Welcome to the Webinar – if you have not dialed into the audio portion, please do so now. In the U.S., dial 1-719-457-6209, passcode **733 424 0539**. 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

Wednesday 15th April 2020 – Webinar 136

Human Systems Integration:
From Virtual to Tangible

Guy Andre Boy

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INCOSE®

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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 his 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

Human Systems Integration
From Virtual to Tangible

Design for Flexibility, a Human-Centered Design Approach:
From rigid automation to flexible autonomy

GUY ANDRÉ BOY

The Infusion of

- **Human Factors**
- **System Architecture**
- **Autonomy Design**
- **Mission Operation**

INCOSE Webinar Group – April 15, 2020

MY WORLD FOR ~40 YEARS…

From correction…

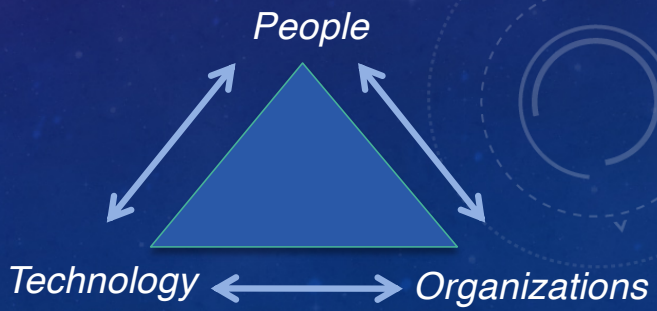
… to interaction

… to integration

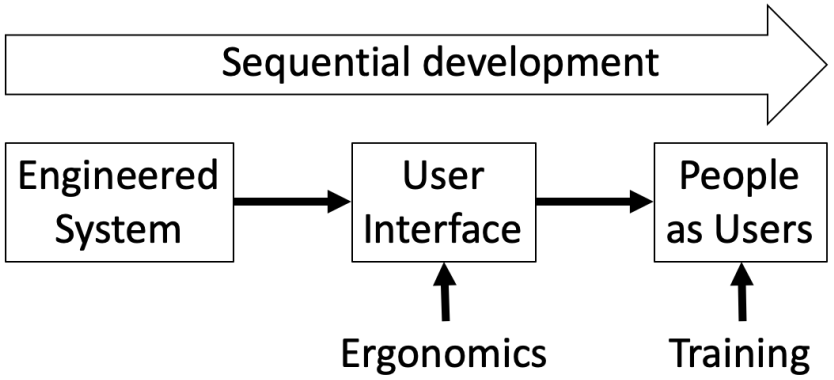
… and other things

WHAT DID WE LEARN FROM APOLLO 13 SUCCESSFUL ACCIDENT?

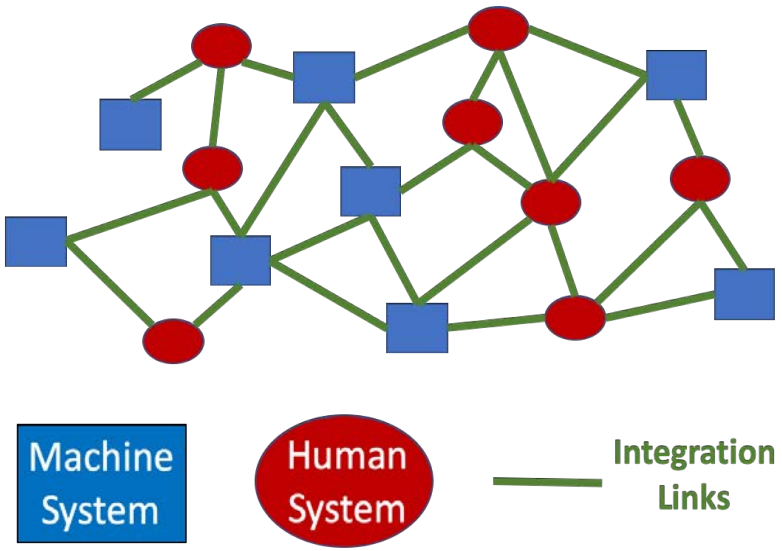
- Human Systems Integration (HSI) is a matter of technology, organization and people



DEPART FROM SEQUENTIAL DEVELOPMENT…



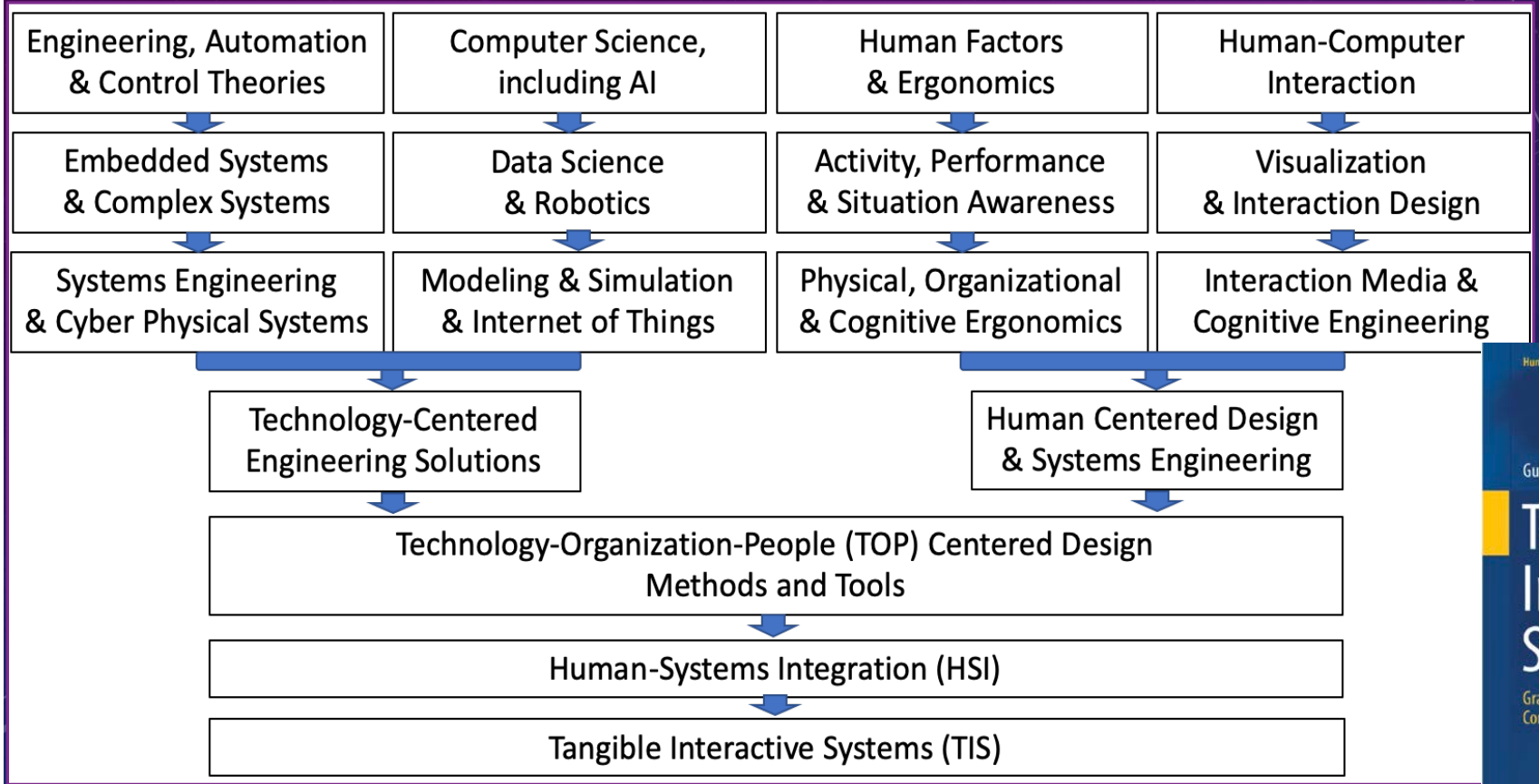
… TOWARD HOLISTIC DEVELOPMENT

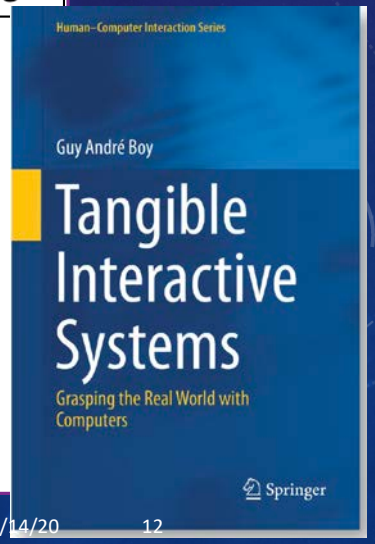


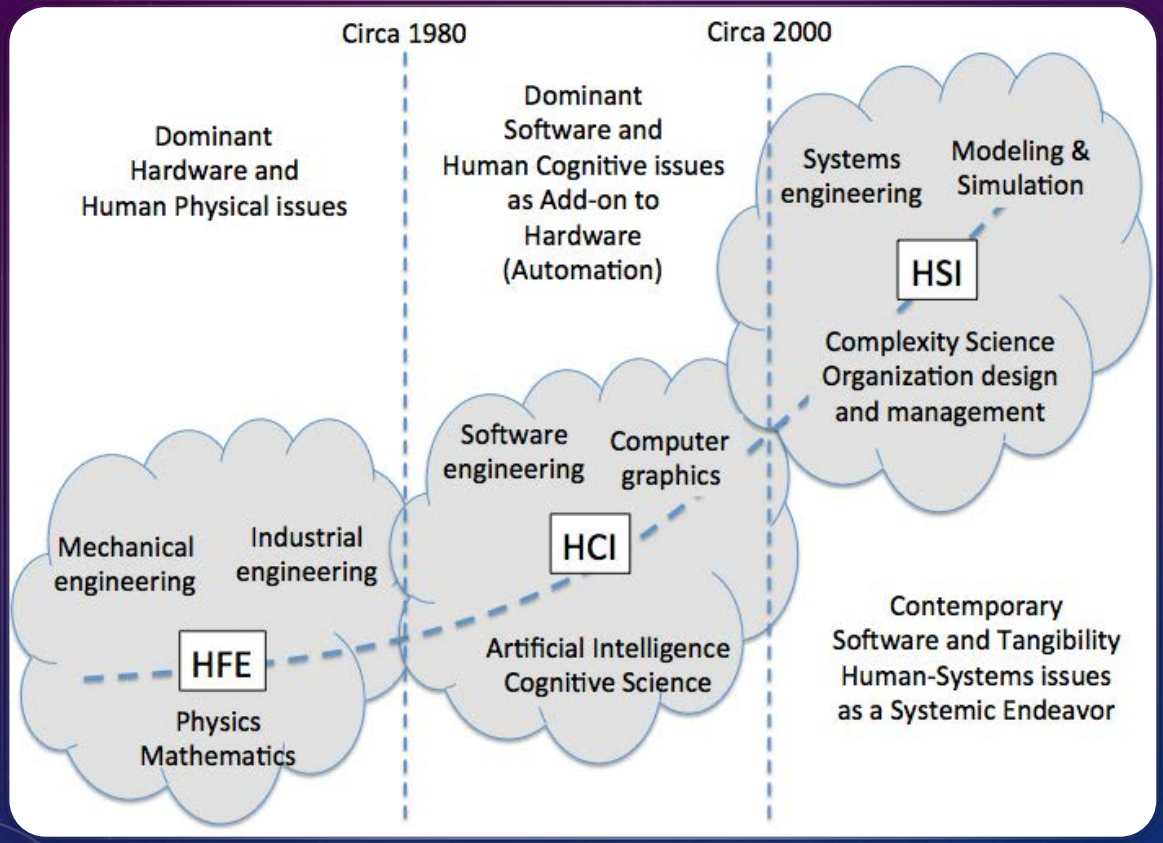
VIRTUAL HUMAN-CENTERED DESIGN

- Virtual prototypes
- Tangibility testing and development of tangibility metrics in our growing digital world
- Human-In-The-Loop Simulations
- Agile development
- Participatory design

GENESIS OF HSI & TANGIBLE INTERACTIVE SYSTEMS

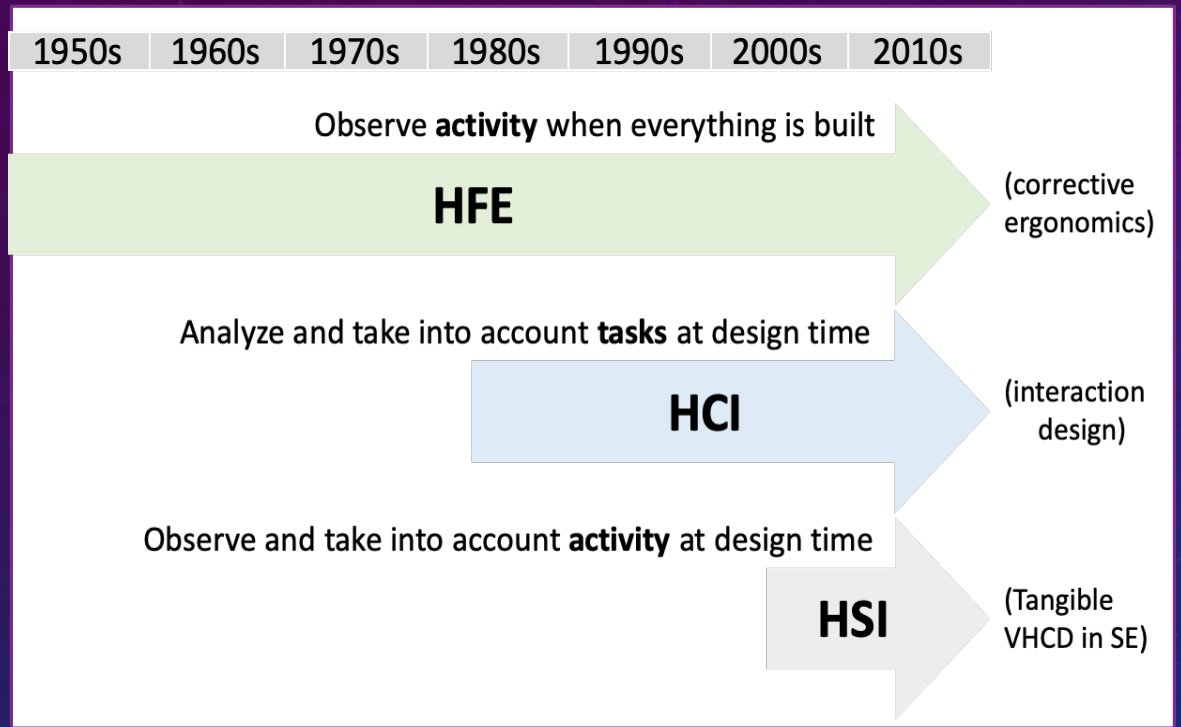






EVOLUTION OF ENGINEERING-ORIENTED HUMAN-CENTERED APPROACHES

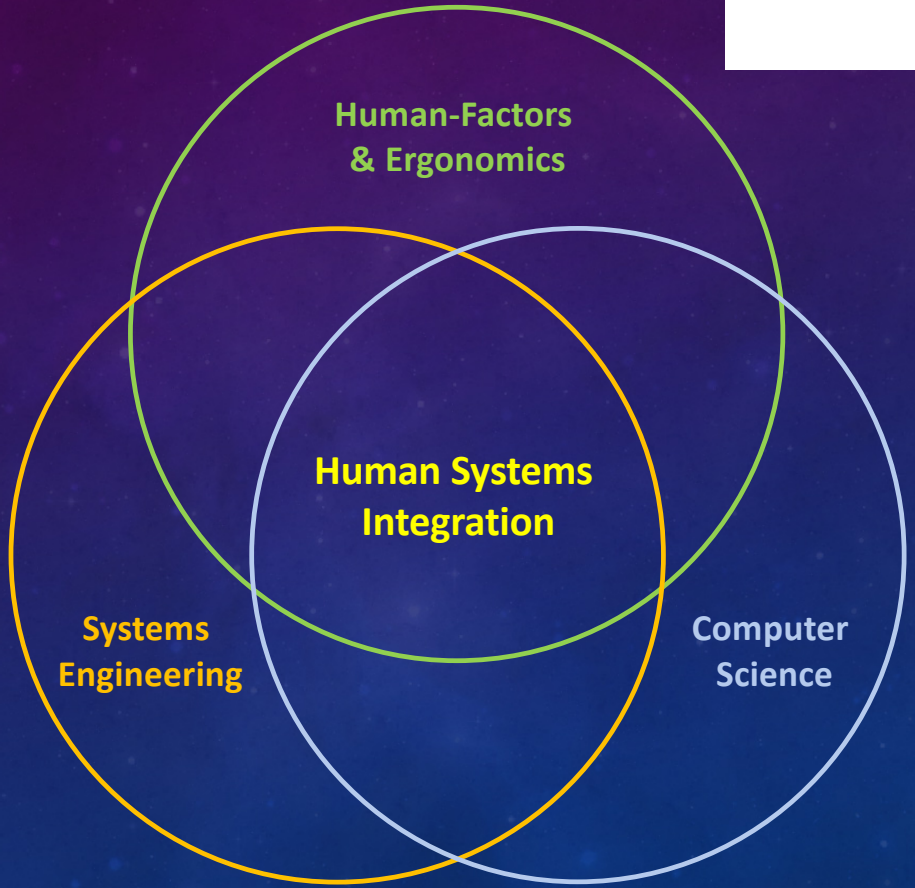
- From cognition to socio-cognition
- Complexity science
- Organization design & management
- Modeling and simulation



EVOLUTION OF ENGINEERING-ORIENTED HUMAN-CENTERED APPROACHES

- Task vs. Activity Analysis
- From corrective ergonomics to interaction design to tangibilization of virtual prototypes

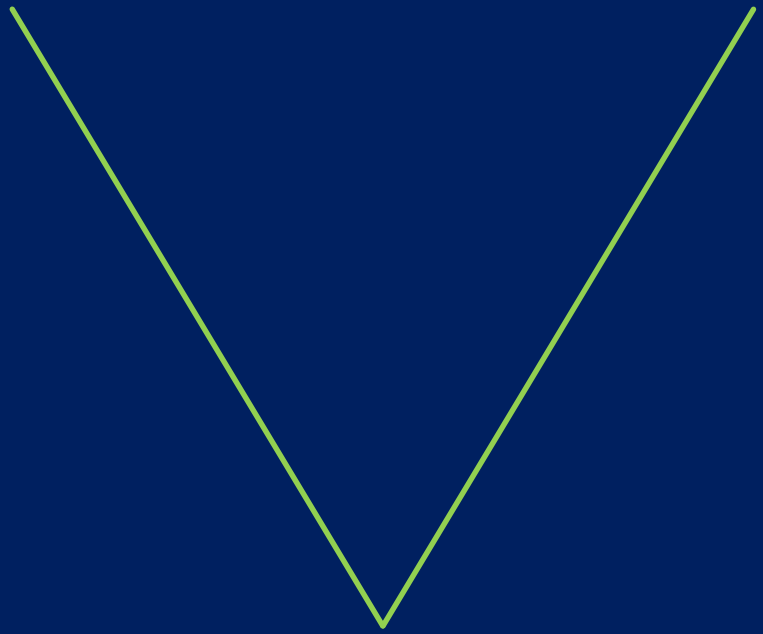
Task & Activity Analysis
Human & Organizational
Performance
Evaluation & Metrics

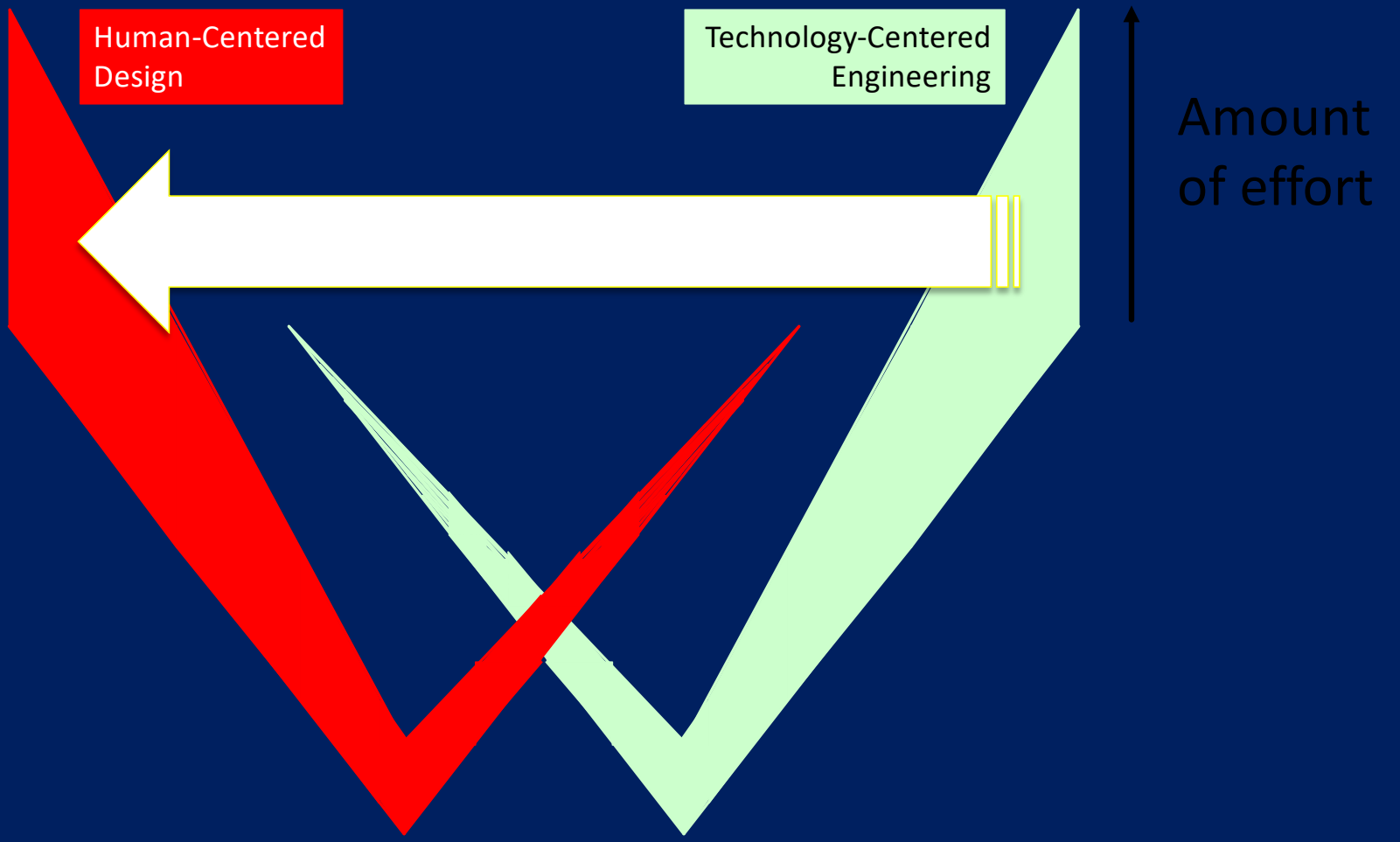


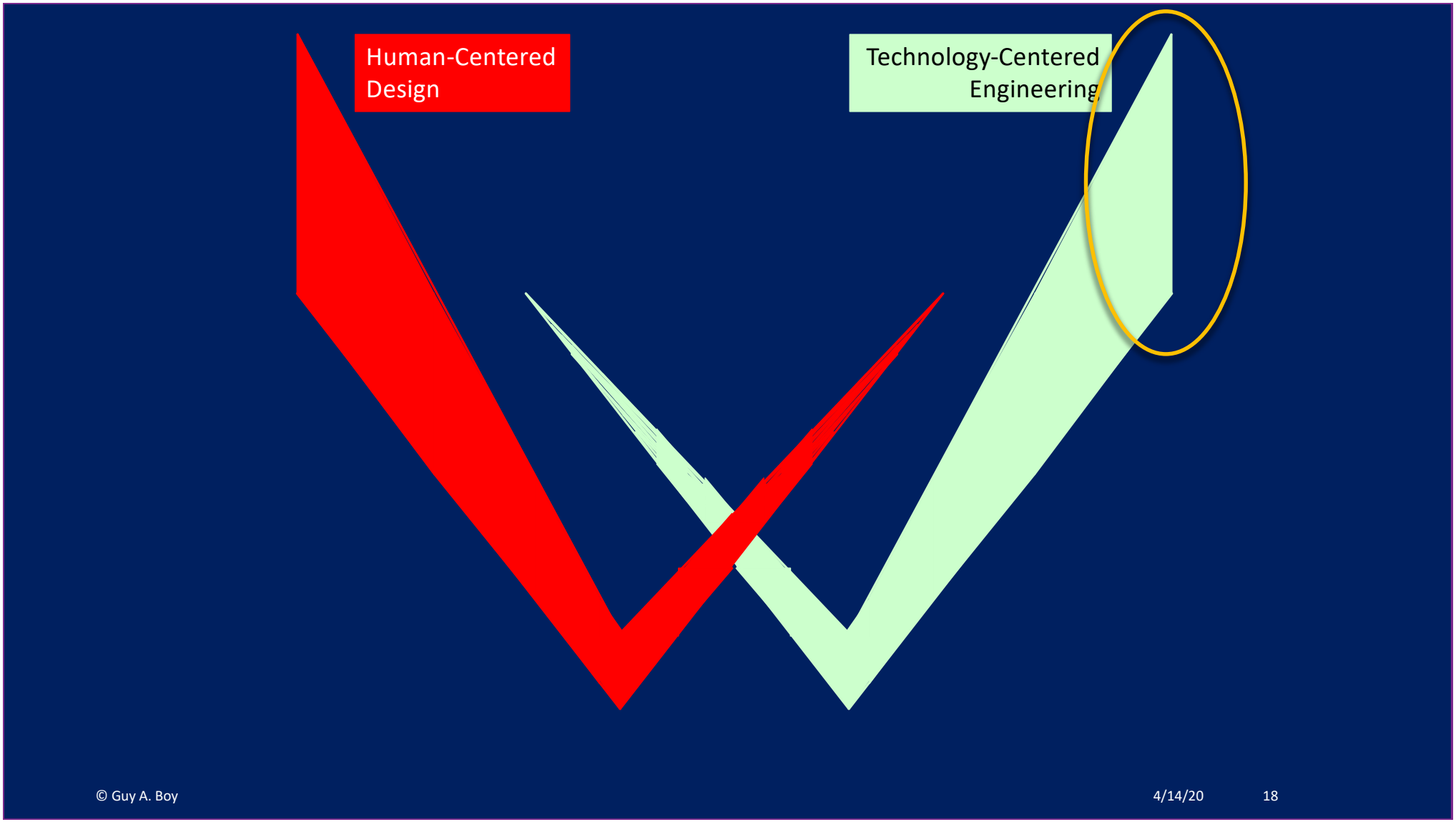
Systems of Systems
Agile Development
Design & System thinking
Model-Based SE

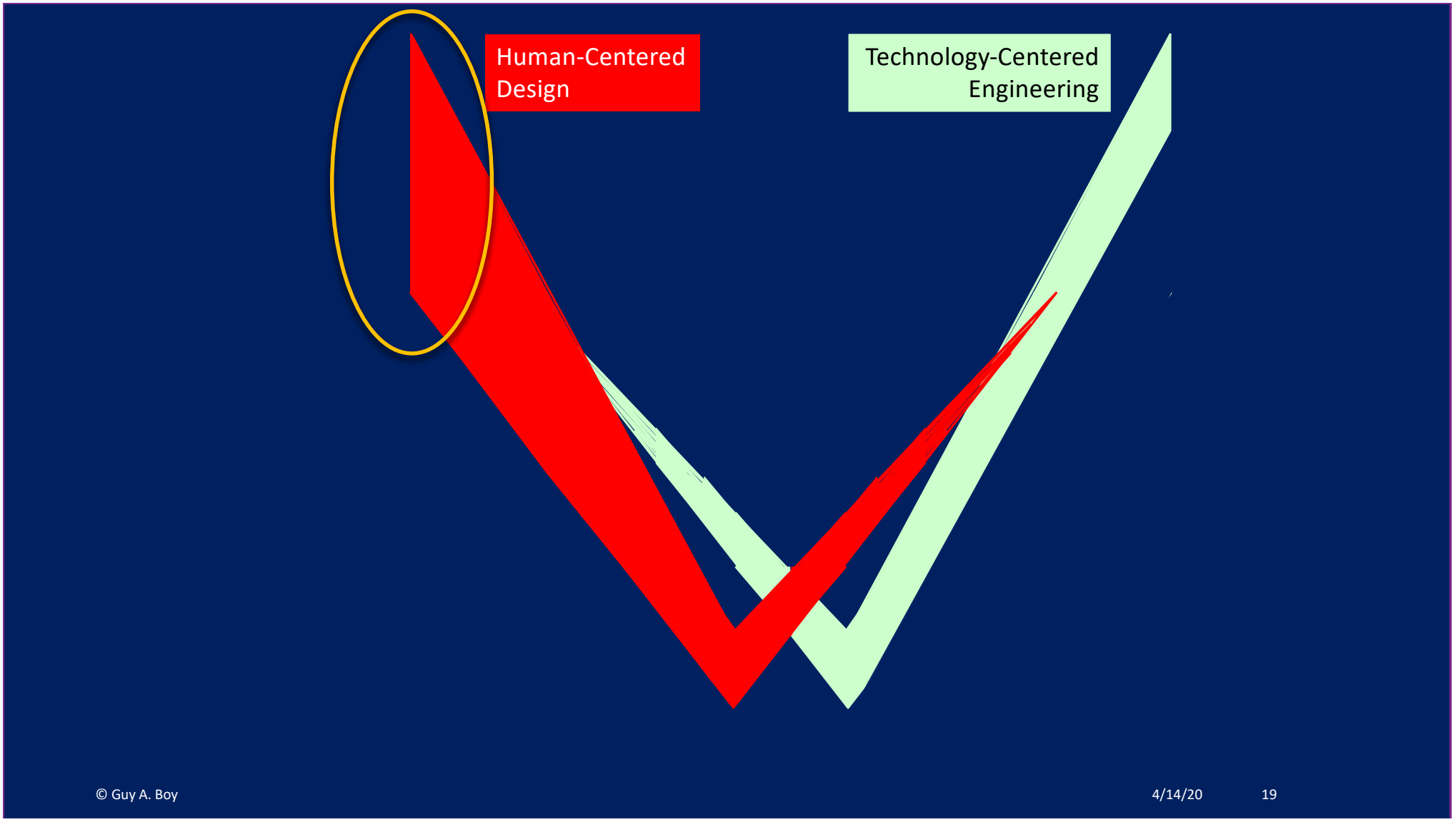
Human-Computer Interaction
Artificial Intelligence
Visualization techniques
Modeling & Simulation

THE V MODEL




Human-Centered Design
Technology-Centered Engineering
Amount of effort





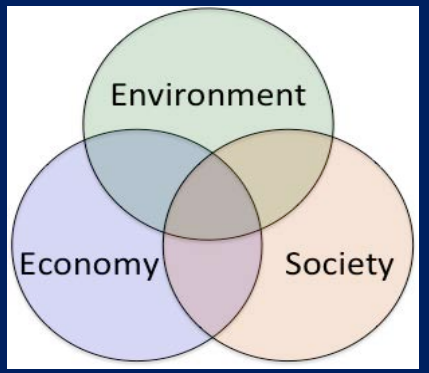
From Virtual Interactive Systems…

Human-Centered Design

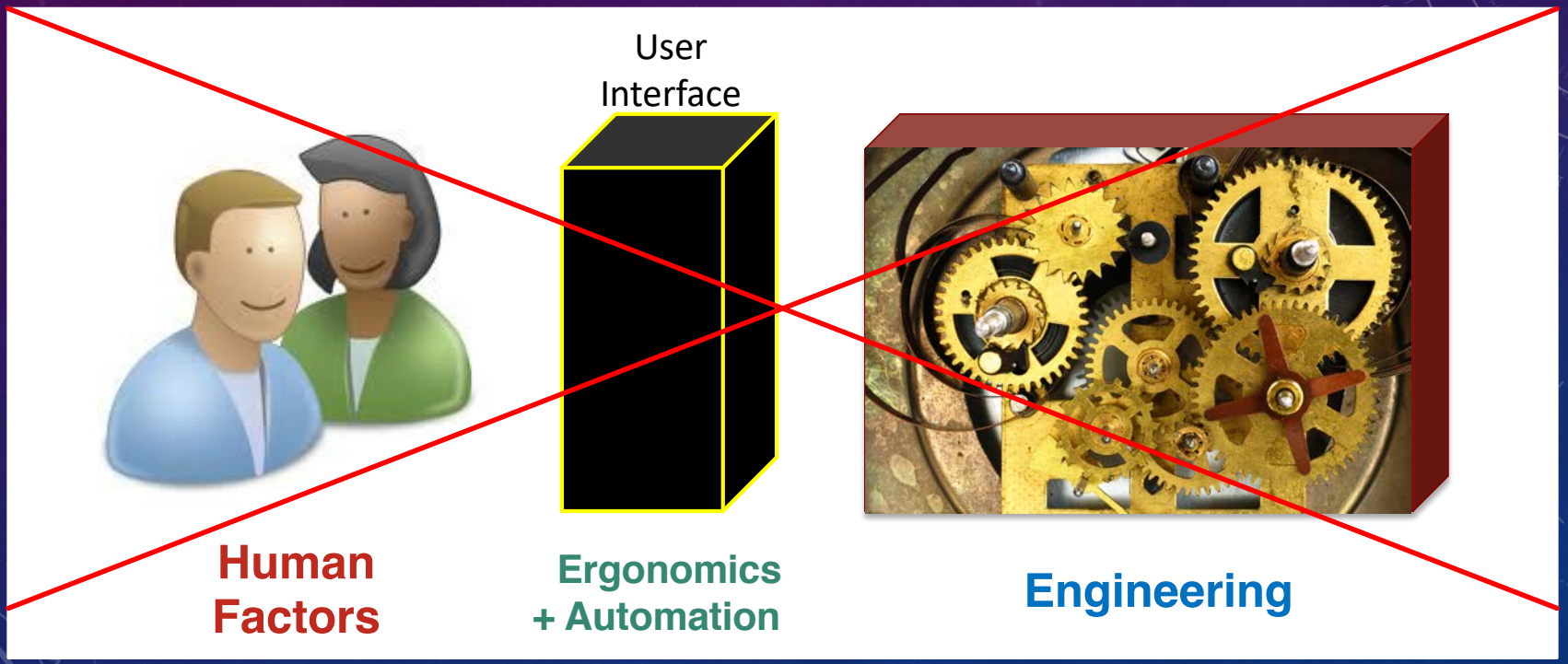
Technology-Centered Engineering

Human-Systems Integration

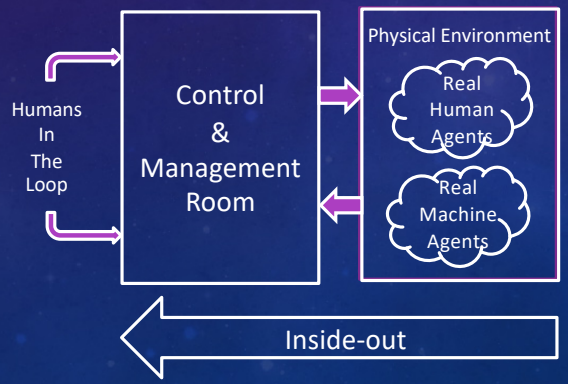
… to Tangible Interactive Systems



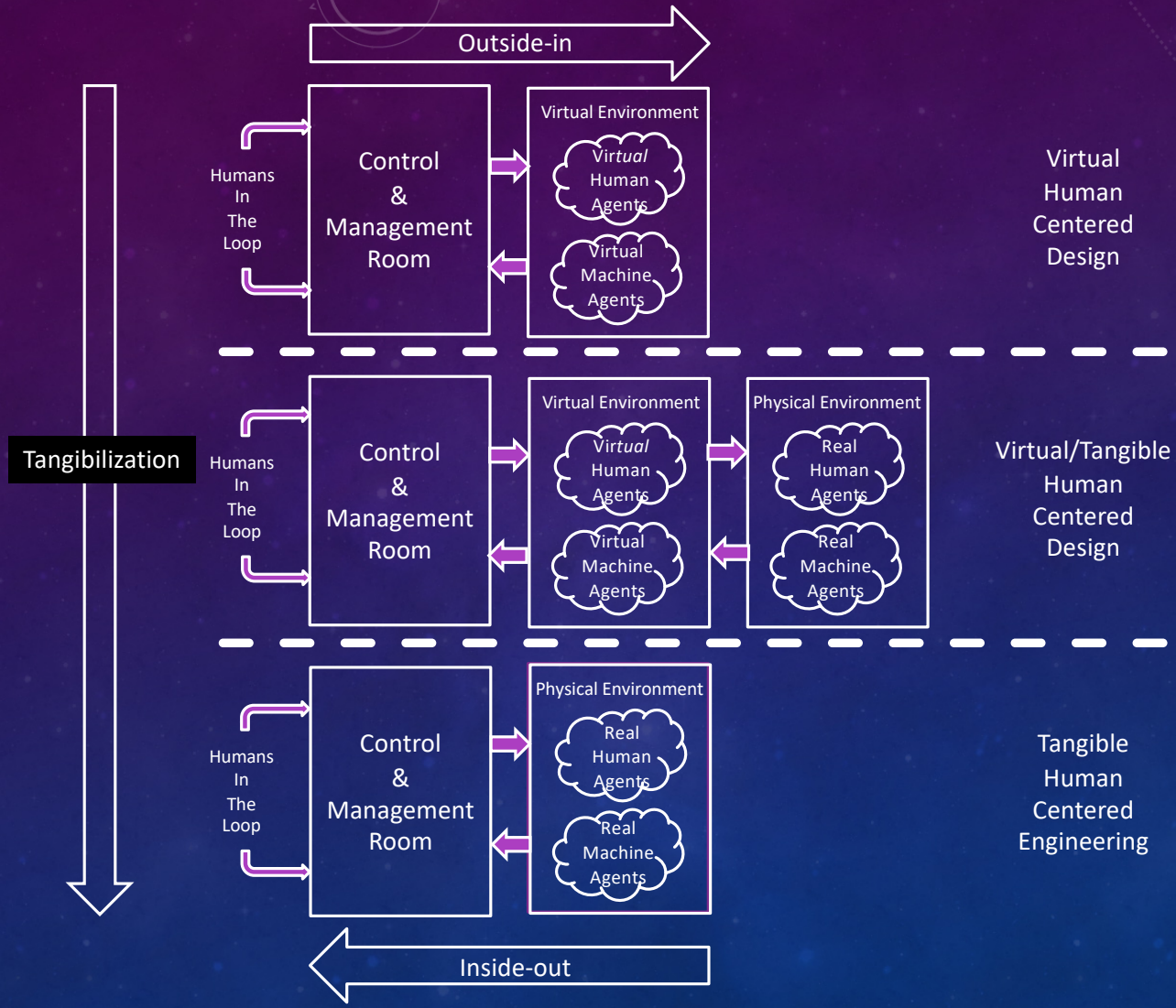
20TH CENTURY APPROACH



20TH CENTURY APPROACH



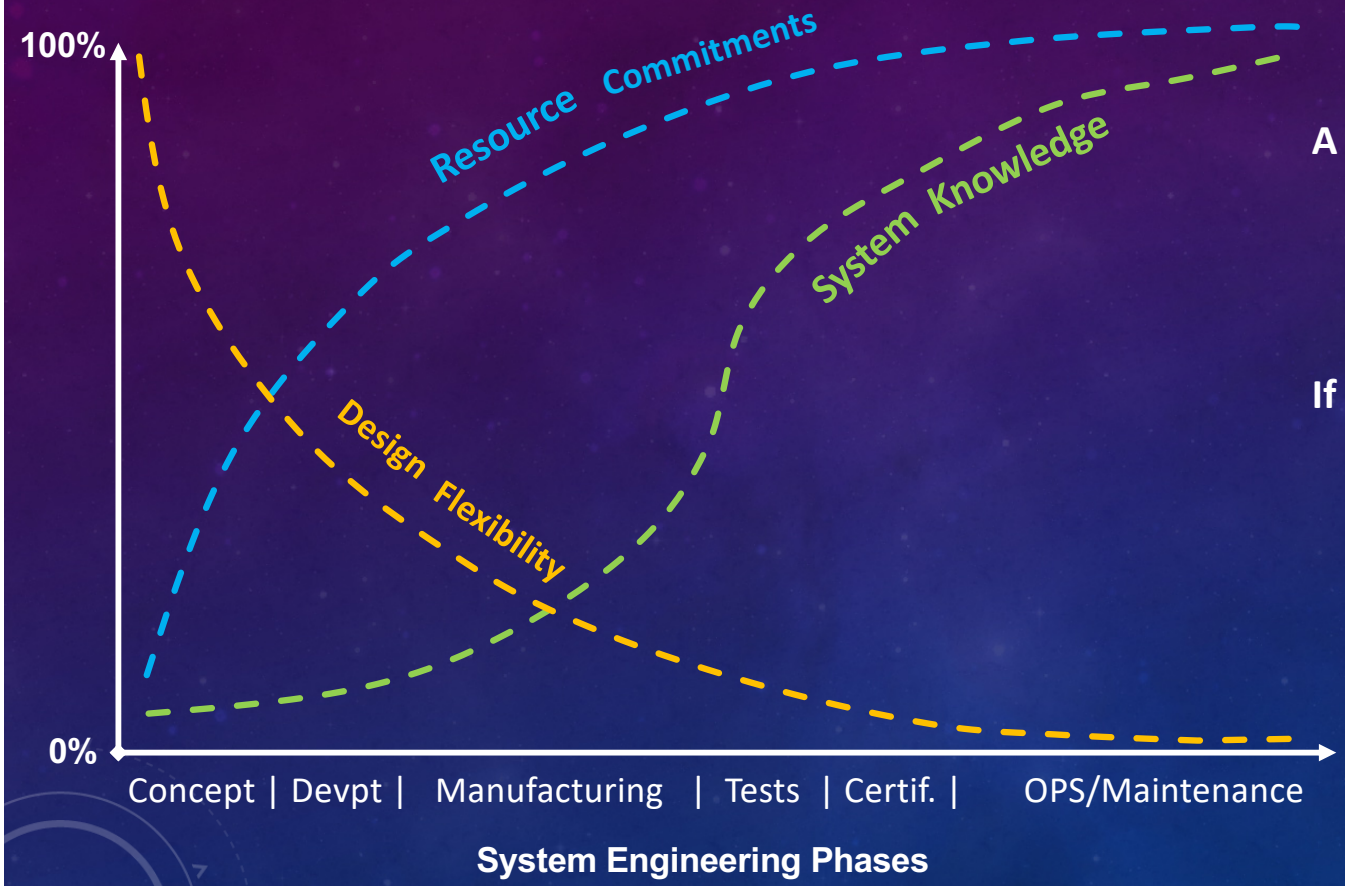
21ST CENTURY APPROACH



NOT ABOUT SHORT-TERM… BUT ABOUT LONGER-TERM!

- From inside-out to outside-in engineering design
- From prediction to testing possible futures
- From event-driven to goal-driven approaches
- From continuous corrections to anticipation

TECHNOLOGY- CENTERED: 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

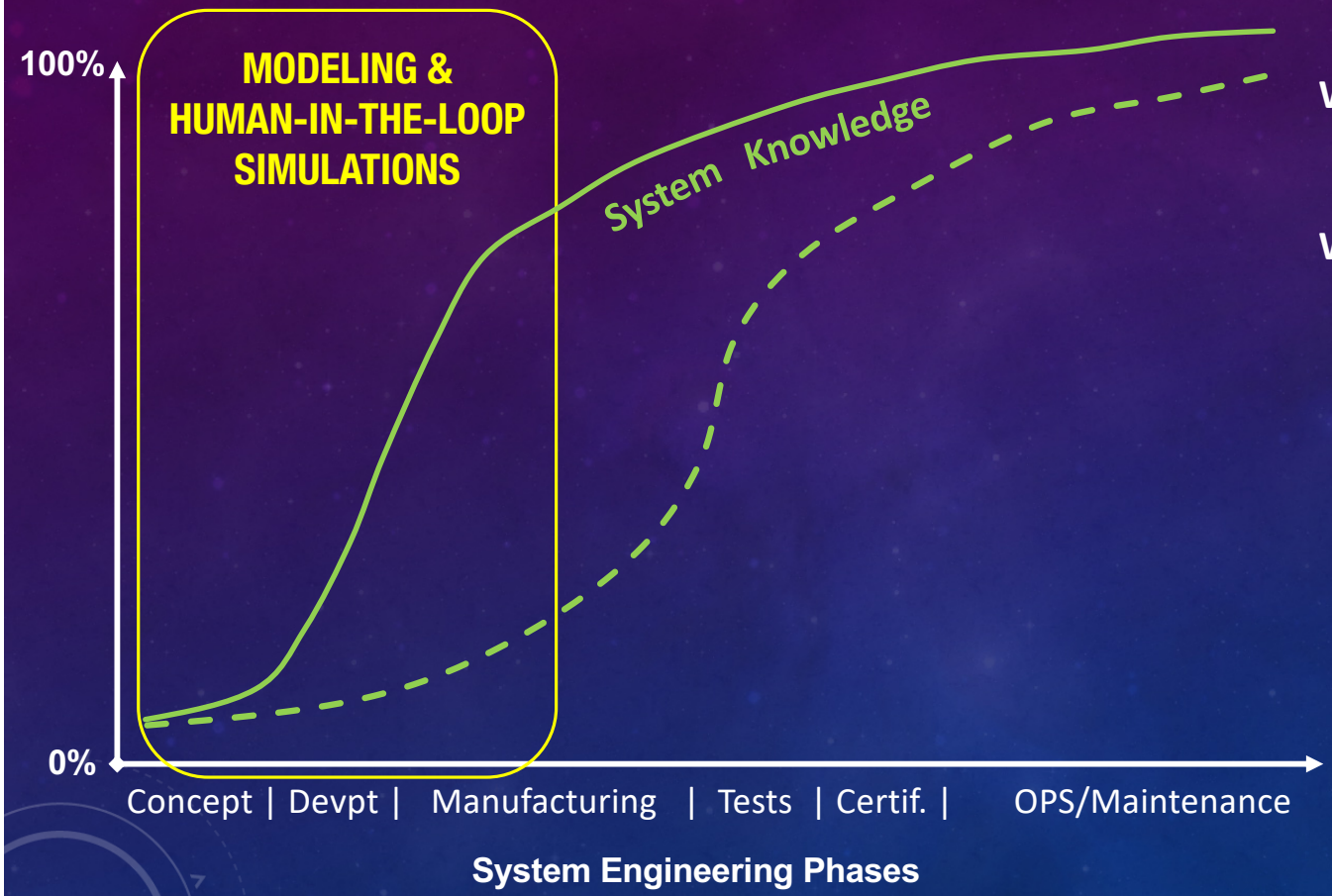
If there is a change:

I have no design flexibility

I have no money

I learn about the system too late

HUMAN-CENTERED: WHAT WE REALLY WANT…



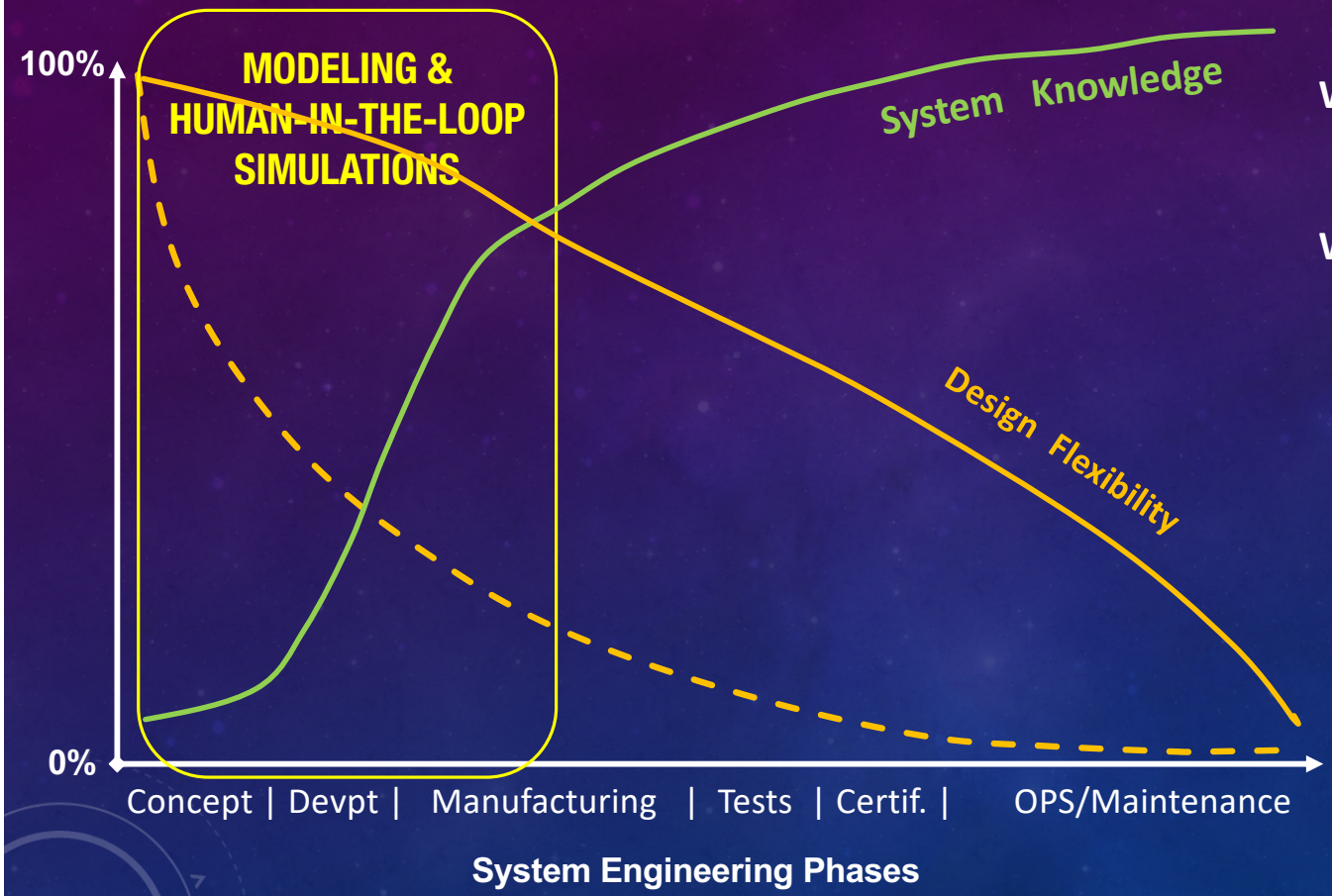
When Stakeholder asks "What will it look like?"

What "We" Really Want:

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

(Conroy, 2016)

HUMAN-CENTERED: 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)**

(Conroy, 2016)

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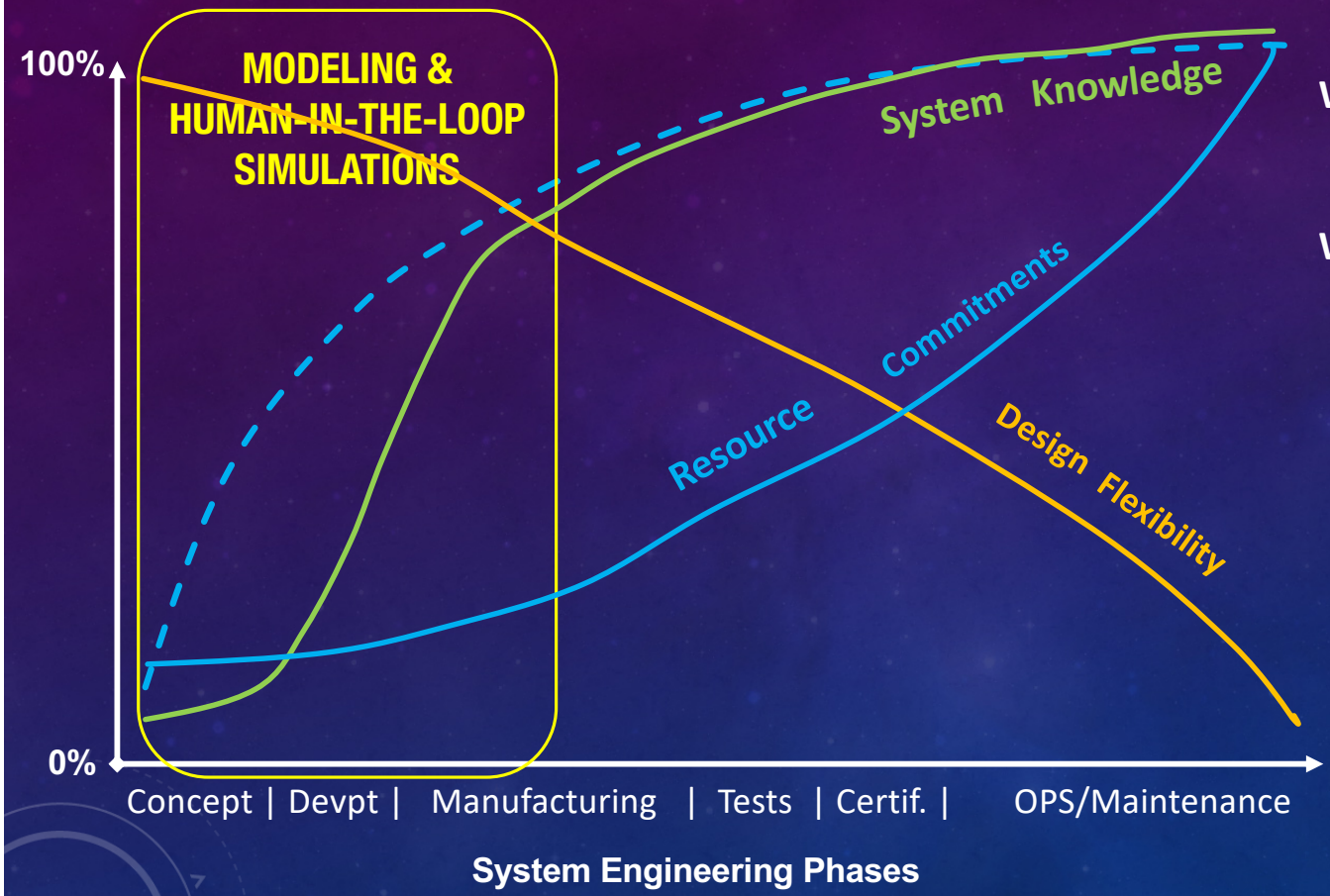


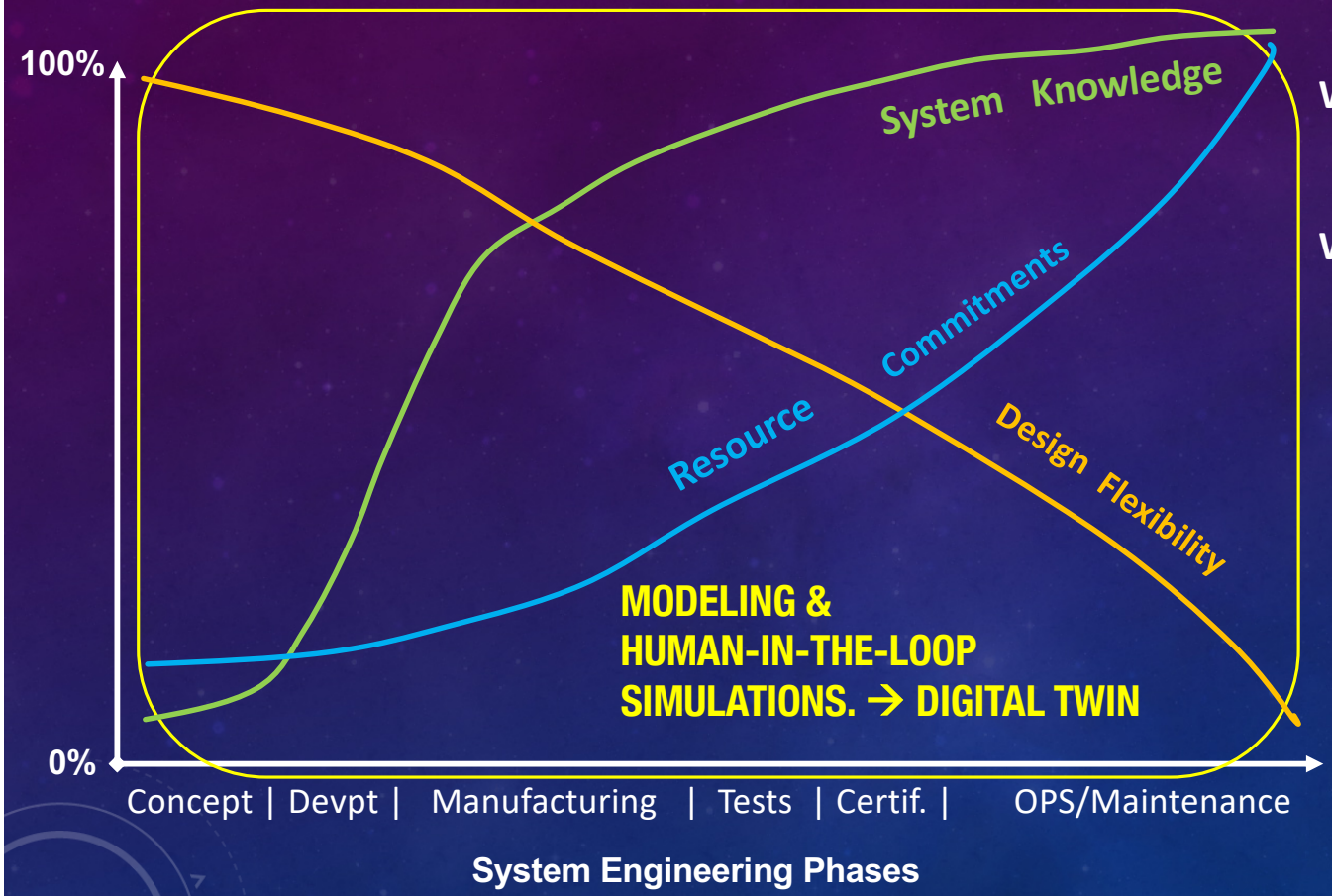
When Stakeholder asks "What will it look like?"

What "We" Really Want:

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

(Conroy, 2016)

HUMAN-CENTERED: WHAT WE REALLY WANT…



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(Conroy, 2016)

SUMMARIZING…

What we want

System knowledge + Design Flexibility + Resources Management

What we should have

Modeling & Sim + Complexity Analysis + Organization HCD

What we target

Human-systems integration → Safety + Efficiency + Comfort

SOMETHING IS TANGIBLE
WHEN IT IS **GRASPABLE** IN THE **PHYSICAL** SENSE,
BUT ALSO **UNDERSTANDABLE** IN THE **FIGURATIVE** SENSE
(E.G., AN IDEA OR A CONCEPT THAT CAN BE GRASPED BY THE MIND)

TANGIBILITY METRICS…

complexity (e.g., intrinsic complexity of the system being developed,
and extrinsic complexity of the environment influenced by the system)

maturity (e.g., technological maturity, maturity of practice,
and societal maturity of the system being developed)

stability (e.g., passive and active stability, robustness,
and resilience of the system being developed)

flexibility (e.g., ease of operations provided by the system being developed
in abnormal and emergency situations

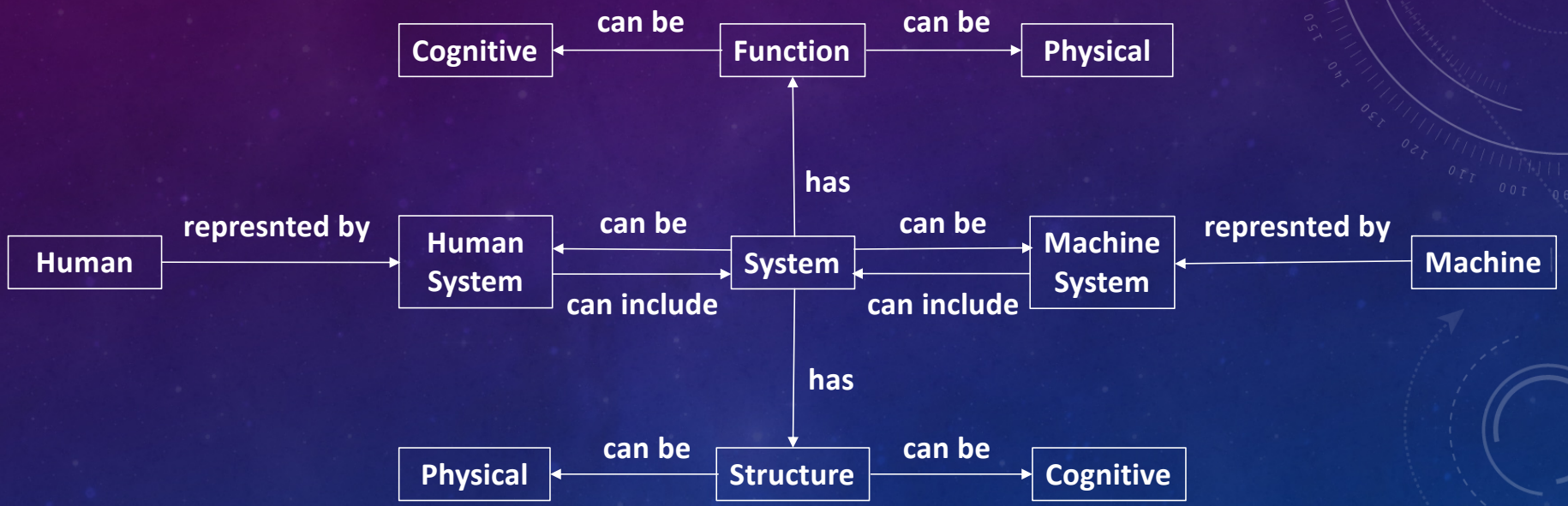
sustainability (e.g., influenced by and influencing economy, environment and society).

FORMALIZING HUMAN SYSTEM INTEGRATION…

"Human capabilities, skills, and needs must be considered early in the design and development process, and must be continuously considered throughout the development lifecycle."

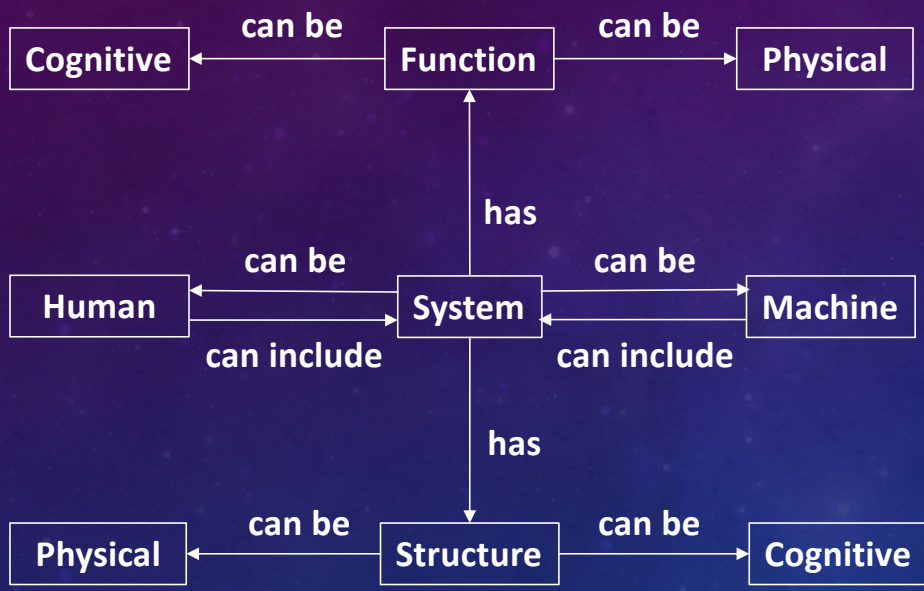
David J. Fitts, Space Architect

WHAT IS A SYSTEM?

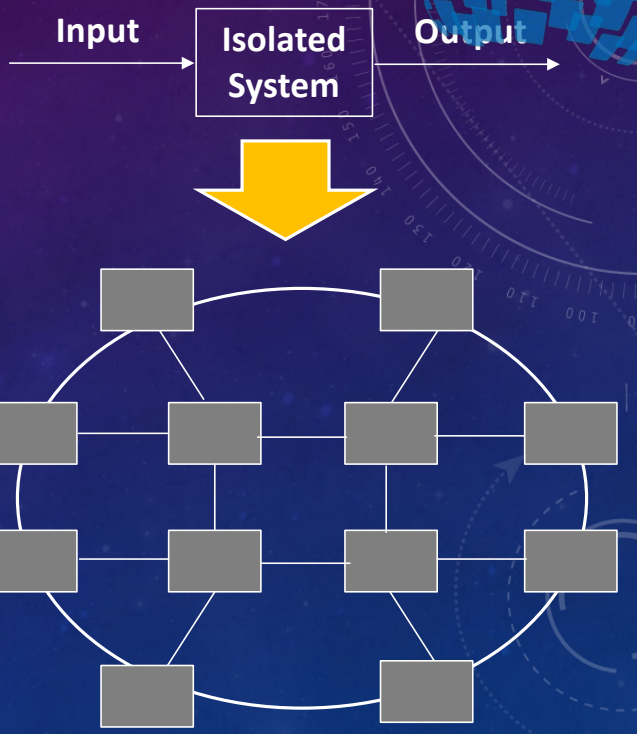


Systems represents Humans and Machines…

WHAT IS A SYSTEM?

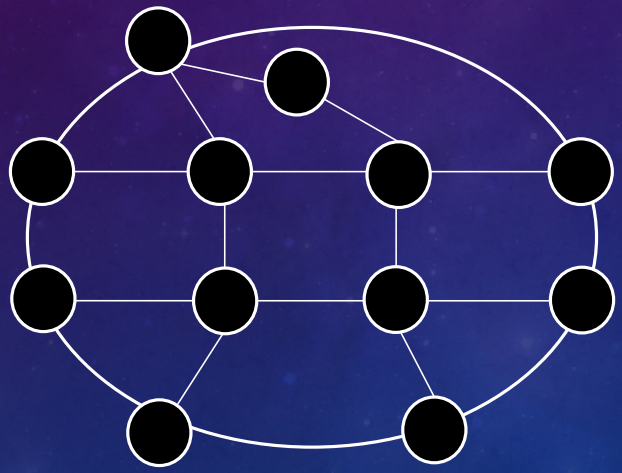


Systems include Humans and Machines…



Interconnected System of Systems

SYSTEM = STRUCTURE + FUNCTION

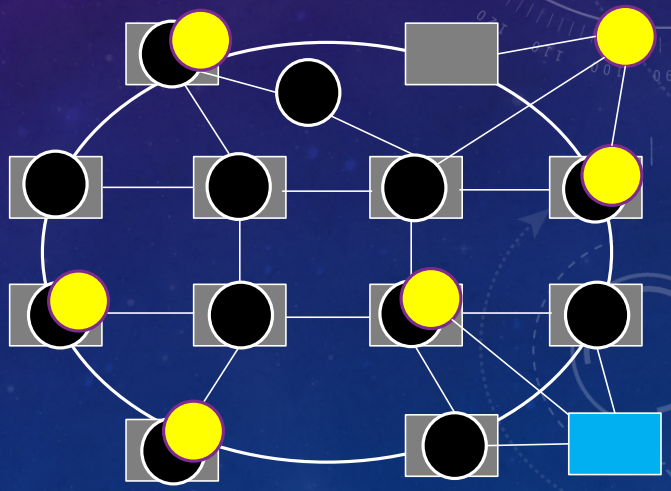


Interconnected Functions of Functions

Emergent Structures

Emergent Functions

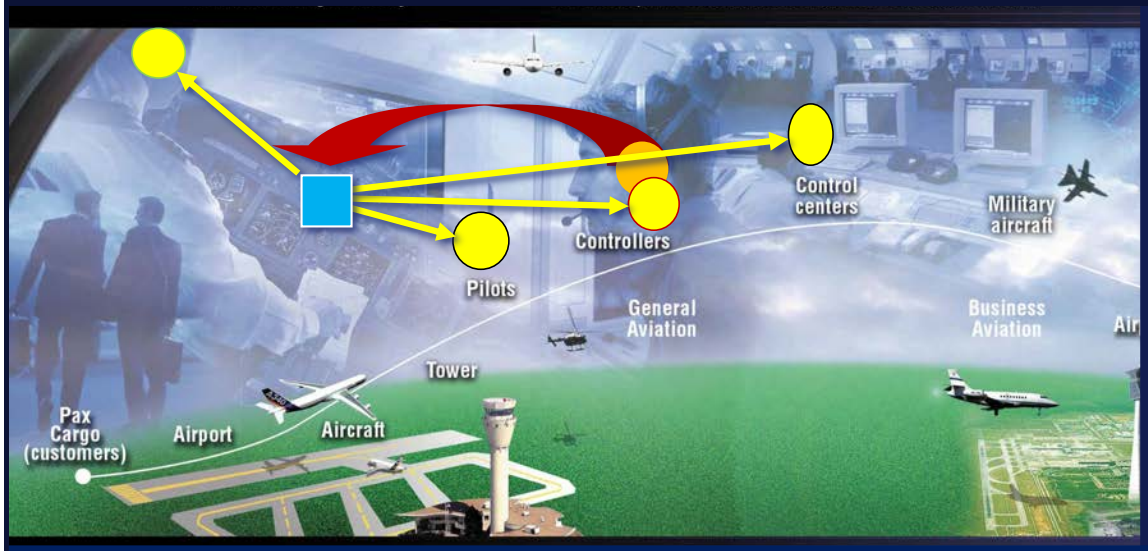
Overlapping Functions of Functions



Interconnected Structures of Structures

SYSTEM = STRUCTURE + FUNCTION

ATM SYSTEMS OF SYSTEMS



Machine cognitive function

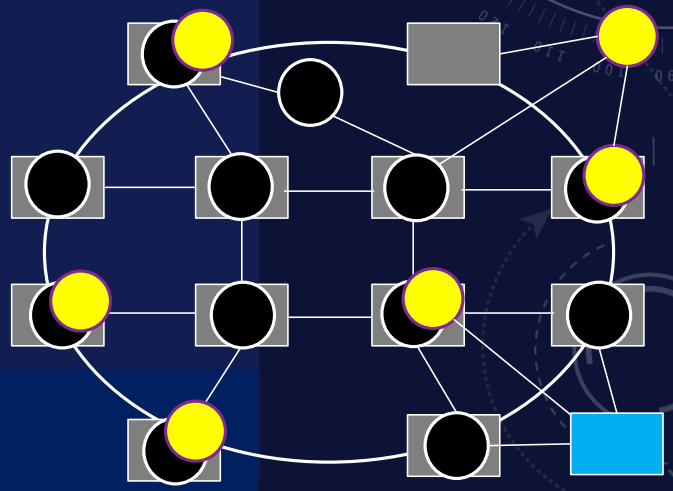
Human cognitive function

PAUSA: Authority Sharing in the Air Space (2006-2008: France; 9 Partners)

Emergent Structures

Emergent Functions

Overlapping Functions of Functions



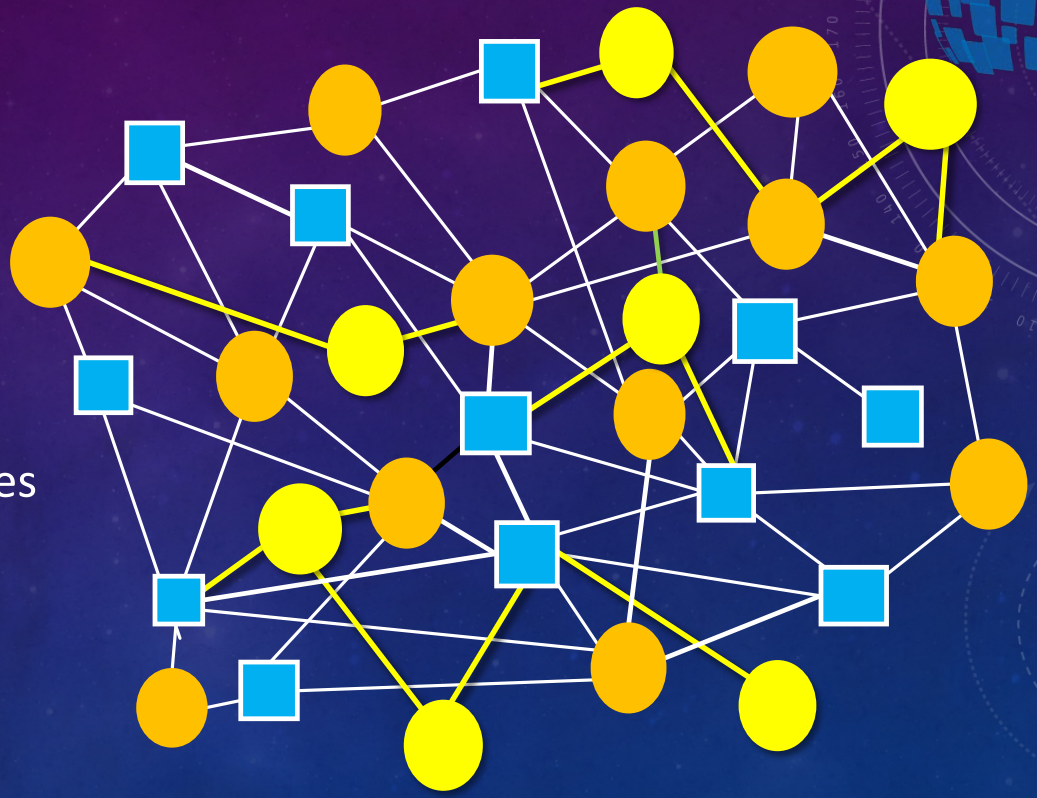
Interconnected Structures of Structures

SYSTEMS OF SYSTEMS PROPERTIES

Separability
a crucial issue

Complexity
in connections
as well as
in agents/systems themselves

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



… therefore, this is a living organism

OPERATING ROOMS

PROTOTYPING, AGILE DEVELOPMENT & FORMATIVE EVALUATION

Develop a simulation facility

Various levels of tangibility (virtual vs. Physical)

Develop use cases

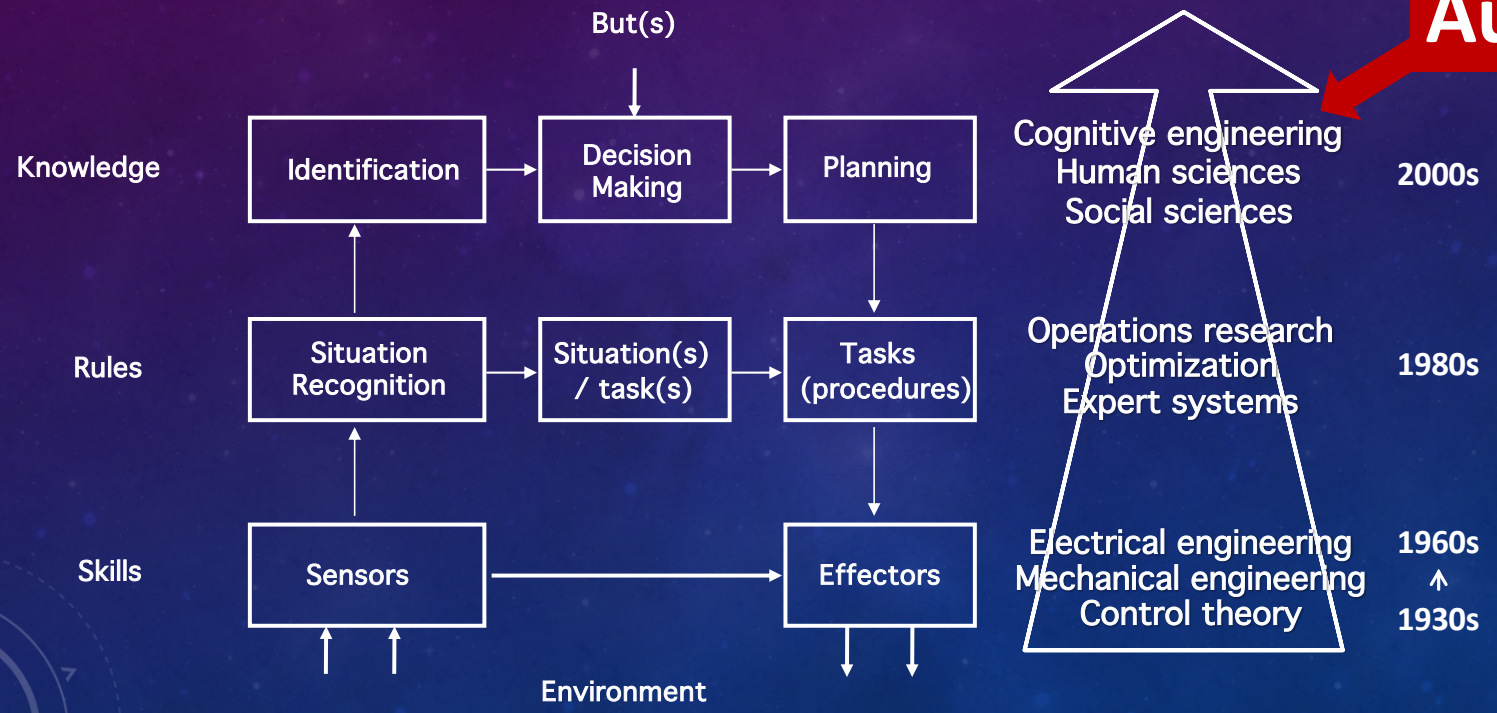
Useful and usable

Run simulations

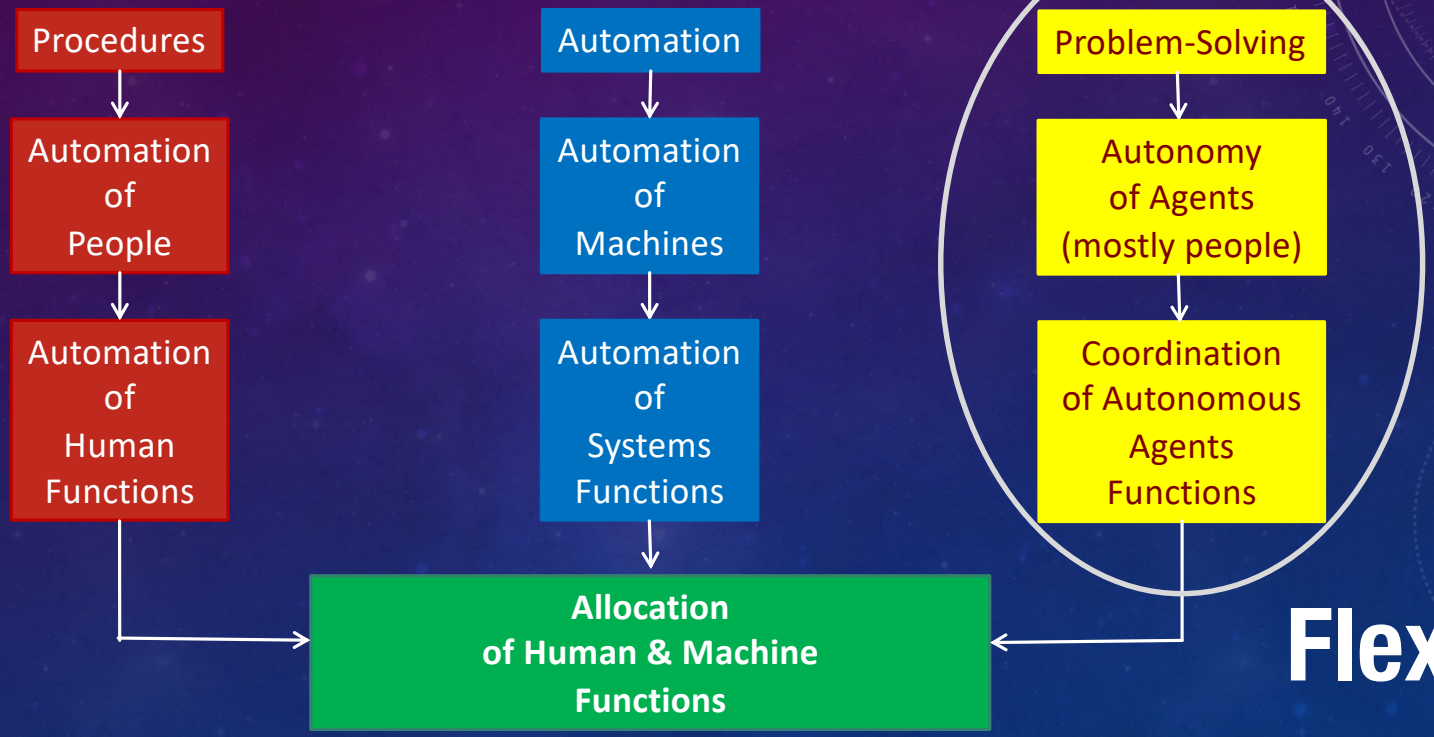
Observe activity

FROM AUTOMATION TO AUTONOMY…

… and emergence of contributing disciplines (Rasmussen's model)



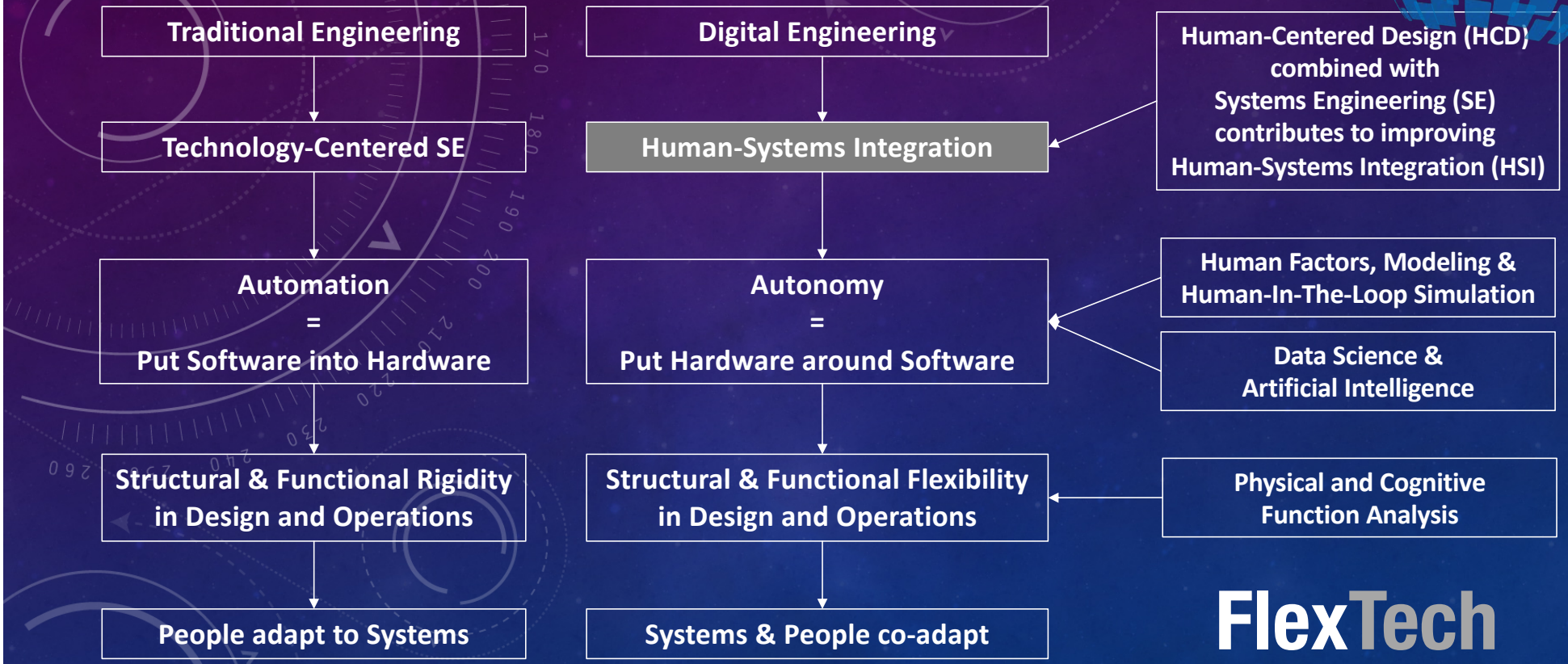
FROM RIGID AUTOMATION TO FLEXIBLE AUTONOMY



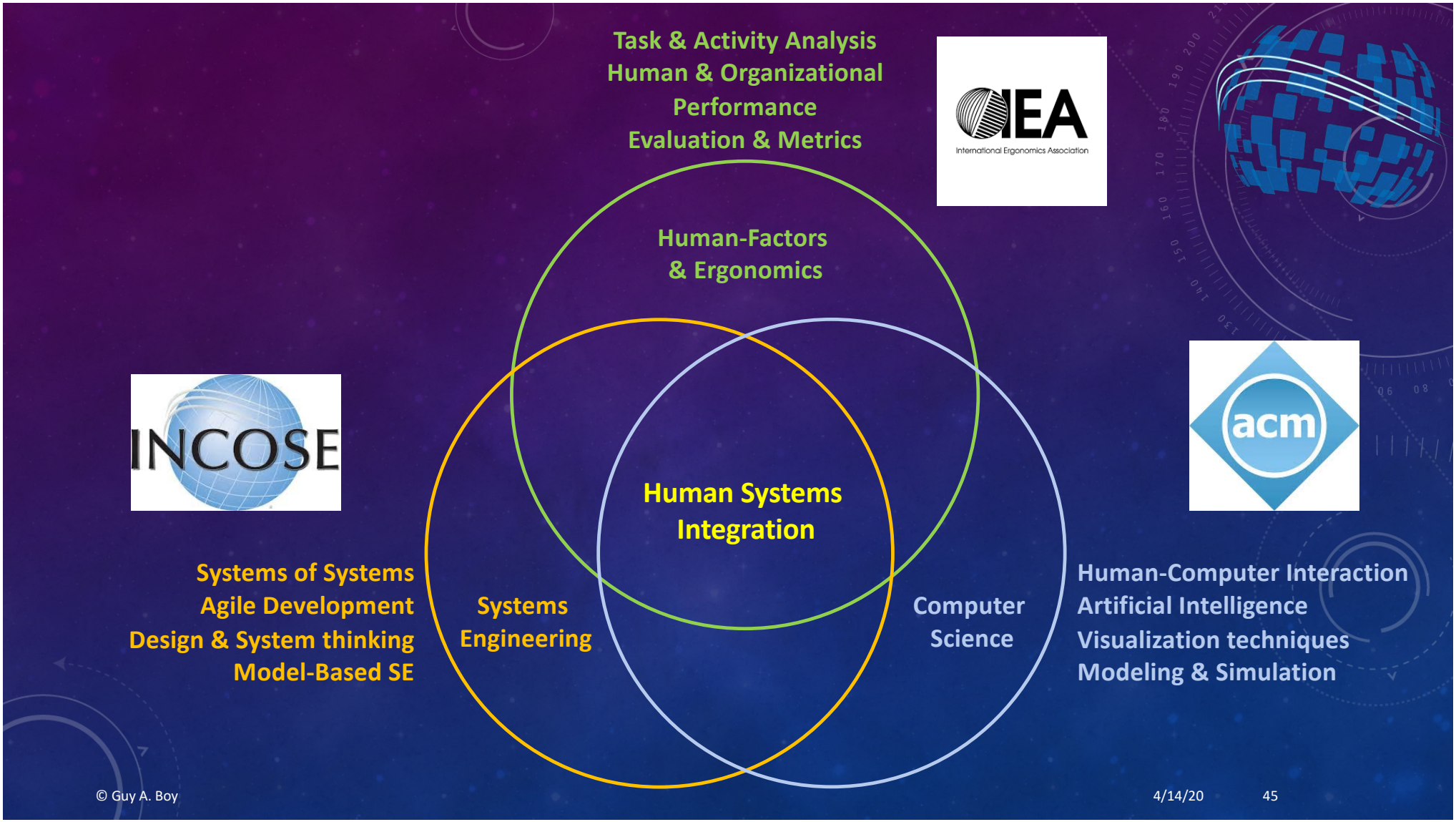
FlexTech

FROM RIGID AUTOMATION TO FLEXIBLE AUTONOMY

HOW FLEXTECH WILL PROVIDE MORE AUTONOMY AND FLEXIBILITY?



FlexTech


Task & Activity Analysis
Human & Organizational
Performance
Evaluation & Metrics
IEA
International Ergonomics Association
Human-Factors
& Ergonomics
INCOSE
acm
Human Systems
Integration
Systems of Systems
Agile Development
Design & System thinking
Model-Based SE
Systems
Engineering
Computer
Science
Human-Computer Interaction
Artificial Intelligence
Visualization techniques
Modeling & Simulation

HSI CONFERENCES…

- HSI2019, Biarritz, France
- HSI2021, TBD
- In cooperation with IEA and ACM

WORKSHOPS IN 2020

- **Writing up HSI Chapter for the next SE Handbook**
- Locations and dates:
  - Torrence, California, USA – January
  - Frankfurt, Germany – April (via teleconference)
  - New Delhi, India – July (waiting for confirmation)
  - Haifa, Israel – October

This book is a follow-up of previous contributions in Human-Centered Design and practice in the development of virtual prototypes that requires progressive operational tangibility toward Human-Systems Integration (HSI). The book discusses flexibility in design and operations, tangibility of software-intensive systems, virtual human-centered design, increasingly-autonomous complex systems, Human-Factors and Ergonomics of sociotechnical systems, and systems of systems integration.

This is an attempt to better formalize a systemic approach to HSI. Good HSI is a matter of maturity… it takes time to mature. It takes time for a human being to become autonomous, and then mature! HSI is a matter of human-machine teaming, where human-machine cooperation and coordination are crucial. We cannot think engineering design without considering people and organizations that go with it. We also cannot think new technology, new organizations and new jobs without considering change management, especially in digital organizations.

The book will be of interest to industry, academia, those involved with systems engineering, human factors and the broader public.

Features:

- Discusses flexibility in design and operations of complex systems
- Offers tangibility of software-intensive systems
- Presents virtual human-centered design
- Covers autonomous complex systems
- Provides human factors and ergonomics of sociotechnical systems

About the Author:

Guy André Boy is one of the pioneers and a world leader in the study and applications of human centered design and human systems integration. He is also the Chair of INCOSE Human Systems Integration Working Group worldwide.

Ergonomics and Human Factors

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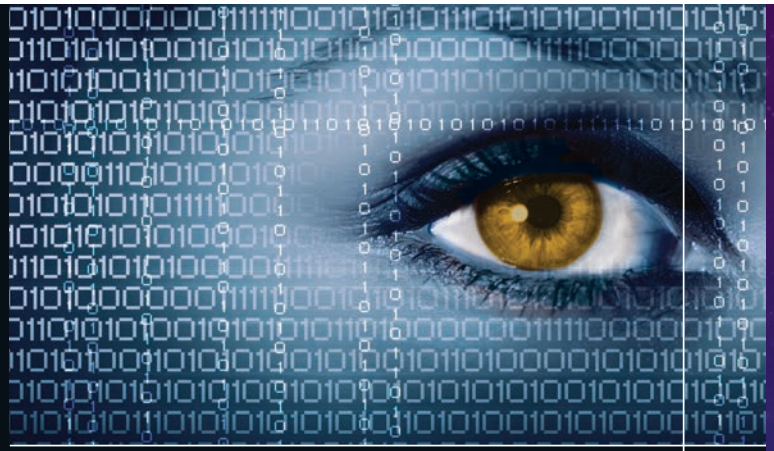
HUMAN-SYSTEMS INTEGRATION

Guy Andre Boy

CRC Press



HUMAN-SYSTEMS INTEGRATION

From Virtual to Tangible

Guy Andre Boy

CRC Press
Taylor & Francis Group

THANK YOU…

UPCOMING WEBINARS (TENTATIVE SCHEDULE)

Who	What	When
Becky Reed and Ian Presland	How to Create a Value-Added SEMP	Wednesday 20th May 2020 at 11am EDT
Pascal Paper	SE Driven Modelling & Simulation Method; a Paradigm Shift in Digital System Development	Wednesday 17th June 2020 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/products-and-publications/webinars for more info on the webinar series, including a way to view the last 134 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 be added around two weeks before the webinar is scheduled to take place.

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