By Sheng-Hung Lee

Centering humans within larger systems to design services, products, and experiences can help designers create solutions with a "human temperature," business value, and social impact.

Transformation by Human-Centered System Design

HUMAN-CENTERED DESIGN (HCD) IS no longer a new term in the field of design, innovation, and business. In the era of transformation, traditional industries, social infrastructure, healthcare systems, financial planning, our education systems, and most people's common sense have been challenged—all of which have changed the predictable way we think and live. ChatGPT, DALL·E, Fabrie, robo services, and immersive technologies such as augmented reality (AR), virtual reality (VR), extended reality (XR), Gravity Sketch, and other artificial intelligence (AI) tools have disrupted people's daily rituals while forcing them to develop a new lifestyle and perception.

We may need to rethink our design frameworks, theories, and processes to adapt to the dynamic context of intellectual, behavioral, and environmental change. Inspired by, learning from, and integrating system engineering and system thinking into HCD is one approach that could aid in these changes.

Centering humans within larger systems to design services, products, and experiences can help designers create solutions with a "human temperature," business value, and social impact. The work lies at the intersection of HCD, engineering systems, service design, and the social sciences. Although HCD has been successfully used in many fields such as the social sciences, engineering, and management, there remain challenges. *How do we scale the HCD design process and outcomes? How do we prototype a complicated system such as a satellite? How do we create adaptable, comprehensive approaches to solve complicated systemic socioeconomic challenges?*

In response to these questions, we proposed and developed a human-centered system design (HCSD) framework that provides a process for scoping and solving complicated systemic problems while centering the needs of humans. The aim is to experimentally integrate theories and methods from across these disciplines including HCD, engineering systems, service design, and the social sciences to apply them in the process of design research to conduct evidence-driven experiments to measure qualitative and quantitative results.

The idea of HCSD also resonated with what Donald A. Norman mentioned about the shift from human-centered design to humanity-centered design in his recent book *Design for a Better World: Meaningful, Sustainable, Humanity Centered*. HCD was developed in the 1980s to accommodate the need for the mass production of products. The industry and market need to define the designer's role to modify the design solutions to meet the requirements for production and manufacturing to ensure products' usability and human factors. Humanity-centered design considers not only people but also socioeconomic and natural systems around people, all living things, and the physical environment. It also raises the importance

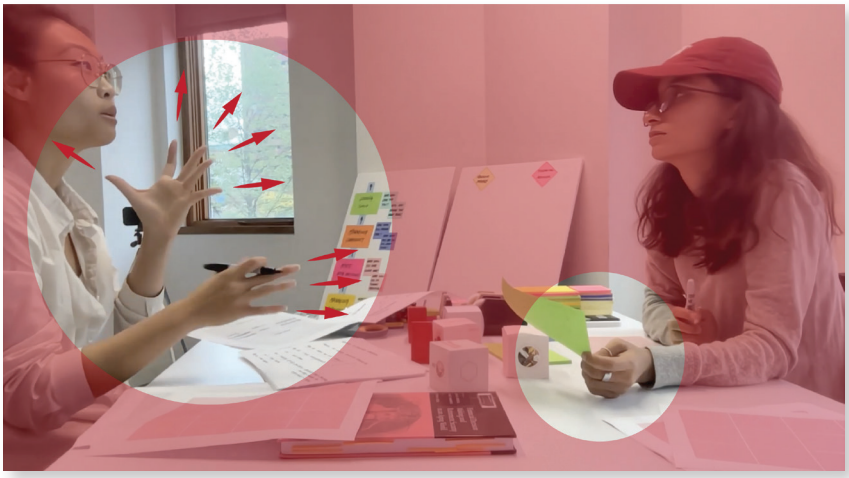
of inclusiveness, ethics, diversity, inequality, and bias in the design context. When using humanity-centered design or HCSD to tackle these complicated challenges, considering both long-term goals and systems in the context of nature has become an integral and essential criterion.

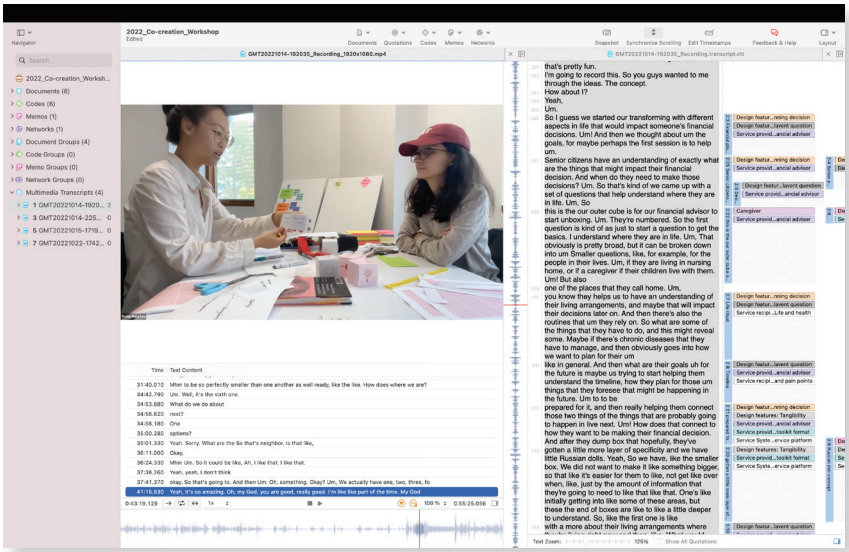
If we consider our world as consisting of various combinations of signals, we can simply explain the term *design* as a way to decode signals (de-coding-sign-al) with meanings. The idea of design+ is to combine and curate HCD, system engineering, and system thinking. This article briefly discusses four possible integrations (ATLAS.ti, ultra-wideband (UWB) wireless technology, object-process methodology (OPM), and service system) paired with separate case studies as to what each can accomplish with positive impact.

HCD + ATLAS.ti: building a financial planning toolkit

We drew on HCD and social science ethnographic methods to explore the question of *how we create and apply tangible, provocative artifacts to enable people to talk about sensitive and personal financial planning topics*. The goal of the research was to be able to use these artifacts to improve people's financial literacy, confidence, and planning ability with an emphasis that these artifacts support equity, inclusiveness, and diversity of financial well-being. For the research we recruited eight senior designers to participate from industrial design, interaction design, branding, graphic design, communication design, and business with limited experience in design in the financial domain. We intentionally recruited designers with limited financial literacy, aligning with our target persona to co-create a physical financial planning toolkit as a provocative object.

For data collection, we set up four cameras and one GoPro MAX 360-degree action camera in the experimental space to capture participants' behavioral data (e.g., body language and gestures) as shown in Figure 1, and we used Zoom Cloud to record participants' verbal data (conversation,





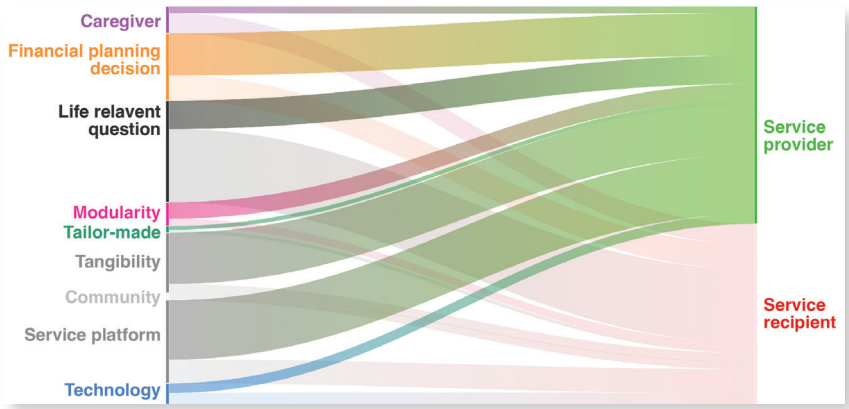


FIGURE 1 (TOP)
Co-creation workshop participants' non-verbal behavior and verbal conversations were observed and analyzed to visualize results in a Sankey diagram.

FIGURE 2 (MIDDLE)
We used ATLAS.ti to code participants' verbal data for semantic analysis to develop insights (interface screenshot).

FIGURE 3 (ABOVE)
Visualization of the verbal conversation data in a Sankey diagram.

Humanity-centered design considers not only people but also socioeconomic and natural systems around people, all living things, and the physical environment.

discussion, and tone of voice). For the ethnographic analysis, ATLAS.ti, a computer-aided qualitative research software, can be a helpful and great tool for coding data. Figure 2, page 89 displays a conceptual code map that emerged from the analysis, and Figure 3, page 89 shows a Sankey diagram, a data visualization technique I used to illustrate the relationships between significant data codes from the study. The results provided support for the important role the use of tangible, provocative artifacts can play in building trust and amplifying user experience. It gave HCD a new perspective to build empathy through users by applying social science ethnographic methods.

HCD + ultra-wideband (UWB) wireless technology: footwear design for an aging population

This research aims to analyze the relationship between space and people's behavior in a confined environment informed by studying people's indoor trajectories. The research emphasized the design of human-centered, service-enhanced environments with and for users. We used HCD tools including ideation, user and expert interviews, and co-creation workshops, and leveraged technology to generate behavioral data. To generate the experiment results with accurate positioning (up to 10 centimeters), we purposefully applied ultra-wideband (UWB), a wireless radio assistive technology operating between 3–10 GHz frequency. The technology was attached to people's footwear to capture their indoor walking trajectories within their home spaces across six defined zones as well as the time spent in each zone, and the frequency of entering each zone (Figure 4). These data allowed us to identify residential behavioral patterns and, in turn, to re-envision indoor living spaces.

We translated people's behavioral data into a set of design needs that center on and reconsider users' dignity and data privacy, and it pointed to business opportunities helping us integrate UWB technology with space design. For example, the decision of space design no longer solely relies on designers' preferences but can also be supported by behavioral data. One future research question this work generated is how to disentangle the variances

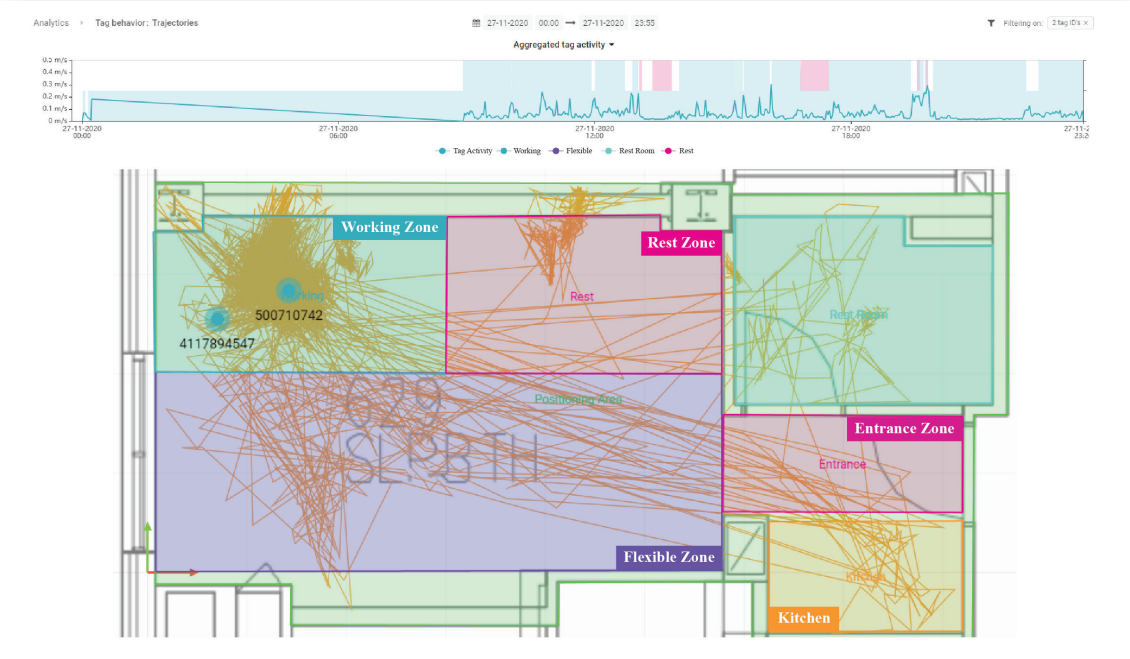


FIGURE 4
A floor plan of a single-person dorm. We applied UWB wireless technology to track indoor footsteps and trajectories to study people's unconscious behavior and decision-making processes.

between users from the design of the space, accounting for personal preferences and patterns of behavior. *How might we build an HCD space that considers behavioral, functional, and desirable aspects with emotional technologies and human touch?* By applying assistive technology and HCD, we believe we can create inclusive spaces and human-centered interaction for and with people to help improve equity with respect.

HCD + system engineering: redesigning the MIT campus tour experience

As part of a six-week collaboration project with the MIT Admissions Office to redesign the MIT campus tour experience, we applied engineering systems thinking and HCD. Considering the campus tour as a human system, we chose and applied OPM, a model-based system language that decomposes systems into multiple subsystems such as space, people, equipment, and even culture (Figure 5). OPM offered a lens through which to navigate the user experience to identify systemic pain points. In the past, we considered the campus tour experience for visitors. We also need to think about the prospective students, investors, alumni, and other key stakeholders' needs in various cultures to incorporate them into the tour (Figure 6).

In this project, considerations of equity, health, and inclusion were key to creating a successful universal design to ensure the tour experience provided a neutral and effective wayfinding system that reflected different languages, that it created a wheelchair-friendly and fully accessible environment, and that it built and communicated a gender-friendly and inclusive culture. The project won several international design awards in 2020: International Design Awards™, Bronze—Design for Society & Design for Public Awareness, Spark Award, DNA Paris Design Award, Novum Design Award, Gold—Service Design, and International Design Excellence Awards (IDEA). While the awards were gratifying, my greatest satisfaction came from the realization that we can leverage the strength and power of HCD integrated with systems engineering tools to solve systemic challenges.

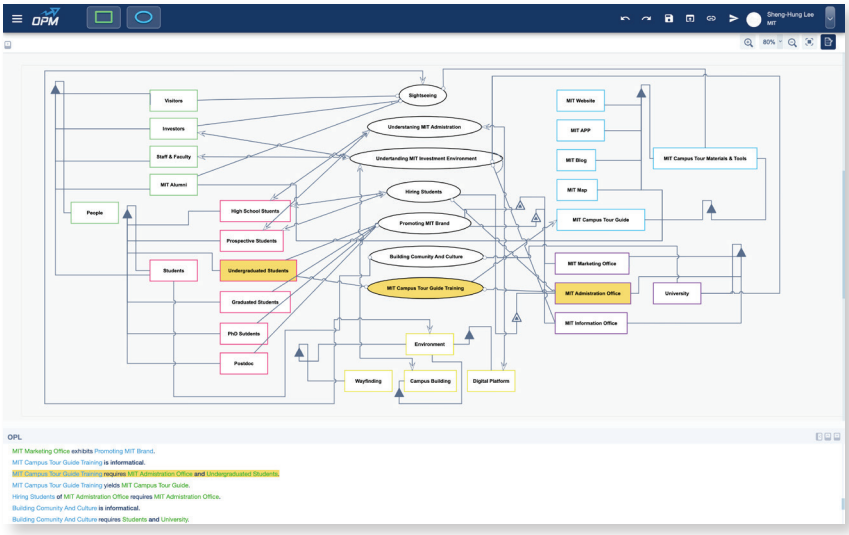


FIGURE 5 (TOP)
We decomposed the MIT campus tour experience (considered as a system) by applying OPM to generate an object-process diagram (OPD).

FIGURE 6 (ABOVE)
We considered the MIT campus tour experience as a complex and dynamic system to identify different key stakeholders' needs including prospective students, industry investors, alumni, visitors, MIT students, and staff.

For most design researchers, the ability to build empathy has become more critical than ever, especially in the era of transformational socio-technological change.

HCD + service and experience design: innovating a longevity planning experience

My current research collaborating with MIT AgeLab, MIT Ideation Lab, and MIT Behavioral Research Lab focuses on redesigning and envisioning financial planning service experiences through shifting people's mindsets and behavior from "design for retirement" to "design for longevity" (D4L) with the goals of improving financial literacy, well-being, and overall quality of life.

The intention of D4L originates from product and fashion design. Scholars mentioned the conceptual frameworks such as product lifecycle, circular design, and design for sustainability. There are various D4L definitions with different historical contexts including the fields of design, financial planning, and gerontology. Still, the key lies in whether we can gain and develop holistic views aligning with our mindset and behavior in the face of systemic and complicated challenges.

In this experiment, we made a hypothesis that D4L can and should encompass 12 critical factors that go beyond financial planning (e.g., health, family, education, risk, transportation, housing, etc.). This work aims to design, prototype, control, measure, and quantify longevity planning services and experiences in the financial planning context.

FIGURE 7
The longevity coaching service experiment with tangible artifacts and projection AR at MIT AgeLab to measure participants' perceived service quality.

FIGURE 8
Twelve tangible artifacts with provocative questions, visuals, and photos to understand people's perception of longevity planning, health equity, and financial well-being at the level of individuals, families, and communities.

Figure 7 demonstrates the D4L service experiment environment with 12 tangible artifacts (Figure 8) and projection AR by using script theory from social psychology to manipulate the service experiment with different script-based variables (e.g., scenes, actions, roles, props, and entry and exit conditions). In survey questionnaires, we used SERVQUAL which is a set of multi-dimensional criteria from the business and marketing field to capture consumer expectations and perceptions of a service along five dimensions—reliability, assurance, tangibles, empathy, and responsiveness—to measure perceived service quality pre- and post-experiment. We expect to have results from this ongoing work in the spring of 2024.

We experimentally applied HCSD to explore and understand D4L in the financial planning context. We believe that putting on a longevity lens can empower designers, researchers, and advisers to have more in-depth systemic thinking with inclusive perspectives to challenge the status quo financial planning product, process, and platform. The goals of this D4L experiment are to raise people's awareness, especially young adults, enhance their longevity literacy, manage longevity risk, improve longevity well-being, develop foreseeable short-term longevity strategies, and envision long-term longevity blueprints.

Sheng-Hung Lee *is a designer and Ph.D. researcher at MIT AgeLab and Board Director at IDSA (Industrial Designers Society of America). He is inspired by multiple domains of knowledge and perspectives, and he thrives on creating value on multi-disciplinary teams while working at IDEO and Continuum. He is trained as an industrial designer and electrical engineer, and his approach to problem-solving is influenced by his passion for how design and technology impact and can be integrated into society. Lee graduated with a dual Master's degree (Hon.) at MIT Integrated Design & Management and the Department of Mechanical Engineering. Currently, he is pursuing a Ph.D. in Human Behavior and Service Design at MIT.*

Research trends shift from artificial intelligence to anticipating intelligence

Changing is not an easy task. Changing requires people to escape their comfort zone, their typical ways of thinking, and maybe their lifestyle. In additional discussions, individual level, communal, organizational, and social changes can be considered as a series of interconnected and integrational transformation processes associated with many stakeholders in complex systems. Undoubtedly, it takes patience, effort, commitment, and much love to successfully and seamlessly transform an organization's culture, people's behavior, governmental policies, beliefs, and mindsets.

Consider that HCD, systems engineering, and service design all originate from people's needs. For most design researchers, the ability to build empathy has become more critical than ever, especially in the era of transformational socio-technological change. We want to leverage new technologies and tools: AI, computational science, and immersive technologies such as wearable or mobile AR, VR, or XR to conduct qualitative research with the goal of yielding new and deeper insights into analyzing and synthesizing people's behavior.

Design research has been empowered already by computation science and AI. But I think the focus should shift further from "artificial intelligence" to "anticipating intelligence." For further research, I want to consider the core value of design research deeply: *Can we make our world more equitable, diverse, and inclusive by applying emerging technologies and AI?* For example, building on existing work on *how AI may amplify biases or discrimination*, a series of studies will be designed and planned to examine *how AI-powered services can be re-designed to minimize bias and support inclusion*.

Further, let's envision the design by applying the lens of an HCSD, a paradigm shift away from the typical HCD approach, to shape and simulate possible scenarios with artifacts through immersive technologies (e.g., projection, mobile, and wearable AR/VR), computational intelligence (e.g., generative AI), and service innovation. We can explore the boundaries of HCD by integrating system thinking, systems engineering, and evidence-driven approaches to explore questions such as whether HCSD scale design solutions consider complexity, equity, social justice, culture, and social science dimensions. ■