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Evolving Ethics in Design Research: Reshaping Design Considerations for Product Designer

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The contribution and core analysis of the study explores how the Systems Thinking and Systems Architecture Framework can be combined and curated with the design-thinking process. The research is an experimental study to understand how to empower users and leverage their feedback and ideas before/during/after the product design process to assist the design and engineering team to have better frameworks and solutions with great insights to reflect the user needs. We compared a typical design-thinking process modified from IDEO's version and system architecture framework adapted from Media Lab Space Enabled Research Group at Massachusetts Institute of Technology (MIT) to envision a Human-Centered System Design (HCSD) to solve systemic design challenges. In the study, we partially used a project designing footwear for an aging population as an example to discuss stakeholders by using the HCSD. We considered the project as a sociotechnical challenge on the industry and social levels and use the case study to fill in the content according to the definition of system architecture framework paring with the design process.

We are in the era of transformation, with disruptive advanced technologies, complicated relationship networks, organic organizational structures, complex products, a fast-paced society, and diverse culture, which have made consumers much more sophisticated than ever. For example, it is complicated for design and research teams to precisely predict users' daily behaviors, their interactions with others, and decision-making logic. Therefore, understanding users through Systems Thinking and Systems Architecture Framework and design approaches has become increasingly important from the perspective of both the design and the system-architecture. In response to the HCDS-related topics and research, we did a thorough literature review and a search of other relevant materials for inspiration.

We summarize our research and contribution by proposing our HCSD framework, which is a suggested research outcome through curating and merging the design process modified from IDEO's version and system architecture framework adapted by Media Lab Space Enabled Research Group at MIT. For further research, we can focus on and explore the following four questions: 1. How to apply HCSD to precisely identify the key stakeholders' desirability? 2. How to best filter out the users' feedback and ideas in the process of product design and development to distill the essential parts of their suggestions to shape the value from the users? 3. What are other meaningful approaches, components, and stages to integrate the design thinking process and system architecture to form an impactful HCSD? and 4. What are other applications, implementation, and fields to which we can fully apply HCSD to solve these large complex systematic social-technological challenges?

***Keywords**: Human-Centered System Design; Design Thinking; Human-Centered Design; System Architecture; System Engineering*

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1. Introduction

We are in the era of transformation, with disruptive advanced technologies, complicated relationship networks, organic organizations' structures, complex products, a fast-paced society, and diverse culture, which have made consumers much more sophisticated than ever. For example, it is complicated for design and research teams to precisely predict users' daily behaviors, their interactions with others, and decision-making logic. Therefore, understanding users through Systems Thinking and Systems Architecture Framework and design approaches has become increasingly important from both the design and the system-architecture realms.

The contribution and core analysis of the study are to discuss and explore how the Systems Thinking and Systems Architecture Framework can be combined and curated with the design thinking process forming an inclusive, systemic and human-centered approach to understand, gather, and integrate users' feedback, suggestions, and ideas in the process of product design. We want to know how to empower target users or system stakeholders and to receive their advice, understand their behaviors, leverage their ideas, and thinking processes to improve the current product design process and better inform design and engineering teams to create Human-Centered Design (HCD) solutions.

In the study, we partially used footwear design for an aging population project as an example to discuss stakeholders by using System Architecture Framework and we considered the footwear design project as a sociotechnical challenge in an industry and social level (Table 1). In response to the research question above, we did a thorough literature review and a search of other relevant materials for inspiration. Figure 1 shows the overall structure and scope of this study.

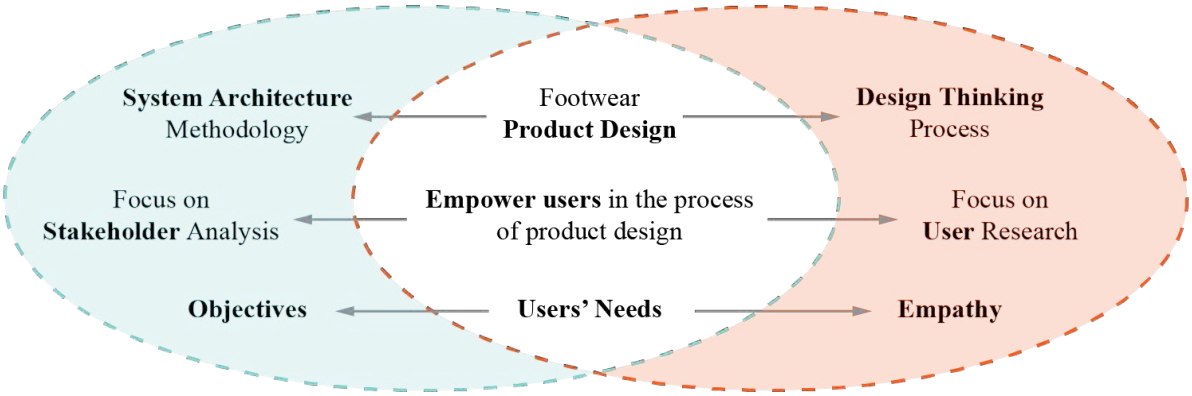

Figure 1. The overall structure and the scope of the study (designed and illustrated by Sheng-Hung Lee)

Challenge Scale	System Level	Footwear Example	Consideration
Product Design Challenge	Product and Object Level	Footwear design, product design features	We consider a product as a single object in the system, which includes the features or functions of product design covered in this section.
Service Design Challenge	Platform and Company Level	Footwear manufacturing capabilities, product maintaining and repairing services	We consider the service or service providers around the product in the system. For example, product design companies might be equipped with product manufacturing capabilities and provide product repairing services.
Sociotechnical Challenge	Industry and Social Level	Footwear-related industries, systems, and communities	We consider a product in a broader context of the system and view it as a projection of the industry. We need to take various aspects e.g., technologies, economic, social impact, community into consideration.

Table 1. The overview of different scales of challenge and system levels

2. Literature Review

There are many approaches to study targeted users/stakeholders in both the design field and system architecture realms. Understanding people can help the design and engineering team identify their pain points and core needs to satisfy their desires and trace the root cause of problems. In the study, we focus on four selected sections from the design field and system architecture realms to compare and analyze their methodologies and terminologies separately to inform us for more in-depth research.

Regarding design thinking, there are many different versions and definitions for reference. In the study, we use IDEO's version (IDEO, 2015) and Hasso Plattner Institute of Design (the "d.school") at Stanford University (Roth, 1973) as two representative case studies to emphasize the values and the definition of users in the different stages of the product design process. In the field of system architecture, we selected and analyzed the system architecture framework adapted by Professor Wood's research to discuss the usage and definition of the stakeholders. Then we compare the pros and cons of both creation and evaluation systems focusing on stages that involve users.

The goal of the literature review is to help researchers, product designers, and system engineers know how to integrate and curate suitable frameworks, methodologies, and useful tools to solve large complex systemic social-technological challenges accurately and effectively.

2.1 Design Approach, Human System, and Ethics

"Design thinking is a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success" (IDEO, 2021a). Here, Tim Brown, chair of IDEO, summarizes the value of design thinking and HCD. In the era of change, the challenges that designers and engineers are facing or will encounter have shifted from purely aesthetic issues on the product level to ecological problems or even ethics problems at the system level.

The traditional design thinking or HCD process (Table 2.) has been challenged from a systematic angle. Especially when we solve large complex, systemic challenges, how do we ensure people's feedback and ideas are heard in the process of design and development? The biggest problems from healthcare, government, education, and social justice are systematic challenges, which are all part of human systems (Cerminaro and Surtees, 2019).

In the context of the design thinking and HCD, designers start to reflect on how we cultivate the creative talents of our next generation in the face of transformation to tackle systemic challenges and the relationships and connections between people (e.g., users, designers or engineers) and large complex systems (Lee, 2021a). Fred Dust and Ilya Prokopoff from design consultancy industry proposed the five principles of the system at scale to respond to the questions above: 1. Ask how the system feels, not just how it works. 2. Recognize that a good system is often the best influencer. 3. Let the user close the loop. 4. Go micro with the human factors. 5. Start with hope, and take the long view (Dust and Prokopoff, 2009).

When we discuss human systems through the design thinking process, we need to cover the ethical aspect of our users, project participants, and designers and to protect them. Jane Fulton Suri, Partner Emeritus and Executive Design Director at IDEO, mentioned three timeless principles—respect, honesty, and responsibility—to respond to one key question: how do we seek and share insights about people's lives in an ethical way? (Suri and IDEO, 2015). The three principles are excellent guidance to help designers with their creation by considering design research ethics carefully and to assist designers in establishing inclusive human systems when conducting product design and development.

Design Process Section	1. Inspiration	2. Ideation	3. Iteration	4. Implementation
Brief Definition (Reference from openIDEO (openIDEO, 2021) and IDEO design approach)	Start with a big, activating question that brings people together. Share stories or research to build inspiration and empathy for those affected by the issue.	Brainstorm bold new ideas and apply fresh insights to advance existing concepts. Test things out: get the tools to build a quick prototype and learn what works.	Share comments to help discover issues and new opportunities. Use expert feedback, community support, and design tools to rapidly optimize ideas.	Elevate and celebrate ideas with great potential for impact. Connect with partners and work together to bring ideas to life around the globe.
User-related Activities (Use footwear design for an aging population as an example)	The users are welcome to join the inspiration (trip) with the design team to help designer team to understand the challenge in the early stage of the product design process.	There are some formal user-related sections such as user interviews, co-creation workshops where participants enable the design team to brainstorm and clarify the project design brief.	There is some, though relatively little, portion of prototyping sections that allow users to participate to give feedback.	The main job including design execution, product design and manufacturing are mainly done by designers and engineers. Users are not required to participate in this section.
Questions and Concerns (HMW stands for How might we)	HMW make the section more transparent and interactive even before the product design and development process start?	HMW maintain the excitement and momentum from the user interviews or co-creation workshop to inspire the design team?	HMW keep involving users' feedback and ideas to form sustainable engaging patterns in the product design process?	HMW translate the implementation section from product production to a series of flexible modular manufacturing lines by integrating users' input?

Table 2. Summary of design process in the system of footwear design for an aging population.

2.2 Users/Stakeholders in System Architecture

There are many overlaps and different definitions between system thinking, system engineering, engineering system, and system architecture. However, in the study, we focus on system thinking and system architecture as two main sources of literature research.

Before discussing users/stakeholders in system architecture, the core ideas of system architecture lie in the concept of system thinking. Edward Crawley, Professor of Aeronautics and Astronautics and of Engineering Systems at MIT, encapsulates that system thinking is not to view things systematically; instead, system thinking is to view things as a system (Crawley *et al.*, 2016). To understand the essence of the system thinking and its characteristics in a scientific way, Olivier L. de Weck, Professor of Aeronautics and Astronautics and of Engineering Systems at MIT, introduced the V-model, lifecycle analysis, and used the term "Illities" to measure and study the complexity of the system (De Weck *et al.*, 2012).

The system architecture framework (Figure 3.) modified by Danielle Wood, Professor of MIT Media Lab Space Enabled Group, is a great tool and platform to encapsulate the key concepts above and to make meaningful connection with users/stakeholders. The modified system architecture framework is an informative example to highlight the importance of understanding stakeholders' objectives and needs in complex systems (Joseph and Wood, 2021; Kazansky *et al.*, 2016). Wood clarified the system stakeholders in three layers (Table 3.): primary, secondary, and tertiary within the system boundaries to illustrate how to achieve the differently layered stakeholders' objectives through the system architecture framework (Ovienmhada *et al.*, 2021). The three-layer structure to categorize system stakeholders can be a useful source to be integrated into the design thinking process when designers or design teams are conducting user-related studies, interviews and ethnographic research.

Stakeholder Type	Primary	Secondary	Tertiary
Brief Definition (Modified from Professor Danielle Wood's research.)	Those who make direct decisions about the design of the system	Those who have influence on the Primary Stakeholders via authority or funding	Those who exert little or no control over the system but are impacted by it
Stakeholders (Use footwear design for an aging population as an example)	The care recipients (e.g., senior user, customer), the care provider (e.g., family, friends), footwear company.	The medical professional (e.g., doctor, nurse), footwear design team (e.g., designers, engineers), business investor.	People who sell the footwear products or services (e.g., footwear dealers).

Table 3. Summary of stakeholders in the system of footwear design for an aging population.

Since this study will emphasize how to empower users' ideas and leverage them before/during/after the product design process to assist the design and engineering team to have better human-centered solutions with great insights to improve design quality and people's quality of lives, we use the modified system architecture framework by Professor Danielle Wood as a baseline to develop the design process.

2.3 Human-Centered System Design (HCSD)

Besides dividing the methodologies into two categories, the design process and system architecture, there are other studies covering the intersection of the design-thinking process and system architecture approach to discuss the applications and values of curating or merging theories, frameworks, and methodologies. In this study, we define it as Human-Centered System Design, HCSD (Lee, 2021b) such as combining ConOps with design scenario to design a human-centered campus tour experience (Lee *et al.*, 2020).

MIT xPRO experimentally applied the design thinking approach and toolkit to support the system thinking course (Lee *et al.*, 2021). Lizbeth B. De La Torre used her MIT master thesis project to compare design thinking methods and system architecture/engineering approaches and techniques in the context of space mission development to identify a gap in the literature. Her research provides a structural foundation to initiate a conversation in the aerospace industry to argue how to leverage a broader variety of creative approaches with design techniques and perspectives and revisit the value of integrating design capabilities (B. De La Torre, 2020).

3. Design Consideration and Opportunities

3.1 HCSD Typology

Inspired by the literature review, case studies, and expert interviews, Figure 4 presents the initial outcome of how we experimentally explore and prototype various possibilities to curate, merge, and combine design processes modified from the IDEO design-thinking diagram (IDEO, 2015) and system architecture framework modified by Professor Danielle Wood from MIT Media Lab Space Enabled Research Group (Ovienmhada *et al.*, 2021) to maximize the exposure and involvement of users' voices, feedback, and ideas to influence the product design and development process.

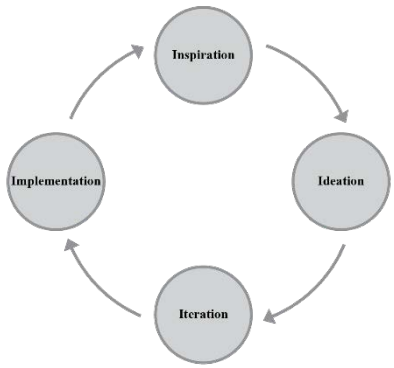

Figure 2. Modified IDEO design thinking diagram (Re-illustrated by Sheng-Hung Lee)

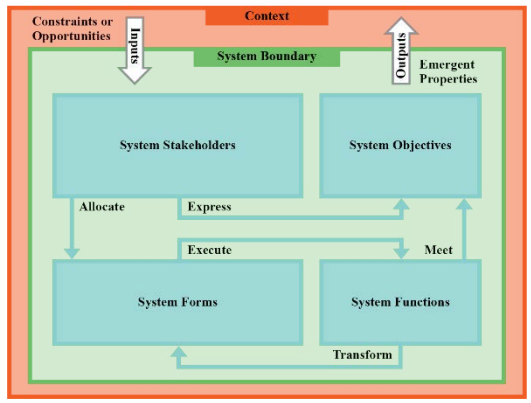

Figure 3. Modified system architecture framework by Professor Danielle Wood (Re-illustrated by Sheng-Hung Lee)

The intention of sketching out the various configurations of HCSD is to view the product-design process in a more holistic aspect. In the study, we define and simplify Figure 2 and Figure 3 as two basic diagram units representing the design-thinking approach and system-architecture framework separately. The colors in the diagram are designed for the purpose of readability and finding patterns.

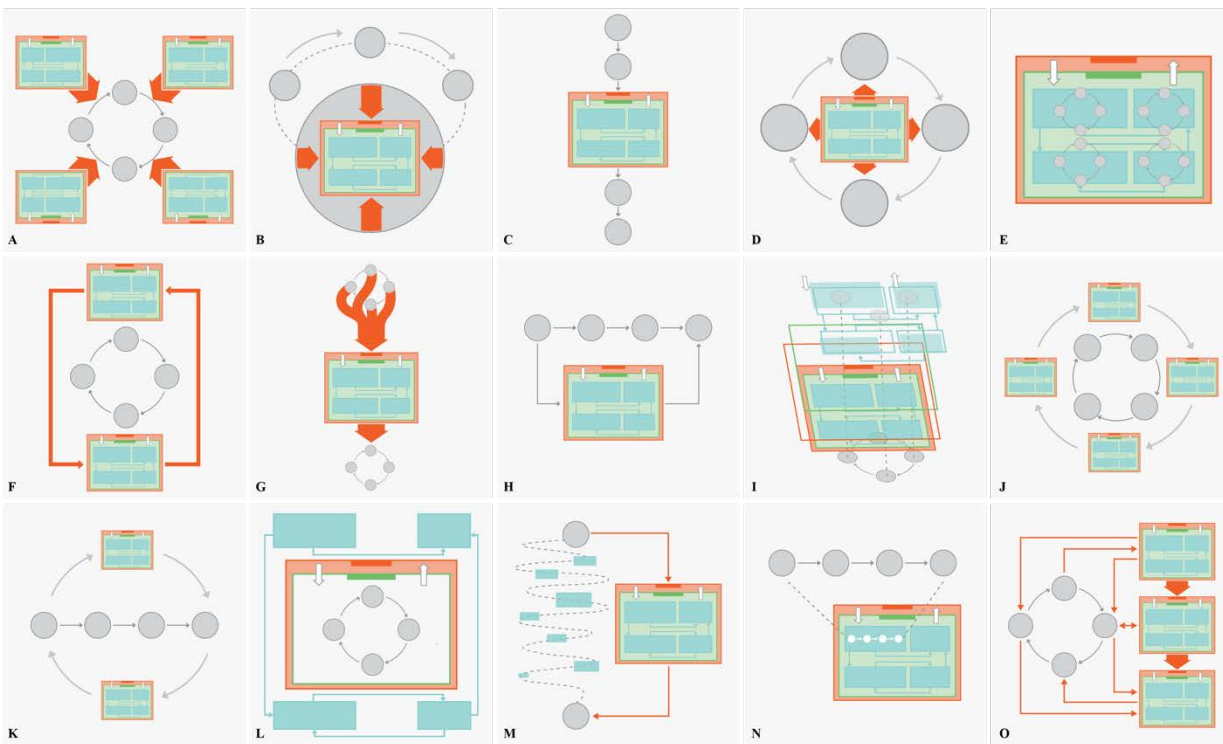

Figure 4. 15 different experimental configurations of HCSD typologies (designed and illustrated by Sheng-Hung Lee)

Configuration	**A**	**B**	**C**	**D**	**E**
Design Intention	Integrate system architecture framework into the in-between design process to constantly estimate the performance and outcome of project.	Apply system architecture framework only in the first section of design process to identify system users and their objectives to lay out the solid foundation of the system.	Add system architecture framework between the ideation section and iteration section of the design process. The goal is to make sure this structure can secure the voices from users.	Put the system architecture framework in the center of design process to have better clarity to control the whole system boundary of design process. It is easy and consistent to apply across the whole process.	Integrate four sub-design processes into the four components of the system architecture framework to maintain the flow of design process and users' voices.
Score	4/5	3/5	3/5	5/5	4/5
Configuration	**F**	**G**	**H**	**I**	**J**
Design Intension	Use the system architecture framework as a holistic approach and guiding principles to review the design process.	Use the system architecture framework to transform the design process in terms of methodology flows, touch points of the system, and structure.	Apply system architecture framework parallel with design process to compare and complement the process and extend the influence of the users.	Define both design process and system architecture framework in three dimensions by including the time component to see how it affects the user.	Use system architecture as a dynamic frame of reference and tool to support and complement the design process across the whole system.
Score	2/5	3/5	3/5	2/5	3/5
Configuration	**K**	**L**	**M**	**N**	**O**
Design Intension	Use system architecture framework as a gate to review the system feedback loop focusing on users' voices, ideas, and pain points.	Put design process in the center of system architecture and use the four system components (blue) to estimate the desirability and objectives of users.	Decompose the four system components (blue) as a set of evaluation matrixes to validate the feedback and ideas from the users and their pain points in general.	Refine and zoom into one of system components—system stakeholders and apply design process to improve the quality of the result learning from users.	Apply the input and output from design process into system architecture framework to form a comprehensive yet detailed process.
Score	3/5	2/5	3/5	3/5	3/5

Table 4. Design intention and score of 15 different experimental configurations of HCSD

In Table 4, we wrote down the design intention of each possible framework and scored the 15 different configurations of HCSD models from one to five points, which is based on how feasible the concepts of the modified design-system framework can successfully amplify the voices, feedback, and ideas from users in the product design and development process.

Table 5 provides the matrix of rating criteria that is referenced and inspired by the matrix for system measurement (Nightingale and Rhodes, 2015) and Professor Danielle Wood's research (Wood, 2012). We created and followed the three key criteria: inclusive, responsive, and effective as a guide to consider 15 different configurations of the HCSD framework by rating from one point to five points. Table 4 shows that configuration D got the highest score among the rest of the concepts, so we use it as a reference point to discuss in the summary.

Suggested Criteria	Questions to Consider	Rating Scale
Inclusive	How adaptive is the framework to reflect on diverse users' opinions to cater to different scenarios and needs in the system?	1: lest inclusive 5: very inclusive
Responsive	How responsive/fast/frequent is the framework to reflect users' feedback in dynamic systems? When to ask for response/the reaction/feedback from users during the design process?	1: lest responsive 5: very responsive
Effective	How much impact can be made through applying the framework to change/transform people's/system's behavior, and the result of the design process?	1: lest effective 5: very effective

Table 5. The matrix of rating criteria

3.2. Design Contribution and Opportunities

The research will not come up with brand "new" design-system methodologies, but instead, we will suggest how to curate or integrate the existing design process and system architecture frameworks and approaches to prototype to see if the new model can be applied to solve systemic socio-technological challenges. We assume that the "new knowledge" will be generated and expanded when we apply the model to different types of projects with varied challenges and hence it will help us refine the HCSD incrementally.

In the study, we encourage designers and engineers to solve large systemic socio-technological challenges by using a HCSD, which can increase many design opportunities. For example, how are they going to adapt the process to make the modified system-design model fit different scenarios? What types of challenges do they think are suitable to use the HCSD to solve?

3.3. Potential Threats to Internal and External Validity

Before selecting any type of HCSD for prototyping and testing the framework, we need to consider potential threats through internal validity and external validity while using the model. Therefore, we raise three questions of both internal validity and external validity as the preliminary steps to discuss the potential threats in the research.

In the study, the word "internal" generally means people (e.g., designers, engineers, or method practitioners) who use the model to study subjects or apply the model to the design process, whereas the word "external" stands for people (e.g., users, customers or project participants) who are being studied or observed through the model. The brief definition of validity refers to whether the research findings accurately reflect reality, that is, whether the method practitioners/observers (e.g., designers, engineers) and project participants (e.g., users) can understand the problems and concepts (LeCompte and Goetz, 1982).

3.3.1. Internal Validity

- How to define the internal system boundary of the HCSD to clarify the roles and responsibilities of the internal team? Who are the internal team and what are their relationships with the internal system?
- How to establish the structural internal feedback loops or platform to systematically gather suggestions from the method users (e.g., designers or engineers) and project participants to help the internal team refine the HCSD?
- How to purposefully select the suitable projects or challenges for the HCSD testing by establishing a filtering matrix to control the system input?

3.3.2. External Validity

- How to train the trainer of people who are interested in the HCSD? What are the mechanisms of the train-the-trainer program/curriculum?
- How to decompose the HCSD to highlight its modularity feature so that people can follow the guideline to choose the components that matter or are relevant to their projects the most and execute them precisely?
- How to build the robustness of HCSD in terms of establishing its reputation, providing clear instruction of process, and covering presentable case studies?

4. Discussion

The modified design-system framework can push the design field/industry to re-evaluate the purpose and the value of empowering users in the process of product design and development. IKEA aligns its company's mission and vision to the five dimensions of democratic design (IKEA, 2021); openIDEO initiates an open innovation platform allowing its clients and participants to put HCD in the hands of many (openIDEO, 2021); NIKE ID invites its customers to tailor-make their personal product experience (Nike, 1999). These are all great examples to demonstrate how we as designers or engineers make some selected parts of the typical design process transparent and interactive with users and integrate their creativity, ideas, and feedback into the system loop.

4.1. Academic Benefits

In the era of transformation, to solve socio-technological systemic challenges, design approaches merge with system thinking/engineering/architecture; this is the critical trend not only in academia but also in industry. For example, the MIT has provided a few relevant degree programs such as System Design & Management (SDM) and Integrated Design and Management (IDM). MIT xPRO online learning platform also had launched a series of System Thinking courses to meet the needs of the market and share the latest academic research (MIT xPRO, 2021).

Design firms such as IDEO and Frog have started to post and hire positions for organizational design or system design, with their unique definition "Org designers make people's lives better at work. Specializing in the design and integration of new structures and systems, we help clients create values, incentives, rituals, teams, and spaces that drive an organization's behavior and culture" (IDEO, 2021b).

They published articles like "Designing Systems at Scale (Dust and Prokopoff, 2009), A Not-Quite-Textbook Definition of Systems Design" (Cerminaro and Surtees, 2019), which indicate that, in the academic research, our current education system and curriculum design need to consider how we might cultivate a new generation of creative talents with hybrid skills and capabilities in design-and-system domains and extend the research areas and interest.

4.2. Educational Opportunities

When we discuss where or what are the right conditions that the most likely innovative ideas come from, one of the common answers lies in the overlap of the three circles: the desirability of human angles, the feasibility of technology and science, and the viability of the business and economics (IDEO, 2021a). In this study, the modified design-system framework actually amplifies and enlarges the influence of users. From the educators' angles, it gives a great opportunity to teach the young generation how and why we need to value and empathize from the users'/customers' perspectives.

4.3. Social Impact

Besides the academic benefits and educational opportunities, we also consider how designers or engineers can apply HCSD to various projects, and its process, results, and application can contribute to our society with practical benefits and hence make a social impact, including on communities, government, and business.

- Communities: The modified design-system framework will benefit users (e.g., aging populations, caregivers, and care recipients) by having more exposure in the design process to evaluate their ideas and feedback before/during/after the product design process and development.
- Government: The user-engagement part of the design process might influence how government makes new policies around how a company makes any critical user-related decisions (e.g., customers have the right to ask for tailor-made service for their shoes). Users' perspectives have gained more influence, and designers' decision-making process has been transformed in a more democratic way.
- Business: HCSD will involve the voice of users during the whole product-design process, which enhances the role and responsibilities of the designer, shifting from doing design alone to design facilitators or moderators to guide users. The business will benefit from decentralizing the design stage with much more exposure from the users' participation and engagement. In short, the new business will emphasize more "crafting" the suitable condition for co-creation with users rather than providing closed-ended solutions.

5. Summary

The contribution and core analysis of the study are shown in Figure 4, which we want to discuss and explore how the Systems Thinking and Systems Architecture Framework can be combined and curated with the design thinking process.

We summarize our research and contribution by proposing our Human-Centered System Design (HCSD) framework (Figure 4. Configuration D), which is a suggested research outcome through curating and merging the design process modified from IDEO's version and system architecture framework adapted by Professor Danielle Wood, Media Lab Space Enabled Research Group at Massachusetts Institute of Technology (MIT). Figure 5 suggests HCSD as a research proposal deliverable that we want to prototype, test, and refine in terms of the flow and structure of HCSD, the interface of each component, and the overall experience of applying HCSD to systemic challenges. In Table 6, we hypothetically use footwear design for an aging population project as a case study to fill in the content according to the definition of system architecture framework paring with the design process.

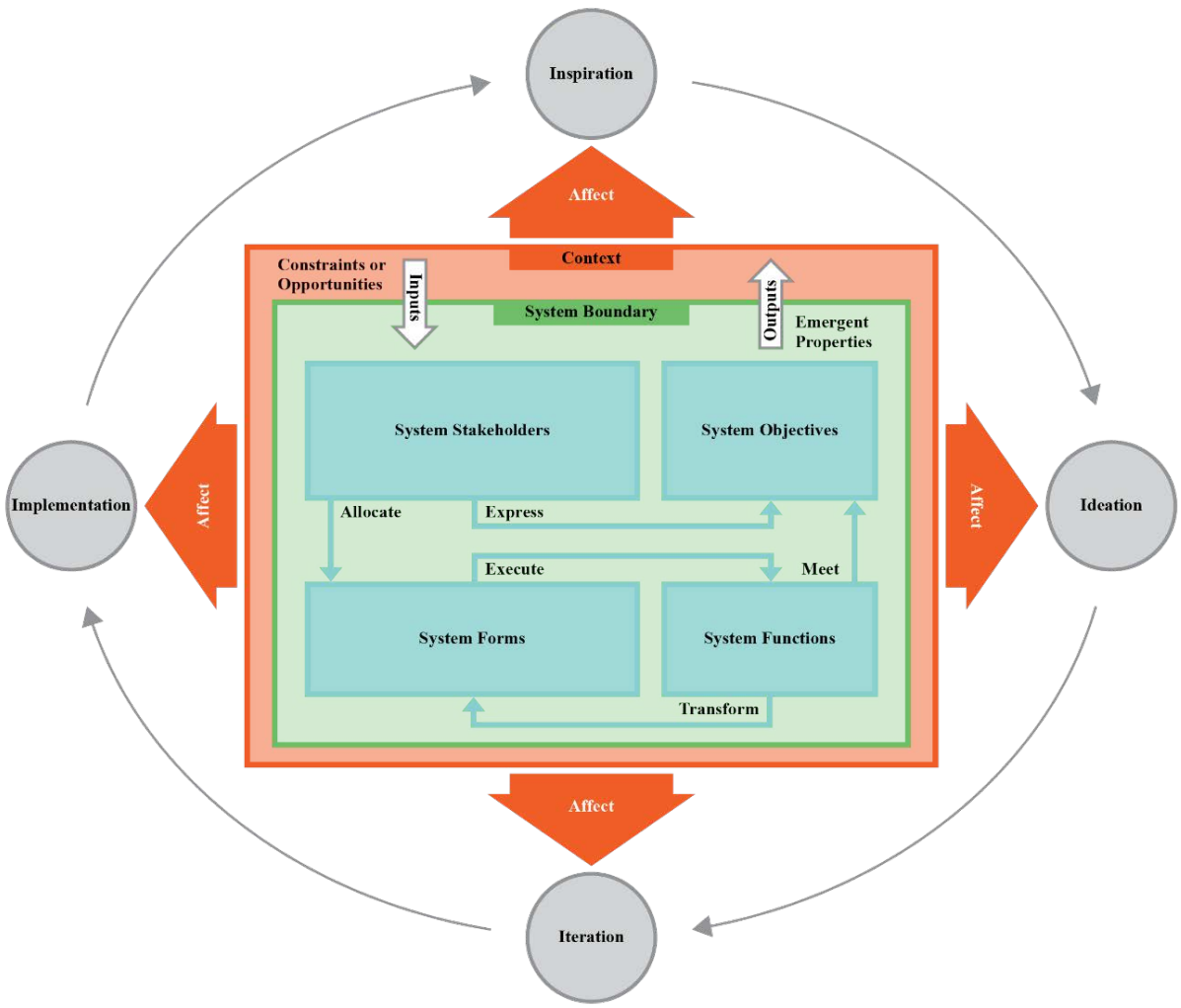

Figure 5. Proposed Human-Centered System Design (HCSD) framework (designed and illustrated by Sheng-Hung Lee)

External Context	System Boundary	Constrains or Opportunities (Input)
We are in the era of transformation, with disruptive advanced technologies, complicated relationship networks, organic organizations' structures, complex-yet-smart products, fast-paced society, and diverse culture, which have made our consumers much more sophisticated than ever. For example, it is not easy for design teams to precisely predict users' daily behaviors, their interactions with others, and decision-making logic. Therefore, understanding our users has become increasingly important to inform the design team to come up with more human-centered products.	Any activity/event connected to or caused by the footwear-related product/service/experience design for an aging population will be considered in the project system boundary. However, the project will focus on a sub-system, which is the interaction between the user (system stakeholders) and the product (footwear) design and development part.	Consider the slow movement of senior people, their behaviors in life and work, purchasing habits, and body conditions (sensitive feet skin, bone density). How do we reflect the above considerations and translate users' needs into research insights to the product (footwear) design and development teams?
Emergent Properties		**System Stakeholders**
How to responsively listen to users' (system stakeholders) feedback and ideas for the design team (designers, engineers) to structurally integrate their suggestions in the product design and development process? How to maintain communication channels between the user (senior people) and footwear service provider (companies, brands) while the product is active (in-use)? People: Senior people at home face emergency situations e.g., falling down in the restroom or having difficulty walking or moving. Product: Footwear is not working/functional e.g., out of battery or the device needs to be repaired.		Senior people (care recipients) Family (caregivers) The medical team (doctors, nurses) Service providers (footwear companies, brands) Product design and develop teams Investors (clients, agency, sales)
System Objectives	**System Forms**	**System Functions**
The system objective (proposed methodology—HCSD) is to help the design team curate, merge, combine a series of the design process and system architecture approaches that can responsively and accurately reflect, receive, and integrate users' (system stakeholders) needs, ideas, feedback and empower users to be able to influence the decision-making process and its outcome of product design and development.	The system form of the product consists of the footwear product (physical form) and its service around the product (informational form), whereas the proposed methodology, HCSD, mainly consists of an informational form.	Footwear design needs to provide a safe, comfortable, tailor-made product, service, and experience to enhance the quality of life of senior people. The system functions of the proposed methodology, HCSD, is to make the users (system stakeholders) have clear, transparent, and interactive communication channels.

Table 6. Summary of applying modified system architecture framework to analyze footwear design for an aging population.

6. Further Research Areas

We can focus on and explore the following questions for further research areas: 1. How to apply the design thinking process with the system architecture framework adapted from Professor Danielle Wood to other product design and development projects to precisely identify the key stakeholders' desirability? 2. How to best filter out the users' feedback and ideas in the process of product design and development to distill the essential parts of their suggestions to shape the value from the users? 3. What are the other meaningful approaches, components, and stages to integrate the design thinking process and system architecture to form an impactful Human-Centered System Design (HCSD)? 4. What are the other applications, implementation, and fields to which we can fully apply HCSD to solve these large complex systematic social-technological challenges?

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