INCOSE Webinar: Human-Systems Integration: An Evolution

Guy Andre Boy

Welcome to the Webinar – if you have not dialed into the audio portion, please do so now. In the U.S., dial 1-855-747-8824, passcode **4348124177**. If you are outside the U.S., the webinar invitation includes a list of toll-free numbers for different countries. Please note that your phone is automatically on mute when you join to avoid disturbing other participants.

INCOSE Webinar Series

Thursday 26th July 2018– Webinar 114

Human – Systems Integration – An Evolution

Guy André Boy

INCOSE is offering Webinars…

- To provide a forum for experts in the field of Systems Engineering to present information on the “State of the Art”
- To explain how INCOSE works, and how to make the most out of INCOSE membership

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Here is the link to details about certification renewal, including information on PDUs.
http://www.incose.org/certification/CertProcess/CertRenew

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."

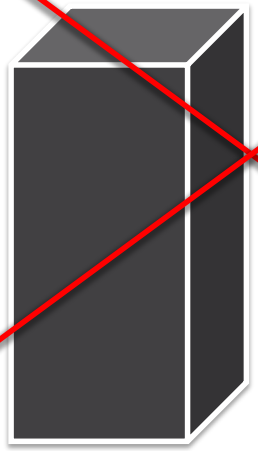
SE Handbook Working Group, 2007.

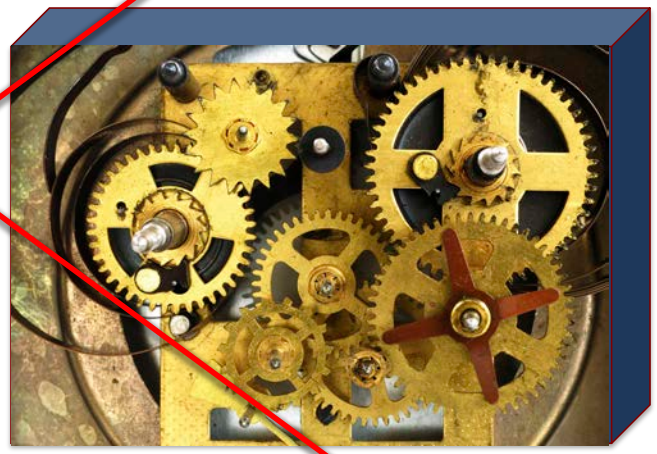
Outline

- 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?

User Interface





Human Factors

Ergonomics + Automation

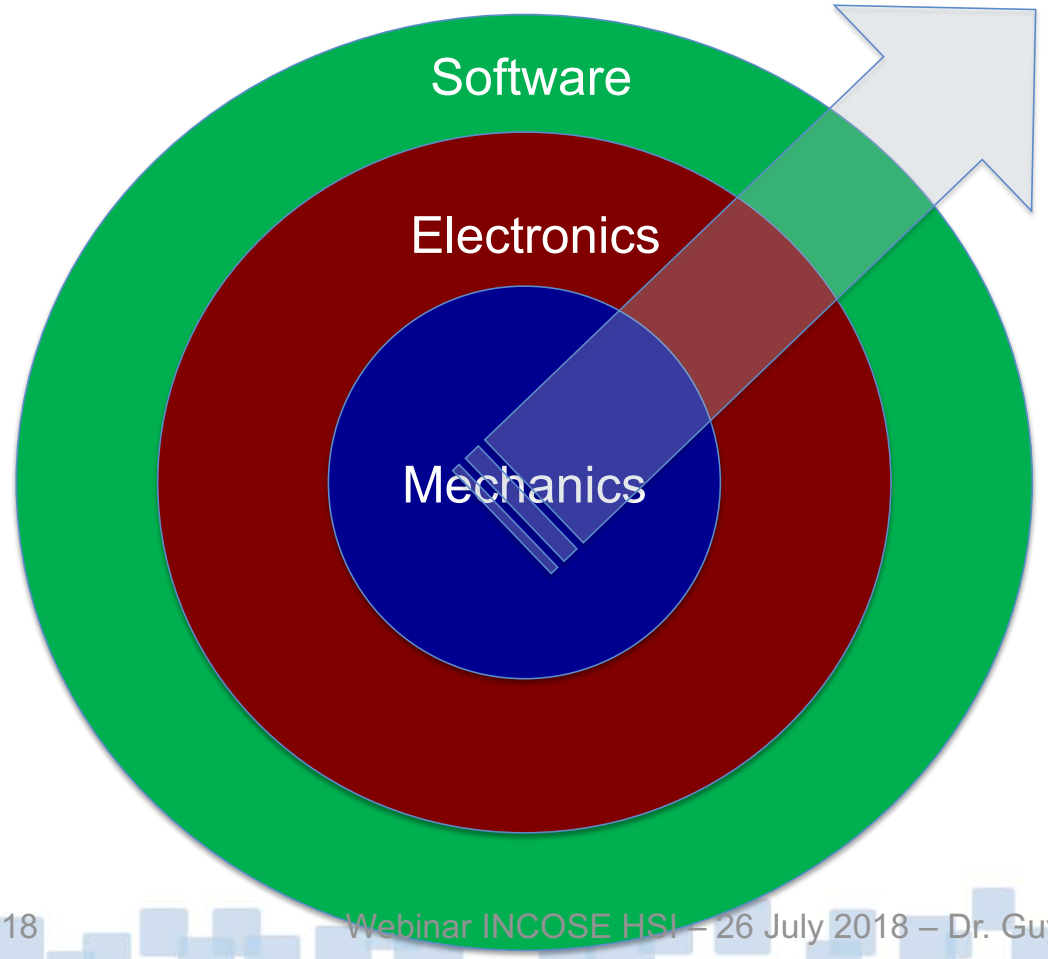
Engineering

Why is Human-Centered Design possible now?

- Let's provide a historical evolution…

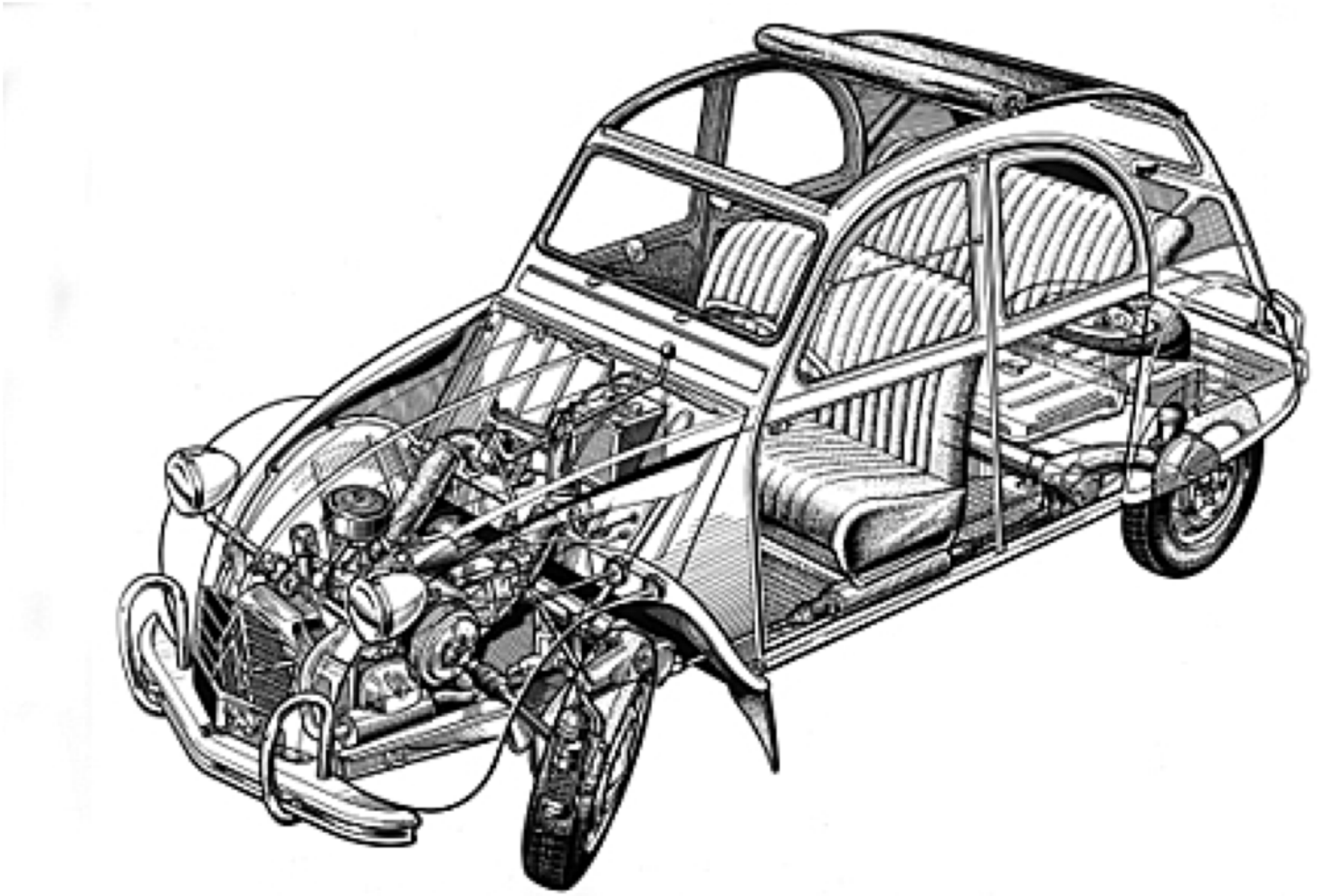
20th century

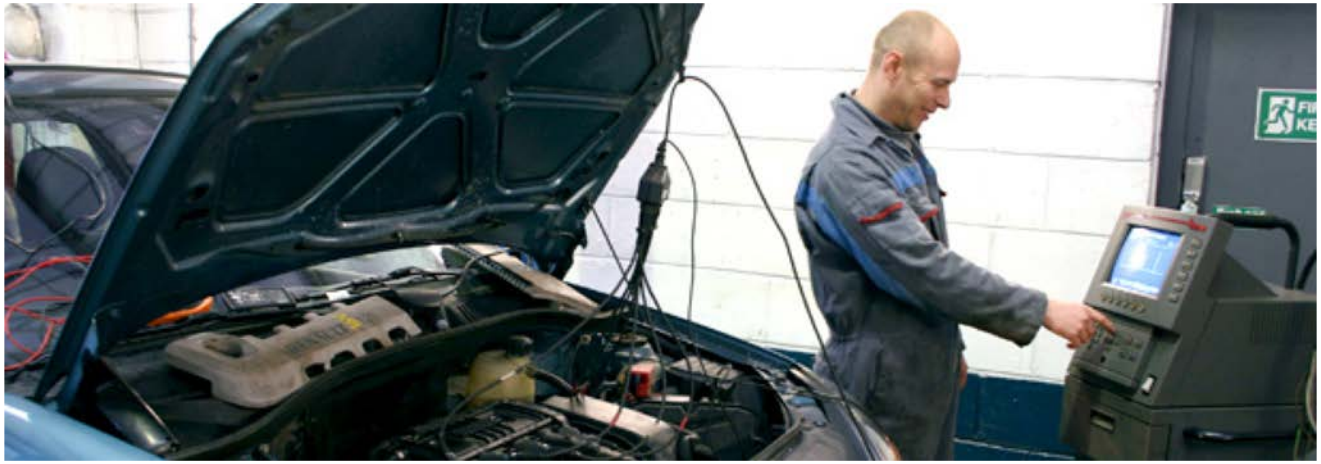
From Hardware to Software



Incremental Accumulation of Artificial Functions into Structure …

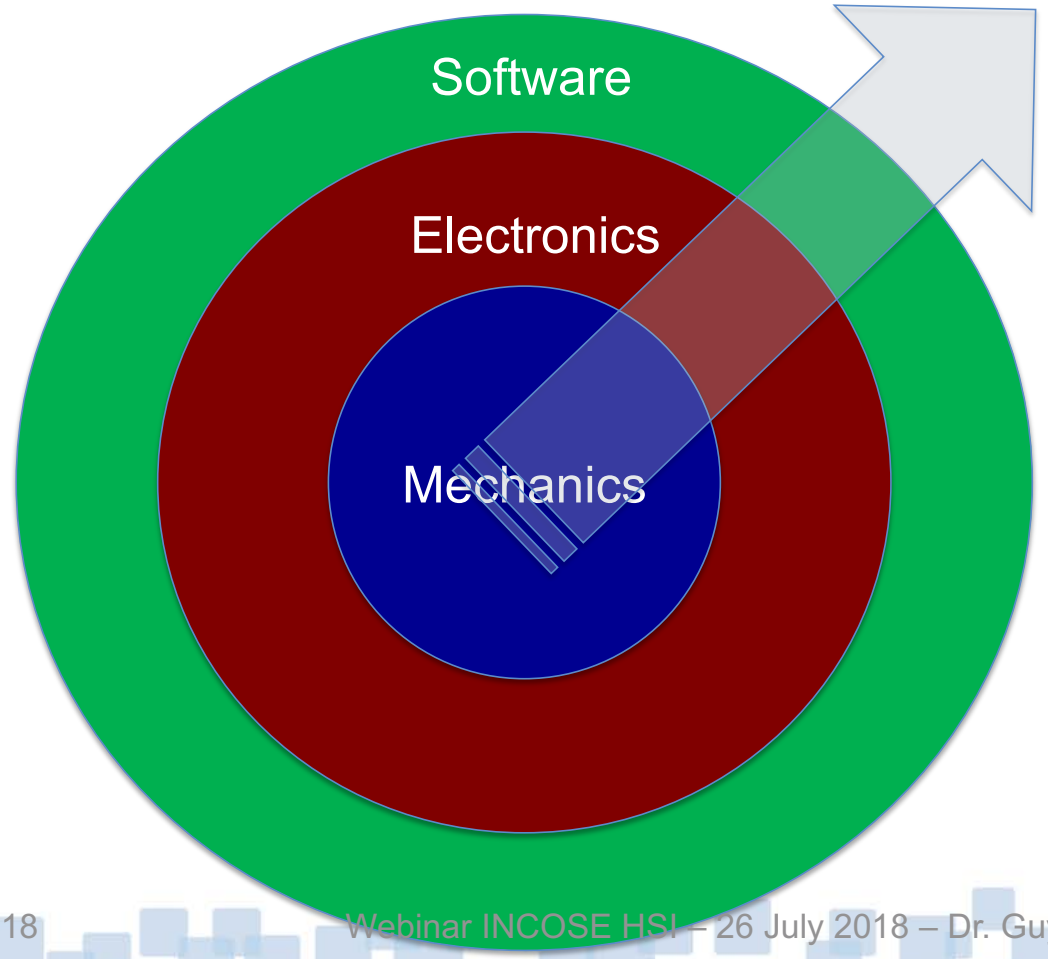
Automation & HCI





20th century

From Hardware to Software



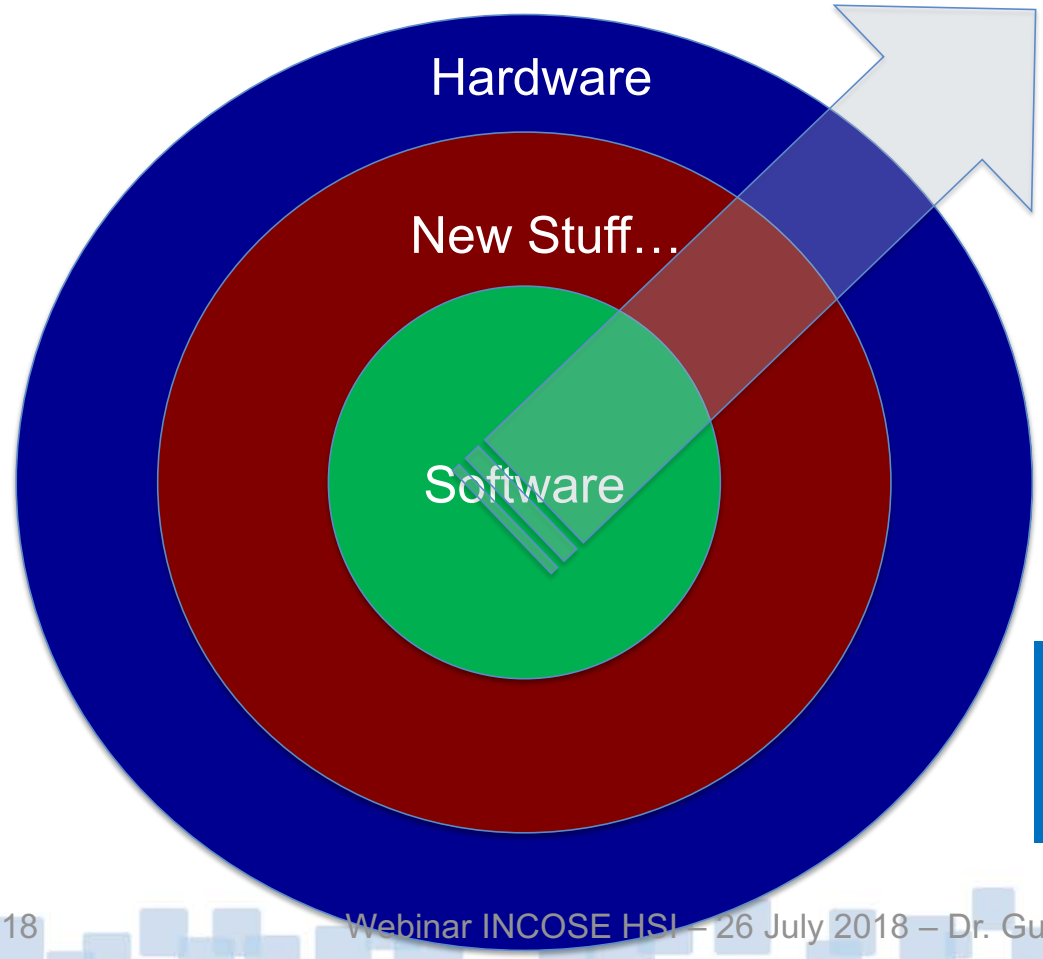
Incremental Accumulation of Artificial Functions into Structure …

Automation & HCI

Why is HCD now possible?

21st century

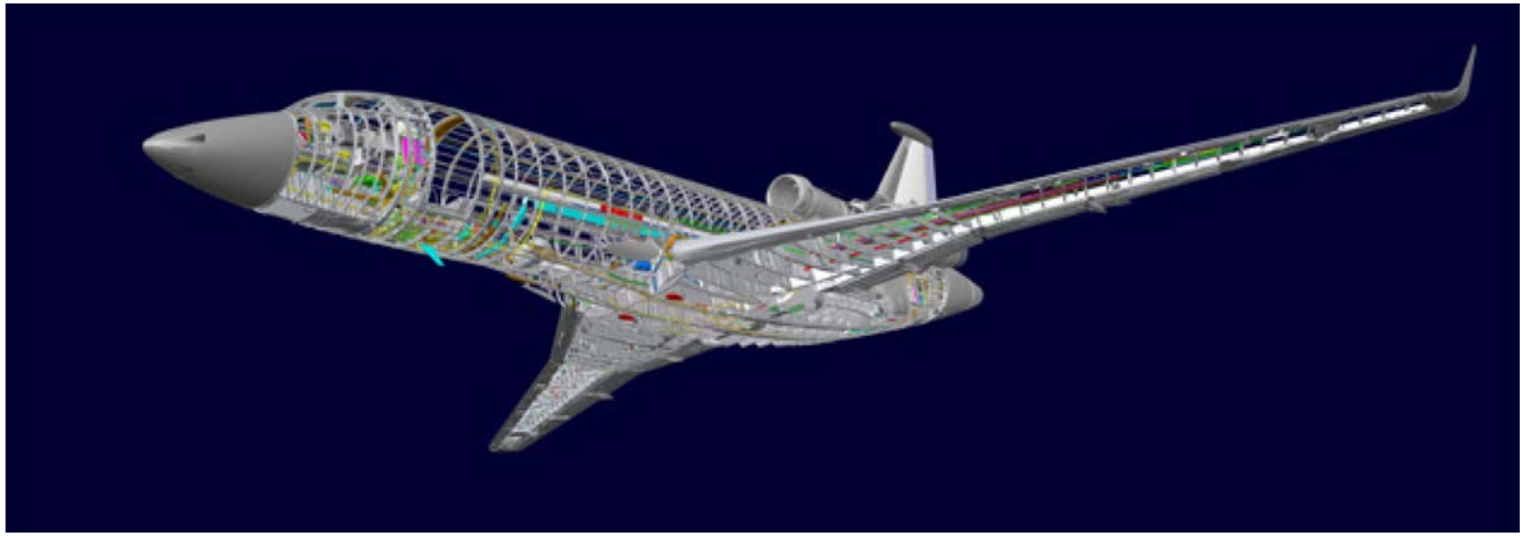
From Software to Hardware



Modeling
Simulation
Connectivity
Orchestration
3D Printing
…

Artificial Intelligence & Tangible Interactive Systems

Why HCD is now possible?



Digital/tangible human-in-the-loop simulation

at design time…

… more acurate physics models → fidelity & realism

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

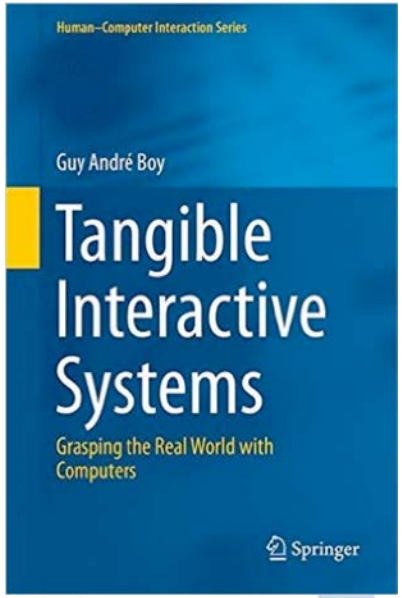
... explore human-systems function allocation → separability issue & complexity management

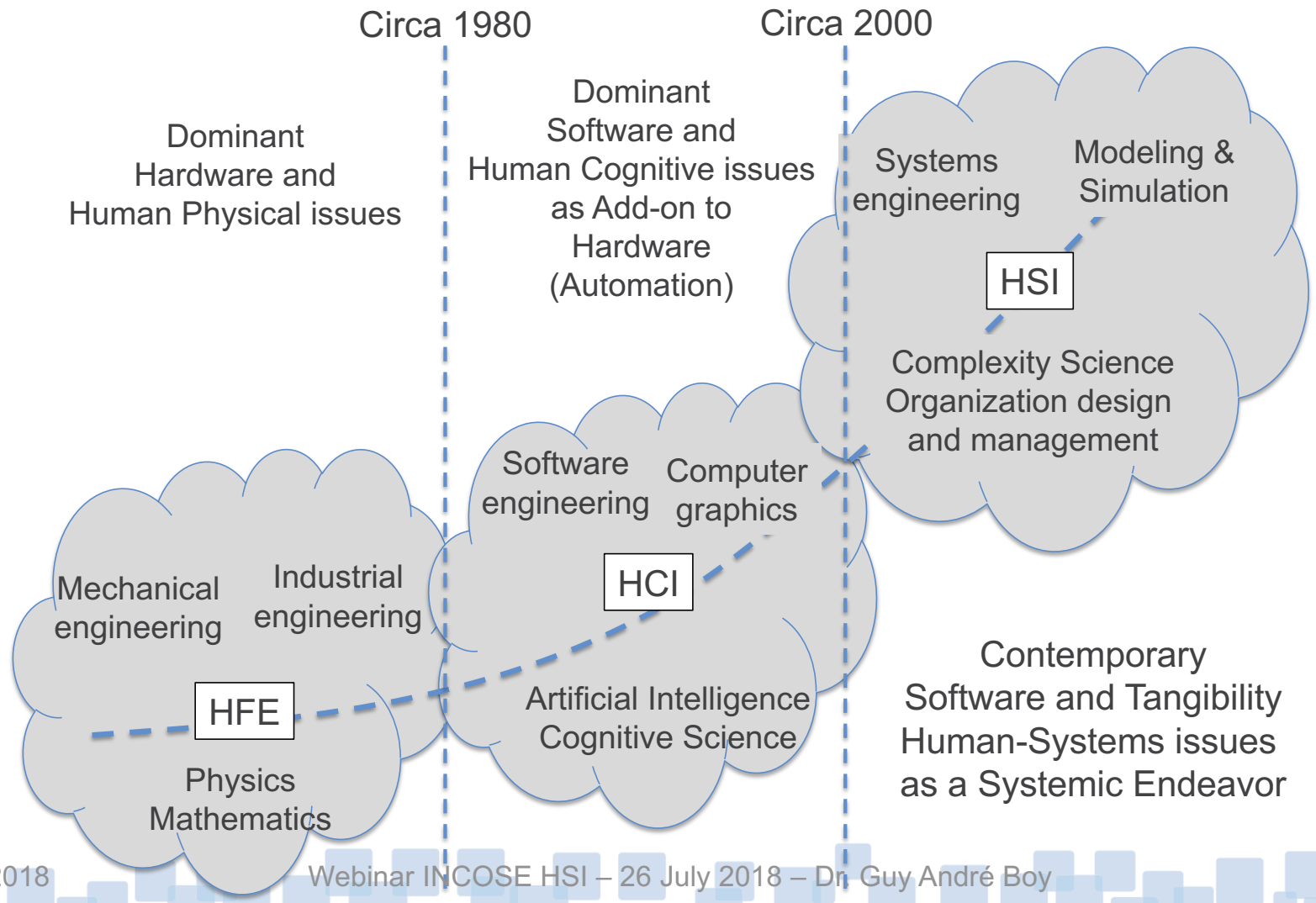
➢ Data Science + Tangibility

Tangible: What do we mean?

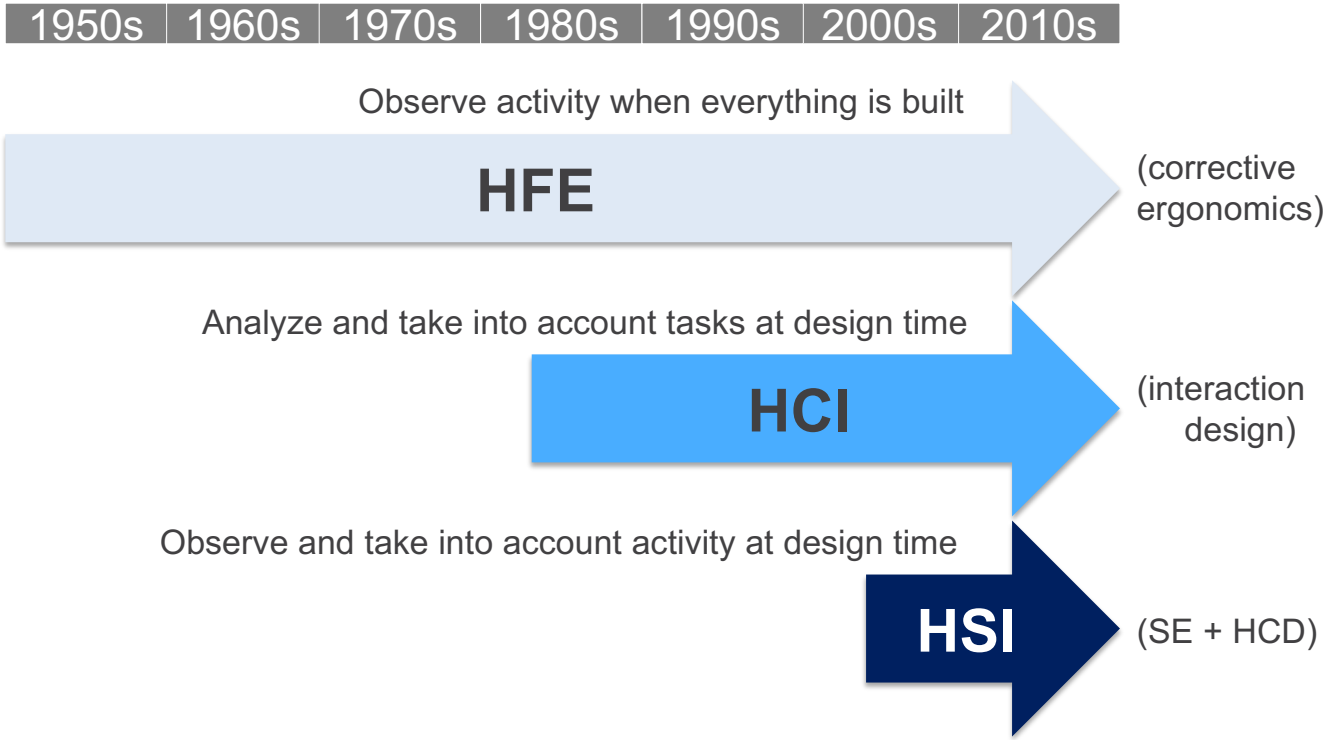
Something is tangible when it is **graspable**
in the **physical** sense,
but also in the **figurative** sense.

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




Circa 1980
Circa 2000
Dominant
Hardware and
Human Physical issues
Dominant
Software and
Human Cognitive issues
as Add-on to
Hardware
(Automation)
Systems
engineering
Modeling &
Simulation
HSI
Complexity Science
Organization design
and management
Software
engineering
Computer
graphics
HCI
Mechanical
engineering
Industrial
engineering
HFE
Artificial Intelligence
Cognitive Science
Physics
Mathematics
Contemporary
Software and Tangibility
Human-Systems issues
as a Systemic Endeavor

Activity-based HSI…



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

Human-Systems Integration (HSI)?

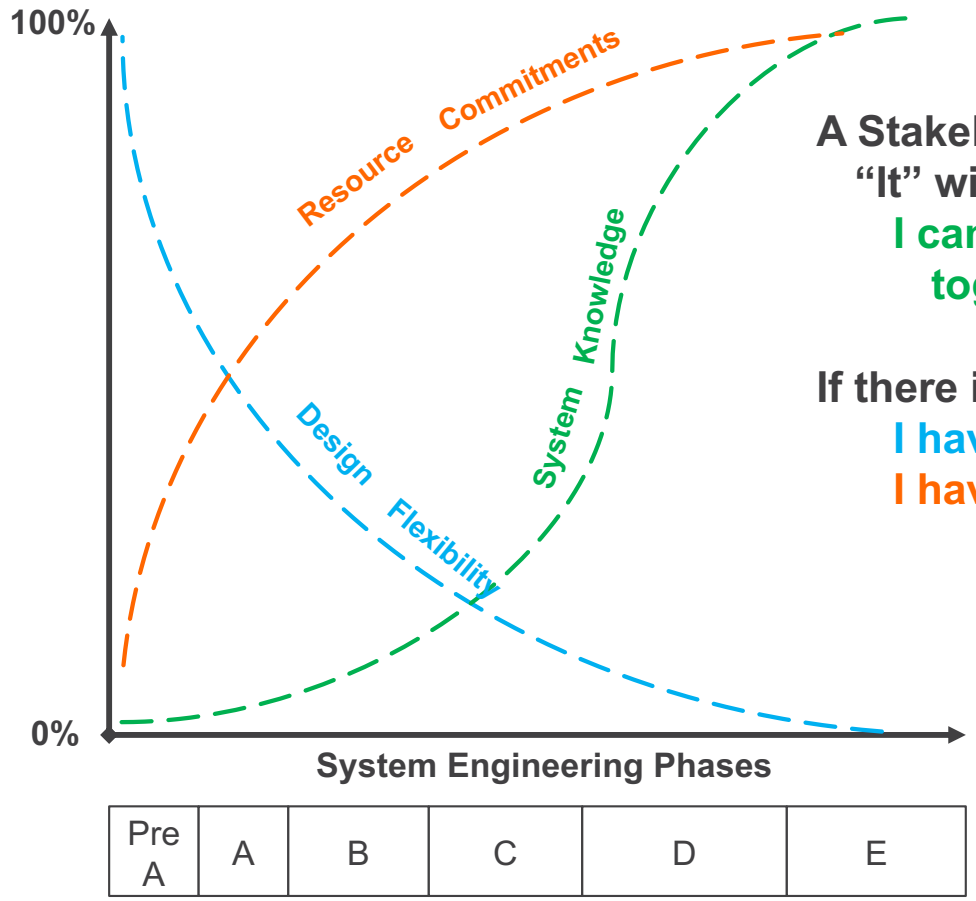
Human-Centered Design

+ 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

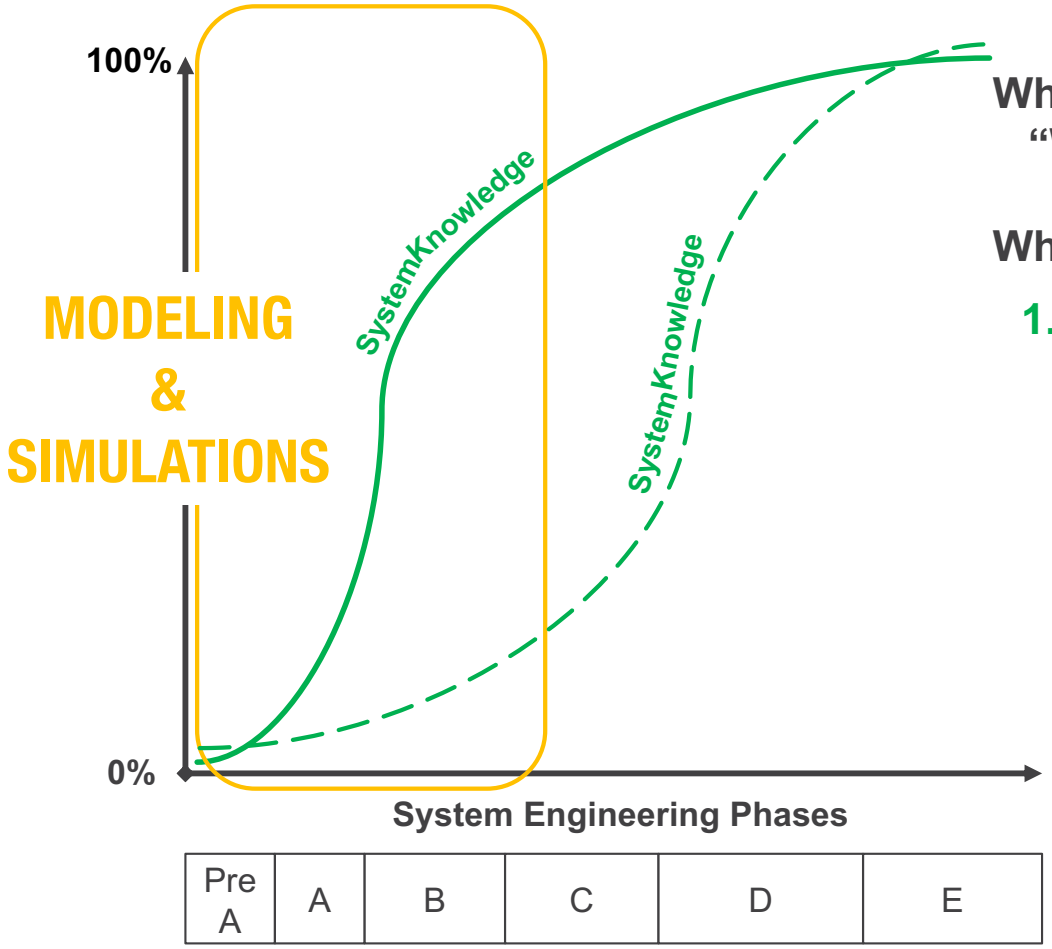
If there is a change:

I have no design flexibility

I have no money

(Conroy, 2016)

What we Really Want …

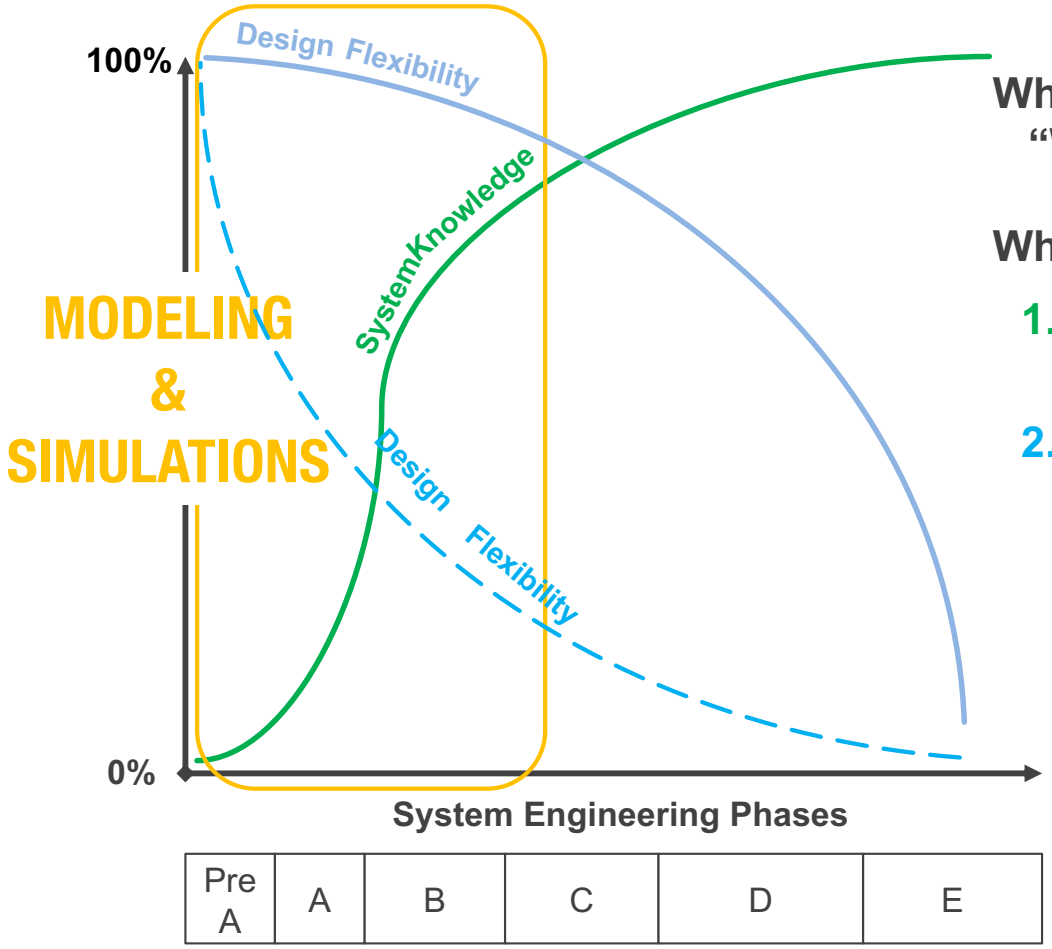


When Stakeholder asks "What will it look like?"

What "We" Really Want:

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

What we Really Want …

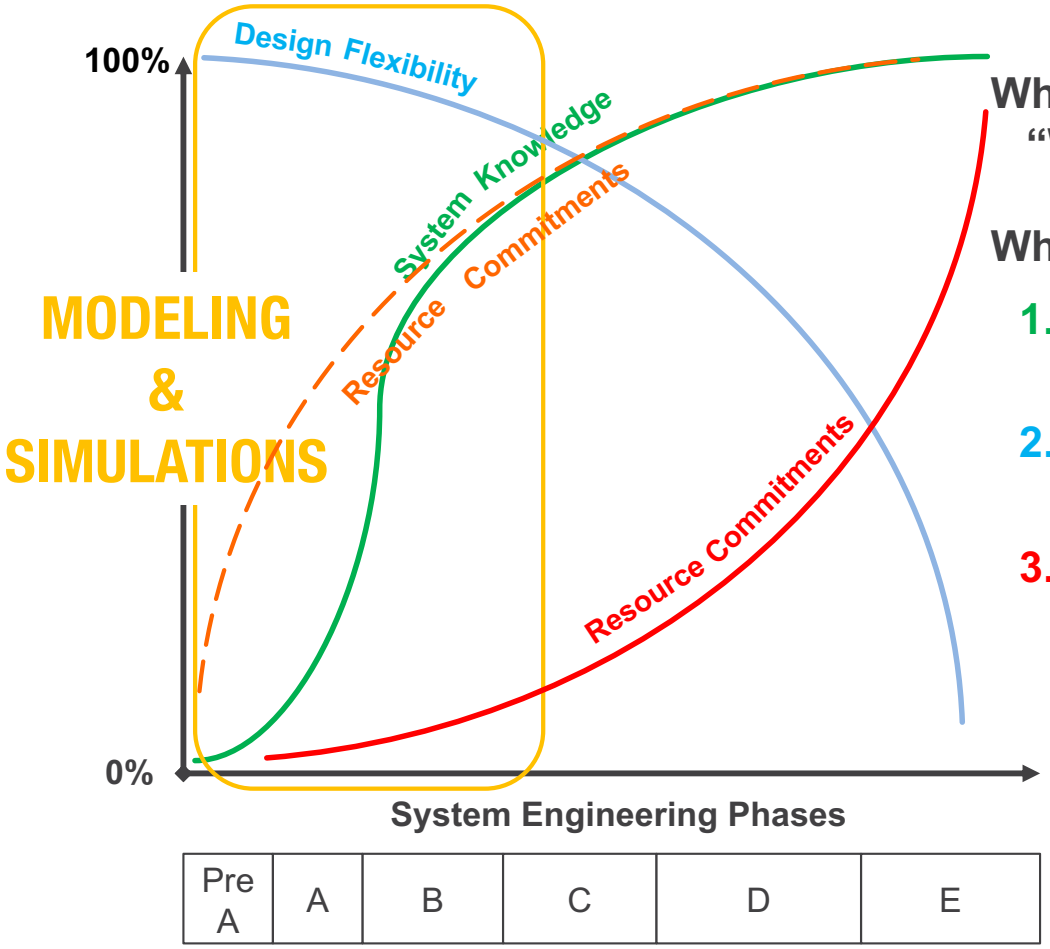


When Stakeholder asks "What will it look like?"

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 …

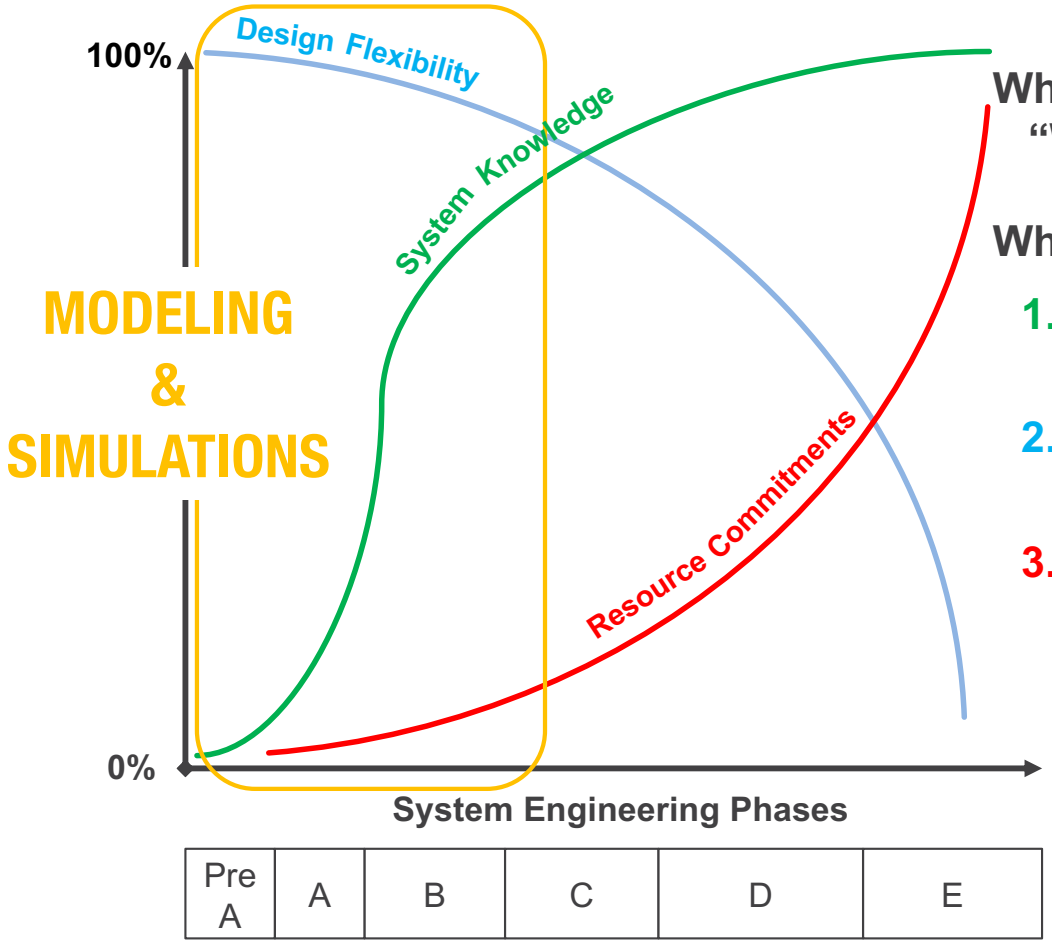


When Stakeholder asks "What will it look like?"

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 …



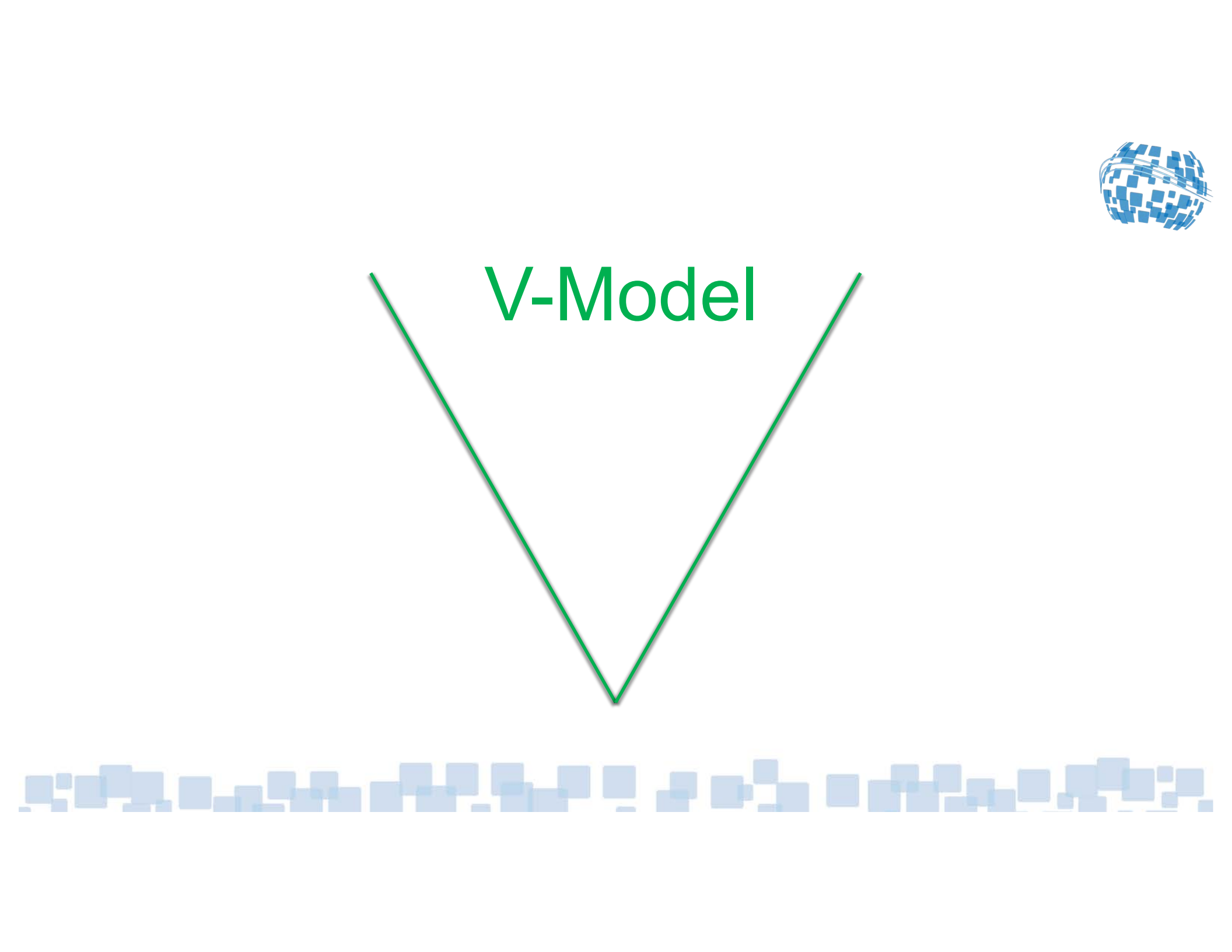
When Stakeholder asks "What will it look like?"

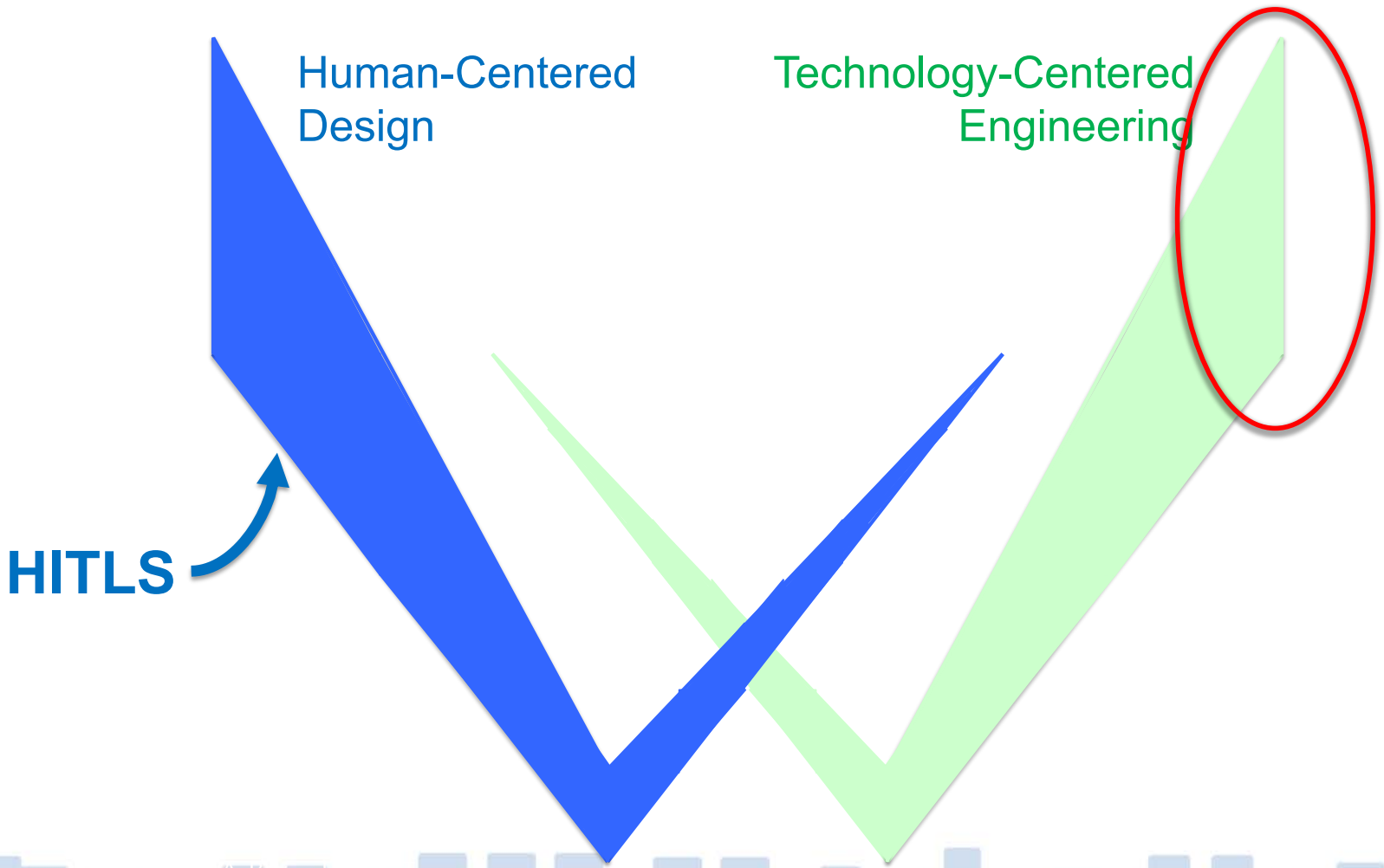
What "We" Really Want:

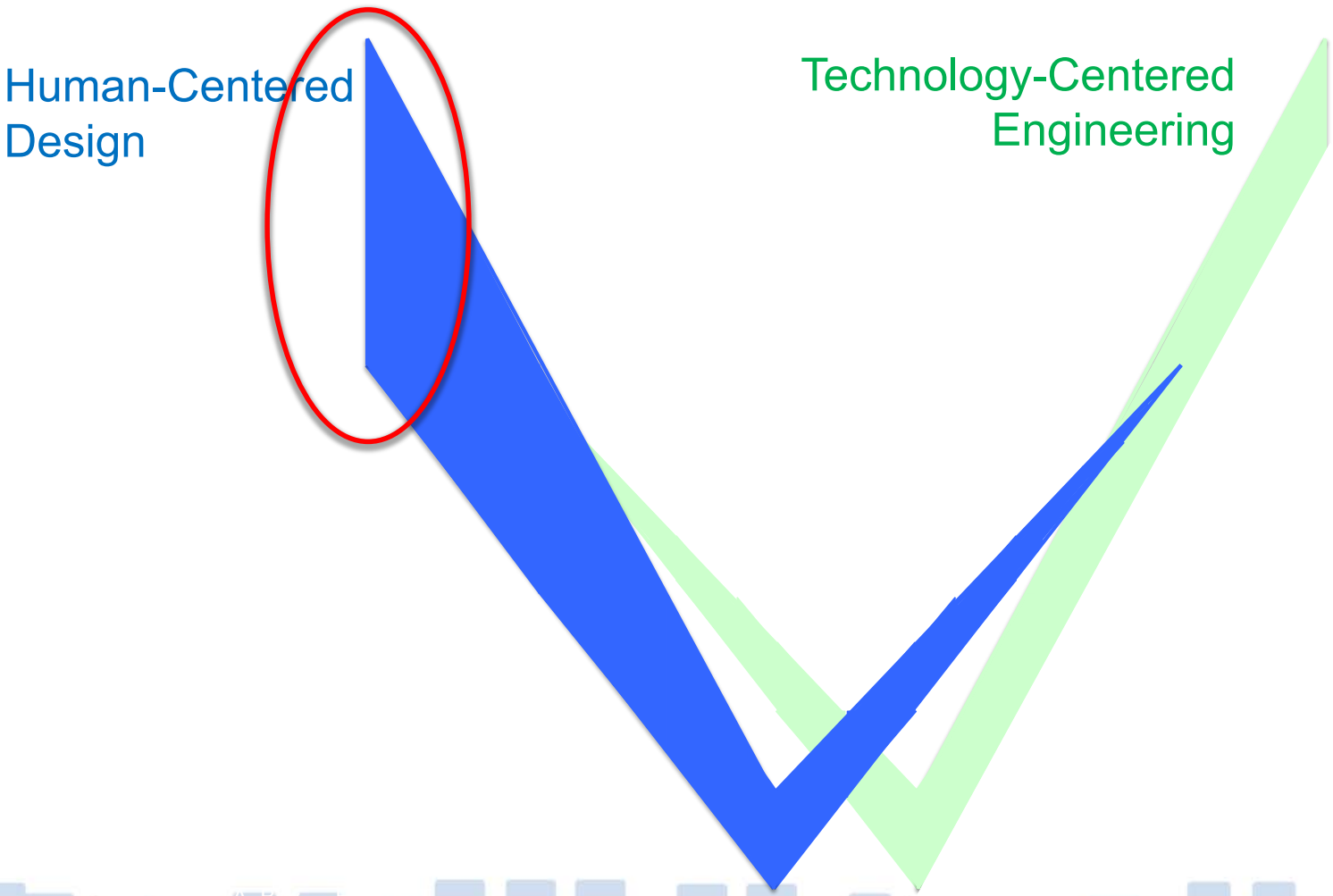
1. **I can show you the Sim. (Early System Knowledge)**
2. **Then you can help guide me (Still have Design Flexibility)**
3. **And we can look at the what we need to change (Still have Resource Options)**

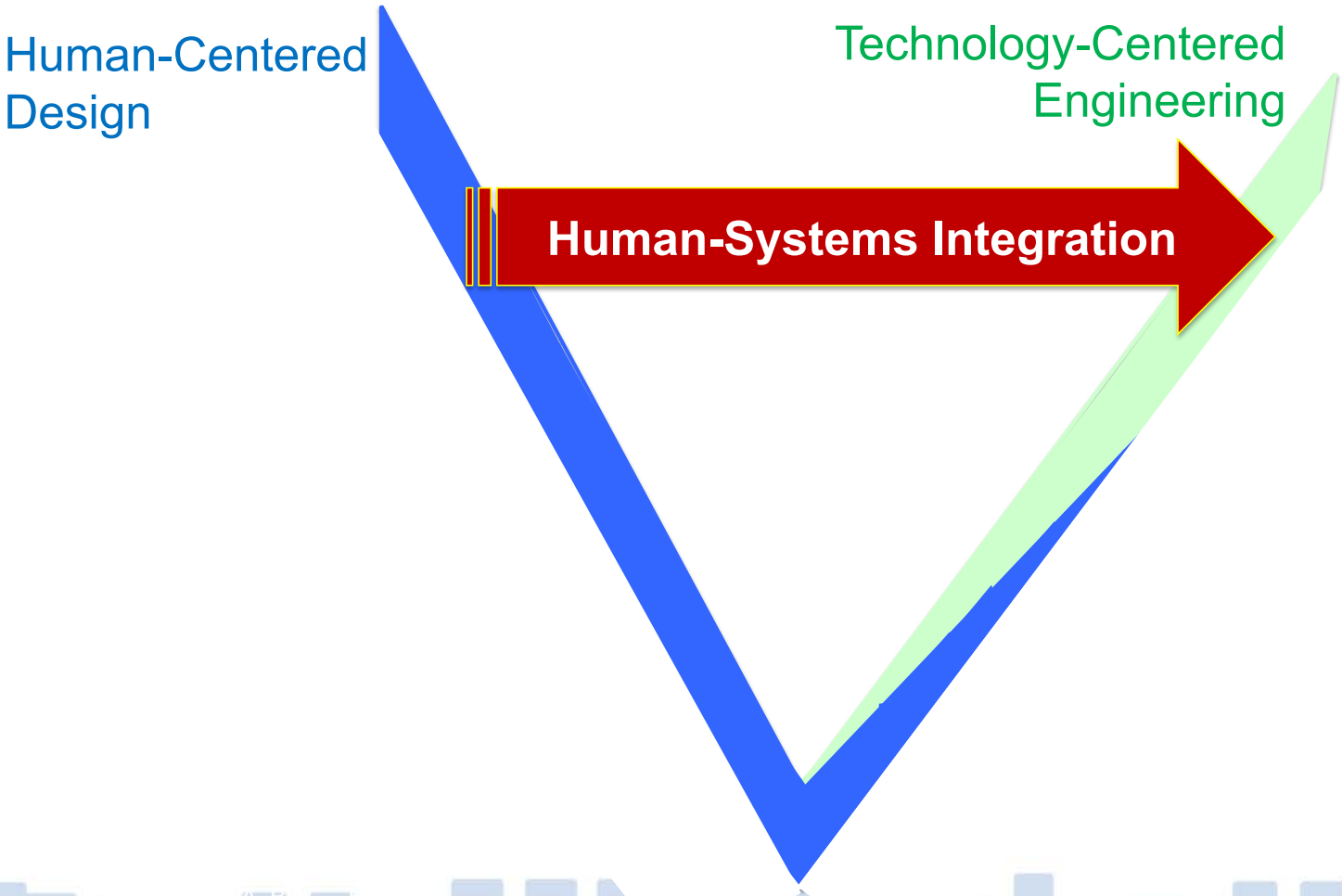
Modeling & Simulation

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

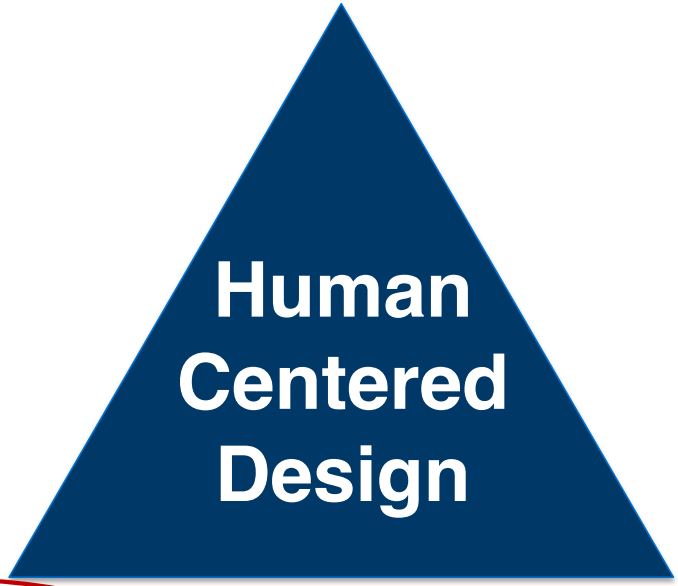

V-Model


Human-Centered
Design
Technology-Centered
Engineering
HITLS


Human-Centered
Design
Technology-Centered
Engineering


Human-Centered
Design
Technology-Centered
Engineering
Human-Systems Integration

People



Technology

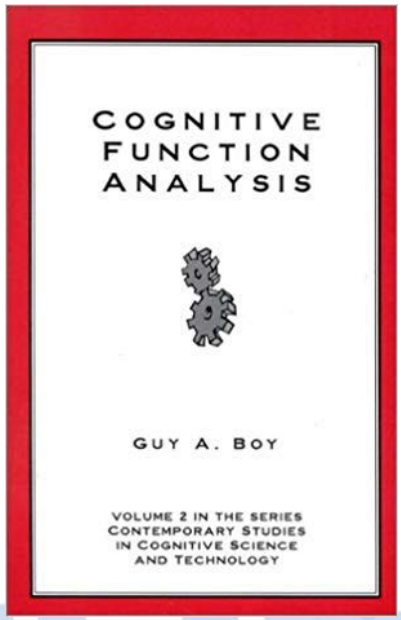
Organizations

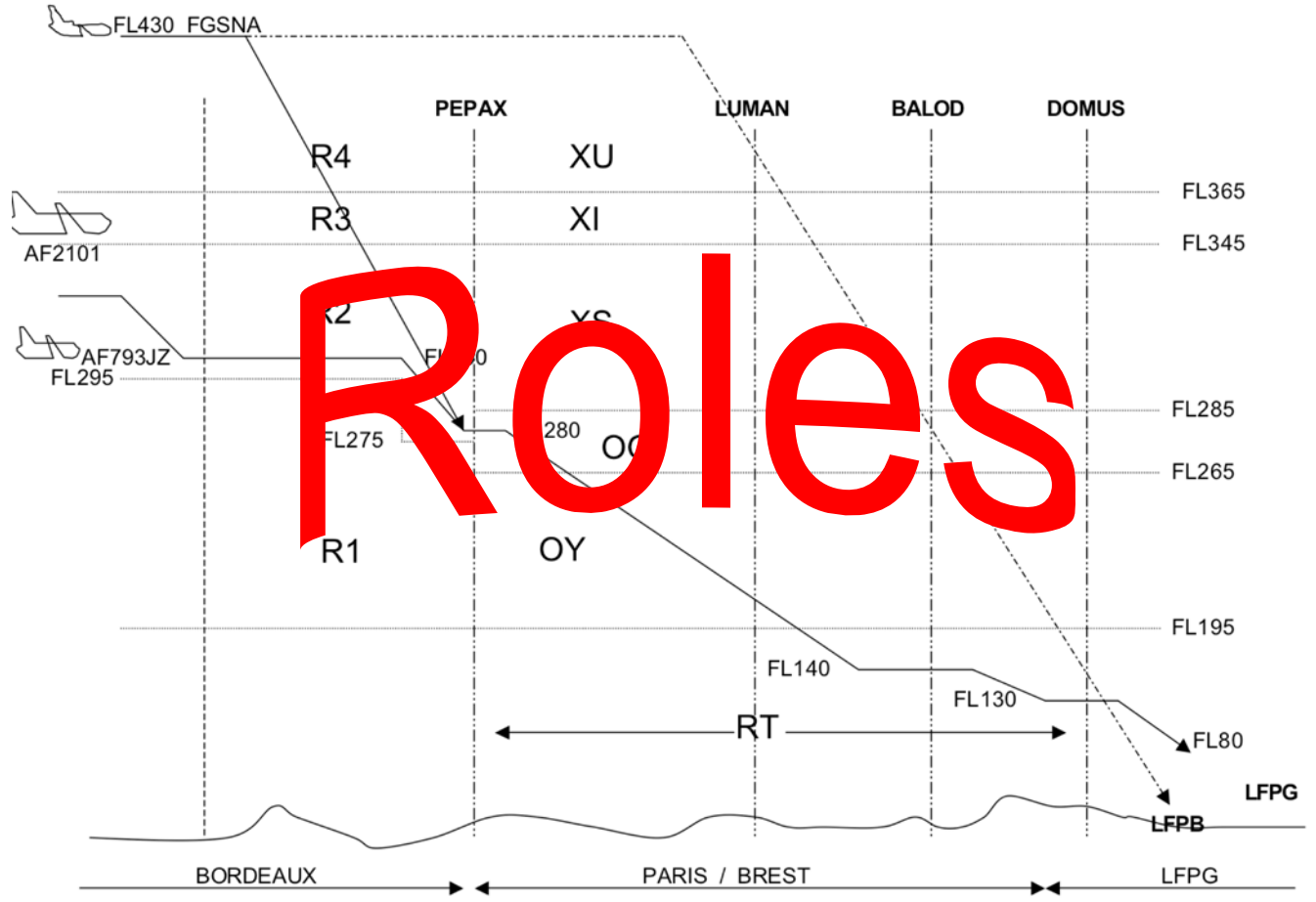
From purpose to means…

Function allocation is a matter of:

- Roles
- Contexts
- Resources

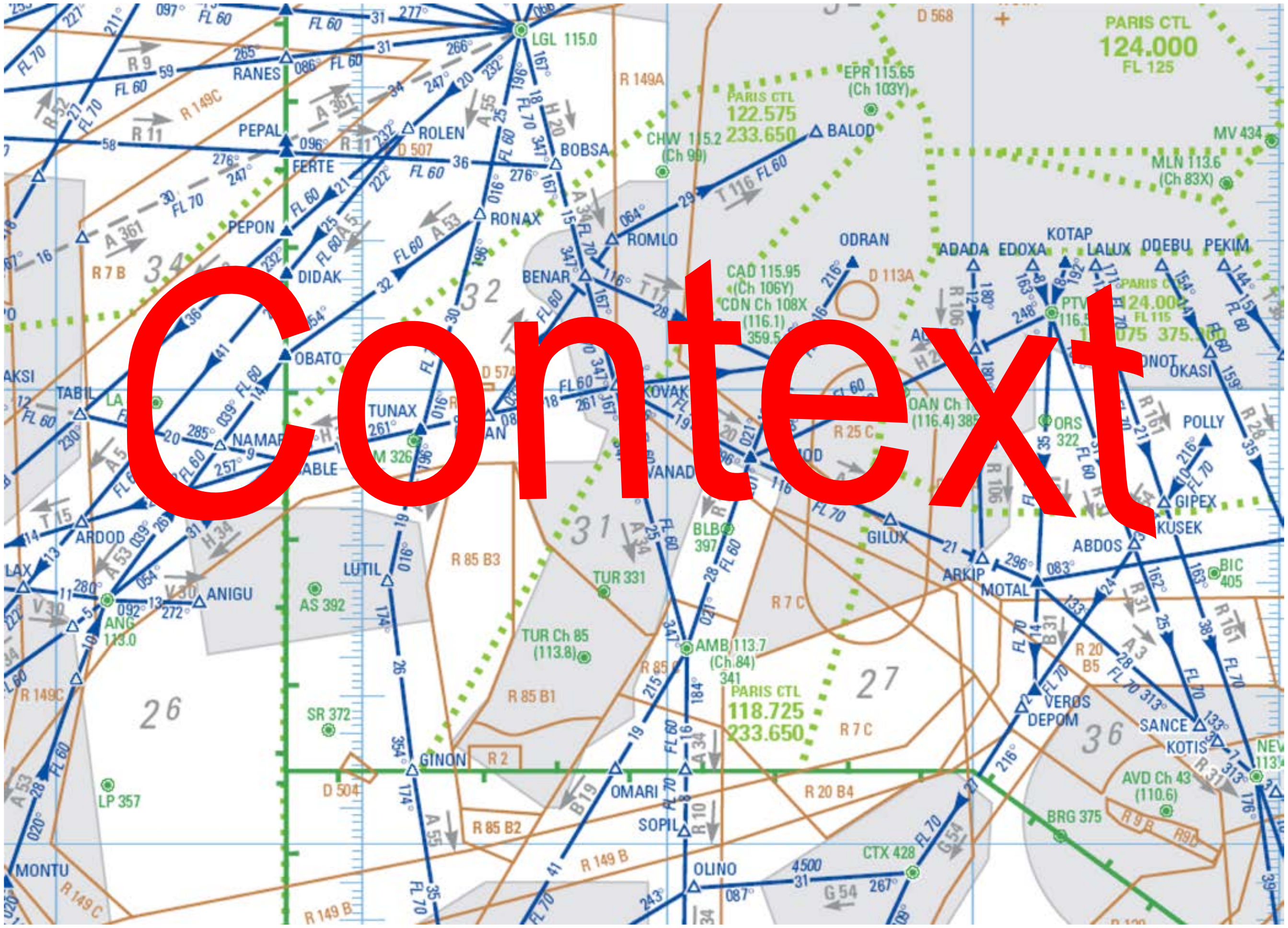
- Task → CF → Activity
- Structure-Function
- Multi-agent approach



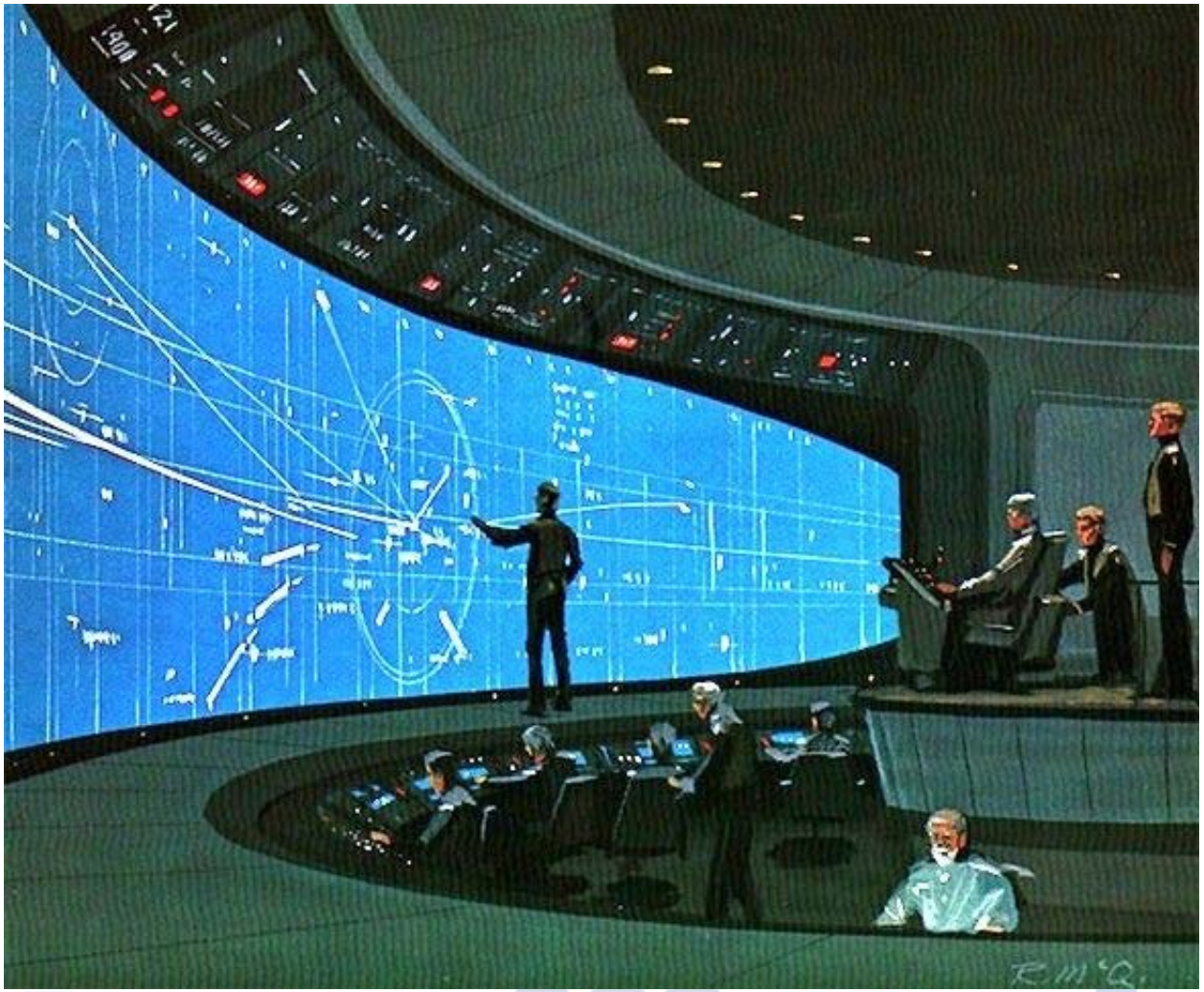

FL430 FGSNA
PEPAX
LUMAN
BALOD
DOMUS
R4
XU
R3
XI
FL365
FL345
AF2101
AF793JZ
FL295
FL285
FL275
280
FL265
R1
OY
FL195
FL140
FL130
RT
FL80
LFPG
LFPB
BORDEAUX
PARIS / BREST
LFPG

Roles

Context


PARIS CTL
124.000
FL 125
PARIS CTL
122.575
233.650
PARIS CTL
118.725
233.650
LGL 115.0
EPR 115.65
(Ch 103Y)
CHW 115.2
(Ch 99)
MLN 113.6
(Ch 83X)
CDN Ch 108X
(116.1)
AMB 113.7
(Ch 84)
TUR Ch 85
(113.8)
AVD Ch 43
(110.6)
ANG
113.0
RANES
PEPAL
FERTE
PEPON
DIDAK
OBATO
TUNAX
ROLEN
BOBSA
RONAX
ROMLO
BENAR
BALOD
ODRAN
ADADA
EDOXA
KOTAP
LALUX
ODEBU
PEKIM
POLLY
GIPEX
KUSEK
ABDOS
ARKIP
MOTAL
GILUX
VEROS
DEPOM
SANCE
KOTIS
GINON
OMARI
SOPIL
OLINO
MONTU
ARDOD
ANIGU
LUTIL
NAMAR
TABIL
CTX 428
BRG 375
LP 357
SR 372
AS 392
TUR 331
MV 434


Resources

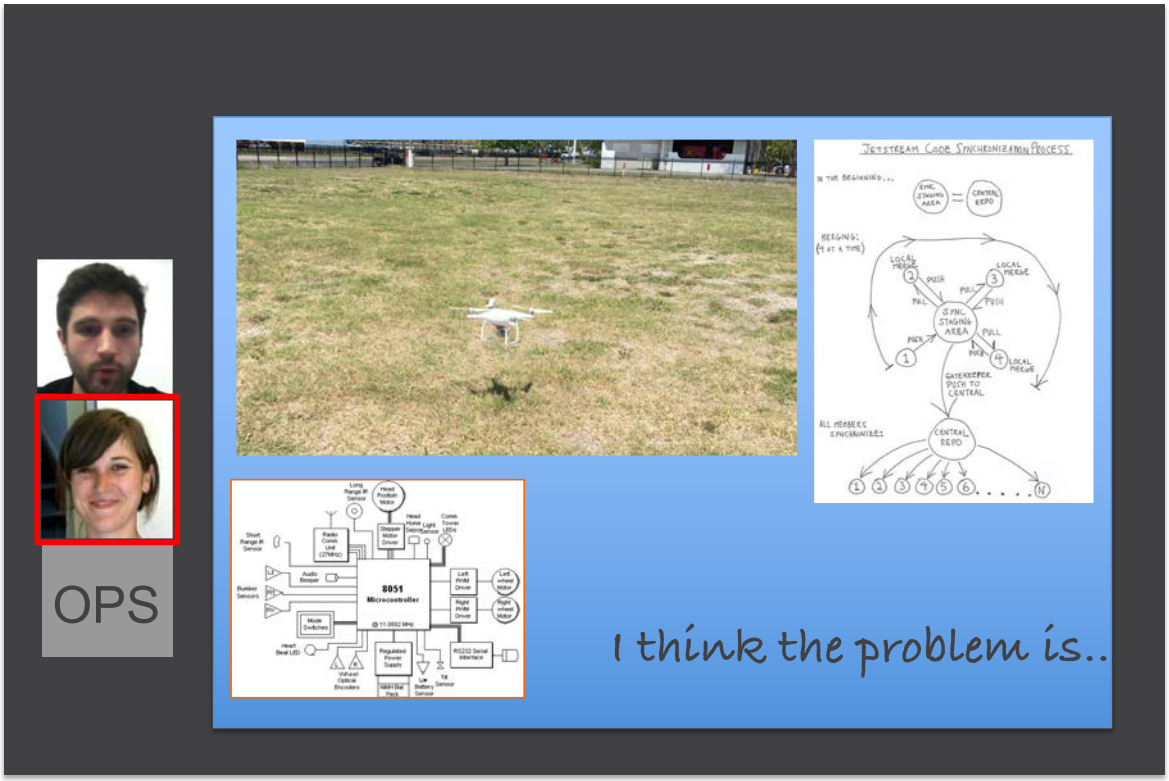


Interactivity
Visualization
CSCW

Computer-Supported Cooperative Work (CSCW)

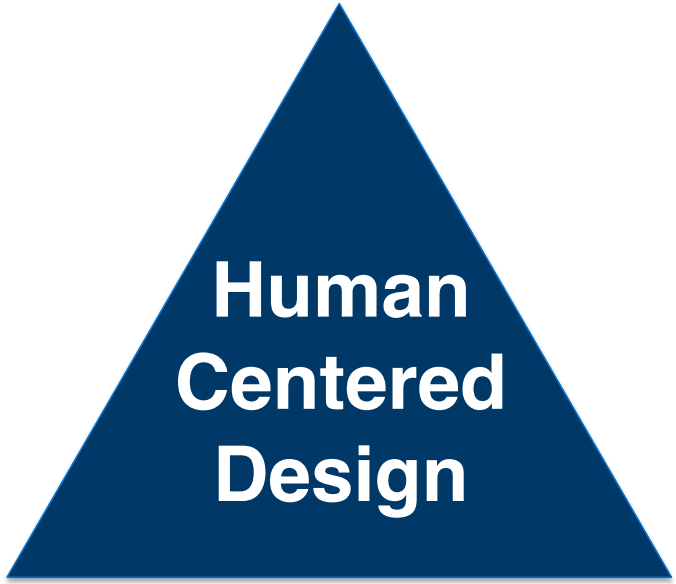
Collaborative problem solving
Shared situation awareness

Computer-Supported Cooperative Work (CSCW)



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

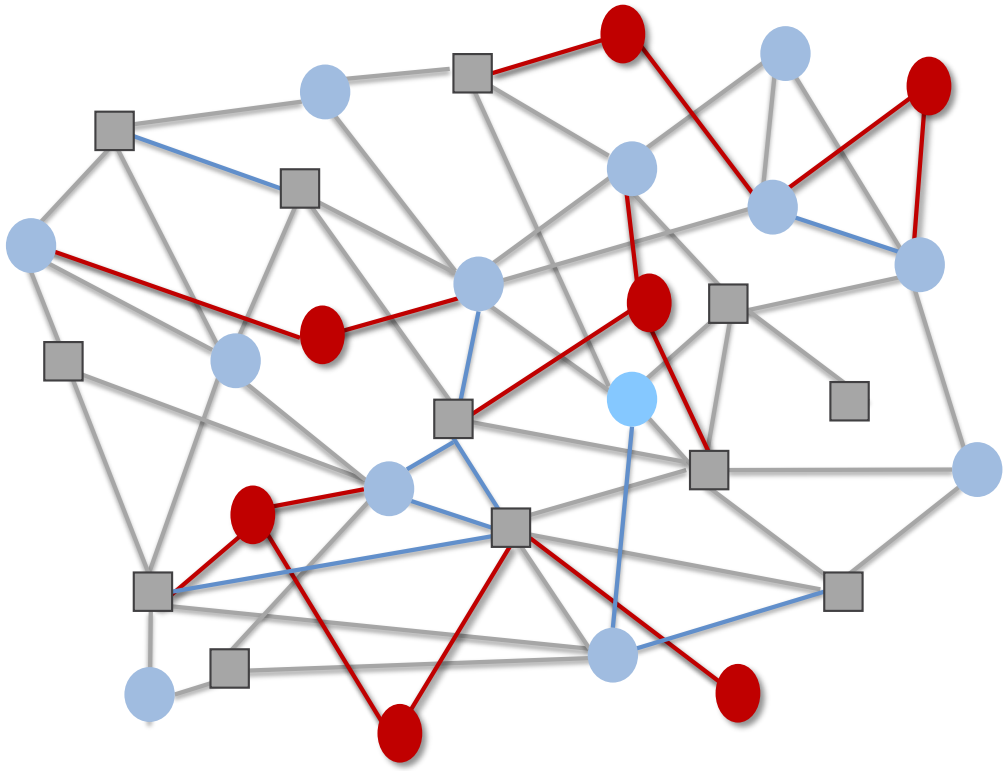
The Orchestra Model

Multi-agent systems properties…

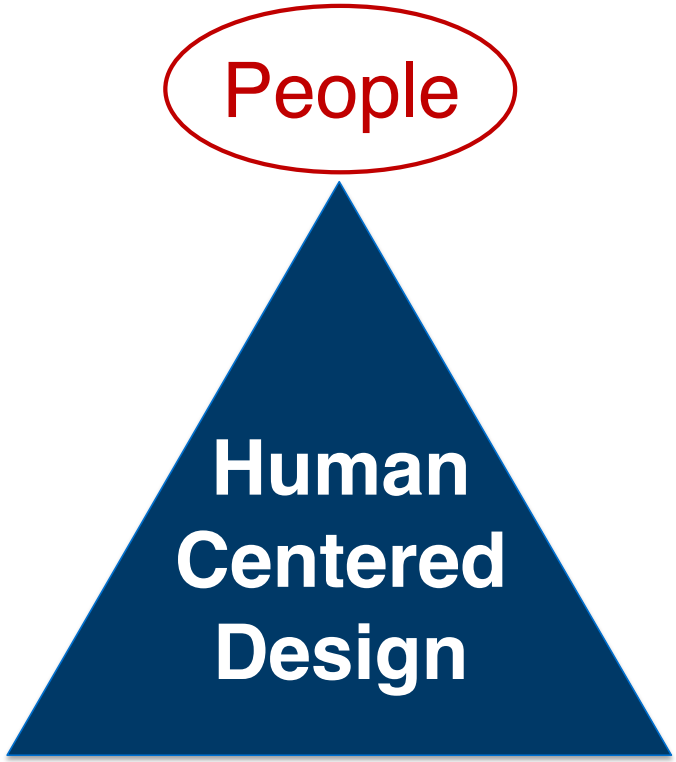
Separability
a crucial issue

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

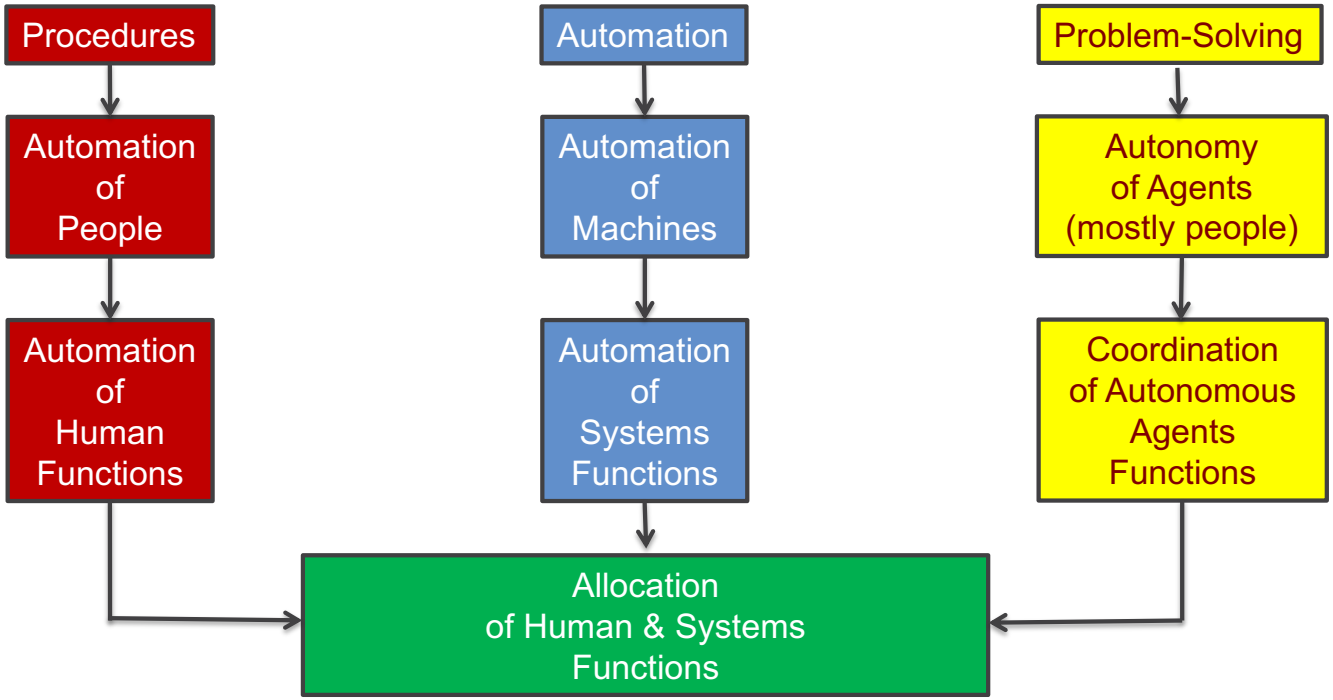
Physical and physiological (anthropometry, movement, neuro-ergonomics, stress)
Perceptual and cognitive (visual & auditory, attention, workload, situation awareness, decision making)
System-level constraints (political & social, economics)

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

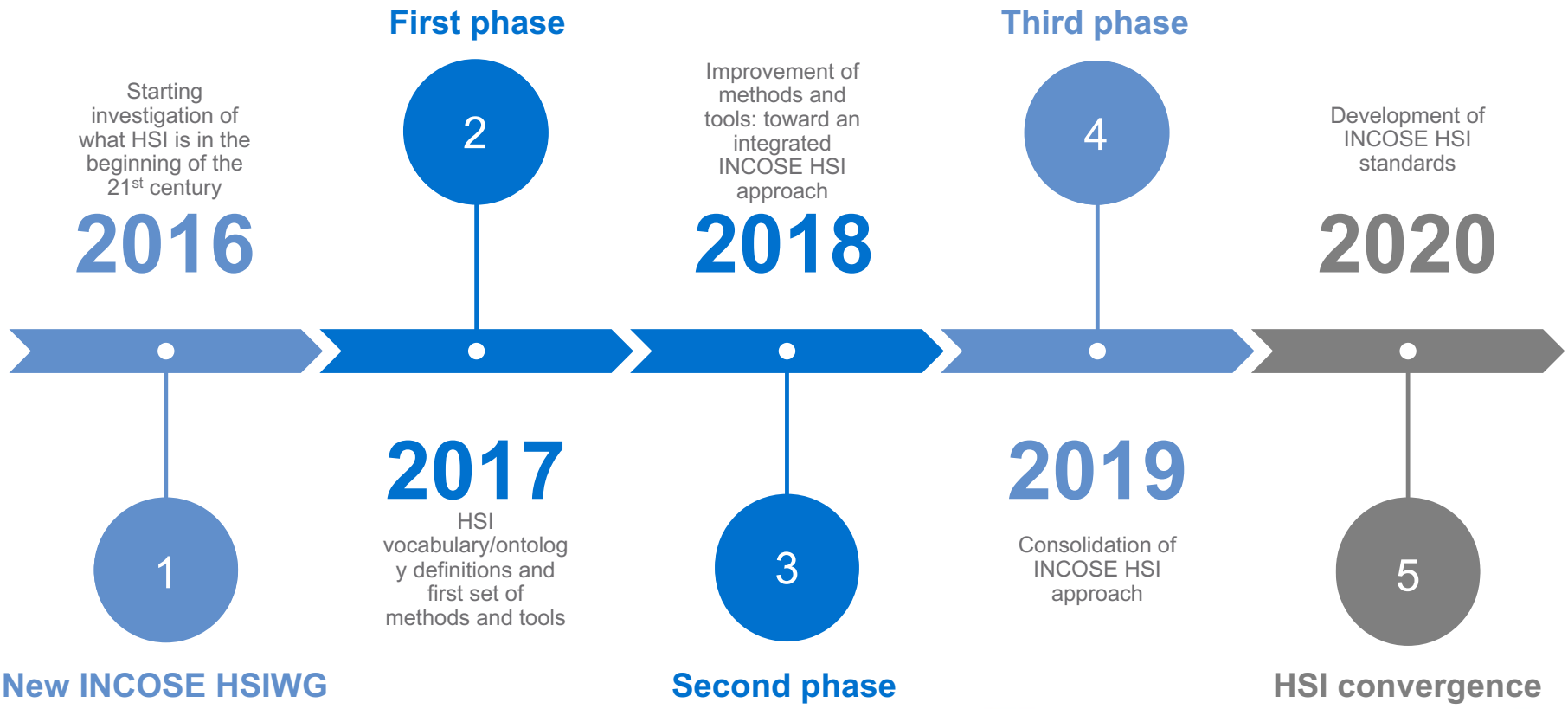
HSI key properties

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



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 15th 2018 at 11am EDT
Rick Dove	Agile SE Processes 201: Problem Space Derived Solution Requirements	September 19th 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.

INCOSE Great Lakes Regional Conference 2018

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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You can also claim credit for previous webinars you have attended; please contact info@incose.org if you wish to know which webinars you attended and if you met the qualification requirements