



Service Systems Engineering in the Human-Centered AI Era

Online Event: October 17, 2022, 11am-5:00pm ET

The Context:

AI is poised to boost service sector productivity and quality, just as previous generations of technology boosted productivity and quality in agriculture and manufacturing. Ensuring that human-centered, data-intensive service systems are safe, ethical, and sustainable is a priority.

The Exploration:

Many academic disciplines are needed to design, engineer, manage, maintain, and sustainably innovate these complex human-center, data-intensive systems that give and get service. For which system characteristics are graduates well-prepared, and for which characteristics are graduates less-well-prepared?

Welcome

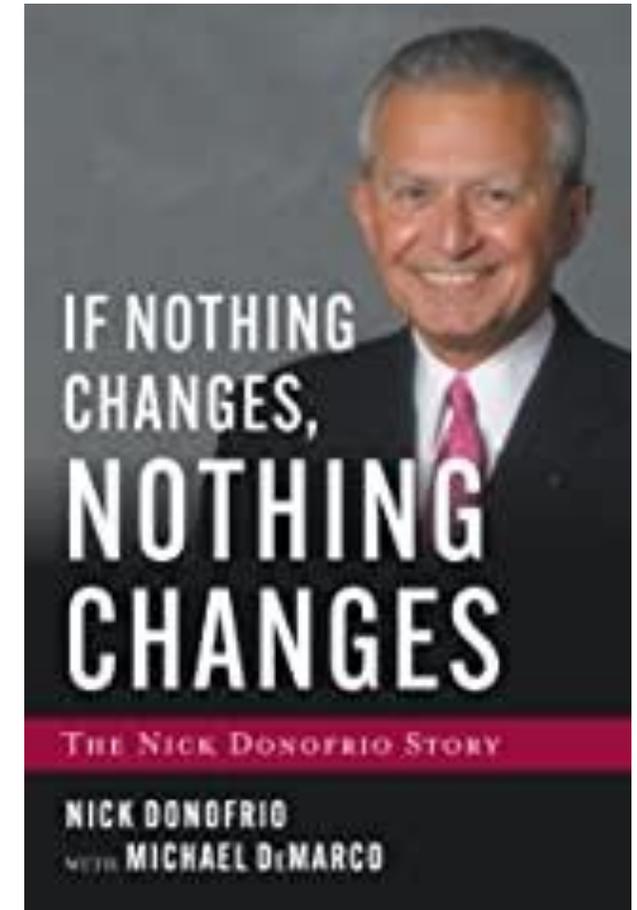


Guru Madhavan
Norman R. Augustine Senior Scholar and
Senior Director of Programs,
National Academy of Engineering

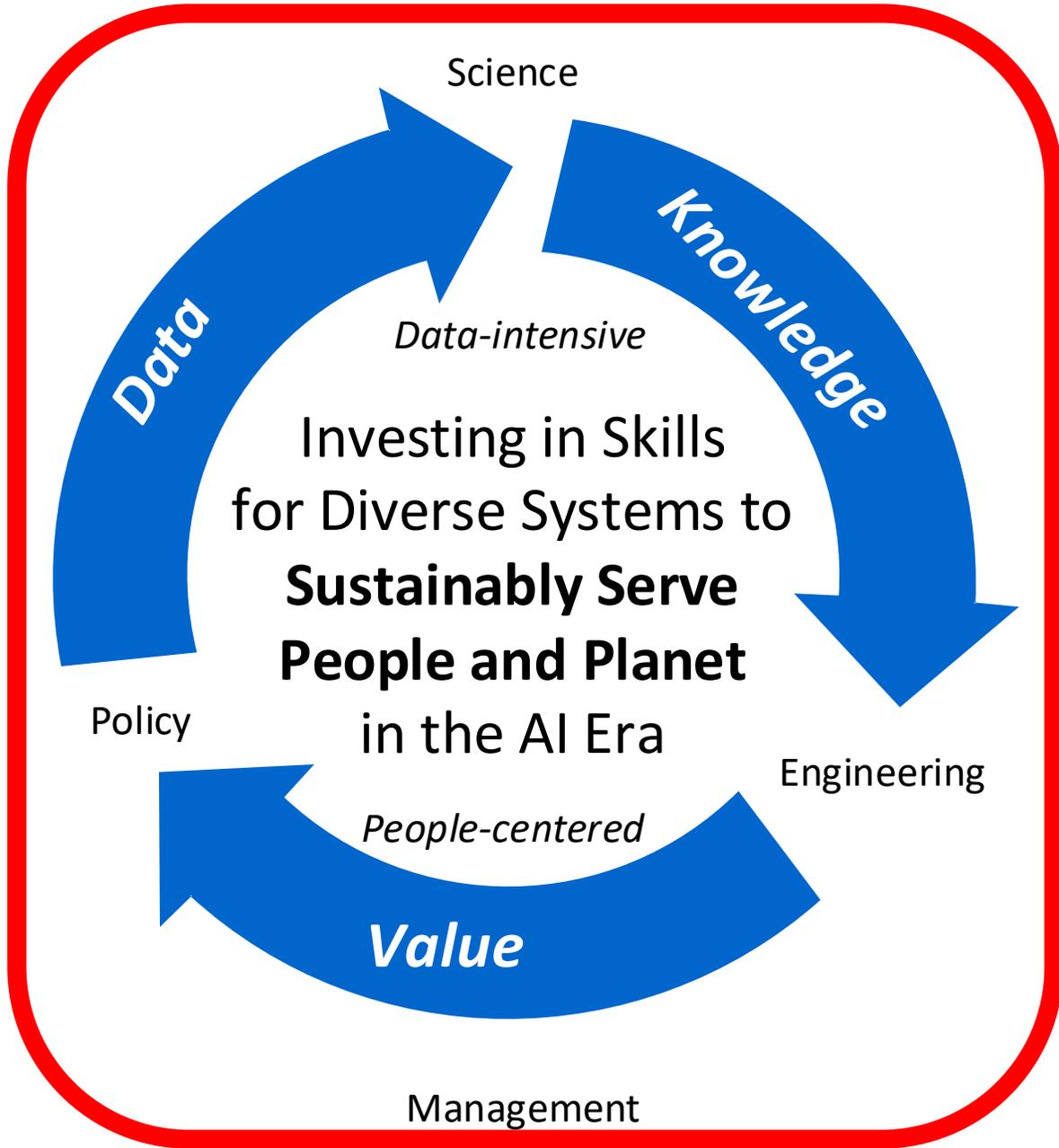
- **Opening statement:** In previous centuries, technological advances improved economic productivity and quality in agriculture and then manufacturing. This century, advancing artificial intelligence (AI) capabilities are poised to improve productivity and quality in the people-intensive service sector – including healthcare, education, government, finance, retail, hospitality, transportation, green energy, and more. We need systems engineered to sustainably serve the well-being of people and planet. We can explore the possibilities of complex unifiable systems, and a cultural engineering mindset change.
- **Objective:** Inform an NAE publication and possible follow-on meeting. See (Madhavan, Poste, Rouse 2020) and (IfM and IBM 2008).
- **Approach:** Expert panels to address (1) service science, (2) artificial intelligence, (3) future engineer, and (4) social implications, followed by “open mic” session to get additional ideas and position statements.

Keynote

- **Revisiting SSME and T-Shaped Skills in the AI Era**
- **SERVICE SCIENCE DEFINED.**—In this section, the term “service science” means curricula, training, and research programs that are designed to teach individuals to apply scientific, engineering, and management disciplines that integrate elements of computer science, operations research, industrial engineering, business strategy, management sciences, and social and legal sciences, in order to encourage innovation in how organizations create value for customers and shareholders that could not be achieved through such disciplines working in isolation.” (US 110th Congress 2007)
- **T-SHAPED SKILLS DEFINED.** – T-shaped skills is a metaphor for describing the skills of a person who combines both breadth and depth, like the shape of the letter T - a combined generalist with excellent interactional communication skills across business and technology as well as a specialist in one or more areas with contributory problem-solving skills, the area(s) of the person’s earned “bon fides.” (see also IfM and IBM 2008).

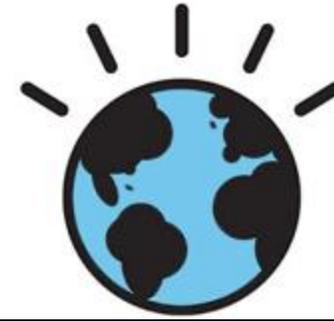


Nick Donofrio
IBM Fellow Emeritus
NAE Member

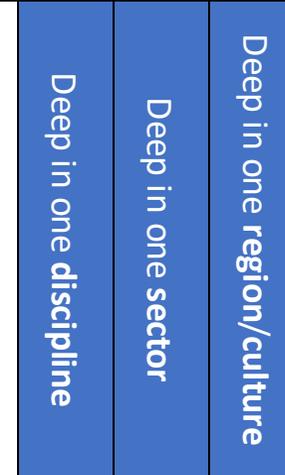


Service
Science
Management
Engineering

+Design-Arts-
Public-Policy



Many disciplines
Many sectors
Many regions/cultures
(understanding & communications)



T-Shaped Skills
Depth and Breadth

Panel 1: Engineering Considerations for Service Systems



Paul Maglio

University of California, Merced Massachusetts Institute of Technology



Richard Larson

University of California, Merced Massachusetts Institute of Technology



Kelly Lyons

University of Toronto



John McDermid

University of York

Service science is an emerging transdiscipline that studies service system innovations - smarter systems engineered to serve the well-being of people and planet. The community of practice that is advancing service science also promotes T-shaped skills for people-centered, data-intensive service system innovations that improve win-win interactions and change in business and society.

What is Service Science?

Paul P. Maglio
Cheryl A. Kieliszewski
James C. Spohrer
Editors

Foreword by Carl J. Schramm and William J. Baumol

Service Science: Research and Innovations in the Service Economy

Handbook of Service Science

 Springer

Maglio, P. P. Kieliszewski, C. A. & Spohrer, J. C. (2010). Why a handbook?. In P. P. Maglio, C. A. Kieliszewski & J. C. Spohrer (Eds.), *Handbook of Service Science*. New York: Springer.

Service Science: Research and Innovations in the Service Economy

Paul P. Maglio · Cheryl A. Kieliszewski
James C. Spohrer · Kelly Lyons
Lia Patricio · Yuriko Sawatani *Editors*

Handbook of Service Science, Volume II

 Springer

Maglio, P. P., Kieliszewski, C. A., Spohrer, J. C., Lyons, K., Patricio, L. & Sawatani, Y. (2019). Introduction: Why another handbook? In Maglio, P. P., Kieliszewski, C. A., Spohrer, J. C., Lyons, K., Patricio, L. & Sawatani, Y. (Eds.). *Handbook of service science, Volume II*. New York: Springer.



What is Service Science now?

Modern businesses rely on people, capital, information, and technology. They operate in a complex web of suppliers, customers, and other stakeholders, creating value by sharing skills and capabilities with others for mutual benefit. The field of service science is emerging as the **study of such complex services and service systems** and involves methods and theories from a range of disciplines, including operations, marketing, information systems, psychology, engineering, computer science, and more. Effective understanding of service and service systems often requires combining multiple methods to consider how interactions of people, technology, organizations, and information create value under various conditions.

<https://pubsonline.informs.org/journal/ser>

The Study of Service: From Systems to Ecosystems to Ecology

Irene Ng, Paul P. Maglio, Jim Spohrer
and Susan Wakenshaw

‘What is service?’ It seemed a simple question, and certainly an important one, as most economic activity in the developed world lies in ‘services’, so understanding, improving, and innovating services was deemed necessary to assure economic and societal progress. And yet, between 15 and 20 years ago, this simple question launched a few of us – separately and collectively – on a journey that shows no signs of ending. We have all learned a lot about service, but we are still discovering the multi-faceted nature of what it truly is, often negotiating its meaning with a whole community of like-minded researchers. Perhaps there isn’t one answer for what service is, but a collective construction of meanings emerging from the community. In what follows, we will present our perspective of that journey and how S-D logic and Service Science became conceptual partners in the discourse of service. We will start with the quest to define service, moving into systems, then ecosystems, and finally to ecology. Along

the way, we will articulate the many different views of service from both the Service Science and S-D logic approaches, where and how they can be reconciled, and its conceptual convergences and divergences. A cryptic quote begins our story:

I slept and dreamt that life was joy. I awoke and saw that life was service. I acted and behold, service was joy. (Rabindranath Tagore, 1913 Nobel Prize Laureate for Literature)

We can interpret Tagore’s quote in many ways. One way is to be deeply philosophical about what it means to live or ‘be’. If we take the Heideggerian view, the language through which we describe ourselves and our existence is the way we understand the meaning in our lives. Thus, the use of the word ‘service’ is part of the language through which we understand ourselves. The way Tagore describes it, service is an activity, or a set of activities, that serves humanity, and the fullness of an individual’s life’s meaning and existence (‘the joy’) therefore emerges from

From Service Systems to Ecologies...

Service system ecology in Service Science may be defined as the macro-scale Interactions of the population of different types of service system entities.... Thus, **the top concept for Service Science is ‘ecology’ rather than ‘ecosystem’** to stress the evolving ecology of service system entities, their value co-creation and capability co-elevation mechanisms, along with capabilities, constraints, rights, and responsibilities.

Ng, I. C. L., Maglio, P. P., Spohrer, J. & Wakenshaw, S. (2018). The science of service of systems: From system to ecosystem to ecology. In R. Lusch & S. Vargo (Eds.), *The Handbook of Service Dominant Logic*.

Sage.

Service in the AI Era

Science, Logic, and Architecture Perspectives



Jim Spohrer
Paul P. Maglio
Stephen L. Vargo
Markus Warg

Perspectives on Service

Science – Models of the World

Logic – Models of Mind

Architecture – Models of Organizations

Spohrer, J., Maglio, P. P., Vargo, S. C. & Warg, M (2022). *Service in the AI era: Science, logic, and architecture perspectives*. New York: Business Expert Press.

Principles of Service Science

Service system entities dynamically configure four types of resources

Service system entities compute value from multiple stakeholder perspectives

The access rights associated with entity resources are reconfigured by mutually agreed to value propositions

Service system entities compute and coordinate actions with others through symbolic processes of valuing and symbolic processes of communicating.

Maglio, P. P. & Spohrer, J. (2013). A service science perspective on business model innovation. *Industrial Marketing Management*, 42, 655-670.

A service science perspective on business model innovation

Paul P. Maglio^{a,b,*}, Jim Spohrer^{b,1}

^a University of California, Merced, United States
^b IBM Research, Almaden, 650 Harry Rd, San Jose, CA 95120, United States

ARTICLE INFO

Article history:
 Received 31 January 2012
 Received in revised form 29 March 2013
 Accepted 19 April 2013
 Available online xxx

Keywords:
 Service science
 Business model innovation
 Value proposition design
 IT outsourcing

ABSTRACT

Using four basic principles of service science, we systematically explore value-proposition design as one type of business model innovation. Service science combines organization and human understanding with business and technological understanding to categorize and explain service systems, including how they interact and evolve to create value. Our goal is to apply a scientific approach to advance design and innovation in service systems. Our foundation is service-dominant logic, which provides perspective, vocabulary, and assumptions on which to found a theory. Our basic theoretical construct is the service system, entities that are dynamic configurations of four kinds of resources. Our core principles center on the way value is computed within and among entities, how interaction is based on access to resources and their capabilities, and on how value computation and interaction depend on symbol processing and language guided by mutually agreed-to value propositions. In this context, service science can inform and accelerate value-proposition design by systematizing the search for adaptive advantages that improve existing offerings, create new offerings, or reconfigure the value-creating ecosystem. © 2013 Elsevier Inc. All rights reserved.

1. Introduction

The rise of globe-spanning service-based business models has transformed the way the world works. This transformation has been enabled by new information and communications technologies, specialization of businesses and professions, global regulations, and increased use of external service by entities at multiple scales (Wirtz & Ewert, 2012). Service innovation is now a key priority for nations, businesses, and citizens (Council on Competitiveness, 2005). In this context, there is a growing awareness of the need for a new interdisciplinary science of service to help make innovation more systematic and more sustainable (Abe, 2005; Chesbrough & Spohrer, 2006; Horn, 2005; IBM Research, 2004; IBM & IBM, 2008; Maglio, Kieliszewski, & Spohrer, 2010; Ostrom et al., 2010; Spohrer, Maglio, Bailey, & Gruhl, 2007; UK Royal Society, 2009; US Congress, 2007). Over the last two hundred years, and accelerating in recent decades, we have witnessed a rise and fall in resources allocated and interactions dedicated to local production of goods, with more reliance on increasingly complex cognitive and social interactions with others (Bell, 1973; Clark, 1940/1957; Fuchs, 1968; Levitt, 1976; Pine & Gilmore, 1999). This represents the rise of the so-called "service sector" of the economy (Fitzsimmons & Fitzsimmons, 2010), and despite its obvious importance, many myths about the

service sector persist, including: (1) productivity is stagnant in the service sector; (2) service sector jobs are low skill and low wage; (3) the service sector is all labor and little technology; (4) science, technology, engineering, and math (STEM) graduates cannot find good jobs in the service sector; (5) service quality is subjective and resists systematic improvement; and (6) the service sector is too diverse to be studied systematically. These can all be easily refuted (see Spohrer & Maglio, 2010b).

Business model innovation can aim at differentiation or cost advantage, often unguided by principles or theory (Zott & Amit, 2008). Similarly, value-proposition design can aim for adaptive advantages (improve existing offerings, create new offerings, or reconfigure the ecosystem), without taking proper account of constraints (Ricketts, 2007). Systematic techniques shift the key performance indicators (Anderson, Kumar, & Narus, 2007; Womack & Jones, 2005), the field of competition (Kim & Mauborgne, 2005), toward adjacent spaces (Slywotzky, Wise, & Weber, 2003), toward open ecosystems (Chesbrough, 2006), away from the priorities of the past (Moore, 2011), or otherwise reconfigure the actors or rules of the game (Brandenburger & Nalebuff, 2007). These shifts and reconfigurations can lead to upward spirals in capabilities over time, or boom and bust cycles (Perez, 2003) or collapse entirely (Diamond, 2005).

In this article, we present a new view of value-proposition design in the context of complex service systems, and particularly from the perspective of service science. We first describe our service science perspective, and then elaborate our four core principles of service science. In the end, we show how to apply our principles to value-proposition design and describe managerial implications of this approach.

* Corresponding author at: University of California, Merced, 5200 North Lake Rd, Merced, CA 95343, United States. Tel.: +1 209 228 4389.
 E-mail addresses: pmaglio@ucmerced.edu (P.P. Maglio), spohrer@us.ibm.com (J. Spohrer).
¹ Tel.: +1 408 927 1928.

A service science perspective on business model innovation

Paul P. Maglio ^{a,b,*}, Jim Spohrer ^{b,1}

^a University of California, Merced, United States
^b IBM Research, Almaden, 650 Harry Rd, San Jose, CA 95120, United States

ARTICLE INFO

Article history:
 Received 31 January 2012
 Received in revised form 29 March 2013
 Accepted 19 April 2013
 Available online xxx

Keywords:
 Service science
 Business model innovation
 Value proposition design
 IT outsourcing

ABSTRACT

Using four basic principles of service science, we systematically explore value-proposition design as one type of business model innovation. Service science combines organization and human understanding with business and technological understanding to categorize and explain service systems, including how they interact and evolve to create value. Our goal is to apply a scientific approach to advance design and innovation in service systems. Our foundation is service-dominant logic, which provides perspective, vocabulary, and assumptions on which to build a theory. Our basic theoretical construct is the service system, entities that are dynamic configurations of four kinds of resources. Our core principles center on the way value is computed within and among entities, how interaction is based on access to resources and their capabilities, and on how value computation and interaction depend on symbol processing and language guided by mutually agreed-to value propositions. In this context, service science can inform and accelerate value-proposition design by systematizing the search for adaptive advantages that improve existing offerings, create new offerings, or reconfigure the value-creating ecosystem. © 2013 Elsevier Inc. All rights reserved.

1. Introduction

The rise of globe-spanning service-based business models has transformed the way the world works. This transformation has been enabled by new information and communications technologies, specialization of businesses and professions, global regulations, and increased use of external service by entities at multiple scales (Wirtz & Ehret, 2012). Service innovation is now a key priority for nations, businesses, and citizens (Council on Competitiveness, 2005). In this context, there is a growing awareness of the need for a new interdisciplinary science of service to help make innovation more systematic and more sustainable (Abe, 2005; Chesbrough & Spohrer, 2006; Horn, 2005; IBM Research, 2004; IBM & IBM, 2008; Maglio, Kieliszewski, & Spohrer, 2010; Ostrom et al., 2010; Spohrer, Maglio, Bailey, & Gruhl, 2007; UK Royal Society, 2009; US Congress, 2007). Over the last two hundred years, and accelerating in recent decades, we have witnessed a rise and fall in resources allocated and interactions dedicated to local production of goods, with more reliance on increasingly complex cognitive and social interactions with others (Bell, 1973; Clark, 1940/1957; Fuchs, 1988; Levitt, 1976; Pine & Gilmore, 1999). This represents the rise of the so-called "service sector" of the economy (Fitzsimmons & Fitzsimmons, 2010), and despite its obvious importance, many myths about the

service sector persist, including: (1) productivity is stagnant in the service sector; (2) service sector jobs are low skill and low wage; (3) the service sector is all labor and little technology; (4) science, technology, engineering, and math (STEM) graduates cannot find good jobs in the service sector; (5) service quality is subjective and resists systematic improvement; and (6) the service sector is too diverse to be studied systematically. These can all be easily refuted (see Spohrer & Maglio, 2010b).

Business model innovation can aim at differentiation or cost advantage, often unguided by principles or theory (Zott & Amit, 2008). Similarly, value-proposition design can aim for adaptive advantages (improve existing offerings, create new offerings, or reconfigure the ecosystem), without taking proper account of constraints (Ricketts, 2007). Systematic techniques shift the key performance indicators (Anderson, Kumar, & Narus, 2007; Womack & Jones, 2005), the field of competition (Kim & Mauborgne, 2005), toward adjacent spaces (Slywotzky, Wise, & Weber, 2003), toward open ecosystems (Chesbrough, 2006), away from the priorities of the past (Moore, 2011), or otherwise reconfigure the actors or rules of the game (Brandenburger & Nalebuff, 2007). These shifts and reconfigurations can lead to upward spirals in capabilities over time, or boom and bust cycles (Perez, 2003) or collapse entirely (Diamond, 2005).

In this article, we present a new view of value-proposition design in the context of complex service systems, and particularly from the perspective of service science. We first describe our service science perspective, and then elaborate our four core principles of service science. In the end, we show how to apply our principles to value-proposition design and describe managerial implications of this approach.

* Corresponding author at: University of California, Merced, 5200 North Lake Rd, Merced, CA 95343, United States. Tel.: +1 209 228 4389.
 E-mail addresses: pmaglio@ucmerced.edu (P.P. Maglio), spohrer@us.ibm.com (J. Spohrer).
¹ Tel.: +1 408 927 1928.

Principles of Service Engineering

Service system entities can dynamically configure four types of resources

Design for human interaction

Service system entities can simultaneously optimize of multiple stakeholder functions

The access rights associated with subsystems are reconfigured by mutually agreed-to value propositions

Defined interfaces for systems and subsystems

Service system entities compute and coordinate actions with others through symbol processing and symbolic processes of computation, language, and logic

Predictive modeling at multiple scales

Maglio, P. P. & Spohrer, J. (2013). A service science perspective on business model innovation. *Industrial Marketing Management*, 42, 655-670.

Commentary

Toward a Research Agenda for
Human-Centered Service System Innovation

Paul P. Maglio

School of Engineering, University of California, Merced, Merced, California

Stephen K. Kwan

Lucas Graduate School of Business, San José State University, San Jose, Calif

Jim Spohrer

IBM Almaden Research Center, San Jose, California 95120,

Solving service problems has enormous practical consequences for the economy. (a) Many of jobs in the United States are in the service sector, with most science, technology, engineering, and mathematics (STEM) graduates working in the service sector; (b) many complex service problems are on the rise; and (c) private investments in platform technologies that underlie business and societal systems are on the rise; and (d) the United States lags in public investment in service research. The search for service innovation requires new theories and methods, and what little students are being taught about the service sector has a long history. This commentary outlines a series of broad considerations and concerns, and proposes a research agenda for service system innovation.

Keywords: service modeling; service theory and principles; service transformation
History: Received November 30, 2014; Accepted January 9, 2015 by Robin Qiu.

Introduction

In the era of smart service systems, technology is critical to real-world engineering research in service innovation critical for future economic progress. Business models has transformed the way the world works, enabled by technologies (ICTs), specialization of businesses and professions, global services (Wirtz and Ehret 2012). Service innovation is a key priority (Council on Competitiveness 2005). Now, there is a new awareness of service to help make innovation more systematic and more successful (Chesbrough and Spohrer 2006, Ganz and Meinen 2003, Horn 2005, Hult and Ostrom et al. 2010, Royal Society 2009, Spohrer et al. 2007).¹

Over the last 200 years, there has been a rise and fall in resources all with more reliance on increasingly complex cognitive and social into Fuchs 1968, Levitt 1976, Pine and Gilmore 1999), resulting in the rise of service (Fitzsimmons and Fitzsimmons 2010). Although there is a rich history of service, including economics, marketing, operations, industrial engineering (see Chase and Apte 2007, Fisk and Grove 2010, Spohrer and Kwan 2009, Spohrer and Maglio 2010), there is also fragmentation and a lack of awareness of works by others among researchers and scientists in these disciplines (Roth and Menor 2003, Rust 2004, Spohrer and Maglio 2010). Service science aims to draw the various disciplinary threads together into a single, coherent study of service phenomena (Chesbrough and Spohrer 2006, Glushko 2008, Larson 2008, Maglio et al. 2006, Spohrer et al. 2007).

The traditional view holds that services constitute the third sector of the economy: service activities are those economic activities that are left over after agriculture and manufacturing (Fitzsimmons and Fitzsimmons 2010). Over time, disciplines such as economics, marketing, operations, management, and engineering have all

¹ See also the America COMPETES Act, Pub. L. No. 110-69, H.R. 2272 (2007).

Some Discussion Questions

Education

There are also many questions related to education, particularly how new knowledge about HCSSs can be disseminated and sustained.

- **Societal context:** How can we, as educators, ensure the steady flow of skills for industry and career paths for individuals as job roles and occupations change given new services, service innovations, and new service configurations? How can we identify knowledge and skill gaps so that we can adapt education and training in time, minimizing the barriers to service industry growth?

- **Sustainability:** How do we prepare the next-generation innovators, educated citizens, and entrepreneurs for effective service innovation? What roles do government and industry play together with academia in innovating and sustaining such efforts?

One key question is how the kind of multidisciplinary knowledge and skills required for HCSSs can be effectively disseminated, and what disciplines will begin maintaining such knowledge.

Maglio, P. P., Kwan, S. J. & Spohrer, J. (2015). Toward a research agenda for human-centered service system innovation. *Service Science*, 7(1), 1-10.



NATIONAL ACADEMY
OF ENGINEERING

FORUM ON COMPLEX UNIFIABLE SYSTEMS

SERVICE SYSTEMS ENGINEERING IN THE ERA OF HUMAN-CENTERED AI: A VIRTUAL
FORUM

Engineering Considerations for Service Systems

Richard C. Larson

Massachusetts Institute of Technology

REFERENCE:

*Service Systems
Implementation*

Haluk Demirkan • James C. Spohrer Vikas Krishna, Editors



Springer

**Foreword by
Richard C. Larson**

Service Systems

- A Service System is a non-physical-product-creating process. *Definition by subtraction!* (eliminates manufacturing, agriculture, mining, ...)
- The Service Provided creates **added value** to one or more human beneficiaries. Examples: Health care, education, transportation,...
- By definition, ***Service Systems are Human-Centered.***



Service Systems Evolving Over Time

- The history of service systems shows a strong growing reliance on **technologies replacing human labor** in providing various types of services.
- Examples:
 - ATM's replacing human tellers;
 - Transponder systems in vehicles used to assess roadway tolls;
 - Self-serve replacing attendants in retail sales (super markets, gasoline stations, ...)



Service Systems Evolving Over Time

- AI (Artificial Intelligence) has recently entered the picture in various settings.
- Examples:
 - Complex medical diagnoses;
 - Automated voice robots;
 - Self-driving cars, ...

Engineering Considerations for Service Systems

- Wikipedia: **Engineering** is the use of [scientific principles](#) to design and build machines, structures, and other items, including bridges, tunnels, roads, vehicles, and buildings.
- **Human-centered systems**, service systems, also need scientifically-informed design, as can be offered by broadly educated engineers.

Engineering Considerations for Service Systems

-- Priority Considerations --

- Humans, not technology, are at the core of the system.
- Human abilities, preferences, and behaviors vary in limitless ways.
- Any closed-form “engineering solution” based on technology alone, including AI, will – with probability 1.0 – run into problems, some severe (like loss of life).
- We need to create technology-supported open systems that can bring the human back in control when the algorithms near their boundaries of applicability.

Thank You!

Dick Larson brainstorm, even in AI era engineers working on service systems need to reaffirm the basics of pencil and paper reasoning...

- Model Thinking for Everyday Life Working Wonders with a Blank Sheet of Paper.
- And this quote below struck me - as highly relevant for the "Service Systems Engineering in the AI Era: NAE event coming up on Oct 17th,...
- "People often confuse a Google search with learning. They confuse dropping data into a “plug and chug” algorithm with learning. With reliance on technology, they have lost track of orders of magnitude, losing ability to guesstimate the approximate answer to a problem. Faced with a new problem, people often lack the ability to frame and formulate it using basic principles. So, we move ahead with all computers off, our only technology being a sharpened pencil and a Blank Sheet of Paper."
- "The purpose of my book is not to criticize any particular method of analysis, including AI. It was to open people's eyes to an old-fashioned fundamental type of analysis that should be done on almost any problem before more “advanced” techniques are used. Else one is unable to self criticize the results of the advanced techniques, and one treats them as “gospel.” Bad bad mistakes can happen this way, with AI, with OR optimization algorithms, etc.. My intuition is that the majority of professionals have forgotten how to use a blank sheet of paper, or maybe never learned."



FORUM ON COMPLEX UNIFIABLE SYSTEMS

**SERVICE SYSTEMS ENGINEERING IN THE ERA OF HUMAN-CENTERED AI
A VIRTUAL FORUM**

Engineering Considerations for Service Systems

Kelly Lyons

Faculty of Information and Department of Computer Science

University of Toronto

Table 2. Summary of service science and iSchool motivations

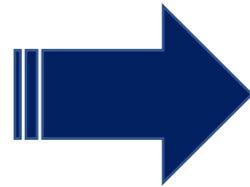
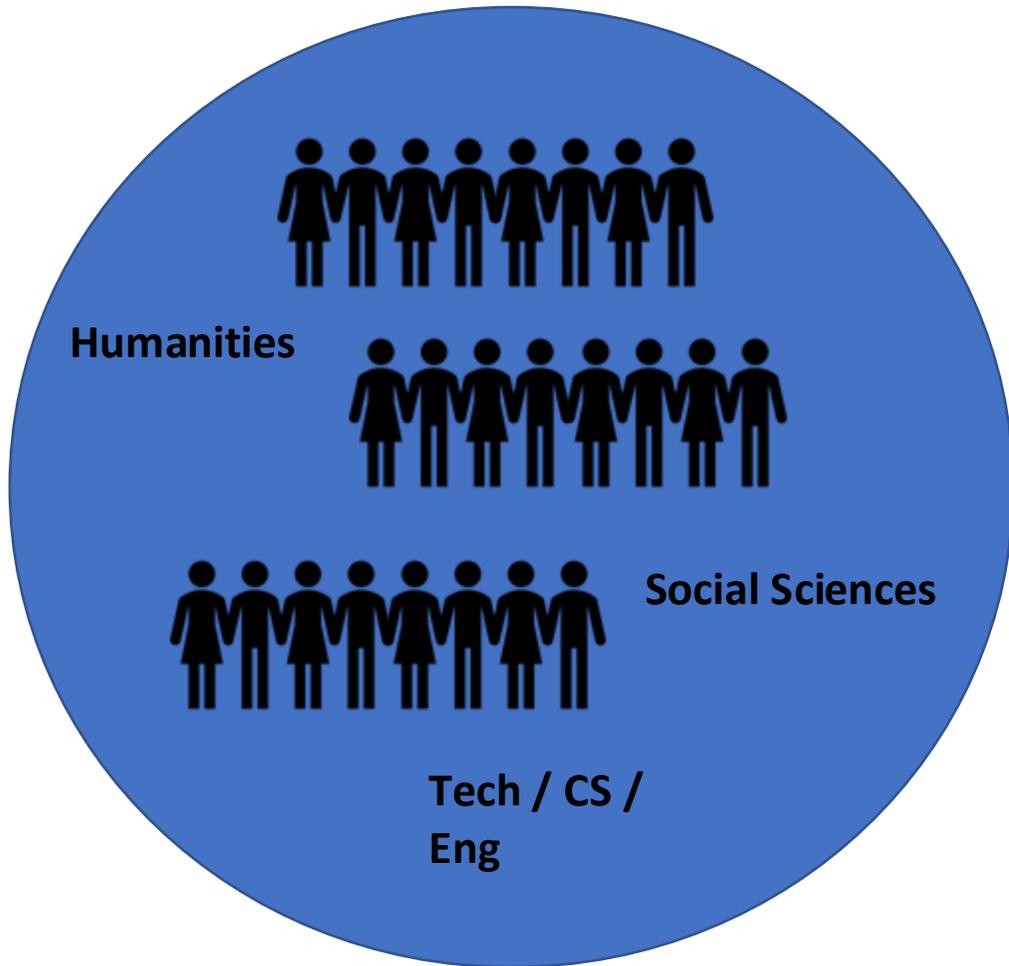
iSchool Vision	Service Science Goal
Interested in relationship between information, people, and technology	Studies service systems which are made up of information, people, technology, and organizations
Requires multidisciplinary approach	Requires multidisciplinary approach
Work with industry to shape research direction	Bring academia, industry, government together
Must bring understanding in uses and users of information, information technologies, applications	Must bring understanding in human and organizations, technology, and business domains
Depth in one of information, technology, people not sufficient to understand connections between them	Requires depth in one or more areas and the ability to communicate across complexities of other disciplines

iSchools bring a multidisciplinary approach to study information, people and technology as equally interacting entities

Interested in the relationship among **information, people and technology**

Engineering systems in an era of human centred AI requires bringing multiple perspectives together

Centre not only on humans but interactions among **humans, data, information, and technology**



INF2313 Introduction to Service Science

- How can we properly describe service systems?
- How can we represent (model) service systems?
- How do we use our descriptions and representations to enable analysis, optimization, and innovation in service systems?

Human Factors and Ergonomics in Manufacturing & Service Industries

Research Article

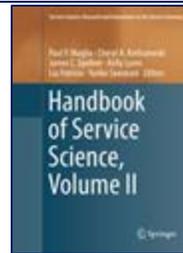
Service systems and the social enterprise

Stephen Tracy, Kelly Lyons ✉

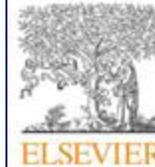
First published: 11 May 2012 | <https://doi.org/10.1002/hfm.20516> |

Chapter 13 A Multilayer Framework for Service System Analysis

Robert Blair Frost, Michael Cheng, and Kelly Lyons



Abstract As service science evolves as a discipline, an important ongoing focus for research has been modeling and representing entities as service systems in order to understand, represent, and innovate within service systems. Recently, there has been interest in exploring how data and data analytics are enabling service innovations within more traditional organizations. In this chapter, we present and evaluate a multilayer framework and analysis technique that can be used to describe an organization as a service system. The framework characterizes service systems within institutional arrangements, identifies key service system components, and describes the service ecosystem, internal relationships, and value-cocreating interactions. To test and validate the framework, we present the results of using the framework to analyze a mining company as a service system and identify ways in which data-intensive technologies can be used to integrate service innovations within it.



Contents lists available at ScienceDirect

International Journal of Information Management

journal homepage: www.elsevier.com/locate/ijinfomgt



From data to value: A nine-factor framework for data-based value creation in information-intensive services

Chiehyeon Lim^{a,*}, Ki-Hun Kim^b, Min-Jun Kim^c, Jun-Yeon Heo^c, Kwang-Jae Kim^b, Paul P. Maglio^d

^a School of Management Engineering and School of Business Administration, Ulsan National Institute of Science and Technology, 50 Unist-gil, Eonyang-eup, Ulsan, Ulsan 44919, Republic of Korea

^b Department of Industrial and Management Engineering, Pohang University of Science and Technology, San 31, Hyoja-dong, Nam-gu, Pohang, Gyeongbuk, 790-784, Republic of Korea

^c Samsung Electronics R&D Center, 33, Seongchon-gil, Seocho-gu, Seoul, 06765, Republic of Korea

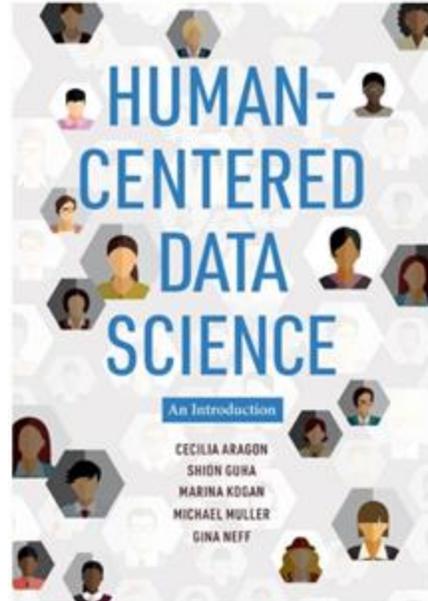
^d School of Engineering, University of California, Merced, 5200 North Lake Rd, Merced California, 95343, USA



Important to Consider Broader Ecosystem and Indirect Stakeholders



Shion Guha



“RIGHT NOW, A LOT OF DATA SCIENCE IS VERY MODEL-CENTERED—THE CONVERSATION IS ALWAYS AROUND WHAT MODEL CAN MOST ACCURATELY PREDICT SOMETHING. INSTEAD, THE CONVERSATION SHOULD BE, “WHAT CAN WE DO SO THAT PEOPLE HAVE THE BEST *OUTCOMES*?” IT’S A SLIGHTLY DIFFERENT CONVERSATION; THE VALUES ARE DIFFERENT.”

<https://srinstitute.utoronto.ca/news/shion-guha-human-centered-data-science>



Blair Attard-Frost

Supervisor: Kelly Lyons

Email: blair.frost@mail.utoronto.ca

Website: <https://www.blairaf.com>



Using a service systems lens to study and analyse AI Governance Systems

Identify areas of “disservice”: where some stakeholders experience benefit and value while others may experience harms

“Data is the New Oil”



<https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data>

Clive Humby, UK Mathematician, architect of Tesco’s Clubcard, 2006: “**Data is the new oil**. It’s valuable, but if unrefined it cannot be used.”

Virginia Rometty, IBM CEO, 2013: “... think about **data as the next natural resource**.”

Joe Kaeser, Siemens CEO, 2018: “**Data is the oil, some say the gold**, of the 21st century — the raw material that our economies, societies and democracies are increasingly being built on.”

Lisa Austin, Law Professor, University of Toronto, 2018: “**This is a 20th-century approach to 21st-century topics**. A better framing recognizes that data is not a natural resource but a new informational dimension to individual and community life.”

Applying a Service Systems Lens

- Can service science can contribute to a multidisciplinary, cross-institutional, cross-border research agenda that:
 - Pursues world-changing data-science research
 - Increases productivity, efficiency, and inclusiveness across industries
 - Furthers the transformation of existing operational systems with advanced data-science capabilities
 - Delivers transparency, explainability, fairness, and ethics in all aspects of data-science deployment
 - Equips policy makers and industry leaders with tools for predicting, managing, and surviving the pending disruption and economic and social consequences of adopting data-science and scale

Thank you!



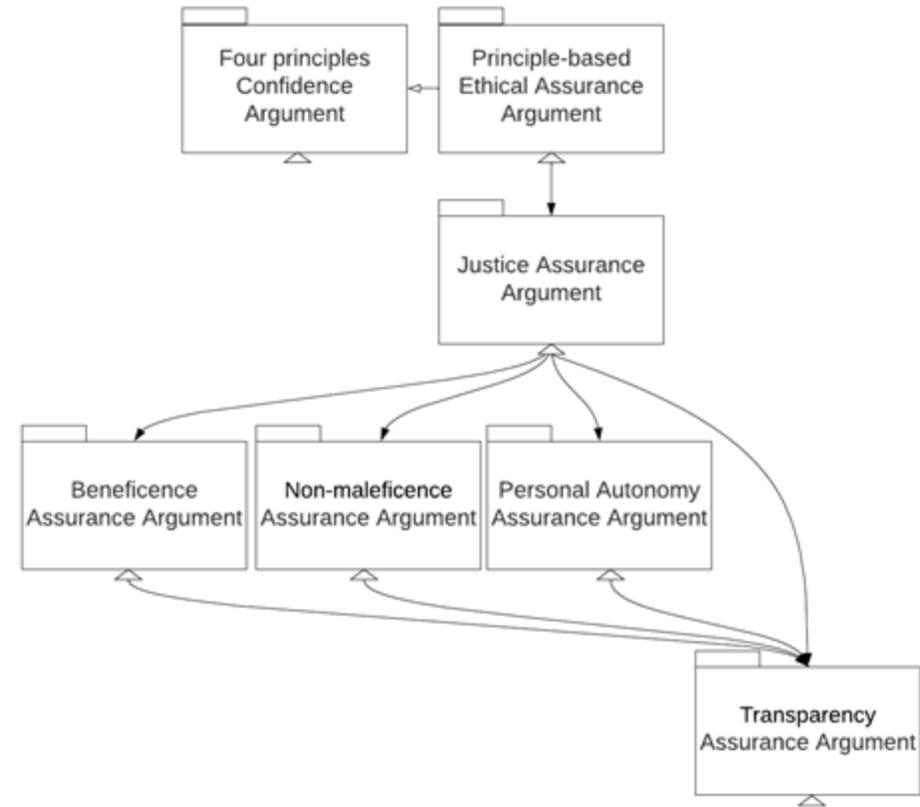
**ASSURING
AUTONOMY**
INTERNATIONAL PROGRAMME

*Prof John McDermid OBE FREng
York, October 2022*

Ethical Assurance Argument

Four principles plus one

- Adopted four principles from biomedical ethics
 - Beneficence – do (some) good
 - Non-maleficence – avoid harm
 - Personal autonomy – freedom to make meaningful choice
 - Justice – fairness in distribution of benefit and harm (& autonomy)
- Supported by transparency
 - Visibility of AI/ML behaviour



Assuring Services

Making the Case at Concept Design

- Systems engineering is about trade-offs
 - How to choose the best (concept) design when properties of interest, e.g. safety, human autonomy, are incommensurable
- Expand the ethical assurance argument
 - Can “reject” designs that don’t satisfy key criteria, e.g. beneficiaries disjoint from those at risk of harm
- Can compare remaining designs in terms of **justice** or **fairness**
 - Export comparisons from lower-level arguments
 - Typically no Pareto optimal/dominant solution
 - Use a process of reflective equilibrium to produce the argument
 - Some similarities with the notion of critical thinking – but group not individual

Mobility as a Service (MaaS)

Safety and Environment

- Electric autonomous vehicles
 - Including two seat vehicles
 - Safety for lone travellers
 - Compare fleets of different vehicle mixes



Vehicle Type	 Adult Occupant	 Child Occupant	 Vulnerable Road Users	 Safety Assist
2 Seat LPV	35%	42%	56%	24%
4 Seat LPV	65%	72%	60%	35%
Shuttle	91%	81%	73%	81%
Bus	23%	38%	18%	15%

Impact	2 Seat LPV	4 Seat LPV	Shuttle	Bus
Vehicle	60 g/CO ₂ /km	90 g/CO ₂ /km	230 g/CO ₂ /km	3,000 g/CO ₂ /km
Av. Occupancy	1.5	2	5	20
Per Passenger	45 g/CO ₂ /pa-km	45 g/CO ₂ /pa-km	46 g/CO ₂ /pa-km	150 g/CO ₂ /pa-km

Mobility as a Service (MaaS)

Benefits and Autonomy

- Assess benefits and individual autonomy for different stakeholders

- No optimal solution
- Fleet C (based on mid-sized shuttles) has most merit but some problems
- Baseline to improve for acceptability

Stakeholder	Fleet A	Fleet B	Fleet C
Lone traveller	++	+	N
Large family	--	-	+
Young family	-	-	+
Blue badge	--	--	N
Free travel	++	++	+

Stakeholder	Fleet A	Fleet B	Fleet C
Lone traveller	++	+	-
Large family	--	-	+
Young family	--	-	N
Blue badge	--	-	N
Free travel	N	N	N

Conclusions

Shaping the Argument

- Designing safe, ethical & sustainable services is hard
 - Believe that an argument-based approach helps to illuminate the issues – a basis for reaching consensus
 - Sketched an approach – some of the concepts & building blocks been published, but more needs to be done

**Safe, Ethical & Sustainable:
A Mantra for All Seasons?**



- Approach **A Principles-based Ethical Assurance Argument for AI and Autonomous Systems**

Zoe Porter, Ibrahim Habli, John McDermid

An assurance case presents a clear and defensible argument, supported by evidence, that a system will operate as intended in a particular context. Typically, an assurance case presents an argument that a system will be acceptably safe in its intended context. One emerging proposal within the Trustworthy AI research community is to extend and apply this methodology to provide assurance that the use of an AI system or an autonomous system (AI/AS) will be acceptably ethical in a particular context. In this paper, we advance this proposal further. We do so by presenting a principles-based ethical assurance (PBEA) argument pattern for AI/AS. The PBEA argument pattern offers a framework for reasoning about the overall ethical acceptability of the use of a given AI/AS and it could be an early prototype template for specific ethical assurance cases. The four core ethical principles that form the basis of the PBEA argument pattern are: justice; beneficence; non-maleficence; and respect for personal autonomy. Throughout, we connect stages of the argument pattern to examples of AI/AS applications. This helps to show its initial plausibility.



**ASSURING
AUTONOMY**
INTERNATIONAL PROGRAMME

Funded by



Lloyd's Register
Foundation



UNIVERSITY
of York

John McDermid brainstorming

- Complex Systems Mantra: Safe, Ethical, Sustainable
 - “... guiding principles on how to achieve and manage the safety of complex systems whose failure causes and consequences go beyond the concerns of traditional safety engineering. ... new models for safety engineering and proposes the adoption of the mantra “safe, ethical and sustainable” to not only focus the attention of the community on the key issues, but also to influence politicians and policies.”

Panel 2: Artificial Intelligence



Jim Spohrer

Retired IBM, Member ISSIP
Co-author “Service in the AI Era”



Hila Lifshitz-Assaf

Harvard & Warwick, UK



Karthik Ramani

Purdue



Shaun West

Lucerne, Switzerland

- Artificial intelligence (AI) has been making rapid advances for specific tasks where massive amounts of data and computing power allow the development of neural network models as input-output functions. AI-enabled, neural network model, digital twins of service systems that give and get a wide range of service types are being predicted, including for people, and their style of expertise. For example, generating text in the writing style of Shakespeare, or digital images in the painting style of Van Gogh. The term “digital muse” has been used to refer to these AI tools used by people.
- In addition, AI-enabled, neural network model, natural language translation systems for multiple language have improved greatly in the last decade. The role of AI in translating between academic disciplines languages will likely be explored in coming years and may help accelerate transdisciplinary efforts.

sustainability

Business and societal systems and supply chains are increasingly complex and interconnected.

Real-world problems do not respect discipline boundaries.

Scalable solutions require many schools of practice working together, and current solutions may have unintended consequences, short-term or longer-term, especially if perspectives are not invited/considered.

Technological progress improved the scalability of agriculture and manufacturing, and next all types of service will be made more scalable (and currently, energy intensive) by future AI capabilities and progress.

A small sampling of schools and disciplines below – more exist 😊 - apologies for not adding yours to this

School of practice for Physical Sciences & Engineering Technology			School of practice for Behavioral & Social Sciences, Humanities & Arts People			School of practice for Managerial Sciences & Entrepreneurship Information & Organizations		
Comp. Sci./AI HCI/Robotics	Electrical & Mech. Eng.	Systems Engineering	Economics	Public Policy & Law	Design	Information Systems	Operations Research	Marketing & Strategy

Read enough of Kline (1995) to understand conceptual foundation of multidisciplinary thinking and the techno-extension factor and the accelerating soci—technical system design loop concepts.

Why upskilling with AI trend is important to systems thinking

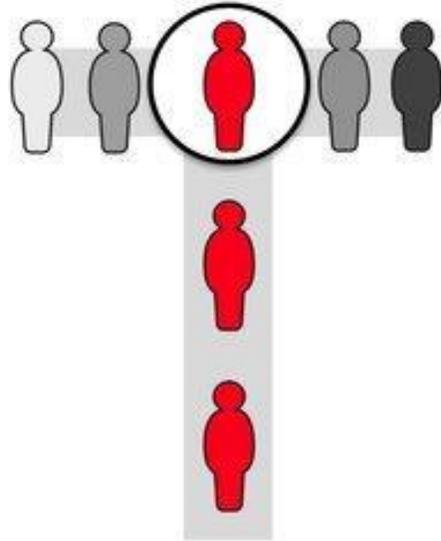
Talent development is moving from I to T to X (eXtended with AI)

CHANGE FOR THE WORKER: Expertise Shifts: The I to the T to the X

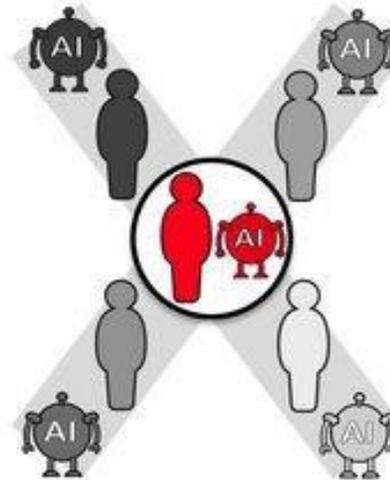
DISCIPLINARY



MULTI-DISCIPLINARY
(T-Shaped)



TRANSDISCIPLINARY
(Human-Machine + Disciplinary Convergence)



Stocks of Knowledge* (Educated)

Flows of Knowledge* (Learning Agility)

*Stocks and Flows of Knowledge (John Hagel, Deloitte)

6 T-shape Skills
Knowledge Areas
To be eXtended
By AI tools:

1. Disciplines
2. Systems
3. Cultures

4. Technologies
5. Practices
6. Mindsets

AI Tools to Experiment with Today

Try at least two from the list before Oct. 17. What do you think?

Thanks to [@TessaRDavis](#) for compiling this list:

- #1 [Magic Eraser](#)
- #2 [Craiyon](#) And [Stable Diffusion](#) and [DALL-E](#)
- #3 [Rytr](#) and [OpenAI GTP 3.0/ChatGTP](#)
- #4 [Thing Translator](#)
- #5 [Autodraw](#)
- #6 [Fontjoy](#)
- #7 [Talk to Book](#)
- #8 [This Person Does Not Exist](#)
- #9 [Namelix](#)
- #10 [Let's Enhance](#)

“Service providers will not be replaced by AI, but service providers who do not use AI will be replaced by those who do.”

Every person in a role in an organization is a service provider.

How, What, and Why? Inspiring upskilling with AI

- How to learn
 - AI-powered search can help motivated people learn about whatever they put their minds to learning
- What to learn
 - AI technological capabilities and limitations – foundational models
 - AI applications that can actually improve processes for how things get done (case studies - productivity, quality, compliance, sustainability, decarbonization)
 - AI-as-a-service investment cases to motivate stakeholders to change to better win-win interactions in business and societal service systems (investment pitch)
 - The “startup of you” investment case – learning to invest systematically and wisely (startup pitch)
- Why learn?
 - Motivation is key – find the very best free online videos/courses and subscribe
 - Nations must upskill with AI and decarbonize
 - Universities will play an increasingly important role even as learners can do more and more on their own



Will a “Google PhD” become as good as a university-granted PhD?

By Ross Dawson



ROSS DAWSON

Jordi Muñoz became President of prominent early drone company 3D Robotics at age 22, having made himself a world-leading expert in drone design and manufacturing, teaching himself through the universe of resources available through the web and his own experiments. **He says:**

“I come from a generation where we have Google PhDs, we can virtually figure out everything by just Googling around and doing some reading online”

Sci-Fi author William Gibson became a deep expert in antique watches by dint of five years research for “the sheer pointless pleasure of learning this vast, useless body of knowledge.” **He notes that:**

“Now you can be a kid in a town in the backwoods of Brazil, and you can wake up one morning and say, “I want to know everything about stainless steel sports watches from the 1950s,” and if you really applied yourself, to the internet, at the end of the year you would have the equivalent of a master’s degree in this tiny pointless field. I’ve totally met lots of people who have the equivalent of that degree.”

If you take this path you don’t get a piece of paper or certificate to put on your resume. But you may well have the same degree of knowledge, potentially even more up-to-date, than many with a formal advanced degree in your field of study, and likely faster.

AI Tools in coming decades...

Read Wakefield (2020) enough to understand what a "digital twin" of you might be like in the future decades with very advanced AI capabilities.

Also see Rouse (2018; 2022) "Life with a Cognitive Assistant."



GETTY IMAGES

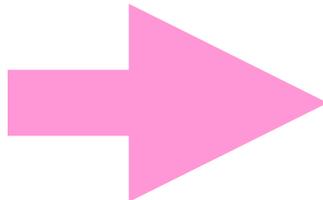
| Some experts say that thinking digital twins of humans may be just a decade away

Predict the Timeline: GDP/Employee

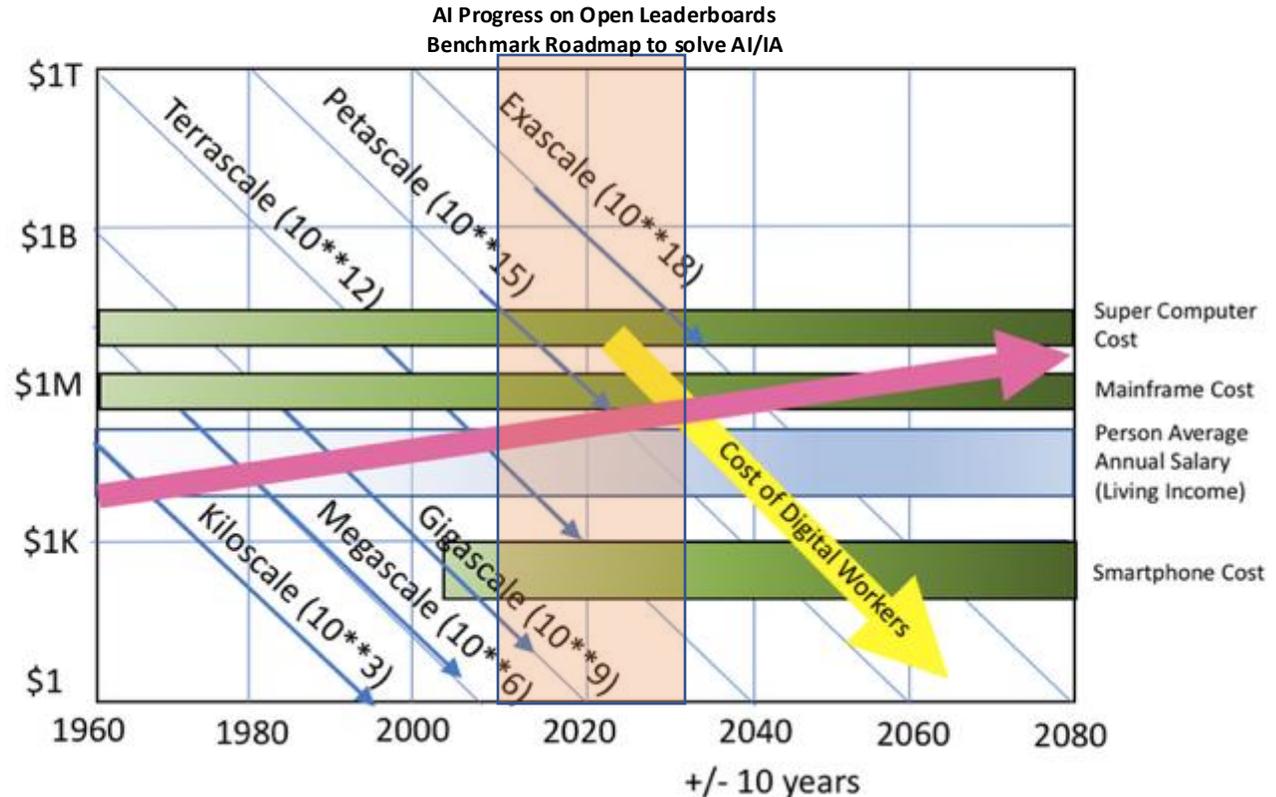
Read Rouse & Spohrer (2018) enough to understand this slide including what "exascale" means

Lower compute costs translate into increasing productivity and GDP/employees for nations
 Increasing productivity and GDP/employees should translate into wealthier citizens

GDP/Employees USA (Source)



- GDP/employees USA
 - 1960: \$10K
 - 1970: \$15K
 - 1980: \$33K
 - 1990: \$55K
 - 2000: \$78K
 - 2010: \$116K
 - 2015: \$127K
- Projected
 - 2020: \$140K
 - 2040: \$350K
 - 2060: \$1M
 - 2080: \$3.25M



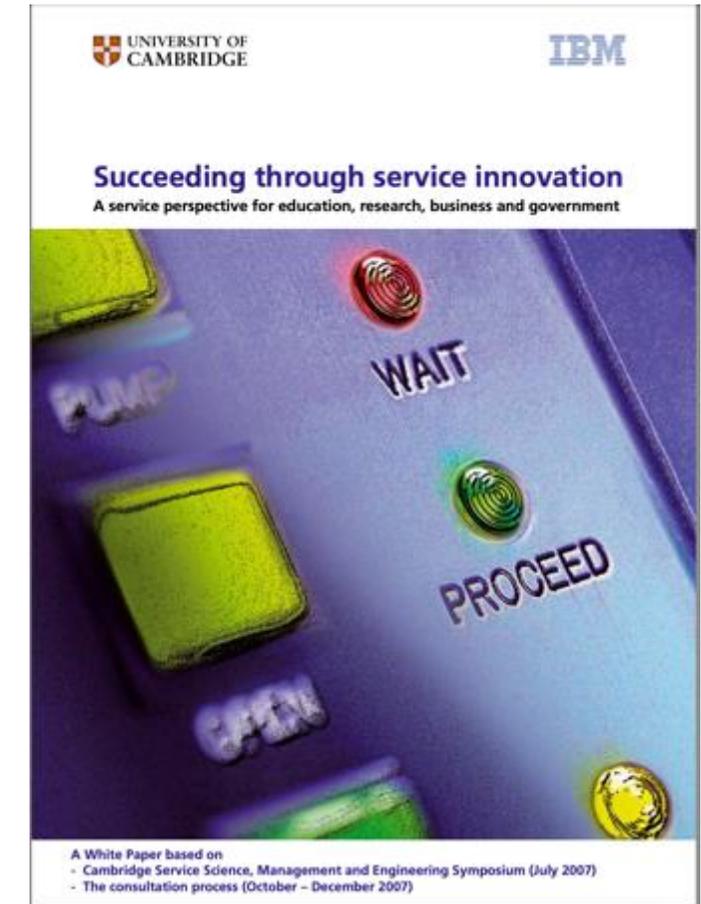
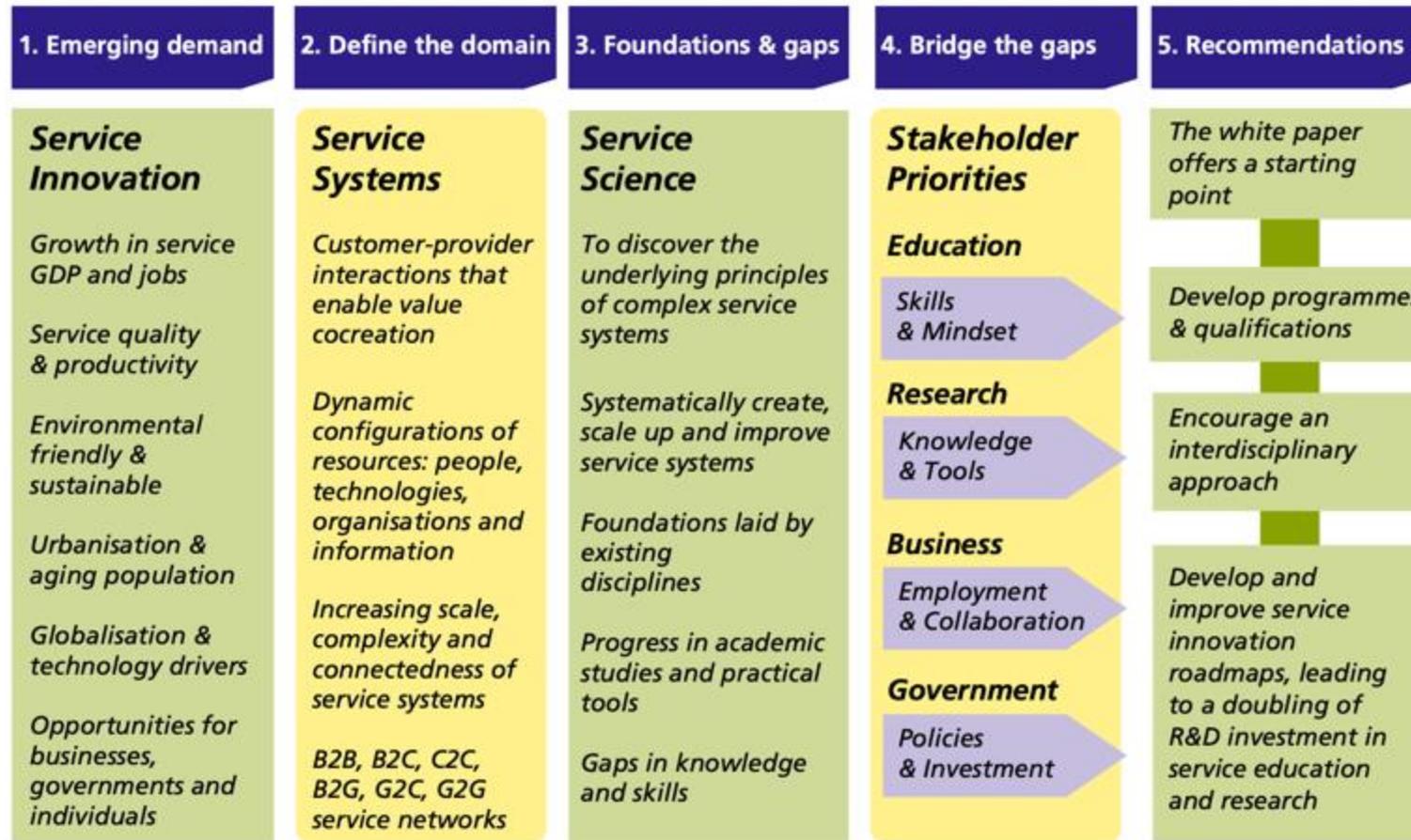
Alistair Nolan (OECD AI for Science Productivity): "It has been stated that the number of engineers proclaiming the end of Moore's Law doubles every two years."

Rouse WB, Spohrer JC. (2018) Automating versus augmenting intelligence. Journal of Enterprise Transformation. 2018 Apr 3;8(1-2):1-21.

Call to Action

- Responsible actors need to learn to invest wisely in getting the future service innovations we want with AI – guided by “Service Innovation Roadmaps (SIRs).”

Read enough of IfM and IBM (2008) to understand what a “Service Innovation Roadmap (SIR)” is – and who should be creating them.

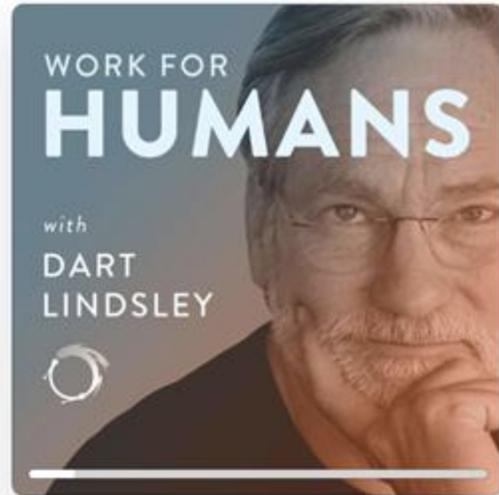


Read enough of pages 45-54 of Spohrer, Maglio, Vargo, Warg (2022) to formulate an opinion on the topic of “investing wisely to get the future service systems we want.”

Discussion

- Are you positive or negative about AI?
 - If positive, are you using any specific AI tools today?
 - See list of AI tools to try on a previous slide
 - How are you investing in upskilling with AI?
 - If negative, do you have a specific concern (“ditch to avoid”) – for example...?
 - AI will take away my job
 - AI will be used primarily by “bad actors” for mischief
 - Or used by social media platforms to generate more clicks/attention thru angry reactions
 - AI will try to take over people and planet
 - AI will deskill and weaken people over time
 - ... or other concerns about AI?
- Do you believe responsible actors (e.g., people, businesses, universities, governments, etc.) are learning to invest systematically and wisely in getting the future we want? If not, why not – what is needed?
- Join ISSIP.org (free for individuals) if you would like to continue the conversation!





TODAY · S1 E13 · 55 MIN LEFT

Service Science and the Impending AI Revolution | Jim Spohrer

Work For Humans

|| Pause



APPLE

<https://podcasts.apple.com/us/podcast/service-science-and-the-impending-ai-revolution/id1612743401?i=1000583800244>

SPOTIFY:

<https://open.spotify.com/episode/0n3h9rgX6UYDCwxgTzokoK?si=yVF0mtHsRZSmdfy-aMi8DA>

GOOGLE

<https://podcasts.google.com/feed/aHR0cHM6Ly9mZWVkcY5idXp6c3Byb3V0LmNvbS8xOTQ5NTE3LnJzcmw?sa=X&ved=2ahUKEwiPzL-Zxvv6AhXzjo4IHVbTAuUQ9sEGegQIARAC>

References

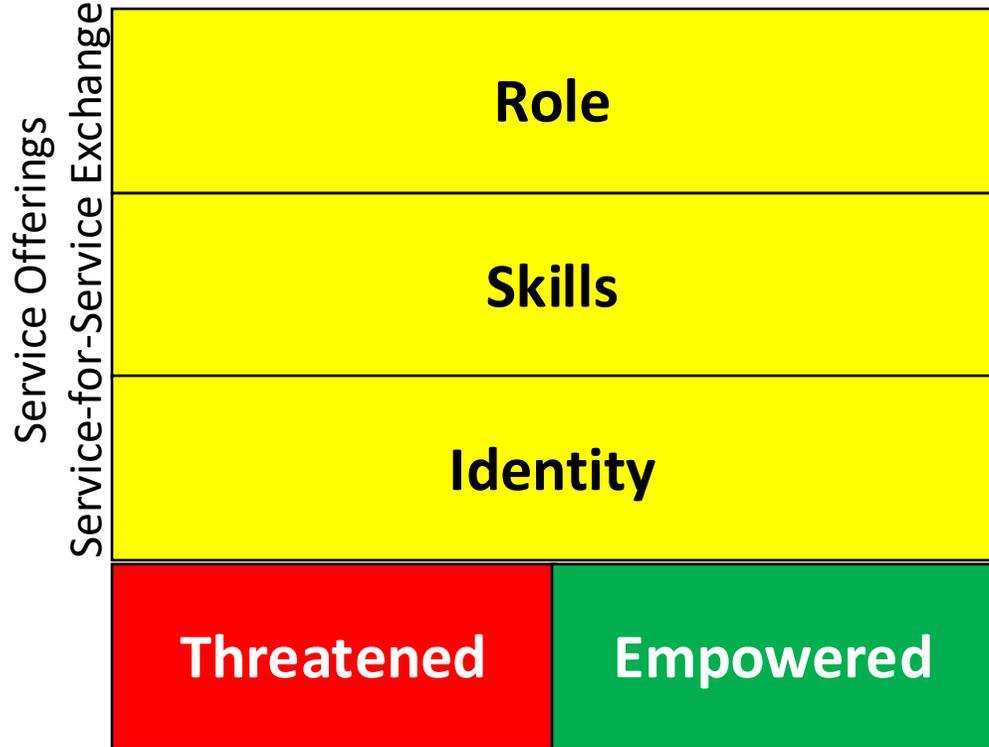
- Araya D (2018) Augmented Intelligence: Smart Systems and the Future of Work and Learning. Peter Lang International Academic Publishers; 2018 Sep 28.
- Bush V (1945) As we may think. The Atlantic Monthly. 1945 Jul 1;176(1):101-8.
- Engelbart D (1962) Augmenting human intellect. Summary report AFOSR-3223 under Contract AF. 1962 Oct;49(638):1024.
- Gardner P, Maietta HN (2020) Advancing Talent Development: Steps Toward a T-Model Infused Undergraduate Education. Business Expert Press. URL: <https://www.amazon.com/Advancing-Talent-Development-Undergraduate-Education/dp/1951527062>
- Kay A, Jobs S (1984) Wheels for the Mind. Apple Computer.
- Kline SJ (1995) Conceptual foundations for multidisciplinary thinking. Stanford University Press; 1995.
- Licklider JC (1960) . [Man-computer symbiosis](#). IRE transactions on human factors in electronics. 1960 Mar(1):4-11.
- Malone TW (2018) Superminds: The surprising power of people and computers thinking together. Little, Brown Spark; 2018 May 15.
- Norman D (1994) Things that make us smart: Defending human attributes in the age of the machine. Diversion Books; 2014 Dec 2.
- Rouse WB, Spohrer JC (2018) Automating versus augmenting intelligence. Journal of Enterprise Transformation. 2018 Feb 7:1 -21.
- Siddike MA, Spohrer J, Demirkan H, Kohda Y (2018) A Framework of Enhanced Performance: People's Interactions With Cognitive Assistants. International Journal of Systems and Service-Oriented Engineering (IJSSOE). 2018 Jul 1;8(3):1-7.
- Spohrer JC (1998) Information in places. IBM Systems Journal. 1999;38(4):602-28.
- Spohrer JC, Engelbart DC (2004) Converging technologies for enhancing human performance: Science and business perspectives. Annals of the New York Academy of Sciences. 2004 May;1013(1):50-82.
- Spohrer J, Siddike (2018) The Future of Digital Cognitive Systems: Tool, Assistant, Collaborator, Coach, Mediator. In Ed. Araya D. Augmented Intelligence: Smart Systems and the Future of Work and Learning. Peter Lang International Academic Publishers; 2018 Sep 28.
- Spohrer J (2020) [Online Platform Economy and Gig Workers: A USA Perspective](#). Presentation.
- Spohrer J & Maglio PP (2006) [Service Science Management and Engineering \(SSME\): An Emerging Discipline](#). IBM Presentation.

Additional Resources

- Arthur WB (2019) [Foundations of Complexity Economics](#). Nature Review Physics.
- Dietrich BL, Plachy EC, Norton MF (2014) [Analytics Across the Enterprise](#).
- Donofrio N, DeMarco M (2022) [If Nothing Changes, Nothing Changes: The Nick Donofrio](#).
- Fleming M (2022) [Breakthrough: The Growth Revolution \(in an Era of Artificial Intelligence and Worker Engagement\)](#).
- IfM and IBM (2008) [Succeeding through service innovation: A service perspective for education, research, business and government](#)
- Larson RC (2022) Model Thinking for Everyday Life Working Wonders with a Blank Sheet of Paper. (Coming Soon).
- Lebovitz S, Lifshitz-Assaf H, Levina N (2022) [To Engage or Not to Engage with AI for Critical Judgments: How Professionals Deal with Opacity When Using AI for Medical Diagnosis](#). Organization Science.
- Madhavan G, Poste G, Rouse W (2020) [Complex Unifiable System. Editors' Note: Systemic Vistas](#). Winter 2020. The Bridge.
- Maglio PP, Kieliszewski CA, Spohrer JC (2010) [Handbook of Service Science](#)
- Maglio PP, Kieliszewski CA, Spohrer JC, Lyons K, Patrício L, Sawatani Y (2019) [Handbook of Service Science, Vol II](#)
- McDermid JA (2022) [Safe, Ethical & Sustainable: A Mantra for All Seasons?](#)
- Munn L (2022) [The uselessness of AI ethics](#).
- Norman D (2023) [Design for a Better World: Meaningful, Sustainable, Humanity Centered](#)
- Rouse WB (2018) [Life with a cognitive assistant](#). (2022) [Emily 2.0](#).
- Rouse WB, Spohrer JC (2018) [Automating versus augmenting intelligence](#). Journal of Enterprise Transformation.
- Schneiderman (2022) [Human-Centered AI](#).
- Spohrer J (2017) [Imagination Challenge: Quantify and graph cost of digital workers and GDP per employee USA from 1960-2080](#).
- Spohrer J, Maglio, PP (2009) [Service Science: Toward a Smarter Planet. In Service Engineering](#).
- Spohrer J, Maglio PP, Vargo SL, Warg M (2022) [Service in the AI Era: Science, Logic, and Architecture Perspectives](#).
- US 110th Congress (2007) [SEC. 1005. STUDY OF SERVICE SCIENCE](#).
- Vargo SL, Lusch RF (2016) [Institutions and Axioms: An Extension and Update of Service-Dominant Logic](#). JAMS.
- Wakefield J (2022) [Why you may have a thinking digital twin within a decade](#). BBC News Online.
- West S, Meierhofer J, Mangla U (2022) [Smart Services Summit: Smart Services Supporting the New Normal](#).
- West S, Stoll O, Muller-Csernietzky P (2022) [A Handbook for Smart Service Design - The design of Smart Services in a world of people, process and things](#).
- Wladalsky-Berger I (2016) [The Continuing Evolution of Service Science](#). (2019) [The Increasing Demand for Hybrid, "T-Shaped" Workers](#). (2021) [The Supply Chain Economy - A New Categorization of the US Economy](#). (2022) [A Measurement Framework for the Digital Economy](#). (2022) [Foundation Models: AI's Exciting New Frontier](#).



ISSIP: Service Innovation and T-Shaped Adaptive Innovators



Individual Expertise – T1, T3

Collective Expertise – T6

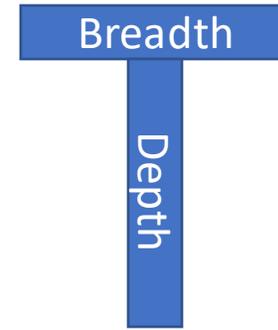
Augmented Expertise – T6

Sustaining “mindsets” requires “like-minded”

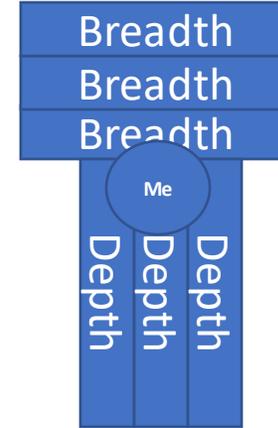
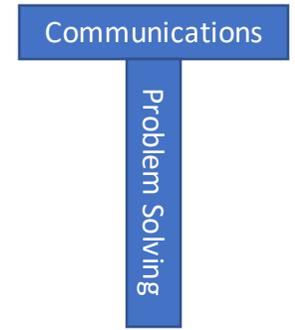
Sustaining “innovation” requires “depth-diversity-inclusion”

Sustaining above requires “lifelong learning – interaction & change”

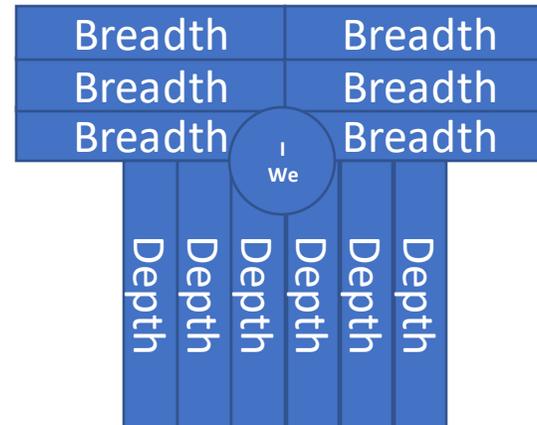
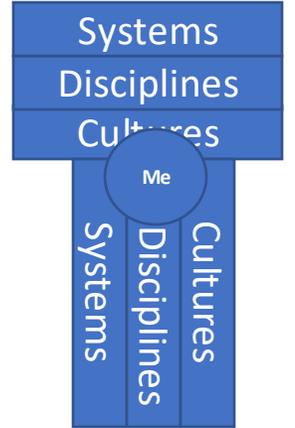
Sustaining people requires “rhythmic cycles” – breath, drink & eat, sleep, etc.



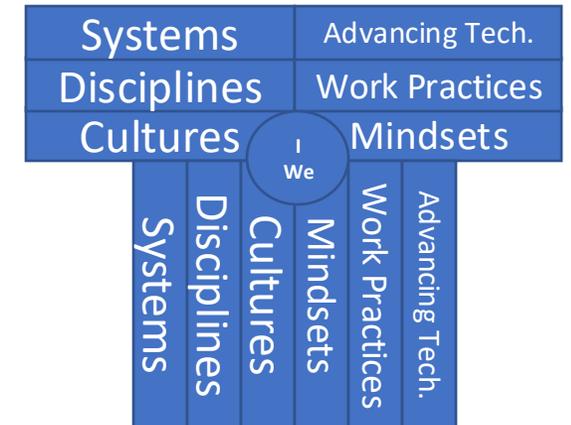
T1



T3



T6



The object of innovation	Strategic intent	Service orientation <i>Service infusion</i>	Economic role <i>Service integration</i>
	Process	Operation <i>Service engineering</i>	Economic activity <i>Service reconfiguration</i>
	Output	Intangible product <i>New service development</i>	Customer experience <i>Service design</i>
		Service firm	Generic actor
		The innovation subject	

Note. The first line in each cell represents perspectives on service. The corresponding perspectives on service innovation are in italics.

FIGURE 1 A framework for defining perspectives on service and service innovation

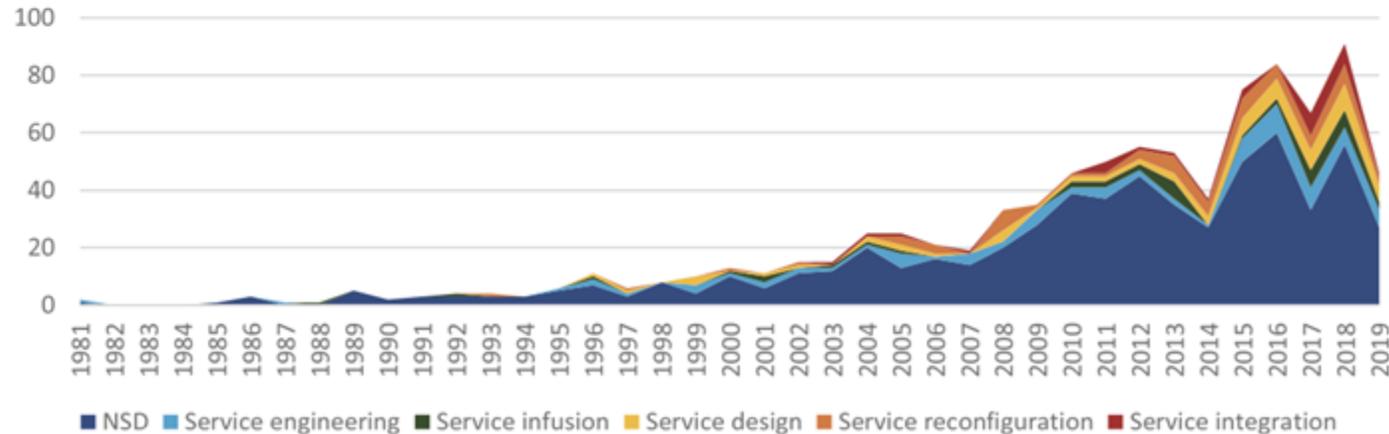
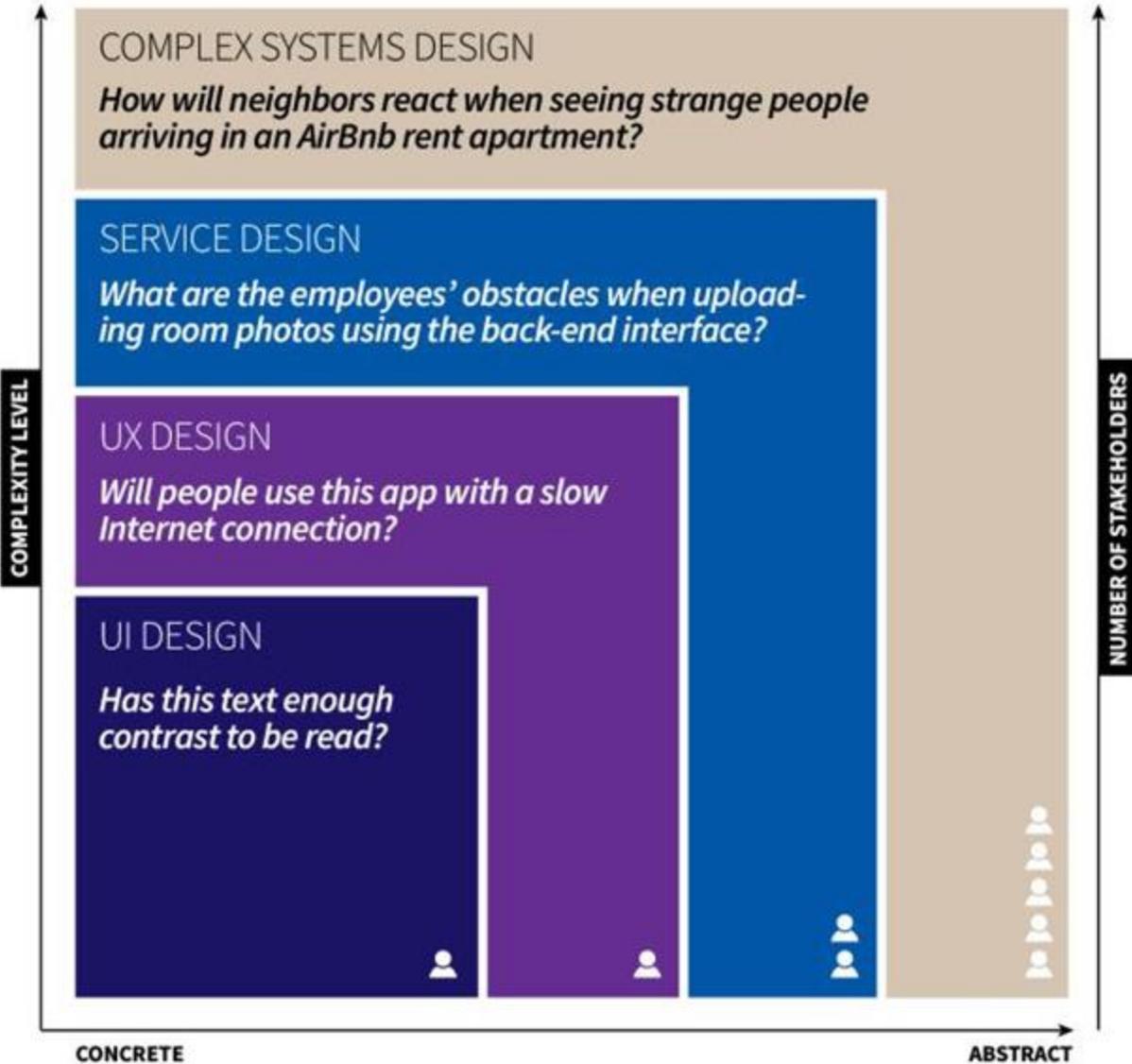


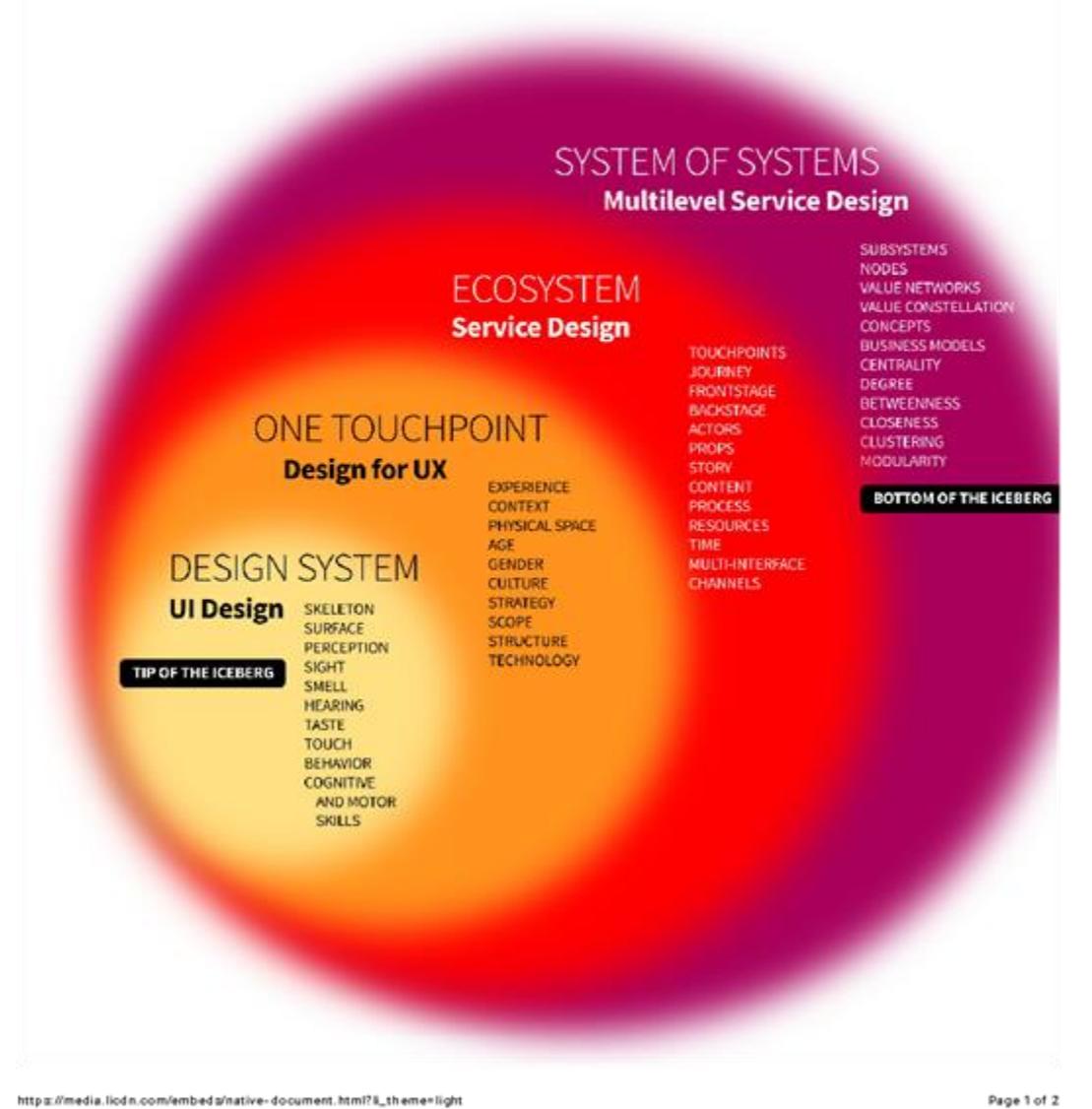
FIGURE 2 The evolution of the number of articles within perspectives on service innovation [Colour figure can be viewed at wileyonlinelibrary.com]

LEARN THE DIFFERENCE

UI DESIGN UX DESIGN SERVICE DESIGN COMPLEX SYSTEMS DESIGN



LOOK BELOW THE SURFACE



Please take the 4 questions [short survey](https://tinyurl.com/service-systems) <https://tinyurl.com/service-systems>

- Best Prepared
(current undergraduate degrees preparation adequate)
 - Narrow, well-defined technical system problems
 - Technology - Automation of simple capabilities
 - Measurement - Productivity, Quality, Costs
 - Data Science and Analytics - Recommender Systems
 - Manufacturing systems and value creation (Goods-dominant logic)
 - Linear supply chains
 - Single discipline, well-defined problems
 - Artifact design and interface design
 - Change of simple processes

Some
early
responses

- Least Prepared
(current undergraduate degrees preparation not fully adequate)
 - Open-ended, ill-defined socio-technical system problems
 - Technology - Augmentation of human intelligence
 - Measurement – Equity and service system value cocreation (Service-dominant logic)
 - Highly interconnected supply networks
 - Multiple discipline, wicked problems
 - Service design and user experience design
 - Change of organizations and ecosystems

Engaged AI Augmentation

- BiblioL2022 Lebovitz S, Lifshitz-Assaf H, Levina N (2022) To Engage or Not to Engage with AI for Critical Judgments: How Professionals Deal with Opacity When Using AI for Medical Diagnosis. Organization Science. Published online in Articles in Advance 10 Jan 2022 . URL: <https://doi.org/10.1287/orsc.2021.1549>
- Quotes: *"Abstract - Artificial intelligence (AI) technologies promise to transform how professionals conduct knowledge work by augmenting their capabilities for making professional judgments. We know little, however, about how human-AI augmentation takes place in practice. Yet, gaining this understanding is particularly important when professionals use AI tools to form judgments on critical decisions. We conducted an in-depth field study in a major U.S. hospital where AI tools were used in three departments by diagnostic radiologists making breast cancer, lung cancer, and bone age determinations. The study illustrates the hindering effects of opacity that professionals experienced when using AI tools and explores how these professionals grappled with it in practice. In all three departments, this opacity resulted in professionals experiencing increased uncertainty because AI tool results often diverged from their initial judgment without providing underlying reasoning. Only in one department (of the three) did professionals consistently incorporate AI results into their final judgments, achieving what we call engaged augmentation. These professionals invested in AI interrogation practices—practices enacted by human experts to relate their own knowledge claims to AI knowledge claims. Professionals in the other two departments did not enact such practices and did not incorporate AI inputs into their final decisions, which we call unengaged “augmentation.” Our study unpacks the challenges involved in augmenting professional judgment with powerful, yet opaque, technologies and contributes to literature on AI adoption in knowledge work."*

Spatial Human Intelligence Augmentation for up-pre-re- skilling

Karthik Ramani

Donald W. Feddersen Distinguished Professor of Mechanical Engineering
Professor of Electrical and Computer Engineering
Professor of Educational Studies, College of Education (by courtesy)



CONVERGENCE
DESIGN LAB

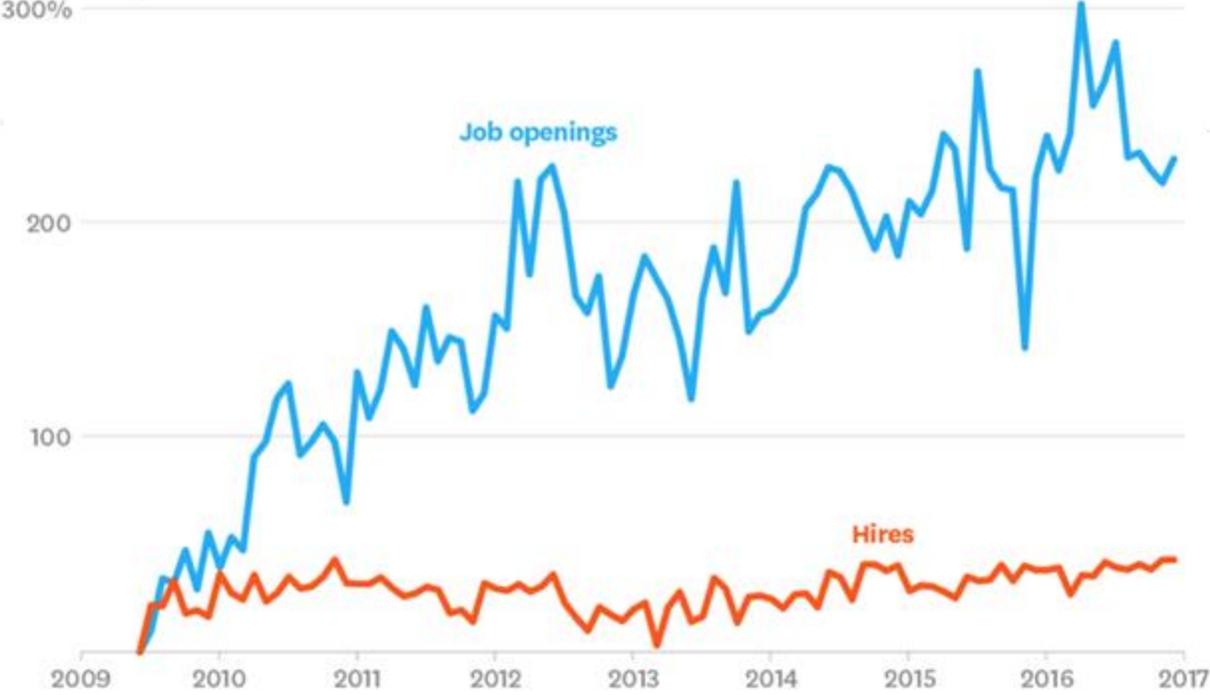


PURDUE
UNIVERSITY®

Skill biased technology changes

The Growing Shortage of Skilled Manufacturing Workers

PERCENTAGE CHANGE IN U.S. MANUFACTURING JOB OPENINGS AND HIRES, SEASONALLY ADJUSTED



SOURCE U.S. BUREAU OF LABOR STATISTICS

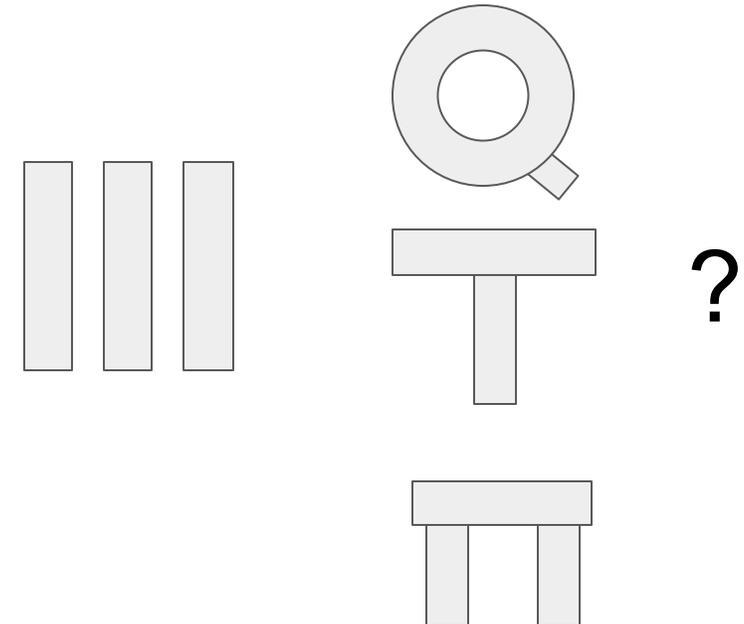
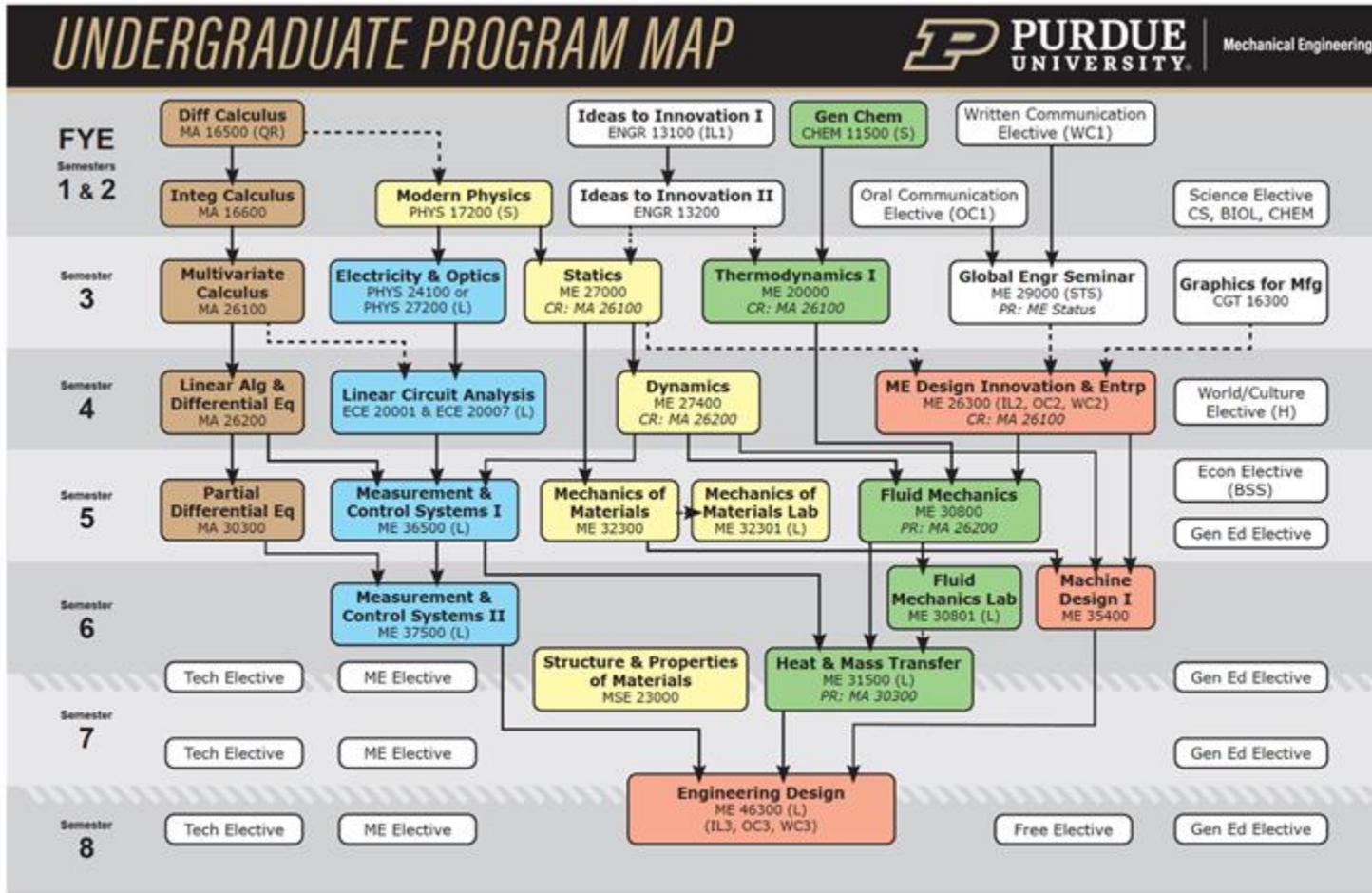
© HBR.ORG

The New York Times

Tech Is Splitting the U.S. Work Force in Two

A small group of well-educated professionals enjoys rising wages, while most workers toil in low-wage jobs with few chances to advance.

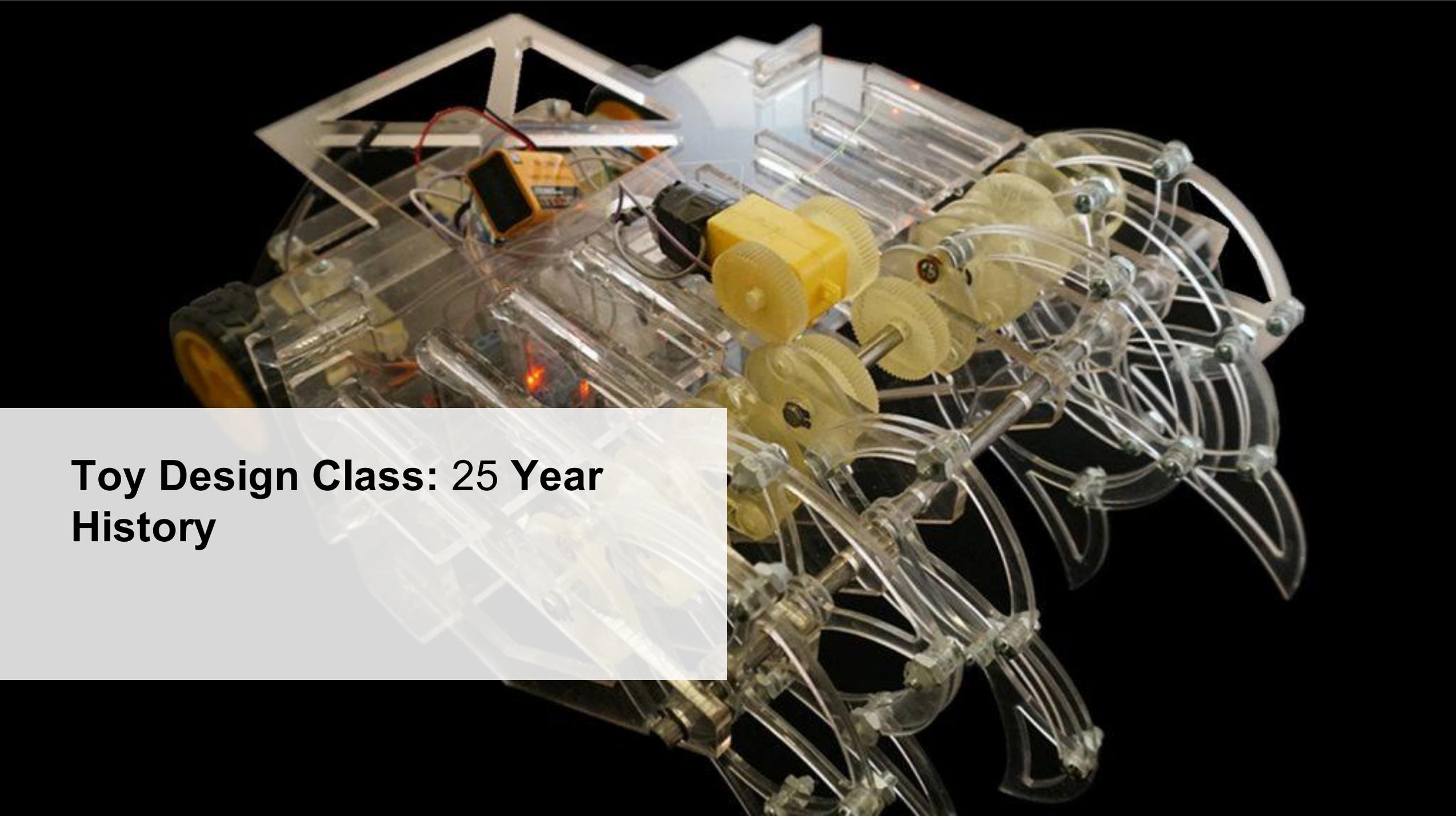
Educational Silos Bimodality: Undergrad vs. Graduate



School of Mechanical Engineering
 585 Purdue Mall, Room 2008
 West Lafayette, IN 47907
 Phone: (765) 494-5689
 Email: MEundergrad@purdue.edu

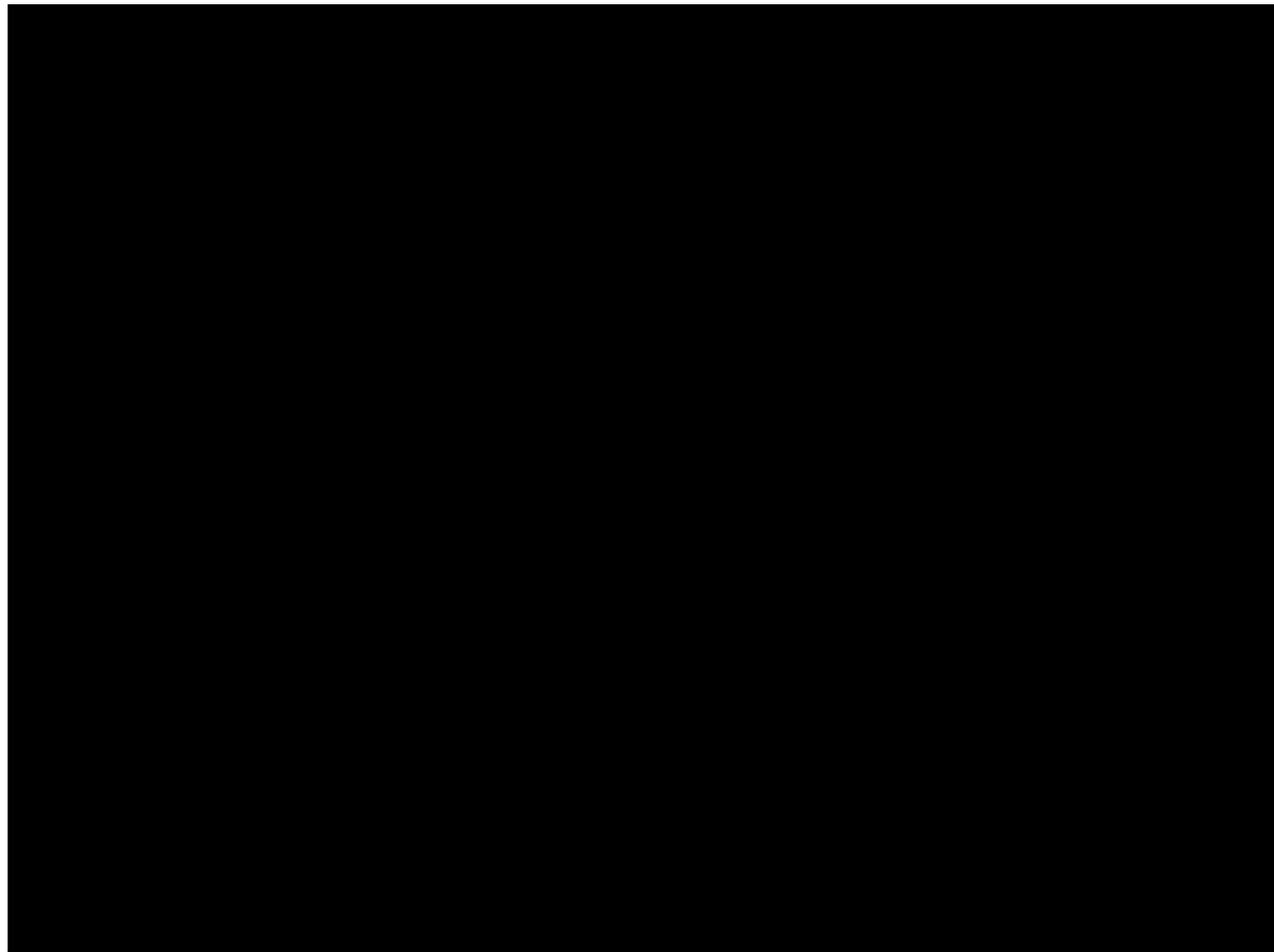
purdue.edu/ME

Program Map updated Aug 2022



**Toy Design Class: 25 Year
History**

Toy Fair at Purdue



Augmentation is not new ...but ...



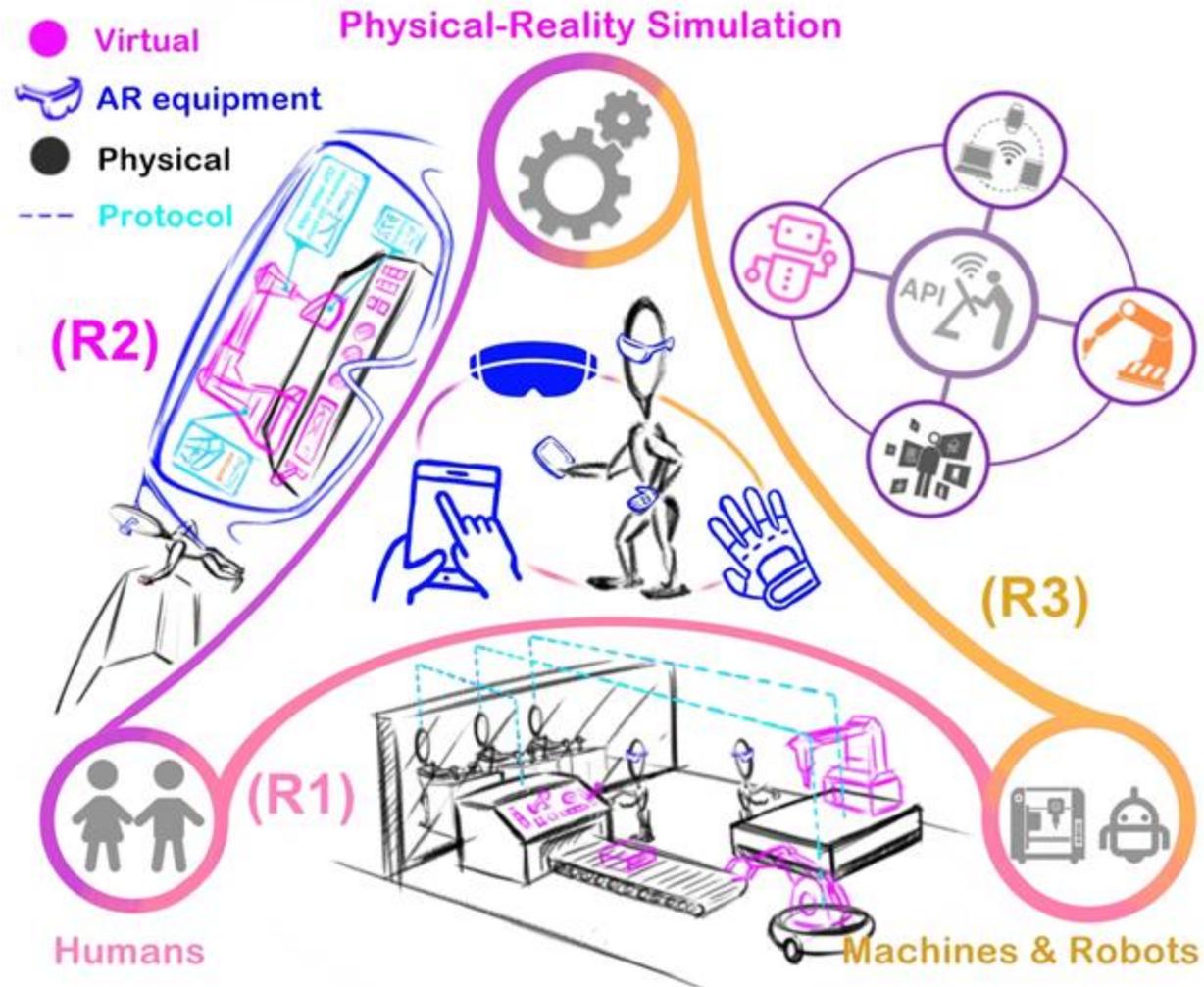
Hololens 2, \$3 K - Industrial, \$5 K - With Trimble, \$5 K



Rayban, Snapchat, Vizix, Nreal, Lenovo, Magic Leap, ArgoDesign

It's the first time in human history that a machine will share our viewpoint and our specific context moment to moment.

Human Augmentation Age

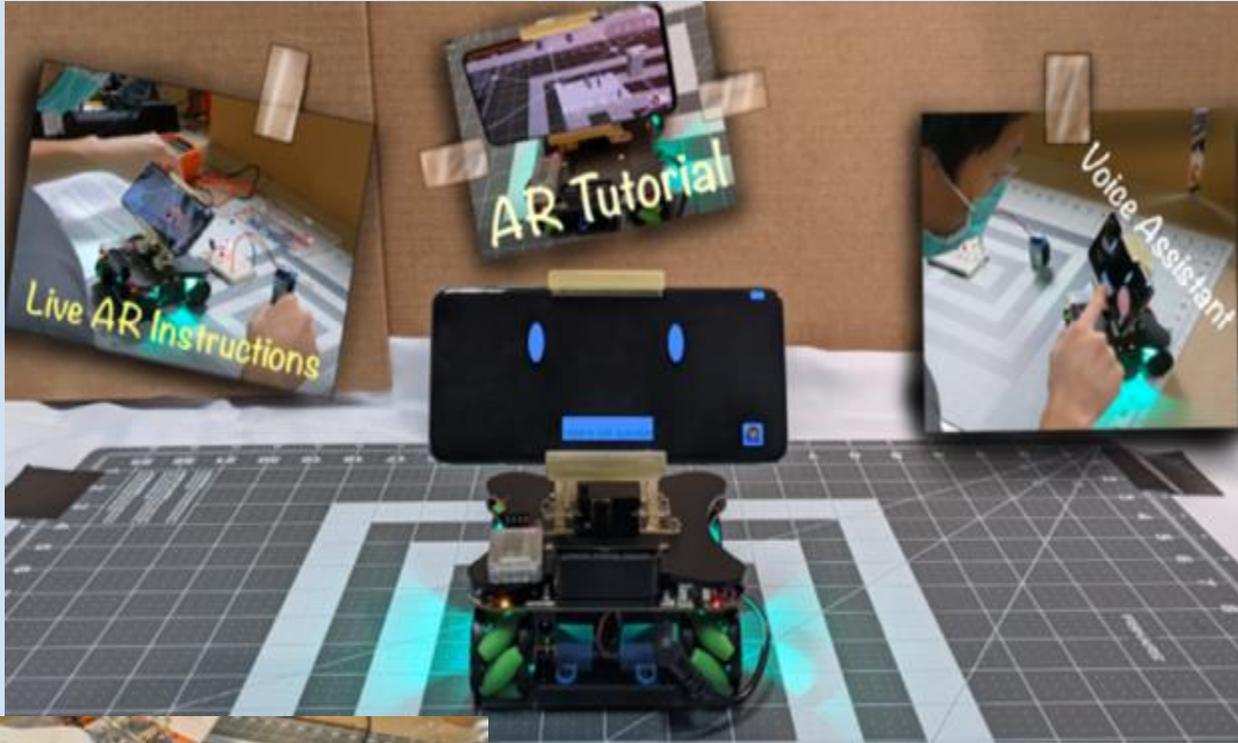


AR Animation



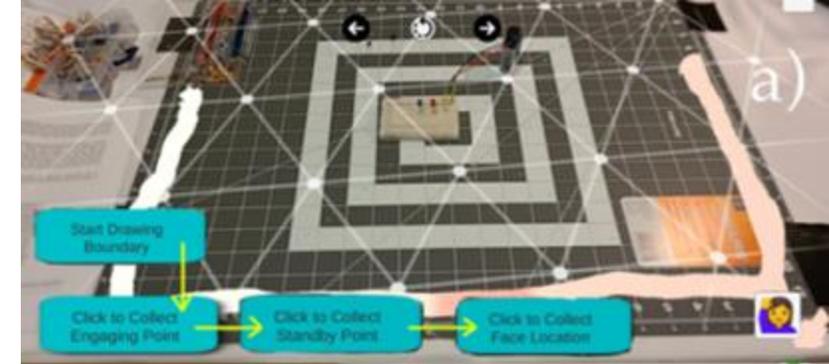
AR Remote Learning

AR for teleconsulting between instructors and students

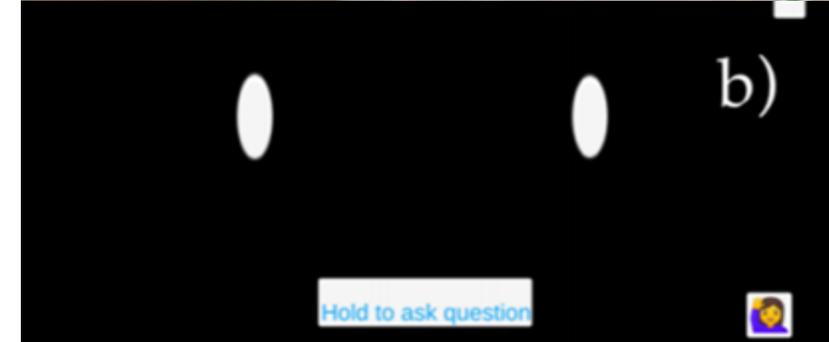


Example of a teleconsulting session. Instructor moves the robot and zooms in to focus on student's question.

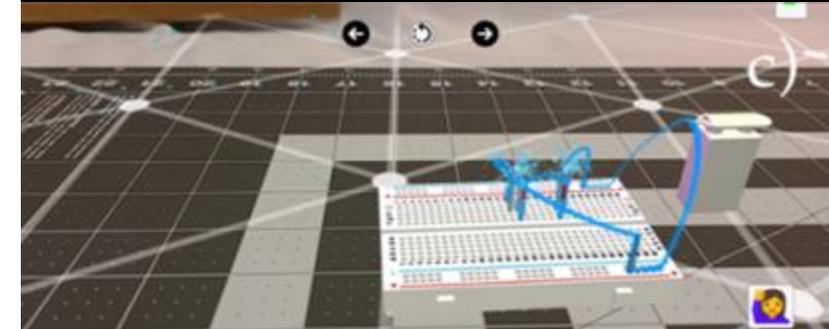
Setting up the environment for the robot to move on the table



Voice AI assistant to answer students' questions



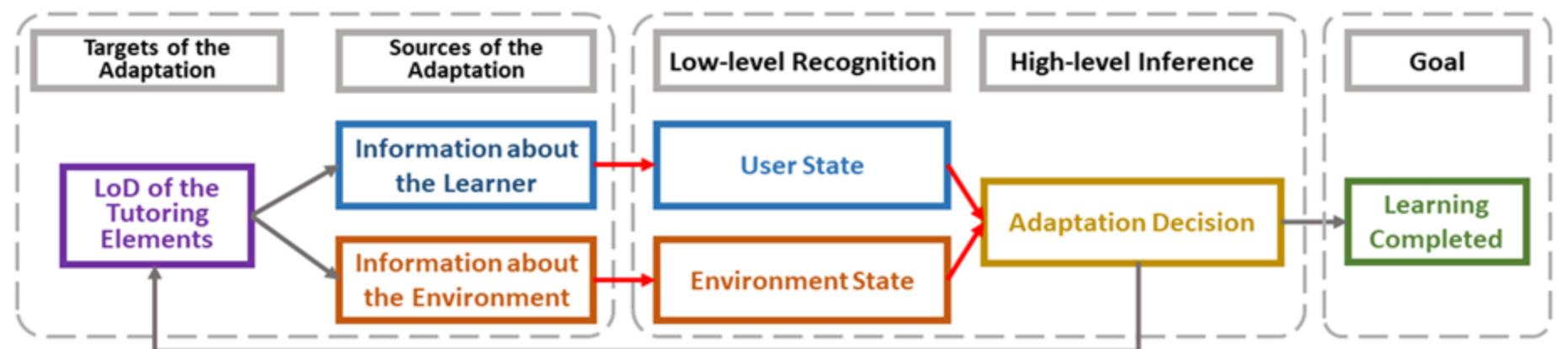
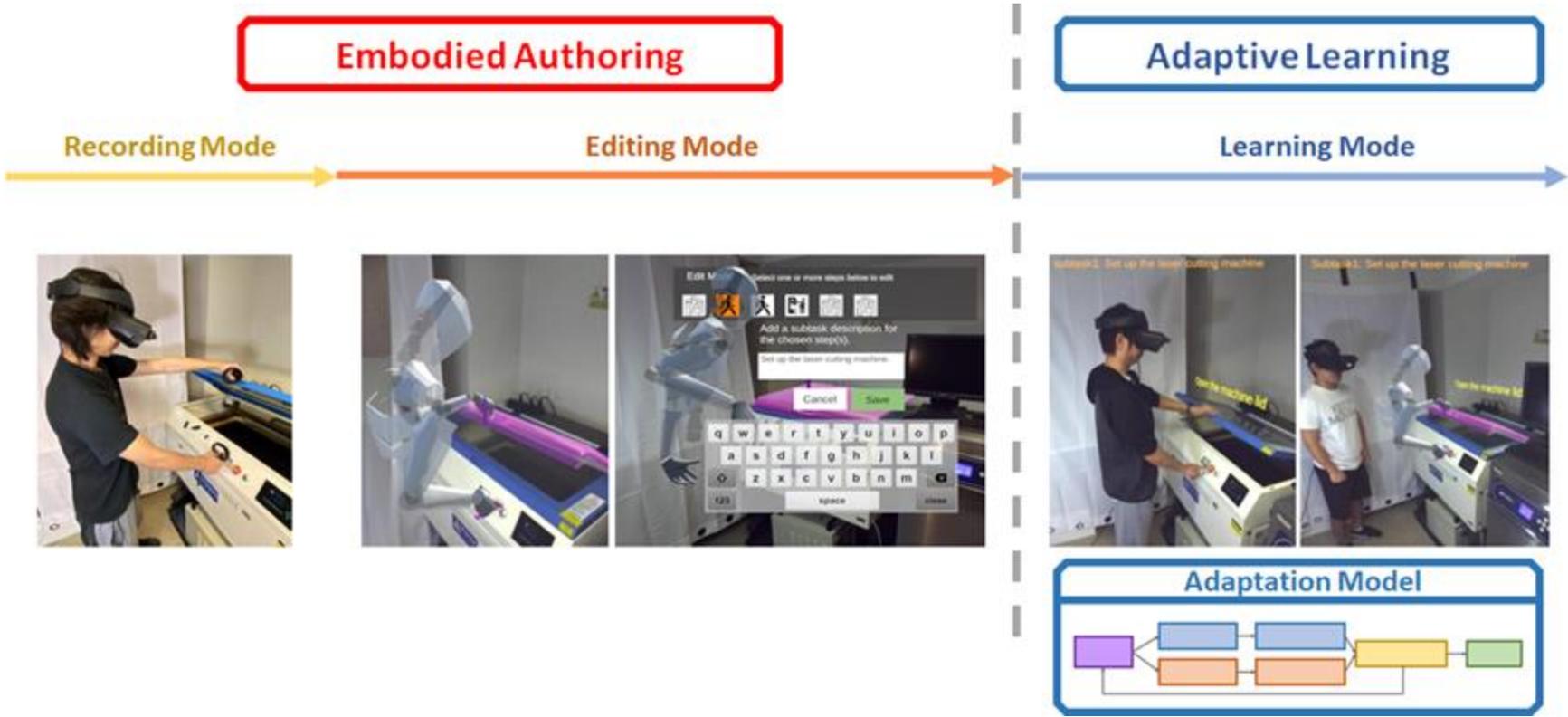
AR animation shown to students



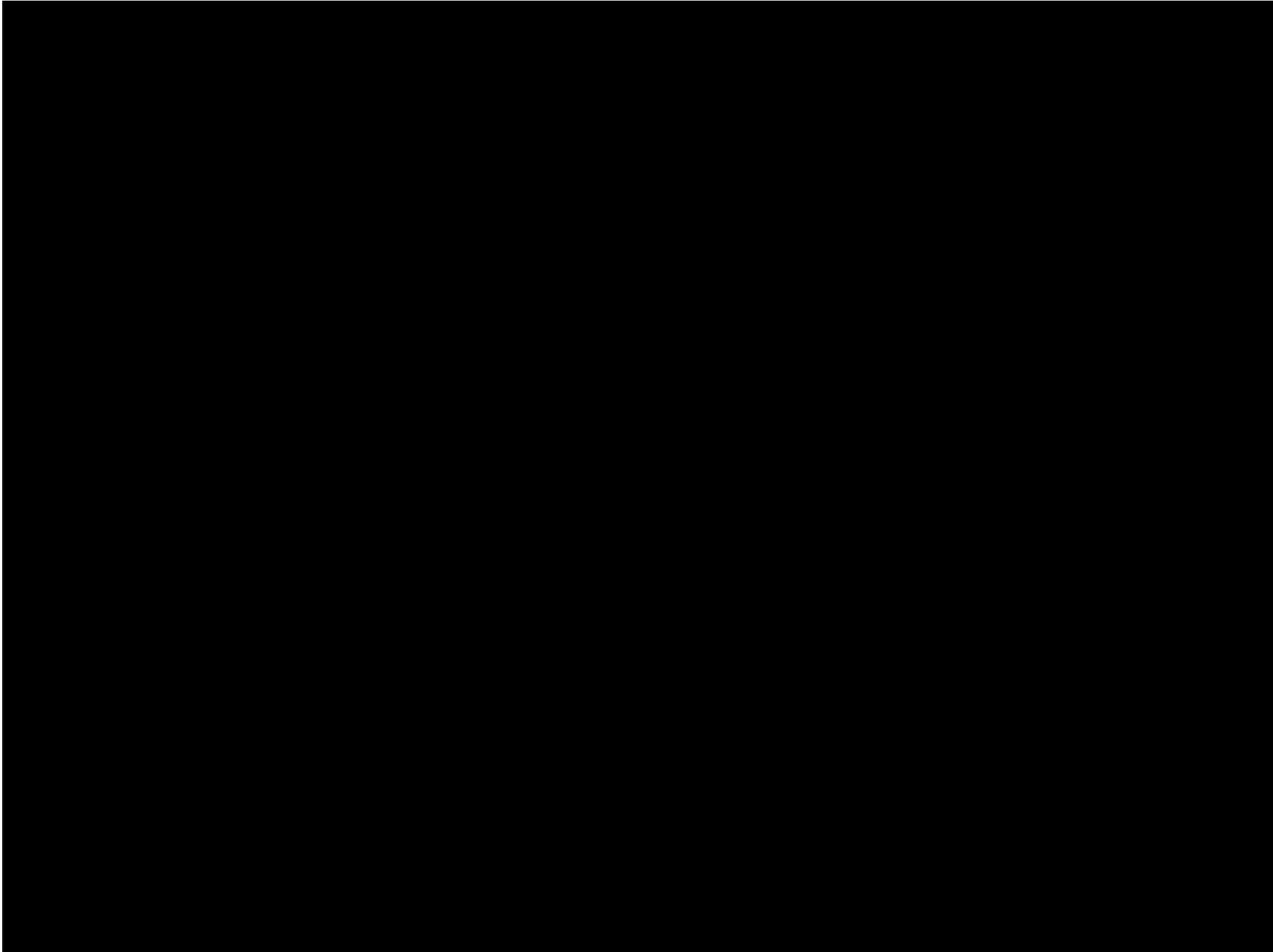
Instructor remotely provides AR instructions to student's screen



Adaptive Training: AdapTutAR: AI + XR



Adaptive Training: AdapTutAR



Augmented perception of all service systems around us

- Feeds into a virtuous cycle
- To create the next generation of hands-on systems thinkers

Education is one of the largest and most important service systems.

The pandemic accelerated the digital transformation

AI and XR will have a big impact on Education

Maker environment and tools.

Upskilling with AI and XR are important for creating more holistic systems thinkers.

Thought questions

Our educational “service system” to create broader system thinkers has to be our edge for societal good in general. And for the impending competition from China. However educational systems are slow to (does not) change. Tomorrow's R&D comes from institutional structures and educational policies. Are we ready ?

(1) Our educational “service system” to create broader system thinkers has to be our edge for societal good in general. However educational systems are slow to (does not) change. Tomorrow's R&D comes from institutional structures and educational policies. Are we ready ?

(2) China is investing enormously in key strategic areas. In China's 20th Party Congress, held two days ago, the party reaffirmed its commitment to turning China into a global technology powerhouse. From the perspective of your talk, can we compete with China in the upcoming AI era ?

(3) You exposed the construct that perceptive AI + XR is a killer application of AI for service systems. What are the barriers to it becoming real ? When do you think it will start to have enough of a ground swell and acceptance to have impact on our economy ?



Field Services and AI

In the world of people, processes and things ...

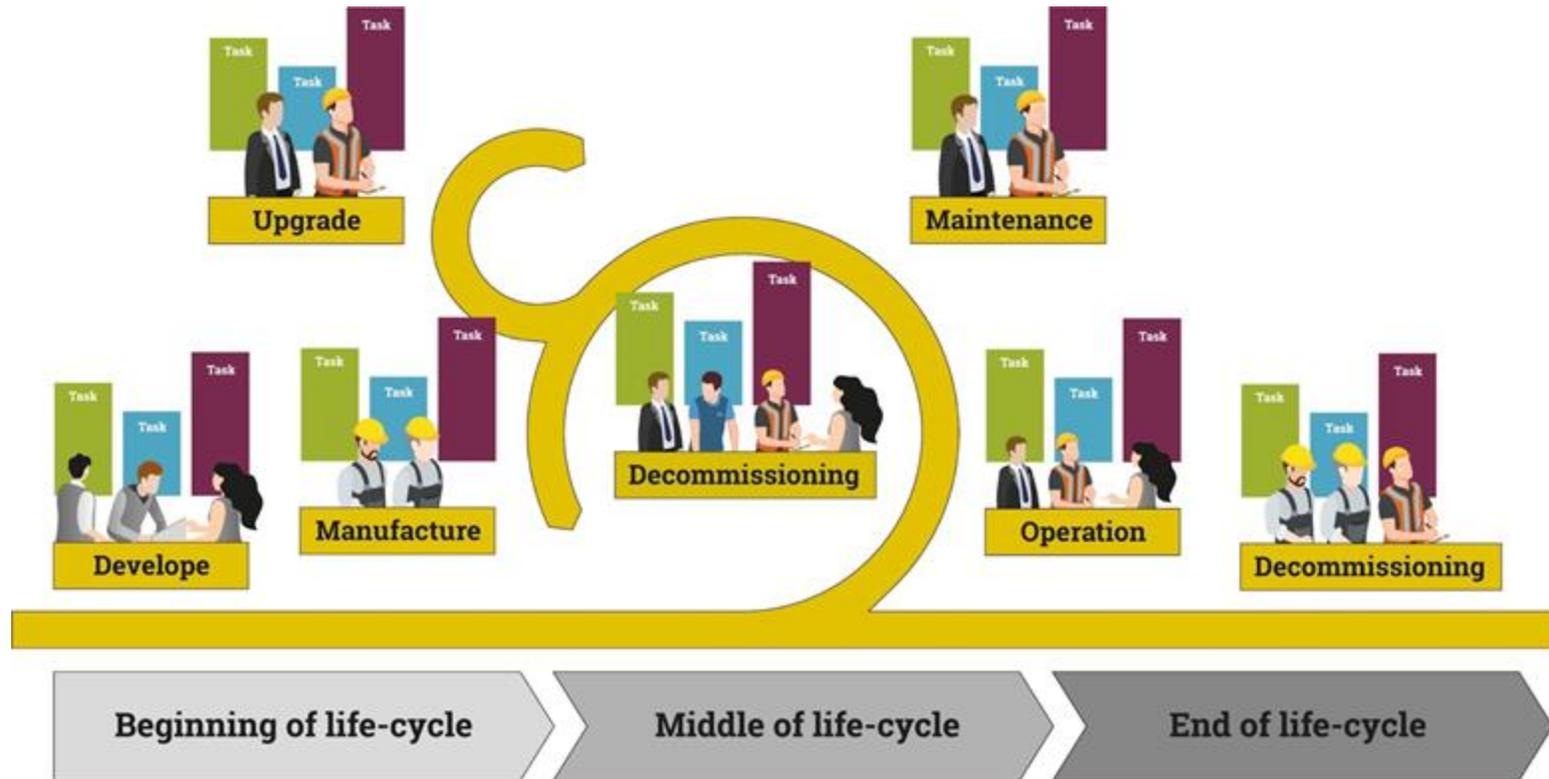
National Academy of Engineering, Service System - Panel 2
17 October 2022

Prof Dr Shaun West



Field Services and AI

Where do we have opportunities for field service and AI?



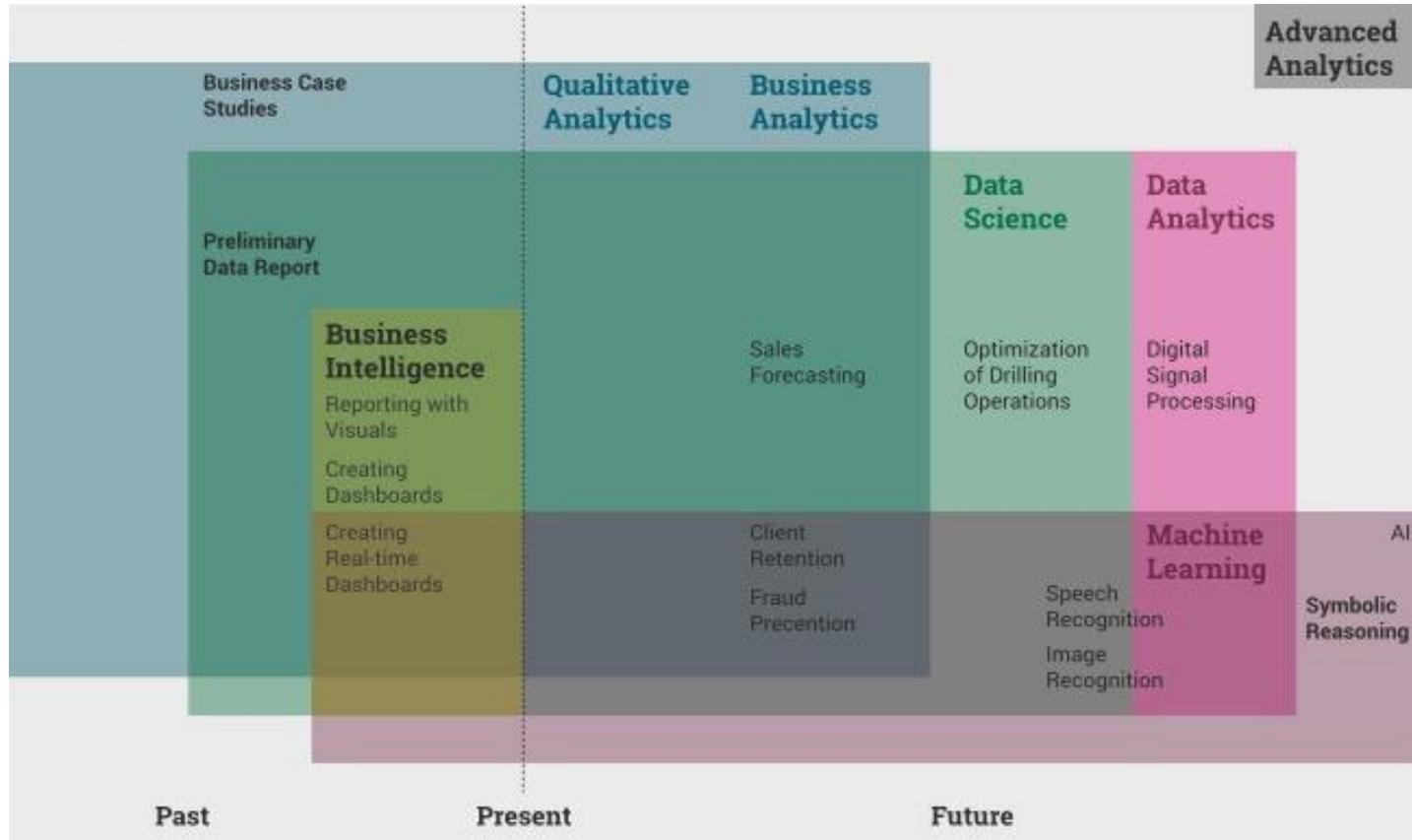
We should start by looking along the whole lifecycle...

- ... what is done
- ... when is it done
- ... how does it

The lifecycle perspective facilitates service innovation

Field Services and AI

Advanced analytics can support us



Field services will use AI to help with decision making in the future. Field services will not be replaced by AI – rather empowered by AI

AI can be 'scary'

Basic and advanced analytics can help create insights

Field Services and AI

Where do we have opportunities to use AI



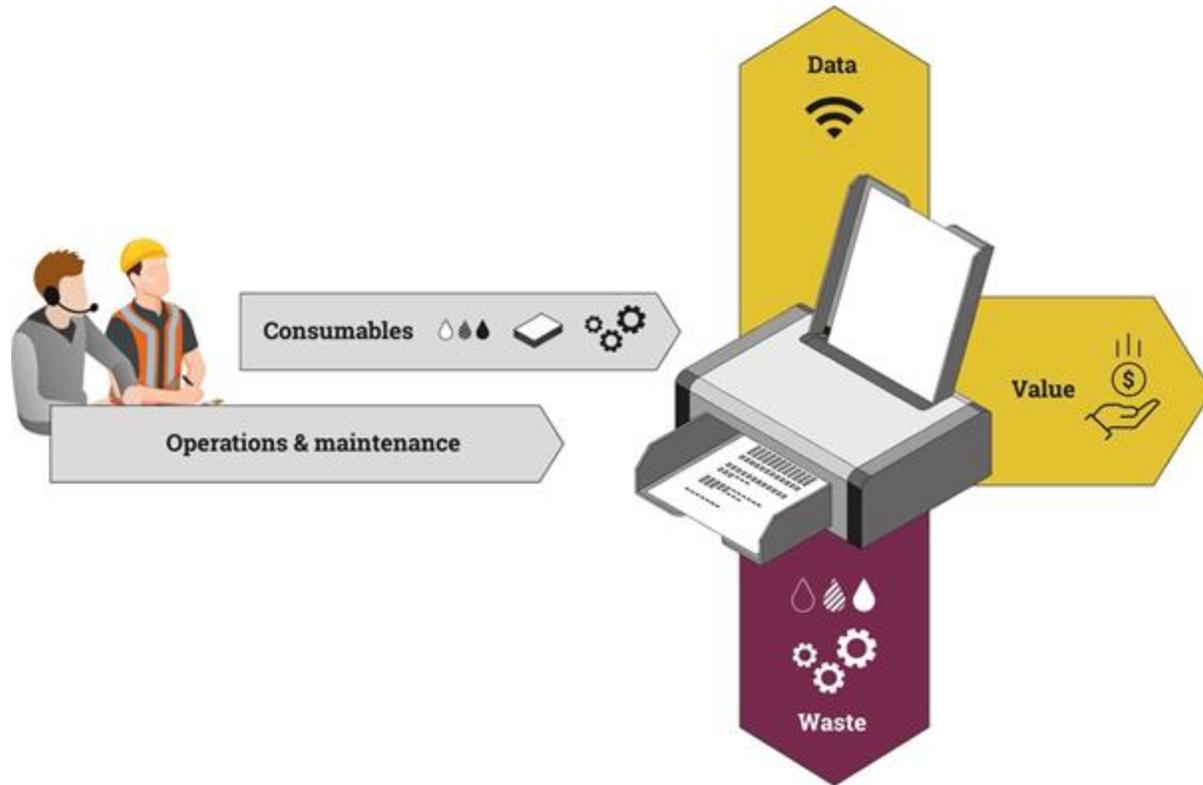
We have many opportunities. First we need to map out the problem space to find where AI could support field services...

This is a change management activity!

We need to consider actors, roles and situations rather than just “users”

Field Services and AI

Using AI to improve 'customer support'



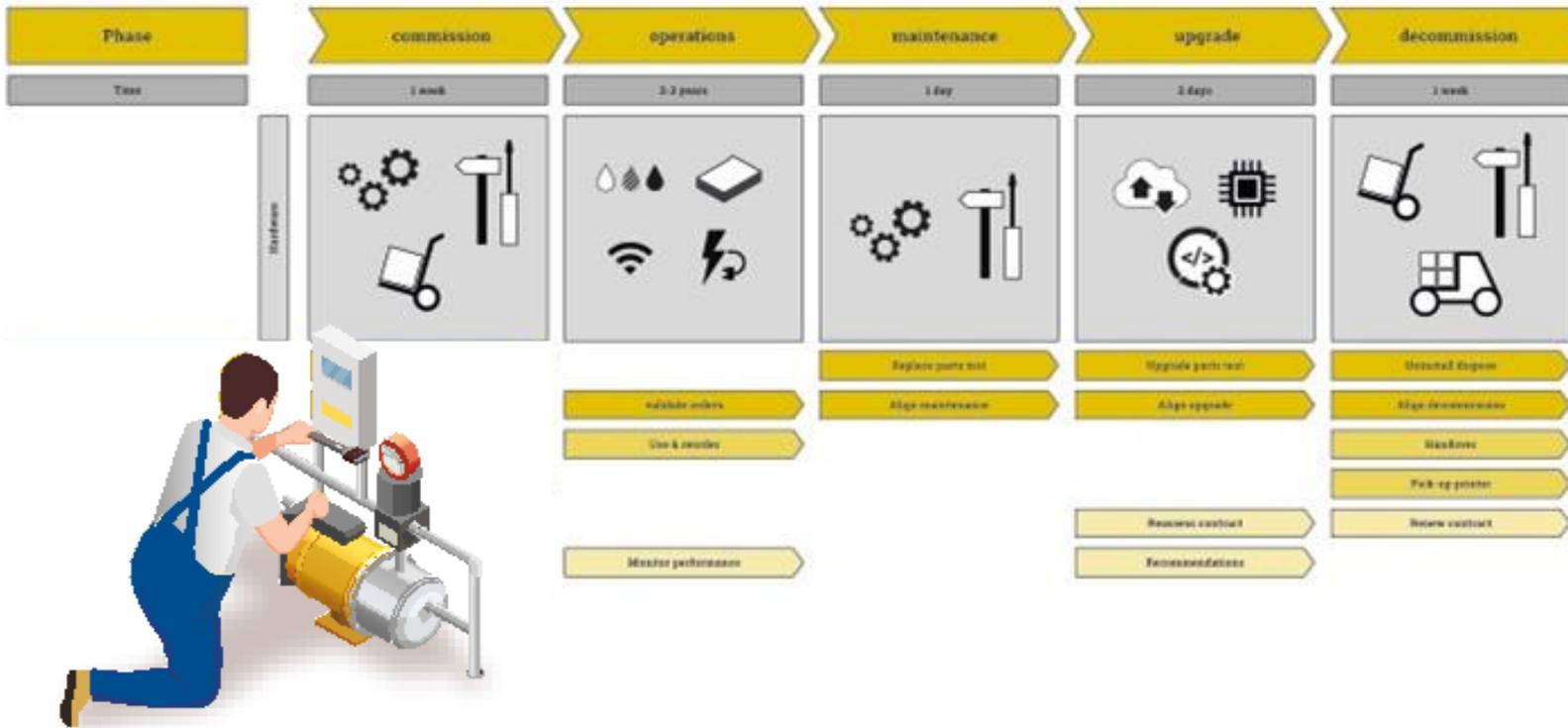
Toner re-ordering was a good example of enabling automation through the use of AI.

Less helpdesk stress!
Better experience!
Lower inventories!

We need to consider actors, roles and situations rather than just “users”

Smart Service Design & Data2Action

Field service operational support



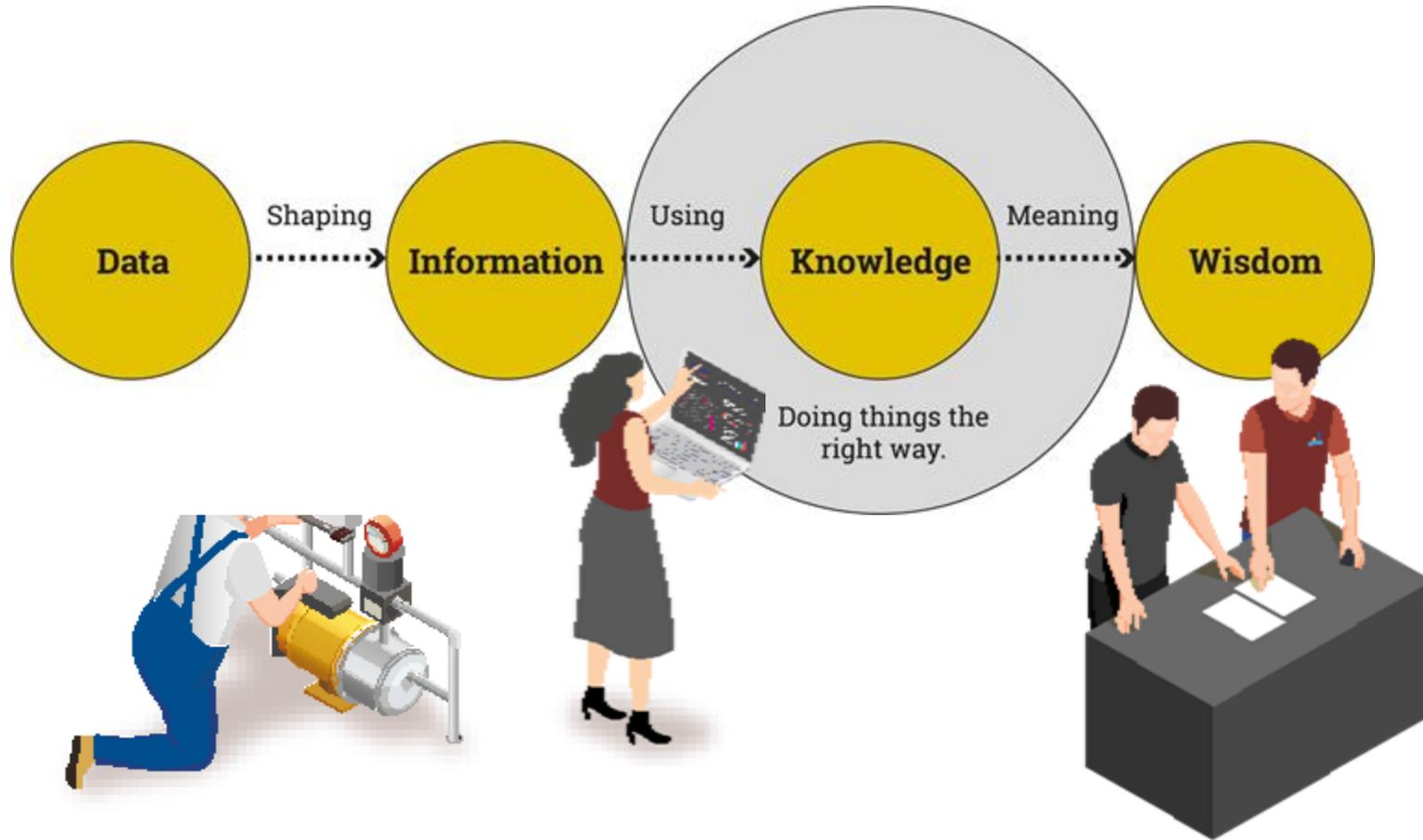
Use cases

- Replacement spares
- Equipment end of life
- Problem shooting
- Report capture
- Tech routing
- ...

Use AI to help the field service technician

Field Services and AI

Use AI to support the (field) service team



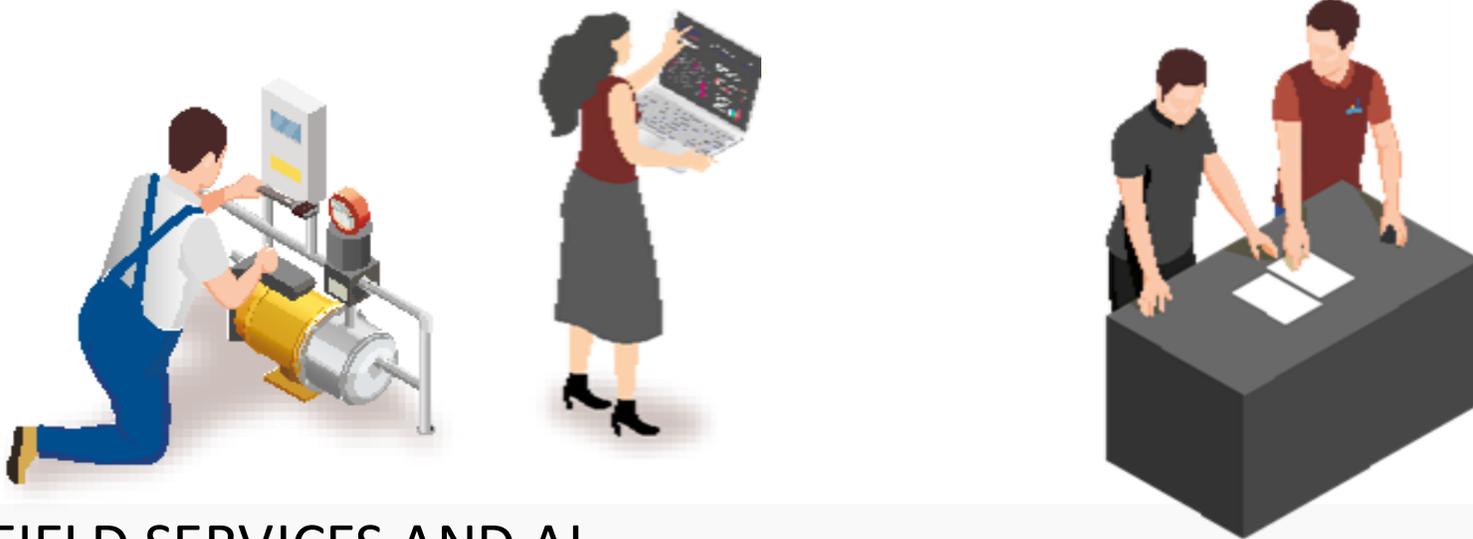
We first need to understand how data is used and how information is evaluated in the organisational context.

This may then enable the building of knowledge.

AI can help us learn and improve

Meta: How do **we** integrate AI into **field services** so that they **enable 'us' to get the job done** rather than **control 'us'**?

Practical: Is **field service** the **'last mile'** of many **supply chains**?



FIELD SERVICES AND AI
QUESTIONS

Digital Twins creating business value

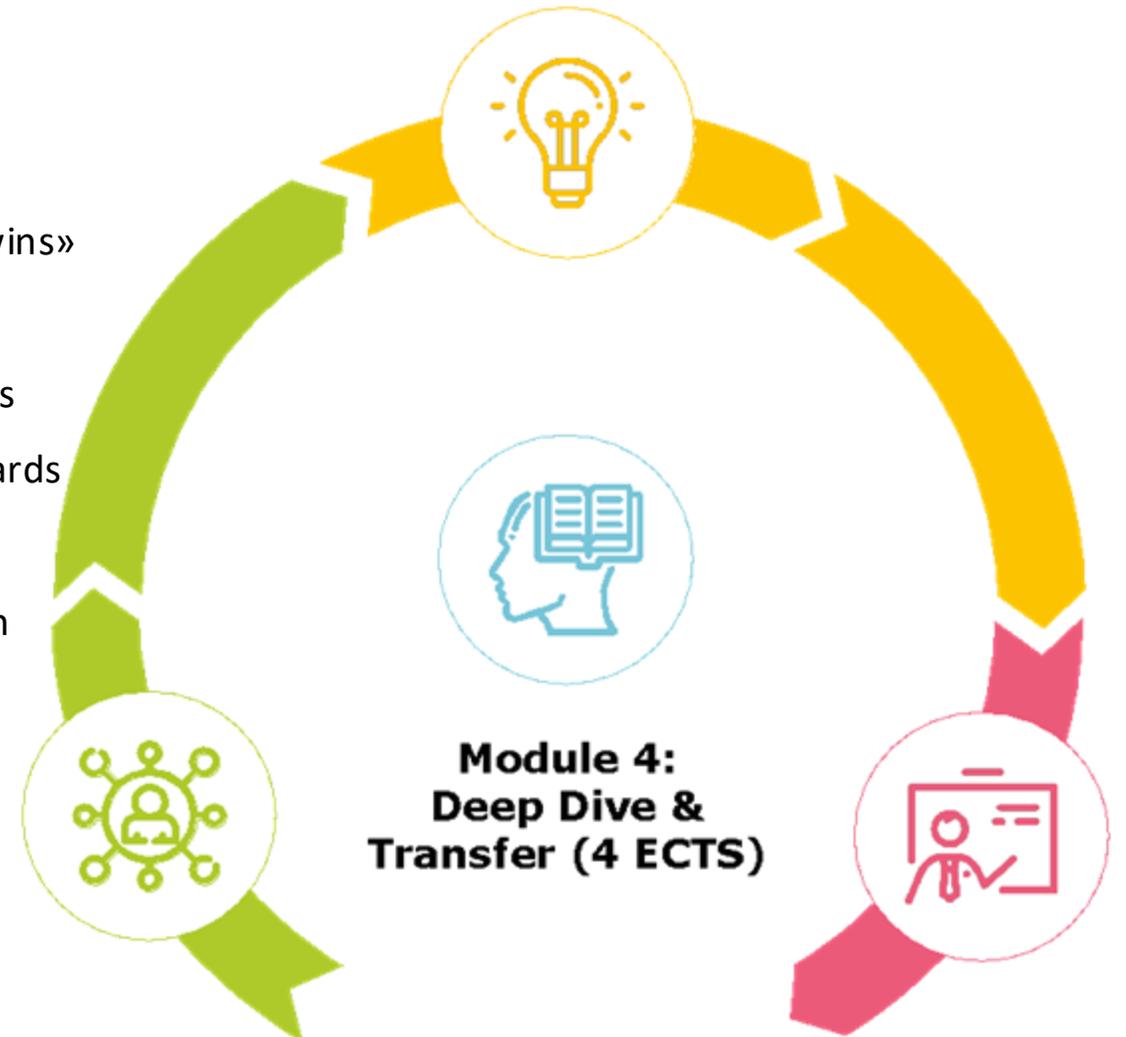
- ✓ Switzerland's only certification opportunity in the field of "Digital Twins»
- ✓ Top lecturers from various industries with many years of experience
- ✓ Real case studies presented by guest lecturers from Swiss companies
- ✓ Apply what you have learned to your own business from day 1 onwards
- ✓ Innovative training setting (on site/remote)
- ✓ Best-of-two-worlds approach with instruction in English and German
- ✓ Insights into different industries



Start March 2023
hslu.ch/cas-digitaltwin

**Module 3:
Creating Digital
Twins in different
contexts**

**Module 1:
Understanding Digital
Twins**



Smart Service Design

The design of smart services in the world of people processes and things ...

Prof Dr Shaun West
Oliver Stoll
Prof Dr Petra Müller-Csernetzky



Smart Service Design & Digital Twins

- “The handbook’s purpose is to formalize the lessons learnt from an Innosuisse-funded project where over twenty different Digital Twin-based use cases were developed in collaboration between ten partners. During the project, we learnt many things: the Digital Twins helped us create new innovative smart services, formalize tacit knowledge, and improve decision-making. Perhaps most important was that the design of the Digital Twin was best achieved based on (business) questions. The Digital Twin enables the development of Smart Services within complex systems.”



Break

- Coming up Next
 - Panel 3: Engineering Education
 - Panel 4: Social Implications
 - Moderated Feedback - Open Mic
 - Closing



Panel 3: Engineering Education



Bill Rouse
Georgetown University
Member NAE



Irving Wladalsky-Berger
MIT Affiliate
Weekly Blog Series



Azad Madni
USC



Alexandre-Medina Borja
NSF

- Several aspects to consider are...

Engineering Education as a Service System

William B. Rouse

McCourt School of Public Policy

Georgetown University

Washington, DC

October 17, 2022

Overview

- The Future of Engineering Education
 - Trends & new challenges
 - New concepts, principles, methods & tools
 - Digital engineering environments
- Educational Service Systems
 - In-person, online, and real world venues
 - Knowledge capture & management capabilities
 - Sage on the Stage vs. Guide on the Side
- AI's Role in Educational Services
 - Digital twin of each student provides lifelong support
 - Behavioral economics underpins design of support
 - Data on learning outcomes enables tailoring to individual students

The Future of Engineering Education

	Today	Tomorrow
Trends & new challenges	Increasingly computational, particularly for physical phenomena	Pervasively computational across physical, economic, behavioral & social phenomena
New concepts, principles, methods & tools	Commercial modeling tools increasingly adopted; tool use becomes a core student competency	Immersive, interactive modeling environments standard across disciplines & industries
Digital engineering environments	All data, models, designs & artefacts increasingly represented digitally	Principles and methods for composing multiple digital representations standardized

Educational Service Systems

	Today	Tomorrow
In-person, online, and real world venues	One mode dominates within individual courses	Mixed modes predominate across the whole curriculum
Knowledge capture & management capabilities	Knowledge managed within individual courses	Knowledge managed across the whole curriculum
Sage on the Stage vs. Guide on the Side	Live lectures predominate; quality varies	Top-quality recorded lectures predominate; live faculty serve as mentors

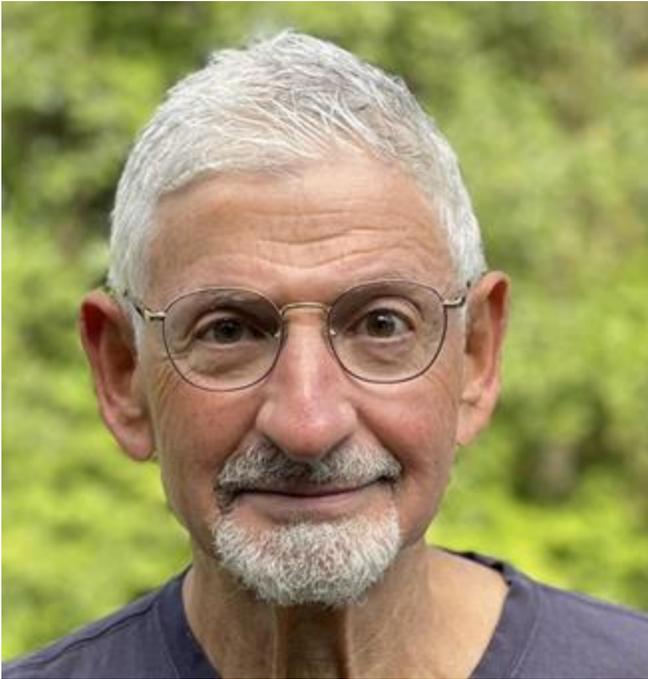
AI's Role in Educational Services

	Today	Tomorrow
Digital twin of each student provides lifelong support	Only if student takes the initiative to create this capability	Intrinsic to value proposition of matriculating with a particular curriculum
Behavioral economics underpins design of support	Weakly applied by individual faculty to particular courses	Designed into overall curriculum; tailored to each student
Data on learning outcomes enables tailoring to individual students	Weakly applied by individual faculty to particular courses	Pervasively applied across whole curriculum across years

Models Needed to Enable Tomorrow

- Models to Support Modeling
 - Economic, behavioral & social phenomena
 - Principles that enable composing multiple models
 - Work processes associated with modeling
- Models to Support Pedagogy
 - Principles & practices of mixed-mode pedagogy
 - Principles & practices of mixed-mode mentoring
 - Tools to relate measured individual outcomes to changes of pedagogy
- Models to Support Lifelong Learning
 - Behavioral economics models of students and workers
 - Digital twins of individuals as students and subsequently as workers
 - Principles & practices for knowledge management across disciplines & time

Panelists



Irving Wladawsky-Berger, PhD
Research Affiliate
MIT Sloan School of Management



Azad Madni, PhD
University Professor of
Astronautical Engineering
University of Southern California



Alexandra Medina-Borja, PhD
Program Officer & Co-Chair Future of
Work at the Human-Technology Frontier
National Science Foundation

Irving Wladalsky-Berger brainstorm

- “When I think of the key challenges in engineering education, the key issue that comes to mind is dealing with complexity. Given the kinds of incredible complex systems and applications we can now build, what should we be teaching? With the "classic" engineering of physical objects, - e.g., civil, mechanical, electrical, etc, - we had the laws of physics guiding what we could and could not do. With services oriented, software-intensive, AI-based systems and applications, the sky is both the limit and our biggest challenge. This is increasingly evident as we look at leading-edge areas like [Foundation Models](#). As a recent NY Times Magazine article said: ‘The very premise that we are now having a serious debate over the best way to instill moral and civic values in our software should make it clear that we have crossed an important threshold.’ “

IWB Comments

- SSME emerged in early 2000's at IBM – remembering the early days
- SSME is ongoing journey and remains a work in progress
 - Some observations
 - Service shows up in GDP and jobs, but is like “Dark Matter”
 - Definition in terms of organizations front-stage (interactions) and back-stage
 - Innovation in service differs from innovation in agriculture and manufacturing
 - In 2016, analysts asked where is SSME? (a) tired/moved on, or (b) accepted/no debate?
 - Service issues evident in AI and data science, cloud computing, and design thinking
 - Design thinking (front-stage), cloud computing (back-stage), AI/data science (both)
- Closing observations – service matters in science, engineering, and management
 - Science advances with new tools (AI/data science lens on social world)
 - Engineering matters for scale (Cloud computing infrastructure for Internet of Services)
 - Management the design of systems, not just artifact (Design thinking grows up and aligns with project managers role, orchestrating design with, not simply design for)

Panel 4: Societal Implications



Carlotta Arthur

Executive Director, Division of Behavioral
and Social Sciences and Education
at the National Academies of
Sciences, Engineering, and Medicine



Cora Marrett

University of Wisconsin
AAAS Fellow



Clarence Wardell III

The White House
Policy Implementation and Delivery



Ben Shneiderman

University of Maryland
AAAS, ACM, IEEE Fellow

- Many considerations including “service system innovation challenges have Social-Technical-Economic-Environmental-Political (STEEP) dimensions.” What are the implications of AI-driven productivity and quality improvements in service systems like healthcare, education, government, etc. that are human-centered and data-intensive?

NATIONAL
ACADEMIES

Sciences
Engineering
Medicine

Socially Conscious Service Systems Design

Moderator: Carlotta M. Arthur

Executive Director, Division of Behavioral & Social
Sciences & Education (DBASSE)

The National Academies

OCTOBER 17TH, 2022 - 60TH ANNIVERSARY

Introductions:

Cora Marrett, University of Wisconsin

Clarence Wardell III, The White House Domestic Policy Council

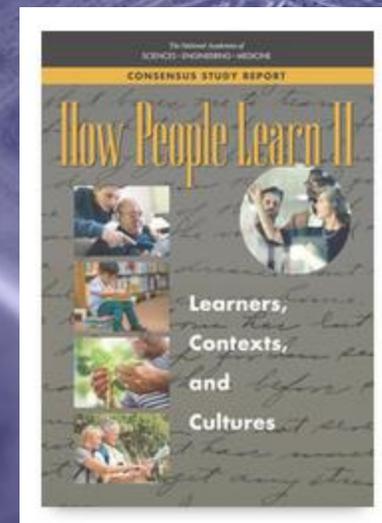
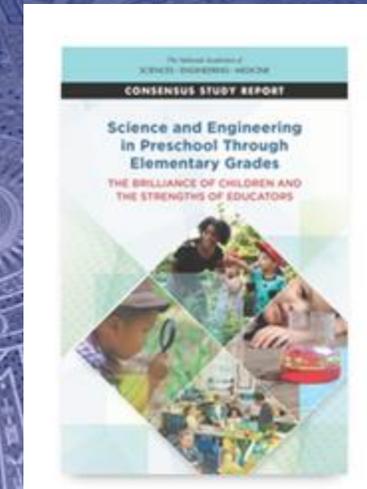
Ben Shneiderman, University of Maryland

DBASSE

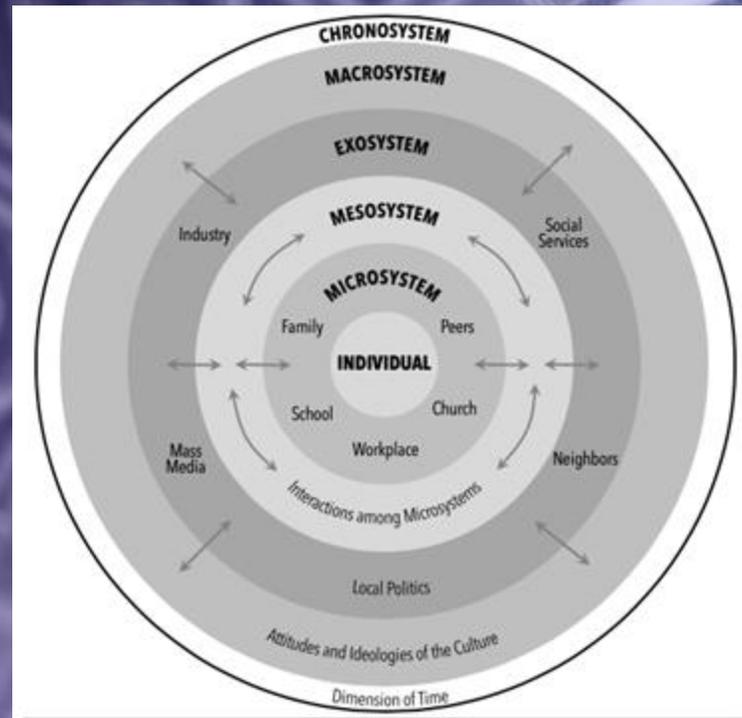
DBASSE advances the behavioral and social sciences and their application to policy and practice; center people; DEI is core.

DBASSE is home to nine units including:

- Board on Human-Systems Integration
- Board on Science Education
- Board on Behavioral, Cognitive, and Sensory Sciences



People are embedded in and navigate complex systems.
One example, Bronfenbrenner's Ecological system:



(Bronfenbrenner, 1979; Bronfenbrenner & Crouter, 1983;
Bronfenbrenner & Morris, 1989)

Definitions:

- What is socially conscious service systems design?
- Is there a single, accepted definition?
- How is it different from ‘customer-centric service system design,’ or from ‘design for optimal user experience?’

Benefits/Pitfalls/Challenges

- What are the benefits of socially conscious service systems design? What do we gain?
- What are the potential pitfalls of not taking a socially conscious approach? What do we lose? What's the potential for harm?

Best Practices

- What are some best practices for socially conscious service systems design?
- How do you go about taking a socially-responsible approach?
- What resources are needed?
- How do you know if it's working/achieving the desired outcomes?

What's next for
socially conscious
service systems
design?

Discussion



Framing Questions

- • What is socially conscious service systems design? Is there a single, accepted definition?
- • How is it different from ‘customer-centric service system design,’ or from ‘design for optimal user experience?’
- • What are the benefits of socially conscious service systems design? What do we gain?
- • What are the potential pitfalls of not taking a socially conscious approach? What do we lose?
- • What are some best practices for socially conscious service systems design?
 - o How do you go about taking a socially-responsible approach?
 - o What resources are needed?
 - o How do you know if it’s working/achieving the desired outcomes?
- • What’s next for socially conscious service systems design?

Moderated Feedback & Position Statements

Moderator



Vittal Prahbu

Charles and Enid Schneider
Faculty Chair in
Service Enterprise Engineering
at Penn State University



Ben Amaba

IBM
IISE Fellow

- Invited comments and position statements from participants and those who took a short [survey](https://tinyurl.com/service-systems) at <https://tinyurl.com/service-systems>
 - What three systems characteristics are graduates well-prepared-for? And less-prepared-for?

Moderated Feedback & Position Statements

Vittal Prabhu

Professor & Charles and Enid Schneider Faculty
Chair in Service Enterprise Engineering

Marcus Department of Industrial and
Manufacturing Engineering

Penn State University

Service Systems

Engineering

Our experience at Penn State

- Service Systems Engineering in the Era of Human-Centered AI: Advancement ~30k feet
- Credentials, teaching and learning materials: Academics ~3k feet
- Awareness among students and society: Advocacy ~300 feet

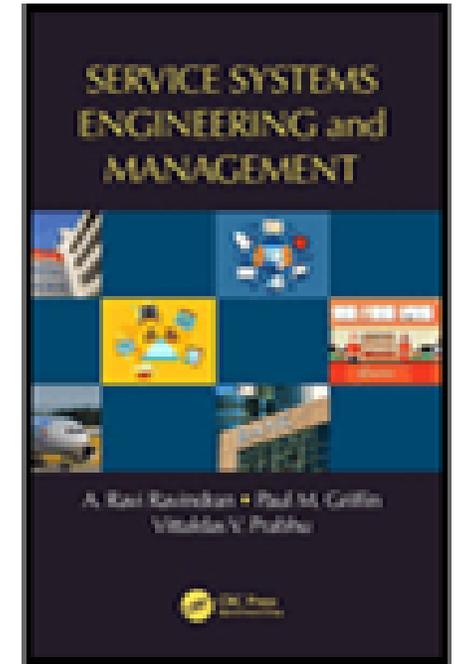
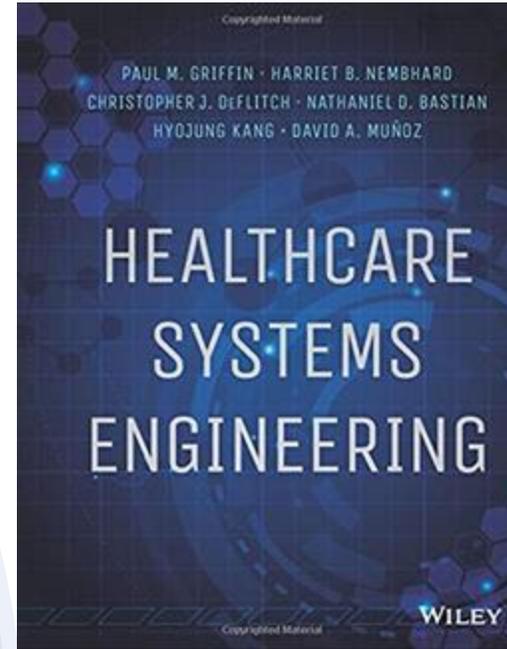




Advocacy

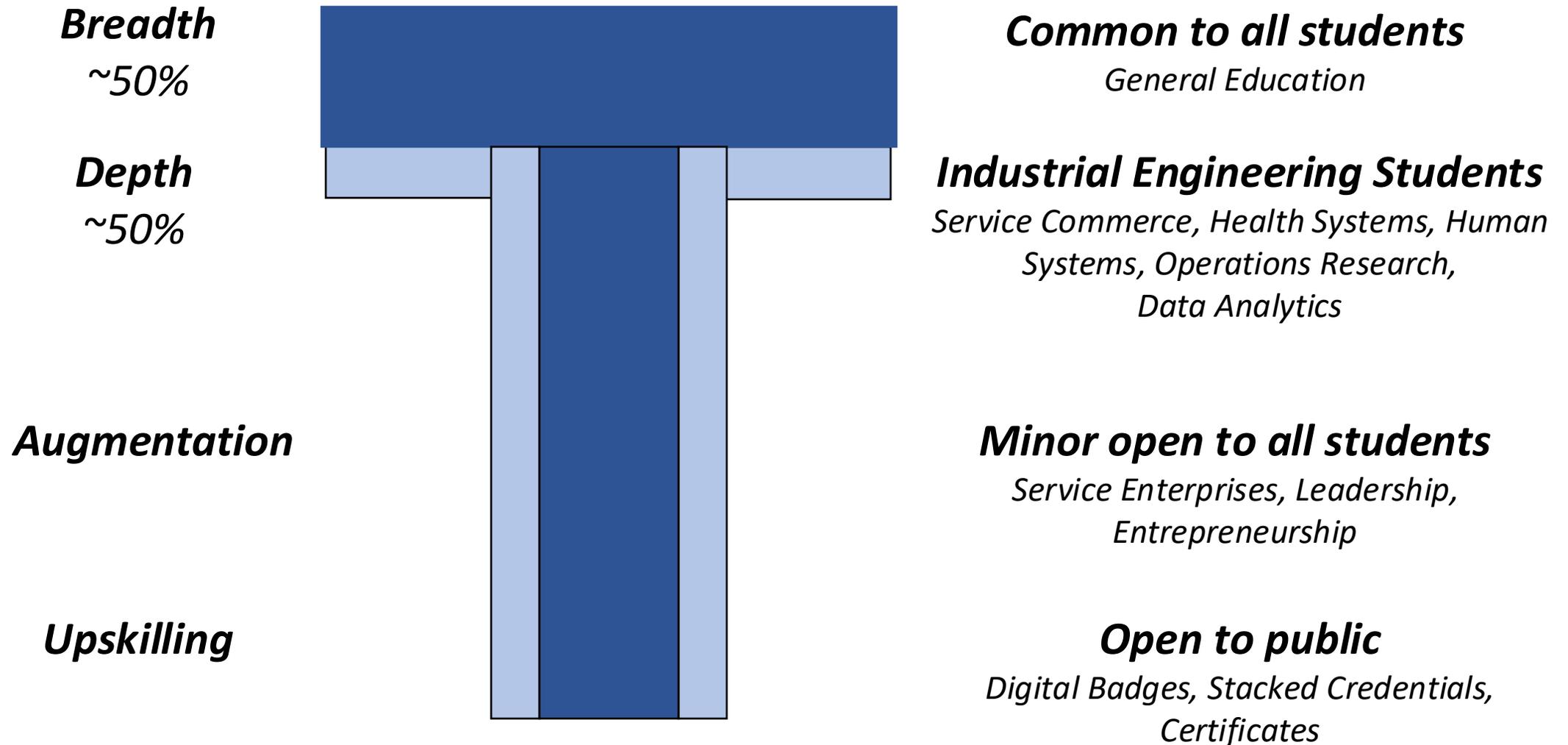
- Raise awareness of opportunities for engineering service systems among students and society – [news stories and short videos](#)
- Student Competitions and Prizes
- [Institute of Industrial and Systems Engineers Outstanding Innovation In Service Systems Engineering Award](#)
- INFORMS Service Science Conference Student Paper Award
- IFIP [APMS SIG and Panels](#)

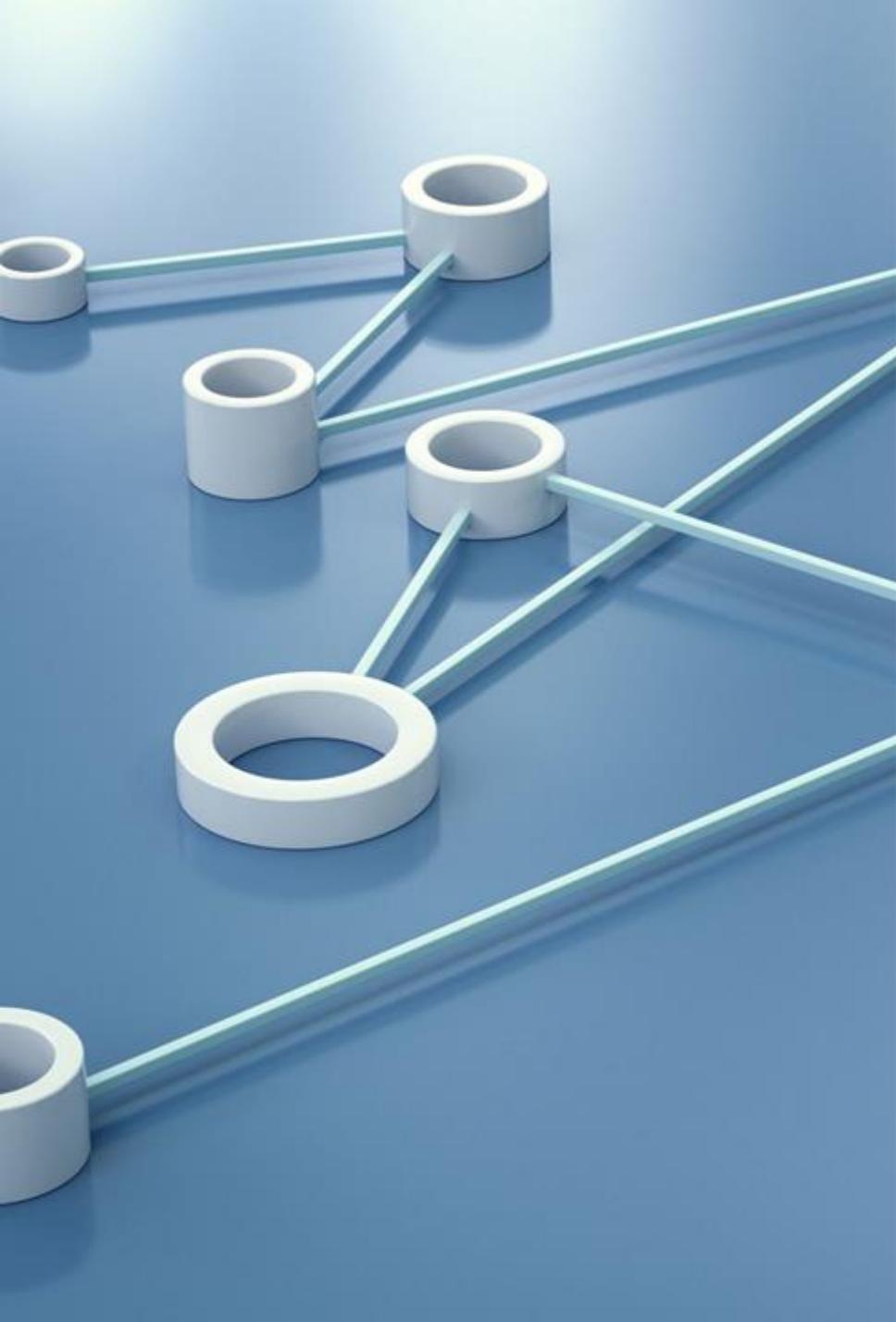
Academics



About 24 case studies with real-world service system contexts and data
Support new and existing courses

T-Shaped Service Systems Engineers





Graduate Level T-Shaped Service Systems Engineers

- Modeling Service System - Descriptive, Mathematical, Computational
- Dual-Degree in Operations Research
- Invite multi-disciplinary faculty from industrial engineering, operations research, statistics, hospitality, health policy, transportation systems, information systems, supply chain, management, marketing, ...
- Include labor-intense service enterprises– can we tackle Baumol’s cost disease?
- Establish a new multi-disciplinary Center for Service Systems Engineering

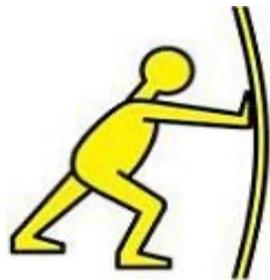
SSE Talent Supply Chain

Preliminary survey indicates Industrial Engineering students are most interested (~20%)

Over 60% of IE students start their careers in service industries

T-Shaped SSE curriculum strongly supported by advisory board
Pilot survey of hiring managers also indicates strong industry support

Students



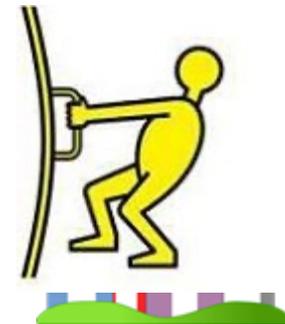
Academics



Universities

Careers

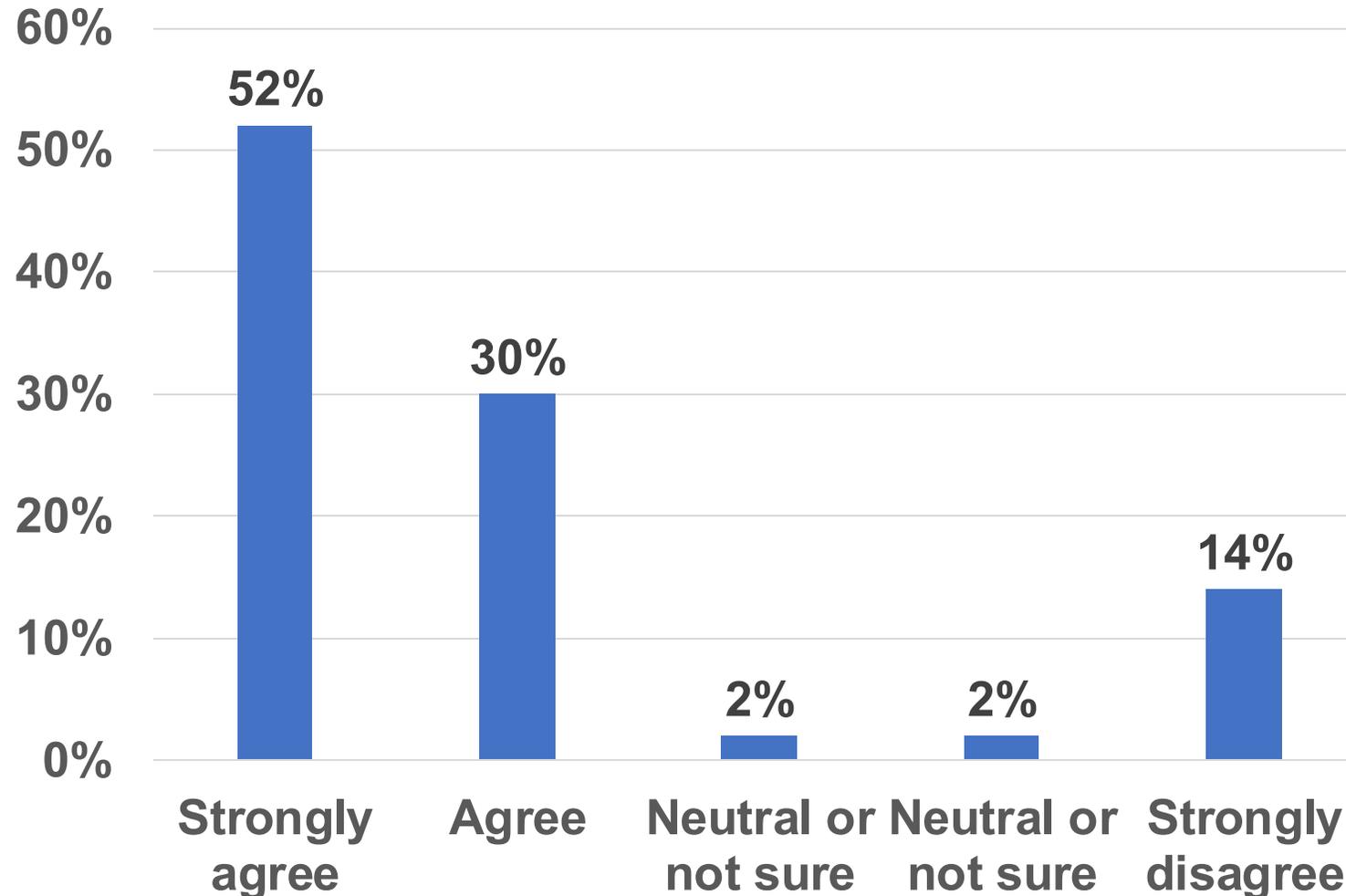
Industry



A blue ribbon graphic with a folded end on the left side, containing white text.

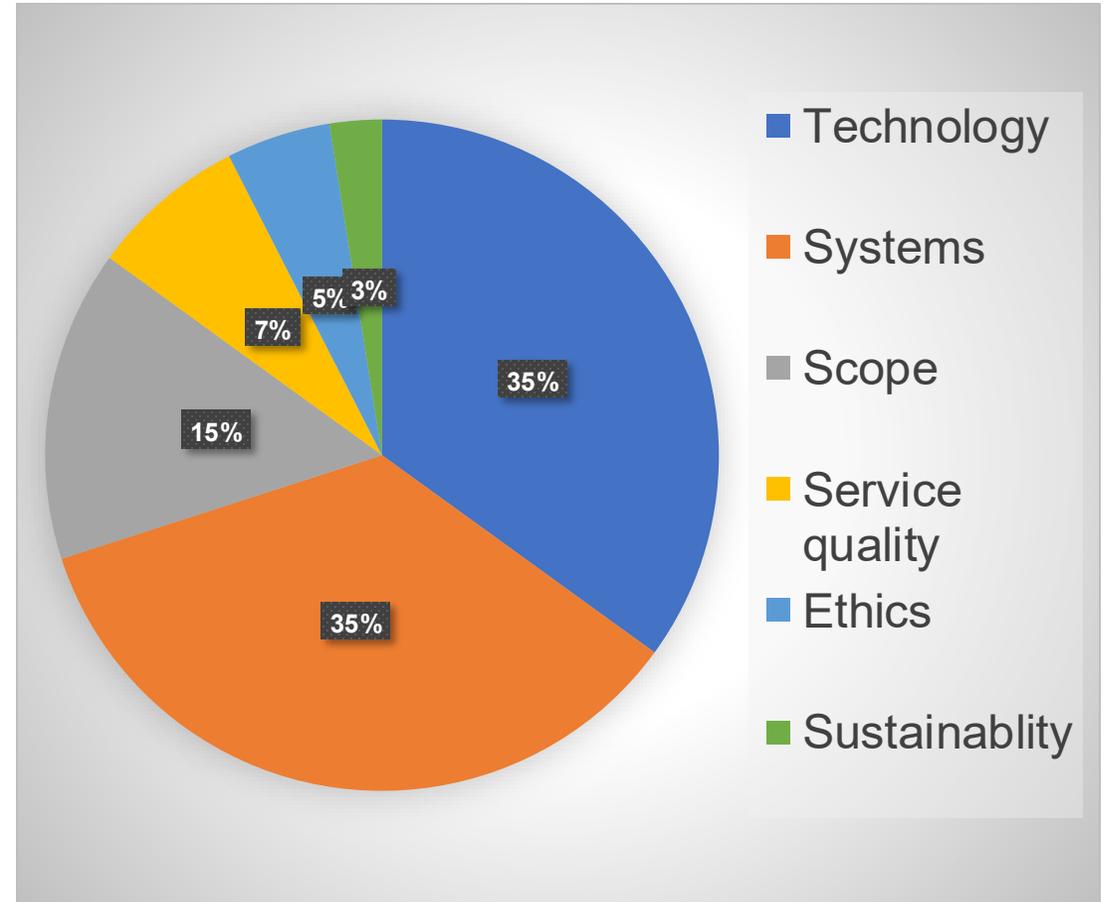
Summary of Position Statements

Existing degree programs (e.g., systems engineering, etc.) should be improved to ensure that graduates can continue to innovate **safe, ethical, sustainable** service systems in the AI era.



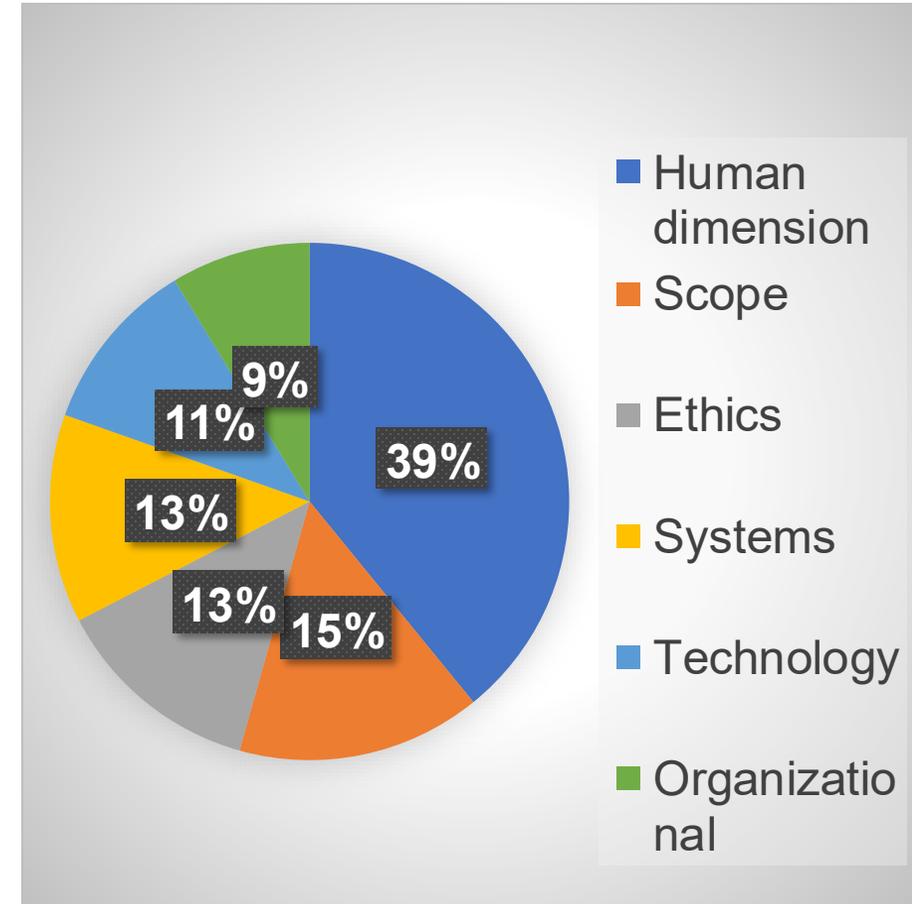
From the perspective of your primary undergraduate discipline, what **characteristics of human-centered, data-intensive service systems** in the coming decade are graduates **best prepared to address**?

1. Technology – AI/ML, Big Data, data networks, human-centric
2. Systems – modeling, design, engineering, control in education, healthcare, financial, circular economy, climate; psychology, marketing, Customer value formation; gamified human assistance and cognitive assistants
3. Scope – Multi-dimensional, narrow, linear deterministic; UX, CX, human-centered design
4. Service quality – consumer behavior, experience, automation
5. Ethics – safe, accountable, transparent,
6. Sustainability



From the perspective of your primary undergraduate discipline, what **characteristics of human-centered, data-intensive service systems** in the coming decade are graduates **least prepared to address**?

1. Human dimension: service quality, interaction design, cognitive engineering, augmented cognition, complementarity between AI and human decision makers, emotional satisfaction and needs of stakeholders, empathy-based best practices, undermining the human experience, demographic bias through data, AI in remote work across multiple cultures
2. Scope: multi-disciplinary (including traditional engineering and law), multilateral, and cross-functional services, that have integrated processes; their control and change management; weakest at mid-range
3. Ethics: harmful effects of AI; unethical design leading to data privacy/security issues; critical thinking to find ethical paths; most difficult
4. Technology: AI-human interactions, digital-physical integration, leverage technology to build new knowledge; not to be seduced by easy dataSystems: dynamics; service systems
5. Organizational: identification of methods and tools

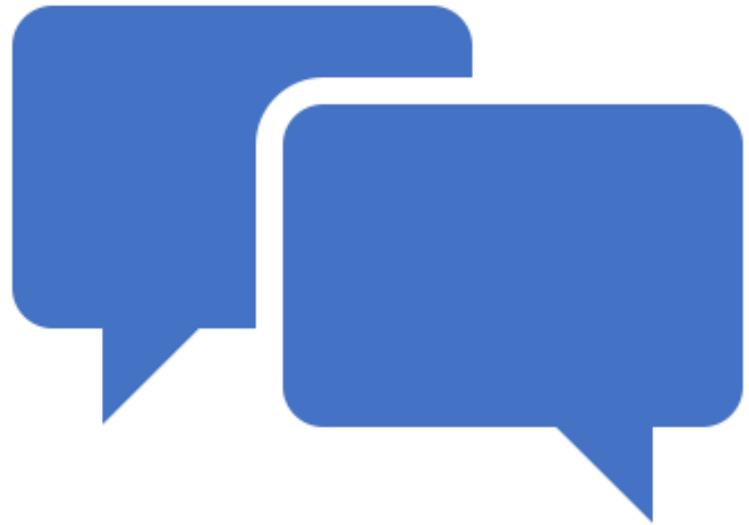


Are there any other thoughts you would like to share regarding innovating future complex business and societal systems that serve people better and/or preparing graduates for the opportunities and challenges ahead? (Select few)

- *“If we are to build human-centred AI, we will need to know a good deal more about humans, which means that engineering and business will need to bridge to the cognitive sciences in a much deeper way, and the cognitive science must change their research to address those concerns. We need to consider the structure of organizations such as universities and research institutes to support this.”*
- *“the application of AI is so problematic in the service area because when digital footprints are primarily created by higher income consumers, because they have the money to buy more things and (for example) those living in higher income neighborhoods will be given priority because of the higher possibility of “higher spend” then automated service will exclude and upset people, who will not use it, and the concentration of good services for high income people in high income neighborhoods will create increasing social unrest. Disparities will not just be in terms of treatment by other people, it will be increasingly unfair due to the way AI;s are trained, and the priorities put on higher spending in a market economy.”*

Are there any other thoughts you would like to share regarding innovating future complex business and societal systems that serve people better and/or preparing graduates for the opportunities and challenges ahead? (Select few)

- *“We often separate people and technology, as if they are opposites. Technology is what makes us human, just as we as humans make technology. We also tend to separate the arts/humanities from the sciences (and definitely separate the social from the business). Those separations have value at a basic level but not in complex systems. So it seems like now we need to fight the natural separation of disciplines and specialities in the other direction in order to survive. HOW to do that is the hard part.”*



Questions/discussion

Summary of Position Statements

- Well-Prepared
 - Well defined, relatively narrow technical issues
 - Ethics - Accountability, Responsibility, Explain ability, and Transparency
- Less-Well-Prepared
 - Open ended problems that require collaboration with two (or several more) professionals with competencies in other disciplines.
 - Interdisciplinary and integrated processes

Summary of Position Statements

- Additional Comments

- Business and societal systems typically encompass what I view as service systems. E.g. global supply chains that deliver products to doorstep today. Or, sometime in the future. provide telerobotic surgery anywhere in the world. Both of these examples requires expertise from several disciplines. Academia in the US and around the world has silos that need to taken down or at least lowered considerably to prepare graduate for the challenges ahead.

- Additional Comments

- The National Society of Professional Engineers and the National Institute for Certification in Engineering Technologies are prepared to help us drive Systems Software Integration certification and Professional Licensure.

Closing

- **Thank-you**



Guru Madhavan
Norman R. Augustine Senior Scholar and
Senior Director of Programs,
National Academy of Engineering

Acknowledgements



Darul West
Program Coordinator
National Academy of Sciences

- Thanks to NASEM for hosting
- Thanks to our keynote, moderators, panelists, participants, and all those who took the short [survey](https://tinyurl.com/service-systems) at <https://tinyurl.com/service-systems> to add a position-statement.

Additional Resources

- Arthur WB (2019) [Foundations of Complexity Economics](#). Nature Review Physics.
- Dietrich BL, Plachy EC, Norton MF (2014) [Analytics Across the Enterprise](#).
- Donofrio N, DeMarco M (2022) [If Nothing Changes, Nothing Changes: The Nick Donofrio](#).
- Fleming M (2022) [Breakthrough: The Growth Revolution \(in an Era of Artificial Intelligence and Worker Engagement\)](#).
- IfM and IBM (2008) [Succeeding through service innovation: A service perspective for education, research, business and government](#)
- Larson RC (2022) Model Thinking for Everyday Life Working Wonders with a Blank Sheet of Paper. (Coming Soon).
- Lebovitz S, Lifshitz-Assaf H, Levina N (2022) [To Engage or Not to Engage with AI for Critical Judgments: How Professionals Deal with Opacity When Using AI for Medical Diagnosis](#). Organization Science.
- Madhavan G, Poste G, Rouse W (2020) [Complex Unifiable System. Editors' Note: Systemic Vistas](#). Winter 2020. The Bridge.
- Maglio PP, Kieliszewski CA, Spohrer JC (2010) [Handbook of Service Science](#)
- Maglio PP, Kieliszewski CA, Spohrer JC, Lyons K, Patrício L, Sawatani Y (2019) [Handbook of Service Science, Vol II](#)
- McDermid JA (2022) [Safe, Ethical & Sustainable: A Mantra for All Seasons?](#)
- Munn L (2022) [The uselessness of AI ethics](#).
- Norman D (2023) [Design for a Better World: Meaningful, Sustainable, Humanity Centered](#)
- Rouse WB (2018) [Life with a cognitive assistant](#). (2022) [Emily 2.0](#).
- Rouse WB, Spohrer JC (2018) [Automating versus augmenting intelligence](#). Journal of Enterprise Transformation.
- Schneiderman (2022) [Human-Centered AI](#).
- Spohrer J (2017) [Imagination Challenge: Quantify and graph cost of digital workers and GDP per employee USA from 1960-2080](#).
- Spohrer J, Maglio, PP (2009) [Service Science: Toward a Smarter Planet. In Service Engineering](#).
- Spohrer J, Maglio PP, Vargo SL, Warg M (2022) [Service in the AI Era: Science, Logic, and Architecture Perspectives](#).
- US 110th Congress (2007) [SEC. 1005. STUDY OF SERVICE SCIENCE](#).
- Vargo SL, Lusch RF (2016) [Institutions and Axioms: An Extension and Update of Service-Dominant Logic](#). JAMS.
- Wakefield J (2022) [Why you may have a thinking digital twin within a decade](#). BBC News Online.
- West S, Meierhofer J, Mangla U (2022) [Smart Services Summit: Smart Services Supporting the New Normal](#).
- West S, Stoll O, Muller-Csernietzky P (2022) [A Handbook for Smart Service Design - The design of Smart Services in a world of people, process and things](#).
- Wladalsky-Berger I (2016) [The Continuing Evolution of Service Science](#). (2019) [The Increasing Demand for Hybrid, "T-Shaped" Workers](#). (2021) [The Supply Chain Economy - A New Categorization of the US Economy](#). (2022) [A Measurement Framework for the Digital Economy](#). (2022) [Foundation Models: AI's Exciting New Frontier](#).



Request Position-Statements From...

... via a short survey at <https://tinyurl.com/service-systems> to add a position-statement

- A diverse set of industry, academic, government, and other thought-leaders, who have contributed to our understanding of complex human-center, data-intensive systems that give and get service (service systems).



Brenda Jorgensen-Dietrich
Professor Cornell
Author "Business Analytics"



W. Brian
Arthur
Santa Fe Institute



Tiffany
Sargent
Intel



Leon McGinnis
Georgia Tech

Preamble: On Value



- Service Science
 - S-D Logic (Vargo & Lusch 2016)
 - Service is the application of resources (e.g., knowledge) for the benefit of another
 - Value ... uniquely ... determined by beneficiary
 - Improvement processes for service system innovation and value cocreation
 - Learning to invest systematically to...
 - Improve win-win interaction
 - Improve win-win change
- Top 10 MC Businesses as service systems
 - Technology platforms, energy, investing, healthcare
- Top 10 GDP Nations as service systems
 - Investments in upskilling people - capabilities
 - Top ranked global universities
 - Population (+ capital-technology-wealth)
- A Brief History of Value
 - Family (MC,GDP,HCI of tribes)
 - Cities (MC,GDP,HCI of cities)
 - Nations (MC,GDP,HCI of nations)
 - Businesses (MC,GDP,HCI of AI-powered platforms that help people interact, upskill, upwealth, uphealth, upenergy, etc.)

Rank	Name	MC	Market Cap	GDP	HDI
1	Apple AAPL		\$2.497 T	1. United States: \$20.89 trillion	17
2	Saudi Aramco 2222.SR		\$2.171 T	2. China: \$14.72 trillion	85
3	Microsoft MSFT		\$1.901 T	3. Japan: \$5.06 trillion	19
4	Alphabet (Google) GOOG		\$1.408 T	4. Germany: \$3.85 trillion	6
5	Amazon AMZN		\$1.290 T	5. United Kingdom: \$2.67 trillion	13
6	Tesla TSLA		\$838.47 B	6. India: \$2.66 trillion	143
7	Berkshire Hathaway BRK-B		\$610.38 B	7. France: \$2.63 trillion	26
8	UnitedHealth UNH		\$481.16 B	8. Italy: \$1.89 trillion	29
9	Meta Platforms (Facebook) META		\$429.76 B	9. Canada: \$1.64 trillion	16
^1 10	Johnson & Johnson JNJ		\$426.97 B	10. South Korea: \$1.63 trillion	23

Value cocreation is accelerated when large numbers of highly skilled people with appropriate technology have a safe, ethical, sustainable environment for win-win interaction and change.