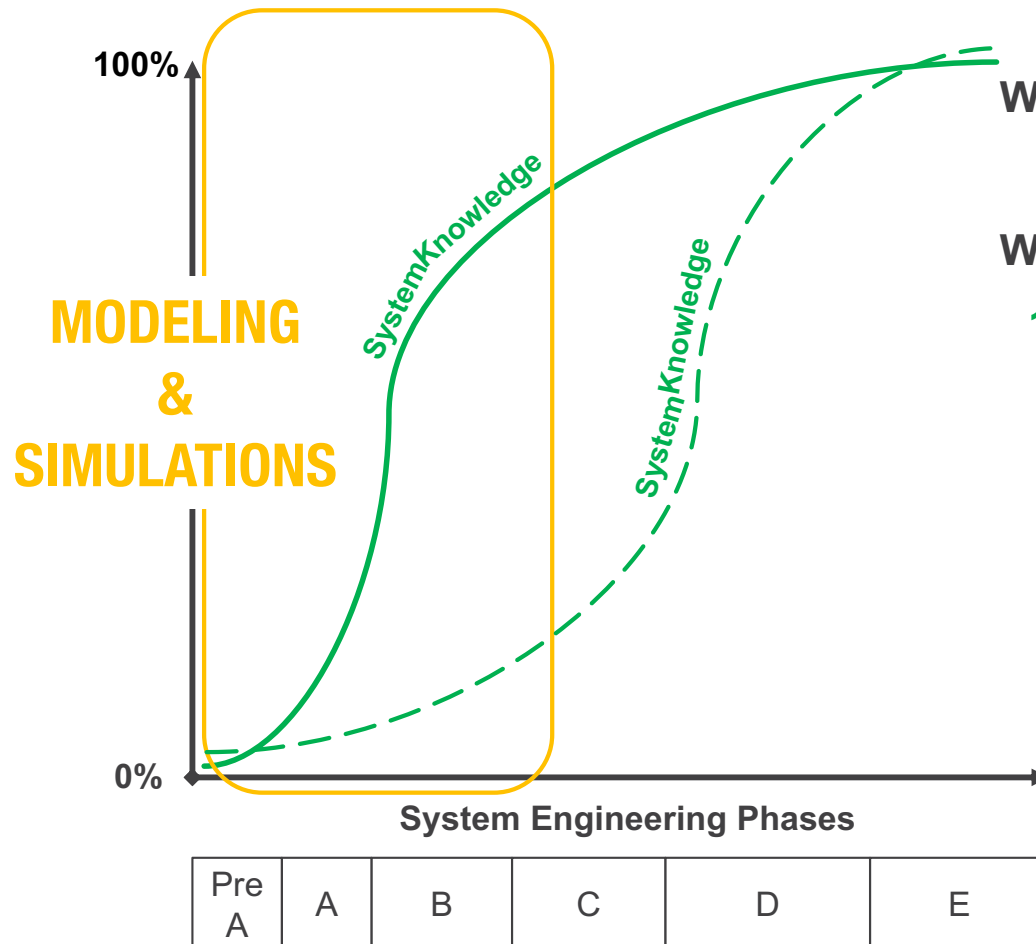
I have no money

| | | | | | |
|-------|---|---|---|---|---|
| Pre A | A | B | C | D | E |
|-------|---|---|---|---|---|

(Conroy, 2016)



What we Really Want ...



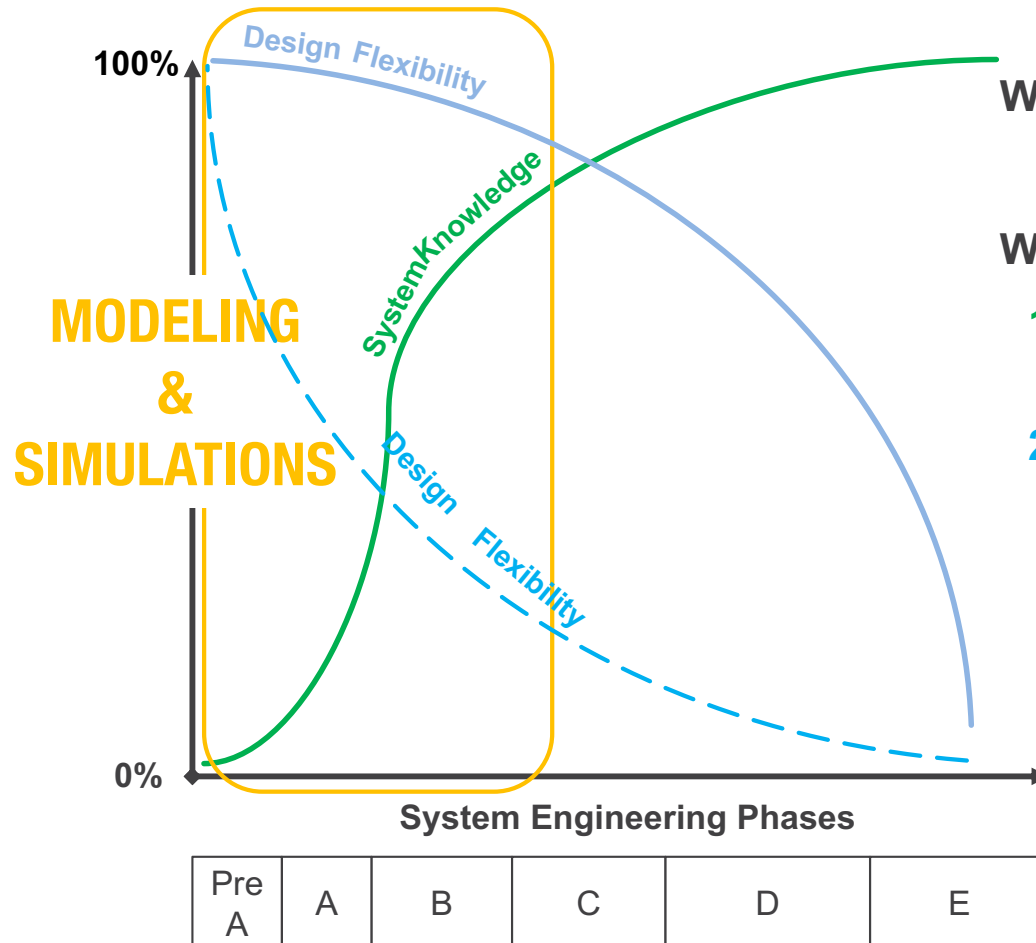
When Stakeholder asks
“What will it look like?”

What “We” Really Want:

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



What we Really Want ...



When Stakeholder asks
“What will it look like?”

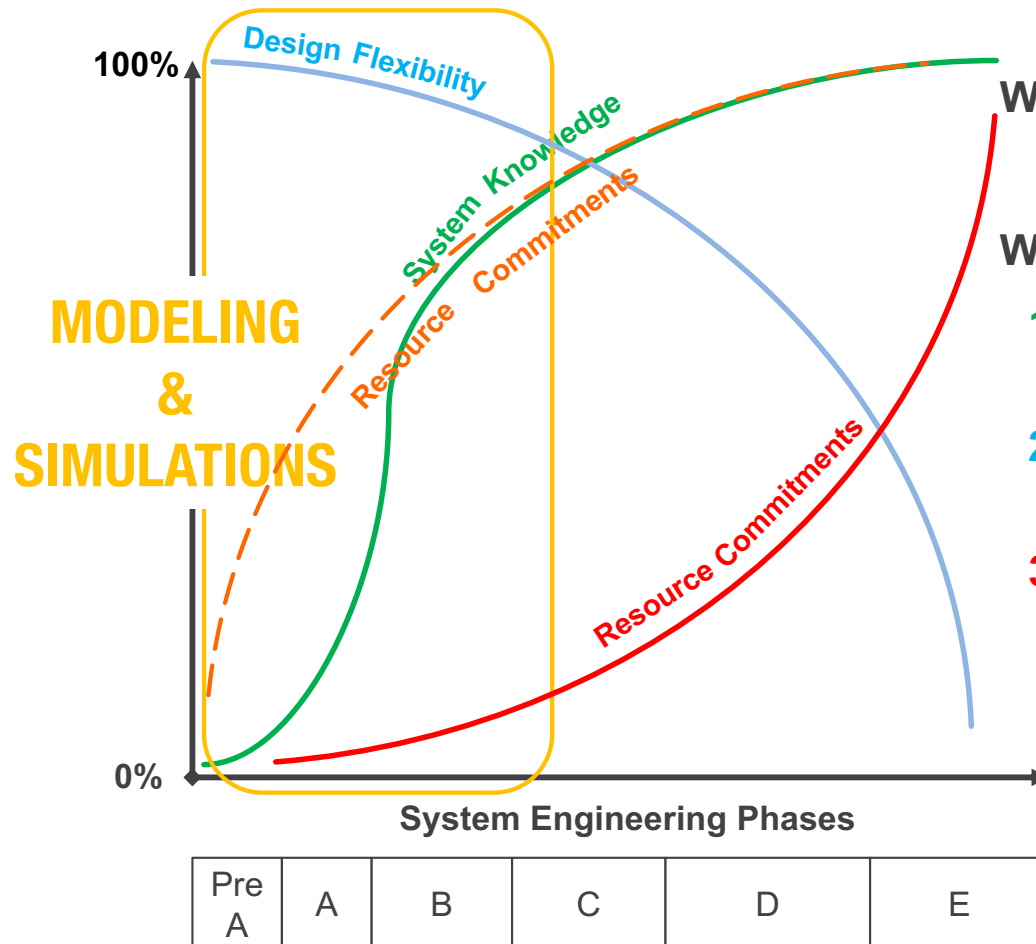
What “We” Really Want:

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





What we Really Want ...



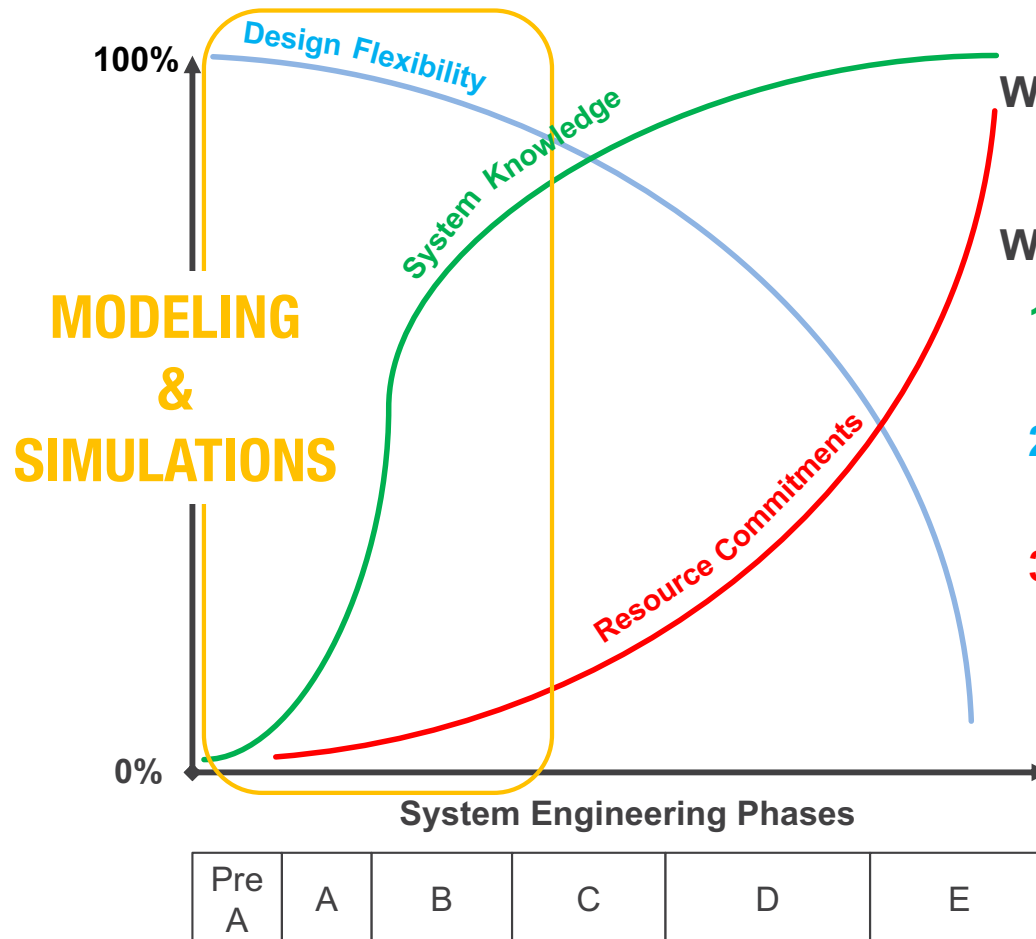
When Stakeholder asks
“What will it look like?”

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)
3. And we can look at the what
we need to change
(Still have Resource Options)



What we Really Want ...



When Stakeholder asks
“What will it look like?”

What “We” Really Want:

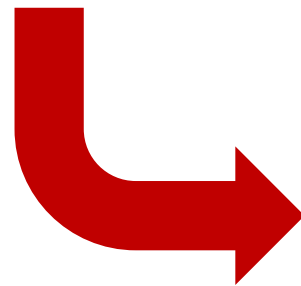
1. I can show you the Sim.
(Early System Knowledge)
2. Then you can help guide me
(Still have Design Flexibility)
3. And we can look at the what
we need to change
(Still have Resource Options)





Modeling & Simulation

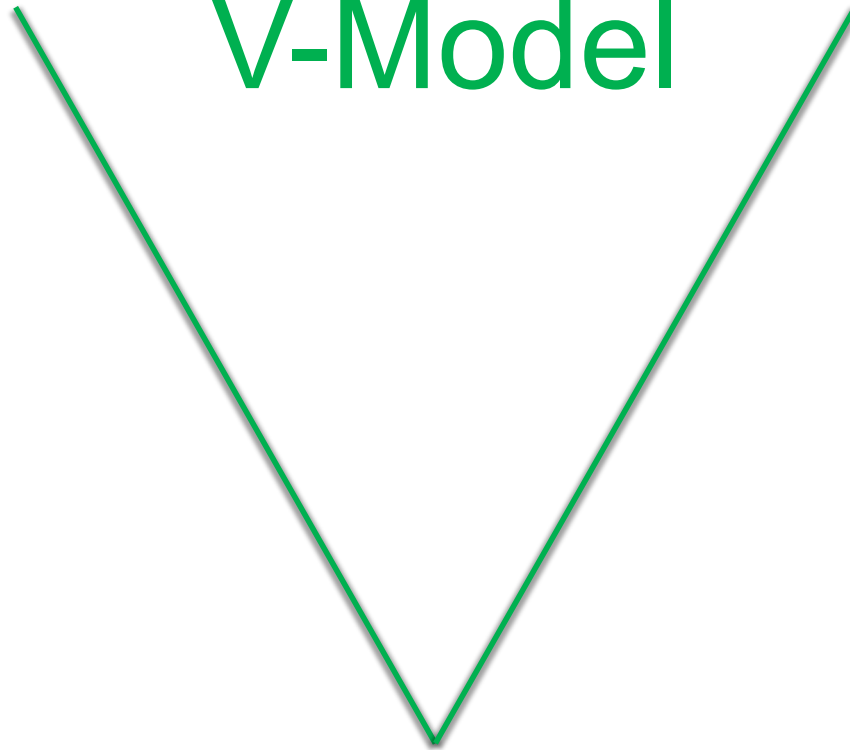
- Yes, but...
- Human-In-The-Loop Simulation (HITLS)



Human-Centered Design



V-Model





Human-Centered
Design

Technology-Centered
Engineering

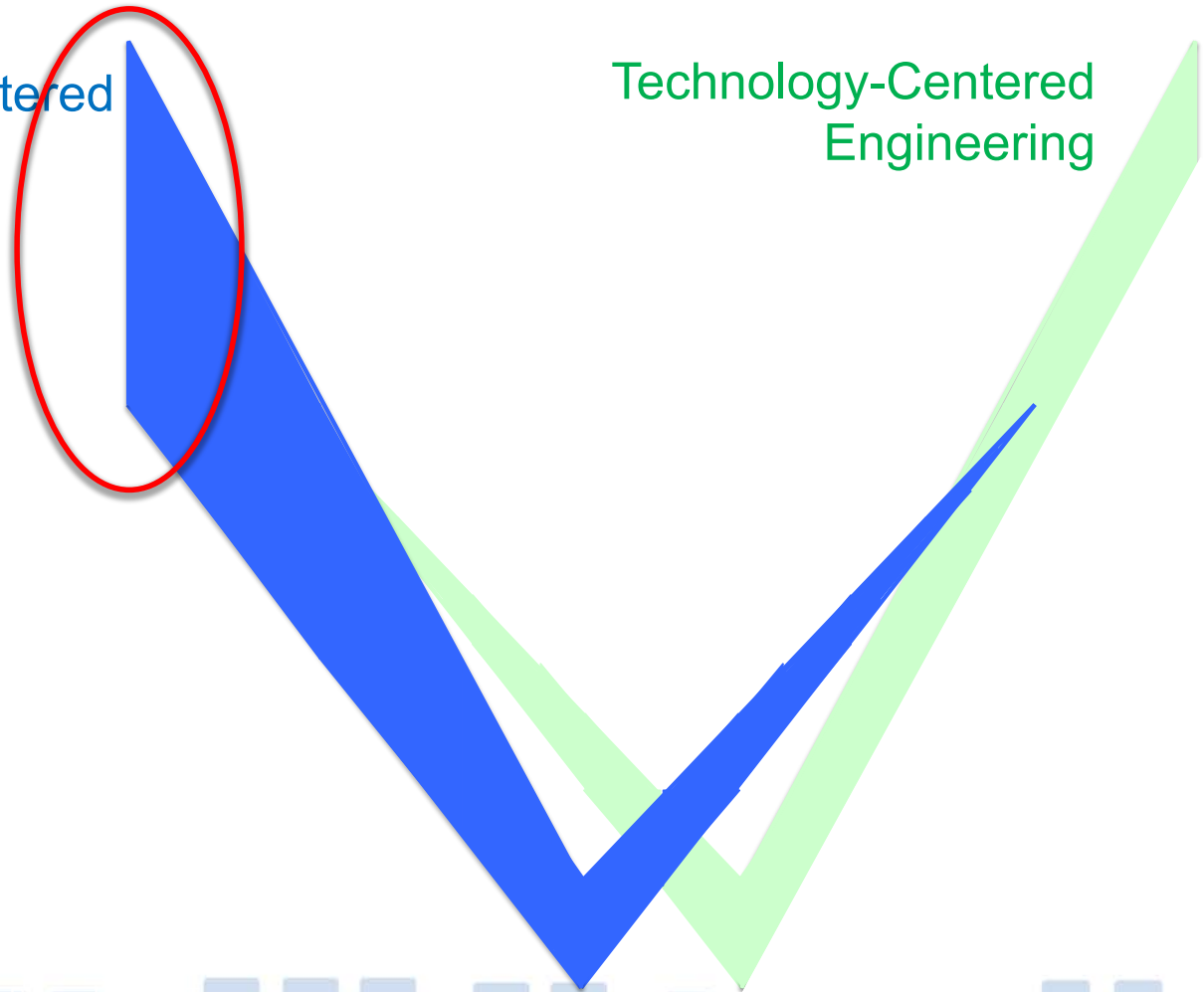
HITLS





Human-Centered
Design

Technology-Centered
Engineering



A. B. —



Human-Centered
Design

Technology-Centered
Engineering

Human-Systems Integration



People

**Human
Centered
Design**

Technology

Organizations



From purpose to means...

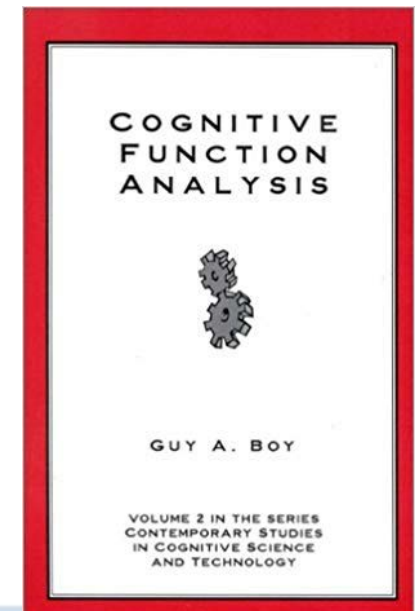
Function allocation is a matter of:

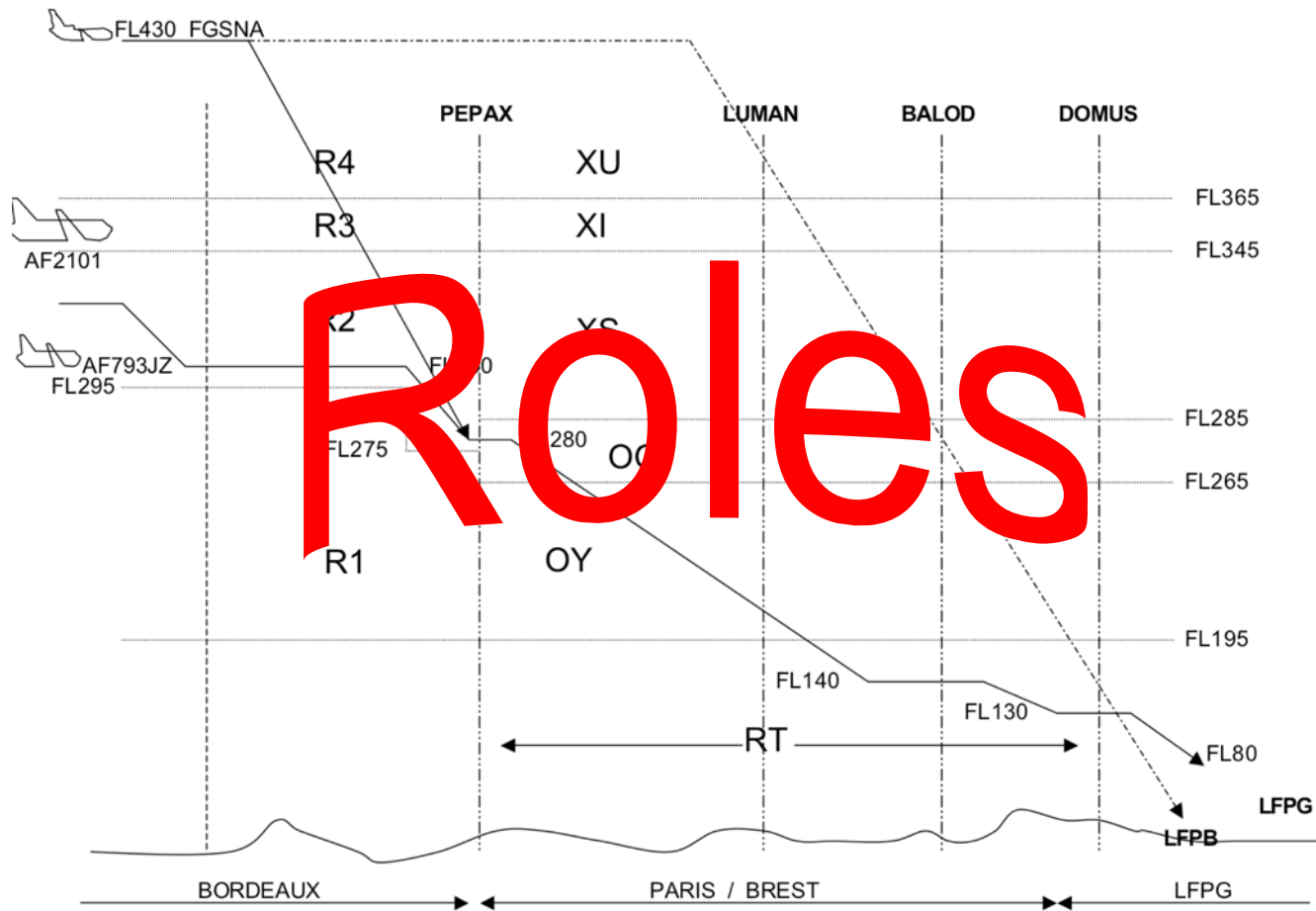
Roles

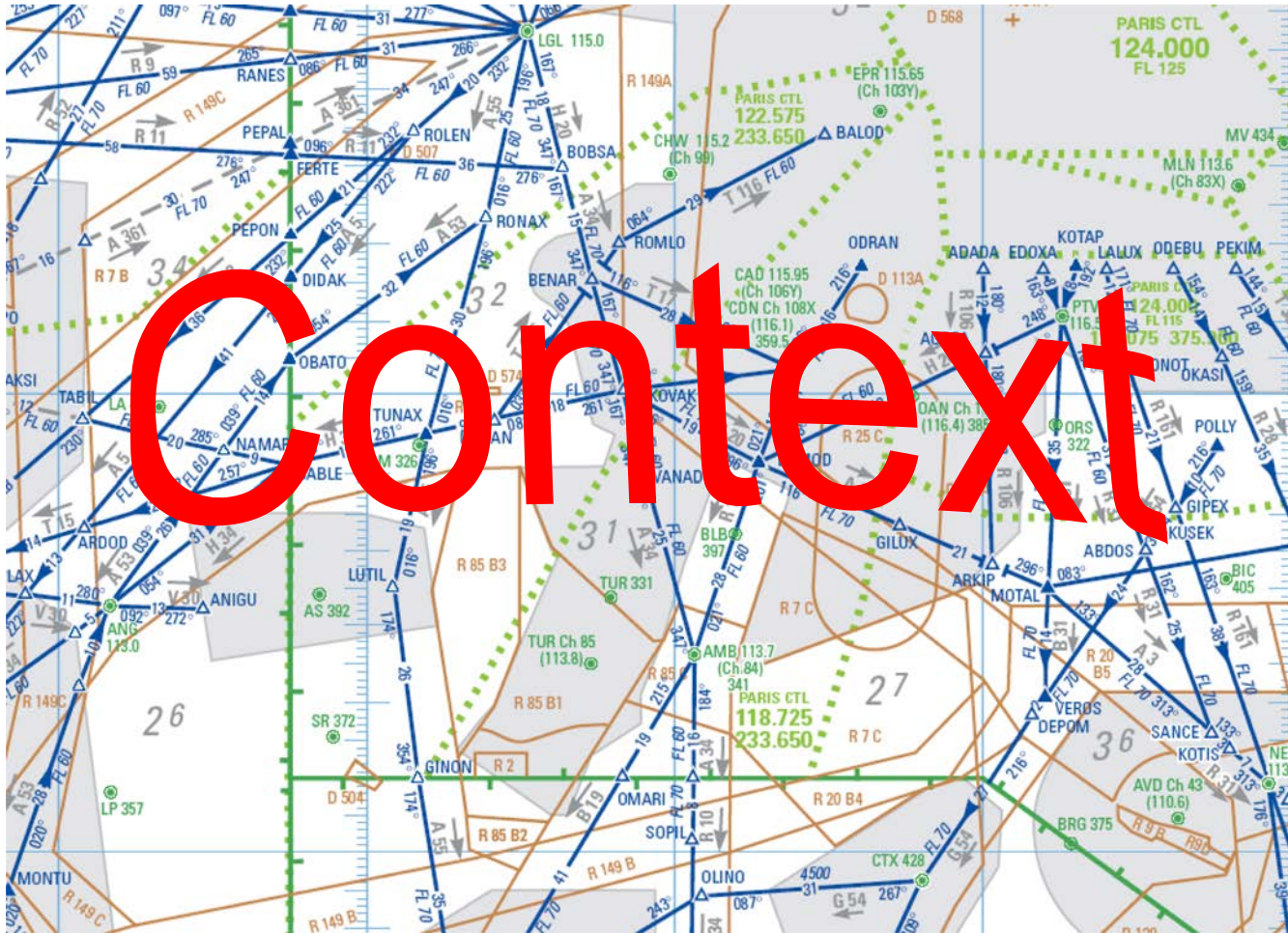
Contexts

Resources

- Task → CF → Activity
- Structure-Function
- Multi-agent approach





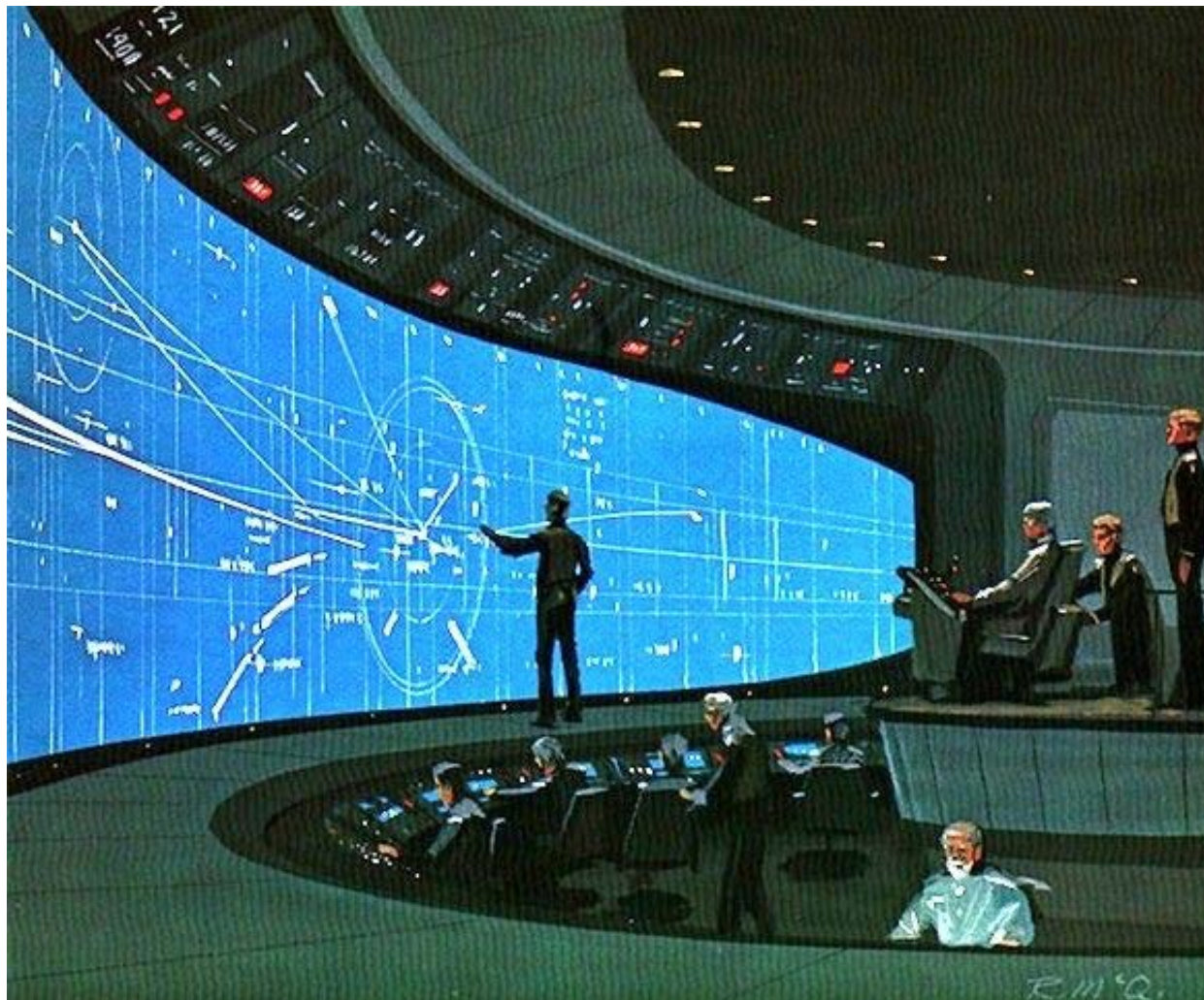




Resources



Interactivity Visualization CSCW



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Computer-Supported Cooperative Work (CSCW)

OPS

Collaborative problem solving
Shared situation awareness



Computer-Supported Cooperative Work (CSCW)

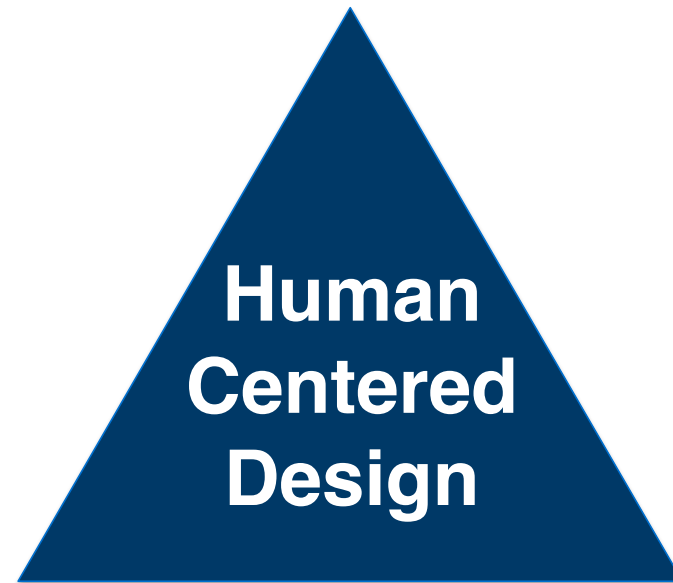
OPS

I think the problem is..

Collaborative problem solving
Situation awareness



People



Technology

Organizations



Integration requires a **model**
that represents **agents** involved
and **relationships**
within the **overall system**

i.e., an **Organizational Model**





The Orchestra Model



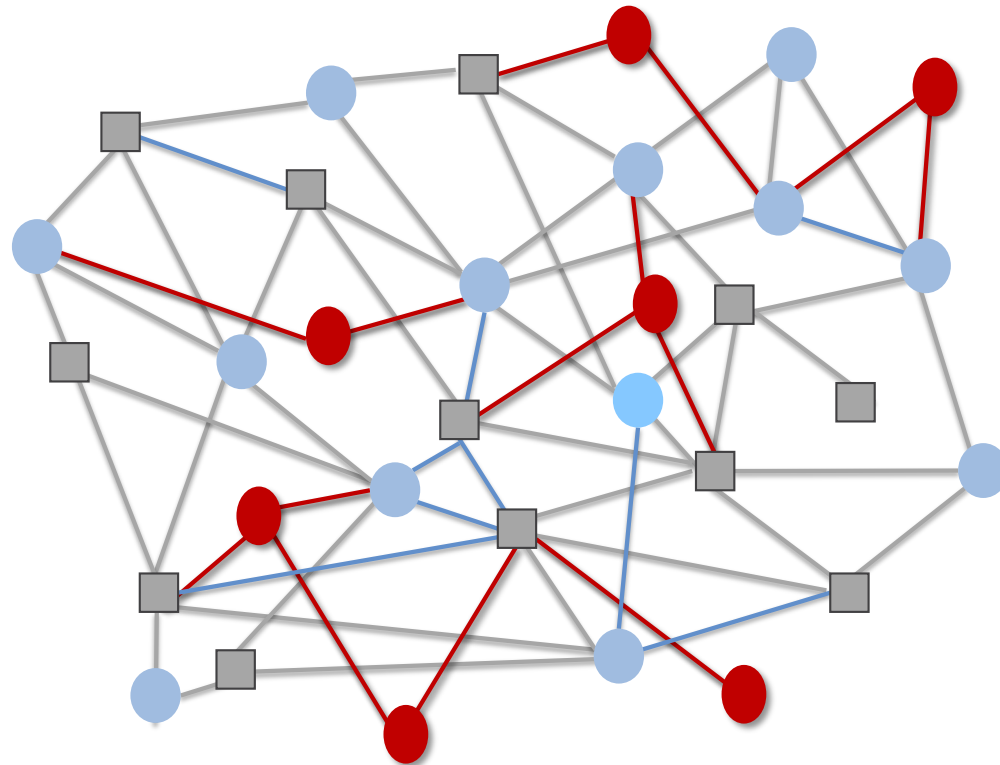


Multi-agent systems properties...

Separability
a crucial issue

Complexity
in connections
as well as
in agents themselves

**Emergent functions,
Coordination rules
and
the maturity issue**



... therefore, this is a living organism



People

Human
Centered
Design

Technology

Organizations



Human-systems performance

Physical and physiological (anthropometry, movement, neuro-ergonomics, stress)

Perceptual and cognitive (visual & auditory, attention, workload, situation awareness, decision making)

System-level constraints (political & social, economics)

Human-centered design

Displays and controls (graphical user interfaces, procedural & problem-solving support, multimodal, automation)

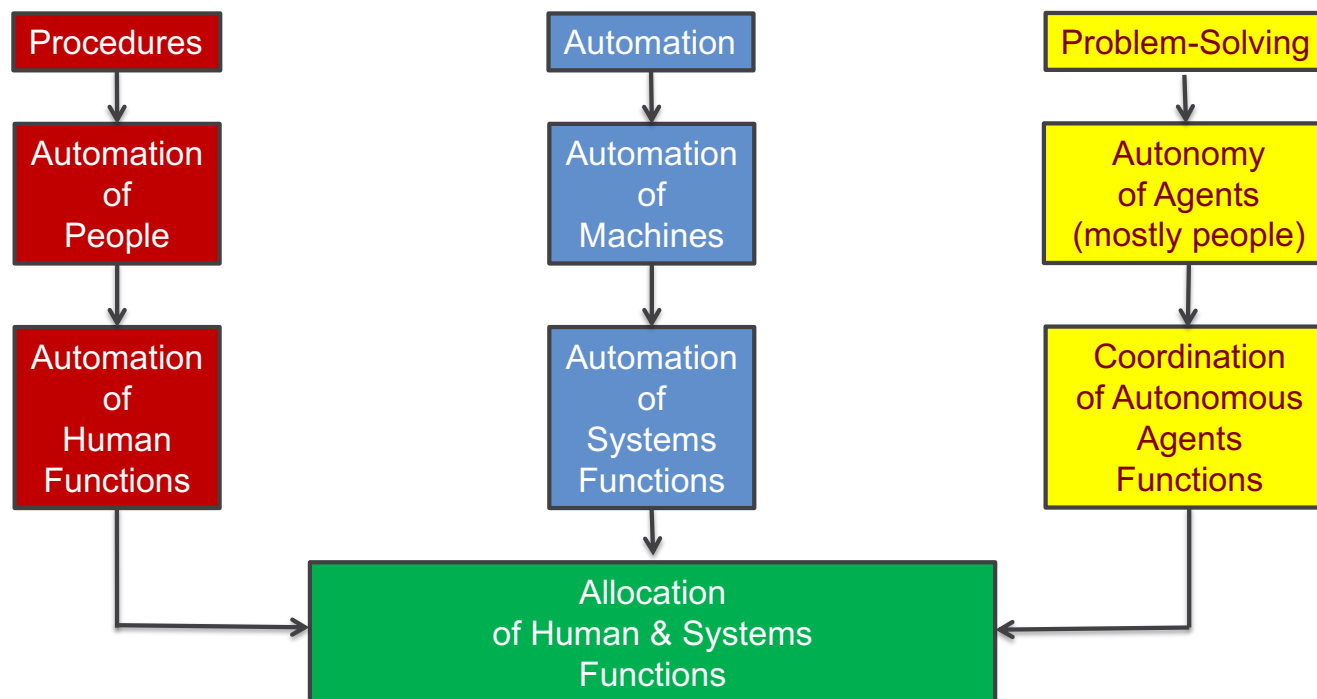
Personnel (manpower, selection, training, motivation, aging)

Teams and organizations (teamwork, teams of teams, organization design and management, culture)

Adapted from APA Handbook of Human-Systems Integration, by D.A. Boehm-Davis, F.T. Durso & J.D. Lee (eds.) 2015



From Rigid Automation to Flexible Autonomy



INCOSE HSIWG Workshop in Florida (Oct 4-5, 2016)



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





HSI key properties

tangibility, complexity, flexibility

human-in-the-loop simulation, fidelity

goal, task, activity, function, structure... experience and expertise

integration, autonomy

context

societal

maturity



HSI key properties

tangibility, complexity, flexibility

human-in-the-loop simulation, fidelity

goal, task, activity, function, structure... experience and expertise

integration, autonomy

context

societal

maturity

space and time

environmental, social and historical, culture and education

normal, abnormal and emergency (nominal and off-nominal)

expected vs. unexpected

life cycle processes: design, manufacturing, certification, training, operations, maintenance, decommissioning, etc.

ethical values, legal and regulatory, economical and business



HSI key properties

tangibility, complexity, flexibility
human-in-the-loop simulation, fidelity
goal, task, activity, function, structure... experience and expertise
integration, autonomy, dependency

context
societal
maturity

systems of systems → teams of teams (multi-agent)
types and locus of control (hierarchical vs. heterarchical)
centralized vs. distributed organizations
3C (communication, cooperation, coordination)
delegation, authority, responsibility, accountability
safety and security
common frame of reference (language) – knowledge management



HSI key properties

tangibility, complexity, flexibility

human-in-the-loop simulation, fidelity

goal, task, activity, function, structure... experience and expertise

integration, autonomy

context

societal

maturity

classical approach:

- process-driven (CMMi, TRLs)

three-fold alternative approach:

- technology and product (usability, usefulness)
- culture, practice and training (social and human readiness, ISO 9241/220)
- organization



HSI key properties

tangibility, complexity, flexibility

human-in-the-loop simulation, fidelity

goal, task, activity, function, structure... experience and expertise

integration, autonomy

context

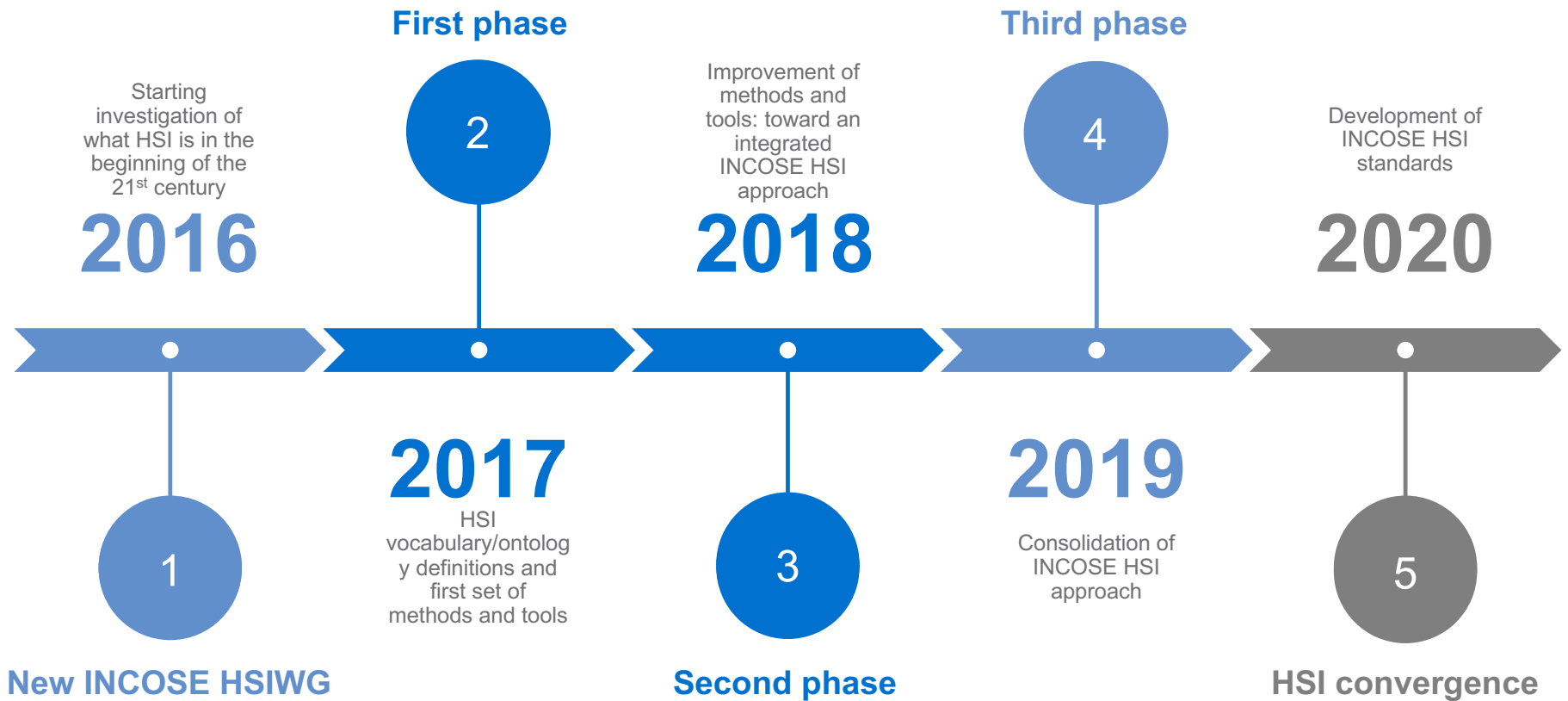
societal

maturity

HSI definition: the interdisciplinary technical and management processes for integrating human and organizational considerations within and across all elements of a socio-technical system during its whole life cycle to improve its safety, performance and comfort.



INCOSE HSI Roadmap



New INCOSE HSIWG

Second phase

HSI convergence

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Action items (short term):

- Write a contemporary HSI chapter of SE Handbook
- Organize teleconferences and webinars
- Set up a series of INCOSE HSI conferences
 - the first one will be in September 2019

Thank you!



I am ready for questions...





Upcoming Webinars (tentative schedule)

| Who | What | When |
|--|--|---|
| Tom McDermott, Sunil Bharitkar, and Christopher Nemeth | Bridging the Valley of Death: Translating Research into Development. | August 15 th 2018 at 11am EDT |
| Rick Dove | Agile SE Processes 201: Problem Space Derived Solution Requirements | September 19 th 2018 at 11am EDT |

Invitations will be emailed in advance and informational updates will be placed on www.incose.org

Go to <http://www.incose.org/ProductsPublications/webinars> for more info on the webinar series, including a way to view the last 111 Webinars and soon – this one!

Information on the webinars is now being posted in INCOSE Connect, in the INCOSE Library area, at

<https://connect.incose.org/Library/Webinars/Pages/INCOSE-Webinars.aspx> .

Joining instructions will added around two weeks before the webinar is scheduled to take place.



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17 - 20 October 2018 | Indianapolis, Indiana

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The Chapters of the INCOSE Great Lakes Region invite you to participate in the 12th Annual International Council on System Engineering (INCOSE) Great Lakes Regional Conference (GLRC2018) at [Indianapolis Marriott East](#), Indianapolis, Indiana.



When/Where
17 – 20 October 2018
Indianapolis Marriott East
7202 East 21st Street
Indianapolis
Indiana 46219
USA

<https://www.incose.org/glrc2018/home/when-where>



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