RESEARCH + EDUCATION FORUM TOKYO 2023

WORLD DESIGN ASSEMBLY TOKYO 2023
DESIGN BEYOND

Forum Proceedings

WDO WORLD DESIGN ORGANIZATION

The following document is the published collection of technical papers accepted for presentation at the WDO Research and Education Forum that took place during World Design Assembly 2023 in Tokyo (Japan), hosted by the Japan Institute of Design Promotion on 27 October 2023.

ISBN 978-1-7770192-2-8

455 St-Antoine Street West, Suite SS10
Montreal, Quebec, H2Z 1J1 (Canada)
WDO.org

About this publication

Held on 27 October 2023, the WDO Research and Education Forum 2023 took place on the first day of the World Design Assembly at Chiba University's Design and Research Institute in Tokyo (Japan). Hosted by the Japan Institute of Design Promotion, the Forum explored the theme of Design Beyond and aimed to share perspectives and ongoing research demonstrating the future impacts of design across different human, technological and planetary contexts.

Bringing together academics, students and industry leaders from around the world, the event focused on three distinct sub-themes: design for humanity, design for human-centred technology and behavioural design for planet. Merging diverse insights, the Forum put forth a dynamic vision for tomorrow that showcased the value of designing beyond the borders and boundaries that have shaped our modern era.

The following proceedings are the collection of papers selected for presentation and publication.

To view the keynote presentations and panel discussions from the Research and Education Forum, as well as see the posters presented, please visit: wdo.org/programmes/world-design-assembly/wda-2023/wdo-research-and-education-forum-2023/

Theme 1

Design for Humanity

This track invites explorations and debates that leverage our understanding of design and designing for humanity. Exploring contributions from various practice-based and thinking viewpoints, this theme highlights projects where design plays a key role in areas such as social change, social innovation, social inclusion and cohesion.

Theme 2

Design for Human-centred Technology

Digital and physical technologies have radically transformed the way we live and work, and technology is one of the drivers of humanity's future. As a product of humans, it exists because we have designed, developed, financed, disseminated, accepted, and employed it. However, technology can also embody the negative aspects of humanity. As we look to the future, this theme explores the role of technology in achieving the Sustainable Development Goals and their global impact.

Theme 3

Behavioural Design for Planet

This track aims to highlight design research, training projects, educational tools and methods capable of generating products and services that trigger behavioural change to benefit Planet Earth. These inspiring recommendations aim to generate, in individuals as well as in communities, a new conscious and engaging push to change habits and adopt virtuous behaviours.

Pier Paolo Peruccio
WDO Research and Education Forum Chair

WDO's Research and Education Forum is not just a seminar on design education. It is a global event that connects the world of industry, professional design research and design universities and schools across diverse geographical contexts.

Through this goal of bridging the gap between design academia and industry, we have created a legacy of sharing – ideas, best practices and innovations that are not only shaping design education and research but also effectively preparing the next generation of designers with the skills they need to affect change. In the last year alone, we've seen a massive shift across design academia, from the methodologies and tools we leverage to the research approaches we engage in.

Exploring the theme of Design Beyond, the WDO Research and Education Forum 2023 looked at the intersection of design across three themes: design for humanity, design for human-centred technology and behavioural design for planet. The insights shared as a result of this Forum, and throughout this publication, demonstrate that while Design Beyond may concern the future of design, there are many ways that designers are addressing this theme in the present.

As evidenced by the record number of paper and poster submissions we received, this year's theme did indeed resonate across our global community. This publication compiles the papers that were selected and presented on 27 October 2023 in Tokyo (Japan) by international research academics, designers and educators. On behalf of the committee, we would like to thank them for sharing their insights as part of the WDO Research and Education Forum 2023.

David Kusuma
WDO President (2022-2023)

Since 2019, WDO's Research and Education Forum has brought together designers, academics, students and design professionals from around the globe as a showcase of design education and research. Under the banner of Design Beyond, 2023 saw our community come together in Tokyo (Japan) to explore future perspectives on design through the lens of humanity, technology and planet.

It is fundamental that in this age of digital transformation designers are consistently pushing the boundaries of innovation and creativity. They are designing beyond what we can imagine to ultimately create for a future that is yet unknown. Designers globally are grappling with the impact and potential of technologies that mimic human sentience and capabilities, and what this means for the future of both people and planet. Curating perspectives from across the fields of design, the WDO Research and Education Forum 2023 and this resulting publication identify how we can best prepare the next generation of designers to design beyond boundaries.

We extend our appreciation to WDO Promotional Member Japan Institute of Design Promotion for their collaboration and support in hosting this event. A special thanks as well to the WDO Research and Education Forum Committee lead by Chair Pier Paolo Peruccio (Italy) who committed their time and expertise to overseeing the development of our programme: Anne Asensio (France), Thomas Garvey (Canada), Lilian González-González (Mexico), Sheng-Hung Lee (USA), Hari Nair (USA), Verena Paepcke-Hjeltness (USA), Srini Srinivasan (China), Pradyumna Vyas (India).

Keynote Speakers

Ayse Birsel

Designer, Author and Co-founder of Birsel + Seck (USA/Turkey)

Ayse Birsel, is a Turkish-born, New York-based award-winning industrial designer, author, executive coach. She is the co-founder of Birsel + Seck, working with Amazon, Herman Miller Knoll, Toyota, among others.

Jian Liu

Professor, Associate Dean, School of Architecture, Tsinghua University (China)

Jian Liu is a Professor of Urban Planning and Design and Associate Dean of School of Architecture Tsinghua University. She is also a Registered City Planner in China, the Managing Chief-Editor of China City Planning Review and the Past President of Asian Planning Schools Association.

Katja Forbes

Design Leader & DEI Director, Data Visualization Society (Singapore)

Katja Forbes is a seasoned leader in the digital industry with a proven track record of driving growth and innovation. She is an expert in areas such as ethical navigation of emerging technology, CX, UX, data science, and product design.

Panelists

Moderator

Tadanori Nagasawa

Professor, President of Musashino Art University (Japan)

Cultural Engineer and educator in art and design. Nagasawa was formerly the President of Musashino Art University and a Senior Fellow of Royal College of Art. He received an MA from Royal College of Art (UK) in 1981 after graduating from Musashino Art University in 1978.

Jacob Mathew

Senior Design Principal, Srishti Manipal Institute (India)

Jacob Mathew spent his early work life transforming business with design. He now leverages business, design and entrepreneurship to transform society, as a mentor, at Industree Foundation and as Design Principal, Srishti Manipal Institute.

Kenta Ono

Professor, Design Research Institute, Chiba University (Japan)

Kenta Ono is currently researching system design and design theory in the System Planning Research Unit at the Design Research Institute of Chiba University. With a ME and Ph.D. from Chiba University, his previous experience includes Mitsubishi Electric Corporation and Mitsubishi Telecom Europe S.A. (France) as an interface designer.

Hyungkun Yoon

Director, Korean Society of Design Science (South Korea)

Hyungkun Yoon is a 'Japan-Korea-China Three Country Design Specialist' who has been in the design field and design education for more than a decade in each country. He received a doctorate in 'Emotional Engineering' from Chiba University (Japan) and worked for R&DMAK in Tokyo. After graduating from Yonsei University in Korea, he went to China in 2004 at the request of Shanghai Jiaotong University. He has since consulted for companies in areas such as Chinese sensitivity analysis on Toyota design and UI/UX for Samsung MP3. He is currently a director of the Korean Design Association.

Michal Ziso

Architect, Founder & CEO, ZISO Innovation + Architecture Lab | The SLEEP (Israel)

Michal Ziso is an architect, a futurist entrepreneur and space architect revolutionizing the designed environment on Earth through space innovation. As the founder and CEO of ZISO Innovation + Architecture Lab and The SLEEP - SpaceTech startup, she pioneers inclusive-human-centred design on a global scale. Michal is a graduate of the Technion and the International Space University, and an advisor to SpaceTech VC's.

Programme

27 October 2023
Tokyo (Japan)

Opening remarks

David Kusuma
Kazuo Tanaka
Toru Yamamoto (Mayor of Sumida City)
Pier Paolo Peruccio

Keynote Sessions

Ayse Birsel
Jian Liu

Paper Presentations

Theme 1: Design for Humanity
Moderators: Lilian González-González and Pradyumna Vyas

Theme 2: Design for Human-centred Technology
Moderators: Anne Asensio and Meghan Preiss

Theme 3: Behavioural Design for Planet
Moderators: Pier Paolo Peruccio and Srini Srinivasan

Panel Discussion

Jacob Mathew
Kenta Ono
Hyungkun Yoon
Michal Ziso

Closing Keynote

Katja Forbes

Close of Forum

Pier Paolo Peruccio
Akira Ueda (Director of Design Research Institute, Chiba University)

Posters

The following posters were accepted and presented during the poster exhibition held during the WDO Research and Education Forum. To view these posters, please visit: wdo.org/programmes/world-design-assembly/wda-2023/wdo-research-and-education-forum-2023/

Theme 1: Design for Humanity

Addressing Food Accessibility & Food Services in the Aftermath of 2023 Turkey Earthquake
Bengisu Akviran, Yilmaz Ege Nergis, Arda Tunç Özyörük, Nisan Ürerer, Elif Kocabıyık Savasta, Can Özcan

Human-centred Design Approach for Bettering Lives of Construction Workers in India
Srikar Avr and Padam S

System Design to Bring University Students Closer to STEAM
Javier de Jesus Cervantes Estrada

Develop & Lead your Organization by Design to Deliver Value Across the Triple Bottom Line for Prosperity Not Profit and Not at the Expense of People or our Planet
Stephan James Clambaneva

Te Kāhui Tika Tangata, the Human Rights Commission
David Hakaraia

Study on CMF Design and Process Development System for User Emotive Satisfaction
Jiyoung Han

OLTA: Human Rights Issue Selectshop Platform
Yejin Lee

Design for Activating Citizens to the Future(s)
Aiko Monoi, Yu Ikemoto, Mami Takahashi, Tasuku Soga, Yoshitaka Shibata, Takashi Shirasawa, Toshiomi Moriki

Deforme' Water Bottle
Fatima Muhammad Nasir

The Intersection of Design and Craftsmanship for Crosscultural Creation
Fabiola Cristina Rodriguez Estrada and Nakano Yoshito

A Visual Analysis of Facial Expressions in Cross-Cultural Character Design
Siddharth Sinha, Lisa Winstanley

Theme 2: Design for Human-centred Technology

Anthropological Methods in Design
Thomas Ask

Water Resilient Oasis: Adapting Design Technologies for Water-stressed Regions Based on Urban Resilience Attributes
Soheil Dashti

Stepping Out of the Slate
Manabu Kawada, Yoshihiro Katsumata, Akie Hinokio, Yurii Kasao, Hinako Matsui

Dystopias of Digital Memory: Technology Helps Us Remember but are We Allowed to Forget?
Aparna Raman

Web Accessibility in the Future: An Attempt to Combine Service Design Approach and Inclusive Design
Yasuko Yamamoto, Akira Nakayasu, Atsushi Akiyama, Keisuke Shoji, Fumino Suzuki, Takeshi Youoku, Atsuko Uda

Theme 3: Behavioural Design for Planet

Designing Failure to Successful Design
Massimiliano Cavallin

Promoting Local & Sustainable Food Practices Through Visual Communication Design
Peter Kwok Chan, Ben McCorkle

Recycle-inducing Plastic Bottle Label Design
Yeonhoon Choi

System Glitch: Shifting Consumer Behavior Through an Embrace of Repair Mentality
Hazal Gumus Ciftci

Curation as an Approach to Ecological Design Research – Sustainable Revolution Driven by Eco-design Curating
Siyang Jing

Edo Piano Concept Model Design
Manabu Kawada, Yoshihiro Katsumata, Akie Hinokio, Yurii Kasao, Kenta Ono, Chihaya Sakai, Ritsu Arai, Teppei Hanawa

What Will Happen to All the Dead Batteries?
Hyeil Kim

Designing a Culture of Care through Embodied Sustainability: A Design Research Approach to Understand, Translate and Implement Japanese Cleaning Culture in Western Society
Birgit Neu-Severin, G. Neu-Rinaudo

Paper Basket: A Sustainable Design Project to Rediscover Leftovers
Jiyeong Yun

Theme 1

Design for Humanity

Crafted Resilience: Designing for Empowerment and Social Impact Using Phulkari, a Traditional Craft in a Heritage Setting

Authors:
Puja Anand
Harbina Kaur
Alok Bhasin

Institution:
Pearl Academy (India)

Abstract

The paper explores the potential of traditional crafts, specifically Phulkari, from Punjab (India), as a means of empowerment and social impact within a heritage setting. The authors conducted a case study and proposed the establishment of an experiential centre that would celebrate the craft of Phulkari, provide immersive experiences to the public, function as a training facility for local women, and feature a retail space. The centre would preserve the historical significance of Phulkari and promote economic empowerment and social well-being in the local community. With the adaptive reuse of heritage buildings, the centre provides a tangible link to the past, enabling communities to reconnect with their roots, traditions, and values. The study concludes that the experiential centre has the potential to sow the seeds of resilience, leading to a more inclusive and prosperous society, particularly for women.

Keywords: Adaptive reuse, empowerment, heritage setting, Phulkari, resilience

UNESCO recognizes the profound influence of design on social and economic development and has embraced the power of creative solutions to uplift marginalized communities and promote sustainable models.

Introduction

In a world that is constantly evolving and faced with complex challenges, the pursuit of sustainable development and gender parity has become increasingly vital. The Sustainable Development Goals (SDGs) established by the United Nations provide a guiding framework emphasizing the urgency of empowering women and building resilient communities. Among the 17 SDGs to be achieved by 2030, the fifth goal that espouses Gender Equality stands out as a fundamental pillar, focusing on the ambition to enable women to achieve equal status in society and attain financial independence.

UNESCO recognizes the profound influence of design on social and economic development and has embraced the power of creative solutions to uplift marginalized communities and promote sustainable models (UNESCO 2005).The fusion of heritage, craftsmanship, and social impact is a realm in which design can exert its transformative power. This research paper delves into the integration of Phulkari, an intricate traditional craft practiced by women in the northern region of India, as a means of empowerment and social impact, particularly within the unique context of heritage sites.

Phulkari, an exceptional and captivating textile embroidery technique, boasts its distinctive floral patterns and has profound cultural significance. Predominantly practiced by women in the state of Punjab, it has been a cherished art form passed down through generations. The term 'Phulkari' itself translates to 'flower work', a name that accurately reflects the delicate and intricate floral patterns that grace its vibrant fabrics. The essence of Phulkari lies in the expert hands of its artisans, who painstakingly hand-stitch colourful silken threads onto cloth, imbuing life into mesmerizing motifs and designs. Each piece they create serves as a canvas for storytelling, often depicting themes from nature, mythology, or daily life. These tapestries, alive with vibrant colours and intricate patterns, have evolved into symbols of resilience and empowerment for Punjabi women. It is within this cultural treasure that we find the seeds of our exploration – a craft that is deeply interwoven with the life stories, hopes, and dreams of the women who continue to preserve it.

This research endeavour is not only an attempt to shed light on the significance of Phulkari but also to consider its potential when harnessed in the context of heritage sites. Heritage sites, with their rich historical and cultural tapestry, provide an exceptional backdrop for integrating traditional crafts such as Phulkari. They serve as repositories of collective memory, representing a bridge between the past and the present. However, these heritage sites often confront the dual challenge of preservation and relevance in a rapidly changing world.

Our study aims to explore the potential synergy between traditional craftsmanship, such as Phulkari, and heritage sites. The hypothesis at the core of our research is that by integrating Phulkari into heritage settings, we can empower women artisans, promote community engagement, and contribute to the preservation and revitalization of cultural heritage. This multi-faceted approach offers a unique opportunity to address the challenges faced by marginalized women, heritage sites, and the wider community. Our research seeks to bridge the divide between traditional craftsmanship and heritage sites, in the process promoting social and economic empowerment and preserving cultural heritage.

Research Objectives

This research aims to investigate the potential of Phulkari as a tool for women's empowerment in a heritage context. The study seeks to understand how this traditional craft can promote social transformation by providing economic opportunities, agency, and increased societal influence for women. Additionally, the research focuses on gender empowerment and economic development, highlighting Phulkari's role in fostering gender equality and local economic growth.

Moreover, the study underscores the importance of a community-centred approach, emphasizing the significance of aligning the project with the local community's aspirations and requirements. The research objective is to gain knowledge, apply it to design, and ensure community involvement and satisfaction in the project.

Research Methodology

The authors employed a comprehensive research methodology for their case study, which was undertaken as a final-year thesis project. Their primary objective was to revitalize the time-honoured art of Phulkari by integrating it within a heritage building. This was achieved through the proposal for designing an experiential centre and a training and retail establishment, which aimed to empower local women.

The research process commenced with a thorough investigation into Phulkari, encompassing its historical significance and cultural relevance in the Punjab context. This foundational knowledge was essential to inform the subsequent design and implementation phases. The project team actively engaged with local communities and Phulkari artisans, gaining a deeper understanding of their perspectives, needs, and aspirations. To gather valuable insights, site visits were carried out to the heritage building, interviews were conducted with key stakeholders, and surveys were administered to a diverse range of participants. This multifaceted approach ensured that the project was grounded in academic research and attuned to the practical realities and aspirations of the community.

The research process was further enriched by the invaluable contributions of Dr. Maneet Kaur, a distinguished researcher in Phulkari Craft, and Ms. Seema, a prominent Phulkari craftswoman. Their expertise and hands-on experience added depth and authenticity to the research endeavour.

Through in-depth interviews and dialogues with skilled artisans, the research gained a profound understanding of the intricacies of Phulkari craftsmanship, as well as the challenges and aspirations of the women who dedicated themselves to this traditional art form.

About Phulkari

Phulkari holds immense cultural significance. The craft, which derives its name from the Punjabi words 'phul' meaning flower, and 'kari' meaning work, is deeply rooted in the history and traditions of Punjab (Hitkari 1980). The primary attribute of Phulkari is that the embroidery is executed on the reverse side of the fabric, thus automatically creating a design on the right side of the fabric. Historically, Phulkaris were bestowed upon brides as a wedding gift. This auspicious symbol of happiness and prosperity, and a representation of the marital well-being of a married woman, is deeply intertwined with the life of a Punjabi girl. The traditional Phulkari embodies the resilience and vibrancy of Punjabi women, reflecting the challenges and triumphs they face in their daily lives (Kaur and Gupta 2014). Passed down through generations, Phulkari serves as a testament to the rich cultural tapestry of the region. Women, particularly in rural areas, meticulously create these vibrant textiles, with each piece telling a visual story that reflects not only the artistic skills of the maker but also the emotions and narratives of the women who crafted them. These Phulkari pieces are laden with history and tradition, symbolizing the continuity of Punjabi culture across time (Kohli et al. 2020). It is deeply intertwined with a woman's life from birth to death. The craft's unique designs and vibrant colours capture the exuberance and spirit of Punjab, echoing the region's flourishing farmlands, lively festivals, and energetic dances. Phulkari has become an integral part of the Punjabi identity, representing their resilience, creativity, and deep cultural pride (Kohli et al. 2020).

Prominent Motifs of Phulkari and their Significance

Image 1: Phulkari representing flower motifs.

Image 2: Phulkari with peacock motif.

Floral Motifs

Flowers, as the central element of Phulkari, play a crucial role in the craft. They symbolize the beauty of life, growth, and fertility, and various types of floral motifs are utilized, including marigolds, lotus, and other blossoms. These motifs represent abundance and prosperity, making them a popular choice for Phulkari pieces created for weddings, where they reflect the desire for a fruitful and prosperous married life. The vibrant colours in which flowers are often depicted in Phulkari add to the craft's exuberance (Kaur and Gupta 2014).

Birds and Butterflies

Birds and butterflies are recurring motifs in Phulkari, representing freedom and transcendence. They embody the aspiration for a life filled with colour and happiness. These motifs commonly depict birds in mid-flight or butterflies fluttering among flowers, bringing a sense of movement and lightness to Phulkari pieces. They are well-suited for celebratory occasions and impart the hope for a joyful and liberated existence.

Image 3: Phulkari showcasing village life.

Image 4 : Phulkari with geometrical motifs.

Peacock Motif

The peacock motif is a symbol of grace and beauty, often associated with love and romance. The Phulkari artisans often feature the graceful, regal stance of the peacock in their work. Its vibrant plumage and majestic presence evoke feelings of elegance and allure, making it a preferred choice for bridal Phulkari pieces, where it conveys the idea of beauty, love, and the beginning of a new chapter in life.

Village Life

Phulkari needlework depicts rural life, including motifs such as dwellings, trees, and other agricultural occupations. These symbols honour the rural culture of Punjab, where farming is strongly woven into the societal fabric. This type of Phulkari embroidery expresses a deep connection to the land and the rich traditions of the region, expressing a yearning for the simplicity and vitality of rural life.

Geometric Patterns

Triangles, squares, and rectangles are widely used as fillers or borders in Phulkari stitching. Although these patterns look less detailed than other motifs, they have symbolic meaning because they reflect order and harmony in the cosmos. Phulkari artworks create balance and visual appeal by integrating geometric patterns. These patterns represent the ordered and organized components of existence, adding to the artwork's overall wholeness and aesthetic appeal.

Types of Phulkari

Image 5: Example of a Bagh Phulkari.

Image 6: Example of a Sainchi Phulkari.

Bagh Phulkari, the term 'bagh' comes from Hindi, meaning garden, due to its elaborate needlework and portrayal of large gardens on some Baghs. Often crafted for significant events like births and weddings, Baghs feature embroidery covering the entire base fabric, revealing only thin lines of the base cloth in the design. 'Bagh' literally means 'garden of flowers', and what sets it apart from flowered Phulkaris is the dense needlework that obscures the base colour, transforming the embroidery into the fabric itself. It is commonly used for special occasions, known for its opulent appearance, and brides frequently wear Bagh Phulkari pieces during weddings.

The Sainchi Phulkari is a type of Phulkari featuring human and animal forms in a storytelling format, deriving its name from the Punjabi word 'Sainchi', meaning 'authentic'. The stories depicted are based on real events or traditional folk tales, with naturalistic imagery typical of rural Punjab. Motifs include cattle, birds, crops, combs, mirrors, and cooking utensils, reflecting the artisans' world. It is often used for everyday wear and is noted for its elegance.

Image 7: Example of a Thirma Phulkari.

Image 8: Example of a Chope Phulkari.

Thirma Phulkari, distinguished by an unbleached base fabric, deviate from the usual red khaddar of other types. Embroidered with floral or geometric motifs, those with full embroidery are also considered Baghs. The intricate design primarily uses silk thread in shades like red, magenta, blue, yellow, or green. Traditionally worn by older women and widows, the Thirma Phulkaris symbolize purity.

Chope Phulkari is a reversible Phulkari that features prominently in wedding rituals. A Chope is a large red chaddar (or wrap) embroidered with yellow and gold thread. The Chope's design is composed of geometric forms, mainly triangles, and lattice formations, with the occasional inclusion of a peacock or cow motif. It is commonly given as a gift during various ceremonies, symbolizing best wishes and blessings.

Image 9: Example of a Darshan Dwar Phulkari, with columns, arches and human and animal figures.

Image 10: Vari Da Bagh Phulkari with gold coloured silk thread.

The Darshan Dwar Phulkari, often donated to temples and gurudwaras, features a red base adorned with variously coloured threads, typically yellow, known as the 'gateway for beholding the divine'. Its embroidery includes columns along the sides, topped with outward-pointing arches. The central area resembles a lively street with human and animal figures, while geometric shapes like diamonds, stars, and triangles fill the borders (Kaur and Gupta 2014).

The Vari Da Bagh is a sort of chaddar or shawl used in Punjabi wedding ceremonies, deriving its name from the phrase 'garden of the bridal trousseau.' This Bagh is distinguished by a main field decorated with gold-coloured silk thread and borders with a vibrant colour palette. Geometric features dominate the design, which includes a core field with repeated concentric diamond shapes and borders ornamented with a complementary pattern of diamonds and zigzag lines.

Image 11: Example of Bawan Bagh Phulkari with 52 motifs.

The Bawan Bagh Phulkari is a highly intricate embroidery style that features a striking crimson fabric adorned with rectangular compartments containing a variety of vibrant geometric motifs. The main component of the fabric, referred to as a 'chaddar', typically contains 42 to 48 cells, with additional cells added along the borders at both ends. The name Bawan Bagh is derived from the Punjabi language and translates to 'fifty-two'. The Phulkari design will consist of 52 distinct motifs.

Result/Outcome: Proposal for the Establishment of an Experiential Centre Celebrating the Craft of Phulkari

The proposal advocating the establishment of an experiential centre dedicated to the celebration of the Phulkari craft originating from Patiala in Punjab, and its neighbouring regions has yielded a multifaceted outcome that transcends its initial conception. The fundamental concept of this centre revolves around the transformation of traditional crafts to align them with contemporary market demands. It places particular emphasis on the development of women-led and women-oriented traditional crafts from the region, thereby introducing a new dimension to the contemporary sector within the interior lifestyle market. As the entire centre is directed and operated by women, with its products crafted by women, it significantly contributes to the realization of the fifth Sustainable Development Goal (SDG), which pertains to gender equality. This endeavour is primarily focused on nurturing cultural preservation, skill development, and economic empowerment, all while embracing the adaptive reuse of heritage buildings. The project extends beyond merely celebrating the Phulkari craft; it provides immersive experiences for the public, imparts training opportunities to local women, and establishes a sustainable market for Phulkari products. This holistic approach highlights the importance of preserving and showcasing traditional heritage crafts within the context of heritage buildings, while simultaneously addressing critical aspects of socio-economic empowerment and community identity.

Describing the Project

The Proposed Centre will have Four Primary Spaces.

Experiential Centre: This core element offers immersive experiences, workshops, demonstrations, and exhibitions that educate visitors about the rich history and cultural significance of Phulkari. The aim is to attract visitors and create an informed and appreciative audience for the craft, promoting its cultural importance.

Training Facility: Empowering local women with valuable Phulkari craft skills is a primary objective. By providing marketable skills, the facility enhances women's economic opportunities and societal well-being, contributing to gender equality.

Retail Space: Creating a sustainable market for Phulkari products in the retail space ensures the craft's viability, supports economic sustainability, and preserves tradition. Artisans within the heritage setting will craft interior lifestyle products, available for sale on-site and for external markets.

Collaborative Space: A space within the centre where designers and craftswomen/artisans can brainstorm, ideate, collaborate, and generate new product ideas for the contemporary luxury market.

Image 12: Proposed logo of the Craft Experience Centre, meaning direction.

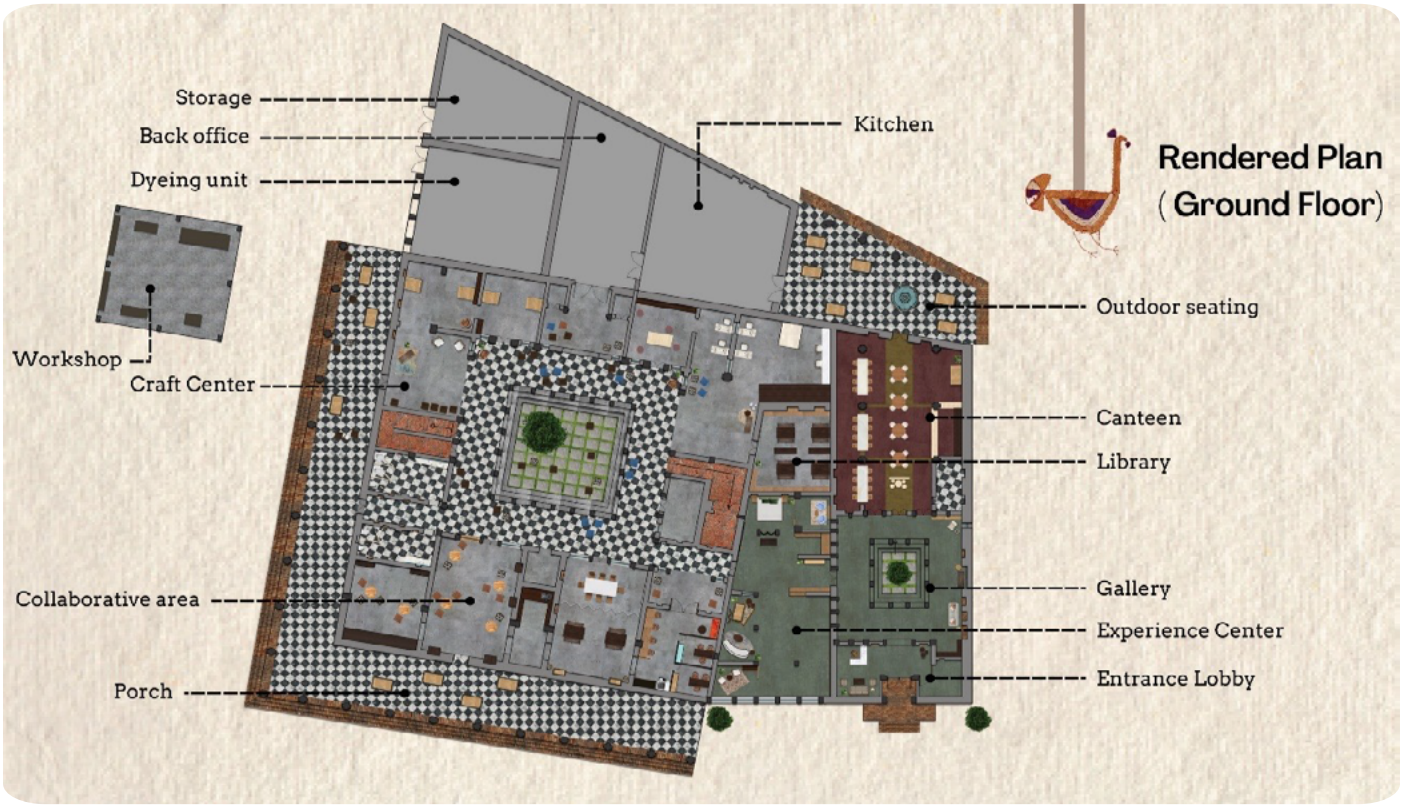


Image 13: Proposed layout – Ground floor of experience centre.

Image 14: Interiors of the experience centre: corridor spaces, traditional arches and alcoves in traditional brick style doors which are integral features of traditional Haveli's in Punjab (India).

The Experiential Centre: A Nexus of Education and Celebration

The experiential centre, a central component of the project, has the potential to become a vital space for visitors to uncover the captivating history, intricate techniques, and profound cultural significance of Phulkari. Conceptualized as an educational hub, the centre unveils the artistry and heritage of Phulkari through an array of interactive experiences, workshops, demonstrations, and exhibitions.

Immersive Experiences and Public Education: The experiential centre offers immersive experiences to the public, providing them with the opportunity to engage with Phulkari on a deeper level. These immersive experiences at the centre have several key outcomes outlined below.

Deepened Appreciation for Phulkari: Visitors can gain a comprehensive understanding of the history, technique, and cultural significance of Phulkari.

Education and Awareness: The centre can become an educational space, fostering awareness about the cultural heritage of Punjab and the significance of Phulkari.

Interactive Learning: Immersive experiences allow for interactive learning. Visitors can actively participate in workshops and demonstrations, gaining hands-on experience.

The Training and Retail Centre: A cornerstone of this transformative project, aims to empower local women by imparting intricate Phulkari crafting skills, preserving the craft, and promoting gender equality. The centre's retail section can establish a consistent market for Phulkari products, ensuring long-term viability and economic opportunities for women artisans. This multifaceted centre can bridge tradition with modernity, fostering empowerment, and help secure Phulkari's prosperous future.

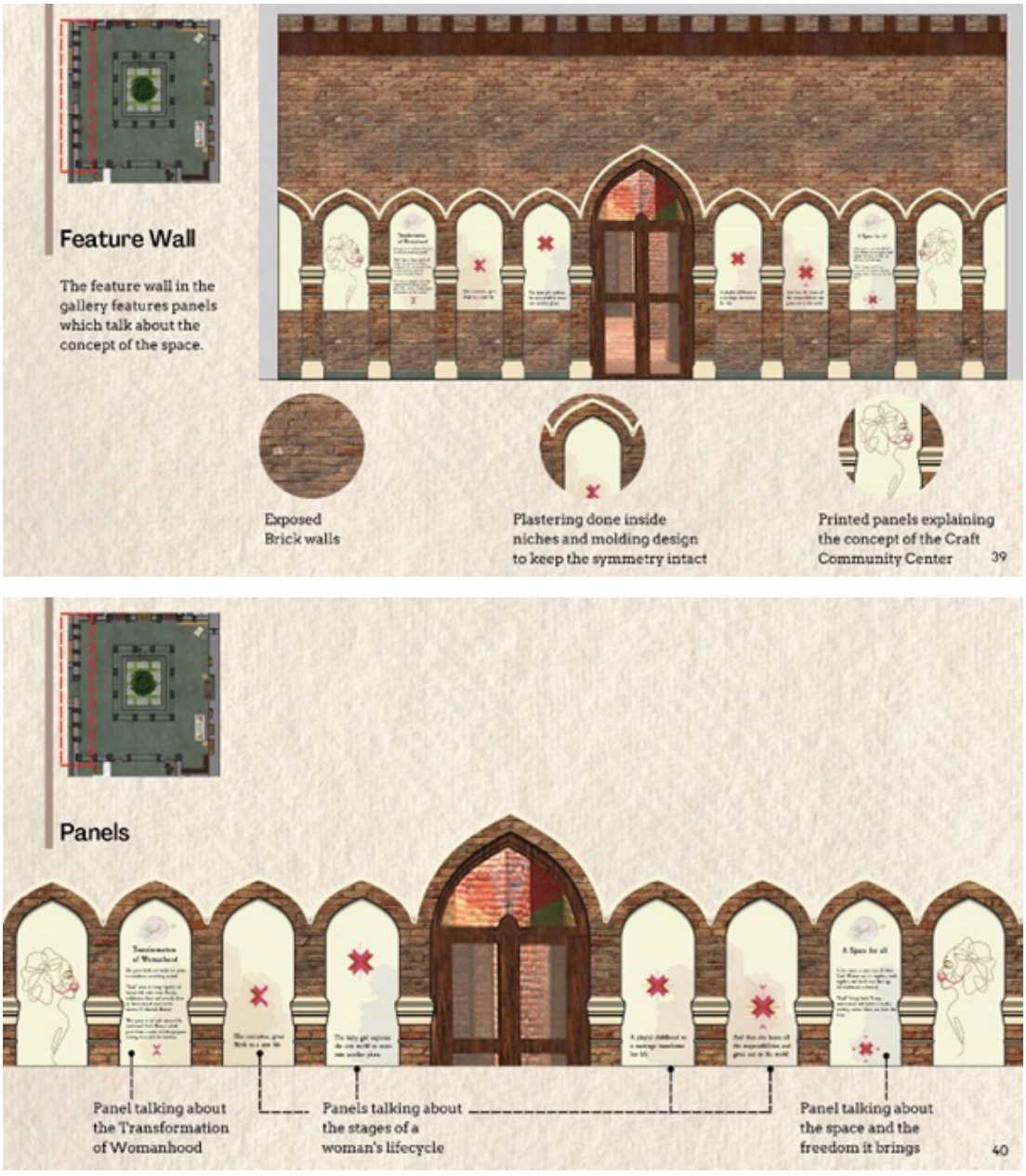


Image 15: Gallery space with infographics related to Phulkari craft, traditional style arches repeated in design.

Image 16: Retail space – Showcasing the brand's interior product range developed as a collaboration between artisan and designer.

Harnessing the Adaptive Reuse of Heritage Buildings

A fundamental component of this project, the adaptive reuse of heritage buildings emerged as an inspired approach to preserve and showcase traditional heritage crafts. By intertwining Phulkari craftsmanship with historical structures, the project breathed new life into these buildings, enhancing their appeal and restoring a sense of historical continuity (LinkedIn March 2023). Heritage buildings are more than just physical structures; they carry the collective memory and historical narrative of a community. When traditional crafts like Phulkari are practiced within a heritage setting, they not only retain their historical significance but also become a powerful tool for empowerment and social impact.

In a recent report by the Heritage Alliance (2020), it has been mentioned that there is a unique role for heritage in engaging with and promoting societal and individual well-being. Heritage can offer a "sense of rootedness and identity, of place and understanding" (The Heritage Alliance 2020, p. 4). This underscores the profound impact that heritage settings can have on individuals and communities, contributing to their well-being, identity, and sense of place.

This Adaptive Reuse of a Heritage Building in the Context of the Project Achieved Several Noteworthy Outcomes

Preservation of Cultural Identity: By integrating Phulkari craftsmanship within a heritage setting, the project successfully preserved and celebrated Punjab's cultural identity. This amalgamation of traditional crafts with architectural preservation represented a harmonious symbiosis where both elements enriched each other's essence. The historical significance of the heritage buildings was retained and revitalized, becoming a living testament to Punjab's artistic legacy.

Community Pride and Ownership: The project instilled a deep sense of pride within the community. Through the preservation and adaptive reuse of heritage buildings, the local community felt a renewed sense of ownership and responsibility for preserving their cultural identity and heritage for future generations. This project not only celebrated the craft of Phulkari but also reinforced the community's connection to their roots, traditions, and values.

Community Engagement: The integration of traditional crafts within heritage settings attracts community engagement. The community becomes an active participant in preserving and celebrating their heritage, contributing to the sustainability and continued relevance of the heritage buildings. The engagement of the community thus fosters a sense of unity and shared responsibility for their cultural legacy.

Cultural Resilience: Preserving cultural heritage and fostering identity contributes to the cultural resilience of a community. It allows communities to adapt to changing circumstances while holding onto their cultural values and traditions. In the face of modernization and globalization, projects like these become vital tools for maintaining cultural resilience and preserving the unique character of a place.

Tourism and Economic Benefits: Heritage settings, with their historical and cultural significance, attract tourists and visitors who appreciate the authenticity of traditional crafts. This influx of visitors contributes to the local economy (Kee 2019), supports local businesses, and fosters community development. By embracing the adaptive reuse of heritage buildings, the project generated economic opportunities and stimulated the growth of the local economy (Alhojaly et al. 2022).

Overall, the adaptive reuse of heritage buildings has far-reaching implications, encompassing cultural preservation, community pride, economic benefits, and community engagement. This approach not only preserves the historical significance of heritage buildings but also leverages them as a platform for empowerment, socio-economic growth, and the preservation of cultural identity.

The project's efforts in preserving cultural heritage and fostering identity align with the research by Wellesley-Smith (2023) and underscore the significance of cultural heritage in maintaining and promoting cultural identity and continuity.

Image 17: Exterior view of experience center with branding.

Image 18: Views of the inner courtyard, workshops and reception.

Empowerment and Social Impact

Economic Betterment: This initiative creates employment opportunities, greatly improving women artisans' well-being by equipping them with marketable skills that enhance their financial independence.

Empowering Women: This aspect focuses on empowering local women through skill development and economic contribution, leading to a sense of self-worth.

Gender Equality: By involving women as active economic contributors, this project promotes gender equality and social inclusion.

Cultural Heritage Preservation: Integrating traditional crafts with architectural preservation helps to preserve the rich cultural heritage of Punjab, fostering community pride and cultural identity for future generations.

Image 19: Views of the retail area with traditional style brick patterns on the walls.

Image 20: Sample of visiting card for the crafts women at Raah.

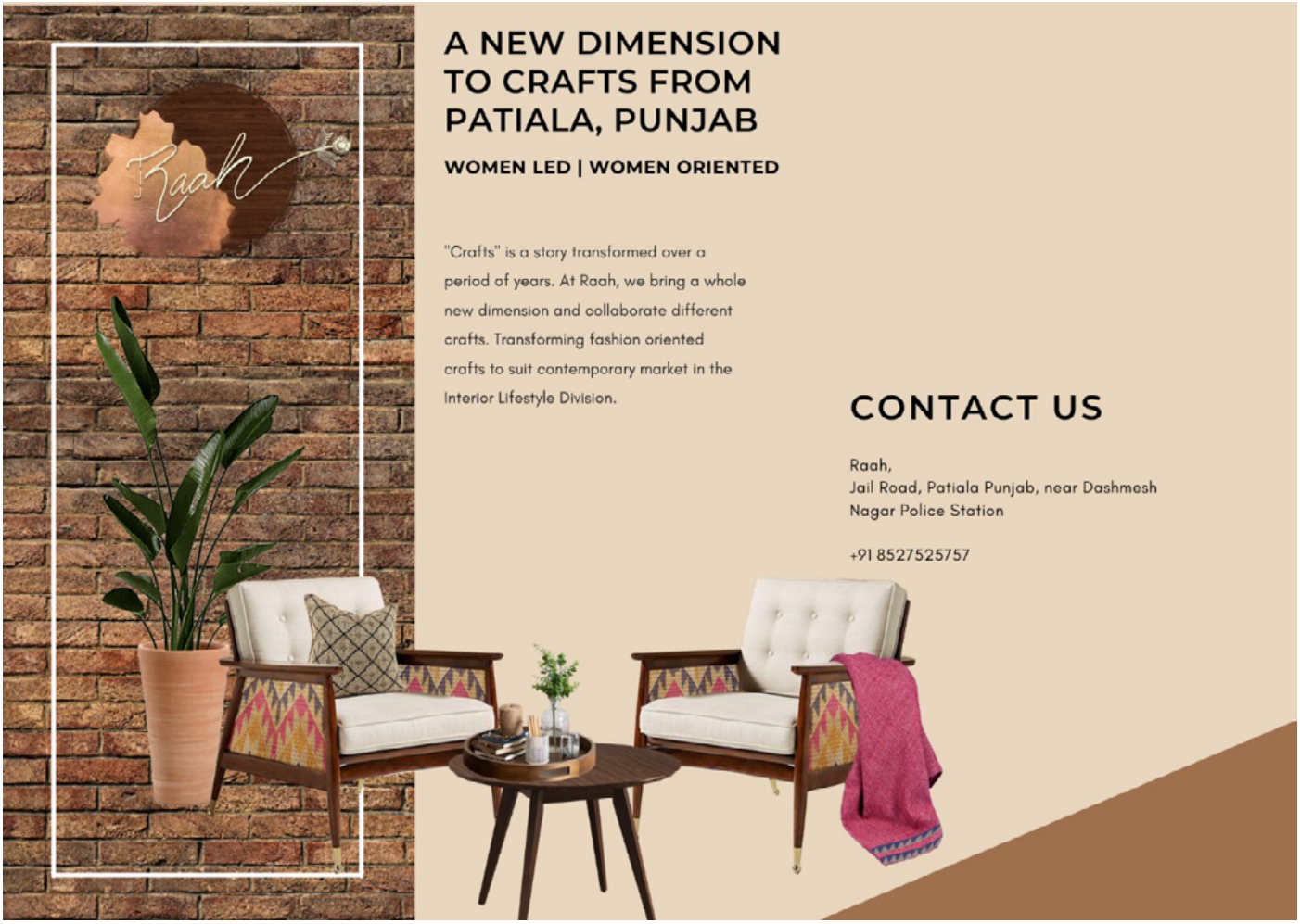


Image 21: Brand's brochure with emphasis on women-led, women-oriented centre.

Conclusion

This research paper highlights the transformative power of design for humanity by empowering women through traditional crafts. By integrating the craft of Phulkari into a heritage building in Punjab (India), the project showcased the potential of incorporating traditional crafts in architectural settings. The establishment of an experiential centre, training facility, and retail platform contributes to economic empowerment, gender equality, and the preservation of cultural heritage. Through community engagement and active participation, the project fosters a sense of pride and ownership in the local community. It serves as an inspirational model for design's potential to empower individuals, preserve cultural heritage, and contribute to building a more inclusive and resilient world. This research underscores the transformative power of design, reinforcing its significance in shaping a brighter future.

Call to Action

This conclusion strongly advocates for the replication of such projects on a global scale, highlighting heritage crafts' latent potential for empowerment and community development. It proposes the use of the strategies adopted in this programme as a comprehensive model to revitalize traditional crafts worldwide. In a world threatened by cultural loss and gender inequality, this research offers hope and demonstrates the transformative power of design. The call to action encourages governments, groups, and communities to invest in the preservation of cultural heritage, economic empowerment for underprivileged populations, and gender equality. This research offers a model for a more inclusive, resilient society where traditional crafts survive, communities prosper, and cultural heritage is preserved.

References

Alhojaly, Rawan Abdullatif, Abeer Alawad, and Noura Abdulrahman Ghabra. 2022. “A Proposed Model of Assessing the Adaptive Reuse of Heritage Buildings in Historic Jeddah.” *Buildings*. Multidisciplinary Digital Publishing Institute, March 27, 2022. https://doi.org/10.3390/buildings12040406.

Hitkari, S. S. 1980. *Phulkari: The Folk Art of Punjab*. New Delhi: Phulkari Publications.

Kaur, P. 2011. “Revival of Punjab’s Traditional Handicraft: Phulkari.” *Asian Journal of Management* 2, no. 1 .

Kaur , Rajinder and Ila Gupta. 2014. “Phulkari and Bagh Folk Art of Punjab: A Study of Changing Designs from Traditional to Contemporary Time.” *American International Journal of Research in Humanities, Arts and Social Sciences*, no. December 2013-February 2014: 35-43. Accessed April 10, 2022. http://iasir.net/AIJRHASSpapers/AIJRHASS14-118.pdf.

Kee, Tris. 2019. “Sustainable Adaptive Reuse – Economic Impact of Cultural Heritage.” *Journal of Cultural Heritage Management and Sustainable Development* 9, no. 2 (May 20, 2019): 165–83. https://doi.org/10.1108/jchmsd-06-2018-0044.

Kohli, Harpreet K. Dr., Ritu Lehal Dr., Harpreet Kaur Dr., and Naina Sharma Dr. 2020. “Phulkari Art: A Tool for Women Empowerment in Punjab.” *Pramana Research Journal* Volume 10, no. Issue 9 : 176-187. Accessed May 18, 2022. https://www.pramanaresearch.org/gallery/prjp%20-%201671.pdf.

Maskiell, Michelle.1999. “Embroidering the Past: Phulkari Textiles and Gendered Work as ‘Tradition’ and ‘Heritage’ in Colonial and Contemporary Punjab.” *The Journal of Asian Studies* 58, no. 2 (May 1999): 361–88.

Ranjan, Aditi, and M.P. Ranjan. 2009. *Handmade in India*. Abbeville Publishing Group.

Sharma, Naina Dr., Harpreet Kaur Dr., Harpreet K. Kohli Dr., Ritu Lehal Dr., and Amandeep Kaur. 2021. “Phulkari: Issues Faced by Artisans in Sustaining the Traditional Handicraft of Punjab.” *Pramana Research Journal* (ISSN 2249-2976), Volume 11, no. Issue 5 (2021): 16-29. Accessed May 18, 2022. https://www.pramanaresearch.org/gallery/prjp%20-%201671.pdf

The Heritage Alliance. 2020. “Heritage, Health and Wellbeing: A Heritage Alliance Report,” 2020, https://www.theheritagealliance.org.uk/wp-content/uploads/2020/10/Heritage-Alliance-AnnualReport_2020_Online.pdf (accessed July 7, 2023).

UNESCO. 2005. Craft Revival Trust, Artesanías de Colombia S.A. Designers Meet Artisans: A Practical Guide. *Chicago: University of Chicago Press*.

United Nations. “Transforming Our World: The 2030 Agenda for Sustainable Development.” Annex A/RES/70/1. Available online: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf (accessed July 3, 2023).

Wellesley, Smith, and Elizabeth Claire. 2023. “Crafting Resilience: Cultural Heritage and Community Engagement in Post-Industrial Textile Communities.” PhD Thesis, UK: The Open University.

www.linkedin.com. 2023. “What Are the Benefits and Challenges of Adaptive Reuse of Heritage Buildings?”, March 21, 2023. https://www.linkedin.com/advice/0/what-benefits-challenges-adaptive-reuse-heritage-buildings.

Image Sources

Images 1-11
Map Academy. "Types of Phulkari." *Map Academy*, https://mapacademy.io/article (July 5, 2023).

Images 12-21
Source – Authors (Part of the thesis project developed and rendered at Pearl Academy)

Leveraging AI to Infuse Humanity in Industrial Design Education

Author:
Sooshin Choi

Institution:
Department of Industrial Design, Savannah College of Art and Design (USA)

Abstract

Design for Humanity emphasizes the integration of human-centred principles in industrial design practices and education. The emergence of artificial intelligence (AI) presents a transformative opportunity to effectively infuse humanity into industrial design education. This extended abstract explores the pivotal role of AI in fostering human-centredness, inclusivity, and empathy within industrial design education. By harnessing the potential of AI technologies, educators can empower students with the necessary skills and mindset to create designs that authentically cater to the diverse needs and aspirations of individuals and communities. However, the incorporation of AI technology into the design curriculum presents challenges for educators in maintaining the fundamentals of industrial design while seamlessly integrating AI capabilities. This paper aims to discuss strategies and pedagogical framework for successfully achieving this improvement within the limited duration of degree programmes.

Keywords: Design for humanity, industrial design education, artificial intelligence, inclusive design

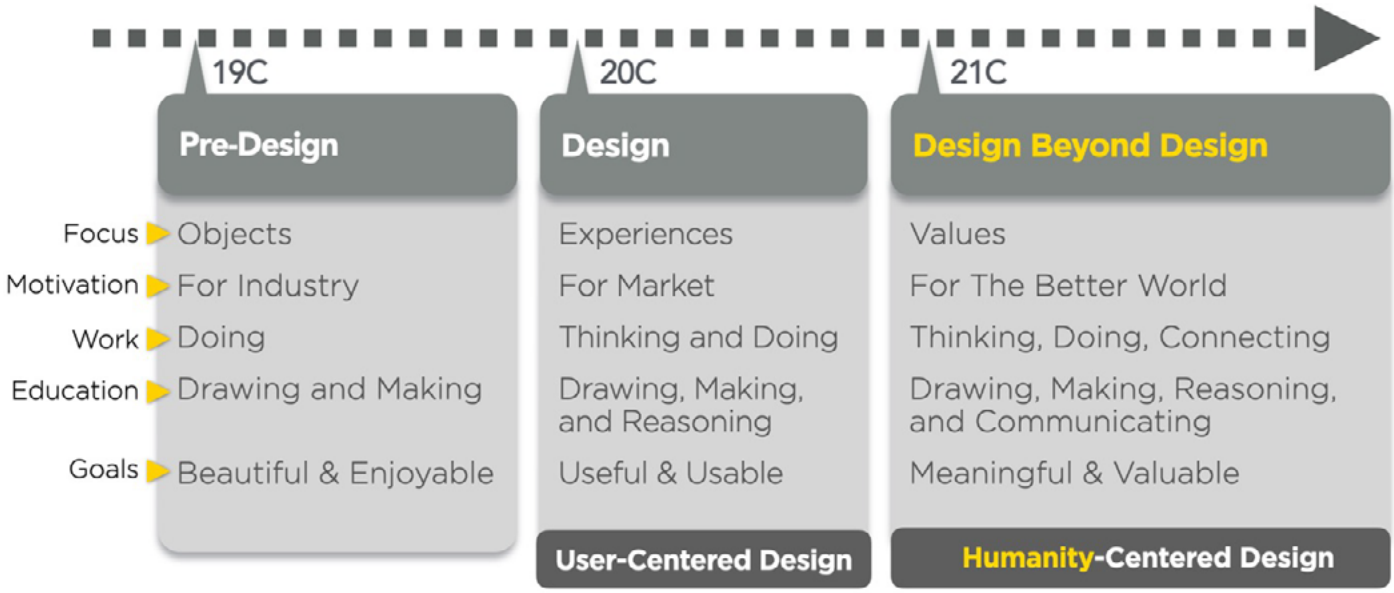


Figure 1: Evolution of industrial design and emanating of humanity-centred design.

1. Evolution of Industrial Design and Design Education

Before delving into the current and fore coming issues in industrial design, it is imperative to review how industrial design, or design in general, has evolved significantly over the past century. Early industrial designers, or industrial artists more precisely, focused primarily on the form and function of products, and industrial designer's tasks were drawing and production of the design, and thus design education was focused on the quality of the drawing and the making. The expected outcome was valued by the aesthetics and enjoyability of products.

1.1. Pre-design Era (19th Century)

During the 19th century, the design landscape was largely shaped by the Industrial Revolution and the ideals of modernism. The Art and Crafts movement and Art Nouveau, for instance, played a significant role during this period, influencing the design of objects and products. The primary motivation behind design was to facilitate successful industrialization. Designers focused on the act of creating and designing, with design education emphasizing skills like drawing and making. The typical goal for designers was to produce beautiful and enjoyable products.

1.2. Design in the 20th Century

The 20th century witnessed a shift in design paradigms, primarily driven by technological advancements and lessons learned from World War II. Additionally, design began to be strongly influenced by engineering and marketing. The focus of design shifted towards creating products that offered enhanced user experiences. The primary motivation was to succeed in the market. Designers took on a more comprehensive role, involving both thinking and doing, with design education emphasizing reasoning, drawing, and making. The overarching goal was to design products that were not only beautiful and enjoyable but also useful and usable.

1.3. Design Beyond Design in 21st Century

In the 21st century, design kept evolving driven by growing environmental concerns and the emergence of advanced technologies. Designers now aimed to create products that carried intrinsic values. The designer's role expanded to encompass thinking, doing, and connecting various aspects of design. Design education adapted to this change by emphasizing reasoning, drawing, making, and effective communication. The ultimate goals of design included creating products that were beautiful, enjoyable, useful, usable, meaningful, and valuable.

1.4. The Transition to Human-centred Design

As the importance of usability and user experience became prominent, the concept of user-centred design emerged. However, this approach often fell short in comprehending users as holistic human beings. Consequently, the notion of human-centred design gained traction, emphasizing the need to address all aspects of human life and experience. During this period, inclusive design and universal design principles began to take shape, aiming to address the diverse needs of differently-abled individuals. The goal is to protect human dignity and human rights (Buchanan 2010), which often suppressed by emphasizing the business and political avarice.

1.5. Human-centred Design in the Face of Global Challenges

With society confronting serious and profound challenges such as global warming, environmental devastation, resource depletion, social division, cruelty, and complex, deep-rooted problems, the importance of humanity itself became a focal point. Human-centred design emerged as the ultimate guide for designers, emphasizing a broader perspective that considers the well-being of all humankind. Designers began to address global issues with the intention of creating a better world for all (Norman 2023).

This shift towards human-centred design signifies a new era in which design thinking is not only about creating beautiful, enjoyable, and usable products but also about making a meaningful and valuable impact on the world at large. In the face of these challenges, designers play a pivotal role in shaping a more sustainable and inclusive future for humanity.

2. Is Human-centred Design Enough?

Human-centred design, while a valuable approach, has its inherent limitations. At its core, it revolves around addressing the needs, preferences, and experiences of humans. However, this singular focus on the human perspective may not be sufficient to tackle the complex challenges that we face in the 21st century. Most of troubles that we see are result of industry-centred and human-centred approaches.

Human beings are merely one piece of the intricate puzzle that is our planet. Serving human interests alone fails to consider the broader ecosystem and the intricate interconnections between all elements of our world. This myopic view could lead to unintended and adverse consequences that ripple throughout the ecosystem.

By exclusively concentrating on the human aspect, human-centred design may overlook crucial dimensions of design and their far-reaching consequences. Many aspects of design go beyond immediate human concerns and encompass broader implications that affect the environment, society, and the planet at large.

The limitations of human nature further complicate the effectiveness of human-centred design. Human beings are often driven by self-interest and short-term thinking, which can blind them to the long-term and collective consequences of their actions.
Human-centred design is challenged by the natural human resistance to change. People are often reluctant to embrace new approaches or behaviours unless there is an immediate, personal benefit for them. This resistance can hinder efforts to implement more sustainable and globally beneficial designs.

The pursuit of convenience, which is a natural habit for humans, often at the expense of sustainability, is another aspect of human behaviour that human-centred design must contend with. People frequently seek easy and convenient solutions without fully considering the consequences or trade-offs involved. Most of industrial products and systems are to deliver the convenience. Their side effects are undoable.

To overcome these limitations, a broader and more holistic approach is needed. The concept of humanity-centred design emerges as a response to these challenges. Humanity-centred design transcends the confines of individual human needs and desires, seeking to address the well-being of the entire planet and all its inhabitants. It is rooted in the recognition that our actions, choices, and designs have far-reaching impacts and that we bear a responsibility to consider the greater good (Russel, Buck 2020).

In an era marked by global challenges, it becomes increasingly imperative to acknowledge the limitations of human-centred design and adopt a more comprehensive approach. Only by expanding our design thinking to encompass the well-being of humanity as a whole, can we hope to address the complex and interconnected problems facing our planet. By doing so, we can play an active role in shaping a sustainable, equitable, and inclusive future for all life on Earth.

Humanity-centred design is a design approach that puts the well-being of all stakeholders at the forefront of the design process. This includes not only humans, but also the planet itself. Humanity-centred designers emphasize empathy, inclusivity, sustainability, and addressing the diverse needs and aspirations of individuals, communities, and all surroundings.

In practice, humanity-centred design means taking the time to understand the needs of all stakeholders, including those who are often overlooked or marginalized. It means considering the long-term impact of our designs, both on people and on the planet. And it means working collaboratively to create solutions that are truly beneficial to everyone (Russel, Buck 2020).

3. Why Humanity-centred Design?

In the intricate tapestry of our world, humans are not solitary beings. We share this planet with countless other species and ecosystems, and our actions have profound consequences on the well-being of all. Humanity-centred design arises from the recognition that our existence is interwoven with the broader environment, and that we must consider the harmony of all living things.

Humanity-centred design underscores the significance of ‘being’ over ‘doing’. It urges us to pause and reflect on the essence of our existence and our collective responsibility. It encourages us to prioritize the well-being and harmony of all living beings over relentless, often shortsighted, actions. A fundamental tenet of humanity-centred design is the belief that everyone and everything deserves good design. It transcends the boundaries of species, race, class, and geography, aiming to create environments and systems that uplift all.

At the core of humanity-centred design lies the belief that humanity itself is the ultimate virtue. It calls for empathy, compassion, and a profound sense of responsibility toward one another and the planet. In a world that faces multifaceted challenges, embracing this virtue becomes essential to nurture a more equitable and sustainable future.

Humanity-centred design recognizes that innovation often originates from the pursuit of the greater good. By addressing the diverse needs of humanity and the environment, we tap into the wellspring of creativity and innovation. In this approach, innovation is not driven solely by self-interest but by the collective well-being of all beings.

Humanity-centred design serves as a clarion call to acknowledge our interconnectedness and interdependence. It compels us to adopt an approach that considers the intricate web of life on Earth. In an era marked by environmental challenges, social inequalities, and ethical dilemmas, humanity-centred design emerges as a moral and practical imperative.

To respond effectively to the multifaceted challenges of our time, humanity-centred design provides a framework that nurtures harmony, compassion, and collective well-being. By embracing this approach, we can collectively shape a future that is not only innovative but also harmonious, equitable, and enduring for all living beings. In doing so, we fulfill our profound responsibility to humanity and the world we share.

Since the concept of humanity-centred design looks at the entire stakeholders on the planet with a new insight and perspective, it may be an excellent course of innovation for businesses as well.

4. Advent of AI – Opportunities and Threats

Artificial Intelligence (AI) has ushered in a new era in the field of design, offering a multitude of opportunities and potential benefits that are reshaping the creative landscape. Few of the opportunities of using AI are:

Access to Bigger Data

AI empowers designers with unprecedented access to vast datasets, enabling them to draw insights, patterns, and inspiration from a wealth of information. This access to extensive data sources enhances the creative process and expands the horizons of design possibilities.

Efficiency in Design

AI-driven tools streamline the design process, enabling designers to work more efficiently. Tasks that once required extensive manual effort, such as repetitive design iterations, can now be automated, freeing designers to focus on higher-level creative tasks.

Advanced Analysis and Prediction

AI's analytical capabilities offer designers the ability to predict trends, user behaviour, and the effectiveness of design choices. This data-driven insight enables more informed decision-making, leading to better-designed products and experiences.

Reducing Manual Labor

Automation through AI reduces the burden of manual labor in design, making the creative process more accessible and less labor-intensive. Designers can allocate their time to more strategic and imaginative aspects of their work.

Shifting Towards more Valuable Work

AI's ability to automate routine tasks allows designers to focus on higher-value activities. It encourages the exploration of creative and innovative solutions, ultimately enhancing the quality of design work.

While AI has the potential to transform the field of industrial design education, this integration is not without its challenges and concerns. Here are some of the threats associated with incorporating AI in industrial design education.

Potential for Plagiarism

As AI-generated content becomes more sophisticated, there is a concern about the potential for plagiarism and the replication of design concepts without proper attribution. This poses ethical and legal challenges within the design community.

Weakening of Design Abilities

Over-reliance on AI tools may diminish a designer's inherent abilities, such as problem-solving, critical thinking, and creativity. Relying too heavily on automated solutions may erode the skills that make a designer unique.

Loss of the Struggles Integral to Growth

The challenges and struggles faced in the design process play a vital role in the growth and development of a designer's abilities. AI's ability to simplify tasks may eliminate these formative experiences.

Diminishing the Human Touch

AI, while powerful, lacks the human touch and intuition that can bring warmth, emotion, and cultural sensitivity to design. The risk of losing the authenticity and relatability of design outcomes is a significant concern.

The Lack of Empathy in AI

One of the most significant threats posed by AI in design is its inherent lack of empathy. Design is deeply rooted in understanding human needs, emotions, and experiences, which AI struggles to comprehend. The absence of empathy in AI-driven design may result in products and experiences that fail to resonate with human users.

As AI becomes increasingly integrated into the design process, designers must navigate the complex landscape of opportunities and threats. Striking a balance between leveraging the capabilities of AI while preserving the human touch, creativity, and empathy in design is a challenge that the design community must address. By embracing AI as a complementary tool rather than a replacement, designers can harness its power to enhance the quality and efficiency of their work, while safeguarding the unique qualities that make design a deeply human endeavor.

5. Use of AI to Ensure Inclusivity and Sustainability

In a world that is becoming increasingly reliant on technology and artificial intelligence, it is essential to harness the potential of AI to ensure humanity remains at the heart of the design process. Here are some of the ways in which AI can be used to uphold and enhance the human element in design.

Automating Mundane Tasks

One of the most significant contributions of AI to design is its ability to automate routine and time-consuming tasks. By relieving designers of these burdens, AI frees them to focus on more creative and human-centric aspects of their work. This allows designers to invest more time in understanding human needs, emotions, and experiences, ultimately resulting in designs that are more attuned to the user.

Literature Search and Summary

AI's capacity to search and summarize vast amounts of literature accelerates the research phase of design projects. By providing designers with comprehensive insights and knowledge, AI assists in informed decision-making, allowing designers to incorporate relevant human-centred research into their work.

Data Analysis and Consolidation

AI's analytical capabilities are invaluable for sifting through large datasets and identifying patterns and trends. Designers can leverage AI to gain deeper insights into user behaviour, preferences, and needs, enhancing their understanding of the human elements at play. This data-driven approach ensures that design decisions are grounded in empirical evidence.

Design Validation and Optimization

AI plays a crucial role in design validation and optimization. By simulating and testing various design iterations, AI can help designers refine their creations to better meet the human factors, such as usability and comfort. This iterative process ensures that the final design is optimized for the end user.

Filling Human Gaps and Shortfalls

While AI lacks the empathy and creativity of humans, it can complement these human attributes. AI can assist in filling gaps and addressing shortfalls in human capabilities. For example, AI can provide recommendations and insights that augment a designer's creative thinking, ensuring that the final design is well-informed and responsive to human needs.

The Collaborative Potential

AI and humans can form a symbiotic partnership in design. When used as a tool and collaborator, AI can augment the human design process, contributing its data-processing prowess and pattern recognition, while humans provide the creative, empathetic, and ethical dimensions that AI inherently lacks. This collaborative approach ensures that design remains deeply rooted in humanity while benefiting from the efficiency and analytical power of AI.

Preserving the Human Touch

Designers must remain mindful of the balance between AI's role in design and the preservation of the human touch. AI should be a tool in the hands of skilled designers who can ensure that empathy, cultural sensitivity, and the unique nuances of human experiences are at the forefront of the design process.

In a world where AI continues to advance, maintaining a commitment to humanity in design is paramount. By utilizing AI to automate tasks, analyze data, and enhance the design process, designers can ensure that their work remains profoundly human-centric. In this partnership between humans and AI, design becomes a powerful force for improving the lives and experiences of individuals and communities.

6. Adapting AI in Industrial Design Curriculum – Two Columns

As the field of industrial design evolves in the digital age, the incorporation of AI and emerging technologies is both an opportunity and a challenge for design educators. This chapter explores the duality of preparing students with future literacy while preserving the fundamental aspects of design education (Jones et al 2022).

6.1. Future Literacy

- Adaptiveness to Tech: The industrial design curriculum must equip students with the adaptability to evolving technology. This includes understanding and integrating AI, VR, AR, XR, machine learning, and other cutting-edge tools.
- New Tools and Terms: Teaching students how to utilize new tools and navigate tech-driven jargon is essential. Familiarity with these technologies enables students to stay relevant in a rapidly changing design landscape.
- Digital Entrepreneurship: Future literacy also encompasses cultivating digital entrepreneurship skills. Students should learn how to apply design thinking in a digital context, fostering innovation and problem-solving.
- Cross-Pollination: Encouraging interdisciplinary thinking is crucial. Cross-pollination with fields like computer science, psychology, and engineering opens up new perspectives for design students, allowing them to explore fresh and innovative approaches to problem-solving.

6.2. Fundamentals

As much education of students to be prepared for the future changes, it is empirical to maintain the fundamentals of design, which has a timeless value. If the fundamental is lost, there is no hope for meaningful designs.

- The 'Why's of Design: A solid foundation in the fundamental principles and philosophies of design is irreplaceable. Understanding the 'why' behind design decisions ensures that students create with purpose and intention.
- Craftsmanship: Students should learn and hone the art of craftsmanship, which includes manual sketching, physical prototyping, and a deep appreciation for materials and production processes. These skills help students understand the tangible aspects of design.
- Being a Designer: Beyond technical skills, instilling in students what it means to be a designer, including the designer's ethical responsibilities, is essential. It's about fostering a sense of professionalism, empathy, and understanding the role of design in society.
- Curiosity and Courage: Nurturing curiosity and the courage to explore the unknown is vital. These qualities drive students to ask questions, challenge assumptions, and innovate, keeping design fresh and responsive to human needs.
- Taking Challenges: Encouraging students to embrace challenges is crucial for their growth. Design often involves overcoming obstacles, and this resilience equips students to adapt and thrive in the face of complex problems.

The challenge in adapting AI into the industrial design curriculum lies in striking a balance between future literacy and fundamentals. It's about blending the latest technological trends with timeless design principles. This requires educators to create a curriculum that acknowledges the significance of AI and emerging tech while ensuring that students remain rooted in the enduring values of design.

By fostering a holistic approach, design educators can prepare students for the ever-changing landscape of industrial design while preserving the core values that make design a profoundly human endeavor. In this way, students can be equipped to not only adapt to new technologies but also to lead and shape the future of design, ensuring that it remains deeply rooted in human experiences and aspirations (Yang et al. 2021).

The integration of artificial intelligence into traditional design curricula is a complex and challenging task. On the one hand, AI can be a powerful tool for augmenting human creativity and problem-solving abilities. On the other hand, there is a risk that AI could lead to the neglect of fundamental human skills, such as critical thinking, empathy, and intuition.

AI modules should be incorporated into the curriculum in a way that emphasizes the augmentation of human skills, rather than replacing them. Students should be encouraged to combine AI tools with their own creativity, critical thinking, and empathy. By integrating AI as a complementary tool, the curriculum can enhance students' abilities while preserving the essential human skills that make design uniquely empathetic and innovative. By incorporating AI in a balanced way, design curricula can prepare students for the challenges and opportunities of the 21st century.

References

Russell, Peter, and Buck, L. "Humanity-centred design – defining the emerging paradigm in design education." In DS 104: Proceedings of the 22nd International Conference on Engineering and Product Design Education (2020).

Buchanan, Richard. "Human dignity and human rights: Thoughts on the principles of human-centered design." *Design Issues* (2010).

Jones, David, et al. "Futures of Design Education." In Proceedings of Design Research Society DRS 2022 Bilbao (2022).

Yang, S. J. H., Ogata, H., and Matsu, T. "Human-centered artificial intelligence in education: Seeing the invisible through the visible" (2021).

Developing City Design Power Index Model

Authors:
Shyhnan Liou[1, 2]
Chi-Yi Chang[1]
Yu-Chen Chen[1]
Junyu Chen[1]
Ying-Yi Hsieh[1]
Tu-Chung Liu[1]
Tang-Ling Kuo[1]

Institutions:
[1]Taiwan Design Research Institute (TDRI) (Taiwan, Chinese Taipei)

[2]Nation Cheng Kung University (Taiwan, Chinese Taipei)

Abstract

This study proposes a comprehensive model for evaluating city design power, with a focus on diagnosis, prescription, and enhancement. The research highlights the dynamic nature of cities as intricate systems where design power operates at various levels, from individual to organizational and industrial, underscoring the interconnectedness of these tiers. The study employs a diverse research approach, including an inventory of international design indexes, development of a theoretical foundation, expert surveys, empirical validation, data visualization, and a prospective longitudinal study involving World Design Capital® events. The findings contribute to a deeper understanding of city design power and offer a practical tool for policymakers aiming to enhance design power and city branding. Future research should explore cross-level constructs, enhance indicator reliability and validity, examine causal relationships, and consider each city's unique context.

Keywords: Design power, city index, process model

1. Objectives

The purpose of this study is to develop a model for measuring the design power of cities. The model is positioned as a mechanism for diagnosis and prescription, that is, it provides respectively: the measurement describing the current status of design power, the strategies suggested for improving design power, and the explanation and prediction of the effect of design power. In parallel, we aim to develop a design power index system to provide a stable and effective (with reliability and validity) description of a specific city's design power within a particular context and time. This model is intended to be used to diagnose the conditions of a city's design power, suggest strategies to enhance specific design power, and explain their impact on better city performance (creativity, competitiveness, happiness, and impact of SDGs). In addition to using the index model as the city's diagnosis and treatment system, we can also learn about the city's special characteristics, as a manifestation of city branding.

This study advocates that a city is a dynamically evolving open system, encompassing design power at different levels, including individual, organizational, and industrial levels. The interaction of design power conditions at different levels create a synergistic effect on overall performance during the development process. The unique historical, economic, and cultural contexts of different cities define their distinct development themes. This model conceptualizes city design power as the operational ability to creatively solve problems for pursuing better cities, and is a dynamic system of continuous innovation. Therefore, this study adopts an ABC process model (Antecedent-Behavior-Consequence) to reflect the dynamic descriptive power of 'strategy-activity-effect'.

2. Methods

In terms of research methods, this study firstly adopts a comprehensive review of existing international indexes, and development of a theoretical basis of the city design power process model to determine the validity of the indicators. Following that, a questionnaire survey is conducted, which invites design experts from various countries to provide experience and feedback on the city design power index model constructed above. In addition to these methods that formed the index model, empirical validation, data visualization and WDC longitudinal study were also conducted or planned to make the index model more pragmatic and easier to be adopted by city policy makers by developing visualized dashboard models. Details of the research methods are as follows.

Study 1: Collection of International Indicators

In order to understand the relevant index models that have been proposed internationally for measuring design power, this study inventoried 18 international index studies related to city design power. These studies included the World Design Survey 2010 (Icograda and Seoul Metropolitan City Government 2011), Global Design Watch 2010 (Aalto University School of Art and Design 2011), Global Innovation Index 2022 (WIPO 2022), and others. It collected a total of 251 indicators and consolidated them into 108 indicators using a focus group method. Cluster analysis was conducted to categorize these indicators.

Study 2: Theorizing Model of Design Power

To explore the components of design power and how it exerts influence, this study reviewed 15 design power related theories. These theories included the National Design Competitiveness Matrix (KIDP 2008), the National Design System (Moultrie & Livesey 2009), and the Design Economic Logic Model (Kimbell et al. 2021). After synthesizing these theories, an ABC process model was proposed (as shown in Figure 1), with A representing design power developing strategy, B representing design activities, and C representing effects and impacts. The results were mapped to correspond with the cluster analysis of indicators, resulting in nine major dimensions, including A: infrastructure, talent development, and economic support; B: industrial dynamics, creative professionals, and innovation R&D; C: economic impact, social impact, and environmental impact.

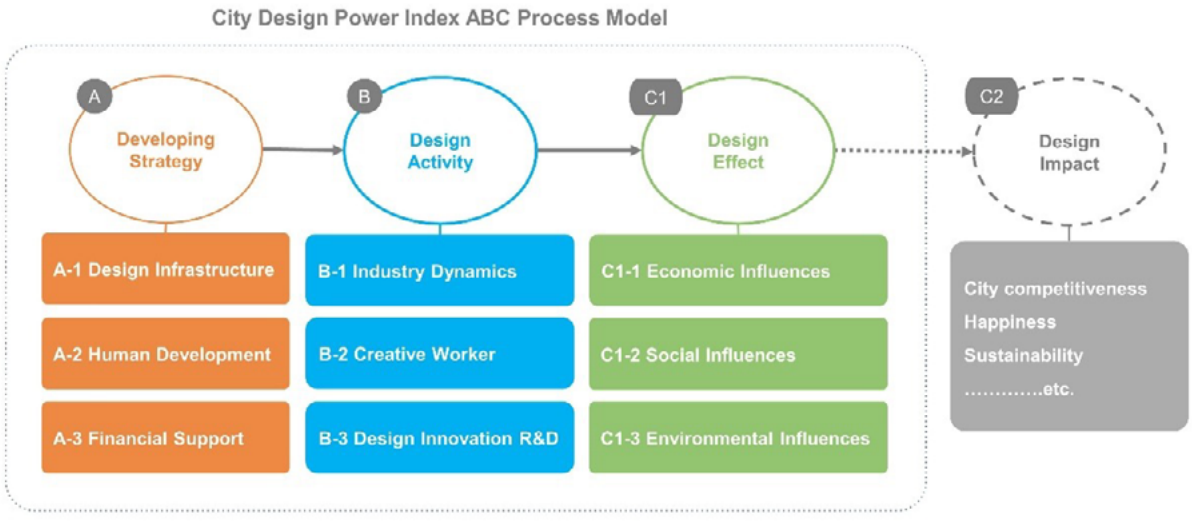


Figure 1: ABC process model of city design power index.

Study 3: Expert Survey

To ensure the applicability and ecological validity of the ABC process model for the international context, this study invited 17 design experts from 8 different countries to complete an online questionnaire. The experts were asked to provide feedback and suggestions on the definitions of the city design power index's ABC process model and the nine major dimensions. They also assessed the suitability of the 108 indicators and their respective dimensions.

Study 4: Empirical Validation

The design power indicator data of 22 cities/counties in Taiwan from 2010 to 2022 was collected, to verify the causality of the City Design Power Index ABC process model with longitudinal analysis. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to examine the correlation between developing strategy, design activities, design effects, and design impact on city happiness referencing CommonWealth Magazine's City Happiness Survey result between 2015 and 2022. Analysis of different type of cities/counties in Taiwan were also conducted to demonstrate how cities with different context and goals developed their own city branding through different city design power developing strategy.

Study 5: Data Visualization

To empower the proposed index model usability for the policy makers, dashboards were built to visualize the index data presentation for better sensemaking of holistic and dynamic of the target city. The dashboards include a radar chart and a city map. The radar chart visualizes design power indicator data of 22 cities/counties in Taiwan from 2010 to 2022. The city map shows locations of design infrastructures, such as museums and design districts, and design companies in each domain or sector of the design industry. The demonstration dynamically shows how design power evolves in the city over time, and how it is distributed in the city. It provides a reliable and valid description of the city's design power in a specific context and time, and suggestions for formulation of developing strategies.

Study 6: WDC Longitudinal Study

To advance the practicality of the city design power index model to cities across the globe, a longitudinal study is underway involving multiple cities which have or will host the World Design Capital (WDC) designation. A tripartite collaboration is discussed between Taiwan Design Research Institute (TDRI), University of Valencia (UV) and University of California San Diego (UCSD), to apply the city design power index model on the impact study of WDC Taipei 2016, WDC Valencia 2022 and WDC San Diego-Tijuana 2024.

3. Results

In Study 1, the result show that existing design index systems discussed vary at different levels. In addition, all are lacking a complete index system that covers all stages of the process. The current study focused on indicators at the city level and provided explanations of indicators on different levels for their potential application at the city level. It systematically categorized these indicators into the ABC process with the theoretical definition, resulting in a clearer and more comprehensive design power process model. Some international indexes have been in existence for more than a decade, and new index systems should be proposed to reflect current social development trends and applications of design, such as intelligent governance in the era of digital transformation.

In Study 2, a review of various theories of international design models revealed that their indicators implicitly reflected the three parts of the 'strategy-activity-effect' process. Some theories did not fully articulate all these parts, while others advocated process models but hard to explain the dynamics of the process when conducting cross-sectional measurements at specific point of time. This study further reclassified the indicators based on this process model and defined the nature of indicators for each dimension. The future development of more specific indicators can be adapted based on the unique characteristics of different city contexts and issues, making the index model more adaptable. Additionally, the characteristics of indicators should not be limited to objective and measurable external indicators. Instead, it is recommended to focus on process functionality in the development and adoption of more diagnostic indicators, integrating sources of indicators (external objective conditions and subjective experiences of cultural psychology) and reflecting both quantitative and qualitative descriptions in the characteristics of the measurement.

In Study 3, design experts from different countries agreed with the process model proposed in this study. Their feedback mainly reflected on the uniqueness of different city contexts and how they should be represented by parameters beyond the current system. This study will further optimize the index model to express the context and process stages. After expert evaluation, the original 108 indicators were filtered to 84 main indicators based on consensus (standard deviation less than or equal to 1) and appropriateness (average score above 4). The experts' suggestions for the index model were used to enhance the definitions of each construct, as shown in Figure 2. The results showed that design operates on the three main pillars of 'developing strategy', 'design activity', and 'design effect' in the context of city conditions. The starting point for each city may vary based on cultural, social, historical context, and industrial structure. 'Developing strategy' is the foundation for city design power, it includes design infrastructure, human development, and financial support. 'Design activity' encompasses the effective mechanisms and energy of design in a city, covering industry dynamics, creative worker, and design innovation R&D. 'Design effects' reflects the outcome brought about by design in the city.

	Construct	Definition	The main indicators	The secondary indicators
A. Design Strategy	Design Infrastructure	"Design Infrastructure" covers both software and hardware environments, including the aspects of public and open spaces and regions of design, which offer people gathering places to facilitate exchange of knowledge, enhance the development of design network (such as connecting with design associations and industry chains) and international connections, and facilitate open discussions, shaping the design knowledge and culture of a city.	Number of design museums	Number of cafés, restaurants, and parks
			Number of design libraries	Number of coworking spaces in the city(including: shared studio, shared office)
			Number of art and cultural venues (including art museums, cultural centers, and art saloons)	Number of community development associations
			Number of cultural exhibition and performance venues	
			Number of areas regarded as design districts	
	Human Development	"Human Development" includes the aspects of a city's investment in capacity building, academic research, and R&D resources, embodying the concepts of accumulating design knowledge and capacity and incubating design talents. This is not limited to incubation of designers, but also covers enhancement of the society's aesthetic literacy and design thinking ability.	Number of government talent incubation courses for the design industry	Number of higher education institutions with design departments
			Number of talents incubated by the government for the design industry	Number of design related programs offered by higher education institutions
			Number of government talent incubation courses for the cultural and creative industries	Number of faculty members of design departments at higher education institutions
			Number of talents incubated by the government for the cultural and creative industries	Number of students of design departments at higher education institutions
			Number of students enrolled in design related programs at higher education institutions	Number of graduates from design departments at higher education institutions
			Number of designers with a bachelor's degree or higher	Number of people with Interior Design Certificate
			Number of designers with a master's degree or higher	Number of people with Visual Communication Design Certificate
			Number of design-themed international conferences	Number of articles published on design journals by higher education institutions
			Number of research centers (public/private)	
			Government R&D expenditures	
			Percentage of R&D manpower in overall industry manpower	
			Design company R&D expenditures	
	Financial Support	"Financial Support" includes aspects of entrepreneurship, culture, design support, and design tender. These aspects do not just symbolize the government's support and investment (ex：subsidy), but also shape the city's ability to attract talents. Also, systems should be established to offer design professionals related protections that are beneficial to the operation and execution of projects.	Number of incubators/accelerators	Amount of government startup subsidies
			Amount of government startup investments	Amount of government investment in industry design subsidies
			Budget for related manpower of government cultural agencies	advertisements invested by the government for design promotion
			Number of related manpower of government cultural agencies	
			Amount of government investment in design activities and promotion	
			Percentage of government funding for culture (and design) in overall funding	
			Number of design related projects launched by the government	
			Number of dedicated design agencies/committees established by the government	
			Number of government's public construction design tenders(including: landscape, architecture, space…etc.)	
			Number of government's non-public construction design tenders (including: brand visual, service flow, design activity, and system development…etc.)	
B. Design Activity	Industry Dynamics	"Industry Dynamics" includes aspects of industry scale, invested cost, and entrepreneurial vitality, with an emphasis on interdisciplinary co-creation to build industrial ecosystem and facilitate knowledge and technical exchange among different disciplines. The direction of industrial innovation within a city should also be evaluated.	Number of design companies	Number of cultural and creative businesses
			Number of design related NPOs (including: legal entity, society, association…etc.)	Number of gTLD registrations by design related corporates and companies
			Median salary of designers	Number of lenders of the Youth Business Startup Loan (under 35)
			Corporate design expenditures	Average number of days required for registration application of design companies
			Average cost of design startups	
			Number of startups	
			YoY increase rate of number of startups	
	Creative Worker	"Creative Worker" refers to the number and diversity of creative workers in a city, allowing us to understand the city's innovative energy at the moment. Creative workers not only possess the ability of interdisciplinary communication, but should also establish guidelines for required pre-design preparation; administrative/legal/patent teams should also be established to provide assistance to design.	Number of working designers(including: design companies and corporates)	Number of employees in the design industry
			Number of designers internally employed by corporates	
			Number of freelancing designers	
			Number of employees in the cultural and creative industries	
			Percentage of designer job openings in overall job openings of the industry	
			Number of new jobs in the design industry	
			Percentage of designers with disabilities	
			Percentages of men and women working in design related industries	
			Percentage of foreign employees working in design related industries	
			Percentages of age groups working in design related industries (four groups: 18~34, 35~44, 45~54, and over 55)	
			Percentage of young designers (under 35)	
			Average years of experience of designers	
	Design Innovation R&D	"Design Innovation R&D" represents the capacity of design research, including research results of design related industries in a city that can be objectively recorded, as well as the level of investment in design research of city/regional institutions, such as numbers of intellectual properties and design labs, and papers and publications on design research.	Number of domestic design patents	
			Number of domestic design patent applications	
			Number of foreign design patents	
			Number of design patent applications to WIPO	
			Number of domestic trademark registrations	
			Number of foreign trademark registrations	
			Design patent licensing rate	
			Number of international co-inventions	
C1. Design Outcome	Economic Influences	"Economic Influences" includes industry output value, as well as mass consumption and city branding, representing the design effects and shared values brought by design operations in a city.	Percentage of contribution to GDP from the design industry	YoY revenue increase of the cultural and creative industries
			Revenue of the design industry	
			YoY revenue increase of the design industry	
			Average output value per designer	
			Percentage of cultural and creative merchandise export in total exports	
			Percentage of design merchandise export in total exports	
			Revenue of the cultural and creative industries	
			Income generated by government design exhibitions and activities	
			YoY increase rate of the public's cultural expenditures	
			Average design expenditures per capita	
			Percentage of each household's cultural expenditures in total expenditures	
			Average times of participation in cultural activities per household	
			World's best cities ranking(refer to information released by Resonance Consultancy)	
			City Brand Value(refer to Top 500 Global Cities)	
			Number of design awards(Counting four major design awards: IF Design Award, Red do Design Award, Good design Award, Golden Pin Design Award)	
	Social Influences	"Social Influences" includes public engagement, discussion, evaluation, and communication, which cover the public's accessibility of design related knowledge and participation, showing that design can make the society better and solve social issues.	Number of art and cultural activities and exhibitions	Number of design publications
			Number of city design activities (including: academic, holiday, and exhibition…etc.)	Number of design related magazines
			Number of design competitions organized	
			Number of participants in city design activities (including: academic, holiday, and exhibition…etc.)	
			Number of public participation in city design activities	
			Number of public participation in design exhibitions	
			Domestic and foreign internet volumes of top three design activities	
			Reach of top three design activities	
			Number of visitors to websites of public design agencies	
			Number of searches of design related keywords	
			Positive feedback of top three design activities(public opinion analysis; positive words)	
			Number of design related TV programs	
			Number of design related websites	
			Number of domestic and foreign media coverage of city design activities	
			Number of city tourism promotion videos	
	Environmental Influences	"Environmental Influences" includes the concepts of sustainability, environmental protection, and ecology, showing that design can bring positive impacts on the environment of a city, including: energy conservation and carbon reduction, net-zero emissions, biodiversity, symbiosis with nature and other species, and environmental sustainability and resilience.	To be added	

Figure 2: Definition of each construct of city design power index.

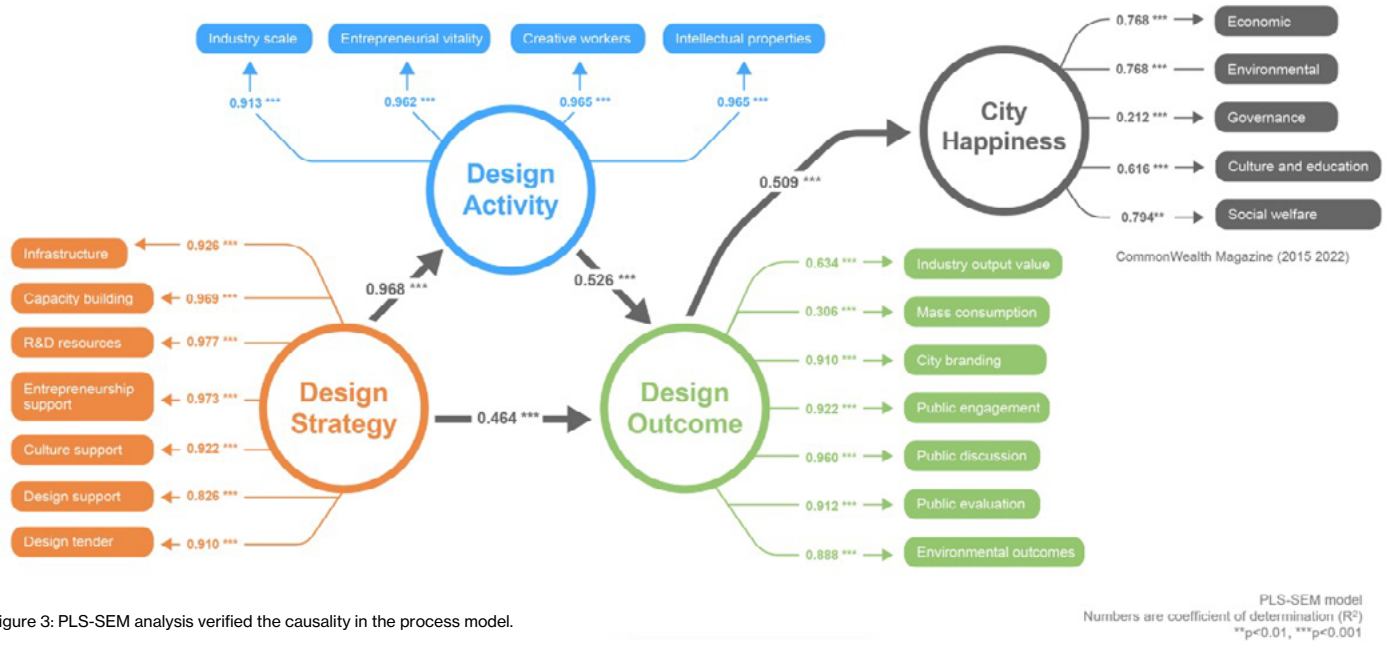


Figure 3: PLS-SEM analysis verified the causality in the process model.

In Study 4, based on the longitudinal data of Taiwan cities, PLS-SEM was used to verify the casual process model proposed. The empirical data supports the proposed process model, that is from developing strategy to design activities, and then to design effects and design impact, as shown in Figure 3.

Further analysis was conducted to recognize the pattern which differentiate the design power operation process in different types of cities which are tech-savvy metropolises and cultural tourism cities, as shown in Figure 4. In the tech-savvy metropolis, the governments invest ample and diverse resources. Data analysis reveals significant influences from 'A-3. Financial Support' and 'A-2. Human Development' to 'B-1. Industry Dynamics', and is highly correlated to 'C1-1. Economic Outcomes'. Cities of this type are relatively maturely developed; thus, less new design infrastructures are built and less influence is from such factors. Compared to a tech-savvy metropolis, in cultural tourism cities 'A-1. Design Infrastructure' plays a more important role on influencing 'B-1. Industry Dynamics' rather than 'A-3. Financial Support'; and 'B-1. Industry Dynamics' is more highly correlated to 'C1-2. Social Outcomes' than 'C1-1. Economic Outcomes'.

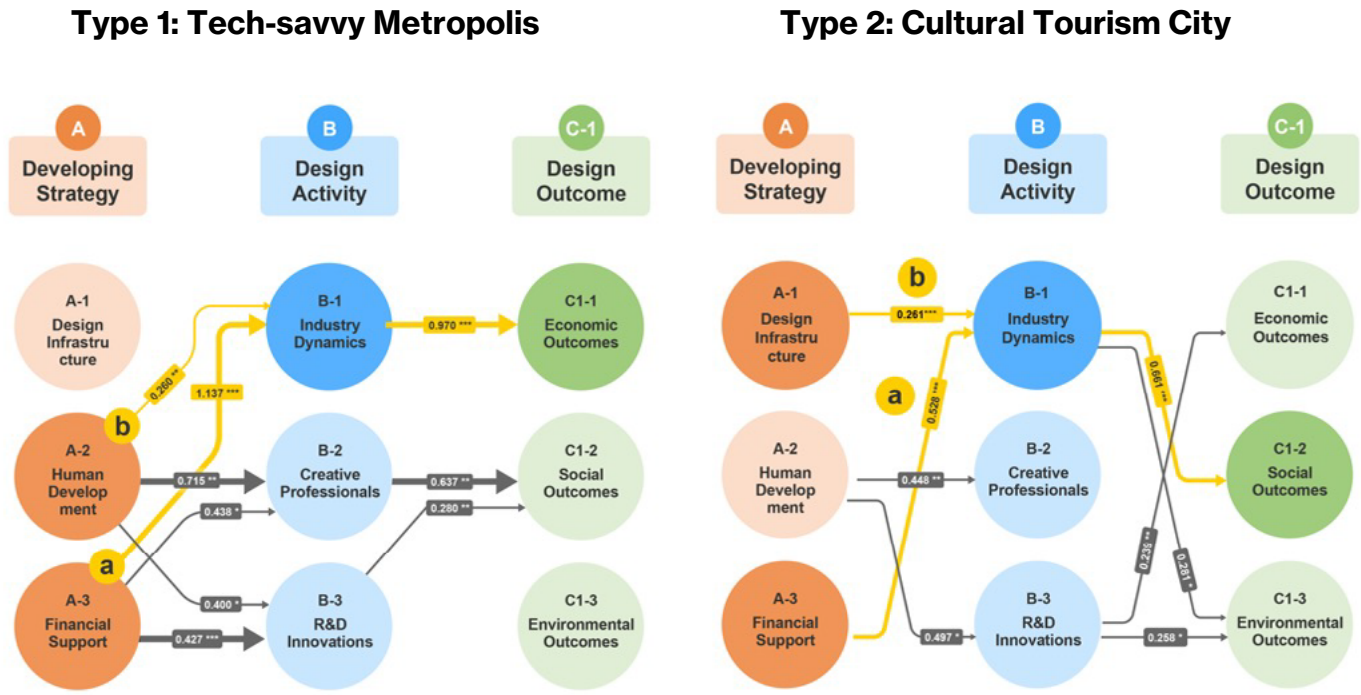


Figure 4: PLS-SEM analysis of different types of cities.

In Study 5, in order to advance usability of these index presentations, two dashboards were built to visualize the city design power index data – a radar chart and a city map, as shown in Figure 5 and Figure 6 respectively. It allows users to upload indicator datasheets to visualize their own data. Users can select a specific city and year from the datasheet and visualize the city's design power. By pressing the play button, the city's development of design power over time is displayed. Another city can be selected at the same time as a benchmark, for identifying the gap between two cities, or each city's advantage for city branding. By switching to the map view, users can see the distribution of design infrastructures and design companies in a city. This view helps users identify the lack of design infrastructures in a certain area, and see the clustering of specific design industries. It can be used as an urban planning tool for policy makers who wish to boost city design power.

Figure 5: Radar Chart.

Figure 6: City Map.

4. Discussion

The proposed city design power model provides an initial contribution by offering a more valid and practical diagnostic and actionable system. Through the reorganization of existing design power indicators, it offers a clear understanding of how and why indicators reflect developing strategy, operational activities, and design effects while providing better descriptive and explanatory function. The theoretical framework provided for this process model serves as an explanatory model, as a diagnosis-treatment prescriptive model for understanding the essence of design power reflected by indicators, thereby enhancing the usefulness of the indicator system in predicting the outcomes of design power. This study was empirically verified using longitudinal data in Taiwan. In addition, with deep exploration of case studies on cities with different design power strategies and outcomes, this model is strengthening with a solid empirical basis. Future developments can enhance the effectiveness and explanatory ability of the model based on more international case data of different types of cities with different levels of design power varied in contexts.

Further research suggested the following areas of focus:

(1) Cross-Level Constructs: Explore different level of analysis of design power, which across national design power, organizational design power, and individual design power, and examine the cross level mechanisms contribute to city design power.

(2) Indicator Reliability, Validity, and Complexity: Clearly define the ABC constructs and their corresponding indicators. Establish a model for construct validity (nomothetic networking) by defining conceptual features for theoretical constructs in ABC and developing operational definitions for indicators that can be objectively measured.

(3) Causal Relationships in the ABC Process Model: Build causal models to explain how A influences B and how B influences C for different patterns. In complex systems like cities, it can be challenging to find specific causal mechanisms. It might be necessary to identify a few paradigmatic pathways and validate these causal relationships based on past theoretical discourse and empirical evidence as part of model development.

(4) Contextualizing of City Design Power: Recognize that each city has its unique cultural and policy context, affecting the development strategies of city design power. Understanding the historical context of cities, the policy direction of local governments, and the development direction of industries is crucial before formulating appropriate strategies. With solid foundational data, suitable strategies can be devised. The index model will help identify development strategies that fit individual cities and will further enhance the system based on data feedback from continued use by WDO Member Organizations in different countries.

References

Icograda and Seoul Metropolitan City Government. 2011. *World Design Survey 2010*. Seoul Metropolitan City Government.

Aalto University School of Art and Design. 2011. *Global Design Watch 2010*. DESIGNIUM.

World Intellectual Property Organization (WIPO). 2022. *Global Innovation Index 2022: What is the future of innovation-driven growth?* WIPO.

KIDP. 2008. *National Design Competitiveness Report 2008*. Korean Institute of Design Promotion.

Moultrie and Livesey. 2009. *International Design Scoreboard: Initial indicators of international design capabilities*. University of Cambridge.

Kimbell, Bailey, Nold, Kaszynska, Todd, and Mazzarella. 2021. *Design Economy 2021 Scoping Project: Introductory Paper*. London: Design Council.

Design for Humanity: Exploring the Power of Co-design to Empower Young Population for Social Impact

Author:
Anastasios Maragiannis

Institution:
College of Design, Creative & Digital Industries
University of Westminster
(United Kingdom)

Abstract

This paper explores the transformative potential of design as a catalyst for social change and its capacity to yield positive societal outcomes. It delves into co-practice-based thinking, emphasizing design's role in addressing complex social issues, including planetary sustainability, social change, and inclusion. The central focus is the 'Diversity and Inclusivity by Design' (d+iD) mission, employing co-design methodologies to shape diversity and inclusion policies within humanitarian and cultural organizations across Europe and Africa. This project has engaged a diverse audience of over half a million individuals and influenced governmental and non-governmental organizations, especially those concerned with refugees and cultural integration. The research demonstrates the effectiveness of co-design in engaging marginalized groups and diversifying design practices. It also extends its impact to projects like the EYES, an EU NWE INTERREG-funded project (Empowering Youth through Entrepreneurial Skills) aimed at addressing labour market exclusion. Additionally, the research also explores other areas that could impact humanity, e.g. aesthetic and personalization choices in wearables and their social and cultural implications. The d+iD has received significant recognition and awards, affirming its contributions to advancing design for the betterment of humanity.

Keywords: Co-design, inclusivity, underrepresented youth, social impact, design diplomacy.

Prologue

"Excellence is never an accident. It is always the result of high intention, sincere effort, and intelligent execution; it represents the wise choice of many alternatives – choice, not chance, determines your destiny." -Aristotle 323 BC.

Aristotle's emphasis on excellence serves as a poignant illustration of how collaborative design possesses the potential to shape societal trajectories. The cultivation of values and promotion of innovation play pivotal roles in making deliberate choices that not only influence societal outcomes amid uncertainty and growth but also contribute to meaningful social change and positive community development. However, it is worth noting that, contrary to Aristotle's perspective, the option to make choices within a social context is not always universally available.

In recent years, co-design has emerged as a powerful catalyst for societal transformation, demonstrating its capacity to instigate significant social change and foster positive community outcomes. Nonetheless, it is essential to acknowledge that, in some instances, choices within a social context may face constraints.

Conversely, social exclusion is an intricate and multi-dimensional phenomenon encompassing the denial or lack of resources, rights, goods, and services. It involves the inability to partake in normal relationships and activities accessible to the majority within a society, spanning economic, social, cultural, and political arenas. The repercussions of social exclusion extend beyond individual well-being to impact the equity and cohesion of society.

Within the research project's exploration of social exclusion, insights derived from Joel-Gijsbers and Vrooman's theoretical model (2007), tested in the Netherlands, offer valuable perspectives. This model, disseminated by the Netherlands Institute for Social Research/SCP, enhances our understanding of social exclusion and its intricate dynamics. The publication *Explaining Social Exclusion* provides a theoretical framework that has been referenced to scrutinize and comprehend the nuanced process of social exclusion (Joel-Gijsbers and Vrooman, 2007).

Introduction

Building upon Aristotle's profound insights into excellence, this paper delves into the realm of practice research, specifically the Diversity and Inclusivity by Design (d+iD) project. Introducing a co-design methodology, our critical exploration focuses on design's transformative power, emphasising its ability to address intricate social challenges and empower marginalized populations. This inquiry unfolds within the broader landscape of design thinking and its relevance in navigating contemporary societal complexities. The central thrust of this paper is to underscore the paramount importance of co-practice-based thinking paradigms, highlighting design's pivotal role in advancing social impact across multifaceted dimensions, including planetary sustainability, societal transformation, and inclusivity.

Design for humanity goes beyond society; it wields the potential to shape a more environmentally responsible future, and designers are the ones – among others – who navigate the intricate landscape of planetary sustainability. By developing eco-conscious products, systems, and practices, design and, in particular, co-design methodologies can significantly enhance the Quality of Education (SDG 4), have a direct impact on innovation and infostructure (SDG 8,9,12,17), lead innovation that could foster less environmental harm (SDGs 6,7,14,15), (United Nations 2023). Furthermore, creativity can be a driving force enabling marginalized populations to participate actively in shaping their communities and driving economic growth. It has the capacity to bridge gaps and create opportunities that were previously inaccessible. As Papanek articulated, "Design has become the most powerful tool with which man shapes his tools and environments (and, by extension, society and himself)." This underscores design's capacity to usher in a sustainable ethos, driving innovation in materials, energy efficiency, and environmentally conscious strategies (Papanek 1971).

In essence, co-design methodologies are not only a means to environmental responsibility but also a means to empower marginalized communities, promoting their active involvement in the design and development processes that directly impact lives. This inclusive approach reflects the broader ethos of design for humanity, where creativity becomes a catalyst for positive change and social empowerment. Concurrently, co-design serves as a catalyst for societal transformation. Rooted in empathy and problem-solving, the principles of design thinking enable designers to tackle deeply entrenched societal issues. From poverty alleviation to equitable access to education and healthcare, design's creative problem-solving methodologies can lead to innovative solutions that propel societal progress. Brown, CEO of IDEO, noted design thinking aligns "people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown 2009). In this paper, we traverse the intricate terrain of design's potential as a force for positive societal change. We scrutinize the methods and impact of the d+iD project, shedding light on how co-design principles can empower marginalized communities and promote the betterment of society at large. The investigation provides invaluable insights into the transformative capabilities of design, the significance of co-practice-based thinking, and the profound implications of these endeavours on societal well-being.

In this way, co-design becomes a dynamic force for reshaping societies, promoting social equity, and advancing the well-being of communities on a global scale. The examples below showcase this impact.

Setting the Scene: Diversity + Inclusivity by Design (d+iD)

At the heart of our investigation lies a comprehensive analysis of the 'Diversity and Inclusivity by Design' (d+iD) project, an ambitious research initiative that harnesses co-design methodologies to craft diversity and inclusion policies within humanitarian and cultural organizations operating across the regions of Europe and Africa. The overarching goal of this initiative is to foster a more inclusive society, cultivate essential skills, and nurture the self-assurance of marginalized young individuals.

Inclusivity stands as a foundational principle of design overall but also co-design methodologies and strategies. The project immerses diversity and inclusivity research within the realms of creativity in general, employing co-design methods to address the pivotal question: "What possibilities emerge when designers collaborate with and design for diverse communities?" This research delves into the transformative potential of pioneering co-design approaches, aiming to magnify, broaden, and activate different facets of the design process (Smith and Johnson 2018). The ultimate goal is to empower through co-design to embrace inclusivity, transcending barriers related to disability, gender, ethnicity, vulnerability, language, and age and ensuring accessibility for all. Embracing inclusive design principles not only fosters a more equitable society but also creates environments where everyone can fully participate. As Microsoft's inclusive design toolkit emphasises, "When we solve for one, we solve for all." (Maragiannis and Ashford 2019). Through design, we have the means to break down barriers, champion inclusivity, and elevate the voices of individuals who have been historically marginalized.

At the heart of the d+iD project lies a foundational commitment to the integration of co-design methodologies into the design development process. This commitment serves as a means of exploring a multifaceted question: "What are the possibilities that emerge when designers embark on collaborative design endeavours with and for others?" The project's research findings have compellingly demonstrated that involving users in the design process results in outcomes that effectively address their unique needs. Co-design methodologies, by their very nature, facilitate a comprehensive understanding of user and stakeholder requirements, giving rise to enhanced design solutions and fostering productive collaborations that span diverse disciplinary domains.

The d+iD project's profound impact becomes evident when considering its extensive outreach, which has resonated with a diverse audience comprizing more than half a million individuals. This engagement unfolded through a series of events spanning the years 2016 to 2022, encompassing prestigious global exhibitions such as the London Design Festival and others. Beyond the confines of these exhibition spaces, the project's influence has radiated outward, instrumental in shaping both governmental and non-governmental organizations dedicated to the welfare of refugees and the integration of diverse cultures.

Policy Changes to Support Economic Migrants and Refugees

This practice research project has significantly contributed to the development of two pivotal policies – one for the Cyprus High Commission (CHC) in 2020 and another for the International Refugees Forum in Greece in 2021. These policies play a crucial role in serving communities that often feel disenfranchised and forgotten, reflecting the project's dedication to inclusivity and diversity. They serve as tangible frameworks for promoting integration, fostering cultural understanding, and ensuring the well-being of marginalized communities, leaving a legacy by shaping the policies and practices of organizations committed to social welfare and diversity (Adams 2017). The transformative essence of the d+iD project has yielded numerous positive outcomes, notably enhancing the creative practices of young refugees and socio-economic migrants, empowering them and reinforcing their skills and self-confidence (Sjöberg and D'Onofrio 2020).

The inception of the CHC and Cultural Section collaboration involved devising and co-designing diversity and inclusivity themes with London-based designers. The subsequent d+iD 'Empower Individuals' exhibition at the London Design Festival 2019 highlighted social and political issues, consumerism, gender issues, and conflict, attracting a record-breaking 600 000 visitors from over 75 countries. Following this success, the CHC Cultural Section (CS) commissioned the d+iD team to co-develop their inaugural cultural and arts policy, focusing on the empowerment of individuals and the engagement of diverse participants. This collaboration led to tangible outcomes, with the new policy becoming mandatory in their creative projects/participation and application processes. It has significantly influenced the decision to create new projects focusing on more inclusive outcomes (Adams 2017).

Dr. Marios Psaras, Cultural Counsellor at CHC, highlighted the project's impact in supporting diverse collectives and individuals, including youth groups, LGBTQ+ artists and projects, female leaders in the arts and culture, and ethnic minorities. The diversity and inclusivity by design research project has made a substantial contribution to their evidence-based approach, playing a pivotal role in their work. Additionally, the research outputs of the 'Empower Individuals' exhibition addressed issues relevant to the CHC's own cultural programme. In March 2019, the research extended its impact to the Greek Refugees Forum (GFR), leading to the 'Creative Citizens of Europe' exhibition in Athens, exploring ways to engage refugees through design and the arts. The outcomes influenced the development of a new framework and organizational policy for the inclusion and integration of refugees into society through the arts. This resulted in the creation of an Equality, Diversity and Inclusion policy empowering people through creative arts, design, education, and sports. This policy has raised awareness of GFR's creative activities and positively impacted participation, enhancing their policy and practice for securing diverse project proposals, such as the MATCH social inclusion opportunities project (Adams 2017).

Jean Didier Totow, President of GFR, emphasised the integral role of the policy in their Equality, Diversity, and Inclusion strand, actively reaching out to underrepresented and marginalized groups since 2018. The project has facilitated their support for various community groups.

This research project has also resulted in a collaboration with Africa Risk Consulting (ARC), a pan-African consulting company providing information and advice for informed investment decisions and reputation safeguarding. ARC's emphasis on diversity and inclusion in their commissioned work led to their consultation with the d+iD project team to embed these principles in their outward presentation and processes. This collaboration has been instrumental in shaping their recruitment approach and focusing on diversity and inclusion aspects of participation. ARC utilizes this collaboration as a core means to raise awareness of their commitment to work in Francophone countries, notably in the West African and Central African zones (Adams 2017).

Remarkably, these research efforts have had a particularly pronounced impact on vulnerable young individuals residing in the North-West European region, facilitating their advancement and overall betterment.

This approach challenges the conventional paradigm, which often places undue emphasis on the expertise of individual designers, thereby highlighting the imperative of foregrounding social impact and social innovation, particularly in the context of young people's well-being. In this context, the d+iD project illuminates that the advantages conferred by co-design far outweigh any concerns raised by design practitioners regarding potential disruptions, disorderliness, limitations, and scope. Through this holistic exploration, we unveil the transformative power of co-design in shaping a more inclusive, innovative, and impactful design landscape.

The project serves as compelling evidence of the profound efficacy of co-design in actively engaging marginalized groups, thereby bestowing upon them a newfound sense of agency. Beyond this, it acts as a catalyst for the diversification of design practices and the expansion of discourse within the design community. In embracing this inclusive nature, design emerges as a formidable tool, poised to drive transformative change and engender positive social impact on an unprecedented scale. The project is underpinned by a steadfast dedication to reimagining and reshaping the conventional paradigms that have long governed design processes. At its core, diversity and inclusivity are positioned as the nucleus of co-design methodologies, serving as guiding principles that steer the course of this innovative journey.

Through the effective harnessing of co-design methodologies employed in this project encompasses a specific approach to engaging multidisciplinary stakeholders, fostering a deep understanding of each unique practice. The project champions the concept of collaborative co-creation, particularly with marginalized groups. It not only empowers these communities but also offers them a robust platform from which to amplify their voices. Doing so initiates a paradigm shift that challenges the status quo, advocating for the active participation of those often excluded from the design process. This transformative approach is not just a mere deviation from tradition but an inspiring endeavour that marks the convergence of design and social empowerment, setting the stage for profound and meaningful change in the design world (REF2021 Impact 2021).

Case Study Impact: Empowering Youth through Entrepreneurial Skills and Co-design Methods (EYES)

The influence exerted by the d+iD project transcends its immediate boundaries, resonating harmoniously with other prominent initiatives, such as the European Union-funded programme denominated as EYES. EYES operates in synergy with various funding bodies and is primarily dedicated to crafting a co-design methodology expressly tailored to confront the urgent issue of labour market exclusion. This methodology places specific emphasis on individuals categorized as 'not in education, employment, or training' (NEETs). Endowed with a substantial budget allocation of €4.28 million, this concerted undertaking is driven by the imperative to disseminate knowledge and expertise across diverse European regions. The ultimate objective is to establish an innovative, inclusive, and transnational model, finally attuned to the unique requisites and aspirations of NEETs. Notably, this model exhibits an adaptable framework that accommodates the intricacies of local and regional contexts, offering bespoke support tailored to individual needs and aspirations.

Within the context of the North West European (NWE) region, a conspicuous concern emerges, as an alarming 14% of the youth cohort aged 15-34 find themselves ensnared within the category of individuals who are not actively engaged with society. This NEET demographic, displaying resistance to conventional top-down interventions and demonstrating a limited connection with extant support structures, confronts the precarious prospect of protracted exclusion from the labour market. Particularly disconcerting is the heightened prevalence of this issue in economically deprived NWE metropolitan areas, where the propensity for individuals to become or remain NEET is significantly elevated in comparison to the national average (Council of Europe and Kovacheva 2023).

The d+iD co-design methodologies, as elucidated earlier, underscore that while entrepreneurial education has garnered significant attention as a strategic instrument in alleviating labour market exclusion, an evident lacuna exists in the form of a systematic and comprehensive approach to integrating NEETs into this educational paradigm. Evidenced by the paucity of localized initiatives effectively linking NEETs with entrepreneurial education, it is palpable that knowledge dissemination across the NWE region is marked by fragmentation. An exigent imperative is the dissemination of knowledge to engender a novel, transnational model. The co-designed methodological approach represents an innovative solution amalgamating entrepreneurial education, personalized coaching, and a digital platform, thereby facilitating NEETs' ingress into support programmes they might otherwise eschew. With a targeted outreach encompassing 100 000 NEETs residing in five NWE metropolitan areas, the EYES initiative engaged more than 1000 individuals during the project's stipulated timeframe. This endeavour anticipates active involvement by 400 NEETs with conventional support frameworks, while 25 are envisaged to undertake the commendable role of early-stage entrepreneurs.

The comprehensive EYES product package comprises an array of digital tools and coaching materials. Four bilingual training sites have been designated to equip 25 coaches with the requisite competencies to execute pilot programmes in distinct locales, including the Ruhr area, Greater London, the Flemish Triangle, the European Metropolis of Lille, and Tilburg. A central helpdesk resource will complement these initiatives. The project has also proposed new measures to address legal issues arising from social innovation projects. In the context of our research project, which primarily centres around vulnerable populations, it becomes imperative to accord special attention to legal aspects such as personal data protection (GDPR) and liability. However, our project team often lacks the specific expertise required to integrate legal considerations into the research design process seamlessly. This poses a fundamental question: should we initiate the research design phase first and address legal issues at a later stage, or should we establish the legal framework as a priority before commencing the research? The choice made in this regard will significantly impact the outcome of our research endeavour. On the one hand, pursuing highly innovative approaches may lead to subsequent legal challenges, while on the other hand, establishing a predefined legal framework upfront could potentially hinder the development of disruptive solutions right from the project's inception (EYES 2022).

Image 1: Diversity and inclusivity by design, methodological design outputs to reflect on methodologies amalgamating the SDGs practice and participation (London 2023).

Image 2: Co-design participants showcasing their findings as part of the international workshops (London 2022).

The Potency of Co-design:

The stewardship of this initiative is poised to transition under the aegis of the EYES innovation network, which is charged with the iterative refinement of the approach and its subsequent expansion into additional municipalities within the NWE region. This expansion foresees an eventual extension of the initiative's scope to encompass the broader European Union. The envisaged permanence of the training sites ensures a sustained capability to conduct training sessions for successive cohorts of coaches. Furthermore, the integration of the EYES digital platform into existing digital ecosystems, particularly within Smart Cities, serves as a testament to the enduring pertinence and resonance of this transformative endeavour.

Additionally, the potency of co-design holds immediate and enduring implications. For instance, within a related context, this research project explores the intricacies of aesthetics and personalization in wearable technologies. The undertaking seeks to attain a profound understanding of how these devices impact specific communities, with a particular emphasis on empowering individuals across diverse contextual backgrounds and enhancing their overall quality of life. By amalgamating practice-based research with contextual resources, the project delves into the subtleties of women's concerns and preferences concerning wearable technologies. It underscores the critical importance of acknowledging the profound social and cultural connotations associated with these devices, especially regarding the representation of women.

This collaborative endeavour among scholars, designers, and prominent organizations has engendered a dynamic exchange of ideas that transcends cultural and disciplinary boundaries. It has effectively engrossed industry experts, scholars, designers, and the general populace in a productive and enlightening discourse, contributing substantively to a more nuanced comprehension of the intersections between design, culture, and society.

The d+iD project has garnered global recognition and acclaim for its substantial contributions to the field of design. It boasts prestigious accolades, including the International Institute of Information Design Award from a UNESCO-affiliated partner organization. This recognition serves as a testament to the project's profound influence in advancing the domain of design, particularly in its pursuit of human betterment. Furthermore, the project has been distinguished with the esteemed IMPACT award from Interreg Northwest Europe, prevailing over rigorous competition from more than 90 entries from other EU-funded projects. This recognition further underscores the project's significant contributions to the advancement of the ethos of design for the betterment of humanity.

Conclusion

In conclusion, the adoption of co-design and co-production frameworks emerges as a transformative approach with the capacity to empower marginalized youth, addressing the limitations often associated with conventional top-down methodologies. Implementing these strategies on a transnational scale necessitates considerable time investment and the establishment of specialized communication protocols. Such measures are indispensable for harnessing the multifaceted array of values, cultures, traditions, and contextual nuances present across diverse regions and communities.

The establishment of a unified European framework represents a crucial step in advancing this cause. This framework should actively endorse and embed the principles of co-design and co-production within European Union policies and funding initiatives. In doing so, the European Union not only champions a cohesive approach to policymaking but also engages in a collaborative partnership with its citizens.

This collective endeavour underscores a deep commitment to inclusive governance, where the voices and contributions of citizens, particularly vulnerable youth, are acknowledged and incorporated into the processes of policymaking and innovation. It signifies a momentous shift towards the creation of a more cohesive and responsive Europe, one that collaborates with its citizens as genuine co-creators of their shared destiny.

In summary, the d+iD research project stands as a collaborative and interdisciplinary endeavour dedicated to unlocking the profound potential of co-design in driving meaningful social transformations and positive impact. Through active engagement with marginalized and vulnerable communities, this project has emerged as a catalyst for amplifying their voices, enhancing diversity within design practices, and fostering a culture of inclusivity.

Over the course of its implementation, the d+iD research project has not only made significant contributions to the existing body of knowledge on co-design but has also generated tangible benefits extending beyond the realm of academia. It has played a pivotal role in shaping diversity and inclusion policies within governmental and non-governmental organizations alike, thereby empowering marginalized youth with the creative skills and self-assurance necessary for navigating a complex world.

Through its pioneering work, this project has demonstrated the immense potential of co-design in bridging societal divides, dismantling barriers, and effecting lasting positive change. Its impact transcends mere research findings, actively enriching and shaping the social fabric by promoting inclusivity, diversity, and empowerment among the most vulnerable segments of our society.

References

Adams, Robert. 2017. “Empowerment, Participation and Social Work”. 4th ed. *Red Globe Press*, Bloomsbury Publishing.

Brown, Tim. 2009. “Change by Design: How Design Thinking Can Transform Organizations and Inspire Innovation”. *Harper Business*.

Brown, Tim. 2008. "Design Thinking." *Harvard Business Review*. Accessed October 2023. https://www.hbr.org.

Council of Europe. n.d. "Social Inclusion." Accessed October 2023. https://pjp-eu.coe.int/en/web/youth-partnership/social-inclusion.

Eyes - Empowering Youth Through Entrepreneurial Skills. URL: https://vb.nweurope.eu/projects/project-search/eyes-empowering-youth-through-entrepreneurial-skills/#tab-2. Accessed October 2023.

Kimbell, Lucy. 2012. "Rethinking Design Thinking: Part II." *Design and Culture* 4 (2): 129-148.

Joel-Gijsbers, G., and C. Vrooman. 2007. "Explaining Social Exclusion; A Theoretical Model Tested in The Netherlands." *The Netherlands Institute for Social Research/SCP*. Archived from the original on May 25, 2019. Accessed September 10, 2019. https://web.archive.org/web/20190525085023/https://www.scp.nl/english/Publications/Publications_by_year/Publications_2007/Explaining_Social_Exclusion#!. ISBN 978-90-377-0325-2.

Vrooman, C. J., and S.J.M. Hoff. June 2013. "The Disadvantaged Among the Dutch: A Survey Approach to the Multidimensional Measurement of Social Exclusion." *Social Indicators Research* 113 (3): 1261–1287. https://doi.org/10.1007/s11205-012-0138-1. ISSN 0303-8300.

Impact Case Study Database. 2021. Retrieved from https://results2021.ref.ac.uk/impact/d2866bc8-70f8-4edc-b8b3-30c9ced4fdb2?page=1. Accessed October 2023.

Maragiannis, Anastasios, and Rain Ashford. 2019. "Diversity and Inclusivity in the Age of Wearables: A Buzzword, a Myth, an Uncertain Reality." *Body, Space & Technology* 18 (1): 198-214. https://doi.org/10.16995/bst.320.

Maragiannis, Anastasios, Stephen Kennedy, Kamalveer Rehal, and Catherine Maffioletti. 2019. "Co-design Methods Towards Inclusive Design in Diverse Communities: Empowering Youth Through Entrepreneurial Skills." In *Design Research for Change 2019*, 118-119. Lancaster University. ISBN 978-1862203631.

Manzini, Ezio, and Franca Rizzo. 2011. "Small Projects/Large Changes: Participatory Design as an Open Participated Process." *CoDesign* 7 (3-4): 199-215.

Microsoft. n.d. "Inclusive Design Toolkit." Accessed October 2023. https://www.microsoft.com.

Papanek, Victor. 1971. “Design for the Real World: Human Ecology and Social Change”. London: Thames & Hudson.

Sanders, Elizabeth B.-N., and Pieter J. Stappers. 2012. “Convivial Toolbox: Generative Research for the Front End of Design”. *BIS Publishers*.

Sjöberg, Jonas, and Alessandro D’Onofrio. 2020. "Moving Global Horizons: Imagining Selfhood, Mobility and Futurities Through Creative Practice in Ethnographic Research." *Culture & Psychology* 26 (4): 732-748. https://doi.org/10.1177/1354067X20922141.

Smith, John, and Alice Johnson. 2018. "Co-design Methods: Designing with and for Users." *Design Studies* 57: 160-180.

United Nations. "Sustainable Development Goals." Accessed October 2023 https://sdgs.un.org/goals.

Design Beyond Politics: Socio-political Obstacles in India's Healthcare

Author:
Mary Reisel

Institutions:
Rikkyo University (Japan)

The Ceruleans (Japan)

Abstract

During the COVID-19 pandemic, India faced a devastatingly high mortality rate, ranking second globally after the USA. Officially surpassing half a million deaths, subsequent studies suggested the toll could be three to four million, making India the worst-hit. Factors contributing to this included recurring waves of Corona virus variants, insufficient medical resources, patient overload, and a lack of hygiene awareness whereby mask-wearing and limiting contact or travel were not widely adopted. This study delves into a critical aspect of the healthcare system obstructed by social and political norms during the crisis: the ASHA system. Accredited Social Health Activists (ASHA) act as vital links between urban healthcare centers and rural populations. Despite their potential, the ASHA themselves belong to the same lower classes of the population they serve, and this fact created a conflict of values that disabled the urgent response and didn't allow a fluent and fast work of these activists to mitigate immediate issues. This report outlines challenges in developing a healthcare app to support the ASHA during the pandemic, revealing the deep-rooted impact of India's caste system dating back 3500 years. The findings emphasize the need for innovative research methodologies, redefining user experiences beyond traditional personas, and addressing sociopolitical conflicts for more effective healthcare solutions.

Keywords: UX, UI, India, ASHA, healthcare, socio-political design.

Introduction and Background: Why the ASHA Matter

The ASHA members are a major component of the healthcare system in India and they form an important part of the larger CHM (Community Health Workers) providers nationwide. With the meaningful word ASHA – which means "hope" – as a symbol, the programme was launched in 2005 with the aim of creating a support system that will provide supervision and health education in rural villages and urban suburbs that have less (or no) access to medical care facilities and/or to professional doctors. By 2019, before the COVID-19 pandemic erupted, the ASHA members included about one million individuals who were spread all over India covering most of the rural areas and providing meaningful and valuable help and healthcare knowledge to a large section of the disadvantaged and marginalized population. However, the ASHA themselves are part of the same population they support, and that fact proved to be the biggest challenge and obstacle of the goal we were trying to accomplish.

The ASHA work requirements include only female workers, married, with eight years of education, and living in the local area where they would be working in order to be available and familiar with the nature of the population. The activists go through a short training programme of 23 days which also provides a certificate that qualifies them to work. Their activities are conducted in pairs (or more, depending on the dangers of the specific area) and the national plan designates one ASHA per 1000 people.

Over the years, the ASHA provided indispensable help in issues of maternal health, family welfare, and child health including social problems such as school and studying difficulties. India was facing an extreme high death rate of women and newborn babies among developing countries, and the support of the ASHA proved highly valuable in changing the situation (Khanna et al. 2019, 31:4, UNICEF reports). ASHA were expected to perform regular home visits, participate in community meetings, keep steady connections and deliver reports to the health centres that assign their tasks, and keep the records of the community and its people in order to be able to follow up regularly (Ved et al. 2019, 17:3). In return for their activity, they receive basic, low remuneration (mostly paid per number of tasks performed).

The ASHA During COVID-19

As India was facing unusual health challenges and high mortality rates during the COVID-19 pandemic, there was no doubt the contribution of the ASHA was crucial and therefore was constantly mentioned and praised in different media tools in order to promote their activities and their value to India in times of all-national distress (UNICEF reports, NPR, NYT, Science). Being the only connection between rural areas and central health facilities, and due to the urgency of the pandemic situation, their responsibility expanded significantly. They were in charge of delivering vaccines, educating the population about COVID-19, teaching new life-saving hygiene behaviour, delivering masks, gloves, and transferring people to hospitals when necessary. Above all, they were the only ones allowed to cross the roads and report on problems when India banned movement within the country in order to stop the spread of the virus. The workload was tremendous and posed considerable danger to their own health. Thus, it became vital to keep up their motivation that started declining under the overload of urgent tasks and the actual fear of the pandemic they faced daily. For the first time, the ASHA had higher value, which provided agency to control their own work conditions, change the low stereotype of their social class, and demonstrate the extreme importance of their contribution to the nation.

This was the opportunity we had to support their work and help them gain respect, higher awareness, and status.

Credit: Asha Project India.

Project Objectives and Methodology

The goal of the design was to develop an app that would cater to the unique needs of the ASHA during the pandemic. The initiative was led by an Indian NGO, *Aaroogya*, and Priyanjali Datta, a doctor who was leading the project and the team in India. *Aaroogya* was in need of an applied anthropologist in order to better understand the particular needs of the target users – the ASHA – as well as the type of assistance *that* would furnish them with the connection and knowledge demanded to meet the unique challenges that the pandemic created. The initial problems assumed several major issues that were on the practical level:

1) Absence of a communication tool and a closed network system to help activists support each other in emergency situations during work.

2) Lack of fast connection with hospitals and healthcare facilities that could provide immediate and qualified professional advice.

3) No transportation for many of the target areas (the roads were blocked and later movement was completely banned).

4) Protection and safety on the roads (due to reports of attacks on traveling ASHA).

Due to the pressure of time and the ban on flying, the methodology had to be modified and adapted in many creative ways in order to meet the requirements and the deadline (which was obviously 'yesterday'). On the technical side, a large network of Internet spots and Wi-Fi connections were already developed by the Indian government, and they provided constant connection between Japan (where I was located) and the Indian team. We decided to assign a few key research methods that could be done quickly and result in meaningful insights of UX for the design of the UI and the prototype.

Qualitative interviews: with the support of my Indian colleagues, seven interviews were conducted with different women who were living in villages in the north part of Delhi and around Hindon area in the east. We used mobile phones to connect in real time, and later Zoom when it became available (it was impossible to work face-to-face). Sharing was done via Slack for longer messages and WhatsApp for shorter ones and for Q&A. Facebook was another major tool to connect with participants in India since it is popular, and most people know how to use it.

Participant-observation: I succeeded to conduct one live observation with two ASHA who were traveling together from Delhi up north on their daily work. We used a simple mobile phone video recording with short movies of the road they were traveling in, the people they met, and the work throughout the day. One sample size is indeed small and usually insufficient, however, this was the only thing we could have in the time we had and luckily it exposed many issues that later were confirmed and supported by insights from the interviews and by academic studies.

Desk research: a lot of data and background information about the ASHA project and its history were gathered from desk research that included newspapers, academic research articles, surveys, and previously conducted interviews.

Questionnaires and one survey: both were designed and executed by the team in India, and then translated into English with quotes.

Results and Design Challenges, or, How to Deal with Non-design Issues in Design

The results revealed an array of pain points and dissatisfaction that surfaced during the pandemic due to the high risk the ASHA were facing at work and the pressure of their own families to be better supported, appreciated, and paid. The media provided higher coverage of the ASHA and the activists had the courage to complain, demonstrate, and demand approval, respect, and better conditions of work or else they would stop working. Many NGSs, healthcare personnel, academics, and institutions supported their struggles and promoted the agenda all over India.

The research discovered that our users had more complicated problems and needs than originally expected, and in other areas than assumed. Therefore, the solutions became a bigger challenge, even more so when determining we had to find a visual answer in the design of the actual UI prototype.

The key insights from the UX studies showed the following issues:

1) Lack of remunerations and proper payments: ASHA were paid extremely small fees – about $40 USD per month – and even those were not regularly paid nor officially delivered through an organized banking system. In 2022, the middle period of the pandemic, the ASHA won a prestigious award from the WHO, but it didn't include any financial prize, and was therefore immediately undermined. "Awards don't fill stomachs" (*NPR*, 2022). The fee for ASHA tasks per month during the pandemic was raised only to $60 USD, and the women refused to work for such low sums of money. In addition, there was a demand to organize proper transfer of fees through a controlled bank system on a consistent monthly basis.

The interviews revealed the money was indeed a major, and not a minor issue of stress and disappointment (as was originally assumed): "my husband fights with me all the time and wants me to leave because he says it is an insult the way they treat us, so I am constantly thinking if to stay or continue. But we are poor, even this (amount) is helpful. I don't know what to do." The lack of financial remuneration was a key factor in the declining motivation of the ASHA.

The desk study and academic research exposed a complicated Pandora's box related to payments to the ASHA. If the underprivileged social classes would be paid properly, and through formal salary channels, they would gain a different status over the one they had, something that could shake society hard after many years of stable social status quo (Bidner & Eswaran, 2015). This was the first circle of caste boundaries that became a major block in promoting motivation, and no UI could solve a traditional issue established for so long.

2) Respect vs. career aspirations: the observation of the pair of ASHA revealed a big gap in their motivation to become ASHA. The different reasons led to conflicts and lack of harmony in the pair's work, and they should have been separated rather than together.

One activist, Leela, was in her early thirties, married with no children, and with a strong desire to become a professional nurse in an urban hospital. Her husband supported her aspirations and her continuing education that was originally stopped at the age of 11. Having the required level of literacy as well as proper medical knowledge, work was for her a stepping stone on the way to a better position, and her attitude was practical, logical, and professionally-oriented. The people she met were "patients, and I have to learn how to be with patients in different stages of disease so this period is good for my training." She maintained a professional distance and focused on the practical issues and medical advice. Despite a relatively poor financial background, she owned a small old car and was driving to the local village.

The second activist, Rajni, was much older, in her mid-fifties, married with children who had already left home, traditional in her way of thinking and with no level of literacy at all. She couldn't even read basic sentences. Her aspirations were to gain "special respect in the community because I have experience, and life. I had eight children, that's eight childbirths myself and growing a big family. This is more than others, I know and understand family". She was looking for what the Japanese call *ikigai* – a meaning of life that could be found through meaningful work for others followed by respect and social status from the community. She wanted to have a sense of accomplishment that would mean her existence was still meaningful even after her own children left. She was friendly, loved to talk with the people, remembered each individual, and was careful to follow up with daily questions about life and family issues. For her, people always came before their diseases and they were all her friends and her personal responsibility – her new expanded family. Rajni made me wonder how she could have gone through the training and the recruitment demands without having the basic level of literacy demanded. However, studies revealed that ignoring demands and providing inadequate training were common, and many of the ASHA weren't even clear on what they were supposed to do and what kind of help they need to provide.

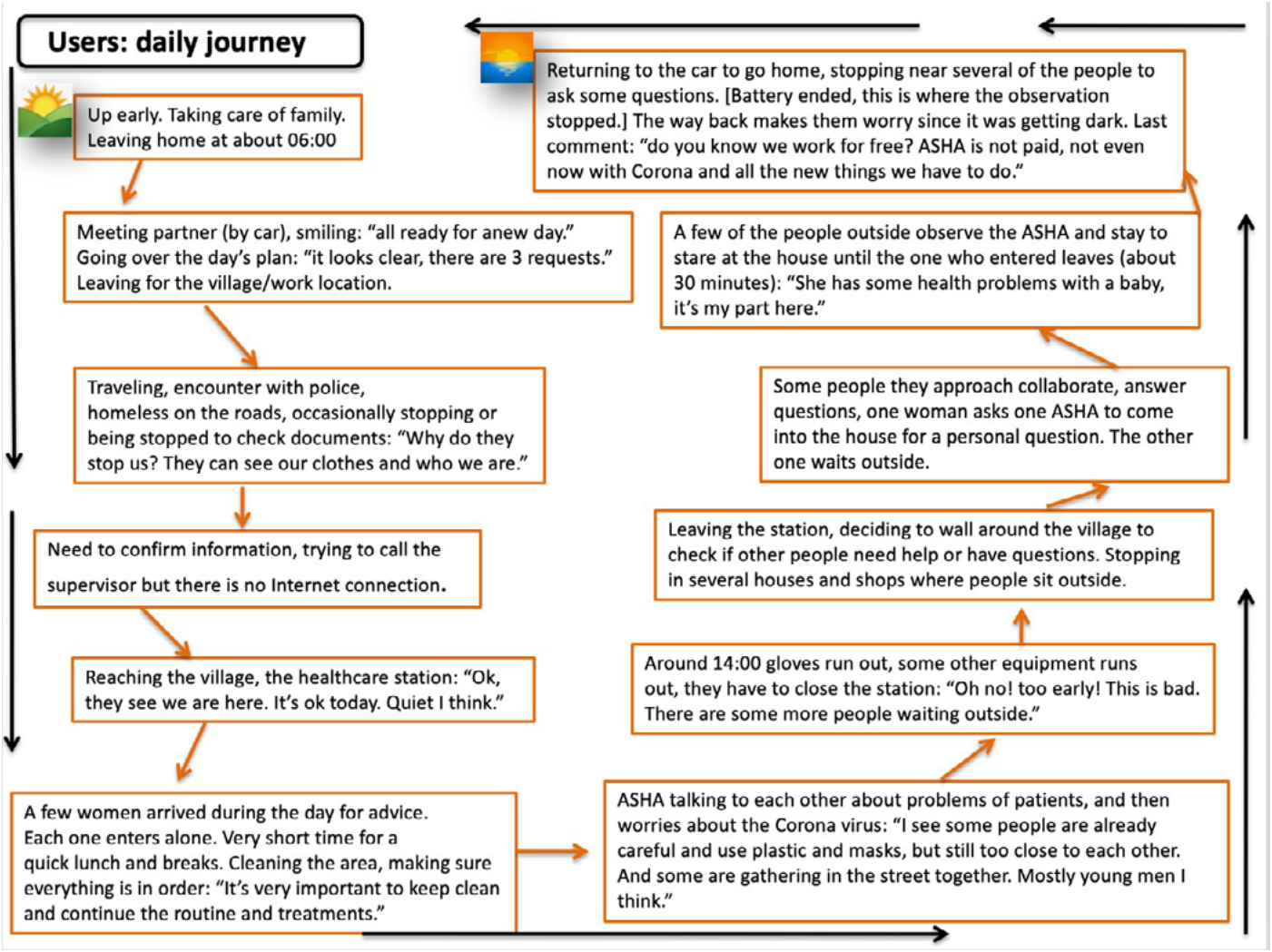


Figure 1: The most important questions about a new product are: how will it become part of an individual's daily practices and habits? How will it be used in real life, beyond the plan and the designer's intentions?

A detailed map of user journey is the key to provide valuable insights of the daily lives of the people we support, and how/when they will need our product.

In terms of the required design, we were facing completely new demands that some could have indeed been absorbed and implemented through a better developed visual. Creating a prototype for such different personalities, different aspirations, and above all a lack of literacy of some of the important users, required a much bigger emphasis on images, colours, and shapes. It also required we limit the amount of written information and texts we could add, and make a software that could support a voice (and recording) system. As a result, the entire basic software and its deadline had to be readjusted. In addition, we needed to conduct quick new research in order to discover trendy shapes and images that would deliver information to all ASHA and would encourage the use of the app.

3) Lack of support and safety: The final major issue was the abundance of connectivity problems, which was a major demand due to many dangers ASHA could face while on the roads to their destination: "There is always news about rape and even murder, it is so dangerous to be ASHA on the roads now. This is impossible. How can we work that way?"

Designing an emergency button was easy, but how to connect it to police or military centers that would be willing to provide immediate response? For this purpose, one needs connection to politicians and institutions but those were again bound by the caste system: "if we help them, we have to help so many others in similar situations, this is not possible," one municipality supervisor, who was sympathetic to the cause but unable to help, told me.

Safety was also expressed in the lack of medical equipment: "I never find gloves in the places where I work, never! And we ask every day, but nothing! We do vaccines just like that (showed exposed hands with no gloves)". Surprisingly, this issue was much easier to solve and healthcare supervisors could take care of supply much faster than expected. It didn't involve any change of social structure and traditional value.

And so, we found ourselves with a good design but with a wall stronger than the any other that could have endangered the entire project – the caste system.

Crossing the Indian Caste Wall

Once we were ready with the findings, the analysis, several different personas we developed for the ASHA users, and an outline of the prototype pages after many different designs, I suddenly faced a devastating and demotivating statement: “But you’re working in vain,” a colleague of mine from a university in New Delhi said in a determined voice. “It’s all about the caste here, this is the lowest caste and nobody will help you develop something meaningful for them. Even if you have it done, it won’t work. You’re an anthropologist, you know you can’t fight tradition, right? You have better chances financing a design of a spaceship.”

Nobody had seen it coming with this force. I was sure the caste system had lost its stronghold and importance in India, especially during a period of such grave emergency. What could be done?... Back to research and learning.

I returned to my research desk slightly depressed and started investigating. One obstacle was already discovered during the interviews with officials of the government: had we succeeded to elevate the ASHA and provide them better conditions, it could have elevated the entire caste they belonged to, and that could never happen due to a chain reaction that would shake the entire society.

The caste system in India has over 3,500 years of history and, as Bidner & Eswaran study shows, it “has proven to be one of the most enduring of Indian institutions” since it is based on hereditary factors, with a pattern of internal marriages within the castes and specific professions that have also been transferred through generations (Bidner & Eswaran, 2014). Women are expected to complement their husbands’ occupations and skills, and as a result, their own productivity outside of the home is low and with no opportunities to reach even slightly higher positions and independence. Dumont’s classical caste theory provides a good explanation of the type of work done by the ASHA, and why workers in marginalized communities are called “activists” and are not paid steady salaries. It also explains why only women can be ASHA and why attempts to improve their conditions were in vain over the years (Dumont, 1981, Bouglé, 1971 quoted in Bidner et al). Young Leela belongs to a new generation that is fighting to change the status quo but it is still early to predict the amount of success this generation will have.

However, the caste system also provides social benefits that cannot be ignored, especially in a country with a large and diverse population like India. For one, it maintains social stability and it is an important political tool that enables control and supervision of the population. Another positive aspect is the internal network of connections that holds the closed community together and with mutual help, loyalties and obligations.

Conclusions and Future Contribution

Political issues and social traditions are a much bigger obstacles of future design than them seem, and there is not enough discussion on this theme. There are ways to face such issues, or to detour them, which was my attempt in solving the case of the ASHA. During the pandemic period, I had several opportunities to mentor M.I.T. Hackathons, where I met colleagues from Africa and South America. Together, we brainstormed ideas on how to promote rural populations with low literacy levels and lack of basic education. Using this experience, I designed a plan for online fashion shows, adapted fun videos of comedians in Japan, and tried to reach young students from India in order to have influencers that can change the way young people think. The goal was to rebrand the social and political perception of ASHA by using a completely new image that would appeal to the future rather than the past.

The ASHA case study is of the utmost importance since the situation exists in many other countries, and the future of the world depends on joining all of humanity together. Those who are left behind will always be frustrated and creates obstacles, which in a moment when unity is highly needed to tackle the many challenges we all face on planet Earth. Design should be more open and courageous not only in openly discussing social and political conflicts, but also in brainstorming together more creative solutions and ideas to solve them. Only by facing the issues we can indeed go ‘beyond’.

References

Bouglé, Ceelestin. Essays on the Caste System. C*ambridge University Press*, 1971 (English edition).

Bidner, Chris, and Mukash Eswaran. "A gender-based theory of the origin of the caste system in India". *Journal of Development Economics* 114 (May 2015). 142-158. Accessed November 11, 2023.

Dumont, Louis. Homo Hierarchicus: The Caste System and Its Implications. *University of Chicago Press*, 1981 (first edition, 1966).

Khanna, Rajat, Nirupama Prakash, Alka Sharma. "Framework to improve coordination among ministries to strengthen ASHA program in India: Based on the assessment of ASHA program in rural Rajasthan." *Indian Journal of Community Health* 31:4 (Oct-Dec 2019). 442-449.

Ved, R., K. Scott, G. Gupta, O. Ummer, S. Singh, A. Srivastava, A.S. George. "How are gender inequalities facing India's one million ASHAs being addressed? Policy origins and adaptations for the world's largest all-female community health worker programme". *Human Resources for health* 17:3 (2019). Doi:10.1186/s12960-018-0338-0

Internet sources

https://www.worldometers.info/coronavirus/

https://www.science.org/content/article/covid-19-may-have-killed-nearly-3-million-india-far-more-official-counts-show

https://www.nytimes.com/2021/04/24/world/asia/india-coronavirus-deaths.html

https://www.npr.org/sections/goatsandsoda/2021/07/20/1018438334/indias-pandemic-death-toll-estimated-at-about-4-million-10-times-the-official-co

https://www.npr.org/sections/goatsandsoda/2022/06/02/1102212364/these-female-health-care-workers-won-a-huge-who-honor-theyd-like-a-raise-too

https://data.unicef.org/resources/levels-and-trends-in-child-mortality/

Evolutional Creativity Evolutionary Principles for Creative Learning

Author:
Eisuke Tachikawa

Institutions:
NOSIGNER (Japan)

Japanese Industrial designers Association, Kanazawa College of Art (Japan)

Abstract

Evolutional Creativity is a method that captures and trains human creativity through biological evolution. Invented by Eisuke Tachikawa in 2016, it has been adopted as an innovation method by various companies. In 2021, a book further detailing this philosophy was published by a small publisher founded on an island with a population of about 2,000. Despite the seemingly humble production, it ranked first in Japan's Amazon Business Book Rankings.

Furthermore, it won the Yamamoto Shichihei Prize, one of Japan's most prestigious awards in the humanities field, and many other accolades. Evolutional Creativity applies the theory of natural selection, which has been handed down from Darwin and others, as a new method of creative education. In an age where societal sustainability is emphasized, we must awaken our inherent creativity. We cannot resign ourselves to viewing creativity as individual talent; we must learn from nature to structure the methods of nurturing creativity.

Keywords: Mutative thinking, evolutional crativity, selective thinking

Introduction: Is Creativity Something Limited to Those with Talent?

In the 3.8 billion-year history of life, among the tens of millions of species said to exist, no creature seems to have acquired the overwhelming ability to create an endless array of tools as humans have. So, is human creativity an unexplainable miracle of nature? Yet, Eisuke is convinced that this enigmatic phenomenon called creativity is, in fact, a natural phenomenon. And if creativity is a natural phenomenon, its nature and why it manifests in humans should also be explainable.

To objectively describe the phenomena of creativity and design, Eisuke turned his attention to the theory of evolution by natural selection, as posited by Darwin and others. Biological adaptive evolution is a phenomenon that closely resembles human creativity within the history of life. Hence, learning from biological evolution might be effective in comprehending it as a natural phenomenon.

Creativity is often spoken of as an innate talent or ability. It is sometimes discussed as something one cannot learn, something intrinsic. However, a phenomenon similar to it, the evolution of species, has been logically explained since the advent of Darwin's theory of natural selection through On the Origin of Species in 1859, which has become the foundation of biology. Furthermore, various pieces of evidence supporting evolution have been proven to date. Interestingly, the introduction of this evolutionary theory also functions as a counterargument to Intelligent Design, which posits that God designed every creature in a perfect form. Even without a transcendent designer, adaptive biological designs can emerge. The thought that only talented humans can perform the creative act of bringing forth natural forms is structurally the same as thinking only geniuses can conceive creative ideas. Biology has already progressed beyond this misconception. What about our understanding of creativity?

Suppose we can point out the similarities between the structure of evolution and creativity. In that case, it may be possible to create an educational system where one can systematically acquire creativity from its structure, and we may be able to provide an adequate explanation for the phenomenon of human creativity in the history of life. At that time, everyone might be able to challenge themselves to hone their creativity.

Therefore, grounded in the structure of evolution, Evolutional Creativity aims to show the structure of an essentially creative education.

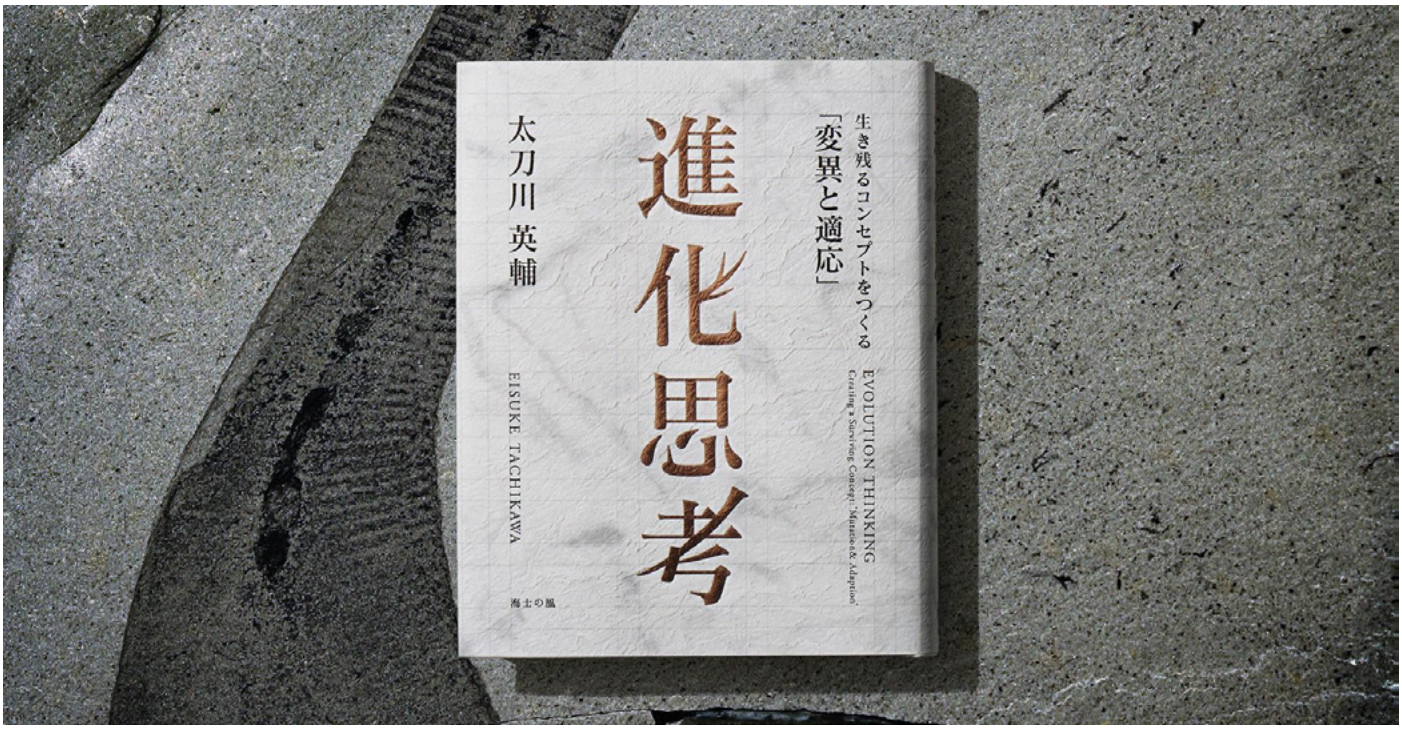


Image 1: Evolutional Creativity written by Eisuke Tachikawa, published in 2021; Source: Eisuke Tachikawa, NOSIGNER

We cannot resign ourselves to viewing creativity as individual talent; we must learn from nature to structure the methods of nurturing creativity.

Literature Review

This thesis is based on the first and second editions of Eisuke Tachikawa's book *Evolutional Creativity* (Tachikawa 2021 & 2023), published in Japan. It aims to create a curriculum that allows students to unravel the structure of creativity by studying the mechanisms of adaptive evolution from living organisms. Specifically, this thesis seeks to structure the process of creative expression through the mechanism of repeated mutation and selection that can be found in the theory of natural selection. The pursuit of creativity has been debated across various fields, not only in design but also in sociology, psychology, medicine, artificial intelligence, and so on. This thesis delves into why humans possess unparalleled creativity compared to other primates. Regarding the difference in creativity between humans and other primates, this paper draws insights from Henrich, J.'s publication, which discusses various perspectives, including physical adaptive evolution and cultural evolution (Henrich 2015). All civilizations and artifacts are rooted in human creativity; thus, a closer analysis of human creativity is meaningful and essential for humanity.

Image 2: Evolutional Creativity written by Eisuke Tachikawa, published in 2021; Source: Eisuke Tachikawa, NOSIGNER

Similarities between adaptive evolution and creativity have been noted in various ways since Darwin's *On the Origin of Species* (Darwin 1859). For example, Dawkins' book *The Blind Watchmaker* explains why the designs of complex organisms developed due to unintentional natural selection (Dawkins 1986). Evolutionary science has maintained the thesis that the seemingly creative evolution of organisms is not due to the design of someone in particular. In this thesis, we reinterpret the act of creation and design that we engage in as a phenomenon guided by chance and necessity rather than will. Although creativity and evolution differ in subjects and objectives, we can find a shared approach based on the theory of natural selection. Furthermore, in terms of the knowledge of evolutionary science and adaptive evolution, much gratitude and acknowledgment is to be given to Dr. Masakado Kawata at Tohoku University – who also serves as the vice president of the Japan Society of Evolutionary Studies, for supervising the second edition of *Evolutional Creativity*, the book on which this paper is based.

There are outstanding prior research studies that treat natural phenomena and creativity as similar phenomena, such as biomimicry (Benyus 1997) and biomimetics (Vincent et al. 2006), which pursue more functional designs inspired by biological traits. As a designer, Eisuke profoundly sympathized with the stance of studying natural mechanisms and was greatly influenced by these studies; however, they fundamentally differ from the theme of unraveling creativity discussed in this paper. In a sense, the *Evolutional Creativity* thesis itself may be a metaphysical form of biomimetics that redesigns creativity from the process of adaptive evolution.

There is a growing body of research in evolutionary psychology (Buss 2005), which analyzes the development of human psychology with the basis of evolutionary theory and is also growing increasingly popular as a way of deciphering the nature of humanity based on evolutionary processes. Then, there is also the field of cultural evolution, which looks into the evolution of tools and culture. *Lead and Disrupt* (O'Reilly et al. 2016) is an example of interpreting business management from the reciprocal phenomena of evolution. Psychologist Simonton, D.K., describes creativity as an evolutionary process in which variations are created and selections are made repeatedly (Simonton 2013). This direction aligns closely with the theme of this paper. While inspired by these precedents, as a designer, Eisuke Tachikawa felt the need for specific creativity methods.

Although it is inevitable since the purpose of the research is different, there is no example of practical methods of conception and education that manage to channel the evolutionary process. From a practical thinking method perspective, the Double Diamond model (Design Council 2003), commonly used in design thinking, proposed by the UK's Design Council, has a structure of iterating divergence and convergence twice. Eisuke's thesis explores why repeating divergence and convergence leads to creative results and what divergence and convergence entail explicitly in terms of cognitive processes. The diversity created by mutations and adaptations through selection in adaptive evolution form an analogous structure, potentially providing a scientific background to the experimental theory of *Evolutional Creativity*.

Regarding the emphasis on contingency in patterns of mutation discussed in this paper, there is a connection to the concept of Disruptive Innovation by Christensen, Raynor, and McDonald (Christensen et al. 2015). Disruptive errors can also lead to creativity. There are instances in creative techniques where patterns are presented, such as TRIZ (Altshuller 1984) and patterns pointed out by A. Osborn in his writings (Osborn 1957). These are convenient for ideation when known. However, they are empirical and do not delve into why such patterns occur in creativity or why humanity can cause them. The *Evolutional Creativity* thesis interprets the emergence of these patterns through the commonalities between DNA and language.

Tinbergen's four questions (Tinbergen, 1963) helped interpret inevitable selective pressures, initially a method to understand animal adaptation. However, when integrating temporal past-future and spatial internal-external axes with this method, we might find that the science of future prediction is missing, as the original method bases itself on animal behavior and only delves into current adaptations. Addressing the future is essential in both creativity and science. Hence, the *Evolutional Creativity* thesis structures four spatio-temporal observations, adding future predictions and integrating developmental and anatomical perspectives. Various predecessors have continued to research the similarities between evolution and creation. This thesis aims to connect these dots and decipher evolution to create a fundamentally simple methodology of learning creativity intrinsically.

There are two main points that Eisuke would like to address in this paper. The first point is a detailed presentation of the structure of creativity based on adaptive evolution. The second point is proposing fundamental and concrete methods for learning creativity, based on the first point, and have it applicable to both children and adults. Achieving these goals could refresh our perception of our creativity and transform design and all forms of education into more creative endeavors. Eisuke believes that a great movement could emerge by inheriting the quest for creativity of our predecessors.

Method:
The Emergence of Evolution and Creation through Mutation and Selection

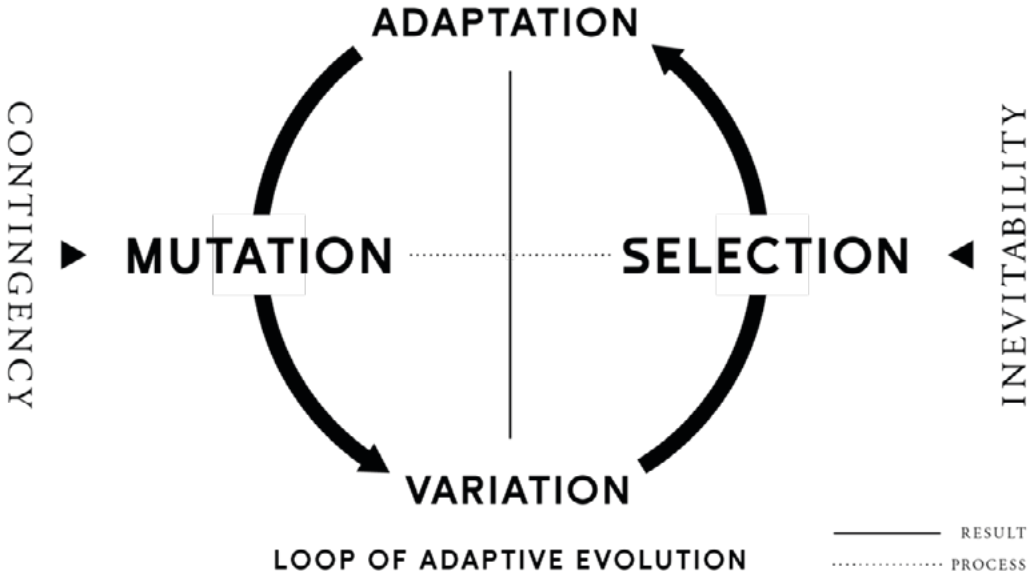


Image 3: Eisuke Tachikawa, NOSIGNER, 2021

Let's visually abstract the phenomenon of adaptive evolution, as described by the theory of natural selection. Imagine a graph where the x-axis represents the process of evolution, and the y-axis showcases its outcomes.

On the left end of the x-axis, we encounter mutations – spontaneous changes in DNA sequences. Much like how siblings differ in appearance and temperament, these variations emerge randomly, bringing forth diversity within populations. On the right end, there's the mechanism of selection. Also known as natural selection, it is a process where individuals suited to their environment have a better chance of surviving and reproducing. Over generations, these adaptive traits become prevalent. This mechanism leads to what we recognize as adaptation, where extant species are fitted to their specific ecosystems. In summary, random mutations generate diversity, and deterministic selection pressures craft adaptations. This process of adaptive evolution is awe-inspiring, especially considering the intricate biological designs it produces without any conscious design or intent – the brilliance of the natural selection theory.

Within *Evolutional Creativity*, it's proposed that the structure of biological evolution and human creativity fundamentally share the same mechanisms. *Evolutional Creativity* suggests that our creative endeavors might also oscillate between Mutative Thinking, where random errors birth novel ideas, and Selective Thinking, where we decipher the inevitable relationships to refine the direction of those ideas. Perhaps this ingrained evolutionary cognitive process is why humans can exhibit such creativity. Recalling Darwin's theory that evolution doesn't reflect individual intentions, we should consider that we oscillate between contingency and inevitability and can't intentionally create an ideal thing from scratch.

However, this doesn't render us powerless in our creative pursuits. While we might not control the final creative outcome, we can engage in the process. We are still creatively free to challenge the process of inducing accidental errors and observing the selection pressures that refine them. While we can slightly mutate what already exists or observe and adapt to selection pressures, it is challenging to create something from nothing.

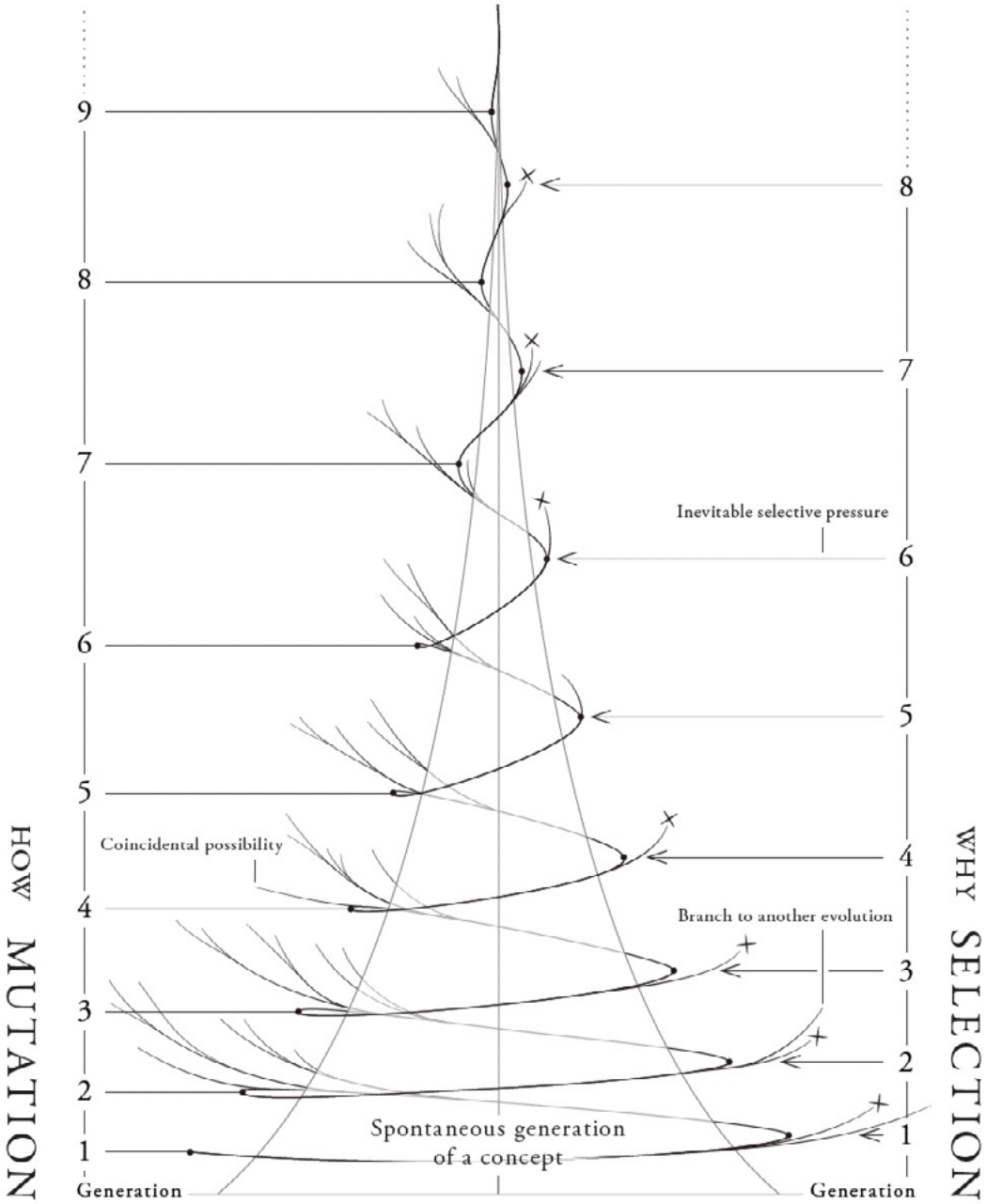
In other words, instead of creativity, the process of making something from scratch, we might be capable of *Evolutivity*, the process of thinking in a way that stimulates the evolution of things.

Because we tend to attribute creativity to individual will, it creates an inferiority complex in many. We may find the clue to letting go of will and achieving a selfless creative process in biological evolution.

When designing or brainstorming, *Mutative Thinking* helps increase the unintended contingency of ideas. At the same time, *Selective Thinking* revolves around observing the selection pressure of a situation and making choices according to the inevitability of the situation.

If we can practice this, then the premise of every idea would be based on something other than will. That is because both the contingency of *Mutative Thinking* and the inevitability of *Selective Thinking* transcend the will of the individual.

In *Evolutional Creativity*, this perspective reimagines our creativity not as a mere act of will but as a reciprocal phenomenon. Let's engage with this framework, grounded in the principles of natural selection, and let mutation and selection guide our creative endeavors.



SPIRAL OF EVOLUTION AND CREATION

Image 4: Eisuke Tachikawa, NOSIGNER, 2021

Patterns of Mutation

How can we reinforce *Mutative Thinking*, which emerges by generating diverse ideas through errors? Biological evolution offers a parallel. In evolution, mutations arise from errors in DNA replication, similar to misspellings and misunderstandings in languages. This suggests that the foundation of mutation resides in coincidental errors. As Eisuke Tachikawa practiced creative ideation throughout his journey as a designer, he noticed the existence of specific patterns. Osborn and other researchers have also highlighted these patterns (Osborn 1957). Notably, these patterns occur not only in art, design, and inventions but also in the natural world.

What is the source of these parallels? Eisuke hypothesized that the similarities between DNA and language might generate similar patterns. DNA, which passes on the traits of organisms to the subsequent generation, has a structure similar to that of language for humans. This indicates that DNA replication errors and the resulting mutations can be paralleled to mispronunciations and misunderstandings in language. Eisuke suggests that evolutionary mutation patterns might echo patterns of language errors; these share similarities with the patterns found in various ideas.

Leveraging linguistic aspects by deliberately inducing random errors, breaking preconceived notions, and spawning diverse ideas is pivotal in creativity. Recognizing and employing these patterns in our thinking can heighten the chances of unexpected ideation. *Evolutional Creativity* identifies nine distinct patterns that are common to evolution and creation. They provide suggestions to stimulate spontaneous ideas that challenge existing stereotypes.

These nine patterns are the following: variate, assimilate, disappear, proliferate, transit, substitute, separate, reverse and integrate.

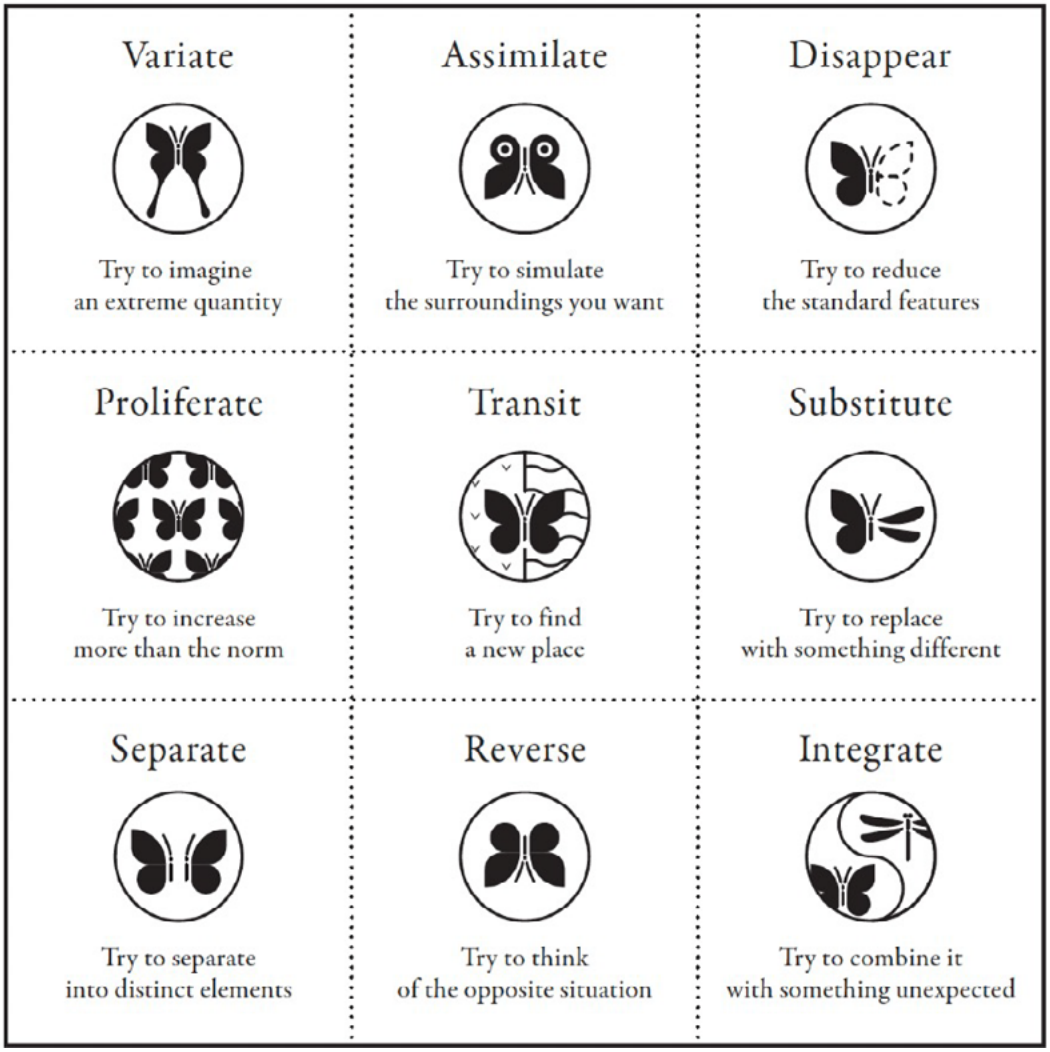


Image 5: Eisuke Tachikawa, NOSIGNER, 2023

Variate is a mutation that hyperbolically amplifies aspects of an object, helping us imagine radical states by shaking the constraints of simple parameters.

Assimilate is a mutation that operates based on imitation and metaphorical thinking. Imitation can capture and replicate specific features. Drawing from another's shape and adopting its properties can shatter our visual biases and unveil fresh perspectives.

Disappear is a mutation in which parts of something disappear. At times, eliminating what's considered vital can foster innovation. Removing elements deemed essential and reducing as much as possible the number of things that cannot function without these parts makes optimization possible.

Proliferate is a mutation in which the number of elements is increased because it is crucial to develop the habit of imagining what things might look like in large quantities. Does something interesting happen when we increase the number of internal parts or the number of people or organizational structures connected to the outside? What if we imagine them as part of a larger group? Interesting things might happen if we break down the stereotypes associated with numbers.

Transit is a mutation that involves moving an element from one place to another. Through transit, it is possible to accidentally create things that could not otherwise be if they stay where they are organically.

Substitute is a mutation in which one element is replaced by another. There are several variations of this mutation, such as physical substitution, like a replaceable battery; semantic substitution, like replacing a candle with something that performs the same function (a gas lamp, an incandescent bulb, or even an LED light); and conceptual substitution, formulated for the sole purpose of exchange, such as money or tickets.

Separate is a mutation that separates an object into different elements. Some species use physical separation to survive, and similarly, properly separating something during the creative process can be valuable. Inventions related to separation include tools used as barriers, such as cans and bottles, but also business models that conceptually separate their members in various ways, such as differentiating paid members from free members.

Reverse is a mutation that creates antithetical situations. Physical reversals, such as elevators and escalators, derive from the idea of moving structures rather than people. There are also semantic reversals, such as black light or submarines, and relational reversals, which result from the inversion of positions and timelines.

Integrate is a mutation that merges different objects. Experimenting with random integration and striving for beauty can open the door to new possibilities. Integration is a powerful source of innovation and a form of evolution that reminds us to always strive to achieve the unprecedented.

These nine patterns are common to many inventions and organisms' biological evolution. They can serve as a methodology for generating a wide variety of ideas. Armed with these patterns, we can break stereotypes while quickly generating countless mutations and creating radical ideas by increasing contingency.

Selection through Space and Time Observations

Let's transition to another way of thinking: Selective Thinking. How can we better understand things and make inevitable choices? Which are the most adaptable to the situation among the multiple ideas produced by variation?

The design of objects, much like the adaptive evolution of living organisms, approaches adaptation through repeated necessary choices. The selective process of evolution emerges during the necessity of certain situations. In other words, Selective Thinking is akin to the ability to analyze and understand the pressure of choices imposed by circumstances to select adaptive ideas. As biology has been systematizing for a very long time, we can learn to observe these selection pressures by watching the adaptation of animals.

How can we comprehensively and accurately observe the inevitable selection pressures? There are numerous types of natural scientific observations, but the author believes there aren't that many major methodologies. Furthermore, he thinks that these fundamental types of observations can be largely categorized into four based on space and time. That's because we can only observe space and time.

Spatially, we have internal and external observations; temporarily, we have past and future observations. Over centuries, these four types have been systematized and divided into disciplines, influencing observation in all areas of natural science.

From a spatial perspective, Anatomical Observation allows us to observe the internal structure, while Ecological Observation enables us to imagine the relationships to the external world. From a temporal perspective, Historical Observation helps us understand the influences and context of the past, while Predictive Observation helps us comprehend data and issues about our future and draw hope for it.

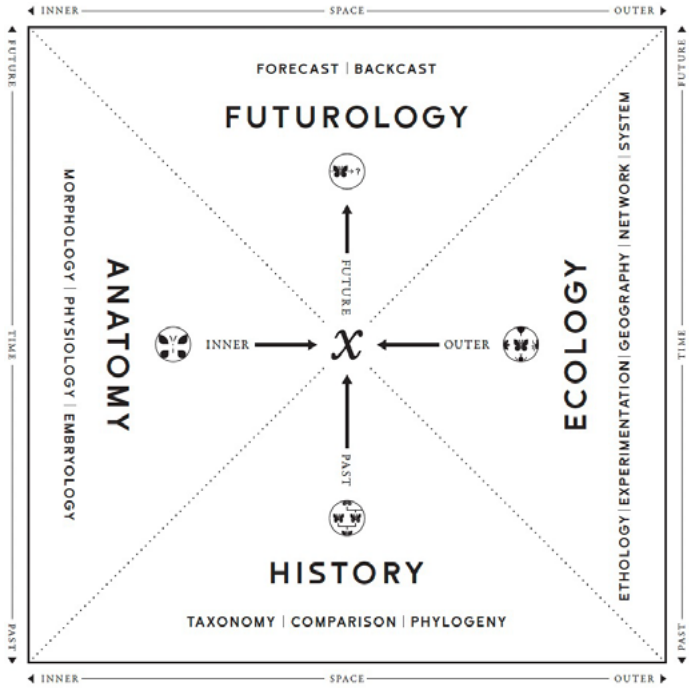


Image 6: Eisuke Tachikawa, NOSIGNER, 2023

Anatomical Observation can be approached from mainly three types of observation methods extracted from biology. These observation methods are to look at the form (morphology); to look at the function and meaning of the elements (physiology); and observing the process by which the elements are formed (embryology). Historical accounts suggest that anatomical observations date back to Imhotep, who built the first pyramid, and even Leonardo da Vinci, who was an anatomist. Understanding the shape, meaning, and construction method of elements and selecting the adapted situation connects to the essence of design. Hence, it's inferred that design and architecture have been deeply intertwined with anatomical observations.

Anatomical Observation
Morphology: observing the details of elements
Physiology: observing the meaning of elements
Embryology: observing the process of formation

Historical Observation is based on natural history. Modern natural history developed biologically from the study of classification (taxonomy) by Carl Linnaeus. On the other hand, the study of comparative anatomy (comparison), started by Buffon's work, compares minor differences between organisms and helped the development of taxonomy. After Darwin proposed his theory of natural selection, phylogenetics developed to understand temporal relationships and organize them into an evolutionary tree (phylogeny). In most fields, experts are well-versed in the history of their discipline; by observing the past, we can understand the historical context of a subject and look back at the reasons for its adaptation.

Historical Observation
Taxonomy: observing to determine and divide into types
Comparison: observing to compare every detail
Phylogeny: understanding the flow of evolution

Ecological Observation involves methods for observing complex ecological relationships. We can learn these methods through the study of ecology, which seeks to understand the relationships between humans and nature, and the mathematics of complex systems, which helps us understand the laws behind these relationships. The first method is to observe users and stakeholders, as in the study of animal behavior; it can also be found in behavioral economics (Ethology). Another common method is experimenting with small, replicated ecosystem models, as in experimental science (Experimentation). Observing from a broader perspective is a method found in geography and various fields such as geopolitics (Geography). Finally, observing to extract and analyze the connections of a complex whole is akin to network science (Network), while observing interactions and dynamic system connections within the overall network is akin to the science of system dynamics (System). We live in relationships with various people and things without being aware of them; forgetting these relationships puts our civilization in a predicament. Creativity in the future will be nothing more than seeking adaptation by considering a wide range of relationships, including ecological ones. Ecological and complex systems perspectives are helpful for such considerations.

Ecological Observation
Ethology: observing to seek the meaning behind actions
Experimentation: observing to reconfirm situations
Geography: observing to understand broader environmental contexts
Network: observing to understand complex connections
System: observing to decipher dynamic systems

Predictive Observation can be categorized in two ways. Forecasting attempts to predict the future by looking at the flow from the past to the present, while backcasting helps set goals in the future and bring them closer to reality. Forecasting is an observation that can be derived from statistical data (Forecast). At the same time, backcasting is a scenario planning method in which one can imagine a tangible future based either on wishes and hopes or, conversely, on negative scenarios of tomorrow (Backcast). Developing the ability to dream unabashedly is essential to bring the future closer to our ideals.

Predictive Observation
Forecast: observing to predict from data
Backcast: observing to work backward from a goal

Each of these observation methods has already been systematized in the natural sciences, which has a long history of its own. Therefore, learning about adaptive observations from these scientific methods not only refines creativity but also nurtures the ability to recognize relationships between objects.

By learning these four analytical methods based on space & time observations, we can deepen our understanding of things.

Results: The Impact Created by Evolutional Creativity So Far

The concept of *Evolutional Creativity*, on which this paper is based, has been published as a book in Japan. The first edition was released in April 2021 and promptly topped the business category on Amazon Japan, which could be considered as the most extensive online bookstore in Japan.

Additionally, the *Evolutional Creativity* book has been distinguished with the 30th Yamamoto Shichihei Prize, an academic honour representing Japan's humanities, marking the first time this award has been bestowed upon work in the field of design and creativity. Its content has been incorporated into entrance examination questions at various educational institutions, including Doshisha University (Kyogakusha Editing Division 2023) and public high schools in Nagano Prefecture (Kyogakusha Editing Division 2023), among others. The NHK broadcasting corporation has produced television programmes around Evolutional Creativity, such as 'SWITCH INTERVIEW' and 'Night of the Makaizo Society'.

A revised edition of *Evolutional Creativity*, scientifically supervised by Professor Masakado Kawata from Tohoku University, who also serves as the vice president of the Japan Society of Evolutionary Studies, will be published in 2023. This thesis is based on the forthcoming revised edition. Following the book's publication in Taiwan in 2023, *Evolutional Creativity* was featured in an exhibition at the Taiwan Design Museum. The book was also published in South Korea in 2023, with further international releases anticipated.

Over sixty companies, including Panasonic, MUJI, Kansai Electric Power, NSK, and PPIH, have adopted *Evolutional Creativity* as an innovative method, conducting workshops to foster sustainable innovation. Most notably, Panasonic has been conducting residential workshops for selected members based on *Evolutional Creativity* for more than five years and has even produced video materials to implement the method within the company. This impact is evident from the title of their 2020 Future Forum, 'NEW EVOLUTION (SHIN SHINKA)', where Eisuke Tachikawa delivered a keynote speech. MUJI conducted several months-long workshops for all designers and product planners, approximately 50 individuals, generating numerous product ideas under the endorsement of Chairman Masao Kanai. In addition, club-like communities have emerged within companies such as DNP and DOCOMO, where enthusiasts of *Evolutional Creativity* create educational videos, as seen in DOCOMO-related services, DOCOMO GACCO. Asahi Kasei commemorated its centennial by organizing a dialogue between Eisuke Tachikawa and Dr. Akira Yoshino, Nobel laureate and the inventor of the fundamental technology for lithium-ion batteries, delivering a lecture deciphering the evolution that led to lithium-ion batteries to employees worldwide. Masaya Kinou, director of Fujitsu Learning Media, Japan's largest training company, and Shusei Watari, former vice president of CELM, a company known for its leading market share in executive training, have acclaimed *Evolutional Creativity* as "The world's most powerful innovation method."

Evolutional Creativity has been taught at many institutions throughout Japan, from elementary schools to universities. Eisuke Tachikawa has lectured at over twenty educational institutions, including Keio University and Anan KOSEN (National Institute of Technology), and abroad at the Bandung Institute of Technology in Indonesia. Comparative studies conducted at the Anan KOSEN by Dr. Yutaka Tada and his colleagues have shown that *Evolutional Creativity* is more effective than other existing Design Thinking programmes, with their findings published in scholarly articles (Tada et al. 2022). Furthermore, Benesse, Japan's biggest educational company, appointed Eisuke Tachikawa as chairperson for their committee formed to consider the future of higher education and published GROWING AMBITION, a compilation of recommendations for higher education based on *Evolutional Creativity*.

Eisuke also had the honour of speaking at the UNESCO MGIEP forum 'Generation AI' in India, a milestone conference based on Sustainable Flourishing Goals, heralding applications for creative education in the future. Lastly, *Evolutional Creativity* was selected to be presented at the World Design Assembly Tokyo 2023, held in Japan for the first time in 34 years.

While *Evolutional Creativity* has seen significant adoption within Japan, as highlighted above, its international recognition is still just beginning, with its publications currently being limited to a few countries. Consequently, its full potential is yet to be realized on a global scale. We hope this thesis will lead to further expansion and innovation in creative education.

Conclusion: Updating the Concept of Creativity for the Future

Evolutional Creativity is a concept similar to the structure of biological evolution, which is repeated genetically, where accidental errors lead to *Mutative Thinking*, and the observation of inevitability leads to *Selective Thinking*.

Evolutional Creativity captures this entire process as a creative thinking method. When expressing creativity, whether we're aware of it or not, all of us might be engaged in this Mutative Thinking and Selective Thinking.

Just as species have evolved, this constant iteration allows us to naturally express our creativity and may also explain the reasons behind our creativity. Designs that survive for long periods result from the constant back and forth between mutation and adaptation, progressing into adaptability to various relationships.

Evolutional Creativity can be seen as a means to achieve a form of creativity that goes beyond our intentions. Our current world is reaching its limits in many ways, and the planet, including the climate, will change dramatically. We must adapt to these coming changes.

Updating the way we learn about creativity helped increase the number of individuals who solve problems with innovative solutions; the future landscape will undoubtedly change. The power to recreate a sustainable civilization that coexists with the ecosystem, surpassing a human-centric worldview, is demanded of all of us from every angle; by learning about *Evolutional Creativity* we can strive to change the present.

Hopefully, *Evolutional Creativity* will be useful for a more creative you and for realizing a sustainable future.

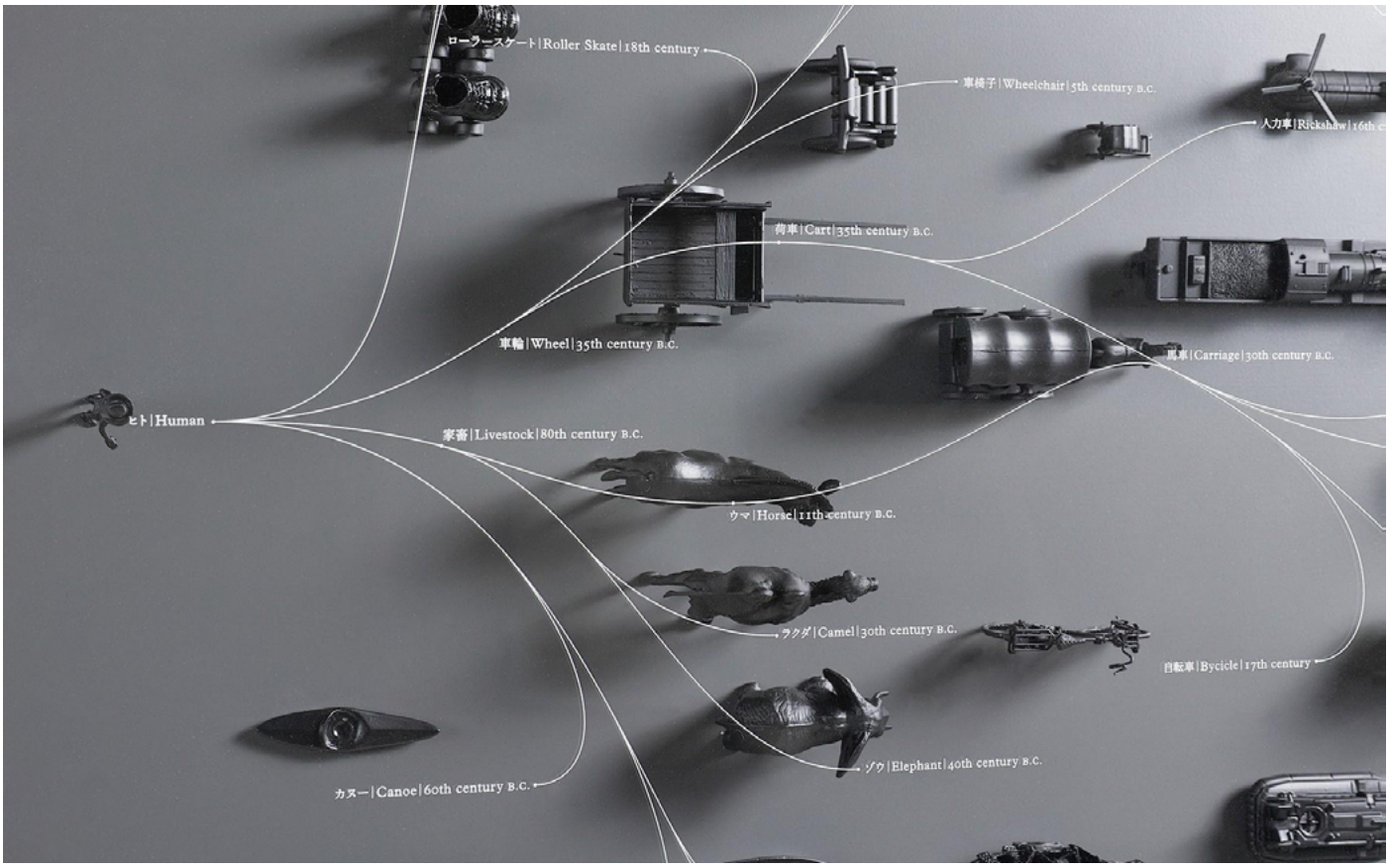


Image 7: Exhibition "NOSIGNER Reason behind forms" by Eisuke Tachikawa, 2016 (Photo: Kunihiko Sato)

References

Tachikawa, Eisuke. 2021. 進化思考 *Evolution Thinking - Creating a Surviving Concept : Mutation & Adaptation*. Ama: Amanokaze.

Tachikawa, Eisuke. 2023. 進化思考第 二版 *Evolutional Creativity - Evolutionary Principles for Creative Learning*. 2nd ed. Ama: Amanokaze.

Henrich, Joseph. 2015. The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter. Princeton: *Princeton University Press*.

Darwin, Charles. R. 1859. *On the Origin of Species.* London: John Murray.
(Note: This is the foundational work on the theory of evolution from 1859)

Dawkins, Richard. 1986. *The Blind Watchmaker.* New York: W. W. Norton & Company, Inc.

Benyus, Janine M. 1997. *Biomimicry: Innovation Inspired by Nature.* New York: William Morrow & Co.

Vincent, Julian F. V., Olga A. Bogatyreva, Nikolaj R. Bogatyrev, Adrian Bowyer, and Anja-Karina Pahl, 2006. Biomimetics: its practice and theory. *Journal of the Royal Society Interface*, 3 (9), 471-482. United Kingdom, Bath: University of Bath.

Buss, David M. 2005. *The Handbook of Evolutionary Psychology.* Hoboken: John Wiley & Sons, Inc..

O'Reilly, Charles A., Michael L. Tushman, 2016. *Lead and Disrupt : How to Solve the Innovator's Dilemma.* Stanford: Stanford Business Books.

Simonton, Dean K. 2013. Creative thought as blind variation and selective retention: Why creativity is inversely related to sightedness. *Journal of Theoretical and Philosophical Psychology*, 33 (4), 253–266.

Design Council. 2003. Design Council website (The Double Diamond page), <https://www.designcouncil.org. uk/our-resources/the-double-diamond/> (Accessed 31 October 2023)

Christensen, Clayton M., Michael E. Raynor, and Rory McDonald, 2015. What is Disruptive Innovation?. *Harvard Business Review*, 93 (12), 44-53.

Altshuller, Genrikh S. 1984. *Creativity as an exact science.* Luxembourg: Gordon & Breach.

Osborn, Alex F. 1957. *Applied imagination : principles and procedures of creative problem-solving*. Revised ed. New York: Charles Scribner's Sons.

Tinbergen, Nikolaas. 1963. On the aims and methods of Ethology. *Zeitschrift fur Tierpsychologie*, 20, 410-463.

Tachikawa, Eisuke. 進化思考 [Evolution Thinking], 2021. AMAZON website（進化思考――生き残るコンセプトをつくる「変異と適応」[Evolution Thinking - Creating a Surviving Concept : Mutation & Adaptation]), <https://www.amazon.co.jp/%E9%80%B2%E5%8C%96%E6%80%9D%E8%80%83%E2%80%95%E2%80%95%E7%94%9F%E3%81%8D%E6%AE%8B%E3%82%8B%E3%82%B3%E3%83%B3%E3%82%BB%E3%83%97%E3%83%88%E3%82%92%E3%81%A4%E3%81%8F%E3%82%8B%E3%80%8C%E5%A4%89%E7%95%B0%E3%81%A8%E9%81%A9%E5%BF%9C%E3%80%8D-%E5%A4%AA%E5%88%80%E5%B7%9D%E8%8B%B1%E8%BC%94/dp/4909934006> (Accessed 31 October 2023)

PHP研究所 [PHP Laboratory]. 山本七平賞 [Yamamoto Shichihei Prize], 2021. PHP website（第 30 回山本七平賞「進化思考」の著者・太刀川英輔氏、受賞の言葉 [Eisuke Tachikawa, author of Evolutional Creativity, on receiving the 30th Shichihei Yamamoto Prize.]), <https://www.php.co.jp/news/2021/11/yamamotoshichihei30th.php> (Accessed 31 October 2023).

教学社編集部 [Kyogakusha Editing Division]. 2023. 同志社大学（社会学部ー学部個別日程）（2024 年版大学入試シリーズ） [Doshisha University (All undergraduate schedule) (2024 University Entrance Examination Series)]. Kyoto: 同志社 [Kyogakusha]

長野県教育委員会 [Nagano Prefectural Board of Education]. 2023. Nagano Prefecture website（令和 5 年度後期選抜学力検査問題正答・正答例及び評価基準 [Academic Achievement Test Questions for the Second Semester of the 2023 Nagano Public High School Entrance Examination]), <https://www.pref.nagano.lg.jp/kyoiku/kyogaku/saiyo-nyuushi/shiken/ko/r5gakuryokukensa.html> (Accessed 31 October 2023)

スイッチインタビュー [Switch Interview]. 2022. NHK website（養老孟司×太刀川英輔 EP1 [Takeshi Yōrō x Eisuke Tachikawa EP1]),<https://www.nhk.jp/p/switch-int/ts/K7Y4X59JG7/episode/te/WWVL2R4Z15/> (Accessed 31 October 2023)

魔改造の夜 [Night of the Makaizo Society]. 2022. NHK website（第 7 回「お掃除ロボット走り幅跳び」から学ぶ、「アイデア」の出し方 [Part 7- Learning how to come up with "Ideas" from the "Robot Vacuum Long Jump"]), <https://www.nhk.jp/p/ts/6LQ2ZM4Z3Q/blog/bl/pK9D e0kO4E/bp/pM9pQVq9xw/> (Accessed 31 October 2023)

海士の風 [Amanokaze]. 2023. Amanokaze website（書籍「進化思考」の改訂について [About the revision of the book "Evolutional Creativity"]), <https://amanokaze.jp/shinkashikou-kaitei/> (Accessed 31 October 2023)

雙囍出版 [Grand Four Happiness Publishing]. 2023. 讀書共和國網路書店[Book Republic website] (進化思考：引導創造力的「變異與選擇」 [Evolutional Creativity - Creating concepts that survive: "Mutation & Selection"]), <https://www.bookrep.com.tw/?md=gwindex&cl=book& at=bookcontent&id=17562> (Accessed 31 October 2023)

給未來百年的設計 [DESIGNS FOR THE NEXT 100 YEARS]. 2023. NOSIGNER website, <https://nosigner.com/next100years> (Accessed 31 October 2023)

흐름출판 [Next Wave Media]. 2023. Next Wave Media website (진화사고 살아남는 콘셉트를 만드는 생각 시스템 [Evolutional Creativity - Creating concepts that survive: “Mutation & Selection”]), <http://www.nwmedia.co.kr/%EC%A7%84%ED%99%94%EC%82%AC%EA%B3%A0/> (Accessed 31 October 2023)

シンシンカ [New Evolution]. 2020. EventRegist website （【パナソニック未来戦略室】未来 FORUM2020 Online [Panasonic Future Strategy Office - Future FORUM2020 Online]), <https://eventregist.com/e/iraiforum2020?fbclid=IwAR0C1HOiWtO77OOl7t6kgBZofNZw 1ZmkMlBXxaGnZsF3s_Avy6p_5lYFCvQ> (Accessed 31 October 2023)

「進化思考」講座 [Evolutional Creativity Course]. 2023. DOCOMO GACCO website （人間の”創造性”を発揮する「x 進化思考」[x-Evolution Thinking - To unleash human “creativity”]), <https://gacco.org/shinka_shiko/> (Accessed 31 October 2023)

旭化成 Talk [Asahi Kasei Talk]. 2023. Youtube website (AK Talk vol.2「創造」と「想像」のあいだ ―旭化成 [AK Talk vol.2 Between “Creation” and “Imagination” - Asahi Kasei]), <https://www.youtube.com/watch?v=WiuRVcPzx6E> (Accessed 31 October 2023)

Tada, Yutaka, Takashi Matsumoto, Ryuusaburou Sugino, Eisuke Tachikawa. September 2022. Educational Practices for Teenage Students to Improve Quality of Architectural Works - An Approach Using Evolution Thinking in Anan KOSEN (National Institute of Technology). 15th International Symposium on Advances in Technology Education.

GROWING AMBITION FOR HIGHER EDUCATION. 2023. Benesse website, <https://berd.benesse.jp/special/growingambition/> (Accessed 31 October 2023)

UNESCO MGIEP GENERATION AI. 2023. UNESCO MGIEP website (Design Thinking and Creativity: Enablers for Flourishing in the Mixed Reality), <https://mgiep.unesco.org/article/games-and-design-thinking-enabler-for-flourishing-in-the-mixed-reality> (Accessed 31 October 2023)

Mapping Everyday Solutions to Foster Social Cohesion and Community Resilience

Authors:
Raditya Ardianto Taepoer[1, 3]
Kenta Ono[2]
Prananda Luffiansyah Malasan[3, 4]
Meirina Triharini[4]
Arianti Ayu Puspita[4]

Institutions:
[1]Graduate School of Science and Engineering, Chiba University (Japan)
[2]Chiba University (Japan)
[3]Research Center for Cultural and Environmental Products, Institut Teknologi Bandung (Indonesia)
[4]Faculty of Art and Design, Institut Teknologi Bandung (Indonesia)

Abstract

Confronted with multifaceted global challenges ranging from climate change and pandemics to geopolitical tensions and social issues, a design-centric approach emerges as a contextual and effective response. Social innovation, fueled by social purpose and utilizing local assets, gains prominence in addressing unmet needs. This paper explores the transformative potential of a design approach to social complexity, emphasizing its role in identifying context-specific solutions and participatory processes. The authors present the Solution Mapping Tools as instruments for uncovering everyday solutions within communities. Two case studies in distinct environments and actors demonstrate the adaptability of the approach and unveil the resourcefulness of grassroots communities. The results show that mapping everyday solutions not only identifies unmet development challenges but also fosters social cohesion and community resilience. This comprehensive approach, grounded in understanding community dynamics, offers valuable insights for informed decision-making and policy design in addressing global challenges.

Keywords: Everyday solutions, solution mapping tools, bottom-up social innovation, social cohesion, community resilience

Introduction

The world is entangled in complex challenges, from climate change and pandemics to geopolitical tensions, economic disparities, and social issues. Climate change threatens our very existence with rising temperatures and ecological disruptions. The COVID-19 pandemic exposed healthcare vulnerabilities and the need for collaboration on a global scale. Geopolitical tensions and regional conflicts persist, economic disparities widen, and social issues such as discrimination and inequality demand attention. These complex challenges encompass interrelated factors that mutually influence each other, leading to uncertain outcomes, ever-changing dynamics, and engaging various stakeholders with differing viewpoints (Norman and Stappers 2015).

Social innovation is a contextualized and effective response to unmet needs and challenges motivated by social purpose, utilizing social assets and capabilities (Baglioni and Sinclair 2014). The acknowledgement of the design approach continues to flourish (Cross 2023), especially in addressing social issues (Manzini 2014; Friedman 2016). Design can also unravel social complexity (Tromp and Vial 2023). In this context, design becomes a means of problem-solving, understanding, and addressing our society's multifaceted issues. By adopting a design approach to social complexity, we acquire the tools to identify root causes, leverage creativity to propose innovative solutions and navigate the evolving dynamics of our ever-changing world.

At least two arguments make the design approach suitable for addressing social issues. Firstly, design transforms abstract concepts into tangible entities that can serve as a medium for discussion. There is a need to make the invisible aspects of the system more tangible and intentional to address hidden social structures. Making norms, rules, roles, and beliefs more visible will make reflecting on and analyzing them easier (Vink et al. 2021). Secondly, design encourages iterative prototyping that can adapt to complexity (Karpen et al. 2021) and dynamic change (Smith and Iversen 2018). Built design artefacts or mediums that serve as a common language for discussion, capable of being both input and output in an evolving design process (Teal et al. 2022).

Design is a non-linear and iterative process that can adapt to complexities and dynamic changes. Design for social innovation moves away from generalized design approaches to develop solutions according to social, political, and cultural contexts (von Busch and Palmås 2016). Multiple endeavours have aimed to depict the evolving nature of design for social innovation practice, offering a plural definition of design for social innovation (Amatullo et al. 2021). The involvement of stakeholders from various backgrounds who reside in the specific context is necessary to ensure the embrace of diverse perspectives in a participatory-based approach. Participatory design involves a constellation of design initiatives focused on constructing socio-material assemblies that foster social innovation and open, participatory processes (Manzini and Rizzo 2011). In participatory design processes, designers and non-designers frequently lack a comprehensive understanding of the community's potential—a shared learning medium is needed to address this issue by exploring how communities utilise available assets such as materials, skills, production techniques, tacit knowledge, and local culture to meet their daily needs.

Solution Mapping Tools

Figure 1: Solution Mapping Tools consist of guides and notes, cards, and canvas.

Understanding everyday solutions involves delving into the manifestations of needs deeply rooted in experiential knowledge, necessitating an in-depth exploration of the daily contexts, interactions, routines, and sociocultural influences that shape them. By mapping these everyday solutions, we gain valuable insights into how communities exhibit remarkable resourcefulness and creativity while navigating various constraints and challenges. Moreover, this mapping process fosters relationships and empathy with the communities. It provides a unique opportunity to profoundly understand their day-to-day lives, personal experiences, and the distinctive contexts that influence them. Through immersion in these contexts, we gain a comprehensive perspective on how social reality is constructed from an insider's viewpoint, shedding light on the motivations and factors behind people's behaviours and actions. This approach plays a pivotal role in elucidating the intricate relationship between available resources and existing needs, and it strongly aligns with the fundamental principles of bottom-up social innovation, often called grassroots innovation (Gupta 2012).

Our approach engages community participation as learners and leverages local knowledge to map out everyday solutions. This is accomplished by facilitating Solutions Mapping Workshops conducted in various locations, where we collaborate closely with communities to organize solution safaris in the field. Throughout these safaris, we take a hands-on approach to actively observe and document the everyday solutions initiated by the communities using our Solutions Mapping Tools. These tools foster relationships and empathy with individuals and communities in the given location, allowing for a profound understanding of their daily lives, experiential knowledge, and contextual factors (Taepoer et al. 2023). The Solution Mapping Tools are the result of collaborative efforts between the Design Ethnography Lab at Institut Teknologi Bandung and UNDP Accelerator Lab Indonesia and consist of various components, including guides and notes to accompany learners during their immersion in everyday life, a canvas that serves as a medium for reflecting on everyday solutions within systems, and cards designed to trigger conversations about the thought processes and attributes involved in mapping these everyday solutions (Figure 1).

In our two distinct case studies, we ventured into diverse and unique environments to uncover and document the everyday solutions that communities had devised (Figure 2). The first case study unfolded in Riangkotek Village, East Flores Regency, a region recognized as one of Indonesia's underdeveloped rural areas. In partnership with the SimpaSio Institute, a community dedicated to sociocultural studies and archiving, and the Lewolema Subdistrict government, we embarked on a collaborative journey to map the resourceful solutions crafted and employed by the village's residents. In contrast, our second case study unfolded in the urban setting of BCCF/ICCN Simpul Space in Bandung City. Here, we engaged with the Teman Tuli, a non-profit deaf community focused on deaf culture and sign language education. Our objective was to map the everyday solutions ingeniously devised by street vendors who operate in the vibrant ambience of Bandung's city square. In this endeavour, we were aided by sign language interpreters who served as co-facilitators, ensuring effective communication and understanding within the community. Both case studies endeavour to explore diverse contexts and engage with communities to uncover and discuss the everyday solutions that communities create to cope with everyday challenges.

Figure 2: Solution Mapping Workshops in East Flores Regency and Bandung City

Mapping Everyday Solutions

Mapping Everyday Solutions is divided into three phases: pre-workshop, solution safari, and solution mapping workshop (Figure 3). Firstly, the research team conducted a pre-workshop meeting introducing the Solution Mapping Tool differently for each case study a week before the workshop. The introduction was conducted online in the first study, using platforms like Zoom and Miro to provide learners with a synchronised and interactive experience. This session allowed them to engage with the tools directly, try them out in real time, and seek clarification by posing questions. In contrast, the team opted for a different approach for the second case study. We provided a video-on-demand featuring the introduction to the Solutions Mapping Tools, complete with captions and sign language assistance. This approach aimed to enhance accessibility and convenience, enabling learners to access the tool introduction at their own pace and convenience before embarking on the workshop. This customized approach demonstrates adaptability and a commitment to ensuring learners can easily engage with the Solution Mapping Tools in a way that best suits their needs and circumstances.

Then, we held a Solution Mapping Workshop that started with reflections using cards, then canvassing based on notes and group work and ended with presentations and discussions. The Solution Mapping Cards session was conducted by linking the keywords from the card to the Safari Solution experience. In the first case study, the cards were randomly distributed to the learners, while in the second case study, the learners were allowed to choose the card with the most attractive illustration. The learners were allowed to guess the keywords according to the visual illustrations and describe their experiences while completing the Solution Safari. This stage intends to recall the events and details in the field and become a medium of dialogue between the learners. Afterwards, a Solution Mapping Canvas session was conducted where each group discussed each learner's notes, wrote them on sticky notes, and arranged them on the canvas according to the group's consensus.

Finally, the Solution Mapping Workshop concluded with a presentation and discussion session, leaving learners from diverse case studies surprised by the capacity of grassroots communities to develop tailored solutions to their needs from their inherent assets and capabilities. The Solution Mapping Tools allowed them to observe everyday things, unveiled the hidden potential within everyday surroundings, and encouraged learners to recognize the previously unnoticed strengths of their communities. The Solution Mapping Tools triggered dialogues among learners in the workshop session and between learners, creators, and users in their context. Ultimately, the workshop was a transformative experience, facilitating participants to immerse themselves in their communities with a more profound viewpoint and fostering a collective sense of proactive problem-solving at the grassroots level.

Figure 3: The Journey of Mapping Everyday Solutions

Figure 4: Everyday Solutions in East Flores Regency (left) and Bandung City (right)

Reflection

Both fieldworks generated many insights into using the Solution Mapping Tool to facilitate community members in mapping and identifying everyday solutions in their context. This approach raised the awareness of the designer and non-designer participants and emphasized the importance of positioning design in a way that priorities community interests and contextualized development. By mapping everyday solutions, learners engage in discussions covering tangible and intangible aspects, explaining the intricacies of materials, production techniques, functions, benefits, current challenges and future possibilities associated with these solutions. This process significantly deepened our understanding of how solutions and needs are paired, with everyday solutions as an essential starting point to identify unmet development challenges. Engaging communities in identifying their needs and assets has shown to be a robust way to cultivate a positive mindset and instil confidence in the potential of natural, human and cultural resources to drive the future development of their environment, resources, and challenges. Mapping everyday solutions marks a shift from ‘empowering’ to ‘activating’ a community’s power and agency, where individuals and groups become active agents in decision-making and take a proactive role in their development, fostering a sense of autonomy and self-reliance.

Further analysis of the findings led to the recognition of the pivotal roles of social cohesion and community resilience in community dynamics. Social cohesion focuses on the internal dynamics of a community, emphasizing the importance of nurturing relationships and unity within the community. This cohesion creates a strong sense of community identity and belonging, encouraging cooperation and collective action. In contrast, community resilience centres on the community’s ability to navigate and recover from external challenges, disruptions, and crises. It entails building the capacity to adapt and withstand unforeseen shocks, be they economic, environmental, or social. Resilient communities can effectively deal with disasters and emerge stronger, learning from their experiences. Prioritizing social cohesion and community resilience ensures long-term sustainability and overall well-being. These principles enhance adaptability to evolving member needs and challenges when integrated into development strategies. This holistic approach prioritizes community fabric and preparedness for the future. The data collected during these mapping exercises offer a nuanced understanding of the specific needs and challenges faced by the community, enabling informed, tailored solutions. The insights gleaned from mapping everyday solutions serve as a valuable.

References

Amatullo, Mariana, Bryan Boyer, Jennifer May, and Andrew Shea. 2021. *Design for Social Innovation*. New York: Routledge. https://doi.org/10.4324/9781003021360.

Baglioni, Simone, and Stephen Sinclair. 2014. 'Introduction: Social Innovation and Social Policy'. *Social Policy and Society*. https://doi.org/10.1017/S1474746414000177.

Busch, Otto von, and Karl Palmås. 2016. 'Social Means Do Not Justify Corruptible Ends: A Realist Perspective of Social Innovation and Design'. *She Ji* 2 (4). https://doi.org/10.1016/j.sheji.2017.07.002.

Cross, Nigel. 2023. 'Design Thinking: What Just Happened?' *Design Studies* 86 (May): 101187. https://doi.org/10.1016/J.DESTUD.2023.101187.

Friedman, Ken. 2016. 'New Challenges for Design'. *She Ji: The Journal of Design, Economics, and Innovation* 2 (4): 271–74. https://doi.org/10.1016/J.SHEJI.2017.07.001.

Gupta, Anil K. 2012. 'Innovations for the Poor by the Poor'. *International Journal of Technological Learning, Innovation and Development* 5 (1–2): 28–39. https://doi.org/10.1504/IJTLID.2012.044875.

Karpen, Ingo O., Stefan Holmlid, and Eun Yu. 2021. 'Service Design in the Context of Complexity: Moving between Plurality and Tension towards a Future Research Agenda'. *International Journal of Design*.

Manzini, Ezio. 2014. 'Making Things Happen: Social Innovation and Design'. *Design Issues* 30 (1): 57–66. https://doi.org/10.1162/DESI_a_00248.

Manzini, Ezio, and Francesca Rizzo. 2011. 'Small Projects/Large Changes: Participatory Design as an Open Participated Process'. *CoDesign* 7 (3–4): 199–215. https://doi.org/10.1080/15710882.2011.630472.

Norman, Donald A., and Pieter Jan Stappers. 2015. 'DesignX: Complex Sociotechnical Systems'. *She Ji: The Journal of Design, Economics, and Innovation* 1 (2): 83–106. https://doi.org/10.1016/J.SHEJI.2016.01.002.

Smith, Rachel Charlotte, and Ole Sejer Iversen. 2018. 'Participatory Design for Sustainable Social Change'. *Design Studies* 59. https://doi.org/10.1016/j.destud.2018.05.005.

Taepoer, Raditya Ardianto, Kenta Ono, Prananda Luffiansyah Malasan, Meirina Triharini, Arianti Ayu Puspita, Intan Prameswari, and Yulia Sugandi. 2023. 'Solution Mapping Tools: Identifying a Bottom-Up Approach to Social Innovation'. *Jurnal Sosioteknologi* 22 (2). https://doi.org/10.5614/sostek.itbj.2023.22.2.8.

Teal, Gemma, Marianne McAra, Julie Riddell, Paul Flowers, Nicky Coia, and Lisa McDaid. 2022. 'Integrating and Producing Evidence through Participatory Design'. *CoDesign*. https://doi.org/10.1080/15710882.2022.2096906.

Tromp, Nynke, and Stéphane Vial. 2023. 'Five Components of Social Design: A Unified Framework to Support Research and Practice'. *The Design Journal* 26 (2): 210–28. https://doi.org/10.1080/14606925.2022.2088098.

Vink, Josina, Katarina Wetter-Edman, and Kaisa Koskela-Huotari. 2021. 'Designerly Approaches for Catalyzing Change in Social Systems: A Social Structures Approach'. *She Ji* 7 (2). https://doi.org/10.1016/j.sheji.2020.12.004.

Theme 2

Design for Human-centred Technology

Smart Display Development with Services and Supporting Tools to Tackle Elderly Care Problems

Authors:
Ara Cho[1]
Inho Lee[1]
Youngjin Chung[1]
Hoyeong Song[2]
Seonhee Jung[3]
Kenny Ryu[4]
Yuwon Jeong[1]
Jihyun Lee[2]

Institutions:
[1]Korea Institute of Design Promotion, Gyeonggi-do (South Korea)

[2]Neofect, Gyeonggi-do (South Korea)

[3]Scube Design Lab, Busan (South Korea)

[4]Blessing Eco Design, Busan (South Korea)

Abstract

This study aims to enhance the quality of life and independence of the growing elderly population through the development of personalized care appliances and services. Facing an aging society by 2025 (Statistics Korea 2022), Korea grapples with social and economic issues like healthcare costs and insufficient caregiving services. Through literature reviews and interviews, we identified the needs, desires, and pain points of stakeholders such as the elderly, caregivers, and families. Specifically, dependent elders often experience a diminished daily life, while caregivers face issues like varying patient needs and burnout. Our research employs user-centric design methods, including persona and scenario development and co-creation workshops. Ultimately, we propose a smart display table that supports elderly self-care, content services, and integrated products. These offerings promote physical and cognitive activities, monitoring, daily management, information sharing with caregivers or family, and social interaction. The study redefines the problem from a user perspective and enhances caregiving quality through design intervention and advanced digital technology.

Keywords: Elderly care, self-care, intelligent display, Human-centred Design, integrated care services

1. Introduction

1.1. Purpose

As of 2022, South Korea's total population is 51.69 million, marking a declining trend since 2020 when it peaked at 51.83 million. The elderly population aged 65 and above makes up 17.7% (9.15 million), showing a 5.1% increase from the previous year. Predictions suggest that by 2025, the elderly will constitute 20.3% of the population. Rapid demographic changes and extended life expectancy have led to single-person (34.9%) and couple households (34.7%) (Statistics Korea 2022) becoming common among the elderly (Kim 2021).

The onset of a super-aged society and the rise of single elderly households are increasing healthcare costs and the demand for caregiving services. While policy and technology are advancing to address these issues, existing elderly care technology and services are hard to apply universally due to individual differences in the elderly's needs and high dependency on caregivers.

This study aims to identify the current state of elderly care services and explore new opportunities by analyzing both the demand and supply sides. Unlike previous studies that focus on caregivers, this research aims to develop services centered around the elderly to support their independent living. We intend to introduce a user-centered design thinking process and methods, grounded in comprehensive analysis, to propose smart display table products and services based on deep learning image recognition and AI voice recognition technology.

1.2. Methodology and Scope

This study was designed using the Double Diamond Process developed by the Design Council (UK).

First, in the Discover phase, we conducted a literature review focused on trends in senior health care technology. To explore the elderly care industry and identify core user types and stakeholder needs, we performed in-depth interviews and user observations with seniors, domain experts, caregivers, and designers. Second, in the Define phase, we designed personas for each user type and derived user experience scenarios. Using the Mandtara method, we identified life values for each user type. Next, in the Develop phase, we advanced ideas for products and services for elderly care through co-creation workshops. Finally, in the Deliver phase, usability tests were conducted in six actual care institutions. The final products were presented after expert evaluations.

The scope of this study is as follows: to analyze stakeholders and identify opportunities in elderly care, to develop an intelligent care display, and to develop linked products and content.

2. Literature Review and Experimental Research

2.1. Discover

Welfare technology for the elderly is defined as technology directly applied to social services that assist in daily life, including caregiving, safety, protection, daily activities and mobility, and health management (Ahn et al. 2017). These technologies aim to help in everyday life support, entertainment, social and emotional support, stimulation, and enhancing physical activity. Despite the growing societal issue of an aging population and caregiving for the elderly, the commercialization of these technologies faces limitations due to the difficulties of integrating digital devices into the daily lives of the elderly (Yoo et al. 2022). Although previous research has indicated that the use of technology has a positive impact on life satisfaction, there is a growing gap in information access and utilization, revealing that ease of use and accessibility are crucial (Hwang et al. 2020).

After researching and analyzing over 80 documents related to seniors, healthcare, caregiving appliances, and services, from both domestic and international government policy documents, public and private research materials, and future predictions, 10 focus trend keywords in smart caregiving were extracted, linked with megatrends, healthcare, and lifestyle issues.

Furthermore, by mapping analyses of domestic and international market case studies, strengths and weaknesses of existing products and services were identified. For example, it was found that the feature of existing smart tables lies in naturally inducing participation and emotional and cognitive healing through game elements. Directions for the development of caregiving welfare technology that can be actively utilized in daily life were established.

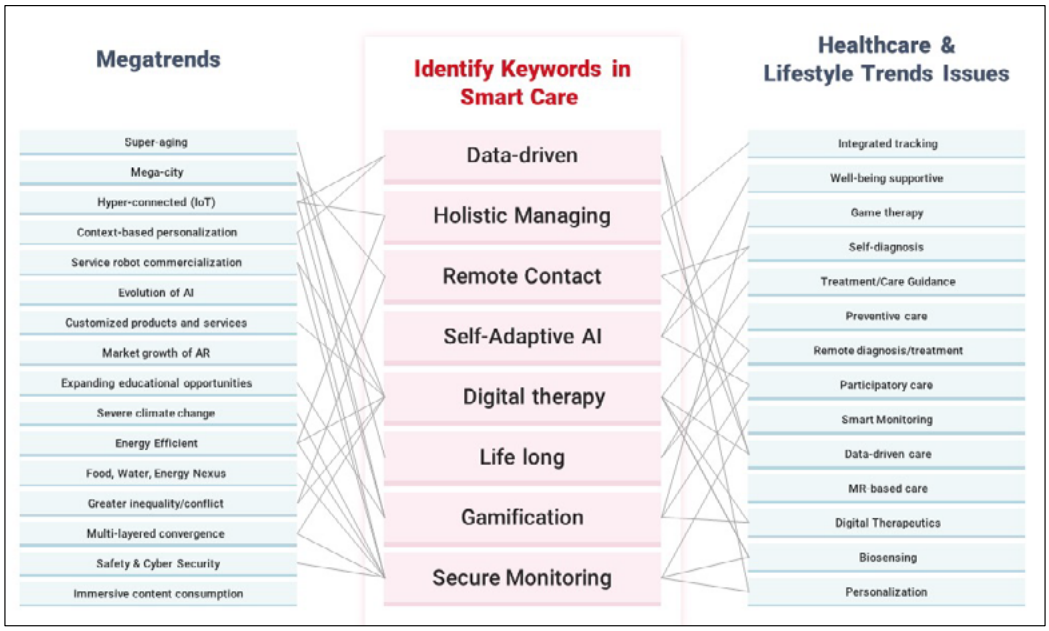


Figure 1: Trend keywords for smart care.

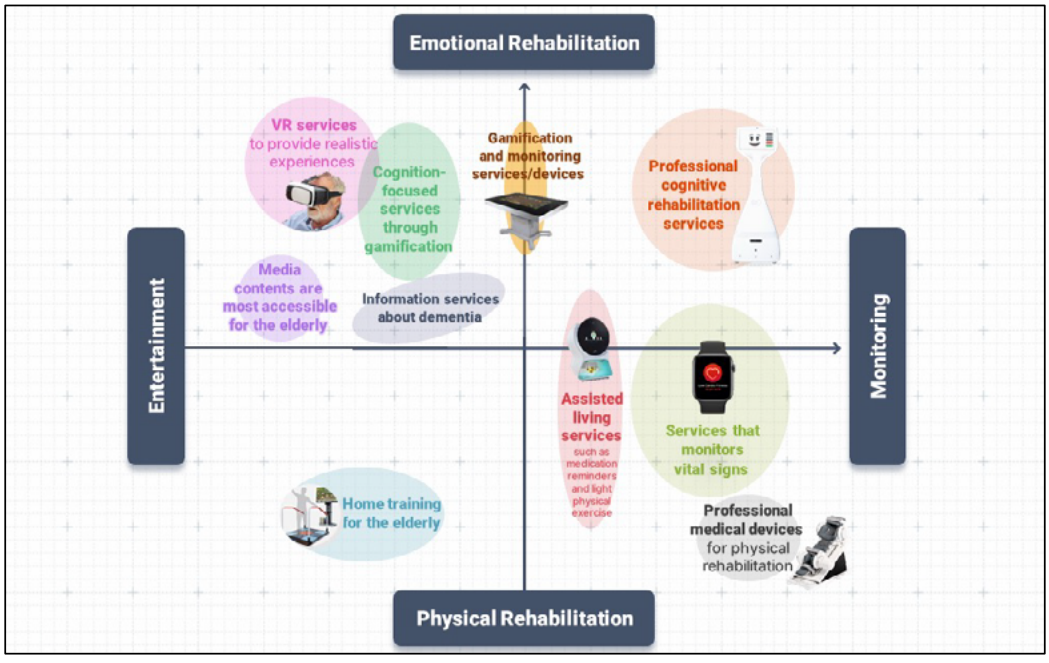


Figure 2: Mapping of smart home appliances and services.

To determine the direction for the table and display design, research was conducted on the physical and cognitive characteristics of the elderly, furniture and appliance design, and CMF trends. For instance, age-related macular degeneration, a representative visual disorder in the elderly, causes perception degradation due to difficulty recognizing blue hues (E. Kim and Kim 2020). From a cognitive perspective, it is important to present visual materials with concise content, as short-term and episodic memories weaken with age (S. Kim 2020). Based on this research, design considerations were extracted in terms of perception, content, and understanding. A 'Senior Experience Quality Assessment Indicator' was proposed, categorizing the final 58 factors and measurement methods to consider when designing products and services for seniors into physical, design, and social-emotional (M. Kim et al. 2022).

Category	Consideration Points
Perceptual	Font size and color - Age-related sight deterioration - Eye aging and macular degeneration
Perceptual	Present visual aid - Present consistent form
Content	Vocabulary level - Low vocabulary level (62.5% of the elderly in Korea have an education level below elementary school, Ministry of Health Welfare 2014)
Content	Conciseness - Short attention span
Comprehension	Show quantitative info - Number interpretation is difficult
Comprehension categories	Present specific practical actions to prevent and mitigate - Clarify specific behavioral information

Table 1: Senior design considerations (Scube Design Lab and Korea Institute of Design Promotion 2022).

In order to understand seniors better and uncover opportunities for caregiving services, we constructed a stakeholder map around the smart tables. In-depth interviews and observations were conducted for each target group. Stakeholder journey maps were visualized for nursing caregivers, in-home care family members, and cognitive rehabilitation experts to identify their caregiving pain points. We found not only experiential knowledge about seniors but also valuable insights into the stakeholder value domains.

The biggest pain point for professional caregivers was the lack of customization in care programmes for seniors of different abilities and temperaments, leading to reduced efficacy and engagement. For family caregivers, the challenges were chronic fatigue due to lack of sleep, boredom in daily routines with seniors, and a lack of solutions. Home-visit caregivers experienced dissatisfaction due to being treated similar to domestic helpers. Lastly, seniors themselves faced limitations in activities and hesitated to express their needs due to feelings of guilt.

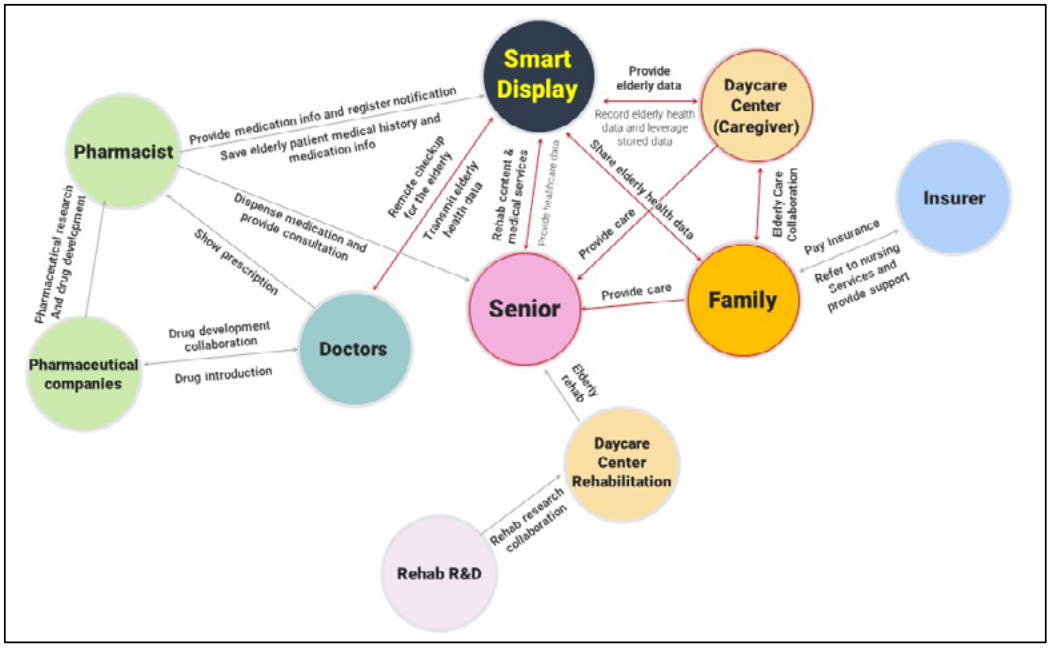


Figure 3: Stakeholder map around the smart table for elderly care.

2.2. Define

Based on the results from the Discover phase, interviews were conducted with 13 seniors aged between 60 and 94. The interview topics were designed around seniors' needs and desires, focusing on hygiene, exercise, health, meals, sleep, cleaning, entertainment, hobbies, and religious activities. Responses were categorized based on personality traits, behavior types, and physical and emotional states. These insights, combined with literature analysis, allowed us to identify nine senior types based on ADL (activities of daily living) and behavior patterns, ranging from 'disabled seniors' who have low functional abilities and passive behavior to 'pre-aging seniors' who are active and preparing for a second life after retirement.

Based on these senior types, the Mandala method, a design-thinking tool, was employed to deduce the life values of each senior group. Also, 18 personas were developed considering the user's character, environment, stage-specific needs, motivating factors, and preferred channels. Representative stories were created for each persona.

Through interviews with actual users and stakeholders, we selected key scenarios to verify and type.

Subsequently, we synthesized the findings of the Define phase to identify five strategic directions to help the elderly with self-care.

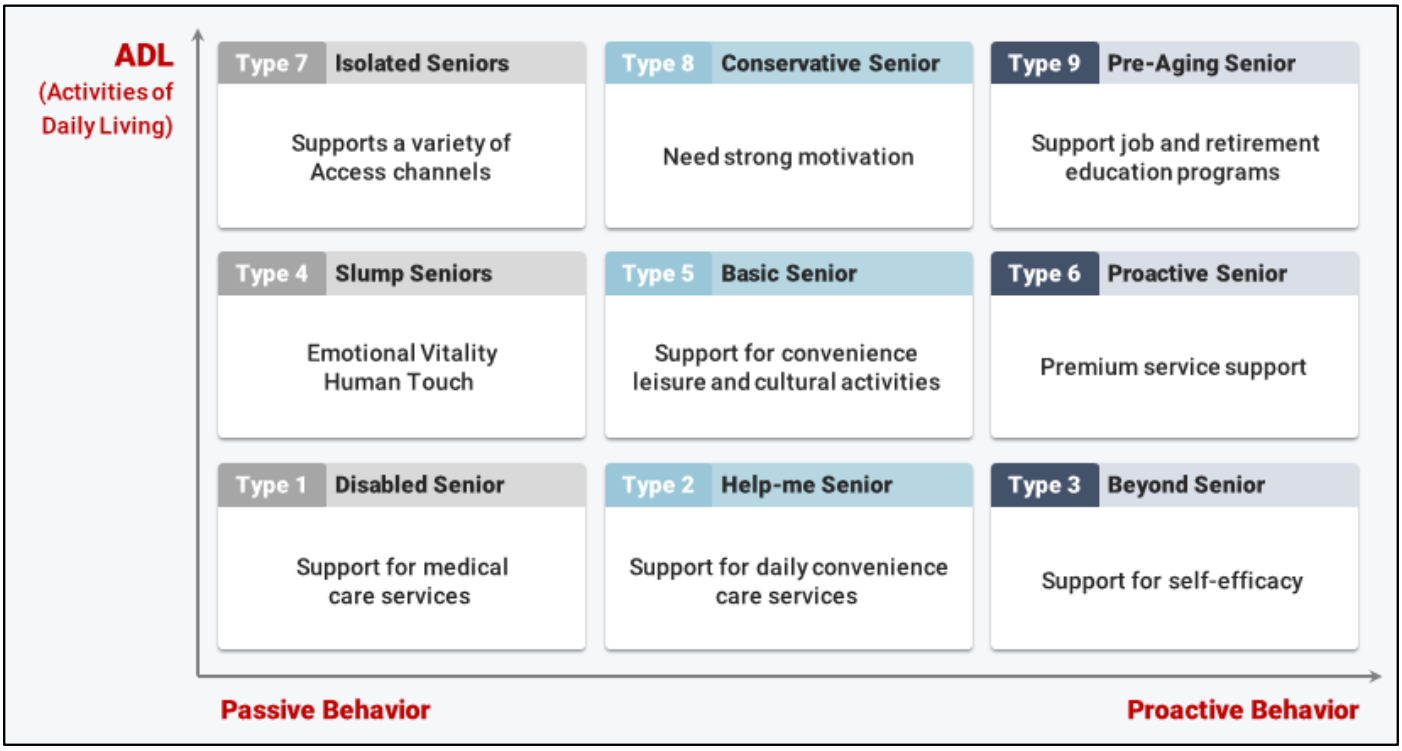


Figure 4: Types of seniors.

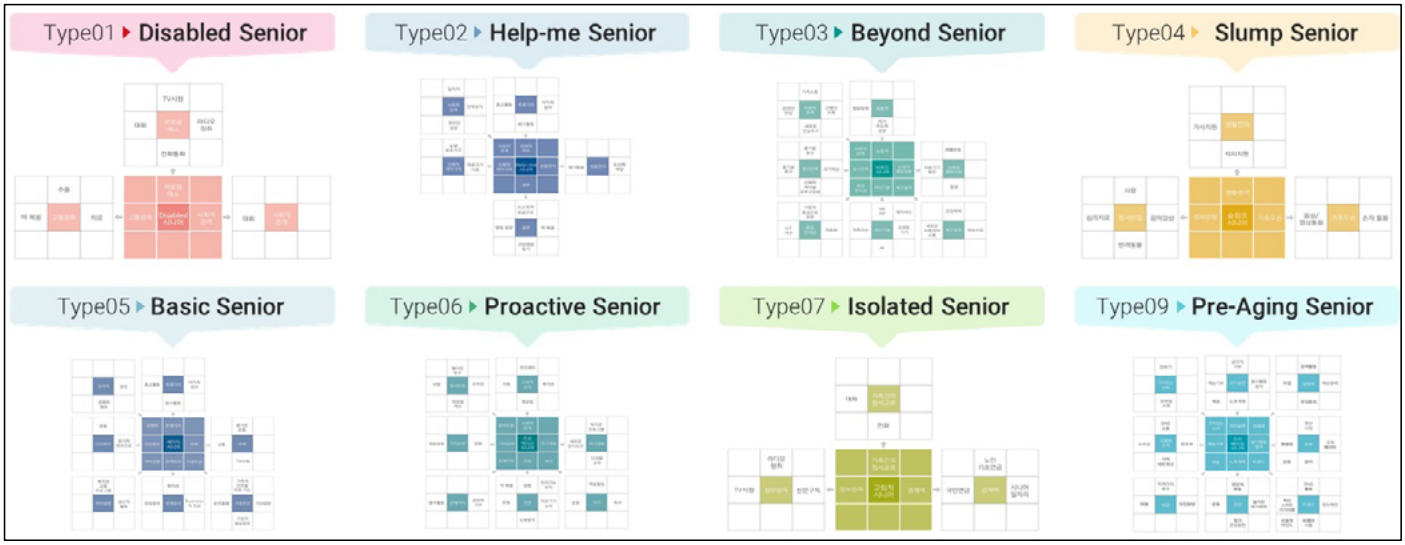


Figure 5: Deriving senior life values based on Mandal art analysis.

Figure 6: Example of senior persona.

Type	Persona	Keywords
1. Disabled	Need full assistance	Dependence on caregivers, Old-fashioned dramas, Visitation restrictions, Walking aids
2. Help-me	Financially struggling	Economic crisis, Basic pension for the elderly, Emergency, House chore support
	Chronically ill	Chronic disease, Continuous care and management, Sensitive to health info, Diet management
3. Beyond	Want to be active at home	Willingness to overcome constraints, Physical limitations, Knowledge acquisition, Smart technology friendly
	Want to get outside	Willingness to overcome limitations, Physical limitations, Aspirations, Prosthetic legs
4. Slump	Reliant on others	Trot (upbeat music), Lethargy, Dependence on others, Passive consumer
	Emotional	Pets, Depression, Emotional, Classical Music
5. Basic	Sense of self-efficacy	Housework, Extrovert, Leisure Activities, Socializing
	Focus on home	Family, Active, Religious, Devoted
	Pursue financial independence	Active, Extroverted, Health, Social
	Pursue leisure activities	Housework, Extrovert, Leisure Activities, Socializing
6. Proactive	Want to live without feeling lonely	Diligent, Active, Economic freedom, Wise with age
	Want to live with good health	Lonely, Active, Financially Free, Wise with age
7. Isolated	Have lost the meaning of life	Isolated, Depressed, Conflicted, Unwilling
8. Conservative	Introverted	Pets, Depression, Emotional, Classical Music
	Healthy but passive	Lonely, Passive, Free, Healthy
9. Pre-Aging	Enjoy consumption	Challenging, Proactive, Economic freedom, Active consumer
	Want to stay relevant and popular	Challenging, Proactive, Economic freedom, Popularity

Table 2: Senior persona and representative keywords.

Category	Strategic Direction	Detail
1	Curing Play	Therapeutic protocol-based on gamification and physical activities
2	Healing Therapy	Emotional care content through emotional awareness
3	Life Data	Personalized management based on personal health data
4	Social Welfare	Collaborative services with stakeholders and outside institutions
5	Care Platform	Integrated care platform based on digital tech

Table 3: Strategic direction for senior self-care.

Figure 7: Co-creation design workshop.

2.3. Develop

To develop the care display table and content concept, two collaborative workshops were held, involving over 20 stakeholders from manufacturing companies, UX/UI experts, designers, welfare centers, and rehabilitation hospitals. Product and service scenarios were used to ideate design concepts, key features, and core technologies.

Eight themes that can be applied to different senior types were presented, and a total of 18 solutions were proposed. These solutions detailed the key features of the product and service, necessary technology specifications, and products that need to be integrated.

Theme	Theme Details	Solution
❶ Therapeutic Play	Personalized prehab and rehab services to encourage active physical activity	①Strengthening and correction exercises based on movement awareness
		② Brain-stimulating game
		③ Physical age through pictures
❷ Emotional Care	Restorative mindfulness for calm emotions in depressed and anxious elderly people	④ Music therapy
		⑤ Art therapy
		⑥ Holistic art therapy game
❸ Stronger Bonds	Chore support for seniors with physical limitations for a safe and pleasant environment	⑦ Personalized user experience
		⑧ Safety monitoring care services
❹ Deeper Daily	Boost activity and leisureliness of seniors in a future-oriented way	⑨ Home interiors using screen savers
		⑩ Personal virtual garden
❺ Daily Care	Efficient daily management support service to boost convenience of active seniors	⑪ Smart calendar service
		⑫ Daily care notification service
❻ A Second Life	Self-development growth partners for retirement readiness programmes	⑬ Smart lifelong learning system
❼ Good Company	Boost emotional exchange and social skills of seniors who are conservative and isolated	⑭ AI speaker
		⑮ Family communication support
		⑯ Community for the elderly
❽ Life Complete	Brighten perspective on life through retrospection	⑰ Time for retrospection
		⑱ Personal record-keeping service

Table 4: Identified themes and solutions.

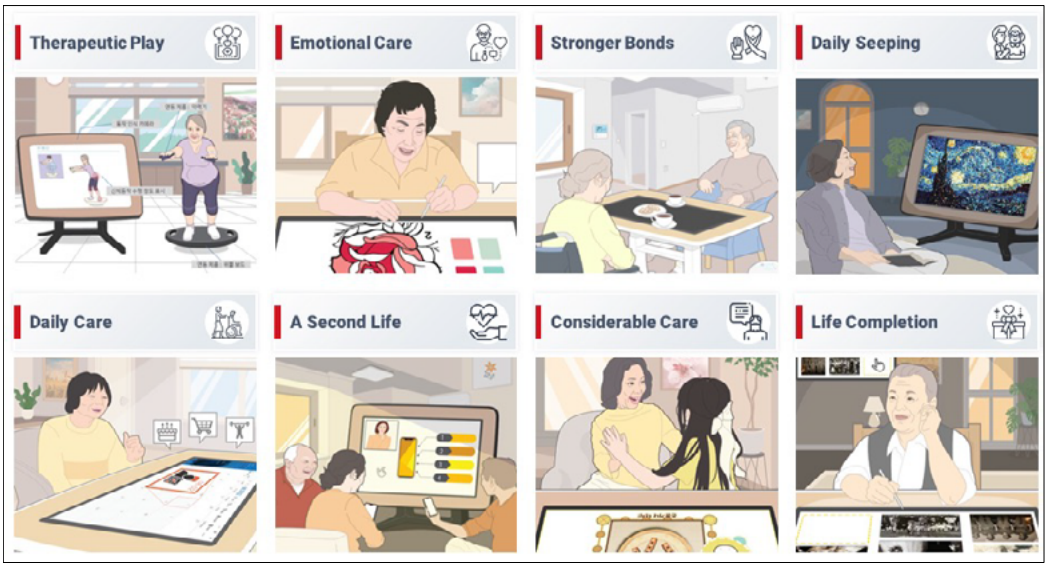


Figure 8: Examples of service concepts.

2.4. Deliver

In the Delivery phase, a comprehensive analysis of the collected data was conducted to make design suggestions for the elderly care smart table and key content. User testing and validation were carried out. The following offerings were intended to be presented through the table and content, based on deep learning and AI technology.

- Health: physical and mental aging alleviation, personalized prevention and treatment, emotional and mental care;
- Entertainment: IoT-based complex media display, interactive gaming, education, and personalization services;
- Monitoring: caregiver and communication, everyday care manager;
- Daily care: a physical space where everyday routines take place;
- Communication: connect with others.

Considering the physical and cognitive characteristics and capabilities of seniors, the products, display screens, and contents were designed. For the content, key features for each user were proposed to be included in a single content service.

Six care facilities were supplied with the first developed display products to validate the usability and applicability of the content. Both in-person and remote expert evaluations were conducted, using criteria such as aesthetics, usability, expertise, comprehensibility, and marketability for the senior care display appliances and content. To broaden the usability of the product and content, improvements were made to differentiate content based on multiple and single users, and areas for improvement for integrated products were identified to establish the direction for the final developed product.

Figure 9: User testing.

Figure 10: Expert evaluation.

3. Results

Through this study, we proposed a plan for the development of intelligent care smart tables, services, and compatible products.

3.1. Smart Display Table

The smart table, integrated with touch-based technology and a 42-inch touch monitor, was designed to be more user-friendly for seniors. It features adjustable height, tilting modes, and multi-touch functionalities. Seniors can tilt the table more than 90 degrees to draw digitally on the table's surface. Additionally, an upright position and a built-in motion detection camera are used to recognize seniors' movements, enabling features ranging from gaming to data collection. The multi-touch feature can recognize up to 10 simultaneous touch inputs, allowing seniors to enjoy and interact with the content collectively.

Figure 11: Smart display table.

3.2. Supporting Tools

Products compatible with the table were developed to make it easier for seniors to use the table and content. Smart wobbles and grips have been developed and applied to content that promotes physical activity, enabling seniors to measure and manage their lower body and overall balance, as well as grip strength. Furthermore, these integrated products collect health data, providing care providers and medical professionals with health-related information about seniors.

Figure 12: Supporting tools.

3.3. Service Contents

The flagship content developed through this study is a virtual fish tank featuring *Care Fish*. By displaying the fish tank on the table, the design aims to make the smart display feel more familiar to seniors. The virtual fish can represent the user and those around them. In essence, *Care Fish* serves as a mediator connecting seniors with technology and design. These virtual fish are designed to represent different personalities and have been certified, securing a trademark for *Care Fish*.

Figure 13: Service contents Care Fish (1).

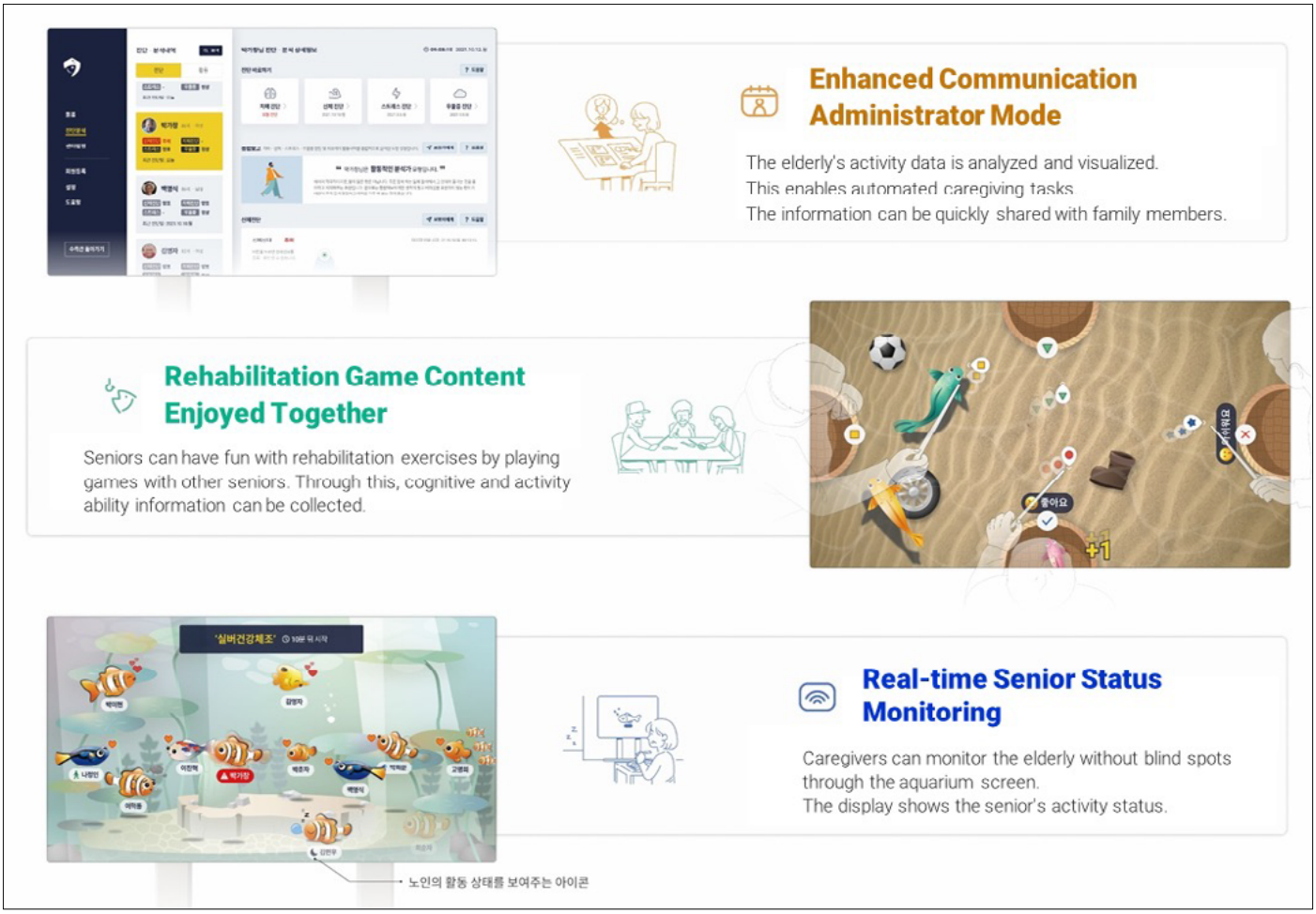


Figure 14: Service contents 'Care Fish' (2).

4. Conclusion and Discussion

This study is the outcome of research aimed at developing products and services based on smart technology for the self-care of seniors. By applying various design research methods targeted at seniors and stakeholders, we've employed Human-centred Design to address social issues arising from aging, using technologies like AI and deep-learning-based motion recognition. This design study aims to provide solutions that address the needs, desires, and pain points of both care providers and receivers. We've also considered the specific elements of products and services that could encourage active participation from seniors, presenting a display table product and associated services.

The results of this study are designed for practical implementation in hospitals and long-term care facilities. Through multiple user tests conducted in senior facilities, we observed meaningful interactions between seniors and technology. Moving forward, the study intends to deeply integrate the table, its content and compatible products into the daily lives of seniors. To accomplish this, the study suggests the need for further research to enhance and expand integrated products and to design them in a way that seniors can use them proactively and independently. (Capability Enhancement Project 20015676).

Acknowledgement: *We would like to express our sincere appreciation to the researchers affiliated with Korea Institute of Design Promotion, Neofect, Scube Design Lab, and Blessing Eco Design for their invaluable contributions to this research. Korea Institute of Design Promotion assumed a supervisory role, overseeing comprehensive research on product and service development. Neofect took charge of core technological development. Scube Design Lab made significant contributions to the development of digital heath contents, and Blessing Eco Design played a pivotal role in the development of product.*

Funding: *This study was conducted with the support of the Korea Evaluation Institute of Industrial Technology, funded by the Ministry of Trade, Industry and Energy (Project Identification Number: Korea Evaluation Institute of Industrial Technology Design Innovation Capability Enhancement Project 20015676).*

References

Ahn, Sanghoon, Soowan Kim, and Jongyeon Park. 2017. "A Preliminary Study on the Welfare Technology Ecosystem Model Centered on Social Enterprises." *Social Value and Business Research* 10 (2): 167–96. https://doi.org/10.32675/ses.2017.10.2.006.

Hwang, Namhui, Hyesoo Kim, Kyeongrae Kim, and Bohye Joo. 2020. "Older Adults and the Digital Divide: Current Conditions and Policy Implications." ISBN 9788968277672. Research@KIHASA. Korea Institute for Health and Social Affairs. https://repository.kihasa.re.kr/handle/201002/37360.

Kim, Eung-cheol, and Hoosung Kim. 2020. "A Color Application Study of Teaching Aids Design to Prevent Dementia -Based on the Change in Color Perception of the Elderly." *JOURNAL OF THE KOREAN SOCIETY DESIGN CULTURE* 26 (1): 99–111. https://doi.org/10.18208/ksdc.2020.26.1.99.

Kim, Kawon. 2021. "Self-Care: Paradigm Shift and Local Community Responsibilities in Self and Aged Care." *Bokji Times*, March 24, 2021. https://www.bokjitimes.com/news/articleView.html?idxno=30714.

Kim, Minju, Yuwon Jeong, and Jaein Lee. 2022. "Development of Experience Quality Evaluation Index Related to Display Products for Seniors." *Journal of the Ergonomics Society of Korea* 41 (6): 561–80. https://doi.org/10.5143/JESK.2022.41.6.561.

Kim, Soojin. 2020. "Mobile UX Design Tips for the Senior Generation." *Digital Times*. November 9, 2020. https://ditoday.com/ux-tips/.

Scube Design Lab and Korea Institute of Design Promotion. 2022. "2022 UI/UX Guidelines for Senior Content Development." Korea Institute of Design Promotion.

Statistics Korea. 2022. "Population Projections for Provinces (2020~2050)." https://kostat.go.kr/board.es?mid=a20108080000&bid=11748&act=view&list_no=419200.

Yoo, Byungseon, Jungkeun Kim, Jung, and Jooyeon Kim. 2022. "Current Status and Future Devekimlopment of the Application of Digital Devices in Elderly Welfare Fields." Gyeonggi Welfare Foundation. https://ggwf.gg.go.kr/archives/60266.

Integrating Intelligent Agents and Service Design for 3H Care: a Path to SDG 3 in Singapore

Authors:
Bo Gao[1]
Di Wang[1]
Robin Chan Chung Leung[1]
Zhiwei Zeng[1]
Benny Toh Hsiang Tan[1]
Yang Qiu[1]
Huiguo Zhang[1]
Xinjia Yu[1]
Jun Ji[1]
Bo Huang[1]
Eng Sing Lee[2]
Hui Hwang Teong[3]
Ray Tian Rui Lai[3]
Wai Han Hoi[4]
Chunyan Miao[1]

Institutions:
[1]Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY) Nanyang Technological University (Singapore)
[2]National Healthcare Group Polyclinics (Singapore)
[3]Tan Tock Seng Hospital (Singapore)
[4]Woodlands Health, National Healthcare Group (Singapore)

Abstract

This paper presents the development of the AI-assisted 3H Care (A3C) System, an integration of intelligent agents and service design methodologies aimed at enhancing primary care regarding hyperglycemia (diabetes), hyperlipidemia, and hypertension (collectively known as 3H), promoting healthy lifestyles, and contributing to the achievement of Sustainable Development Goal 3 (SDG 3) - ensuring healthy lives and promoting well-being for all in Singapore. While artificial intelligence (AI) has the potential to address both group and individual needs in healthcare, achieving Human-centred Technology requires a fusion of design and technology through interdisciplinary collaboration.

This paper discusses the methodological approach and design process employed in the development of A3C, incorporating intelligent agents and service design principles. Through prototyping and testing with 30 adults, the usability and effectiveness of the integration of Intelligent Agents and Service Design framework were asserted. Moreover, this study serves as an exemplar of interdisciplinary collaboration in the design of health-related AI-driven solutions, prompting a reflective analysis of the role and impact of design within this context.

Keywords: Chronic diseases, intelligent agents, service design, SDG 3

Background

Singapore, situated in the tropical region, is characterized by a fast-paced lifestyle and a diet high in calories among different populations (Mair et al. 2023). These factors contribute to hyperglycemia, hypertension, and hyperlipidemia, collectively known as the three chronic conditions (3H), which are among the primary reasons for visits to polyclinics in Singapore (MOH 2019). In 2021, approximately 6.9% of Singapore residents aged 18 to 74 had diabetes mellitus, 15.7% had hypertension (high blood pressure), and 13.9% had hyperlipidemia (high blood cholesterol), all of whom were currently prescribed medication (Ministry of Health, Singapore 2021). Furthermore, the rates of obesity and metabolic disorders, including pre-diabetes, have been increasing (Lee et al. 2023). A forecast study projected that by 2035, the prevalence of prediabetes and diabetes among Singapore residents aged 21+ years is expected to be one in four and one in five, respectively (Wong, Toh, and Tham 2017). Failure to manage these 3H chronic conditions can result in long-term diseases with significant costs and detrimental effects on the patients' quality of life (Pengpid and Peltzer 2018).

Prior studies have highlighted the importance of early detection and intervention for 3H conditions. However, effectively addressing these 3H issues pose three main challenges: early detection of 3H conditions may not be feasible (Grant and Meigs 2006), interventions for 3H conditions may not be individually optimized (Roach and Marrero 2005), and preventing 3H conditions outside clinical settings is challenging.

Existing intervention methods often rely on the limited information obtained from doctor-patient communication during consultations. The efficacy of these interventions is contingent upon patients' self-management after leaving the hospital. Nevertheless, public health, particularly in the context of preventive care, heavily depends on primary care that extends beyond hospitals, encompassing primary care facilities, family environments, and community health centres (Ofori and Unachukwu 2014). Hence, how to support primary care teams to stop or slow disease progression and complication development in 3H patients is an urgent challenge.

Singapore's commitment to the Sustainable Development Goals (SDGs) is evident through its adoption of a Whole-of-Government approach. SDG 3, a pivotal component of the SDGs, emphasizes ensuring healthy lives and promoting well-being for individuals of all ages. To further this agenda, the Ministry of Health (MOH) of Singapore has introduced the Healthier SG programme (Foo et al. 2023), which calls for collaboration to nurture an ecosystem from a diverse range of stakeholders, including general practitioners, community partners, healthcare clusters, employers, and residents. MOH takes an integrated approach by overseeing acute care, public health, and aged care within a unified framework, reinforcing the country's dedication to enhancing the overall health and well-being (Foo et al. 2023).

In Singapore, several mobile apps have been developed to facilitate healthy lifestyle changes. For example, the Health Promotion Board of Singapore has launched the 'Healthy 365' mobile application, which integrates with fitness tracking devices to enable users to log their daily step count and active exercise duration. Another mobile application, 'Health Buddy', developed by SingHealth, assists the public in managing clinic visits and accessing health information and support services. However, due to the absence of integrated solutions, users often need to use multiple apps concurrently to meet their functional requirements. Single app solutions which may limit its effectiveness in addressing more complex health issues, such as 3H chronic conditions (Evans 2017).

There remains a relative lack of holistic, integrated, all-in-one system that provides professional healthcare support for 3H conditions in Singapore. The system could encompass early detection capabilities and cater to a wider range of age groups.

In the following sections, we present the method and design process employed in the development of the Adaptive AI-assisted 3H Care (A3C) system. Subsequently, we show the A3C care system framework and the Holistic Service System (HSS), comprised of Human-AI Interaction (HAI) touchpoints, showcasing a number of implemented functionalities. Finally, we delve into our preliminary study findings and present user feedback, concluding this research paper.

Method and Design Process

While artificial intelligence (AI) has the potential to address both group and individual needs in healthcare, achieving Human-centred Technology requires a fusion of design and technology through seamless incorporation. In this paper, we examine the collaboration between Human-AI interaction and the Human-centered AI ecosystem through the application of the service design methodology in developing the A3C system.

1. Method

Incorporating Human and HAI

We adopted a multidisciplinary approach to develop the A3C system. Experts from diverse fields, including computer science, service design, sociology, and medicine, collaborated closely to ensure a comprehensive and holistic goal of providing effective 3H care. To gain a profound understanding of the experiences, motivations, and barriers faced by adults in managing their health, qualitative evaluation methods were employed. These methods encompassed focus group interviews, surveys, and observations. The focus group involved 11 participants, representing diverse ethnic backgrounds in Singapore and spanning ages from 20 to 75 (mean is 47.5). This diverse representation covered individuals from young, middle-aged, and elderly demographics, and closely resembling Singapore's population distribution of 76.2% Chinese, 15% Malay, 7.4% Indian, 1.4% from other ethnic backgrounds (Ang et al. 2017). The focus group sessions, comprising four offline semi-structured interviews and online surveys through Google Forms, facilitated close collaboration between the end-users and the research team. The semi-structured interviews aimed to investigate participants' attitudes towards lifestyle, health-related needs, and the challenges of adopting a healthier lifestyle. Each interview lasted approximately one hour. Then, we analyzed the observations and coded the narratives from

interview transcriptions and audio recordings. The analysis led to the following three key findings in barriers of end-users managing their health:

1) Challenges in assessing dietary nutrition;
2) Limited health knowledge; and
3) Low confidence in behaviour change. These findings informed the subsequent stages of our research and design processes.

In parallel to these findings, the HAI ecosystem was conceptualized to revolutionize healthcare delivery. This ecosystem comprises several key components designed to enhance the healthcare experience. These components include Persuasive AI, which influences user behaviour through persuasive techniques (Dragoni et al., 2020), Curious AI, recommending medical solutions based on individual healthcare specifics (Esmaeilzadeh, 2020), Explainable AI, enabling healthcare professionals to comprehend AI models' reasoning (Yang 2022), and Ethical AI, addressing ethical implications in healthcare (Yu et al. 2018).

Therefore, human and HAI constitute a comprehensive approach. AI allows the real-time analysis of behavioral data generated by focus groups when they use the prototypes and facilitating rapid iterations of the prototype.

Incorporating Intelligent Agents and Service Design

Intelligent agents are a key component of AI systems, enabling the synthesis and analysis of computational agents that act intelligently. The Intelligent agents are software that can interact with humans using Artificial intelligence techniques. Intelligent agents have played a vital role in providing high-quality care by gathering patient data (Wang et al. 2014) and improving user experiences (Sharma and Ahlawat 2022). The introduction of Intelligent agents requires a service design approach to ensure consistency and comprehensiveness throughout the service process. Human-centred service design approach is instrumental in harnessing technology's potential to advance healthcare systems toward people-centred care (Zeng et al. 2016). Various service design methodologies, such as "empathy design"(Gao and Shen 2019), "co-design"(Akama and Prendiville 2013) , "participatory design" (Oertzen et al. 2022), and "EBCD (experience-based co-design) (Piper et al. 2012) have been developed to incorporate user process experiences and demands into the scope of design considerations. These methodologies promote the development of more comprehensive health and medical services (Mannonen et al., 2017) and deliver the socialized and personalized healthcare models.

2. A3C Care System Framework

We developed the A3C care system framework (Figure 1), seamlessly integrating intelligent agents and service design while capitalizing on their respective strengths. The system comprises four layers, progressing from the bottom up, including the user needs layer, data layer, intelligent agent layer, and persuasive user layer.

The user needs layer serves as the foundation of the A3C care system and is achieved through the incorporation of both human and HAI input, thereby establishing the basis for specific AI applications in subsequent stages. The user needs layer is dedicated to comprehending user requirements, which have been identified from focus group participants and is used to design initial prototypes. The user needs layer needs encompass challenges related to evaluating dietary nutrition, limited health knowledge, and low confidence in adopting healthy behaviors.

We hypothesized that the Data Management Subsystem (DMS) in the data layer serves as the backend database API, incorporating the Health Knowledge Base and User Behavior & Health Data.

Then, we build the model to establish the AI Subsystem (AIS) in the intelligent agent layer as the third layer. This AIS includes Explainable AI and Curious AI, with components such as the Assessment Engine Subsystem and Intervention Engine Subsystem. The Assessment Engine encompasses Health Profiling and Behavior Prediction Algorithms, while the Intervention Engine consists of group-based and individual-based Intervention Algorithms.

Finally, the system utilizes the AI Subsystem (AIS) to gain insights into user behaviour, resulting in the construction of the top layer known as the Holistic Service System (HSS), established upon what we term "HAI touchpoints." The HSS comprises the Akeso mobile App, the hospital dashboard, and the Health Screening Kiosk (introduced in the following sub-section). Within this layer, Persuasive AI is harnessed to encourage users, while Ethical AI is employed to promote inclusivity for a broader user base, facilitating personalized changes in health behaviour.

In the ultimate stage of the process, the A3C system captures comprehensive daily behavioral data and detailed diet intake history through the HSS, storing this valuable information at the backend. These datasets are further enriched with clinical data to train health prediction models within the Data Management Subsystem (DMS) specifically designed for 3H assessments. This comprehensive approach ensures that user-generated data, clinical data, and AI insights work in tandem to provide holistic health assessments for users.

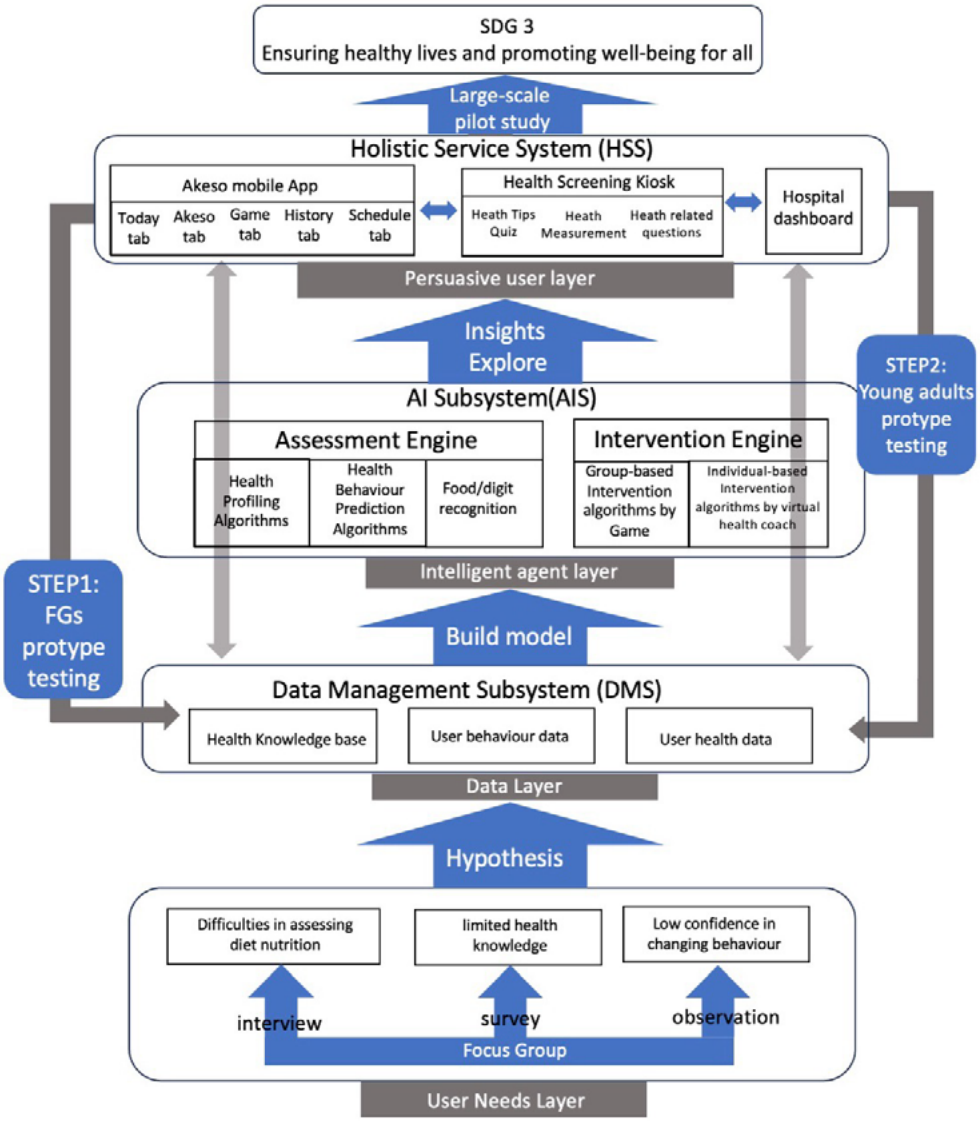


Figure 1: The framework of Adaptive AI-Assisted 3H Care (A3C) system.

3. The Holistic Service System

The Holistic Service System (HSS) (Figure 2) is composed of HAI touchpoints that align with the dynamic user journey in the non-clinical setting. The HSS includes the Akeso mobile app and the Health Screening Kiosk for end-users, while the hospital dashboard is intended for use by medical professionals.

We refer to the integration of different AI and service design touchpoints as 'HAI touchpoints'. Intelligent agents are seamlessly integrated into the dynamic user journey through AI-driven touchpoints, interacting with users to track changes in user behaviour and adapt the intervention accordingly, all while aligning with individual preferences. This integration encompasses providing personalized food analysis, issuing warnings, delivering encouragement messages, and transmitting data to the hospital dashboard for doctors' reference.

There are five tabs in the Akeso mobile app, including Today tab, Akeso tab, Game tab, History tab and Schedule tab. Today tab matched with the direction and specific design content of 'encouraging self-monitoring', is to collect daily data on diet, activities, and health-related measurements. Akeso tab matched with the direction and specific design content of 'providing personalized recommendations', is to put the positive affect to the users. Game tab is a farm-themed virtual game matched with the direction and specific design content of "using social influence". This tab translates users' daily performance on achieving recommended lifestyle goals (exercise time) into elements of a farm game. Users can also leave messages and send comments in the farm game, fostering a sense of community. This game is specifically designed to provide group-based adaptive, long-term interventions through gamification. History tab matched with the direction and specific design content of 'setting clear goals and providing feedback', is to visualize user's historical performance in terms of activity tracking, health- related measurements, achievements, etc. Schedule tab is to show user's daily tasks (with complete or incomplete status) and reminders.

The Health Screening Kiosk, available in multiple community centres, provides a user-friendly option for individuals to perform self-assessments, including measurements like blood pressure, blood glucose, and weight. This is especially beneficial for users who do not have measuring equipment at home. Participants are expected to interact with the kiosk through (i) answering health-related questions, (ii) completing five health quiz questions, and (iii) measuring health parameters (e.g. blood pressure). The kiosk also provides relevant health tips based on user's health status and interactions with the kiosk. Users are invited to interact with the kiosk minimally once a week, with an estimation of ten to twenty minutes per interaction.

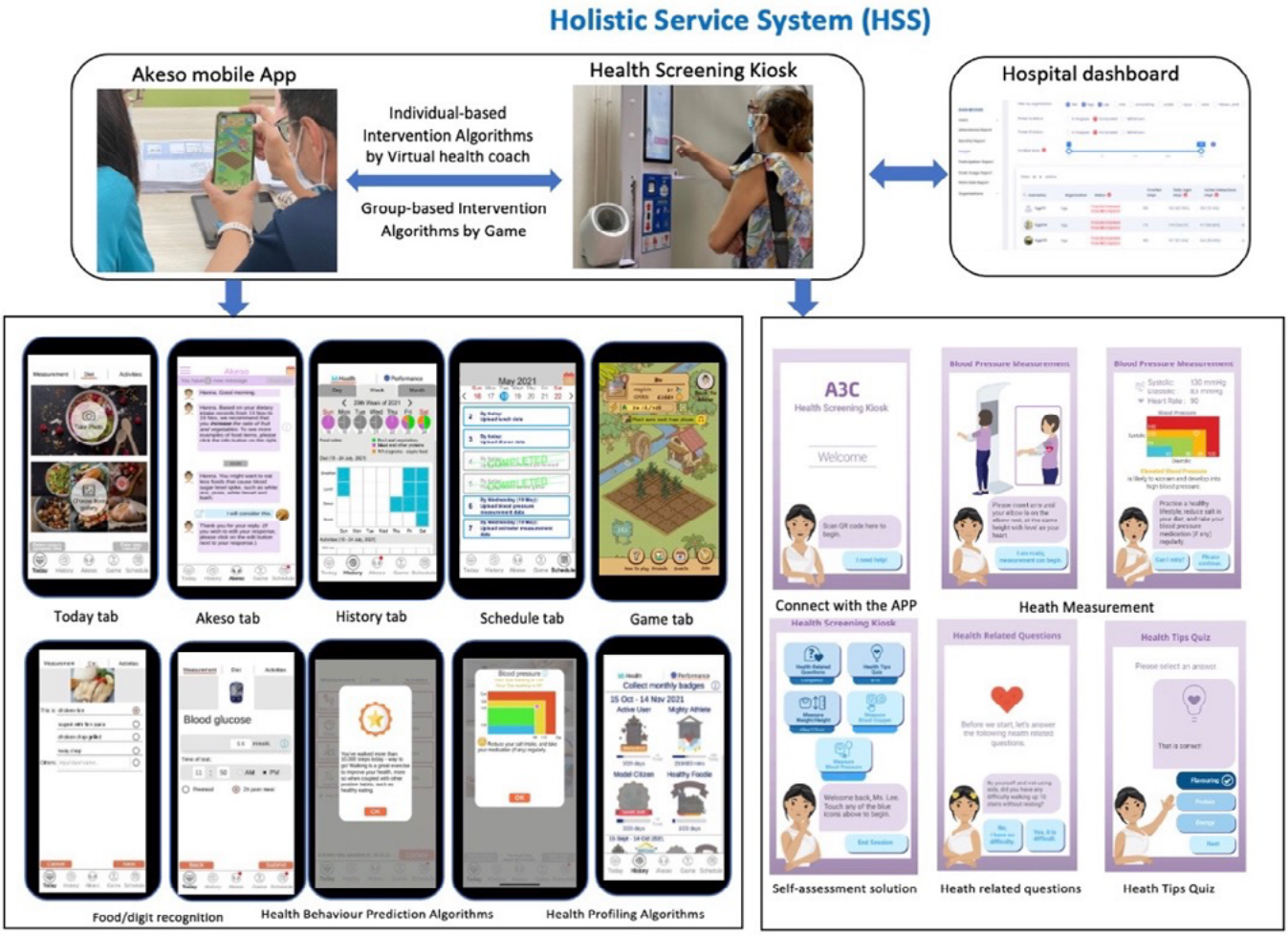
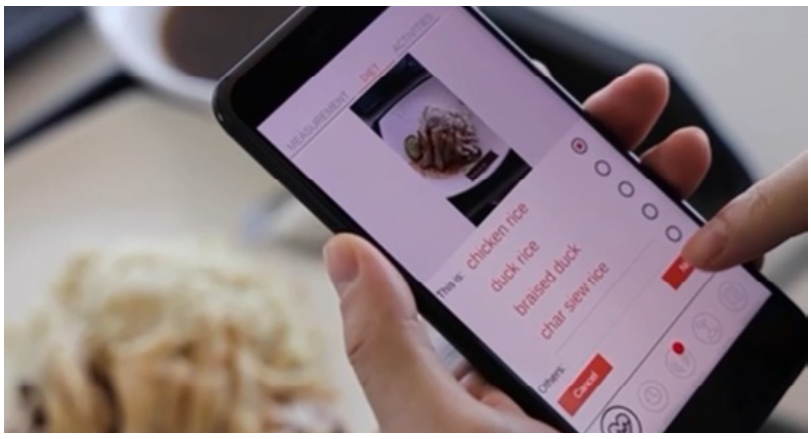


Figure 2: The Holistic Service System.

The HAI touchpoints



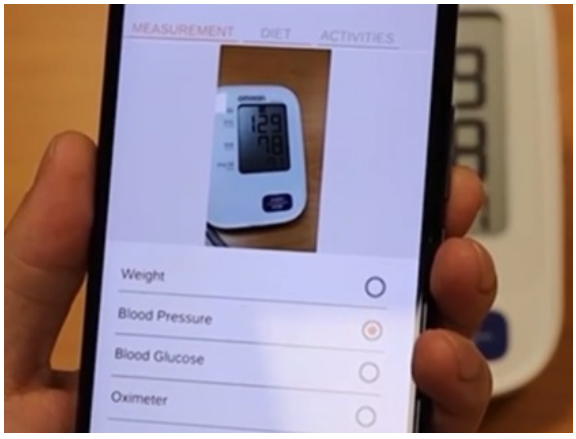


Figure 3: The AI-assisted food recognition and digit recognition in the app.

The HAI touchpoints integrate AI-assisted recognition into users' daily activities. The Akeso app features an AI-assisted food recognition function. We have collected and labelled over 130,000 images of local Singaporean food. Users can take photoes of their meals and upload them to the Akeso app for automatic recognition. The AI Subsystem (AIS) utilizes diet recommendations based on food categorization, including meat and other proteins, fruits and vegetables, whole grains-staple goods, while adhering to the Health Promotion Board's recommendation. The Akeso app will send a food analysis graph to the users based on yesterday's diet and provide personalized advice by assessing their diet's nutritional content.

Digit recognition is used in the Measurement tab, users can upload the readings from 3H related health measurement devices, including blood pressure monitor, weight scale, oximeter, etc. We have collected and labelled 20k+ measurement reading images to train this digit recognition AI model.

Food and digit recognition (Figure 3) simplifies the process of assessing diet nutrition and recording measurements, minimal manual inputs, make the Akeso app easy to use by a large population, especially the elder group. These simplified repetitive actions can easily transform to users' daily habits, fostering self-monitoring and the formation of healthy habits.

Figure 4: Akeso persuades users in App and Health Screening Kiosk.

Virtual Health Coach

Research from the focus groups shows that users tend to prefer interacting with a 'talking face' rather than a text-only interface. Intelligent agents need human likeness, self-representation, and personality to deliver a positive effect to the users (Nicenboim et al. 2020). This perception of communicating with a 'person' instead of a system fosters higher levels of trust and believability. We designed intelligent agent as the virtual health coach, a personified avatar named Akeso. The name of Akeso is taken from the name of one of the goddesses in Ancient Greece who is in charge of healing and curing.

The virtual health coach further enhances the touchpoints by offering personalized interactions, reminders, and cues.

The system utilizes Akeso, the virtual health coach, to persuade users by delivering personalized interactions, reminders, and encouragement at touchpoints, thereby adjusting and sustaining users' health behaviours, such as:

(1) Help the users keep the health goals in mind:
Akeso sends notifications to users to remind them to upload food data at 8:00, 12:00, 18:00 every day.

(2) Encourage users engagement through personalized recommendations:
Akeso has the capability to proactively send customized warnings and suggestions to users. These recommendations are formulated based on personalized insights and reminders provided by the individual-based intervention algorithms, which are seamlessly integrated into the chatbot with the conversational agents.

(3) Value the users' contribution:
When users upload their behaviour data and health data in the app and Health Screening Kiosk, Akeso promptly provides feedback (Figure 4). The feedback is based on the National Physical Activity Guidelines outlined by the Health Promotion Board. By adopting this approach, Akeso not only provides valuable user feedback but also enhances users' health knowledge.

Usability and Inclusivity for Users

The HSS prioritizes usability and inclusivity through smartphone and self-assessment kiosk solutions, ensuring inclusivity for users with varying preferences and technological literacy levels.

1) User-friendly guidance: To accommodate both novice and elderly users, tutorials and HELP content have been integrated into the Game tab. These resources enable users to learn how to use the system independently.

2) Convenient self-assessment: Users can simply scan a QR code generated by the app on the kiosk, which grants them access to their personal account. Data collected at the kiosk is automatically uploaded to the service system for analysis, facilitating interaction with the app.

3) Inclusive design: The kiosk interface has been designed with inclusivity to ensure convenience and safety for users who may require seating (Figure 5), such as individuals in wheelchairs or the elderly. The interface buttons are positioned for ease of use, and specific guidelines have been established for the placement and angles of seating with the kiosk.

Findings and Users' Feedback

This paper only presents the results of prototype testing conducted on young adults aged 20 to 35, who are a critical demographic for pre-diabetes. Ethics approval of the study was obtained from Nanyang Technological University's IRBCO Administrative Review (Ref: IRB-2022-032). In total, 30 participants used the Akeso app for one month and completed questionnaires assessing their satisfaction, and the app's impact on their lifestyle, psychosocial aspects, and physical activity. The average System Usability Scale score of 70.2 indicated above-average usability. Participants reported that they changed their diet, improved health awareness, increased physical activity, and weight loss. They appreciated the app's features such as tips and food recognition and found the suggestions helpful for learning health knowledge. The app effectively increased the well-being awareness, even among participants who are still in good health.

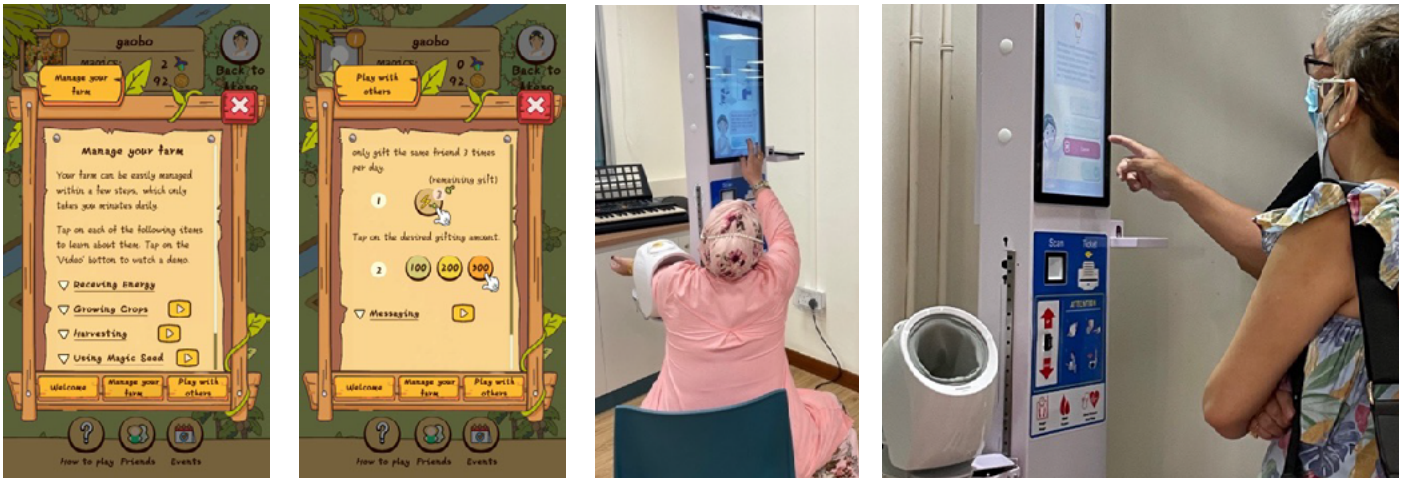


Figure 5: The holistic service system prioritizes usability and inclusivity through smartphone and Health Screening Kiosk.

Conclusion

The AI-Assisted 3H Care (A3C) System integrates intelligent agents and service design principles to enhance primary care and promote healthy lifestyles. The interdisciplinary collaboration in its development highlights the role of design in creating effective AI-driven solutions for health. The positive user feedback and impact observed among young adults through the prototype testing supporting the potential scalability and applicability of A3C in other countries with similar healthcare challenges.

The pursuit of Sustainable Development Goal 3 (SDG 3), which aims to ensure healthy lives and promote well-being for all at all ages in Singapore, represents a visionary goal. It not only necessitates innovative design but also requires diligent and practical execution. We will revolve around the fusion of human and human-AI collaboration, as well as the integration of intelligent agents within the service design in the next step.

Acknowledgements: *This research is supported, in part, by the National Research Foundation (Singapore) under its AI Singapore Programme (AISG Award No: AISG-GC-2019-003). Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not reflect the views of National Research Foundation (Singapore).*

References

Akama, Y., and A. Prendiville. 2013. 'A Phenomenology of Co-designing Services: The Craft of Embodying, Enacting and Entangling Design'. In *Crafting the Future: Proceedings of the 10th European Academy of Design Conference*, Pp.1-16.

Ang, Li Wei, Yiu Wing Kam, Cui Lin, Prabha Unny Krishnan, Joanne Tay, Lee Ching Ng, Lyn James, et al. 2017. 'Seroprevalence of Antibodies against Chikungunya Virus in Singapore Resident Adult Population'. PLOS *Neglected Tropical Diseases* 11 (12): e0006163. https://doi.org/10.1371/journal.pntd.0006163.

Evans, Daniel. 2017. 'MyFitnessPal'. *British Journal of Sports Medicine* 51 (14): 1101–2. https://doi.org/10.1136/bjsports-2015-095538.

Foo, Chuan De, Hui Xiang Chia, Ken Wah Teo, Aysha Farwin, Jumana Hashim, Gerald Choon-Huat Koh, David Bruce Matchar, Helena Legido-Quigley, and Jason C. H. Yap. 2023. 'Healthier SG: Singapore's Multi-Year Strategy to Transform Primary Healthcare'. *The Lancet Regional Health – Western Pacific* 37 (August). https://doi.org/10.1016/j.lanwpc.2023.100861.

Gao, Bo, and Xiaolin Shen. 2019. 'Through Service Design to Improve the HRQOL (Health- Related Quality of Life) in the Treatment and Rehabilitation of Elderly Women with Breast Cancer in Shanghai'. In *Conference Proceedings of the Academy for Design Innovation Management. Vol. 2*. https://doi.org/10.33114/adim.2019.04.294.

Grant, Richard W., and James B. Meigs. 2006. 'Overcoming Barriers to Evidence-Based Diabetes Care'. *Current Diabetes Reviews* 2 (2): 261–69.

Lee, PhongChing, ChinHong Lim, Ravishankar Asokkumar, and MarvinWei Jie Chua. 2023. 'Current Treatment Landscape for Obesity in Singapore'. *Singapore Medical Journal* 64 (3): 172. https://doi.org/10.4103/singaporemedj.SMJ-2022-216.

Mair, Jacqueline Louise, Oscar Castro, Alicia Salamanca-Sanabria, Bea Franziska Frese, Florian von Wangenheim, E. Shyong Tai, Tobias Kowatsch, and Falk Müller-Riemenschneider. 2023. 'Exploring the Potential of Mobile Health Interventions to Address Behavioural Risk Factors for the Prevention of Non-Communicable Diseases in Asian Populations: A Qualitative Study'. BMC Public Health 23 (1): 753. https://doi.org/10.1186/s12889-023-15598-8.

Mannonen, Petri, Johanna Kaipio, and Mika P. Nieminen. 2017. 'Patient-Centred Design of Healthcare Services: Meaningful Events as Basis for Patient Experiences of Families'. *Studies in Health Technology and Informatics* 234: 206–10.

Ministry of Health,Singapore. 2021. 'NATIONAL POPULATION HEALTH SURVEY 2021 (Household Interview)'.
MOH. 2019. 'MOH | Top 4 Conditions of Polyclinic Attendances'. 2019. https://www.moh.gov.sg/resources-statistics/singapore-health-facts/top-4-conditions-of-polyclinic-attendances.

Nicenboim, Iohanna, Elisa Giaccardi, Marie Louise Juul Søndergaard, Anuradha Venugopal Reddy, Yolande Strengers, James Pierce, and Johan Redström. 2020. 'More-Than-Human Design and AI: In Conversation with Agents'. In Companion Publication of the 2020 ACM Designing Interactive Systems Conference, 397–400. DIS' 20 Companion. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/3393914.3395912.

Oertzen, Anna-Sophie, Josina Vink, Gaby Odekerken-Schröder, Birgit Mager, and Salomé Azevedo. 2022. 'Navigating the Tensions of Integrating Lived Experience in Participatory Healthcare Design'. *The Design Journal* 25 (6): 997–1018. https://doi.org/10.1080/14606925.2022.2113223.

Ofori, Sandra N, and Chioma N Unachukwu. 2014. 'Holistic Approach to Prevention and Management of Type 2 Diabetes Mellitus in a Family Setting'. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* 7 (May): 159–68. https://doi.org/10.2147/DMSO.S62320.

Pengpid, Supa, and Karl Peltzer. 2018. 'The Impact of Chronic Diseases on the Quality of Life of Primary Care Patients in Cambodia, Myanmar and Vietnam'. *Iranian Journal of Public Health* 47 (9): 1308–16.

Piper, Donella, Rick Iedema, Jane Gray, Raj Verma, Lee Holmes, and Nicole Manning. 2012. 'Utilizing Experience-Based Co-design to Improve the Experience of Patients Accessing Emergency Departments in New South Wales Public Hospitals: An Evaluation Study'. *Health Services Management Research* 25 (4): 162–72. https://doi.org/10.1177/0951484812474247.

Roach, Paris, and David Marrero. 2005. 'A Critical Dialogue: Communicating with Type 2 Diabetes Patients about Cardiovascular Risk'. *Vascular Health and Risk Management* 1 (4): 301–7. https://doi.org/10.2147/vhrm.2005.1.4.301.

Sharma, Shweta, and Anil Ahlawat. 2022. 'Architecture and Types of Intelligent Agent and Uses of Various Technologies'. 2022 3rd International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT), November, 1–5. https://doi.org/10.1109/ICICT55121.2022.10064524.

Wang, Di, Budhitama Subagdja, Yilin Kang, Ah-Hwee Tan, and Daqing Zhang. 2014. 'Towards Intelligent Caring Agents for Aging-In-Place: Issues and Challenges'. 2014 IEEE Symposium on Computational Intelligence for Human-like Intelligence (CIHLI), December, 1–8. https://doi.org/10.1109/CIHLI.2014.7013393.

Wong, Lai Yin, Matthias Paul Han Sim Toh, and Linus Wai Chung Tham. 2017. 'Projection of Prediabetes and Diabetes Population Size in Singapore Using a Dynamic Markov Model'. *Journal of Diabetes* 9 (1): 65–75. https://doi.org/10.1111/1753-0407.12384.

Yang, Christopher C. 2022. 'Explainable Artificial Intelligence for Predictive Modeling in Healthcare'. *Journal of Healthcare Informatics Research* 6 (2): 228–39. https://doi.org/10.1007/s41666-022-00114-1.

Yu, Han, Zhiqi Shen, Chunyan Miao, Cyril Leung, Victor R. Lesser, and Qiang Yang. 2018. 'Building Ethics into Artificial Intelligence'. arXiv. https://doi.org/10.48550/arXiv.1812.02953.

Zeng, Zhiwei, Di Wang, Ailiya Borjigin, Chunyan Miao, Ah-Hwee Tan, and Cyril Leung. 2016. 'Human-Centred Design for Silver Assistants'. 2016 IEEE International Conference on Agents (ICA), September, 112–13. https://doi.org/10.1109/ICA.2016.038.

Outer Space Technology: Harnessing its Potential for Sustainable Life on Earth Through Human-centred, Service, Policy, and Product Innovation

Author:
Abigail Hoover[1, 2]

Institutions:
[1] Royal College of Art, Faculty of Design (United Kingdom)
[2] Imperial College London, Faculty of Engineering (United Kingdom)

Abstract

This paper explores the collaborative potential of outer space technology and Human-centred Design (HCD) to advance sustainability on Earth in alignment with United Nations Sustainable Development Goals (UN SDGs). HCD methodologies can support space missions for inclusivity and environmental responsibility promoting economic growth and reducing consequences of overconsumption in Space 2.0, notably in space debris and resource usage. HCD's perception in space will be discussed in context of a research study conducted by Imperial College London and the Royal College of Art. Furthermore, this paper examines case studies-Canadian Northern SPIRIT satellite mission and World Design Organization's 'Design in Space for Life on Earth' challenge discussing the HCD benefits in internal dynamics, problem isolation, and risk mitigation. The paper asserts that designers act as crucial links between scientific progress and user-centric applications, asserting their pivotal role in realizing UN SDGs.

Keywords: Human-centred Design, Space 2.0, Design, Engineering, United Nations Sustainable Development Goals (UN SDGs)

1. Introduction

Outer space technology and design are crucial for advancing sustainability and improving life on Earth, contributing to various United Nations Sustainable Development Goals (UN SDGs). Space assets and technologies can be used to support most, if not all, the SDGs, even if the role of space is not specifically acknowledged. For the 2030 Agenda for Sustainable Development to be successful, the use of space services shall become the norm (European Global Navigation Satellite System and Copernicus 2018). The United Nations Office for Outer Space Affairs' (UNOOSA) Space Solutions Compendium (SSC) has collected information supporting each SDG, their corresponding targets and how space resources, applications, and tools play essential roles in their monitoring or fulfillment. Each of these complex problems involves multiple unique user segments defined by location, language, age, beliefs, and values.

Traditionally, these missions and systems have been designed and applied by the scientific and engineering community. However, as the space industry progresses through large-scale economic and systemic growth, individuals outside these fields are facilitating new perspectives and responses to the utilization of space-based technology.

This is of particular interest to human-centered design (HCD). In this paper, design is defined as the generation of products and services from user or human-first design perspective. It will include the services provided by industrial, experience (UX), product, and system HCD subfields. Designers have the potential to bring new perspectives to aerospace through offering strengths in holistic thinking and problem-solving for complex problems such as the UN SDG targets. The inclusion of design thinking in mission creation, development, and operations creates stronger applications for users, broader public engagement, understanding of technology, and strategies to tackle the overuse, misuse, and pollution of critical space environments and infrastructure.

Current space practices and actions are creating large-scale implications for both the continuation of space exploration as well as the fundamental infrastructure and technology currently supporting the planet. The proliferation of space debris and the overutilization of critical space resources such as orbits, highlight the urgent need for sustainable practices in space activities. Design's capacity to facilitate strong policy and behavioural changes through habits and habitats will be critical in creating positive environmental and social practice in the industry.

This paper will examine keyways in which designers have enhanced the space industry's contribution to sustainability. Firstly, it will provide an overview towards general space infrastructure and emerging challenges that are arising from large scale economic shifts. It will highlight designs perception within the space industry gathered from an Imperial College London and Royal College of Art research study. Finally, key case studies will be examined and discussed in the context of the above-stated parameters. These include the Canadian AlbertaSat student satellite mission dedicated to forwarding Northern Canadian cultures, and the benefits of international transdisciplinary collaboration in the World Design Organization's (WDO) 'Design in Space for Life on Earth' Design Challenge.

By embracing design principles in space missions and projects, designers can contribute to the realisation of the UN SDGs. Their unique skill set allows them to bridge the gap between complex scientific advancements and user-centric applications. Designers can help shape a more sustainable, inclusive, and socially conscious space industry that benefits humanity through collaboration with scientists, engineers, policymakers, and local communities.

2. Space's Contribution to Sustainability and Emerging Industry Trends

Space resources have provided critical infrastructure to advance sustainable developments and monitorization for Earth. Produced mission outcomes have evolved understanding in land and ocean health; global access to communications; and evolving advancements in medicine. However, current space practices in mission design, mission management, and minimal policy have created large-scale negative implications for the continuation of space exploration and technology currently supporting the planet.

Scheduled to be retired in 2030, the International Space Station's Benefits for Humanity 2022 highlights the diversification of benefits stemming from microgravity research towards society, science, exploration, the economy, as well as future technologies for the exploration of the Moon and Mars (National Aeronautics and Space Administration 2022). The 'European Global Navigation Satellite System and Copernicus: Supporting the Sustainable Development Goals analysis' shows:

"Shows that all the SDGs are positively impacted by the benefits stemming from the use of European Global Navigation Satellite Systems (EGNSS) and Copernicus applications and, out of the 169 targets associated, 65 (almost 40 per cent) directly benefit from using the EGNSS and Copernicus services."
(European Global Navigation Satellite System and Copernicus 2018)

These endeavours have facilitated critical infrastructure required to sustain life on Earth. Furthermore, space agencies continuously update and share open-source documentation of the hundreds of projects and missions that play vital roles in the pursuits of not only environmental sustainability but key contributions to social and economic development.

In conjunction, the space industry is now entering an exciting era of innovation and accessibility known as Space 2.0. This paradigm shift, driven by a younger generation and new technological, cultural, and economic realities, has reduced costs and expanded opportunities beyond traditional scientific and engineering domains (Madry 2019). Launches to orbit are becoming cheaper, and more frequent (Harris 1986). The space sector has experienced massive growth in investment activity, with a total annual investment growing of more than $10 billion from 2012 to 2021 (Bland et al. 2022). Finally, Lunar/Martian space exploration will continue to develop human space

flight technology and life beyond Earth's atmosphere. This is creating new demands for business and design expertise as stated by McKinsey & Company:

"Given the rapid growth in funding, which has accelerated innovation and led to more competition, winning business strategies are also changing fast. Players looking to build or maintain market leadership in the space sector may benefit from embracing a disruptor's mindset – identifying creative ways to access and deploy capital while delivering value to core customers by staying ahead of the curve on both capabilities and business models. This mindset will become even more important as macro conditions shift and investors raise the bar for deploying capital into higher-risk ventures." (Bland et al. 2022)

As accessibility, production of technology, and frequency of launches increase, there is now an overconsumption and utilisation of space (United Nation's Office for Outer Space Affairs 2022). UNOOSA have stated space debris is a global concern threatening our continued use of near-Earth space activity. There have been less than 6500 successful rocket launches globally yet 25 000 space debris objects large enough for us to track ("ARES | Orbital Debris Program Office" n.d.). This is expected to grow exponentially as launches increase and more space object collisions occur. New sectors such as space traffic control and collision diversion are realities for space-based activities. Space law, policy and governance are also becoming a paramount discussion for countries and companies as new standards are developed to ensure safety, efficiency, and protection of the space environment and the resources it provides.

For designers, Space 2.0 offers a wealth of possibilities to explore, refine, and protect space technologies while connecting services to a larger user base. Designers develop concepts and solutions that seek to optimise function, production, value, and appearance simultaneously and synergistically (Burns et al. 2006). The question can be raised: are space efforts really reaching diverse communities in an environmental, cultural, social, and economically viable way? The inclusion of design in space is an emerging industry that will create new desirable and aspirational solutions, disrupting current practices and enabling more individuals to access the benefits the industry provides.

3. Human Centred Design's Perception in Aerospace

Conducted under Imperial College London and the Royal College of Art, the goal of this study was to investigate and analyse the perception of HCD in the space sector and its envisioned role in addressing trends and challenges presented by Space 2.0.

3.1 Methodology

Seven interviews were conducted with space experts, focusing on the following topics:

- Identifying emerging trends and advancements in design methodologies that could enhance space products, services, and systems.
- Understanding the framework, restraints, and scope of space user design endeavours.
- Gaining cultural insights into how various agencies and countries envision changes in this ecosystem as technology and policy develop.
- Isolating how design parameters differ from conventional considerations for products and services on Earth.

Experts were selected based on their experience of more than three years in space-related disciplines such as space policy, law, design, business (company management), academia or if they had practical experience in real or analog space missions. To meet programme requirements, experts needed to be residents of Canada, Japan, the United States of America or participating in the European Space Agency. English proficiency was a prerequisite due to the unavailability of language translation services. Table 1 illustrates the dispersion of expert locations and disciplines.

Participant Number	Discipline	Located Country
1	Military & Policy	United Kingdom
2	Business - CEO Startup	USA
3	Research & Academia	Canada
4	Business - CEO Startup	Canada
5	Law & Policy	Japan
6	Service Design	Spain
7	Architecture and Project Design	USA

Table 1: Expert interviewees locations and associated disciplines.

3.2 Generated Insights

Interviews were time-limited to 60 minutes and subsequently transcribed from audio recordings. The discussions covered a range of topics, addressing notable concerns such as space debris and the absence of clear policies and governance. A significant discussion point was the concept of dual use products and services utilized for both military and scientific purposes. More specifically the implications of nationalistic agendas in contrast to private commercialism. Despite frequent mentions of potential violence in space, there was a contrasting emphasis on the increasing interest in engaging diverse communities through various open-source platforms and educational tools. Table 2 highlights key insights from the study, with an asterisk (*) denoting insights specifically related to HCD.

Insight Number	Title	Description
a.	Policy and Governance	Space will remain a location of little policy, law and governance. Currently it is a balance of peace consensus between countries. There are few regulating factors nor do space experts expect new 'rules' to be evolved and put in place. Many experts believe regulation won't occur until large disasters or attempts of aggression occur.
b.	'Dual Use' Government versus Military versus Public	Many space products and resources are simultaneously used for government, military, and public purposes. This will not change in the near future. Government projects still hold high due diligence, carrying longer project time frames, and dictate many space-based activities. Although the agile private sector is challenging this operational method, collaboration with large scale government agencies is still required.
c.	Space Violence	Space agencies are creating strong ties to space superpowers of China and USA. Many believe there will be acts of aggression in the future.
d.	General and Public Education	There is a large gap between the general public and resources produced by the outer space industry. This results in small pockets of knowledge making large scale decisions towards the utilisation of space.
e.	Environmental Sustainability	The protection of the outer space environment is of serious concern. The overutilization and misuse of space environments and orbits will have serious consequences for near-future space activities and the emergence of new space industries in traffic control and debris regulation.
f.	A need for human first focus*	As new parties and competition enter space there is an increasing demand for skill diversification. This is focused on understanding end user, internal strategic management, economic and commercial viability, and the standardisation and sharing of practices and resources across domains.
g.	Upfront barriers in technical understanding and mission dynamics*	Although there is a larger demand for these business/design approaches, entering human centred designers face high barriers of technical and scientific knowledge needed to effectively contribute to space products, services, and offerings. This is due to isolated pockets of knowledge developed in individual space missions, lack of practice and content sharing across space missions due to privacy, and the long duration of current space projects.
h.	Perception of Human-Centred Design*	Design holds many titles in aerospace that refer to engineering roles. Aerospace experts do not associate 'design' with human-centred intervention or user interactions.

Table 2: Condensed insights gathered from interview series. * Denotes insights related to HCD.

3.3 Discussion

Three key themes emerged regarding the influence of human-centred design within the space industry. These themes were nearly unanimous among the experts:

1. higher need for end-user focus;
2. clarification and definition of human-centred design; and
3. tangible validation of human-centred design in space.

3.3.1 Higher need for end-user focus

In the competitive and commercial space markets, there is a growing demand for designers with a strong focus on end-users. This contrasts with original space user targets where a user is perceived as a company, organisation, or university, typically neglecting the individual interacting with the product. The changing landscape, with increased commercial interests, emphasizes the necessity to re-evaluate business models and consider end-user interactions.

3.3.2 Clarification and definition of human-centred design & need for technical expertise

There is a consensus on the need for a clearer definition of HCD and its associated benefits within the space industry. Despite recognizing the need for a user-focused approach, many experts indicated that engineers and scientists still predominantly manage corresponding project aspects.

Many space missions' objectives are still set by extremely small user groups, research questions, or niched scientific goals. Commercial or broader applications of space missions fall out of scope or are not considered until later stages of product design. While design thinking offers strengths in visualization, unique idea generation, and creating stronger comprehensibility within products, experts noted a lack of belief in its potential within space missions due to the demanding, rigorous, and highly technical environment.

This is further enhanced by the challenges faced when defining the differences between design subfields such as product, industrial, service or experience design. Space experts needed to know where and quantified results design would bring to their projects.

3.3.3 Tangigle validation of human-centred design in space and associated challenges

The experts highlighted a strong need for tangible validation and promised results of design within the space sector. Validating design practice benefits is notoriously difficult as results may manifest through intangible creative touchpoints, correction of biases, or facilitation of strong communication (Mars and Kohlstedt 2020). To bridge the gap between design and the space industry, experts felt designers needed to present a strong understanding in current industry practices, terminology alongside previous case studies in direct improvements made by design efforts.

3.4 Future Steps

This study stands as a preliminary analysis into the various barriers faced by designers when entering the space industry. To maximize design impacts, efforts should be made towards stronger quantification of benefits in science, technology, engineering, and math (STEM) projects to develop trust; clearer design positions mapped within space projects; and the encouragement of user-focused design intervention at the initial stages of project planning.

4. Supporting Case Studies

Section 4 will discuss two case studies of space missions/ projects driven by sustainable initiatives. Each study will highlight its benefits towards UN SDGs and the impacts design thinking had within internal management and project outcome. Finally, it will highlight the limitations faced by designers in respect to the isolated design parameters discussed in Section 3.3.

4.1 AlbertaSat, Northern Spirit Constellation

The Northern Space Program for Innovative Research and Integrated Training (Northern SPIRIT) is a Canadian initiative focused on the design, build, test, and operation of three CubeSats in Low Earth Orbit. In collaboration with the Canadian Space Agency's (CSA) Canadian CubeSat Project (CCP), Northern SPIRIT includes Yukon University, Aurora College, and the University of Alberta (UofA). Launched in March 2023, the constellation is dedicated to sustainable technological development and education across Canada. Its objectives are fostering student-led innovation, amplifying Northern Canadian voices, creating and developing open-source technology, and engaging in multispectral imaging of Canadian wildfires.

The University of Alberta AlbertaSat student team was responsible for the construction of all satellite bus structures and payloads of the Ex-Alta 2 satellite. The seven-year project exemplifies the nuanced advantages of design thinking in space missions. Beyond imparting students with hands-on experience in spacecraft design and construction, the initiative introduces crucial skillsets encompassing project and knowledge management, research and development protocols, and interdisciplinary design (Hoover and Ganley 2021).

Initial stages of team composition consisted of STEM specialized students who facilitated project aspects related to team dynamics, public engagement, and K-12 educational outreach. As the project scaled due to increased scope and reputation; business, education, and design disciplines joined. The inclusion of humanity-specializing students provided new best practices increasing public awareness, stakeholder engagement, funding and speaking opportunities as well improved internal team efficiency, trust, progress tracking, workflows, and communication.

In the final two years, project management comprised of two senior students specializing in electrical engineering, and human-centered industrial design. This interdisciplinary leadership facilitated integration of technical expertise and human-centric design principles throughout mission activities. The collaboration across design, engineering, and business backgrounds facilitated a systemic design approach reducing risk from turbulent student schedules, stress, and high member turnover. Students worked collaboratively combining skillsets, creating effective human-based research and resulting project changes. Examples can be seen in incorporating terminologies from sources such as the IDEO Design Kit, business model mapping, and consistent in-person workshops to gather and incorporate feedback. Numerous user studies were also conducted, focusing on member onboarding, conflict resolution, student health, and equality, inclusivity, and diversity.

The impacts of design in this context may not always be tangible, requiring years of trial and error to understand how design strategies seamlessly integrate into the project. Beyond occasional tasks like mission patch design and presentation formatting, the real value of design thinking emerged in accurate problem isolation and internal group structuring. This case exemplifies how having design expertise and leadership in a STEM-based group can offer substantial benefits beyond product intervention, underscoring the holistic value of design thinking in complex interdisciplinary projects.

4.2 World Design Organization's Design in Space for Life on Earth Design Challenge

The 2020 WDO Design in Space for Life on Earth initiative was a two-week effort fostering collaboration, education, and design leadership for the sustainable utilisation and development of the International Space Station (ISS). In partnership with the Center for the Advancement of Science in Space (CASIS), and the manager of the ISS National Lab, each of the three categories (Figure 1) was dedicated to advancing UN SDGs. This project provides a comprehensive study on the challenges and benefits of transdisciplinary space projects when a significant representation of design expertise is present.

The initial 2-week phase utilized Jake Knapp design sprint methodologies. Comprised of participation from 71 space industry leaders, researchers, and designers from 26 countries, teams were divided and assigned a specific question. High levels of confusion and self-bias towards individual expertise were observed due to complex problem[1] structure and broadness of the 3 topics. Initial days were lost to developing team relationships and communication strategies. The difficulties arising from international synchronicity, time zones, internet, and language barriers also led to constraints on participation and potential contributions.

However, the benefits of having an environment based in design thinking were seen in concept generation and unique exploration of space resources. The condensed sprint timeline pushed feasibility and technical requirements to later planning stages. This resulted in fostering a more liberated exploration of concepts, with a heightened emphasis on end-user wants, needs, and limitations rather than being restricted by technical constraints. Furthermore, team composition ensured equal leadership between design, science, and engineering backgrounds. Design leaders educated and established low-risk environments to explore design thinking strategies within the mission concept phases.

The 2020 WDO Design in Space for Life on Earth initiative stands as a significant exploration into the challenges and advantages of transdisciplinary space projects. The project faced challenges in team relationship development and communication strategy formulation, prompting a recommendation for pre-established team dynamics in future endeavours. Despite these challenges, the transdisciplinary environment generated unique questions, particularly concerning education and borderless learning. In conclusion, while the initiative faced significant challenges, it provided valuable insights into the potential benefits of design thinking in space missions and highlighting areas for improvement in future collaborative and transdisciplinary projects within the space industry.

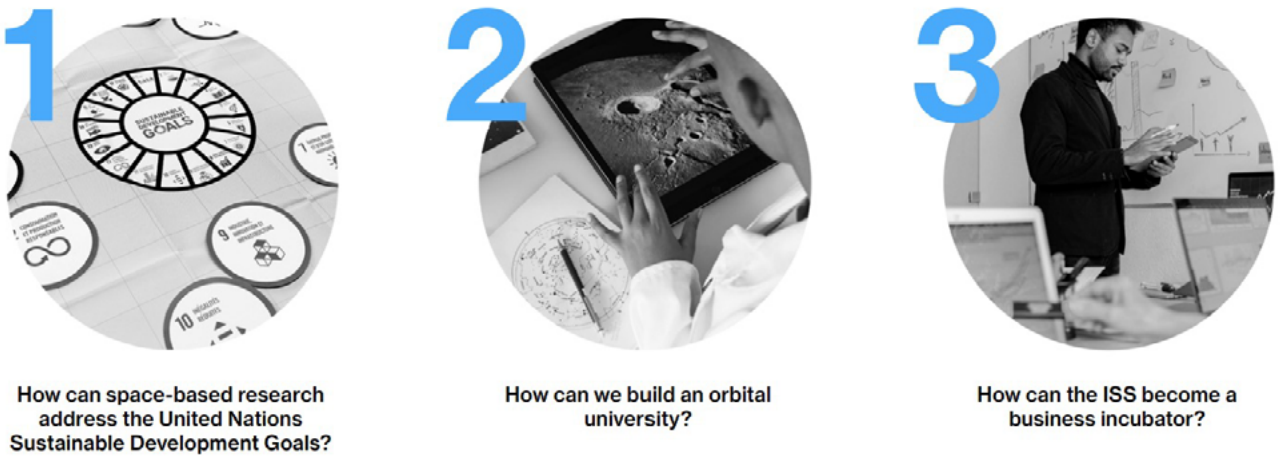


Figure 1: The 3 Categories of the Design in Space for Life on Earth project. Credit: World Design Organization.

[1] *Complex problems are messier and more ambiguous in nature; they are more connected to other problems; more likely to react in unpredictable non-linear ways; and more likely to produce unintended consequences. (Burns et al. 2006)*

5. Conclusion

In conclusion, space infrastructure, research, and technology are critical in ensuring the health and wellbeing of human, planet, and near space environments. The integration of design principles within space missions can advance sustainable impact and enhance societal usability. As highlighted in this paper, the complex challenges associated with space exploration, such as the overutilization of critical space resources, and increased commercial and competitive interest necessitates a shift towards stronger business and project practices. Design, with its holistic thinking and problem-solving capabilities can address these challenges. This paper has underscored the transformative potential of design in shaping the future of space activities by examining the intersection of design and space infrastructure, as revealed in the Imperial College London and Royal College of Art research study, the AlbertaSat student satellite mission and WDO's "Design in Space for Life on Earth" Design Challenge. Through collaborative efforts with diverse stakeholders, designers can contribute to the realization of United Nations Sustainable Development Goals, bridging the gap between scientific advancements and user-centric applications for a more sustainable and socially conscious space industry.

Special thanks to supporting professors, project PI's, and organizations listed: *Sebastian Deterding, Imperial College London; Paula Zuccotti, Royal College of Art; Micheal Lipsett, University of Alberta; Steven Knudsen, University of Alberta; Ian Mann, University of Alberta; Thomas Ganley, AlbertaSat; World Design Organization; International Space Station National Lab; Center for the Advancement of Science in Space (CASIS).*

References

"ARES | Orbital Debris Program Office." n.d. ARES | Orbital Debris Program Office. Accessed November 10, 2023. https://orbitaldebris.jsc.nasa.gov/faq/#:~:text=More%20than%2025%2C000%20objects%20larger,Earth%20exceeded%209%2C000%20metric%20tons.

Bland, Rob, Ryan Brukardt, Will Gangware, and Dale Swartz. 2022. "A Different Space Race: Raising Capital and Accelerating Space Investment | McKinsey." McKinsey & Company. November 16, 2022. https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/a-different-space-race-raising-capital-and-accelerating-growth-in-space.

Burns, Colin, Hilary Cottam, Chris Vanstone, and Jennie Winhall. 2006. "Red Paper 02- Transformation Design." Design Council. February 2006.

Contribution to the "Space2030" Agenda EU Space Supporting A World of 8 Billion People. 2021. United Nations Office for Outer Space Affairs.

"European Global Navigation Satellite System and Copernicus: supporting the Sustainable Development Goals - building blocks towards the 2030 Agenda." 2018. United Nations Digital Library System. 2018. https://digitallibrary.un.org/record/3833375?ln=en#:~:text=The%20analysis%20shows%20that%20all,EGNSS%20and%20Copernicus%20services%2C%20either.

Harris, Philip R. 1986. "The Influence of Culture on Space Developments." *Behavioral Science*, no. 1 (January): 12–28. https://doi.org/10.1002/bs.3830310103.

Hoover, Abigail, and Thomas Ganley. 2021. " Northern SPIRIT Consortium - Canadian Collaboration through Student-Led CubeSat Constellation." DigitalCommons@USU. 2021. https://digitalcommons.usu.edu/smallsat/2021/all2021/119/.

Madry, Scott. 2019. *Disruptive Space Technologies and Innovations.* Springer.

Mars, Roman, and Kurt Kohlstedt. 2020. *The 99% Invisible City*. Houghton Mifflin.

National Aeronautics and Space Administration. 2022. International Space Station Benefits for Humanity Np-2015-01-001-Jsc. Createspace Independent Publishing Platform.

"Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Spaces." 2010. In. United Nations Office for Outer Space Affairs. http://dx.doi.org/10.1163/9789004411029_015.

"Space4SDGs: How Space Can Be Used in Support of the 2030 Agenda for Sustainable Development." n.d. UNOOSA. Accessed November 10, 2023. https://www.unoosa.org/oosa/en/ourwork/space4sdgs/index.html.

United Nation's Office for Outer Space Affairs. 2022. Guidelines for the Long-Term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space. United Nations.

"WDO | World Design Challenge | Design in Space for Life on Earth Design Challenge." 2020. WDO. 2020. https://wdo.org/programmes/interdesign-through-the-years/interdesign-design-challenge/design-in-space-for-life-on-earth-challenge/.

Co-speculation for Future Personal Data Use – Toward Shared Authorship of Future Technology Use Scenarios Among Multi-stakeholders

Authors:
Masako Kitazaki[1]
Fumiya Akasaka[2]
Riichiro Take[3]
Ryoko Koborita[4]
Kazushi Ishigaki[5]

Institutions:
[1]Musashino Art University, Tokyo (Japan)
[2]National Institute of Advanced Industrial Science and Technology, Ibaraki (Japan)
[3]Fujitsu, Tokyo (Japan)
[4]NTT Communications, Tokyo (Japan)
[5]LDAT Research & Consulting, Yamagata (Japan)

Abstract

This paper describes the project CoDa, which envisions a desirable data-driven society that is inclusive and collaborative among multi-stakeholders, from citizens to service providers to policymakers. The initial two phases of the co-speculation methodology, which this paper details, focused on citizens unfamiliar with the data-driven technology to empower them to become co-authors in shaping future technology usage scenarios. We developed the workshop employing a shared-authorship level of participatory speculative design, which motivated participants to express their desires for the future. The workshop also transformed the participants into active players in the collective decision-making process.

A shared-authorship level of participatory speculative design benefited mindset changes in participants and could be the steppingstones to the next level, initiation, or ownership of speculative design. We highlight that designing appropriate tools and their distribution is crucial for designers to delegate the facilitator role to others, which is required to scale up citizen-led speculative design.

Keywords: Speculative design, participatory design, personal data, co-design, use scenario

1. Introduction

In alignment with the Society 5.0 vision, the Japanese government and companies power AI-powered services using personal data, which includes biological and behavioral data. They assume that a data-driven society will benefit citizens through customized services, promote economic growth, and solve social problems, such as an aging society and depopulation. However, citizens are anxious about these scenarios. Research (Hitachi, Ltd. 2020) has shown that twice as many people are afraid of giving their data to the government and platformers as those who are not bothered by it. Worldwide, smart city projects tend to stall because of citizen opposition movements. Unsurprisingly, there is tension between data takers (service providers and governments) and data givers (citizens).

The gap between data takers and givers has emerged because of citizens' disinterest and a small group of technology elites and policymakers dictating technology use scenarios. They are typically formulated by elite technologists, primarily located on the West Coast of the United States of America (Manski 2017). Once endorsement is gained from profit-driven neoliberals at the core of the capitalist economy (Feltwell et al. 2018, Tuters and Varnelis 2006), the use scenarios are regarded as self-evident futures by the top government and business leaders in Japan and are promoted in a top-down manner. Conversely, citizens who are hesitant about data utilization harbor a 'fear of the unknown', along with concerns about information leakage and data sharing with third parties (Kitazaki et al. 2023). Invisible information and communication technology, including data and AI, are challenging for non-technical citizens to grasp, leaving them unable to form informed opinions or raise questions relevant to their lives (Pschetz, Pothong, and Speed 2019). Consequently, this leads to a lack of motivation for engaging in creating a technologyuse vision together.

We, a group of designers, co-creation experts, technologists, educators, and nonprofit organization members, initiated the Co-speculation for Future Data Use (CoDa) project. Our goal is to foster an inclusive sense-making process in which everyone, from citizens to service providers and policymakers, collaboratively shape future technology use scenarios. To make this new collaboration a reality, it is crucial that people with different perspectives and opinions share their thoughts on the desired future on an equal footing, acknowledge each other's diversity, and try to understand one another. We believe that creativity is the key to realizing this collaboration and created an initial methodology as a starting point by carefully choosing and combining various design methodologies. This paper describes the initial two phases of the methodology.

2. Methodology and Previous Studies

We hypothesized a co-speculation methodology consisting of three phases. In the first phase, we understand people's new technology usage by capturing their experiences, emotions, and emerging practices. The second phase involves designing a workshop programme in which citizens engage in speculative design to envision diverse future scenarios, fostering a sense of ownership over preferable technology use scenarios. In the third phase, we invite multi-stakeholders, such as service providers and policymakers, in addition to citizens, to exchange each other's views about desirable futures and facilitate discussions on potential action plans through role-plays and theatre methods.

We focused on citizens in the first two phases of this project because the power dynamics in data use were asymmetrical between those who provided data and the service providers and governments that acquired data. We often see visions of personal data use services from governments and data platformers, but the experiences and emotions of the citizens who use these services and provide data are veiled, and little previous research has attempted to qualitatively clarify them (Kitazaki et al. 2023), so the first step was to understand them. Furthermore, it takes a certain kind of coaching for ordinary citizens to envision desirable futures for themselves and act toward them in the face of major data platformers, corporations, and government control structures. Therefore, we decided that citizen empowerment was needed first before the multi-stakeholder collaboration in the third phase.

To break it down further, the first phase involves understanding the experiences and emotions of citizens as they use personal data services, which provides valuable insights to fuel the speculative design of the second phase. We utilized speculative design for co-speculation to explore alternative future perspectives of dominant frameworks (Dunne and Raby 2013). In recent years, design research and practice communities have employed various approaches to investigate diverse futures, including critical design, speculative design, adversarial design, discursive design, and design fiction (Kozubæv et al. 2020). The common emphasis in these studies is that speculative design should be rooted in scientific and societal facts. A critical aspect involves building a perceptual bridge that allows designers to engage their audiences and evoke an emotional response. This requires careful crafting and management of speculative elements (Auger 2013). The ethnographic study conducted in the first phase helped establish this perceptual bridge.

In the second phase, we actively involved citizens, motivating them to become co-authors in shaping future technology usage scenarios. To enhance this approach, we incorporated participatory elements into speculative design. While speculative design was originally intended to provoke discussion, it has drawn criticism for its one-sided presentation in showrooms, primarily driven by artist–designers without involving the audience (Kozubæv 2016, Gerber 2018, Kozubæv et al. 2020). Consequently, recent research has underscored the importance of inviting people to participate in speculative design, not merely as spectators but as active contributors and owners of the process (Stals, Smyth, and Mival 2019). We believe that the deeper the level of participation, the more drastic the change people experience, as delegating initiatives empowers citizens to be more proactive. Farias, Bendor, and Van Eekelen (2022) carefully divided the level of engagement and participation that we aimed to study: shared authorship, for which non-designers would produce speculative designs with designers' support. We created a three-step workshop for the second phase: brainstorming, speculating, and critiquing.

3. Context

We chose workplaces as the research context because 1) the number of services using personal data in workplaces is dramatically increasing, and 2) more people have already encountered data-driven services in workplaces than in other contexts.

Examples of data-driven management applications in workplaces include communication and facility management sharing employee location data in and outside companies; crisis management monitoring the safety of employees based on temperature, humidity, worker location, and biometric data; work monitoring to understand employees' work statuses using PC and smartphone data; health management monitoring mental and physical statuses through pulse surveys, health checkups, and biometric data; and human resources technicians evaluating work efficiency, making training plans, and recruiting through behavioral data, pulse surveys, and competence assessments.

4. The First Phase

4.1 Study

We recruited and interviewed fifteen participants using data-driven services from their workplace mentioned in the previous section. To gain insights into their experiences, we asked the participants to show their typical work processes using the services and explain why they worked that way. We analyzed their remarks after the interviews and found emerging practices and personas in data-driven work.

4.2 Insights

The participants managed their communications through personal data services. However, we found three emerging communication practices that may lead to future data-driven miscommunications. The first involves falsification in reporting. The participants' companies had adopted health services for routine employee mental health checks and daily biometrics. However, some participants input false data into the health applications due to fear of judgment by managers or human resources. The second involves 'peeping'; that is, subordinates' data are viewed for management purposes. Although viewing data helps visualize unseen conditions, the participants anticipated that this could be used as a new form of harassment. The last emerging practice is a collision between data takers and givers. Higher-ups seek more employee data, while employees feel excessively anxious about providing it or waive their rights to refuse. However, there are no discussions between the two parties to resolve the issue.

After categorizing the participants' experiences and remarks, we identified nine distinct personas. Initially, we observed two main categories: those who underestimate the potential of data and those who overestimate it, believing that data can reveal everything. Additionally, there were two types of data providers: those who were suspicious of data recipients, fearing misuse or sharing without their consent, and those who placed trust in data recipients. Among the data recipients, which included managers and human resources personnel, we identified two management styles. The first style showed attentiveness to employees' feelings, offering flexible guidance tailored to individual abilities and circumstances. The second style prioritized overall control and efficiency over individual employee considerations.

As a result of our findings, we developed two matrices. The first matrix is for data providers, the vertical axis of which represents their trust in data recipients, and the horizontal axis reflects their estimation of the potential of the data. The second matrix is for data recipients, with the vertical axis indicating their management style and the horizontal axis representing their estimation of the potential of the data, the same as the givers' horizontal axis. Figure 1 displays the nine personas that were determined after plotting the participants' experiences and thoughts.

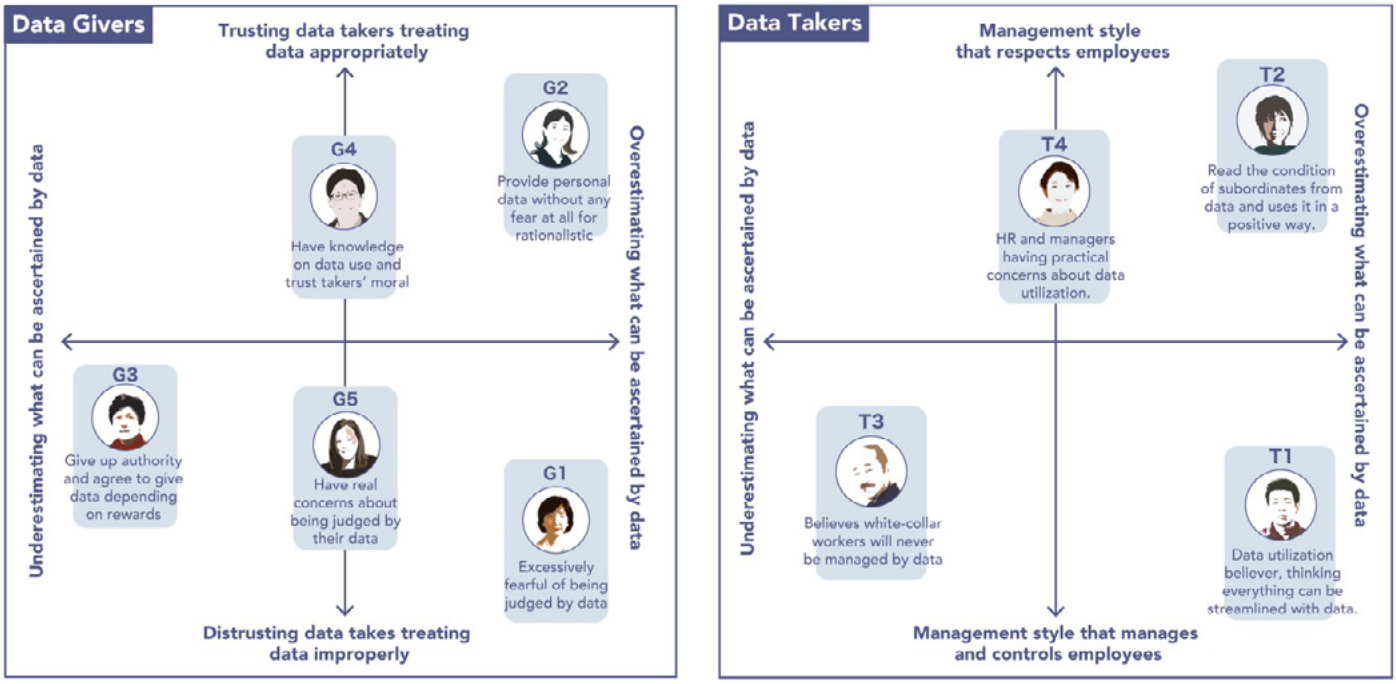


Figure 1: The nine personas identified from the ethnographic interview.

5. The Second Phase

5.1 Workshop Development

We created a workshop for those who assumed that they did not have the power to be involved in creating a vision of what future personal data use should be. To increase their confidence and inspire co-authorship in shaping future technology use scenarios, we used a participatory speculative design that enabled them to engage in exploring the unknown future (Stals et al. 2019), liberate their potential imagination (Farias, et al. 2022), and foster infrastructures of democratic imagination (Baumann et al. 2017).

We created tools for the workshop: a newspaper, persona cards, what-if cards, and an online platform (Figure 2). These items were created based on facts for perceptual bridges (Auger 2013). The newspaper described data technology and world trends of data-driven societies. We created it for communicating the facts of what is happening worldwide from a neutral standpoint, neither for nor against, so as not to influence the participants' ideas about data-driven societies. The persona cards detailed the nine-character personas and experiences from the first phase. The names and pictures on the cards were fictional, but their experiences were described as inspired by the interviews. The what-if cards depicted future fictitious situations and asked the provocative question, "What if this happens in the future?" (Dunne and Raby 2013) We created the cards by learning the latest phenomena about data-driven societies worldwide. For example, one asks, "What if credit ratings calculated from behavioral and purchasing data were introduced into the workplace?" Finally, the online platform allowed participants to upload their speculative future stories created during the workshop, which elegantly transformed the texts into web fictions.

Figure 2: The tools created for the workshop.

5.2 Workshop Procedure

The workshop was divided into three steps: brainstorming, speculating, and critiquing so that participants become active contributors not just spectators (Stals, et al. 2019). During brainstorming, the participants first read the newspapers to increase their knowledge. Then, they chose one persona with which they sympathized, randomly picked one what-if card, and imagined what would happen or how the persona would react to the prompt. They jotted down their ideas on paper and shared them with the other participants during several rounds of ideation. The next step was speculating, in which the participants wrote an 800-word fictional scenario using the ideas they had brainstormed. We chose novels as the medium of speculative design because they allowed participants to express their imagination without any design techniques, such as movies and objects, which speculative design usually employs. After uploading the text to the online platform, the critiquing session began. The participants were first divided into pairs and selected their favourite story from the two they wrote. Then, as pairs, they shared their thoughts on whether they agreed or disagreed with the story and why (Voss, et al. 2015). After that, they discussed how they and society must change for the story's realization or prevention. Finally, the pairs shared what they discussed with the rest of the participants.

The brainstorming workshop spanned two and a half hours. The speculation phase lasted one week following the brainstorming session, during which the participants worked on their scenarios as homework. Finally, the critiquing session lasted two hours and took place one week after the brainstorming session (Figure 3).

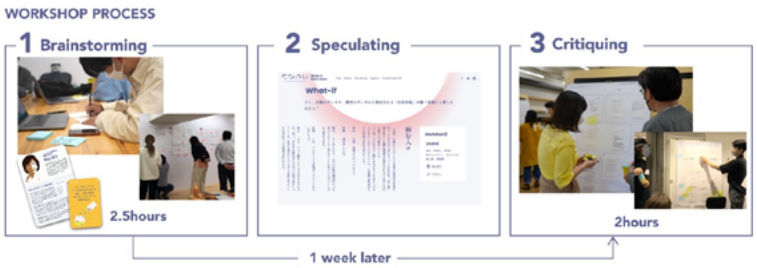


Figure 3: An overview of the workshop process.

5.3 Participants

We aimed to include a diverse mix of participants, including those with and without work experience. Our rationale was that individuals with work experience might have more realistic imaginations, while those without might have more flexible perspectives. Thus, we sent invitations to universities and co-working offices, ultimately recruiting fourteen participants: five university students and nine working professionals. According to the pre-workshop questionnaire, all the students and seven of the nine professionals were not in the data platformer or policymaker domains and had no prior experience managing data-driven management services. We divided the participants into two groups and conducted the workshop twice.

5.4 Results

The results from the workshop involved three parts: the stories, the participants' ideas to create a better data-driven society, and the participants' observed changes.

5.4.1 Stories

All the participants created speculative stories, except two, who faced time constraints caused by unexpected work situations. In the fourteen stories (some participants uploaded more than one story), five were dystopian, seven were neutral, and two were utopian. Regardless of being dystopian or utopian, all the stories had unique details and exemplified rich imaginations yet were based in science and social facts. Interestingly, nine stories related to the theme of deceiving someone through data, including stories of data providers deceiving management and their organizations, data providers deceiving AI, and data takers deceiving data providers (employees). Despite most participants' having no prior experience as data collectors or managers, the protagonists of the stories were diverse. Among them were executives advocating for data utilization, employees of service providers responsible for managing acquired data, and middle managers in companies embracing data-driven management practices, in addition to the employees serving as data contributors.

5.4.2 Participants' Ideas to Create a Better Data-Driven Society

In the critique sessions, the participants actively discussed the future shifts necessary to realize or prevent the speculative stories. By categorizing their statements according to the PESTLE (Policy, Economy, Society, Technology, Law, and Education) analysis, which Royal Dutch Shell used to conduct as strategic analysis for the unknown future, we can summarize the participants' demands for future change as follows.

1. Political Shift
   a. When constructing a data utilization model for the complex human decision-making process, there is a risk that those in charge might develop biases. Therefore, a policy is needed to encourage a multifaceted examination of the process and to avoid relying solely on data for decision-making.
   b. Once data evaluation indicators are defined, people may focus solely on them, potentially stifling creativity and innovation outside of these indicators. Therefore, a data-driven evaluation policy is essential.

2. Technological Shift
   a. Develop technology that presents AI algorithms in a way that is understandable to humans for decision-making based on data.
   b. Implement mechanisms that enable users to consider their data-sharing preferences while using data-driven management apps and opt out at any point.
   c. Create interactions that display data-driven AI decisions as one possible solution, rather than the sole correct answer.
   d. Provide functionality to customize the frequency and granularity of data utilization recommendations.

3. Educational Shift
   a. Education is needed on how to receive the results of data utilization and how to use them safely and reliably.

4. Legal Shift
   a. Supervisors and personnel currently determine data usage, but a licensed service, legal oversight, or a professional third-party organization to audit the data handling process is required.
   b. Laws should compel data collectors to transparently demonstrate their data usage intentions and refrain from collecting data that they will not use.
   c. When individuals in positions of authority control data, there is a risk of manipulating data and AI outcomes as evidence to exert control. This underscores the necessity of specific laws governing data access and management.

5. Sociological Shift
   a. Evaluating the outcome of data utilization is crucial. This means not merely praising data for being above average but examining its diversity.
   b. A social culture is needed that acknowledges that data utilization results and evaluations are not everything, and that there are limits to what data can achieve.
   c. A social culture is needed that acknowledges that emergence and response to new modes of behavior (data jokes, 'made-up' data, return to philosophy, and religion)

6. Economic Shift
   a. A new business to audit the data-handling process in organizations need to be flourished.
   b. When using data-driven management applications, it is important to have a service within the organization that facilitates discussions about the boundaries of data usage and the extent of data utilization efforts.

5.4.3 Participants' Observed Changes

To observe the participants' changes, we distributed a questionnaire before and after the workshop. Of the fourteen participants, eleven responded. When comparing participants' self-assessments on a seven-point Likert scale, their knowledge of personal data utilization improved (from 2.6 to 4.5), as did their interests (from 4.6 to 5.6) and their confidence in co-authoring data use scenarios within their community (from 3.5 to 5.2). In the open-ended questions that asked about their thoughts after the workshop, some participants mentioned that describing potential futures transformed their vague negative perceptions of a data-driven society into concrete fears and coping strategies.

Most participants were unfamiliar with data utilization and were passive in developing a desired scenario for the future before the workshop. In contrast, some participants had knowledge

and experience in data utilization and had a proactive attitude about it before the workshop experience. Although they were not the workshop's primary target participants, the workshop promoted empathy and respect for different types of people. One participant who initially described the data utilization supremacy manager persona (T1 in figure 1) as similar to himself switched to the balanced type manager persona (T4) after the workshop and wrote, "I used to prioritize rationality and efficiency, but after hearing how other participants felt during the workshop, I began to see the potential issues that can arise from a purely rational approach."

When we compared which personas participants identified with before and after the workshop, we discovered a trend. There was a decrease in sympathy with excessive fear (G1, G5 in figure 1) and data supremacy (T1), and an increase in sympathy with the balanced type (G4, T4), which considers both the advantages and disadvantages of data utilization. Interestingly, votes also went to G3 in figure 1, who waive their rights to refuse providing data. According to the questionnaire, the participants admitted that they were less interested in data utilization and vulnerable to peer pressure. Some participants also chose G3 after the workshop; they may have discovered G3 in themselves while writing their future scenarios.

6. Discussion

Our project aimed to flatten the current asymmetrical power dynamic regarding personal data usage so that everyone, from citizens to service providers and policymakers, can participate in discussions. In Phases one and two, we intended to empower citizens to confidently express their opinions on future desirable data-driven societies. The uniqueness of the empowerment approach is to employ the shared authorship level of the participatory speculative design (Farias et al. 2022), in which non-designer participants produce speculative designs alongside designers. We chose this level anticipating that it would improve not only the participants' belief that a data-driven society is relevant to them but also their confidence to take part in creating its future vision. As a result of the workshop we developed, we observed changes in the participants. Most participants, unfamiliar with personal data usage, created imaginary future stories and articulated shifts necessary for a desirable data-driven society. The comparison between pre- and post-workshop questionnaires also indicated their change in mindset on the potential of co-authoring a desired future data-driven society. In this section, we reflect on the first and second phases and discuss the benefits and limitations of conducting this participatory speculative study.

Regarding benefits, the shared authorship offered positive changes in participants. They were more motivated to get involved in making a desirable future vision together than before the workshop. They also developed vocabulary about the topic and manifested the shifts necessary for a better future data-driven society using PESTLE analysis, even though they were not very interested in a data-driven society before the workshop. This change is a crucial step in moving to the next level – the initiative or ownership of the participatory speculative design – which is necessary for long-term cultural change (Baumann et al. 2017). These levels require self-mobilization (Cornwall 2008, Farias et al. 2022), the sense of which that has grown in our participants during the workshop. Some of them even mentioned in the free text section of the questionnaire that they would like to be facilitators of conducting the workshop in their communities. Practicing the shared-authorship speculative design creates the steppingstones needed to jump to the next levels.

The other benefit is that the shared authorship level of speculative design allows for various designer involvements. For example, 'Sankofa City' project was conducted at the same level at which residents produced speculative designs with design students (Baumann et al. 2018, (Baumann et al. 2017). While the project required design students to make movies and objects during the entire design process, we did not need such designer involvement during our design process because we chose novels as a medium of speculative design. Text allows people without design experience to express their imaginations and makes designers and non-designers equal, which makes the critique sessions lively. Different degrees of involvement could be designed depending on the number of designers in the project and whether or not there is an objective to train designers.

To achieve the participant-led shared-authorship speculative design, we carefully crafted tools as scaffolding so that non-expert designers could find and express their desirability (Teal and French 2020). For example, designing the appropriate vagueness of the illustration representing a persona on the persona cards was crucial. We first used concrete pictures; however, during the test runs, these representations prevented the participants from projecting themselves onto the personas and creating unique scenarios of what actions the personas would take. Because an artifact with a certain level of openness and closedness stimulates people's imagination (Kitazaki 2018, Kitazaki et al. 2019), careful adjustment is essential to the designer's work.

The other tool that was essential to fuel participant-led shared-authorship speculative design was the online platform. It played the role of a designer, which beautifully laid out the texts in a vertical writing style familiar to the Japanese. The fact that the novel was officially published online, and that other participants could see the novel, created good peer pressure. As a result, good quality can be maintained without any help from designers or facilitators.

In terms of limitations, scaling up practices of the shared authorship level of the speculative design takes time if designer involvement is needed. To create a situation in which this workshop can take place in local communities, the following two efforts are necessary. First, the tools created by the designers would need to be made available for worldwide distribution. Second, as our participants mentioned, facilitators are needed. There is also a need to design facilitator guidebooks and online training courses. If the designers delegate the role of facilitator to others, we can empower them to reach the next level of initiation and ownership of the participatory speculative design.

7. Future Work

The third phase involves engaging a broader range of stakeholders, including data processors, data utilizers, and those in positions of leadership, in addition to data providers. Facilitating open dialogue and fostering empathy among these stakeholders are crucial to achieving our goals. Concurrently, we are actively expanding the citizen empowerment workshop from the second phase by motivating community leaders and enhancing the distribution system. As a result of practicing the three phases of co-speculation, we are looking forward to a healthy civil society where multiple stakeholders from different positions can talk to each other, respect different opinions, and decide things together.

Additionally, as Baumann et al. (2017) highlighted, we must also identify the components of an infrastructure for co-speculation because it has the potential to become part of the infrastructure of a future democracy where citizens are part of the policymaking process. Upon completing all three phases, we will conduct a comprehensive reflection on our work to gain insights that will contribute to long-term social and cultural innovation.

References

Auger, James. 2013. “Speculative Design: Crafting the Speculation.” *Digital Creativity* 24 (1): 11–35. https://doi.org/10.1080/14626268.2013.767276.

Baumann, Karl, Ben Caldwell, François Bar, and Benjamin Stokes. 2018. “Participatory Design Fiction: Community Storytelling for Speculative Urban Technologies.” Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems, April. https://doi.org/10.1145/3170427.3186601.

Baumann, Karl, Benjamin Stokes, François Bar, and Ben Caldwell. 2017. “Infrastructures of the Imagination: Community Design for Speculative Urban Technologies.” Proceedings of the 8th International Conference on Communities and Technologies, June, 266–69. https://doi.org/10.1145/3083671.3083700.

Cornwall, Andréa. 2008. “Unpacking ‘Participation’: Models, Meanings and Practices.” *Community Development Journal* 43 (3): 269–83. https://doi.org/10.1093/cdj/bsn010.

Dunne, Anthony, and Fiona Raby. 2013. Speculative Everything: Design, Fiction, and Social Dreaming. *MIT Press*.

Ehn, Pelle. 2017. “Scandinavian Design: On Participation and Skill.” In *CRC Press eBooks*, 41–77. https://doi.org/10.1201/9780203744338-4.

Farias, Pedro Gil, Roy Bendor, and Bregje F. Van Eekelen. 2022. “Social Dreaming Together: A Critical Exploration of Participatory Speculative Design.” Proceedings of the Participatory Design Conference 2022, August. https://doi.org/10.1145/3537797.3537826.

Feltwell, Tom, Shaun Lawson, Enrique Encinas, Conor Linehan, Ben Kirman, Deborah Maxwell, Tom Jenkins, and Stacey Kuznetsov. 2018. “‘Grand Visions’ for Post-Capitalist Human-Computer Interaction.” Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems, April. https://doi.org/10.1145/3170427.3170609.

Gerber, Alix. 2018. “Participatory Speculation: Futures of Public Safety.” Proceedings of the 15th Participatory Design Conference, August. https://doi.org/10.1145/3210604.3210640.

Hitachi, Ltd. 2020. “Fifth Survey on Consumer Information Handled by Big Data,” December 22, 2020. Accessed November 11, 2023. https://www.hitachi.co.jp/New/cnews/month/2020/12/1222a.pdf.

Kitazaki, Masako. 2018. “Connected Resources: A Research through Design Approach to Designing for Older People’s Resourcefulness.” 2018. https://repository.tudelft.nl/islandora/object/uuid:f72db950-9816-4e06-b2aa-cb73fb9ac418.

Kitazaki, Masako, Fumiya Akasaka, Riichiro Take, Ryoko Koborita, and Kazushi Ishigaki. 2023. “Miscommunications Made by Data - Implications for Personal Data Use Explored through the Project CoDa: Co-Speculation for Future Data Use.” The 11th Conference of the Society for Serviceology, March. https://coda-pj.org/outcome-2/.

Kitazaki, Masako, Iohanna Nicenboim, Elisa Giaccardi, and Benjamin Lopez. 2019. “Connected Resources - A Research through Design Approach to Designing for Older People’s Resourcefulness.” RTD2019 *Research Through Design*, April. https://doi.org/10.6084/m9.figshare.7855868.v2.

Kozubæv, Sandjar. 2016. “Stop Nigmas.” Proceedings of the 9th Nordic Conference on Human-Computer Interaction, October. https://doi.org/10.1145/2971485.2993921.

Kozubæv, Sandjar, Chris Elsden, Noura Howell, Marie Louise Juul Søndergaard, Nick Merrill, Britta Schulte, and Richmond Y. Wong. 2020. “Expanding Modes of Reflection in Design Futuring.” Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, April. https://doi.org/10.1145/3313831.3376526.

Manski, Sarah. 2017. “Building the Blockchain World: Technological Commonwealth or Just More of the Same?” *Strategic Change* 26 (5): 511–22. https://doi.org/10.1002/jsc.2151.

Pschetz, Larissa, Kruakae Pothong, and Chris Speed. 2019. “Autonomous Distributed Energy Systems.” Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, May. https://doi.org/10.1145/3290605.3300617.

Stals, Shenando, Michael Smyth, and Oli Mival. 2019. “UrbanIxD: From Ethnography to Speculative Design Fictions for the Hybrid City.” Proceedings of the Halfway to the Future Symposium 2019, November. https://doi.org/10.1145/3363384.3363486.

Teal, Gemma, and Tara French. 2020. “Spaces for Participatory Design Innovation.” Proceedings of the 16th Participatory Design Conference 2020, June. https://doi.org/10.1145/3385010.3385026.

Tuters, Marc, and Kazys Varnelis. 2006. “Beyond Locative Media: Giving Shape to the Internet of Things.” *Leonardo* 39 (4): 357–63. https://doi.org/10.1162/leon.2006.39.4.357.

Voss, Georgina, Tobias Revell, and Justin Pickard. 2015. “Speculative Design and the Future of an Ageing Population Report 2: Techniques.” *Foresight*, July. https://assets.publishing.service.gov.uk/media/5a7f348740f0b6230268e150/speculative-design-workshop-techniques.pdf.

Two Approaches to Human-decentred Design: Between Life and Matter

Authors:
Nobuhiro Masuda[1]
Yosaku Matsutani[2]
Yasuharu Akiyoshi[3]
Juppo Yokokawa[4]
Kazuhiro Jo[1, 5]

Institutions:
[1]Kyushu University, Fukuoka (Japan)
[2]Otemon Gakuin University, Osaka (Japan)
[3]Kyoto Seika University, Kyoto (Japan)
[4]Tokyo University of the Arts, Tokyo (Japan)
[5]YCAM, Yamaguchi (Japan)

Abstract

This paper aims to present the significance of decentring the human being in design practice through an approach called Human-decentred Design (HDD) for overcoming ecological and economic problems mainly caused by Human-centred Design (HCD). We argue that the fundamental cause of these problems lies in the preservation of anthropocentric standardizations at the core of technology under capitalist imperatives. From this critical perspective, this paper introduces two projects, A *Record without Prior Acoustic Information* by Kazuhiro Jo and *Chromatophony* by Juppo Yokokawa, which are designed respectively corresponding with alternative materials or living tissues for challenging the established standards of audiovisual media, such as high/low-fidelity sound, frame rate, and resolution. In doing so, we demonstrate that HDD, which aims to be entangled with brute and living materials, serves as a means of repositioning technology within an ecology of life and matter, an energy flow beyond the human realm.

Keywords: Human-(de)centred design, ecology, materiality, biodesign, nonhuman

Introduction

The purpose of this paper is to present two examples of what we call Human-decentred Design in order to overcome the industrial and ecological predicaments caused by Human-centred Design. Human-decentred Design refers to an attempt to problematize the anthropocentrism behind current design through our projects corresponding with nonhuman materials and life. Although this is currently only a tentative definition, we would like to introduce two specific attempts to embody and show the effectiveness of this approach, referring to the preceding discussions related to it.

A prime example of the problems caused by Human-centred Design is the excessive use of plastic. Especially in Japan, we can see over-wrapping even for individual vegetables for a clean and hygienic image. An article reporting on this also points to the deception about the recycling system in this country (Denyer 2019). According to government reports, Japan is an excellent country recycling 86% of its plastic waste. However, 58% of it is used as fuel for 'thermal recycling' and another 14% is exported to other Asian countries without regard to its end. Needless to say, these deceptions are causing environmental problems such as greenhouse gasses and economic disparity.

Our goal, however, is not to solve these problems directly. Because they are not limited to over-packaging but are relevant to the Human-centred Design that has relied on this material for a century. Furthermore, we believe that this problem is linked to the need to fundamentally rethink the concept of technology itself, which deals with various materials including plastics.
There is no doubt that one of the factors accelerating the abuse of plastic derives from capitalist imperatives. The relentless pursuit of innovation will put issues such as declining biodegradability and overmining energy resources on a secondary or background level. Why does this happen? One of the main reasons, we believe, is that the value and meaning of technology are standardized according to the criterion of human scales.

In the case of audiovisual media, for example, advanced reproducibility of sound and images has been refined continually, while their specifications, such as fidelity and resolution, remain untouched and unreviewed. As the numbers and values indicating high reproducibility, such as 8K and 60 fps, have risen to obsessive levels, what is more surprising is that the standards themselves have hardly changed. This is where the significance of Human-decentred Design becomes apparent because it allows us to revisit and challenge the standardization from the sides of the materials and the organisms, not just humans. Two examples of this are the following projects on which we are working.

1. A Record without Prior Acoustic Information: Designing with Brute Materials

The first example is *A Record without Prior Acoustic Information* designed by Kazuhiro Jo, who attempts to reinvent the record through materials other than vinyl used in ordinary analog records. The title was inspired by the visionary words of designer László Moholy-Nagy (1895-1946) a century ago.

"I have suggested to change the gramophone from a reproductive instrument to a productive one, so that on a record without prior acoustic information, the acoustic information, the acoustic phenomenon itself originates by engraving the necessary Ritchriftreihen (etched grooves)" (Moholy-Nagy [1923] 1989, pp.54-56).

After nine decades, we realized this idea by using several materials including wood, paper, metal, and porcelain, with the help of current do-it-yourself (DIY) digital tools such as laser cutters or cutting plotters. We could not only play some music with these records but also discern the texture of sounds according to the differences of each material. [Figure 1]

The work features a motif from a French folk song "Au Clair de la Lune," engraved on a sooted paper by French inventor Édouard-Léon Scott de Martinville (1817-1879) in 1860, which is believed to be the earliest recording of the human voice at that time (Feaster 2012). Jo first determined the frequencies of the melody from the score. Next, he drew the sine waveforms corresponding to the melody in Adobe Illustrator. Finally, he used the laser cutter or cutting plotter to engrave those waveforms into the chosen materials in horizontal grooves.

However, the employed method varies somewhat depending on the material such as a laser cutter with the wood, and a cutting plotter with the paper to carve the groove. The metal for reproducing the tune on a gramophone, a device contemporary with Moholy-Nagy's provocative idea, was examined for a material that could withstand high needle pressure. Ultimately, an anodized aluminum plate coated with lacquer was selected, which closely resembles the material used for the master recordings of traditional vinyl. With the porcelain, in collaboration with a potter, the grooves were carved into the clay before it was glazed and baked.

Although these grooves with diverse materials produce vibrations that are based on the same digital data (i.e., an Adobe Illustrator file), their actual sounds are not only different but also change over time due to the difference in materiality. This makes us reconsider the temporal durability and sustainability of each media. Wood and paper records decompose more easily than vinyl, and the grooves are more prone to deterioration. Metal records last longer than vinyl, but the grooves deteriorate more quickly. Porcelain records are the longest lasting and the grooves can probably be preserved for thousands of years. These possible facts encourage us to reevaluate the meaning and value of sound media around the material reality of duration and transformation rather than the standardized idea of fidelity.

From this perspective, each of Jo's works stands in contrast to the social demands of the mass production market for vinyl records due to their inherent limitations in terms of scalability in creation. The works also suggest the possibility of escaping the characteristics associated with vinyl records, such as audiophilic and nostalgic attachments, as well as the dependence on the oil economy in their format.

Figure 1: Kazuhiro Jo, *A Record without Prior Acoustic Information* (2013) Clockwise from top left, wood, metal, porcelain and paper.

2. Chromatophony: Designing with Living Materials

The second example is *Chromatophony* by Juppo Yokokawa. Composed of the excised portion of a squid's skin, this work transforms its colour-changing ability into an audio-visualizer. It is well known that cephalopods, including squid and octopus, can change their skin colours and patterns. These visual signals serve various purposes, such as camouflage, intimidation, and communication (Hanlon 2007). This unique biological phenomenon is enabled by the tissue called chromatophores, small pigment-filled sacs surrounded by muscles and nerves (Messenger 2001).

Using this biological mechanism, although there have been attempts to induce changes in the body colour of squid by using existing music as electrical stimulation (Backyard Brains 2012), Yokokawa designed proper sound signals for *Chromatophony*, that are more likely to elicit a response from the chromatophores. As a result, it realizes the vivid appearance and disappearance of vibrant mosaics transforming and changing rhythmically as moving images. This work presents dynamic changes under an optical microscope in a magnified state and is currently available on YouTube. It should be noted, however, that the changes in the chromatophores are visible to the naked eye, and the results are markedly different from those observed through the display. Because there are no frame rates and resolutions in the usual sense. [Figure 2]

From a historical perspective, moving images have been standardized with reference to the human eye. It is not possible to represent motion well if a film strip of frames simply passes in front of the lens of a projector (Mannoni 2000). To solve this problem, the early developers first made each frame image stand still temporarily in front of the lens and then sent it out, while at the same time placing the blade shutter in front of the lens to create a steady rhythm of blinking light. However, this alone would cause a flicker, so the number of frames and blinking light presented at a certain rate were explored. The appropriate ratios were designed to create images with stable motion without flicker, such as 16 frames and blinking lights per second, 24 frames and 48 blinking lights per second, and so on. It is clear from this fact that the standardization of frame rate is derived from the relationship with the human eye: whether it is 'natural' is based on human perception.

This history of technology since the cinema allows us to reinterpret the images presented by Chromatophony in a different way. As mentioned above, the appearance of various colours and patterns on a white surface, caused by the contraction and expansion of chromatophores, looks like a digital pixelated screen or, in earlier examples, as if a pointillism of an impressionist painting is moved (Yokokawa et al. 2022). However, in contrast to these examples, which were also realized based on human perception, squid and other cephalopods had realized colour variations that surpassed them in an evolutionary span. Because they do not assume human vision, we are fascinated by the vibrancy and diversity of their colours.

What makes this point even more enigmatic is that squid has been found to be dichromatopsia, or so-called colour blindness in the human sense, although it is unclear why the squid is able to achieve such rich body colour variation. Furthermore, it has been suggested that cephalopods may change their body colour through the mode of distributed control by skin cells and nerves, not necessarily by the brain alone (Godfrey Smith 2017), which is contrasted to the central control just as digital displays. Thus, the abstracted and dynamic images by colour change of the squid body lead us to rethink designs and technologies that have been standardized to suit human values and meanings.

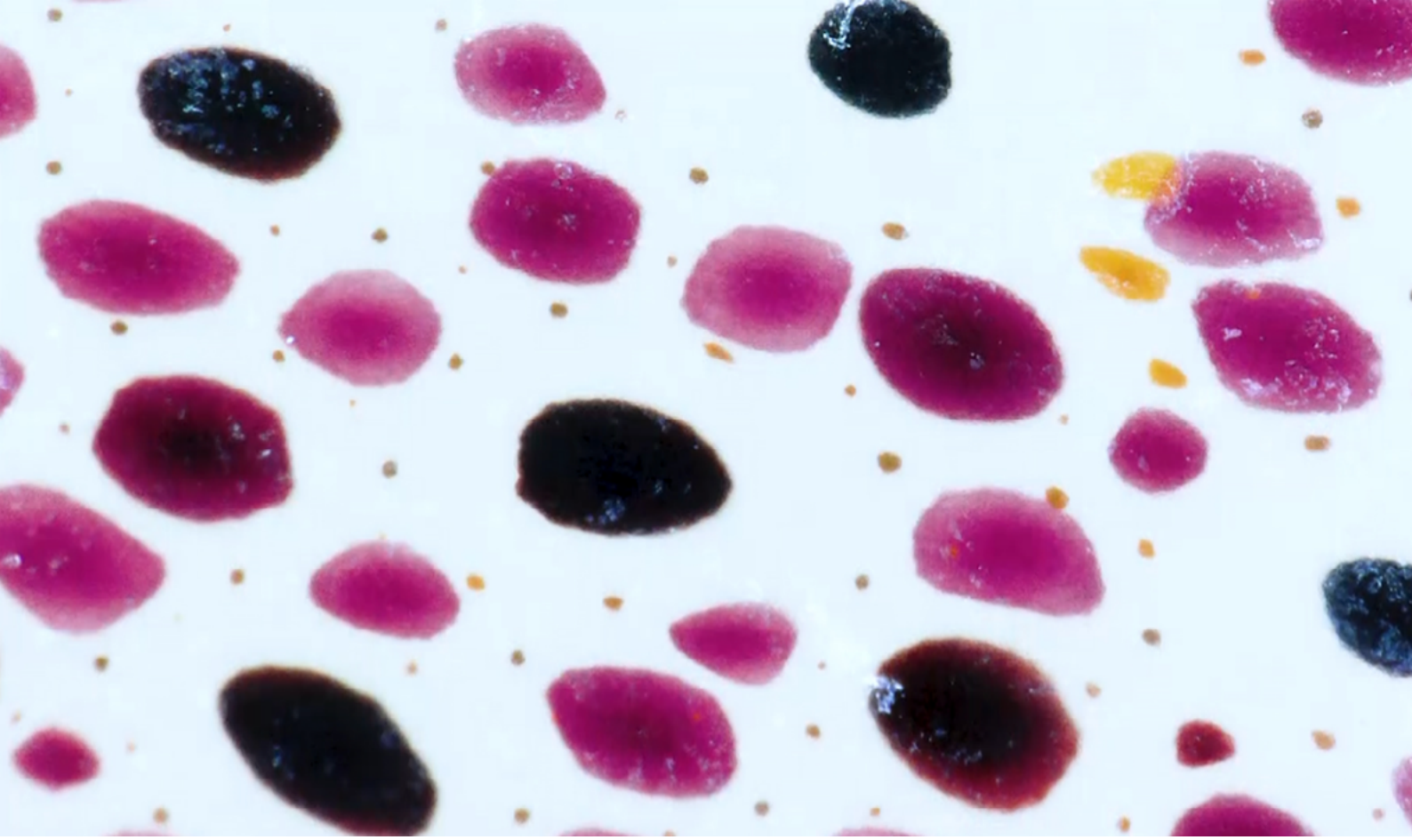


Figure 2: Juppo Yokokawa, *Chromatophony* (2019, Screen Capture)

3. Discussions

What insights can be gained by these audiovisual media designs? As a useful reference, Devine (2019) reconsiders the material history of the music industry from a political ecology perspective. His work is divided into three parts, each of which mainly focuses on three raw materials used for recorded media: shellac (1900-1950), plastic (1950-2000), and data (2000-). The author then carefully traces the history of both ecological and economic exploitation caused by the music industry in the United States of America.

To cite a striking example, the book opens by noting that the recent vinyl revival in North America has unfairly relied on a single company in Thailand to manufacture PVC, reproducing the environmental pollution and health problems that once occurred in the USA. These facts suggest that no matter how technology appears to advance, the nature of an industry that has accelerated resource mining and energy consumption remains unchanged. “[E]very time a needle glides through a groove,” as Devine (2019) argues, “people suffer, communities scatter, oils spill, environments suffocate, wars storm, empires soar” under the regime of fuel economy (p.7). The ideal of endless improvements in fidelity and resolution has served as an ideology to disguise these material realities.

Returning to Jo's work in the light of these discussions, this work not only indicates an alternative genealogy to the orthodox history of audio media but also foregrounds its materiality with their noises prior to the meaning and value assigned by the human ideal of fidelity. Although such noises are generally characterized as unwanted sounds, the humming, hissing, or crackling noise of different media (radio, magnetic tape, vinyl, etc.) can also be seen as elements with their own material and aesthetic value (Cox, 2018). Therefore, we could hear the accidental sounds in Jo’s records as the ‘voices’ of their materials rather than unexpected or meaningless noises. In addition, when we contrast the distinct sounds of wood, paper, metal, and porcelain with the familiar resonance of vinyl, it becomes apparent that our works exhibit a delicate material nature due to their susceptibility to burning, cutting, shaving, and breaking. These characteristics contrast with the tough character of vinyl, as Devine (2019) has pointed out, both materially (strong but supple, bending but rarely breaking, and potentially emitting toxic smoke) and socially (LPs circulating almost endlessly in second-hand economies).

Reflecting on this situation, some scholars have recently begun to criticize the anthropocentric view of technology and design that regards nonhuman beings – both living and non-living – as mere economic resources, questioning the better relationship with them. In particular, nonhuman organisms remind us that they are not always completely controlled by humans as objects of design. In the case of *Chromatophony*, the image that emerges is not only different for individual squid but also changes over time after the skin is sliced, making it impossible to reproduce the same image. Even if this impossibility of reproduction appears inappropriate for design products, we can draw from it the critical considerations about technology.

From a new perspective of ‘ecomusicology’, Dawe (2016) draws attention to the fact that the tradition of musical instrument-making has intrinsically intertwined with the material world. For them, “the wood, bone, skin, metals, and clay” are “agents of a material reality that affects the construction of musical cultures at the most fundamental level” (Dawe 2016, p.109).

For them, materials are not just an inanimate resource. Since materials fundamentally determine the tone quality of an instrument, caring for forests and mountains is essential to both the economy and aesthetics of acoustic instrument makers. Of course, this focus on traditional practice might be seen as a kind of nostalgic return from highly developed technology. However, there is no doubt that such arguments are fundamentally related to the practice of technological design, leading to a critical reassessment of the very concept of technology itself. What is important here is that when we think of design as entangled with non-humans, it opens up the possibility of transformation not only of objects, tools, and techniques but also of us humans ourselves (Masuda et al. 2023).

From this point, we could go further on a more fundamental level on this issue with the help of anthropologist's thought. Ingold (2011) criticizes the classical concept of technology because this concept has traditionally been associated with anthropocentric ideas, "that things are constituted in the rational and rule-governed transposition of preconceived form onto inert substance" (p. 212). According to him, this is a variation of hylomorphism that has governed Western thoughts, including the practice of design. This is because it is precisely in the realm of design that the stereotype has prevailed that "[f]orm came to be seen as imposed by an agent with a particular design in mind, while matter, thus rendered passive and inert, became that which was imposed upon" (Ingold 2011, p.210).

Here we can see the fundamental reason why the standardization of technology has been fixed and maintained in the anthropocentric realm. Criteria such as fidelity and resolution are not merely indicators of enhanced attractiveness to the consumer but also serve as the basis on which designers, whether consciously or unconsciously, impose their ideas as form into inert matter. In sum, fixing anthropocentric criteria was the axis for the effective advancement of human-centred design. On the contrary, Ingold (2011) proposes the designer as a practitioner who "is intervening in the fields of force and currents of material wherein forms are generated" (p.211). What such a designer can do is nothing other than follow and bend its course to their evolving purpose. Developing this proposal through the two projects examined above, we can define the human-decentred design as a practice that unfolds in a dynamic flow of meshwork that continues to change with nonhumans and the environment, rather than aims to control them.

Conclusion

From the discussion so far, we suggest again the significance of decentring the human in design practices for overcoming anthropogenic problems. In the impasse of Human-centred Design, its relentless pursuit of innovation has preserved the anthropocentric standardization at the core of technology. In contrast, our project challenges the established standards or criteria such as hi/lo-fi sound, frame rate, and resolution, and is oriented toward the design corresponding with brute or living materials (Ingold 2012). Although these attempts could not immediately solve the problem of plastic waste or e-waste and energy consumption, they could be a step to envision a designer who would effectively follow and bend the flows of material for the transformations of design under capitalism. Then, Human-decentred Design should be a means of relocating technology within an ecology of life and matter, a flow of energy beyond the human realm.

Acknowledgement: *This paper was supported by JSPS KAKENHI 21H00495, 23H00579, 23H00591.*

References

Backyard Brains. 2012. Insane in the Chromatophores. Backyard Brains: Neuroscience for Everyone!. https://blog.backyardbrains.com/2012/08/insane-in-the-chromatophores/ (Accessed on 9 November 2023)

Cox, Cristoph. 2018. Sonic flux: Sound, Art, and Metaphysics. Chicago: *University of Chicago Press*.

Dawe, Kevin. 2016. Materials Matter: Towards a Political Ecology of Musical Instrument Making. In *Current Directions in Ecomusicology: Music, Culture*, Nature. Edited by Aaron S. Allen and Kevin Dawe. New York and London: Routledge, pp.109-121.

Denyer, Simon. 2019. Japan Wraps Everything in Plastic. Now It Wants to Fight Against Plastic Pollution. *The Washington Post*, https://www.washingtonpost.com/world/asia_pacific/japan-wraps-everything-in-plastic-now-it-wants-to-fight-against-plastic-pollution/2019/06/18/463fa73c-7298-11e9-9331-30bc5836f48e_story.html (Accessed on 9 November 2023)

Devine, Kyle. 2019. Decomposed: The Political Ecology of Music. Cambridge, MA.: *The MIT Press*.

Dunne, Anthony and Raby, Fiona. 2013. Speculative Everything: Design, Fiction, and Social Dreaming. Cambridge, MA.: *The MIT Press*.

Feaster, Patrick. 2012. *Pictures of Sound: One Thousand Years of Educed Audio*: 980-1980. Atlanta: Dust to Digital.

Godfrey-Smith, P. 2017. *Other Minds: The Octopus, the Sea, and the Deep Origins of Consciousness*. New York: Farrar Straus & Giroux.

Hanlon, Roger. 2007. Cephalopod Dynamic Camouflage. *Current Biology* 17, no. 11: 400-404.

Ingold, Tim. 2011. *Being Alive: Essays on Movement, Knowledge and Description*. New York and London: Routledge.

Ingold, Tim. 2012. Toward an Ecology of Materials. *Annual Review of Anthropology* 41, no.1: 427-442.

Jo, Kazuhiro. 2014. The Role of Mechanical Reproduction in (What was Formerly Known as) the Record in the Age of Personal Fabrication. *Leonardo Music Journal* 24: 65-67.

Jo, Kazuhiro. 2023. Wood, Paper, Metal, and Porcelain - A Record Without Prior Acoustic Information – [Exhibition]. EUREKA, Fukuoka, Japan.

Mannoni, Laurent. 2000. The Great Art of Light and Shadow: Archaeology of the Cinema. Translated and edited by Richard Crangle. Exeter: *University of Exeter Press*.

Masuda, Nobuhiro, Matsutani, Yosaku, Akiyoshi, Yasuharu, Jo, Kazuhiro and Yokokawa, Juppo. 2023. Reinventing Phonography: Three Case Studies of the Transduction. ISEA2022: International Symposium on Electronic Art, Barcelona: 861-863.

Messenger, J. B. 2001. Cephalopod Chromatophores: Neurobiology and Natural History. *Biological Reviews* 76, no.4: 473-528.

Moholy-Nagy, László. 1989. New Plasticism in Music: Possibilities of the Gramophone. In *Broken Music: Artists' Recordworks*. Edited by Ursula Block and Michael Glasmeier. Berlin: Berliner, Künstlerprogramm des DAAD and gelbe MUSIK, pp. 54-56. First published 1923.

Yokokawa, Juppo, Masuda, Nobuhiro, Jo, Kazuhiro. 2022. Chromatophony: A Potential Application of Living Images in the Pixel Era. *Leonardo* 55, no.3: 252–257.

Science Fiction and Design Fiction to Learn About AI

Author:
Luisa Mok

Institution:
Division of Emerging Interdisciplinary Areas, Academy of Interdisciplinary Studies, The Hong Kong University of Science and Technology (Hong Kong SAR)

Abstract

Artificial intelligence (AI) has been thriving fast and is reshaping the world. Alongside technology advances are ongoing concerns that the AI boom will have a pervasive influence on society and the environment. Amid such massive socio-technical transformation, an alternative approach is required to envision desirable AI futures. Surrounding disciplines studying technology futures, science fiction (sci-fi) in literature and design fiction in artefacts provide creative and inquisitive approaches to inquire futures. This case study research develops a new theoretical proposition integrating sci-fi and design fiction aiming to enhance students to learn about AI in wider socio-technical context and accept their accountability for technology futures. The proposition is applied to a design course on AI to explore the reasoning in advancing design education through integrating the two fields of knowledge. The research result demonstrates a new approach to learn about AI and proposes a new interdisciplinary research area in design research.

Keywords: Design fiction, speculative design, science fiction, artificial intelligence, socio-technical transformations

Introduction

Artificial intelligence (AI) has been thriving, consequently reshaping the world. Such technological advances have brought concerns that the AI boom will have a pervasive influence on society and the environment. Even AI experts have made public their concerns about the unforeseen effects of AI's future development (Crawford 2021; Mitchell 2019). An equally critical issue is algorithmic bias due to constructed human stereotypes, creating new social problems (Heaven 2020). In the context of education, most science and technology students are competent in innovating AI systems. However, they may not take the critical view of this technological advancement that is necessary to understand AI in a wider context and accept their accountability for technology futures. Amid such massive socio-technical transformation and the ensuing unforeseen consequences, an alternative approach is required to envision desirable AI futures. This study proposes such an alternative approach, specifically comprising an integrated knowledge of science fiction (sci-fi) and design fiction and explores the reasoning underlying this advance in design education.

Surrounding disciplines studying technology futures, both sci-fi and design fiction adopt similar inquisitive approaches. However, the driving theories behind their approaches and methods are distinct. Such similarities and differences are likely to indicate a complementary relationship between the two. Yet an interdisciplinary approach that integrates sci-fi and design fiction to address technology transformations has remained unaddressed in the design discipline. Therefore, to push the knowledge frontier, this research integrates sci-fi and design fiction. The research aims are defined as to explore a new approach to learn about and discuss AI and to propose a new pedagogical framework to enhance design education. To fulfil the research aims, three research questions are set,

1. How can sci-fi and design fiction complement each other to enhance the study of technology futures?
2. What form of approach can be provided to study technology futures?
3. How does this new pedagogical framework enhance design education?

The exploration is conducted in a new design course running in Spring 2023, titled 'AI, Design and Sci-Fi: Coding 2053'. The research plan involves, first, developing a conceptual proposition by drawing theoretical insights from sci-fi and design fiction literature. Next, this proposition is used to structure a new pedagogical framework for the design course. Applying a case study research method, the adequacy of integrating sci-fi and design fiction to enhance learning of AI is assessed. Finally, this paper concludes with the case study results and an analysis, as well as student feedback.

Literature Review

"It has become axiomatic to say that the world is becoming like science fiction" (Vint 2021, 1). Sci-fi extrapolates possible future ways of living from actual science and emerging technologies and may present either a world perfected by technologies or a dystopia caused by the societal impact of technology (Vint 2021). 'Social' sci-fi furthermore conceptualizes widespread socio-technical changes and explores the social implications of such changes for society and humans (Gerlach and Hamilton 2003). From classical novels by renowned writers including Philip K. Dick, Isaac Asimov and Ray Bradbury to contemporary works by Kazuo Ishiguro and Ted Chiang, sci-fi stories have extrapolated possible yet undesirable AI futures impacting humans and the environment. While sci-fi is futuristic and fictional, it does present truths about how people negotiate a futuristic world.

Design fiction is a field of design that takes a tangible approach to visualizing and inquiring into socio-technology futures. In this paper, the concept of speculative design is specifically adopted for its focus on probing into advancing science and technology. Anthony Dunne and Fiona Raby (2013) have conducted socio-technical explorations through speculative design. The word 'speculative' in this context stresses the use of solid scientific support when conjecturing about future scenarios, to avoid a work of complete fantasy. When defining preferrable futures, a path from where we stand today to our future is visualized in the speculative scenario (Dunne and Raby 2013).

Above all, design fiction does not tell stories as sci-fi does; rather, it materializes and illustrates technology's impact on society to provoke people to think forward and explore making changes to achieve preferrable futures.
In summary, the aim of both sci-fi and design fiction is exploring technology futures. However, the former produces knowledge in the form of literature, and the latter produces it in a tangible form. The difference between the two disciplines in the forms of knowledge produced may be explained by their respective distinctive modes of thinking: writing and prototyping, respectively. Using the two thinking modes together constitutes a new, integrated approach to learning AI. The following section analyzes the two bodies of disciplinary knowledge to derive theoretical insights.

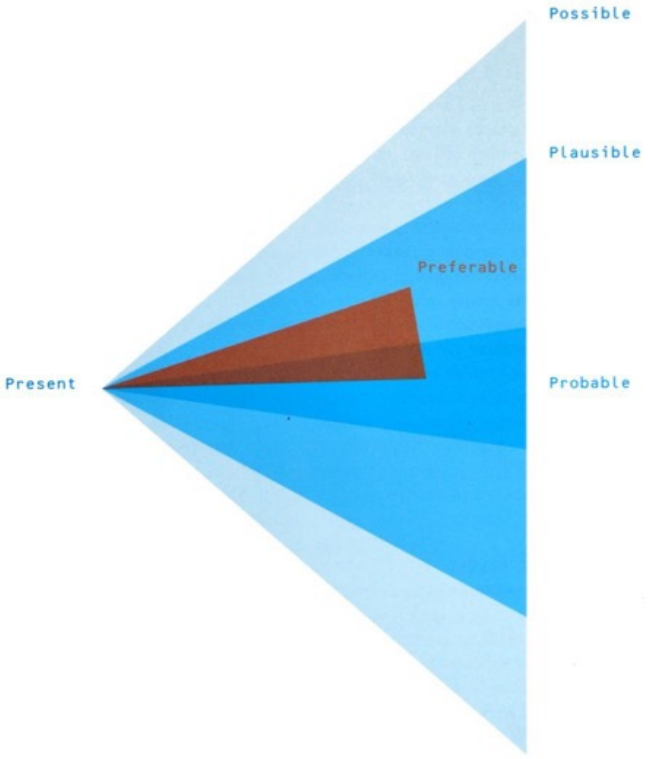


Figure 1: As illustrated in the PPPP diagram, Speculative design focuses on defining Preferrable futures. Adapted by Dunne and Raby from the futurologist Stuart Candy and re-represented by Dunne and Raby (Dunne and Raby, 2013:4, 5).

Initial Theoretical Proposition: Integrating Science Fiction and Design Fiction

This section draws theoretical insights from the review of the sci-fi and design fiction bodies of literature. The integration of these two bodies of knowledge into an initial proposition is explained below.

Sci-fi is text-based, in that it articulates futures in text form. The driving theory behind this form of expression is analyzed in terms of complex cognitive processes, to comprehend and pursue new ideas (Flower and Hayes 1981). The foundational elements of writing sci-fi are the sci-fi novum, worldbuilding, plot and characters. 'Sci-fi novum' describes scientifical innovations that are futuristic but scientifically plausible (Suvin 1972). Worldbuilding, as defined by Nora Keita Jemisin (2019), is the context of a story that constructs a possible future world. This context includes both the physical environment where the story takes place, such as the planet and ecology as well as the cultural and societal conditions developing from the physical environment. Jemisin called the former context as macro-worldbuilding and the latter micro-worldbuilding. Plot refers to what happens in a story, specifically a series of events in a timeline, with each event affecting each other. Character is informed by both macro- and micro-worldbuilding wherein the behaviours and the inner worlds of each character as well as the conversations between characters introduce experiences of the futures. The novum, worldbuilding, plot, and characters interplay in an exploration of socio-technical implications in a sci-fi story (Zaidi 2019). Vint (2021) describes sci-fi as a tool for us to speculate a vision of the world and negotiate technological changes.

Different from sci-fi, design fiction is artefact-based, in that it articulates futures in tangible forms. The driving theory behind prototyping in tangible forms is studied as a cognitive modelling process to organize new concepts and solve problems through reasoning aloud (Archer 1979). Furthermore, the concept of prototyping in design fiction is closely associated with the field of industrial design, for the nature of design problems necessitates that industrial designers prototype to think of appropriate solutions (Malpass 2017). Furthermore, the visual literacy of industrial design engenders meaningful interpretations of artifacts producing a visual form of knowledge (Goldschmidt 2015). Design fiction involves prototyping fictional products as well as future technology scenarios wherein the artefacts are subsumed within larger future contexts to connect the present and future (Malpasse 2017). Through linking fiction and reality, the effects of the technology emerging in futures are strategically brought to the forefront and considered in an everyday context, which is the essence of design fiction. The physical outcome of prototyping in design fiction does not aim to dictate one solution for technology futures. Rather, it is used to systematically learn and develop various possible future scenarios with the aim of determining how things should be experienced in the future (Dunne and Raby 2013). The discipline provides a vocabulary with which to discuss the future as well as an explorative tool with which to interact with the future. To communicate fiction and reality, the aesthetic quality of design is applied whereby artefacts are usually built in abstract forms with minimal details to reduce functionality; however, they should be well defined and clear enough to retain realness and accuracy (Dunne and Raby 2013; Malpass 2014). Ultimately, these 'real-fiction' setups engage people in experiencing future technology more closely to facilitate their exploration of making changes towards preferrable futures.

I studied the literature further to yield theoretical insights from the fields and four major theoretical insights are drawn:

Scientific extrapolation: sci-fi extrapolates technology trends from actual science and emerging technologies.

Worldbuilding: sci-fi clarifies socio-technical dynamics through writing narrative that interplays between sci-fi novum, worldbuilding, plot and characters.

Prototyping fictional futures in everyday reality: design fiction prototypes tangible fictional artefacts and poses what-if future technology scenarios in everyday reality to conjecture possibilities and examine emerging problems through linking preferrable future to the present.

Experiencing technology futures: enables and concretizes experiences with future technologies in a changed world through interacting with the fictional product and scenario setups.

In addition to the theoretical insights, their implications for enhancing the learning of AI are analyzed, as these are also significant. The writing mode of sci-fi enhances the comprehension of technology trends and clarifies socio-technical dynamics of rich sci-fi narration. Thus, sci-fi can be used as research as well as inspiration to support design fiction for the purpose of learning AI. Moreover, the prototyping mode of design fiction can operationalize the sci-fi narrative as a tool to study AI by posing 'what if' scenarios, as well as concretize the experience of futures in the changed world. In this respect, design fiction can be used as an explorative tool to complement sci-fi for experiential learning of AI. The implications of AI learning are listed as below:

Research: To learn AI needs to understand technology trends based on actual science. In this view, sci-fi narrative is used as research for scientific understanding.

Inspiration: To learn AI needs to address societal impacts of technology. About this point, sci-fi narrative is used as inspiration to incite socio-technical interactions and experiences in technology futures.

Exploration: To learn AI needs to realize problems emerging in future when specific future technology is adapted into an everyday context as well as explore possibilities of a preferrable future when changes are implied. In this view, prototyping in design fiction is used as an explorative tool to examine alternative scenarios for changes towards preferable futures.

Experience: To learn AI needs to systematically learn and evolve different paths towards how things should be experienced in preferrable futures. In light of this point, prototyping in design fiction is used as an experiential learning to experience technology futures.

Table 1 below lists the theoretical insights obtained from the sci-fi and design fiction review alongside their implications for enhancing AI learning (Table 1. Developing theoretical Sci-Fi insights and Design Fiction insights into AI learning implications).

The four insights and the four implications listed above indicate that the two thinking modes complement each other when used to achieve the research aim of enhancing the study of AI technology futures. Thus, the initial proposition is formed that the integration of sci-fi and design fiction should be adopted in a course to confirm its adequacy to facilitate the learning of AI.

Theoretical insights		AI learning implications
Sci-fi theoretical insights Scientific Extrapolation.	Sci-fi extrapolates technology trends from actual science and emerging technologies.	**Research:** To learn AI needs to understand technology trends based on actual science. In this view, Sci-Fi narrative is used as **research** for scientific understanding.
Worldbuilding.	Sci-fi clarifies socio-technical dynamics through writing narrative that interplays between sci-fi novum, worldbuilding, plot and characters.	**Inspiration:** To learn AI needs to address socio-technical impacts on society. About this point, Sci-Fi narrative is used as **inspiration** to incite socio-technical interactions and experiences in technology futures.
Design fiction theoretical insights Prototyping Future Scenarios in Everyday Reality.	Design fiction prototypes tangible fictional artefacts and what-if future technology scenarios in everyday reality to conjecture possibilities and examine emerging problems through linking preferrable future to the present.	**Exploration:** To learn AI needs to realize problems emerging in future when specific future technology is adapted into an everyday context as well as explore possibilities of a preferrable future when changes are implied. In this view, prototyping in Design Fiction is used as an **explorative tool** to examine alternative scenarios for changes towards preferable futures.
Experiencing Technology Futures.	Design fiction enables and concretizes experiences with future technologies in a changed world through interacting with the fictional product and scenario setups.	**Experience:** To learn AI needs to systematically learn and evolve different paths towards how things should be experienced in preferrable futures. In light of this point, prototyping in Design Fiction is used as an **experiential learning** to experience technology futures.

Table 1: Developing Theoretical Sci-Fi Insights and Design Fiction Insights into AI Learning Implications.

Research Method: Case Study

This research aims to determine whether AI learning can be enhanced by integrating sci-fi and design fiction in a course on AI. Regarding research strategy, the case study method is adopted and the cases under study are projects of an undergraduate course in the Hong Kong University of Science and Technology. This course, titled *AI, Design and Sci-Fi: Coding 2053*, targeted students across several schools and eight students from year two to year four attended the course. Amongst them, six students were from School of Engineering, one from School of Science and one from School of Business. The course lasted for one semester comprising thirteen weeks in Spring 2023. The students worked in teams and four teams were formed.

Case study method is adopted as a research method to assess the practical relevance of this proposed course content by capturing empirical evidence of such relevance. Specifically, the proposition formed in the above section regarding the integration of sci-fi and design fiction is applied to practical cases to capture empirical insights, which are then used to refine the concept and ensure its practical relevance (Eisenhardt 1989). In this research, causal relationship analysis is adopted to analyze the link between the proposition and the case results to establish internal validity (Gray, 2004; Yin, 2014 [1984]). Furthermore, a multiple-case study is planned to identify recursive patterns in the relationships across cases, to establish external validity (Eisenhardt and Graebner, 2007; Yin, 2014 [1984]).

The Pedagogical Framework: Design Course Content

The proposition of integrating sci-fi and design fiction is developed into a three-level pedagogical framework for the purpose of developing a course to facilitate learning AI.

The structured framework guides students to analyze the societal and environmental impacts of AI development. In addition, several preparations are also planned. First, a topical framework focusing on major socio-technical issues emerging from AI advancement is set. The four learning topics addressing critical concerns about AI growth are: human-machine relationships, future of humanity, agency, and the lost Earth. Next, sci-fi stories relevant to each topic are chosen, based on a literature selection criterion that is outlined earlier. Specifically, the stories must focus on AI technology and have a strong socio-cultural context. The six chosen sci-fi stories are as follows: *Runaround* (Asimov 1950), *Human Is*, *The Hood Maker* and *The Impossible Planet* (Dick 1955), *Klara and the Sun* (Ishiguro 2021), and *Exhalation* (Chiang 2008). Clear reading guidelines with two to three guiding questions for each selected sci-fi story are constructed. To provide guidance on and insights into how to read and write sci-fi, an English literature professor who focuses on sci-fi research is invited as a guest lecturer for one class period.

Table 2. Three-Level Pedagogical Framework to Learn AI, Applying the Initial Integrated Proposition.		
Levels	**Supportive teaching methods, learning activities and assessment:**	**Theoretical proposition adopted in the pedagogical framework:**
Level 1:		
Reading sci-fi and creating design fiction	Weeks 1 – 5: – Topical framework with four topics – Six selected Sci-Fi with Literature Selection Criteria – Reading guidelines and Prototyping guidelines – Smaller-scale fictional artefacts – Guest lecture on how to read and write Sci-Fi	– Adopt Sci-Fi as Research for Scientific Extrapolation – Adopt Sci-Fi as Inspiration for Worldbuilding – Adopt Design Fiction as Exploration to Prototyping Future Scenarios in Everyday Reality – Adopt Design Fiction as Experience to Experiencing Technology Futures
Level 2:		
Writing sci-fi	Weeks 6 – 8: – Address the four topics of the topical framework and the selected Sci-Fi – The theme “Coding 2053” – Writing guidelines and word limit	– Adopt Sci-Fi as Research for Scientific Extrapolation – Adopt Sci-Fi as Inspiration for Worldbuilding
Level 3:		
Creating design fiction	Weeks 9 – 13: – Based on their own Sci-Fi – Prototyping guidelines	– Adopt Design Fiction as Exploration to Prototyping Future Scenarios in Everyday Reality – Adopt Design Fiction as Experience to Experiencing Technology Futures

Table 2: The Three-Level Pedagogical Framework to Learn AI, Applying the Initial Integrated Proposition.

At level 1 ‘Reading and Creating Design Fiction’, students learn to read sci-fi and also to prototype smaller-scale, fictional artefacts based on the sci-fi stories they read (Figure 2).

At this level, all four of the complementary elements in the initial proposition are adopted as introductory practice by the students.

Figure 2: Level 1: Reading sci-fi and creating design fiction. Students learn to read sci-fi and to prototype smaller-scale, fictional artefacts based on the sci-fi stories they read.

Having grasped comprehension skills, students begin to “create” their own text in level 2, ‘Writing Sci-Fi’ (Figure 3).

At this level, the two sci-fi theoretical insights are adopted for research and inspiration. When conceiving their own stories, students address certain topics within the topical framework and draw socio-technical insights from the selected sci-fi. In their own stories, the students build their socio-cultural worlds and describe their AI futures. Furthermore, a deliberate theme is set for writing, ‘Coding 2053’, taking place in the foreseeable future of 2053. Many of the students are in their teens and will be in their 50s by 2053; thus, they can imagine their middle-age years, based on current technology.

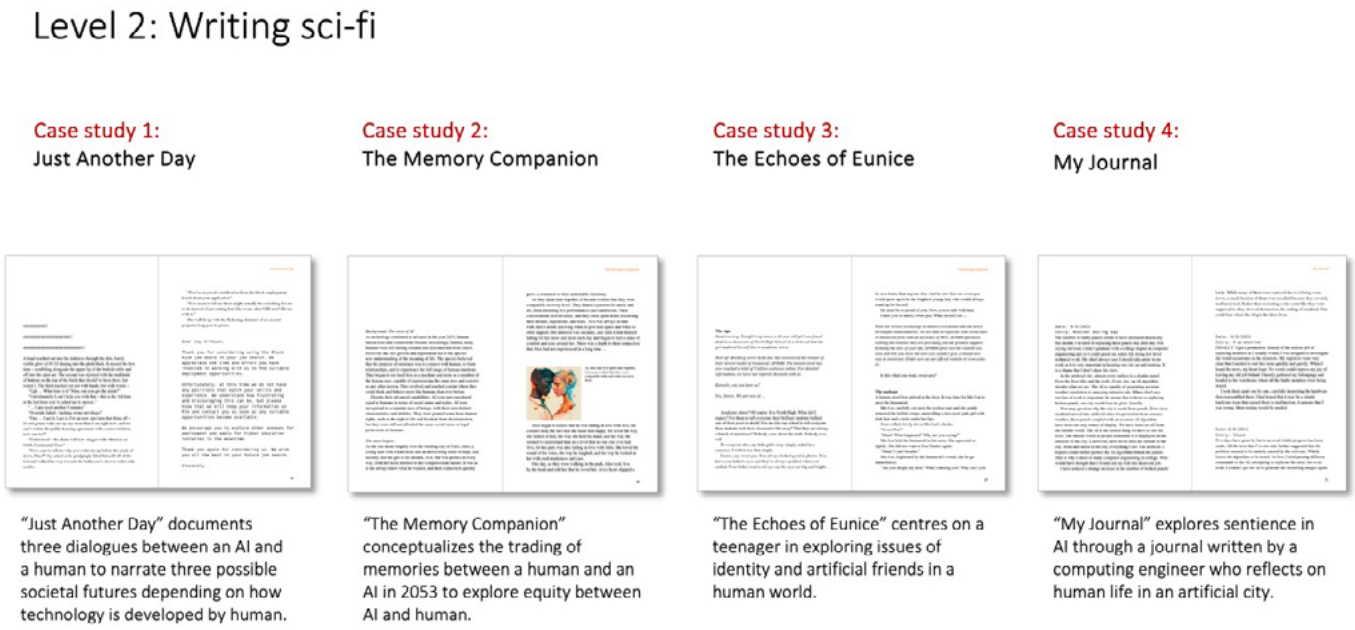


Figure 3: Level 2: Writing sci-fi. When conceiving their own stories, students address certain topics within the topical framework and draw socio-technical insights from the selected sci-fi.

The technological issues discussed in the sci-fi stories are then visualized in the artefact-based design fiction in the last level, level 3 ‘Creating Design Fiction’ (Figure 4).

This level adopts the two design fiction theoretical insights for exploration and experience. At this level, students explore what-if scenarios and prototype fictional products. This results in new works of sci-fi and design fiction by the students. The learning process is observed throughout the course, and the students’ feedback is gathered and documented.

Figure 4: Level 3: Creating design fiction. At this level, students explore what-if scenarios and prototype fictional products.

Analyzing Case Studies

This section analyzes the application of an initial theoretical proposition (that is, to integrate sci-fi and design fiction) to four case studies from a design course to confirm its sufficiency for students' learning of AI. The four cases are: *Just Another Day* (Li and Reza, 2023), *The Memory Companion* (Chong and Li 2023), *The Echoes of Eunice* (Chin et al. 2023) and *My Journal* (Tsoi 2023). *Just Another Day* documents three dialogues between AI and a human to narrate three possible societal futures, depending on how technology is developed by human. *The Memory Companion* conceptualizes the trading of memories between a human and AI in 2053, to explore equity between AI and humans. *The Echoes of Eunice* centres on a teenager exploring the issues of identity and artificial friends in a human world. *My Journal* explores sentience in AI through a journal written by a computing engineer who reflects on human life in an artificial city.

The analysis begins with identifying the four theoretical insights of the initial proposition in relation to the four cases. In the analysis, the predicted insights of Scientific Extrapolation, Worldbuilding, Prototyping Future Scenarios in Everyday Reality, and Experiencing Technology Futures are identified in each new sci-fi and design fiction. This analysis confirms the presumed causal relationships between the theoretical insights and the resulting student-created materials in the individual cases. Moreover, the insights are also identified in all of the cases, further confirming the adequacy of the initial proposition across cases. The case analysis results support the initial proposition. The analysis results are organized in a table below.

Theoretical insights	Case study 1: Just Another Day	Case study 2: The Memory Companion	Case study 3: The Echoes of Eunice	Case study 4: My Journal
Scientific Extrapolation.	AI automation technology is extrapolated.	Technology of AI emotions is extrapolated.	Technology of infinitive cloning and humanoid models are extrapolated.	Artificial consciousness and AI-generated images are extrapolated.
Worldbuilding.	The technology novum of advanced artificial assistance is scientifically plausible. Social inequality and disempowerment are studied through plotting three dialogues of three possible socio-technical futures between an AI assistance and human. Inspiration from the selected Sci-Fi of Future of Humanity and The Impossible Planet (Dick, 1955) and, Klara and the Sun (Ishiguro, 2021).	The technology novum of Trade of Memory is scientifically plausible. Issues of trading memory and other socio-cultural issues including racial inequality between human and AI are explored through plotting a love relationship between human and AI characters. Inspiration from the selected Sci-Fi of The Hood Maker and Future of Humanity (Dick, 1955) and, Klara and the Sun (Ishiguro, 2021).	The technology novum of artificial companions and cloning is scientifically plausible. Concerns of AI replacing humans to substitute human connection and solve loneliness and isolation are addressed through plotting a mother and daughter relationship and a friendship. Inspiration from the selected Sci-Fi of Future of Humanity (Dick, 1955), Klara and the Sun (Ishiguro, 2021), additionally, I sing the Body Electric (Bradbury, 1969).	The technology novum of AI being self-conscious and AI-generated earth simulation are scientifically plausible. The socio-technical dynamics between humans and the damaging earth as well as humans creating AI-generated and AI-conscious world are addressed through plotting a monologue of an innocent computer scientist. Inspiration from the selected Sci-Fi of The Impossible Planet (Dick, 1955) and Exhalation (Chiang, 2008).
Prototyping Future Scenarios in Everyday Reality.	The fictional artefact of an ancient telescope looking into the possible futures through three different lens connects the present and the future of 2053.	The fictional artefact of an enlarged and overloaded artificial brain vividly interprets the aggressive development of AI emotions by human.	The duplicated figure of the cloned daughters projects a future scenario of 2053 (scaled-down) magnifies the issues of infinitive cloning narrated in the story. Furthermore, the orientation of the figures mother and best friend visualizes the relationships between human and AI, which brings forward issues of human loneliness to the present.	The computer with a working screen displaying a working-in-progress programming sets an everyday working reality of a computer scientist in 2053. Together with the fictional artefact of an over-sized purge red button projects what-if scenarios for making a changed world. The fictional button brings anxiety of AI futures to the present but also intervention opportunity to transition AI development.
Experiencing Technology Futures.	To further visualize the emerging issues of AI growth in present context, a fourth lens that is an AI-generated lens allowing individuals to create one's choice of possible futures when they see technology differently, this provides individual experience to explore making changes. The aesthetic quality in abstract forms expresses meanings of human existence.	The tangible memory key and the key slot presented in the fictional artefact prompts decision making and actions from human whether to trade memory with AI, which brings forward socio-cultural issues in technology futures to the present. The aesthetic expression juxtaposing a deadly human skull and vibrant AI brain further provokes thoughts of human-AI relationships.	Prototyping repeating human figures creates an overwhelming scenario bringing future technology impacts to everyday reality. The fictional artefacts fabricated by 3D printing expresses the aesthetic quality of precision, detailed and well-defined artefacts, which enhances engagement and experience to see technology differently.	The over-sized purge red button creates an intriguing experience to provokes punch or not to intervene and stop the outrageous AI growth beyond human knowledge and control. The aesthetic expression of the awkward, abstract red button placing in the everyday mundane workplace inserts strong meaning to urge action of intervention.

Table 3: Identifying predicted theoretical insights in the four cases.

Under the integrated sci-fi and design fiction approach, the students exercise two modes of thinking: writing and prototyping. To create their sci-fi, students use the selected sci-fi stories, as research, to obtain scientific understanding and identify technology trends. They also use sci-fi, as inspiration, to learn socio-technical interactions and consequences. When writing their own text, students begin to make sense of how people negotiate a new world. The writing process allows students to express their emotions and their desires for a better future in a fictional context and following their intuition. Through detailed writing, the students become conscious of human flaws causing unforeseen negative effects of AI technology. Moreover, the four topics on the critical concerns about AI advancement, together with the selected sci-fi readings, are found to be supportive to students to address societal and environmental impacts beyond technology advance.

After writing, students are aware of what they want to express and question; therefore, they can consider specific design fiction based on their own stories. The students use design fiction to examine, through exploration, how to materialize the notion of technology's impact on society as expressed in their sci-fi works. Thus, they prototype fictional artefacts situated in future technology scenarios. Moreover, the design process of conceiving of future scenarios and building fictional artefacts systematically develop the students' reasoning concerning how to evolve various solutions in terms of how things would be experienced in preferrable futures. Lastly, the socio-technical dynamics delineated in student-created stories are presented in a solid manner through the fictional artefacts and scenarios. This allows students to experience themselves the interactions with future technologies in the changed world. In other words, the tangibility of prototyping in design fiction provides experiential evidence of requiring changes in order to avoid unforeseen disastrous consequences.

Student feedback is also documented, supporting the promising integration of sci-fi and design fiction to facilitate learning about AI. Most of the gathered feedback reflects that students have learned to take a critical view to see the wider societal impact of technological advancement and to express their accountability for technology futures. The feedback from students are noted below,

"ChatGPT was popularized during the time we took this course; the learning materials prompted us to stay up-to-date with the latest technology while at the same time also alert us [to] be mindful of the potential social-cultural impacts caused by technologies," (Chong and Li, 2023).

"A unique approach to learn and think about AI and the implications on society. Through reading SF, we get to think and picture the future, near or far. Writing our own story allows us to create our own future and picture how AI will shape it. Creating an artefact makes the future more real and closer to use," (Tsoi, 2023).

"Delving into Sci-Fi also enables us to explore future scenarios from a protagonist's viewpoint, exposing to ethical dilemmas that may arise as AI learning skills advance. Building artefact-based designs can provoke thoughtful discussions on these ethical controversies, encouraging a more comprehensive understanding of AI's societal implications, Chin, Choi and Wan, 2023).

"We began expanding our worldview by reading thought-provoking Sci-Fi and discussing the technical and moral implications. We then switched our role from an audience to a creator. We imagined the world in 2053 and presented it in the form of a story and an artefact," (Li and Sameer, 2023).

Discussion

This paper describes how works of fiction can be used to learn about, visualize, and describe AI technology futures. The analysis reveals that the writing and prototyping modes of thinking in sci-fi and design fiction, respectively, are complementary. Sci-fi, as research and inspiration, facilitates extrapolation and the expression of ideas about AI futures, while exploration and experiential learning through design fiction are complementary to operationalize to sci-fi, allowing the use of sci-fi to interpret and materialize ideas about socio-technical impacts on society. The find of this complementary relationship answers research question 1.

Furthermore, the literature review in the fields of sci-fi and design fiction yields four key theoretical insights: Scientific Extrapolation, Worldbuilding, Prototyping Future Scenarios in Everyday Reality and Experiencing technology futures. These are used to develop the initial proposition. The theoretical proposition provides a new approach to the study of technology futures, namely, the integrated sci-fi and design fiction approach in AI-related coursework, answering research question 2. This new approach is then used to develop a 3-level pedagogical framework for a new design course for learning AI intended to advance design education, which answers research question 3. With the theoretical proposition at hand, the case study research method is applied to capture empirical evidence to inform a causal relationship analysis, and a multiple-case study is used to ensure the practical relevance of the proposed pedagogical framework.

The results of this meticulous research process demonstrate the validity of the research, and the case study results, together with student feedback, also demonstrate the adequacy of the integrated knowledge to enhance students' learning about AI, with a focus on socio-technical implications. Finally, the research results offer theoretical and practical contributions to the research community. This fulfils the research aims of exploring a new approach to learn about and discuss AI and developing a new pedagogical framework to enhance design education are fulfilled.

Conclusion

In this research paper, fiction is used to allow students to imagine and intervene in socio-technical changes. Design practice, specifically design fiction, is connected to sci-fi to further strengthen and expand the strategic attributes of design. The integration of the two unique inquisitive approaches – sci-fi through narration and design fiction through tangible artefacts – can be used to powerfully inquire into technology futures. The research results indicates that the integrated approach is potentially effective for students' learning of emerging technologies, with a focus on socio-technical implications. Research on integrating sci-fi and design fiction is scarce, and this study proposes a new interdisciplinary research area in the field of design research. In future research, the framework could be applied to more case studies with the aim of formulating principles for wider empirical application, which may ultimately achieve more desirable technology futures.

References

Archer, Bruce. 1979. Design as a Discipline. *Design Studies*, 1 (1). Pp. 17-24.

Asimov, Isaac. 1993. Runaround in *I, Robot*, P7-18 [1950]. Oxford: Oxford University.

Chiang, Ted. 2008. Exhalation. In Evans, A.B. Csicsery-Ronay, I. Gordon, J. Hollinger, V. Latham, R. and McGurk, C. (Ed.). (2010). The Wesleyan Anthology of Science Fiction. P742-756. Middletown: *Wesleyan University Press*.

Chin, Kelvin Chi Lon. Choi, Ruby Tsz Yan. Wan, Ho Yan. 2023. The Echoes of Eunice. In: Mok, L. (eds) AI, Design and Sci-Fi: Coding 2053. *A collection of science fiction and design fiction*. Pp. 95-107.

Chong, Katie Man Hei. Li, Jasmine Hei Yui. 2023. The Memory Companion. In: Mok, L. (eds) AI, Design and Sci-Fi: Coding 2053. *A collection of science fiction and design fiction*. Pp. 83-93.

Crawford, Kate. 2021. Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence. *Yale University Press*.

Dick, Philip Kindred. 2017. Human Is in Electric Dreams Vol. 1. London: Orion. First published in *Starling Stories* 1955.

Dick, Philip Kindred. 2017. The Hood Maker in Electric Dreams Vol. 1. London: Orion. First published in *Imagination* 1955.

Dick, Philip Kindred. 2017. The Impossible Planet in Electric Dreams Vol. 1. London: Orion. First published in *Imagination* 1955.

Dunne, Anthony. Raby. Fiona. 2013. Speculative Everything: Design fiction, and social dreaming. Cambridge: *MIT*.

Eisenhardt, Kathleen M. 1989. Building theories from case study research. *Academy of Management Journal,* 14 (4), pp. 532-550.

Eisenhardt, Kathleen M. Graebner, Melissa. 2007. Theory building from cases: opportunities and challenges. *Academy of Management Journal*, 90 (1), pp. 25-32.

Flower, Linda. Hayes, John R. 1981. *A Cognitive Process Theory of Writing in College Composition and Communication*, Dec 1981, Vol. 32-4, Pp 265-387.

Gerlach, Neil. Hamilton, Sheryl N. 2003. Introduction: A History of Social Science Fiction. *Science Fiction Studies*. Vol. 30 (2), pp. 161-173.

Goldschmidt, Gabreila. 2015. Ubiquitous Serendipity: Potential Visual Design Stimuli are Everywhere. In: Gero, J. (eds) *Studying Visual and Spatial Reasoning for Design Creativity*. Pp. 205-214. Dordrecht: Springer.

Gray, David E. 2004. *Doing research in the real world*. London: Sage.

Heaven, Will Douglas. 17 July 2020. Predictive policing algorithms are racist. They need to be dismantled: Lack of transparency and biased training data mean these tools are not fit for purpose. If we can't fix them, we should ditch them. In *MIT Technology Review*: Artificial Intelligence. Accessed on 30 July 2023 from https://www.technologyreview.com/2020/07/17/1005396/predictive-policing-algorithms-racist-dismantled-machine-learning-bias-criminal-justice/

Ishiguro, Kazuo. (2021). *Klara and the Sun*. London: Faber & Faber.

Jemisin, Nora Keita. 2019. In: Parham, J. (eds) For N. K. Jemisin, *World-Building Is a Lesson in Oppression*. Accessed from Wired on 20 August 2023 from https://www.wired.com/story/nk-jemisin-how-to-write-science-fiction-wired25/

Li, Joycelyn Pui Kwan. Reza, Sameer. 2023. Just Another Day. In: Mok, L. (eds) AI, Design and Sci-Fi: Coding 2053. *A collection of science fiction and design fiction*. Pp. 57-67.

Malpass, Matt. 2017. *Critical Design in Context: History, Theory, and Practices*. London: Bloomsbury.

Mitchell, Melanie. 2019. *Artificial Intelligence: A Guide for Thinking Humans*. London: Penguin Random House UK.

Suvin, Darko. 1972. *On the Poetics of the Science Fiction Genre. College English*, Dec 1972, Vol. 34-3, Pp 372-382.

Tsoi, Matthew Shing Chi. 2023. My Journal. In: Mok, L. (eds) AI, Design and Sci-Fi: Coding 2053. *A collection of science fiction and design fiction*. Pp. 69-81.

Vint, Sherryl. 2021. Science Fiction. Cambridge, Massachusetts: *The MIT Press*.

Yin, Robert K. 2014. *Case study research: design and methods*. 5th ed. Los Angeles: Sage.

Zaidi, Leah. 2019. Worldbuilding in Science Fiction, Foresight and Design. *Journal of Future Studies.* Vol. 23 (4), pp. 15-26.

Theme 3

Behavioural Design for Planet

Design with More than Humans: Reimagining Social Biomimicry through Collaborations in Learning, Performance and Co-authorship

Authors:
Tokushu Inamura
Melanie Sarantou

Institution:
Kyushu University Faculty of Design, Department of Strategic Design (Japan)

Abstract

The aim of this paper is to explore the roles and transformative potential of co-authorship with more than humans (MTHs) through biomimetics. Specifically, how can social biomimicry be reimagined through collaborations in learning, performative practices and co-authorship? Furthermore, how can such collaborations inform models of shared learning spaces for new knowledge transformation in society? To address these questions, this paper presents two case studies on the *Nakagawa* (Naka river) in Fukuoka (Japan), and the Kemi river in northern Finland. Methodological approaches include ethnographic action and analysis. Several entry points for co-authorship with MTH's through biomimicry revealed themselves, represented though the cormorant, kingfisher, dragonfly and salmon. MTH co-authorship presents opportunities to foster a new conscious and engaging push to change habits and adopt virtuous behaviours and attitudes of collaborative learning that encompass plural design and transition. Biomimicry through explorative, meditative, and performative practices present embodied opportunities for such behavioral and attitudinal shifts required to address societal challenges.

Keywords: More than humans, biomimicry, co-authorship, social design, transition, plurality

Introduction

Nature remains an unlimited source of inspiration. Nearly a quarter of a century ago, Latour (1999) called for breaking with modernist frameworks by moving to alternative and plural frameworks that consider the natural environment and include more than humans (MTHs) to sustain life on a scarred planet. By MTHs, we mean every form that assumes an entity displaying some human attributes or, after Bourriaud (1999), materials or media that intrinsically bear qualities that are informed by, resemble, or carry recollections of humanity's actions. However, in this paper, we include pluriversal ontologies of being in this world and (active) becoming (Allport 1955; Escobar 2020). One example is the environmental personhood prescribed to the Whanganui river in New Zealand in 2017 (Hubberstey 2021). The last few decades also saw a rise in interest in attempts to use biology, design and engineering to reshape natural systems with the aim of developing more sustainable futures.

The aim of this paper is to produce new knowledge about the roles and transformative potential of coauthorship with MTHs through novel arts-based methods and processes for the creation of a more pluriversal world (Miettinen et al. 2023). Design inspiration derived from the natural world, often represented as biomimicry (Benyus 1997), can generate a plural understanding of, and solutions to, societal complexities through social innovation (Fewell 2015).

Spanning fields of research and practice in the areas of social and transition design (Tonkenwise n.d.), this paper presents two case studies on the *Nakagawa* (shortened to the Naka) in Fukuoka (Japan) (Inamura 2022), and the Kemi river in northern Finland (Miettinen and Sarantou 2021), thereby reflecting on, reimagining and expanding social biomimicry observation as a design approach that encompasses social design. This paper asks the following questions: how can social biomimicry be reimagined through collaborations in learning, performative practices and coauthorship? How can such collaborations inform models of shared learning spaces for new knowledge transformation in society?

The researcher-authors of this paper and the communities in Fukuoka (Japan) and Rovaniemi (Finland), participated in the case studies. Methodological approaches included ethnographic observation and analysis to identify opportunities for biomimicry that could be embedded in approaches to co-authorship and design. The ethnographic studies delivered visual data that were analyzed using methods of visual analysis to draw conclusions about the social functions that are supported by and connected to the rivers. In each of the case studies, societal issues were identified and acted on by the communities. The observational phase was followed by prototype-making workshops in the form of design jams and arts-based methods and performative practices as methods of resistance and care by both communities. In co-authorship with the two rivers and their surrounding environments, the results were visually documented as second and third data sets and analyzed through collective autoethnography by the author-researchers. In the following sections, we present the two cases.

Case 1: Nakagawa, the Naka River

Figure 1: The Naka as a living and lifegiving being where life and creativity are continuously changing and evolving around the daily lives of communities who live and co-exist with it. Photography by Sarantou (2023).

The Naka has been a field for continued research through design. The river runs through the centre of the city and flows around Nakasu, the centre of night life in Fukuoka. The name draws from the ancient name for the land, noted for the golden imperial seal that permits the king to rule the Kingdom of Na. This seal is stored in the Fukuoka City Museum. The cultural importance of the river is understood, yet its ecological importance is easily overlooked. The river flows close to the research campus of the authors and the nearby landscape can be seen (Figure 1).

The river is home to diverse flora and fauna (Yoshimura et al. 2005). Multiple projects are being conducted on the river to engage in and regenerate the river. The Nakagawa River Conference (Nakagawa Mirai Kaigi, from here on NMK) was established in 2021 as part of this local effort across sectors. Corporate employees, tertiary and primary schools, local organizations and community halls have been involved. Practical projects have been developed to create participatory future plans, with and independently from the NMK. Prior work on the river has introduced the potential of observation from MTH perspectives, such as fish and bird point of view (Inamura 2022 and 2023). Design-based exploration of the river presented opportunities for embodied and biomimetic sensing and exploration. The following section will present examples of biomimetic approaches and viewpoints tested on the Naka from 2018 onwards.

Bird's eye view: The Cormorant

Cormorants are seen on the river, swimming or often resting on artificial structures. They are traditionally trained in Asia for their ability to fish (King 2013). They are adept at swimming using their webbed feet to navigate the river. A way to experience the river from the Cormorant's point of view is to paddle through the water. A local partnering nonprofit, Fukuoka Kaihin Sports, has collaborated in coaching the skills for Stand-Up Paddle (SUP) board on the Nakagawa as part of education, leadership, and community development.

The head of Fukuoka Kaihin Sports, Masatsune Yoshimura, provided coaching in safety and skills. Beyond this as an experienced steward of the river, he imparted many stories of growing and playing on the river as a child and the way in which the river has been altered by anthropocentric interventions. The river has gone through many renovations to make it more resistant to torrential rain and flooding. This, however, has changed the width of the river, which has changed the characteristic flow.

The augmentation of the paddle and board draws from and combines the five senses: feeling the cool of the water and wind, shifts of visual perspective, smells as well as kinesthetic and exploration on the river. Starting from sitting low to the water and then standing on the board allows for shifting proximity with the water. The resistance felt through the hands on the paddle and feet on the board are touch points with the river. Once comfortable in balancing and paddling, the movement with and through the flow of water and wind becomes at once an ephemeral choreographic and collaborative act.

Through this free explorative mode, the river opens paddlers to observe flora and fauna, such as fish, insects, and birds as well as land and water-based plants. From the river, we began noticing floating rubbish such as plastic bags, bottles and cans caught in the watercress and roots near the growth on the riverbank.

Figure 2: Cormorants on the Naka. Photography by Inamura (2019).

Figure 3a: The Naka Hub concept developed. Diagram by Schneeberg, Carioni, Vasile and Inamura (2019).

SUP exploration and walks along the river have been followed by facilitated meditative method sessions for ideation and visualization. The tangible output of future visions for the river were developed by master's level student designers (Figures 3a, 3b). The student team was Benedikt Schneeberg (product), Claudia Carioni (interior architecture) and Valentina Maria Vasile (interior architecture) n.b., for elaboration of the meditative methods, see the referenced chapter (Inamura 2023). The vision has been presented to local communities and government, as well as used as the basis to develop future visions of the NMK.

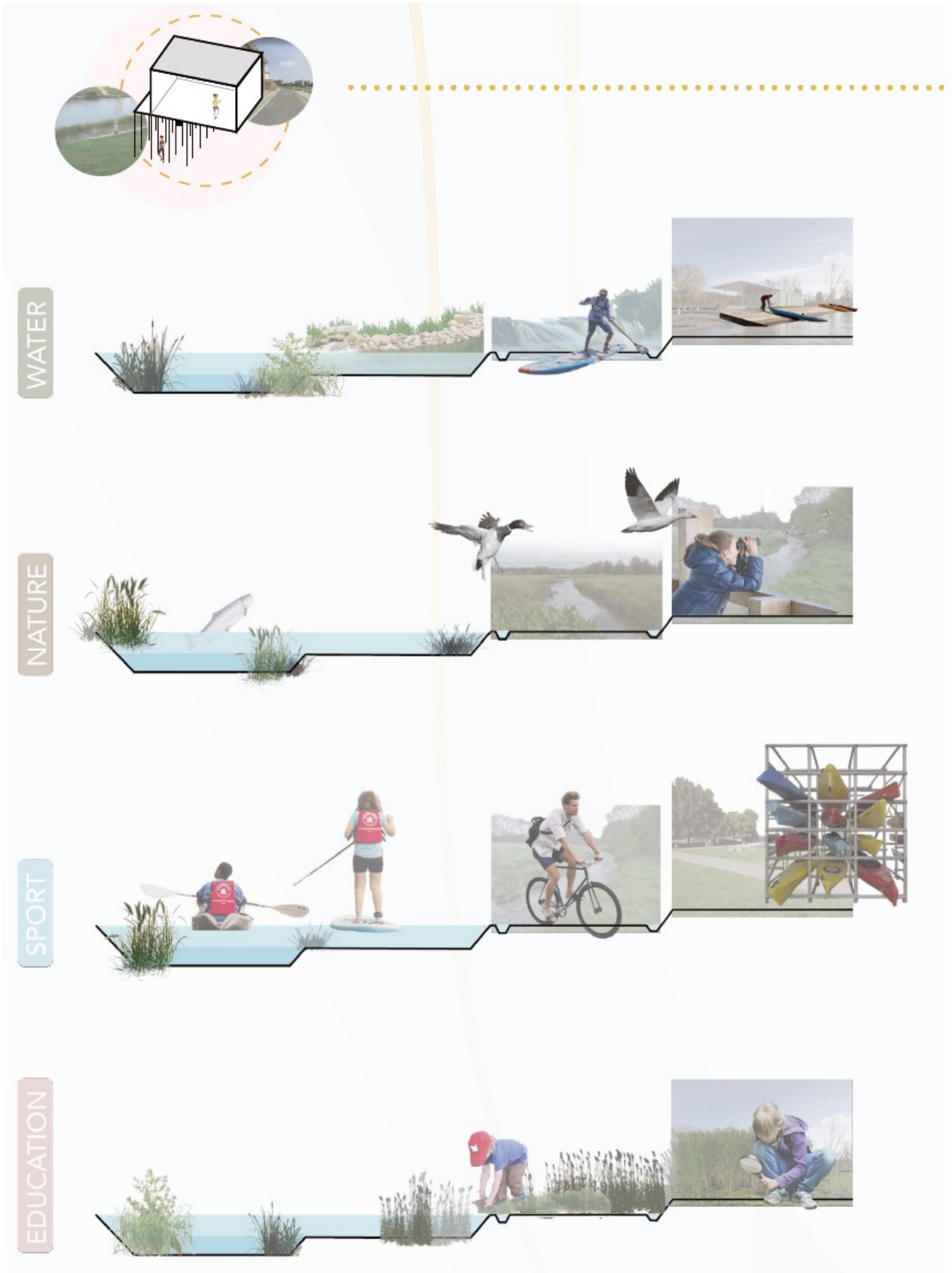


Figure 3b: The Naka Hub concept developed. Diagram by Schneeberg, Carioni, Vasile and Inamura (2019).

Bird's eye view: the Kingfisher

The Kingfisher is a specific species on the river and is the symbol of the eponymous Nakagawa city lying upstream in Fukuoka prefecture (Nakagawa City 2014). It is also one of the most iconic examples of biomimetics applied to Shinkansen bullet trains (Primrose 2020). The avian family became thematic during the Global Goals Jam in Fukuoka, an annual event developed by the United Nations Development Programme and the Digital Society School, where Inamura was a co-organizer. One team was responsible for the river's sustainability. Inamura identified a photographer on the riverside who was originally taking photos of birds, to look for Kingfishers. The photographer noted that the birds required perches to dive into the water and fish. Based on such exchanges, the final output proposed was a design for both humans, kingfishers and surrounding river ecosystems to thrive (Figure 4a). The curiosity of bird watchers and their constant engagement with avian species are examples of important communities of co-authorship.

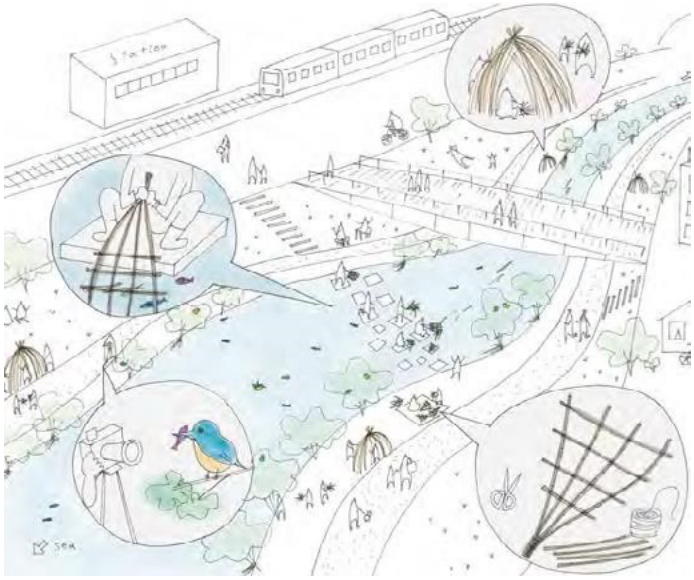


Figure 4a: Result of co-authored space creation and activities of care in a collaborative workshop space 'design jam'. Design by Hayako Oba,Shizuha Heta, Yan Gan, Elisa Desestret, Yuechen Gu and Inamura (2018).

Insect view: The Dragonfly

Co-authorship on the river is not only reliant on empathetic or conceptual understanding, but also on cognitively having access to spatial and structural understanding of the river so that sensemaking can occur. The dragonflies that hover and inhabit the river negotiate the space with ease. The dragonfly is a popular cultural motif exemplified by the nursery song Aka-tombo (Mitchell and Lasswell 2005). The movement of remote-controlled drones with the capability to hover and traverse is analogous to a dragonfly. Drone augmented biomimetic exploration allows for three-dimensional data through light detection and ranging (LiDAR). Drones were flown to gather three-dimensional geographical data and shared with primary school children as part of the Year 12 class, alongside learning about local fish species and SUP demonstrations (Figures 4b and 5). This was conducted as part of a visioning exercise to coauthor pluralistic visions for the Naka and its desirable futures. Both the data gathered by the drones, as well as observing the flying drones, afford the weaving of points of view of the river so that senses of space and scale can become tangible.

Three biomimetic modes have been outlined; they are entry points for coauthorship with MTH from a design approach.

The following section details the case of the Kemi in Finland in contrast with an arts-based inquiry.

Figure 4b: Drone LiDAR photography and operation by AlShawaf Bader ASAMA. Photography by Al Shawaf (2022).

Figure 5: Drone and landing pad on the banks of the Naka. Photography by Inamura (2022).

Case 2: Kemi River

This artivist (artist + activist) project was implemented by artist-researchers Satu Miettinen, Taina Kontio, Mari Mäkiranta and Melanie Sarantou in support of Professor Vesa Puuronen, who was legally sanctioned for the sum of € 20 000 for placing graffiti of two salmons and the slogans and a poem, “Eternal river is grieving the greed of people”, on the private property of the electricity company Kemijoki Oy at Pirttikoski and Seitakorva (Viinikka 2020). Puuronen used the graffiti to protest the newly proposed Sierilä power plant that will be erected on the banks of the Kemi.

Different companies and governments have exploited the Kemi and its salmon since Swedish rule through overfishing, transporting logs and wood on the river and, as a final nail in the coffin, Kemijoki Oy set up power plants during the 1950s and changed the way of life for the local communities and altered the local natural scenery. The indigenous salmon became extinct because of power plants (Niemi 2021).

The case study related to the ephemeral artivist (Penley and Ross 1991) project Five Salmon and Two Fish (*viisi lohta ja kaksi kalaa*) that was implemented on the banks of the Kemi River has been published elsewhere (Miettinen and Sarantou 2021). The artivist action was implemented by four artist-researchers from Finland, one of whom is the coauthor of this paper. The documentary artists for the project were journalists and documentary artist Antti Haase and videographer Mikko Leinonen of the production company Illume Oy, who assisted with capturing the ephemeral and performative project in March 2021. This reflection on the project looks beyond the initial project, its motivation and implementation to understand the value and role of performative and arts-based projects in design education.

The image of a large 20-metre fish that has been installed on the banks of the Kemi (Figure 6) blends gracefully with its natural surroundings. The installation was created from textile strips that were used to create a line drawing of a large fish on the white backdrop of the icy riverbank. The image of the fish was captured by a drone about 10–15 metres above the fish. The large fish appears whimsically from above, like a whimsical line drawing of a fish. The installation was created, documented and removed from the ice within a span of four hours on an early sunny spring day near Rovaniemi in Arctic Finland. A sustainable approach to the ephemeral installation was selected – for creating and documenting the artivist action, harmful impacts on the environment were reduced as far as possible; for example, the textile strips were wholly removed from the environment.

The inspiration for the ephemeral nature of the action, both the installation and the performance, was derived from biomimicry (Benyus 1997), which means innovation that has been inspired by nature. The artist-researchers observed the movement of salmon or trout in rivers when swimming upstream or when they barely showed themselves camouflaged by the dark patches on their backs, like a shadow or glimpse, in one moment visible while disappearing the next when close to the river surface. The whimsical textile installation similarly showed itself, in a moment – a well-camouflaged glimpse of a fish appeared on the banks of the Kemi, before it was removed after documenting the performance. The performance of the moving salmon generated kinaesthetic empathy due to the mimicking of movement and sensual experiences (Reynolds and Reason, 2012), which was generated from the natural

Figure 6: The ephemeral fish installation on the banks of the Kemi. Photography by Satu Miettinen (2021).

Figure 7: Artist-researchers (from left) Melanie Sarantou, Satu Miettinen, and Taina Kontio in a performance next to the installation of the salmon on the banks of the Kemi. Photography by Mikko Leinonen (2020).

environment that was closely connected to the former habitat of the salmon (Figure 7).

The value of performative and arts-based methods for design education lies in driving active and action-based learning in which students can critically reflect on the choices they make for their actions, for example, how it will impact the environment and how they can observe new and innovative ideas stemming from nature. In addition, values such as using ephemeral methods and the reusability and removability of materials used in their actions so that no unwanted traces are left in nature or outdoor spaces can be used in design education. Documentation not only supported the artivist action using place, space and textile strips sought to take a stand and raise awareness of the decline of the Kemi and its inhabitants, the salmon that have been extinguished in this area of the river (Niemi 2021). Value can be created by documenting arts-based actions as part of students’ learning experiences. Such value is vested in having evidenced actions that can be further digitally disseminated for analytical and reflective purposes to aid learning processes because such documentation “speak louder and more persistently than those (more than humans) who have been silenced” (Miettinen and Sarantou 2021, p. 47).

Discussion

Creative co-authorship with communities and MTHs can contribute to the design for plurality by providing new views and ways to design and create new values, as well as those that are embedded in design practices. Co-authorship with a living design medium refers to material production that incorporates simple living organisms, material-driven design and designing with MTHs that have agency of their own. Anthropocene as a worldview, revealing human activities that reshape nature through creativity, connecting humans and MTHs to result in intertwined worlds. Cross-pollinated anthropologies, such as the Anthropocene, enhance dialogue within a hybrid, globalizing world that includes various actors, often MTHs. In such contexts, makers, designers, teachers and researchers become experimenters, collectors, and natural agents. This entails a multifaceted exploration of contemporary material culture, requiring a border crossing between creative actions with MTHs, spaces, fields, and disciplines (Härkönen et al. 2023).

Societal challenges need solutions that drive interactions and organizational processes to deliver impact not only on a social level but on a broader societal scale, which comprises the social and environmental contexts of such challenges. To this end, researchers, artists and designers sometimes adapt or reject behaviours and patterns observed from nature to create innovative solutions. In doing so, social designers can use biomimicry to move on from approaches to social design that seem to have more ameliorative outcomes rather than results that address policy and structural change (Tonkenwise n.d.). An escalating challenge is how to change our interactions and relationships with MTHs to enable futures that can address societal challenges. Moreover, how we (re)design education through this research is paramount to generating a sustainable impact for designed futures.

The impact of this research is to present co-authorship with MTHs for reshaping pluriversal approaches to learning and new models for the implementation of shared learning spaces within different environments and with communities and MTHs. These inspiring recommendations would generate in individuals, as well as in communities, a new conscious and engaging push to change habits and adopt virtuous behaviours and attitudes of collaborative learning. Interactions with MTHs ask for tolerance, plural ontologies and views, and a reflection and reimagination of the future through ideas that should be shared and communicated verbally, visually, kinetically, or other communication channels.

Acknowledgements: *We thank the Ministry of Land, Infrastructure, Transport and Tourism for supporting this research through supporting the Nakagawa Future Conference with the 'Public-private partnership projects to promote town center regeneration' grant.*

This work was supported by JSPS KAKENHI Grant Number 18K18315 and the European Commission Horizon 2020, Grant Number 870621.

References

Allport, Gordon Willard. 1955. “Becoming: Basic Considerations for a Psychology of Personality.” Vol. 20. New Haven, CT: *Yale University Press*.

Benyus, Janine M. 1997. *Biomimicry: Innovation Inspired by Nature*. New York, NY: Morrow.

Bourriaud, Nicolas. 2019. “Coactivity: Between the Human and Other than Human.” FlashArt, #326 JUNE–AUG 2019. Retrieved November 11, 2023. https://flash---art.com/article/coactivity-between-the-human-and-other than human/

Escobar, Arturo. 2020. “Pluriversal Politics: The Real and the Possible.” Translated by D. Frye. Durham, NC: *Duke University Press*.

Fewell, Jennifer H. 2015. "Social Biomimicry: What do Ants and Bees Tell Us About Organization in the Natural World?" *Journal of Bioeconomics* 17: 207-216. https://doi.org/10.1007/s10818-015- 9207-2

Härkönen, Heidi, Rosa Ballardini, Heidi Pietarinen, and Melanie Sarantou. 2023. “Nature’s Own Intellectual Creation: Copyright in Creative Expressions of Bioart.” *NuArt Journal*. Retrieved November 11, 2023. https://nuartjournal.com/pdf/issue-7/11_NJ7-Harkonen.pdf

Hubberstey, Sara. 2021. “Rivers as Persons in Human-Centred Design: Centring Indigenous Leadership and Knowledges in the Design Process.” Retrieved November 11, 2023. https://wdo.org/wp-content/uploads/WDO-2021-ResearchEducationProceedings_vf.pdf

Inamura, Tokushu. 2022. “Design Praxis with the Kingfisher and Bacteria: The River as Place for Post Human-Centered Design Learning.” In Conference proceedings, Design for All Institute of India, June 2022 17, 6: 51-64.

Inamura, Tokushu. 2023. "A Meditative Design Development Framework toward Post Human-Centered Transformation of Pedagogical Processes." In *Design Education Across Disciplines: Transformative Learning Experiences for the 21st Century*, pp. 235-250. Cham: Springer International Publishing.

King, Richard J. 2013. “The Devil’s Cormorant: A Natural History.” Durham, NC: *University of New Hampshire Press*.

Latour, Bruno. 1999. Pandora’s Hope: Essays on the Reality of Science Studies. Cambridge, MA: *Harvard University Press*.

Miettinen, Satu, Enni Mikkonen, Maria Cecilia Loschiavo Dos Santos, and Melanie Sarantou. 2023. *Artistic Cartography and Design Explorations Towards the Pluriverse*. London: Taylor & Francis. https://doi.org/10.4324/9781003285175

Miettinen, Satu and Melanie Sarantou. 2021. "Five Salmon and Two Fish (viisi lohta ja kaksi kalaa)." In *Documents of Socially Engaged Art*, pp. 37-47. International Society for Education through Art (InSEA). Retrieved November 11, 2023. https://research.ulapland.fi/files/21986740/DocumentsOfSociallyEngagedArt_web.pdf

Mitchell, Forrest Lee, and James Lasswell. 2005. A dazzle of dragonflies. Texas: *A&M University Press*.

Nakagawa City. 2014. “City Bird and Kingfisher.” Retrieved November 11, 2023. https://www.city.nakagawa.lg.jp/soshiki/49/symbol.html

Niemi, Tapani. 2021. “Poliitikot murhasivat Kemijoen lohen 70 vuotta sitten, eikä sitä ole vieläkään annettu anteeksi.” Voima 03/2021. Retrieved November 11, 2023. https://voima.fi/artikkeli/2021/poliitikot-murhasivat-kemijoen-lohen-70-vuotta-sitten-eika-sita-ole-vielakaan-annettu-anteeksi/?cn-reloaded=1

Penley, Constance, and Andrew Ross, eds. 1991. “Technoculture.” Vol. 3. *University of Minnesota Press*.

Primrose, Sandy B. 2020. *Biomimetics: Nature-inspired Design and Innovation*. New York: John Wiley & Sons.

Reynolds, Dee, and Matthew Reason, eds. 2012. *Kinesthetic empathy in creative and cultural practices*. Bistol, UK: Intellect Books.

Tonkenwise, Cameron. N.d. “Design for Transitions – From and to What?” Critical Design, Critical Futures. Retrieved November 11, 2023. http://www.cd-cf.org/articles/design-for-transitions-from-and-to-what/

Viinikka, Pekka. 2020. “Kemijoki Oy:n rakennuksia spraymaalattiin vastalauseena vesivoimalle – teosta epäilty Oulun yliopiston professori kiistää rikoksen.” Front Page: Criminal Reports, Yle. Retrieved November 11, 2023. https://yle.fi/uutiset/3-11680307

Yoshimura, Chihiro, Tatsuo Omura, Hiroaki Furumai, and Klement Tockner. 2005. "Present State of Rivers and Streams in Japan." *River Research and Applications*, 21, 2-3: 93-112.

Ephemeral E-commerce: Environmental Design Project Curriculum to Redefine Consumer Behavior

Author:
Christopher Mark Kaltenbach

Institution:
American University of Sharjah (United Arab Emirates)

Abstract

This paper introduces an undergraduate design-studio course project that utilizes a product-service, vending system concept. It is based on a closed-loop product fabrication and disposal system described in a U.S. patent in which the vending machine is melded with a 3-D printer to generate objects from an unspecified, recyclable biopolymer, which are then returned to the vending machine after use to be reconstituted in the same material. In this course, everyday products were reinterpreted as disposable. From each object, along with the connected vending and mobile-phone network that supported its acquisition and disposal, two screen-based user interfaces were created.

Within these parameters and the notion that the consumer will have temporary use of such items, speculation on the future of product ownership and incentivized recycling behaviour are presented, ultimately providing a definition of a product-service.

Keywords: Design education, systems thinking, product-service, dematerialized economy, pro-environmental behavior

Introduction

The United Nations' Sustainable Development Goals provides important targets for government, business, and individual environmental action; however, it remains necessary to demonstrate the implementation possibilities of these targets through underlying environmental principles. Within design-based degree programmes in higher education, design-studio curricula provides opportunities to illustrate environmental action and principles in a proposed project outcome. It is through this speculative objective of student generated schemes that the creative potential of these broad environmental goals can be showcased.[1] Furthermore, if students are given a well-formulated set of project parameters, centered on a clearly defined outcome, their successful results function as a series of test-cases from which to identify underlying trends and broader societal beliefs.

The activities of production and consumption – one of the UN's seventeen sustainable development goals – is a rich synergy for design exploration. When these activities are situated within an invented business model and the presumed necessities and desires of a consumer, a hypothetical, inter-related e-commerce system can demonstrate a reduction of resources in production and responsible consumption behaviors. This is the definition of a basic environmental principle at the centre of many concepts related to ideal economies of responsible resource management. In this paper, a semester-long, design-studio project curriculum is introduced that employs this environmental principle. It also provides a set of specific parameters and directed objectives in which to engage a concept of product production and consumer acquisition and use.

Under the title of 'Ephemeral E-commerce', the conceptual framework of this curriculum is two-pronged. First, it directs the students' empirical research by situating a design problem – the need to imagine an acquired everyday product as a temporary, disposable object – within a speculative, micro manufacturing, distribution, disposal and recycling system as described in a U.S. patent. Secondly, it provides a way to rethink how we come into possession of a product and dispose of it, and fundamentally question the ownership and use of that product – this is the basis for a definition of a *product-service*. Ultimately, this curriculum assists students in imagining entirely new business and consumer behavioural models for reinterpreting a product. As such, environmental stewardship is embedded in an entire system of product manufacturing, acquisition, use and disposal, which inadvertently directs consumer action toward pro-environmental behavior, "without thought."[2]

[1]From 2005 to 2015 the academic work of Anthony Dunne and Fiona Raby at the Royal College of Art, in London, helped to popularize this mode of environmental design education through their own unique perspective on designing speculatively.
[2]In 1997 Japanese product designer Naoto Fukasawa and Diamond Design Management Network (DMN), along with IDEO, conducted a three-day design workshop with Japanese design leaders that eventuated in an exhibition in 1999. Until 2019 Fukasawa and DMN continued to conduct workshops (using a variety of themes) and exhibit the design work from them. "Without Thought" refers to designing for the unconscious. https://mctinc.jp/dmn/without_thought. Naoto Fukasawa Design (edited). *Without Thought*. Vol. 4(2003). Tokyo: Diamond Inc.

Locating a System of Behaviour Independent of Environmental Knowledge

There is growing interest by citizens across the globe to educate themselves in ways of reducing the use of specific goods and services that are harmful to the environment by allowing for engagement with those that afford "recycling, conserving energy, purchasing environmentally friendly products, and so forth" (Pelletier et al. 1998). There still remains however, a large portion of the population that require other means of motivation to act in a pro-environmental manner. We also need economic systems that have naturally built into them required actions that prompt the public to act responsibly. As societies are continually drawn to use new technologies for services supported by the mobile phone, the use of remote automation may provide a path for individuals to be unburdened by expectations of learning and remembering how to conserve resources.

Environmental knowledge and attitudes do not always correlate to actual environmental behaviour, and intrinsic and extrinsic cultural norms shape perception and action (Pelletier et al. 1998). Furthermore, overuse of the word 'sustainable' over the past thirty-five years has diminished its motivational impact. This term was officially used in 1987 under the slogan of 'sustainable development' by Gro Harlem Brundtland, Norway's Prime Minister and Chairman of the World Commission on Environment and Development at that time. It was defined as "meeting the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs. It is a form of progress for social and economic development that enhances the resource-base rather than degrades it. It requires a more equitable distribution of wealth than currently prevails within and among nations, and it aims at the eradication of global mass-poverty, keeping options open for the future" (Brundtland 1987) It is clear that the primary vision put forward was intergenerational-, economic- and equity-based with nuanced reference to the preservation of resources – a freedom-for-human-activity centered objective rather than a planet-centric conservation of resources. As the Chemical and Biomolecular Engineer, Anthony Andrady stated in 2015, "The numerous alternative definitions of sustainability in the literature (over 300 had emerged by 2007) reflect the inadequacy of the original. Proliferation of various, often inconsistent, definitions is, however, not productive in that it questions the credibility of the concept itself and dilutes its interpretation and meaning... Despite its present-day political salience of the notion of sustainability, this definition remains unclear, ambiguous, and qualitative" (Andrady 2015). This has been further compounded by the desensitizing nature of its use in pervasive direct and indirect marketing across all media platforms. Hence, the implication may be that the use of the term may actively disincentivize action.

On the other hand, the use of new technology can provide a strong incentive for adopting pro-environmental behaviors that might otherwise be avoided – solar panels mounted on residences to generate one's own electricity, buying an electric vehicle to become less dependent on petroleum or the use of a location-based multiplayer mobile game that prompts people to recycle virtual objects (Centieiro et al. 2011). All of these require little if any commitment to learning about the specifics of environmental degradation but rather allows for saving money or creating an enjoyable activity.

To assist with generating a similar relevant model, the parameters for this curriculum adopted existing technology into its proposed system of production to create an e-commerce experience for customers. It was inspired by the Japanese company *JR East Water Business Co.* its *Acure* vending machine (first introduced 2010) and *Acure Pass* app e-commerce system, a beverage vending service launched in Tokyo in 2017. This digital vending system was first to integrate a 47-inch touchscreen display and a camera mounted at the top of its usual stand-alone housing. Using a targeted *intelligent marketing* system, the vending machine's internal sensory data recognizes the approaching person's gender and approximate age. It then displays beverage recommendations based on that data. Once a product is selected, additional information appears. After the sale, the screen displays a 'thank you.' When not in use the machine displays advertising appropriate to the time of day, temperature, and season (Filippetti 2011).

While no longer novel, the use of large touchscreens, together with personalized, anthropomorphized and contextualized media interactions, can now be seen on vending machines and such retail locations as McDonald's, outside of Japan. This application of user-interfaces can motivate early adopters use from a generation of young consumers ensconced in mobile digital interfaces and its media since adolescence. If these screens and the user's mobile device could direct consumers to specific actions relative to the product they were purchasing and using, it is safe to speculate that they could inadvertently motivate individuals to recycle, conserve energy or purchase environmentally friendly products without being made aware of the necessity and importance of their behavior.

The Project Brief

Part 1: Conceptual Frameworks

The 2018 U.S. patent, Internet Enabled Apparatus, System and Method for Physically and Virtually Rendering Three-Dimensional Objects (Kaltenbach et al. 2018) provides the first part of the conceptual framework for this course. It proposes that print-on-demand technology is integrated with the vending machine and describes an unspecified biopolymer used to make products that would easily break down into its original state – once disposed of back in the vending machine – to be reconstituted into a new product. The vending machine housing would provide separate areas for the dispensing and the return of the object. It is a closed-loop system redefining how retail products are made, purchased, distributed and disposed of through reimagining the function and material of the 3-D printer.

To create a viable alternative to the typical brick-and-mortar retail paradigm, several key aspects that define additive printing had to be enhanced or overlooked: the considerable decrease in print time (within three-minutes); the absence of support material, which would typically require removal once the object was dispensed; and a biopolymer material that could easily be melted and reconstituted. This last point is critical to this hypothetical 3-D vending system, as Andrady points out: "An endeavor can only be sustainable in the long term only if it consumes resources needed by the process at a rate that is equal to or slower than that for the regeneration of the resources" (Andrady 2015). The idea of a biopolymer with this characteristic is at the centre of chitin-based polymer research currently being carried out (Sanandiya et al. 2020).

The curriculum has also taken advantage of current advancements in 3-D printing: eyeglass lens, textile/fabric, and micron-level printing, to name a few. These printing technologies have allowed for a broader choice of existing products to be considered for this vending application.

The second conceptual framework is a definition of a *product-service*: an actual physical, three-dimensional object, a 'product', that performs in a temporary nature, like a 'service'. Since the product is 'borrowed' for a period of time and not 'purchased', in effect the consumer activity pays for temporary use of the *material* that takes the form of the thing one needs to use.[3] This definition contributes to the board research of the ever-expanding definition of a product-service system (PSS) which has been carried out by researchers since the early 2000s; seventy-four definitions having been identified in 2013 (Boehm and Thomas 2013).

One of the earliest articulations of a PSS concept originates from 1997, which is described in a 2011 paper as "an extension of the service component around a product for business activities that are traditionally product-oriented, i.e., the introduction of a new service component that is marketed as a product for business activities that usually are service oriented" (Yoon et al. 2018). This is a business-to-business (B2B) strategy for foregrounding a service separate to that of a three-dimensional object, that in turn describes it as a 'product' – a marketing strategy in creative semantics. This expansion of the term 'product' beyond the physicality of goods, appears to be deliberate, as to make the intangibleness of a service, concrete. Twenty-five years later, this has become excepted parlance in the field of app design. The use of the term 'product-service' in this project curriculum references a material change to an actual physical object.

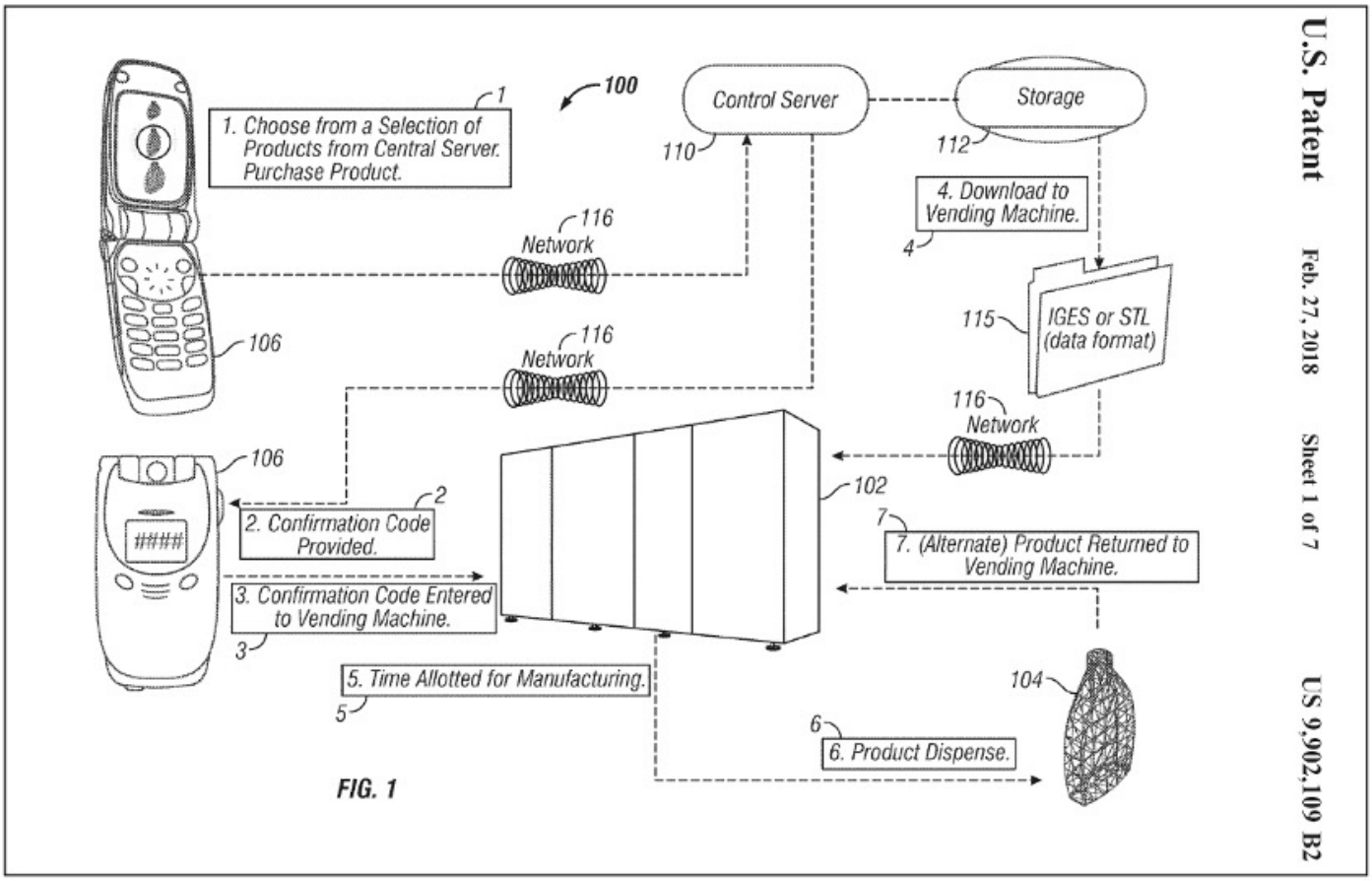
It is from these two conceptual anchors that students are given a two-device system and a new product interpretation in which they are free to invent their own application within the project framework. This produces a highly personalized interpretation and resolution to the project brief.

Part 2: Implementation of Stages

This curriculum was used to create a three-part course project over a twelve- to fifteen-week period. Divided into four stages, students were required to design a product-service, an e-commerce app or website for the mobile phone, and a vending machine and user interface taken from the app/website and reconfigured for a larger screen.

In stage one, students first identified an everyday object found in their home that could be reimagined as a single-use product based on where, when, how, and by whom would use it. This empirical research along with contextual data was then applied to the hypothetical-system-model-diagram (Figure 1). The range of products chosen spanned recreational activities and personal accessories, to tools that would assist in a wide range of activities.

[3]This concept was influenced by the book: Rifkin, Jeremy. The Age of Access : The New Culture of Hypercapitalism, Where All of Life Is a Paid-For Experience. New York: J.P. Tarcher/Putnam, 2000.



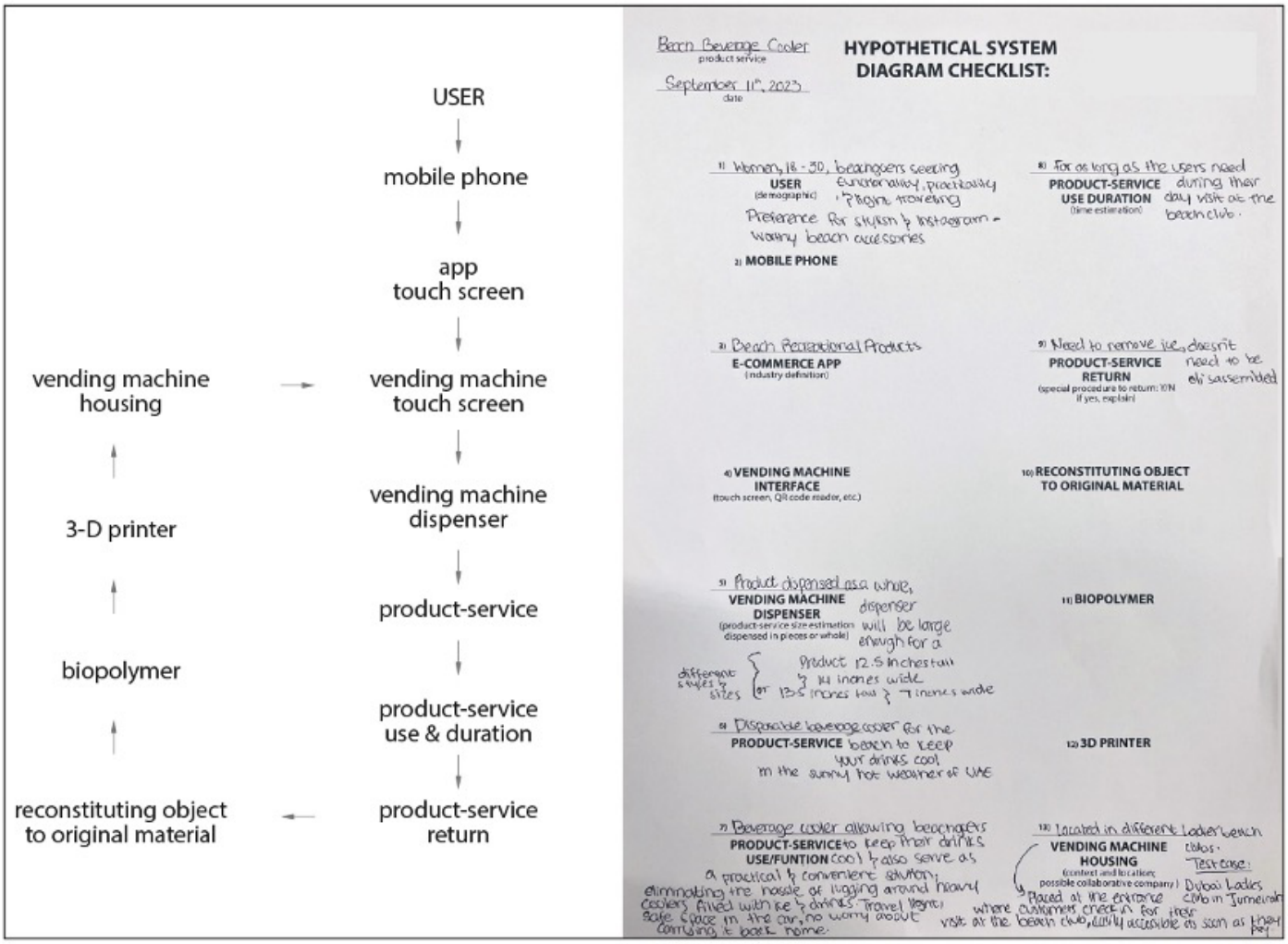


Figure 1: The evolution of the patent's system diagram into the hypothetical-system-model-diagram, which was then used as the research checklist for each student's project.

In stage two, students had to consider the function of the vending machine and the companion mobile e-commerce app or website; this would sell the chosen product (and an imagined range of complementary thematic products) and be used to help activate, at minimum, the printing and dispensing, and return of the product-service to the vending machine. This design work was carried out by envisioning the touchscreen and analogue user interfaces of the vending machine, and the mobile phone. Scenario maps in the form of storyboards were drawn to visualize context and the particulars of using the proposed product-service, as well as both interfaces. (Figures 2 and 3)

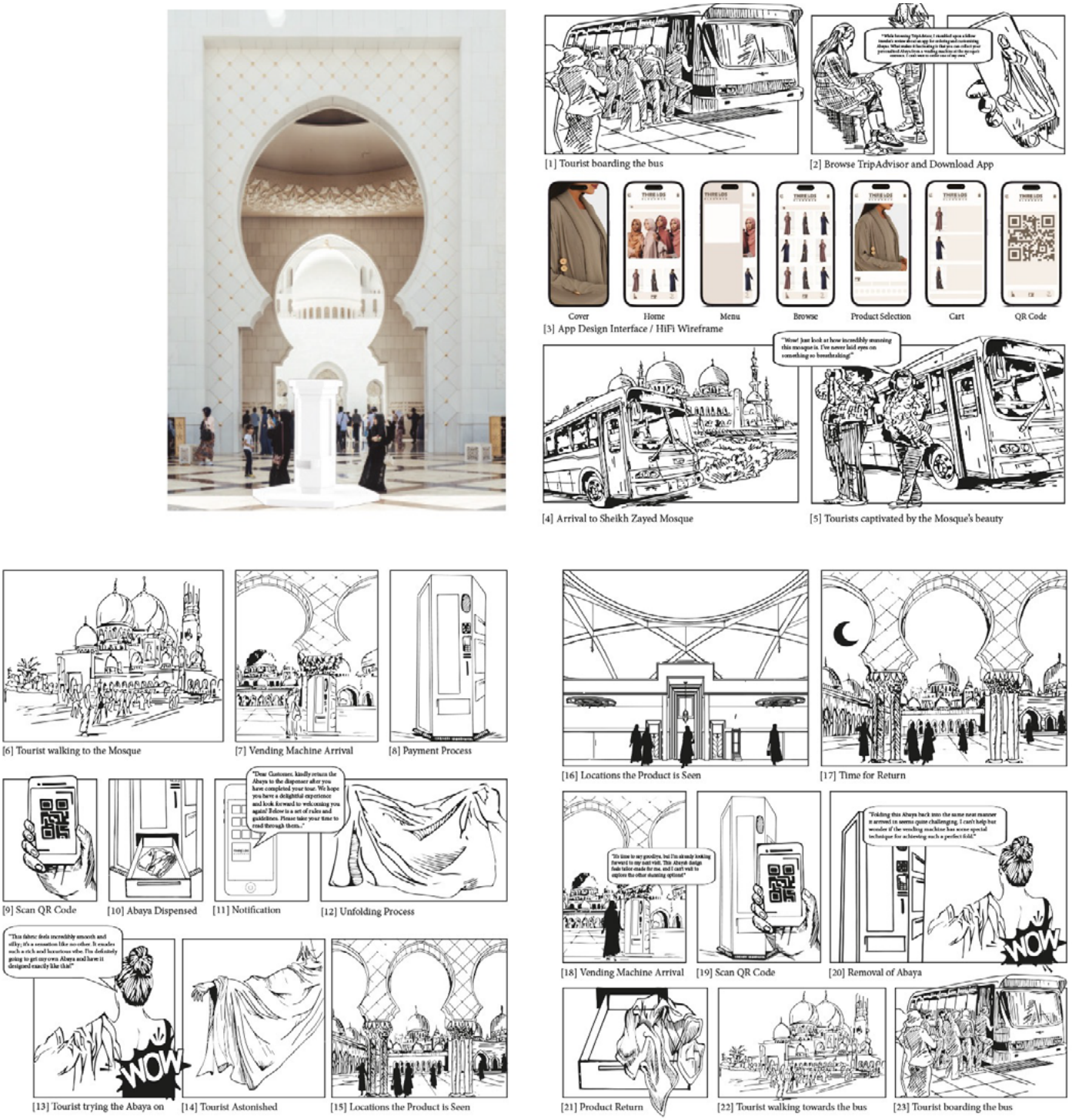


Figure 2: Rendering of the proposed vending machine in situ and the scenario map centered on an abaya product-service concept. Design work by American University of Sharjah student Noor Jbara (BSDM 2025).

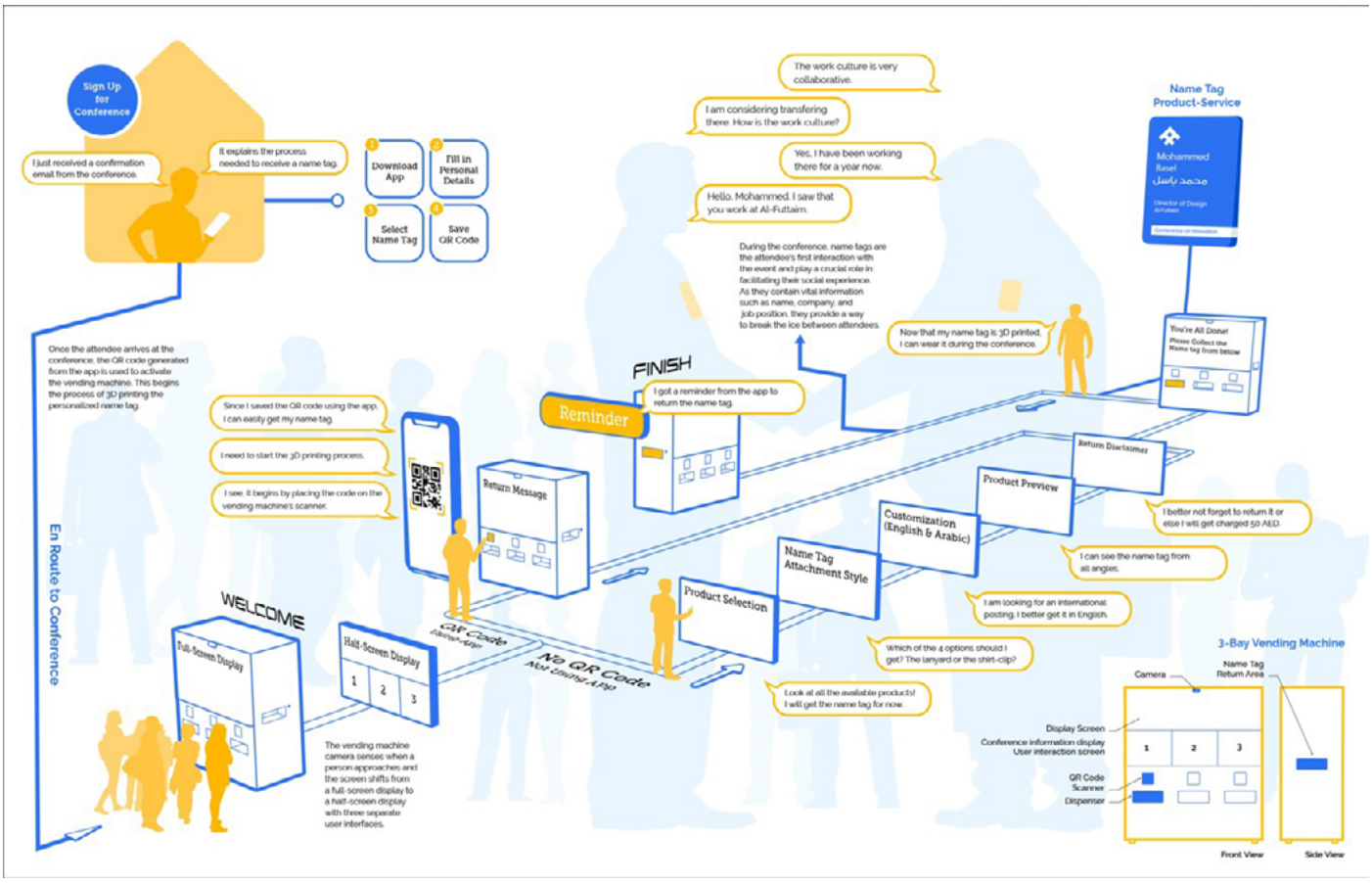


Figure 3: Data visualization describing the navigation of the vending machine and its interface. This project is centred on a name tag product-service concept. Design work by American University of Sharjah student Marianne Breidy (BSDM 2023).

In stage three, students further developed the formal characteristics of the product-service. Using 3-D modeling software, a first iteration of the product-service's digital design was completed. These objects most often remained as general forms with minimal aesthetic design.

In the fourth and final stage, students developed a printed manual that both described and illustrated their entire product-service, app/website, and vending machine concept. This included defining the value proposition of the entire system from the problems it solved – for example the object never eventually ending up in a landfill or storage space not needed to keep the item – to the benefits of its use which in some cases had health benefits or strengthened cultural traditions. (Figure 4)

Figure 4: A student's manual was reorganized on a panel for the purpose of presenting it in an exhibition in Japan. This project is centred on a name tag product-service concept. Design work by American University of Sharjah student Marianne Breidy (BSDM 2023).

Part 3: Ideation, How to Invervene in the System

During this course, students developed their project through a "system intervention ideation methodology," (Kaltenbach 2019) which is supported by an analysis tool with predefined parameters – the hypothetical-system-model-diagram (Figure 1). This diagram tool directs the students research to specific areas that must be individually defined. It illustrates the scope of the research and provides an immediate understanding of the relationship of the various system components that require investigation and definition.

This design methodology was built from the components of a system articulated in Donella H. Meadows' 2005 book, published posthumously, *Thinking in Systems*. Meadows, an environmental scientist, and a member of the MIT System Dynamics group applied her own perspective of systems thinking on solving problems associated with ecological sustainability. She defined a range of system configurations using three key components: elements, interconnections and function or purpose (Kaltenbach 2019). The articulation of these components provided the basis for a language and conceptual approach to articulate to students the systems thinking in this course, a hypothetical system, one unique for intervening in the 3-D-printing-vending-machine-concept patent.

Conclusion

In this paper, an undergraduate design studio course curriculum was presented in relation to the perceived necessity to develop a system of production and consumption that could inadvertently motivate pro-environmental behavior from the consumer. Further research is required to analyze the outcomes– over seventy–from this course, which are in effect, research test-cases. However, a few observations can be made at this time.

To date, this curriculum has been repeatedly taught in a course over a three-year period in a United Arab Emirates University.[4] The project outcomes reflect the interests and beliefs of a particular demographic: primarily young Arab women, eighteen to twenty-one years of age, living in a federal presidential state, also known as a tribal autocracy. Within the uniqueness of this cultural milieu, two primary areas are currently noteworthy: the choice of object and system of use, and the approach to incentivizing the return of the object to the vending machine within a twenty-four-hour period.

Objects associated with the Muslim religion such as the prayer mat, prayer dress, and hajib via the medical face mask (a response to COVID concerns) provided compelling augmentation to daily rituals. Furthermore, the debate as to what extent should the system incentivize and/or penalize the consumer for returning/not returning the product-service to the vending machine provided broader interpretations of the consumer's relation to management of their own waste. The students' schemes are analyzed in relation to the psychological measuring tool, *Motivation Toward the Environment Scale* (MTES) (Pelletier et al. 1998). While the results of this analysis work have yet to be completed, one can see that some students applied an incentivizing points system, while others used a financial penalty of an amount either equal or double to the original fee for the product-service. Many students drew reference to the UAE government's system of points and fines for traffic infringements, acknowledging that they were strict and financially sever, they nevertheless believed it was necessary to incentivize safety for all. The application of their own management return policy reflected a similar prerogative. In one final observation, students often challenged the mandate for the return of the product-service to the vending machine, expressing a desire to keep it, as one would with any product. This identifies an important hurdle in the effectiveness of the underlying objective of this curriculum, the desire to decrease the need/desire for product ownership. As societies continue to associate products with status and the act of shopping as an important public, social activity, it will be difficult to convince people of the need to own less goods.

As outlined in the UN's recent Sustainable Development Goals Report, there is an ever greater need to reduce the "material footprint per capita in high-income countries." What type of mindset is required and at what age should someone be expected to think in this manner? Does this require a social phenomenon intervention of frugal customs (Fujii 2006)? During the three years this course was taught there have been a few projects that have sought to introduce a toy product-service, situated in preschool learning environments and waiting areas in pediatrician offices. One wonders if exposure at an early age to these product-service experiences could help train a new generation to free themselves from the emotional dependency to covet and to own things.

[4]The Ephemeral E-commerce (DES300, User-Centered Design Project) course was taught in the Bachelor of Science in Design Management (BSDM) degree program in the Department of Art and Design at the American University of Sharjah, Sharjah, United Arab Emirates.

References

Andrady, A. L. 2015. *Plastics and Environmental Sustainability. Hoboken*, New Jersey: Wiley. 32.

Boehm, Matthias, and Oliver Thomas. 2013. “Looking Beyond the Rim of One's Teacup: A Multidisciplinary Literature Review of Product-Service Systems in Information Systems, Business Management, and Engineering & Design.” *Journal of Cleaner Production* 51: 245–60. Accessed December 1, 2023. https://www.sciencedirect.com/science/article/pii/S0959652613000243

Brundtland, Gro Harlem. 1987. “Our Common Future — Call for Action.” *Environmental Conservation* 14 (4): 292.

Centieiro, Pedro, Romão Teresa, and A. Eduardo Dias. 2011. “Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology.” Essay. In *A Location-Based Multiplayer Mobile Game to Encourage Pro-Environmental Behaviours*, 1–8. https://doi.org/10.1145/2071423.2071461.

Filippetti, Jenny. “Acure digital vending machine” *Design Boom*. March 2, 2011. Accessed December 1, 2023. https://www.acure-fun.net/en/lounge/vm/entry13.html

Fujii, Satoshi. 2006. “Environmental Concern, Attitude Toward Frugality, and Ease of Behavior As Determinants of Pro-Environmental Behavior Intentions.” *Journal of Environmental Psychology* 26 (4): 262–68. Accessed December 1, 2023. https://www.sciencedirect.com/science/article/pii/S0272494406000600

JR East Japan Water Business Co., Ltd. “Acure Lounge: Vending machines go to the age of ‘Buy on smartphone and receive at station’! Developer Interview ‘Advanced Vending Machine’ Innovation vending machine ‘Why were you born?’ ” Acure. May 5, 2017. Accessed December 1, 2023. https://www.acure-fun.net/en/lounge/vm/entry13.html

Kaltenbach, Christopher, Luke Nihlen, Luis M. OrJz. Internet Enabled Apparatus, System and Method for Physically and Virtually Rendering Three-Dimensional Objects. U.S. Patent US20180194067A1, file 5 January 2018 and issued 1 February 2022. Accessed December 1, 2023. https://patentimages.storage.googleapis.com/68/64/5e/cf5c834cffe83e/US11235530.pdf

Kaltenbach, Christopher "Insecture: interdisciplinary engagements in an emergent entomological design practice" (PhD dissertation, RMIT University, 2019), 28, https://researchrepository.rmit.edu.au/esploro/outputs/doctoral/Insecture-interdisciplinary-engagements-in-an-emergent/9921861871501341#metrics

Pelletier, Luc G, Kim M Tuson, Isabelle Green-Demers, Kimberley Noels, and Ann M Beaton. 1998. “Why Are You Doing Things for the Environment? The Motivation Toward the Environment Scale (Mtes)1.” *Journal of Applied Social Psychology* 28 (5): 438-439, 437–68. https://doi.org/10.1111/j.1559-1816.1998.tb01714.x.

Rifkin, Jeremy. The Age of Access : The New Culture of Hypercapitalism, Where All of Life Is a Paid-For Experience. New York: J.P. Tarcher/Putnam, 2000.

Sanandiya, Naresh D, Christoph Ottenheim, Jun Wei Phua, Augusta Caligiani, Stylianos Dritsas, and Javier G Fernandez. 2020. “Circular Manufacturing of Chitinous Bio-Composites Via Bioconversion of Urban Refuse.” *Scientific Reports* 10 (1). Accessed December 1, 2023. https://pubmed.ncbi.nlm.nih.gov/32170094/

United Nations 2023 The Sustainable Development Goals Report, Special edition. 36. Accessed December 1, 2023 https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf

Yoon, Byungun, Juneseuk Shin, and Sungjoo Lee. 2018. “Technology Assessment Model for Sustainable Development of Lng Terminals.” *Journal of Cleaner Production* 172: 927–37. Accessed December 1, 2023. https://doi.org/10.1016/j.jclepro.2017.10.187.

Bottom-up Circular Economy with the Alternation of Recycling Plastic Waste in CE Strategies by Adapting Open-source Design and Adaptive Manufacturing

Authors:
Daisuke Nagatomo
Hsu Wei-Yun
Tseng Kuan-Wei
Su Ke-Shin
Hung Yu-ju

Institution:
Department of Design, National Taiwan Normal University (Taiwan, Chinese Taipei)

Abstract

Circular Economy (CE) is recently one of the matters most emphasized by scholars and industries. However, there is a lack of research and evidence for evaluating the impact of existing CE strategies on social patterns. There are a few CE indicators. CE is mainly incorporated into the business model from a decision-making perspective rarely trickling down to the consumer. Taiwan has one of the highest recycling rates globally and yet faces challenges in utilizing the collected resources. This research investigates the alternative of recycling plastic waste by incorporating consumer behaviour into CE strategies with Precious Plastic Universe (PPU) Open-source resources. PPU resources provide the know-how for recycling plastic waste into new plastic resources. Incorporating the PPU database, this research explores the potential resources from post-consumer polymer waste. The second phase investigates the tools for converting collected waste to usable polymer. Finally, the last step is to explore the possibility of employing collected polymer wastes to enhance students' design project creativity and problem-solving abilities by incorporating adaptive manufacturing tools at the National Taiwan Normal University Department of Design. The collected research data includes quantitative data from collected single-use polymer with participating student researchers and qualitative data from observations and interviews.

Keywords: Circular economy, open-source design, recycle, single-use plastic

Taiwan has one of the highest recycling rates globally and yet faces challenges in utilizing the collected resources.

Introduction

The importance of sustainable practice has spread widely to many disciplines, such as academica, industry, and policy, in the past decades (Sadhukhan et al. 2020). The United Nations addressed the 17 Sustainable Development (SDGs) goals to achieve a better and more sustainable future for all (Nations 2015). Regarding sustainable development, it is urgent to discuss the economic system since we have relied on the consumption-based linear system in past decades (de Souza Junior et al. 2020). While the past decades' economic system refers to a Linear Economy, the European Union proposed the Circular Economy (CE) action plan to address elongating the product lifecycle to reduce the impact. The European Union's CE approach is to create a system for easy repairing, more sparing parts, facilitating end-of-life treatment, and establishing standards (Plan 2011).

Currently, CE has gained momentum among scholars and industries. Geissdoerfer et al. (2017) articulated more than 100 peer-reviewed articles on this topic in 2016, compared to 30 in 2014. Most recently, Kirchherr, Reike, and Hekkert (2017) summarized 114 CE definitions to create transparency regarding the current understanding of the CE concept through screening related articles. The researchers pointed out that there have been different recognitions in CE core principles on classifying the CE strategies. The various Rs express the key CE idea (Figure 1), and these nine Rs represent the degree of circularity to these products. McDonough and Braungart (2010) noted that most recycling is downcycling; it reduces material quality over time. The authors also pointed to rethinking the production/distribution and consumption process before recycling by reorganizing the waste hierarchy.

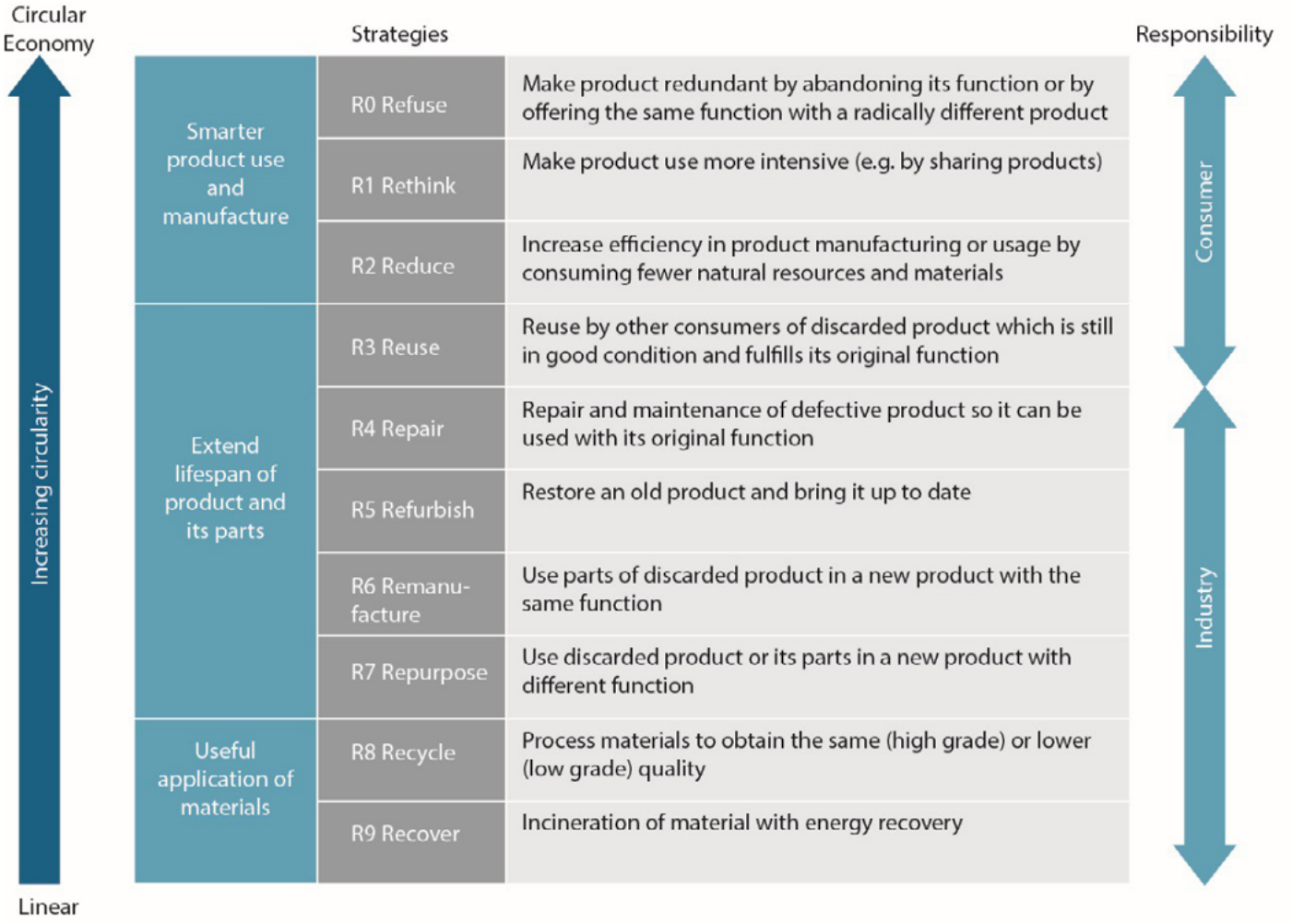


Figure 1: The 9R Framework. Adapted from Kirchherr, Reike and Hekkert 2017.

Among all the investigations for defining CE (Geissdoerfer et al. 2017), most researchers agree with the definition provided by the Ellen MacArthur Foundation, which is:

[CE] an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims to eliminate waste through the superior design of materials, products, systems, and, within this, business models (MacArthur 2013).

This definition has promoted many business sectors to incorporate the basic concept of CE. Lewandowski (2016) claims that circular business models often appear at the core of CE. CE business models consider the most in production and distribution but not consumption patterns. Ghisellini, Cialani, and Ulgiati (2016) note that "the promotion of consumer responsibility is crucial for CE." Lieder and Rashid (2015) also point out the problem of supply chains needing to consider consumption processes. Gallaud and Laperche (2016) mention that the balance between consumer patterns and circular business models is the key to CE strategies.

Research Background

This research dissects consumer responsibility in CE strategies, especially in the recycling phase. CE defines replacing the 'end-of-life' concept with the frameworks of production/ distribution and consumption processes (reducing, reusing, recycling, and recovering). However, recycling and recovering for consumers is the same act as throwing away trash. The most the consumer can contribute to this phase is separating the trash into different types. In big visions of CE (Figure 2), recycling is still part of the circular system. However, promoting recycling is not assisting the CE frameworks in implementing our social mechanism. Most consumers do not have other choices than throwing them into recycling bins. This research hypothesizes observing the consumers' reactions when they have other opportunities other than recycling their daily waste.

In their research, Dantas et al. (2021) describe the implication of combining CE and Industry 4.0 to achieve Sustainable Development Goals. I4.0 utilizes intermixed and affiliated technologies for production and optimization (Drath and Horch 2014). Examples of I4.0 are open-sourcing information, Personalizing Fabrication, and the Internet of Things (IoT). Open-source hardware, software, and hybrid solutions are the key ideas for I4.0, enabling users to drive innovation and optimize efficiency. The engine of achieving sustainability is innovation, which can revise the difficulty we face and convert it into an opportunity. Therefore, exploring how I4.0 can apply to CE and extending further goals to meet SDGs is vital. The researchers concluded that combining CE and I4.0 shows the possibility of developing sustainable practices and solutions for achieving the SDGs.

Precious Plastic is the open hardware plastic recycling project and Open-Source digital commons project. Dave Hakkens initiated Precious Plastic as part of his studies at the Design Academy in Eindhoven, Netherlands (Plastic 2022a). In January 2020, the community expanded to the Precious Plastic Universe (PPU) as the global alternative recycling system. PPU allows people to join and explore the vision for a world with less plastic waste. This research selects tools and methods based on the open-source data and shared knowledge on the PPU platform to accelerate the investigation. Finally, the selected instruments and pre-evaluated methods are applied to the course curricula at the National Taiwan Normal University Department of Design, and the qualitative and quantitative data are corrected via pre and post-course questionnaires and selected interviews.

Research Method

To conduct this research, the researcher investigated two aspects; first, to identify how much single-use plastic each individual generates and, among those wastes, how much polymer can be repurposed (Figure 2). The second aspect is investigating which tool to employ for repurposing the polymer via the PPU open-source database. To identify the single-use plastic waste data, four students from the National Taiwan Normal University Department of Design participated in documenting single-use plastic waste from their daily lives from 14 November 2022 to 28 February 2023. The students use recycle identity numbers, such as 1 for PET, 2 for HDPE, 3 for PVC, 4 for LDPE, 5 for Precious Plastic, 6 for Polystyrene, and 7 for others, to sort their polymer wastes and record the number of plastic items and the volume of total plastic waste (Figure 3). Based on the collected data, most single-use plastic waste comes from food packaging, such as meal containers and bottles. It is due to the nature of students who mostly live in university dormitories that are not equipped with self-cooking facilities. Therefore, for most meals they rely on take-out or delivered food. PET, HDPE, and Precious Plastic are commonly found as the type of polymer for single-use plastic waste.

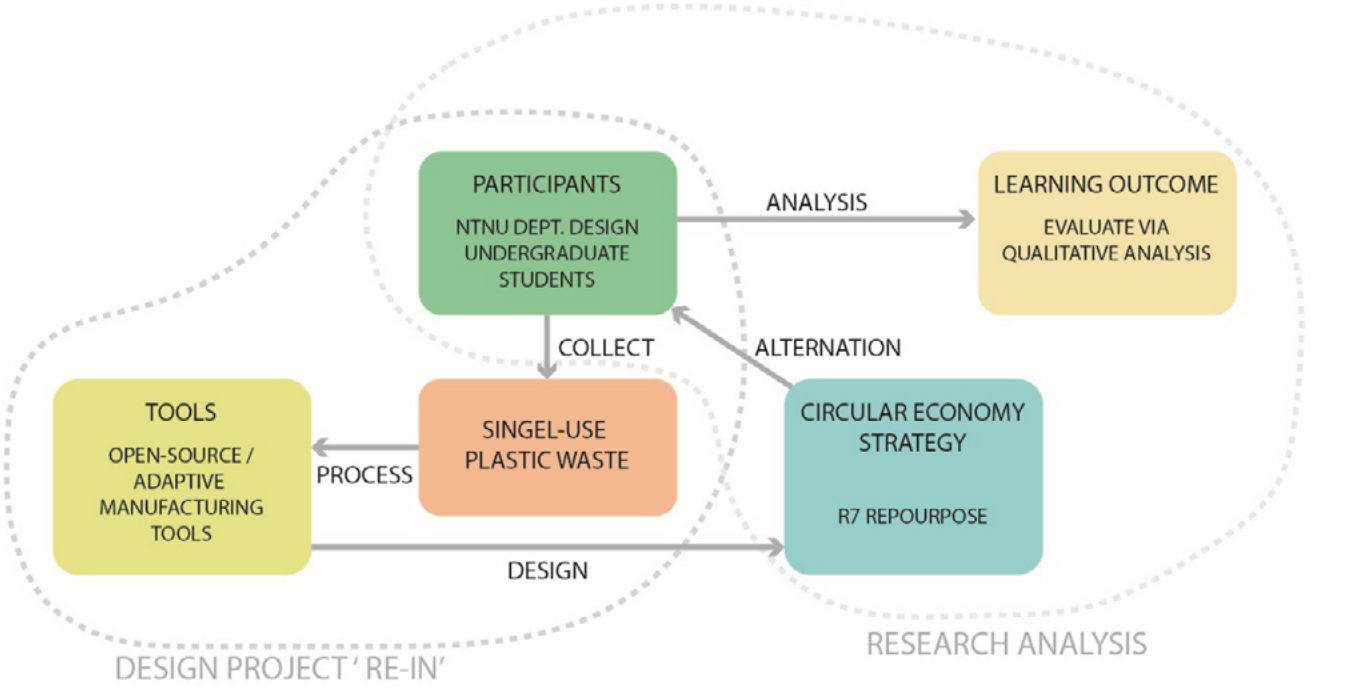


Figure 2: Research Model Diagram.

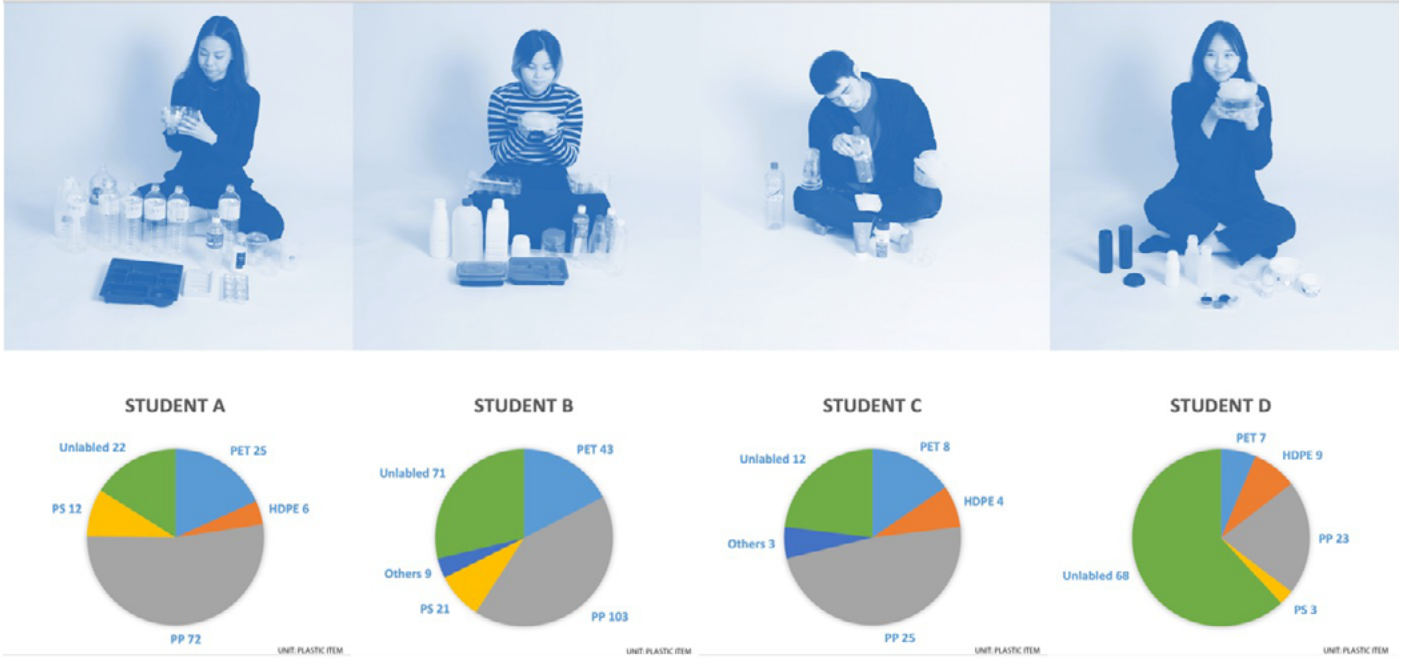


Figure 3: Students' single-use plastic waste collection.

After collecting single-use plastic waste, the researcher and students investigated methods to repurpose those polymers through the PPU database. Since most processing plastic methods require thermal transformation, there is a specific risk of hazardous substances. Therefore, referring to the data from PPU (Plastic 2022b), the students selected Precious Plastic as the primary type of polymer to incorporate in their design project due to its low cyclic compounds, high ductility, colourfulness, and manageable melting point, ranging from 160 to 166 °C. Furthermore, Precious Plastic is found the most in its collection of single-use plastic waste items, dominating over twenty percent of the total volume. Therefore, the researcher and students look into available adaptive manufacturing tools to process Precious Plastic waste to incorporate into their design project.

The PPU database exhibits a series of open-source machines for processing harvested plastics from the waste. The primary purpose of these machines is to thermal transform the polymer by extruding, injecting, and compressing it into other shapes. Despite the source of those types of equipment being open, they demand professional knowledge of mechanical engineering for assembly. Therefore, the researcher looked for alternatives to process the polymer waste. Finally, the small-size industry-use plastic shredder and commercialized heat-press machine, which has a temperature limit of 200°C, were obtained for this research. This research equipment allowed the students to process polymer waste into smaller shredded particles and thermal transform them into a sheet format (Figure 4). However, due to the limit of temperature and bed size of the heat press, the thermally transformed Precious Plastic sheet size could not exceed thirty square centimeters.

The design project conducted by students concluded with producing a light fixture design, which incorporates marbled plastic sheets with weaving joints (Figure 5). The weaving joint system allows the lighting fixture to take on various shapes. Students continued the exploration with the colour and transparency of the design by alternating the repurposed plastic sheets. The project also proposed a circular system so that the product would not be abandoned at the end of its life.

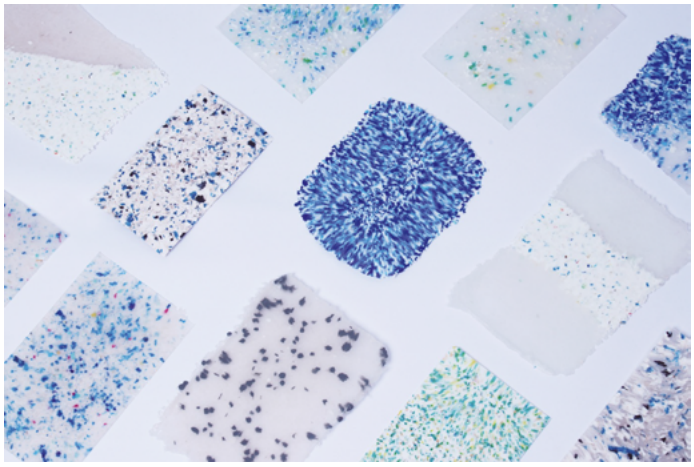


Figure 4: Repurposed plastic waste into editable sheet material.

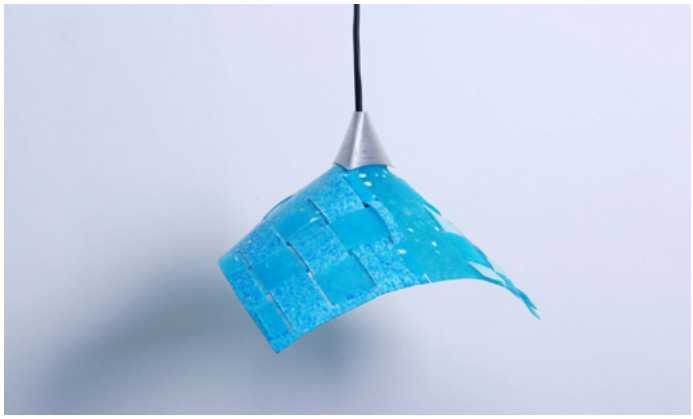


Figure 5: Student's final design by incorporating repurposed plastic sheets.

The European Union's Circular Economy approach is to create a system for easy repairing, more sparing parts, facilitating end-of-life treatment, and establishing standards.

Results and Discussion

The result of this research is evaluated by the student's project outcome and qualitative analysis with interview feedback from the participants (Tables 1 and 2). Based on the observations, students attained ample knowledge of single-use plastic waste and the recycling system in Taiwan during the project. Furthermore, they drastically increased their knowledge of plastic products in their daily life and the problem of disposing of that waste. While students were developing their designs, they encountered several challenges, including the need to consider the lifecycle of their design and the limitation of equipment to produce their design. Therefore, they incorporated a multi-disciplinary approach to solve these problems using adaptive manufacturing tools.

No.	Questions	Answer
1	Could you explain your project and what is the critical factor of your design?	We discovered that apart from behavioural and habitual constraints, the living environment also plays a crucial role in influencing the amount and type of plastic usage. For instance, if someone lives in a rental room without a drinking fountain, the number of water bottles will rise. On the other hand, if someone lives in the dormitory without a refrigerator, the usage of trim packages and drinks rises. The collection also revealed that our lives are filled with plastic products in this era, making it challenging to avoid them.
2	You have collected your plastic waste for a few months. What was the most significant finding?	In the early design stage, we divided the environmental awareness group and the general use group, recording the plastic products in daily life and comparing the differences. In addition to the restrictions of behaviour and habits, the living environment is an essential factor affecting the amount of plastic used. Life is full of plastic products and hard to avoid. Therefore, we aim to try every possibility of recycling plastics through various recycling methods.
3	Did you find any difference before and after working on this project regarding environmental awareness?	After implementing this project, I could roughly distinguish the type of plastic before confirming the plastic recycling label. I also found that whether it is myself or my family and friends around me, I often use or discard recyclables unconsciously.
4	How do you incorporate environmental considerations into your design process?	We conduct the Life Cycle Assessment of our design. It involves evaluating the environmental impacts throughout the entire life cycle of the product and project, from material collection to manufacturing, use, and disposal, trying to transform the plastic waste produced daily and return it to life in another way.
5	What is the most significant difference between your design and recycled plastic products?	We incorporate recycled materials into artistic techniques. Inspired by weaving techniques, a traditional shaping method, we molded the material and designed two interlocking methods to extend the volume of plastic sheets. As a result, the appearance of the products differed with these adhesive-free shaping methods.
6	Was there any specific type of plastic waste you used on your project? Please also describe the reasons.	We use No. 5 Precious Plastic to make hot-pressed plastic sheets. Because of the high ductility, colourfulness, and high melting point of Precious Plastics, subsequent products can be processed and presented better in terms of pressing, weaving, and visual effects.
7	Please describe the difference between your project and other previous school projects, if there is any.	This project took us a whole year. We had to set our goals and maintain from zero on our own. Not only should we finish our project, but we also need to hold an actual exhibition. Furthermore, this is the first time that product design students should cooperate with graphic design students. That caused some cooperation problems. However, learning how to work with different people was also an essential point in the graduation project.
8	What was the most challenging part while working on your project, and how did you overcome the difficulty?	The most challenging difficulty is the restriction of the size of the plastic sheet because of the machine, and we learned from the traditional weaving technique so that the plastic sheets can be joined without the intervention of adhesives or different materials. Different weaving methods also create a unique shape and appearance of the product.
9	Did working on this project help you to develop problem-solving ability? Please also describe your reason.	Yes. We found out the problems of plastic pollution and observed our behaviours of using plastic in our daily lives. We tried to use the plastic waste we made as our materials. We were showing the possibilities of using recycled materials.
10	Please share the innovative design method you have incorporated into this project.	We try to discover various ways of reproducing and shaping the recycled material, allowing plastic to transform into a new form. To present the diversity of recycled plastic sheets, we took pictures of the materials, even the failed ones, with different perspectives and focal lengths. Combining organic and artificial elements can create an exciting and visually appealing aesthetic.
11	After working on this project, do you have any opinion on how the Circular Economy can be implemented in society?	It may be challenging to avoid using plastic in our lives. Then, it is necessary to develop and improve the policy for collection, sorting, and recycling. The policy may include implementing efficient waste management systems and promoting the use of recycled materials in manufacturing.
12	Please summarize your experience through this research and project.	Throughout this research and project, we have gained valuable insights and experiences in recycling plastic materials. Our journey involved documentation, experimentation, and innovative design approaches. We tested the properties of plastics, explored various techniques for transforming recycled materials, and pushed the boundaries of what is possible.

Table 1: Interview questions and interview answers collected from three interviewees. The interview was conducted via an online form.

Meeting these goals is difficult within the constraints of 20th-century higher education due to disciplinary standards and professional accreditation requirements (Bridgstock 2017). Therefore, the STEM model gains much more attention from educational institutes for training students with problem-based projects by incorporating interdisciplinary knowledge. Furthermore, the demand for multi-disciplinary education to face social challenges has increased in the past decade (Chan and Nagatomo 2022). STEM for Sustainability (STEM4S) expands the scope of STEM by setting the goal of educating students with sustainability as the definite prerequisite for their achievements (Figure 6). In the framework of STEM4S, design is a tool for solving problems and enhancing students' creativity. Thus, it shows excellent potential for future creative education to be implemented to achieve a circular society.

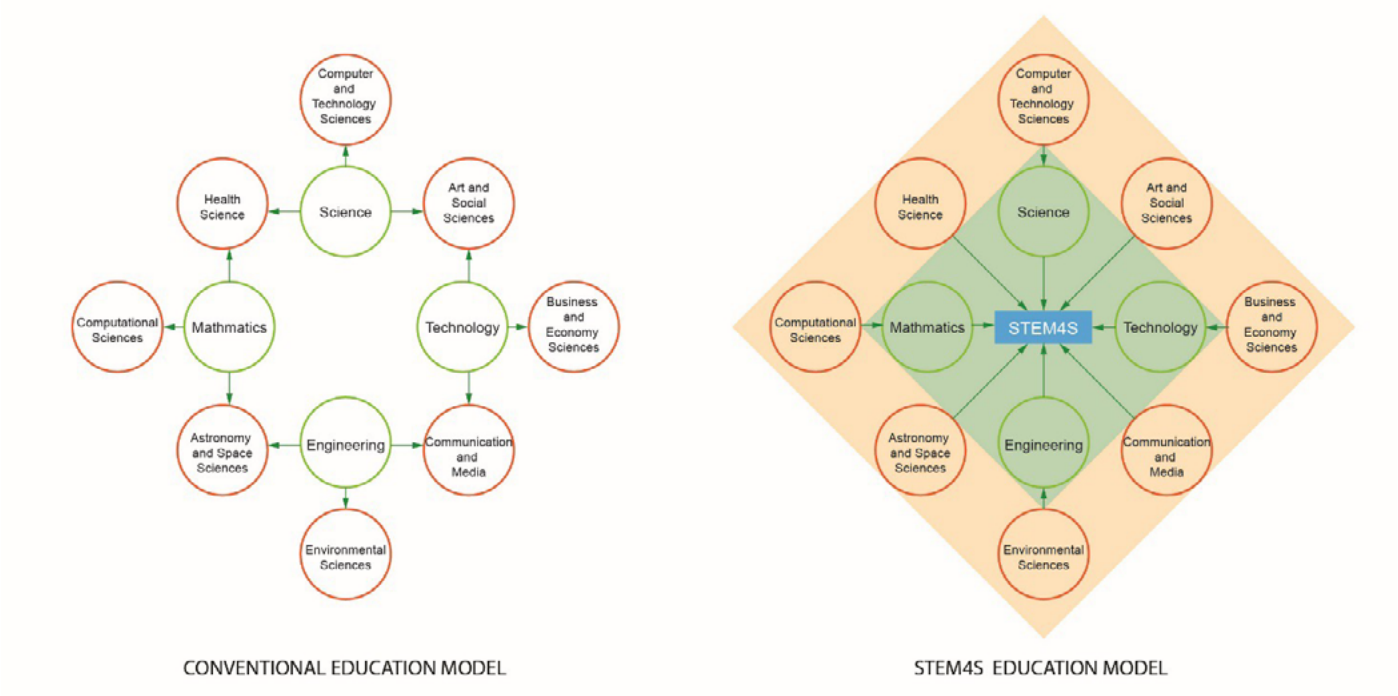


Figure 6: Diagram of Conventional Education vs STEM4S.

Conclusion

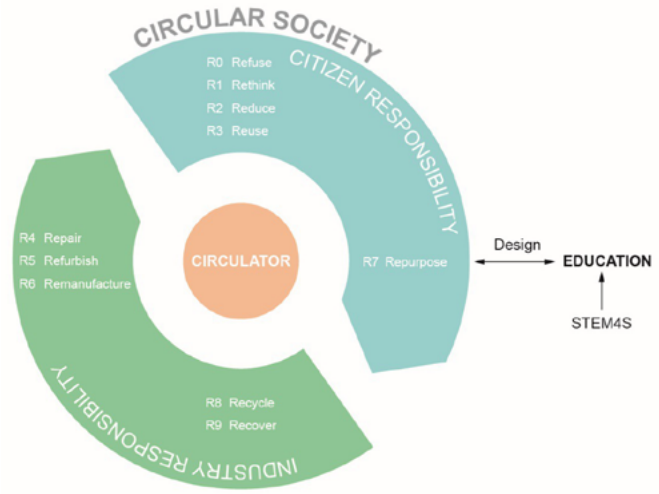


Figure 7: Circulator concept diagram.

Students express that the Circular Economy can only be successfully implemented if every participant is willing to change after participating in this research project. Therefore, spreading knowledge and enlightening society on CE strategies are the foundation of the successful enactment of the Circular Economy. Furthermore, creative education can be an engine to drive social change by nurturing the next generation of global citizens who can face challenges with multi-disciplinary knowledge and skills for establishing a circular society (Figure 7). Finally, a circular society can be achieved by incorporating most of the population at the core and understanding the responsibility of the industries and citizens.

Acknowlegements: *This research was funded by the Taiwan National Science and Technology Council (Project Number: 111-2621-M-003 -004 - 'Investigation of alternation of recycling plastic-waste in Circular Economy strategies with digital and open-source technologies') and also the Taiwan Ministry of Education (Project Number: PHA1110020 'Research of STEM4S scope and framework for design education'). The authors thank all the participants and supporting entities during the research process.*

References

Bridgstock, Ruth. 2017. *"The University and the Knowledge Network: A New Educational Model for Twenty-first Century Learning and Employability."* 339-358. Palgrave Macmillan UK.

Chan, Ming-Ni, and Daisuke Nagatomo. 2022. Study of STEM for Sustainability in Design Education: Framework for Student Learning and Outcomes with Design for a Disaster Project. Sustainability 14 (1). https://doi.org/10.3390/su14010312.

Dantas, T. E. T., E. D. de-Souza, I. R. Destro, G. Hammes, C. M. T. Rodriguez, and S. R. Soares. 2021. "How the combination of Circular Economy and Industry 4.0 can contribute towards achieving the Sustainable Development Goals." *Sustainable Production and Consumption* 26: 213-227. https://doi.org/https://doi.org/10.1016/j.spc.2020.10.005. https://www.sciencedirect.com/science/article/pii/S2352550920307983.

de Souza Junior, Henrique Rogerio Antunes, Thales Eduardo Tavares Dantas, Guilherme Marcelo Zanghelini, Edivan Cherubini, and Sebastião Roberto Soares. 2020. "Measuring the environmental performance of a circular system: Emergy and LCA approach on a recycle polystyrene system." *Science of The Total Environment* 726: 138111-138111. https://doi.org/10.1016/j.scitotenv.2020.138111. https://www.sciencedirect.com/science/article/pii/S0048969720316247.

Drath, R., and A. Horch. 2014. "Industrie 4.0: Hit or Hype? [Industry Forum]." *IEEE Industrial Electronics Magazine* 8 (2): 56-58. https://doi.org/10.1109/MIE.2014.2312079.

Gallaud, Delphine, and Blandine Laperche. 2016. Circular economy, industrial ecology and short supply chain. Vol. 4. John Wiley & Sons.

Geissdoerfer, Martin, Paulo Savaget, Nancy M. P. Bocken, and Erik Jan Hultink. 2017. "The Circular Economy – A new sustainability paradigm?" *Journal of Cleaner Production* 143: 757-768. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.12.048. https://www.sciencedirect.com/science/article/pii/S0959652616321023.

Ghisellini, Patrizia, Catia Cialani, and Sergio Ulgiati. 2016. "A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems." *Journal of Cleaner Production* 114: 11-32. https://doi.org/10.1016/j.jclepro.2015.09.007.

Kirchherr, Julian, Denise Reike, and M. P. Hekkert. 2017. "Conceptualizing the Circular Economy: An Analysis of 114 Definitions." *SSRN Electronic Journal* 127. https://doi.org/10.2139/ssrn.3037579.

Lewandowski, Mateusz. 2016. Designing the Business Models for Circular Economy – Towards the Conceptual Framework. Sustainability 8 (1). https://doi.org/10.3390/su8010043.
Lieder, Michael, and Amir Rashid. 2015. "Towards Circular Economy implementation: A comprehensive review in context of manufacturing industry." *Journal of Cleaner Production* 115. https://doi.org/10.1016/j.jclepro.2015.12.042.

MacArthur, Ellen. 2013. "Towards the circular economy." *Journal of Industrial Ecology* 2 (1): 23-44.

McDonough, William, and Michael Braungart. 2010. Cradle to cradle: Remaking the way we make things. *North point press*. Nations, United. 2015. The 17 Goals.

Plan, Action. 2011. "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions." European Commission.

Plastic, Precious. 2022a. "Precious Plastic." Obtenido de Precious Plastic: https://preciousplastic.com/en/index.html.

2022b. "Safety and Fumes." https://community.preciousplastic.com/academy/plastic/safety.

Sadhukhan, Jhuma, Tom I. J. Dugmore, Avtar Matharu, Elias Martinez-Hernandez, Jorge Aburto, Pattanathu K. S. M. Rahman, and Jim Lynch. 2020. "Perspectives on "Game Changer" Global Challenges for Sustainable 21st Century: Plant-Based Diet, Unavoidable Food Waste Biorefining, and Circular Economy." *Sustainability* 12 (5). https://doi.org/10.3390/su12051976. https://www.mdpi.com/2071-1050/12/5/1976.

!Do Something: Provoking Sustainable Behaviour Change Through Collective Design Initiatives

Authors:
Emma Peters
Emma Mills
Stephen Loo
Rebecca Green
Teresa Crea

Institution:
School of Art and Design, Faculty of Art, Design and Architecture, University of New South Wales (Australia)

Abstract

The climate crisis calls upon the imagination and creativity of designers and design educators to collectively envision futures that generate affective motivation for sustainable behaviour change. This paper argues that using a collective design-led approach is highly beneficial when tackling complex problems such as climate change to provoke behaviour change. In 2022, The Wicked Collective for Climate Change and Sustainable Development, University of New South Wales, set out to achieve a high-impact provocation of multi-modal, interdisciplinary, and speculative design addressing sustainability to alter the trajectory of climate impact as a catalyst for behaviour change. The outcome was an internationally recognized exhibition! Do Something that employed design principles, strategies and frameworks to generate immediate and ongoing behaviour change impact for a sustainable future.

Keywords: Climate change, behaviour change, sustainable innovation, design thinking, wicked problems

Figure 1: !Do Something Exhibition, 2023. Showing work of M. Hank Haeusler and Jiaying Qian. Image Credit: Cheyenne Bardos.

Climate action requires behaviour change from individuals, communities and governments to untangle and rethink the systems that have contributed to accelerated carbon emissions and global warming. Universities are well positioned to develop and lead projects that activate climate change action. *The Wicked Collective* was established in 2021 by five academics from the School of Art, Design and Architecture (ADA) at the University of New South Wales (UNSW) – Dr. Teresa Crea, Dr. Rebecca Green, Professor Stephen Loo, Emma Mills and Emma Peters. The group recognized the need for urgent collaborative action to engage, enhance and energize our student and research community to drive collective sustainable behaviour change. The disciplinary fields of each member of the Wicked Collective encompass simulation and immersive environments, architecture, graphic and textile design, and pedagogy design. We have the shared belief that sustainable design thinking, research, practice, and pedagogy is imperative in the pursuit of urgent climate change action.

Design impacts behaviour in intentional and unintentional ways (Niedderer et al. 2016), requiring those proposing new design strategies to interrogate the impact of their work. Creative interventions offered to the public through exhibitions can generate affective engagement, positive behaviour change and give voice to citizens in relationship to climate change policy (Burke et al. 2018). This paper will reflect upon the guiding principles, outcomes, and influence of the *!Do Something exhibition* through the lens of Bruce Mau's principles of 'new wicked problems demand new wicked teams' and 'fact-based optimism', alongside the power of 'narrative expressions' (Chabay et al. 2019, Hinkel et al. 2020) and the EAST framework developed by the 'Behavioural Insights Team' (2014) to provoke meaningful behaviour change to confront climate change issues.

The *!DO SOMETHING exhibition* (Figure 1) was held at UNSW Library Gallery in Kensington Sydney from September to November 2022. The gallery is a public venue that attracts over one million visitors annually. The exhibition sought to form a purposeful, affective, and transformational narrative expression where the presentation of imagined futures would provoke behaviour change towards sustainability for the participants and audience. *The Wicked Collective* invited students and staff from ADA to submit creative responses and interventions to the wicked problem of climate change. The selected works were required to respond to one or more of the United Nations Sustainable Development Goals (SDGs) and be created during the pandemic lockdown period of 2020–2022.

The exhibition was planned to coincide with *Massive Action Sydney*, and the exhibition was opened by the faculty Dean, and by internationally renowned designer and visionary Bruce Mau and his Massive Change Network co-founder Aiyemobisi 'Bisi' Williams. The impact of the *!Do Something exhibition* went far beyond the university community. As many attendees shared their experiences of the exhibition across multiple platforms on social media, tagging the exhibitors, the university, the exhibition itself, and the *Wicked Collective*. Mau and Williams also shared their experience of the exhibition with their 10,000 strong following across different media channels, providing international exposure and response to the exhibition. Mau, Williams and the *Massive Action* project become integral to the success of the exhibition through their support and judging of the inaugural *Bruce Mau Prize* on opening night. Our faculty also funded three awards and the School of Art, Design and Architecture Dean was the third member of our judging panel. Discussion now turns to the influence of Mau, Williams and *Massive Change* Network.

Sustainable design thinking, research, practice, and pedagogy is imperative in the pursuit of urgent climate change action.

Wicked Teams for Wicked Problems

The work of internationally renowned designer, innovator, and author Bruce Mau provided the *Wicked Collective* with an optimistic and constructive approach to pursing an ambitiously wicked project. Mau's *MC24 Principle* 'new wicked problems demand new wicked teams' (Mau 2020a) was a central tenet for the collective in understanding the importance of working as a team of interdisciplinary design practitioners to generate creative activations that respond to the complexity of climate change. 'Wickedness' presents itself as an alternate mode of sensemaking, way of probing the chaos and contradictions of insurmountable problems such as climate change, to act as a catalyst for new ideas and transformative thinking. We align with the sentiment that wicked problems turn into wicked opportunities (Bailey et al. 2018). Together the collective recognized that understanding and responding to climate change is considered a core competency for designers in terms of responsible and sustainable outcomes (O'Rafferty, Curtis, et al. 2014), and the multiple approaches towards generating action requires visibility and dialogue beyond the studio classroom to propel generative solutions.

Mau argues 'wicked' problems don't respect traditional boundaries, and the most serious challenges we face today spread across multiple disciplines (Mau 2020). Climate change is a dominant wicked problem of our time: there is no single solution; the boundaries are difficult to define; and it is influenced by interdependent and rapidly changing factors. Therefore, teams built on classic models of knowledge are no longer equipped to tackle these complex problems. Instead, they require a richer alternative of dynamic solutions by teams that cross boundaries and disciplines.

The *Wicked Collective* is modelled on Mau's Renaissance Team framework of a diverse constellation of individuals working in concert (Guerra 2020) with a shared commitment to motivate climate-action and inspire behaviour change. The collective is made up of multi-disciplinary academics with a broad range of skills in design thinking, textiles, graphics, architecture, simulation, and immersive environments. As a team the collective collaborated on the *!Do Something exhibition* with professional staff from across the university including curatorial and library teams.

The *!Do Something exhibition* saw the collective display of character traits Mau suggests designers must develop to become effective collaborators – expertise, curiosity, empathy, confidence, humility, independence, and courage (Mau 2020b). This approach was particularly successful as the collective members lead different aspects of the !Do Something exhibition from operationalizing the event, visual communication, and branding, to the curatorial outcomes required. While maintaining a shared vision for the outcome, each collective member exercised skills in leadership and followship at various times in the project depending on their expertise.

The key operative in Mau's 'wicked teams' is the concept of *cooperation*. It would be too straightforward to rest our argument on the fact that members of a wicked collective need to be cooperative, in that they think and work well together. Although working well may arise from a team's common mission, this is not to say that cooperative people need to think and work alike. In contrast, and focussing on being 'wicked', Mau sees the most important contribution that a cooperative design team can make is asking better questions. Questions are generative because they are the 'engine of new thought' (Smith 2020). Questions arrive when disparate, dissonant, and perhaps contradictory facts are placed in adjacency in an environment where difficult conversations can occur safely. Truly dialogical conversation can in fact be 'ruined by too much identification with the other person' (Bahktin 2004) as normatively assumed in cooperations.

Fact-based Optimism

A second MC24 principle, 'Fact-based optimism' (Mau 2020) was invaluable in our approach to the exhibition. We extend this identification to the facts proffered in dialogues. Wicked teams produce facts that cooperate, in their differences to arrive at wicked questions, which in design often compel the meta-question, 'what is to be done' (now)? (Smith 2020). Our exhibition is therefore a proactive response to Mau's call, where the designers and their works represented are all 'doing something!', demonstrating a 'fact-based optimism [as] a collaborative endeavour' (Smith 2020).

In *!Do Something*, climate change is made factual, in the sense that it is made visible and sensible in and through design. Design propositions, objects and projects work together (Latin: co- [together] + '*operari*' [work]) because the exhibition makes factual, not only their materialities, but their relations, the reciprocity of dialogues, on climate change. It is here design does its iterative thinking, imbricating hypothetical thinking of science and technology, and the narratival thinking of the humanities. Quantification and qualification work in wicked ways, to tell new cooperative stories. Mau is optimistic about this factual way of working. To him, 'cooperation, connection, and the creation of global systems for human development are the great untold story of our age' (Smith 2020). Optimism to us is a kind of experimental democracy, where real knowledge and value creation occurs through making factual the things that designers produce when doing something, and the dialogical interpretations that flow from it. Through creative generation, this drives change, and transformation.

Transformative Narratives

Transformative climate narratives, rather than climate 'information', are motivational forces to provoke behaviour change in the context of climate change (Hinkel et al. 2020). The power of curatorial and exhibition design as a methodology and educational tool to showcase transformative narratives that provoke sustainable behavioural change is a shared conviction of *The Wicked Collective*. The *!Do Something exhibition* sought to form a purposeful, affective, and transformative narrative expression where the presentation of imagined futures would provoke behaviour change towards sustainability for the participants and audience. Chabay, Koch, Martinez, and Scholz, in the paper *Influence of Narratives of Vision and Identity on Collective Behaviour Change* (2019) recognize affective narrative expression as a way to present a vision so that a community can redirect towards a shared goal such as greater sustainability. They remind us that 'narratives do not exist in a social vacuum, but are embedded, exchanged, and modified by the contexts and communities in which they exist and through which they may influence the dynamics of social movements toward sustainability' (Chabay et al. 2019).

The *!Do Something exhibition* challenged the normative mode of issue-based exhibitions by bringing together a wide range of multi-modal projects that had not been presented extensively or collectively before. Relationships between curatorial practice and behaviour change were designed to allow for adjacencies and contingencies to emerge between the work. The exhibition became a story-driver, where the possibilities of new narratives and meaning-making arose from the experience of perceiving numerous responses concerned with our climate future in one space, and operated from the research that supports the relevance and impact of arts-based climate change initiatives (Burke et al. 2018, Buckland et al. 2006). The space in which the exhibition occupied – the UNSW Library – introduced an additional layer to understanding the projects in relationship to information sharing and transformative narratives. Many of the projects were in development during the 2021 and 2022 Covid-19 lockdowns, and had not had the opportunity to be shared with and beyond the university community.

The projects included in the exhibition told transformative stories of both utopian and dystopian futures to articulate how our actions today will influence the way forward in relationship to climate change. A vital intention of the collective was to include both student and staff submissions to recognise that transformative narratives are not contingent on hierarchy – each member of the university community has valuable stories to share. The included work represented ideas in motion, encouraging nascent concepts to be brought to the public for further dialogue. The curatorial team visioned a space where a diverse range of open-ended narratives could afford the audience to meaningfully translate their experience of the exhibition into impactful behaviour change for greater sustainability.

The three awarded projects in the exhibition pose questions and propose solutions for a world in the throes of climate change. 'Bioshelters' (Figure 2), awarded the Bruce Mau Prize, had collaboration at the centre of the work, led by academic Hank Haeusler. The project asks if it is possible to design shelters where clams may feel 'more at home' using computational design methods and 3D printing for rapid prototyping. Toby Castle's project (Figure 3), winner of the Dean's Prize, utilizes QR codes in flood impacted neighbourhoods for Australian communities to link and share ideas for how to prepare for natural disaster and share experiences. Augmented reality was used to show effects of flooding to understand what flooding might mean for communities in the future. Rachel Vosila's work, Kelpist, (Figure 4) recognized as the People's Choice Award, explores seaweed as a regenerative, biodegradable and beneficial material for product design. Each of these projects provoked a new way of thinking about the challenges and opportunities of climate change, and consequently offers a space to provoke alternative perspectives that can propel generative thinking and activate behavior change.

Figure 2: M. Hank Haeusler and Partners: University of New South Wales / Computational Design, University of New South Wales Biomedical Engineering, The University of Newcastle School of Architecture, Reef Design Lab, World Harbour Project, Macquarie University Biological Sciences. Concept: Yannis Zavoleas, M. Hank Haeusler with Andre Pereira, Beth Strain, Rebekah Araullo. Design: Yannis Zavoleas and M. Hank Haeusler. Other contributors: Eliot Rosenberg, David Lennon, Alex Goad, Melanie Bishop, Vivian Cumbo, Maria Vozzo, James Gardiner, 2016, Bioshelters. Image Credit: Cheyenne Bardos.

Figure 3: Toby Castles, 2022, QR Collaborate: Using shared spaces to improve flood preparedness. Image Credit: Cheyenne Bardos.

Figure 4: Rachel Vosila, 2022, Kelpist. Image Credit: Cheyenne Bardos.

Applying a Framework for Behaviour Change

Delivering a collaborative project with a central wicked challenge of climate change is a knotty undertaking. Intuitively as designers and educators, we approach complex problems and make them accessible to generate genuine understanding and behaviour change. The EAST framework (Service et al. 2014), originally created for the UK government to provide an accessible framework for policy development, highlights four clear targets that the *Wicked Collective* innately integrated to ensure the translation of the project fulfilled the aim of provoking behaviour change for climate change: make it easy; make it timely; make it attractive; and make it social.

We made it easy by creating a simple form for participants to express their interest in sharing their climate-related projects in the exhibition and streamlined messaging and communication to ensure all deadlines were met. We made it timely with planning, communication and aligning with adjacent events such as the Art, Design and Architecture faculty's *Education Festival* and Innovation Hub's *Massive Action* project. We made it attractive with high-impact, dynamic and consistent visual identity collateral. Additionally, we obtained incentives such as awards and securing the endorsement of Bruce Mau to bring prestige for participants and our audience. We made it social with an opening event that was one of the first post lock-downs, demonstrating the importance of gathering together in solidarity and celebration when confronting wicked problems.

Activating Behaviour Change

The *!Do Something exhibition* occupied the UNSW Library for twelve weeks in 2022, in a public venue that attracts one million visits annually, and gave an opportunity to these visitors to experience a cross section of diverse and innovative climate change narratives from staff and students of the ADA faculty.

Coming together as invested members of a university with the core strategies of 'wicked teams for wicked problems', 'fact-based optimism', and the power of transformative narratives was an affirming experience. The collective members, stakeholders, participants, and visitors entered a space that allowed creative considerations of climate change to be activated, and provoked robust conversations about the roles we all play as change-agents. As members of the *Wicked Collective*, sharing knowledge and expertise generated an opportunity to consider our individual research, teaching and actions within a network of colleagues, providing camaraderie and energy to develop a high-impact climate-related project together.

The *!Do Something exhibition* generated renewed collective energy to propel further dialogue in creating meaningful climate behaviour change and continues to influence and stimulate discourse, reflection, and action within our communities.

References

Bahktin, Mijail. 2004. The Dialogical Imagination. Translated by M. Holquist and C. Emerson. Austin: *University of Texas Press*.

Bailey, Mark, Nick Spencer, Emmanouil Chatzakis, Kate Lampitt Adey, Nate Sterling, and Neil Smith. 2018. "From wicked problem to design problem: Developing actionable briefs and solution opportunities through a collaborative, multidisciplinary design-led approach."

Buckland, David, Ali MacGilp, and Siôn Parkinson. 2006. *Burning ice: art & climate change*. Cape Farewell London.

Burke, Miriam, David Ockwell, and Lorraine Whitmarsh. 2018. "Participatory arts and affective engagement with climate change: The missing link in achieving climate compatible behaviour change?" *Global Environmental Change* 49:95-105. doi: https://doi.org/10.1016/j.gloenvcha.2018.02.007.

Chabay, Ilan, Larissa Koch, Grit Martinez, and Geeske Scholz. 2019. "Influence of Narratives of Vision and Identity on Collective Behavior Change." *Sustainability* 11 (20):5680.

Guerra, Berta Ramos. 2020. "Bruce Mau, optimism and the eternal need for change." https://brucemaustudio.com/press/bruce-mau-optimism-and-the-eternal-need-for-change/.

Hinkel, Jochen, Diana Mangalagiu, Alexander Bisaro, and J. David Tàbara. 2020. "Transformative narratives for climate action." *Climatic Change* 160 (4):495-506. doi: 10.1007/s10584-020-02761-y.

Mau, Bruce. 2020a. *Mau MC24 : Bruce Mau's 24 principles for designing massive change in your life and work*. Edited by Jon Ward, Bruce Mau's 24 principles for designing massive change in your life and work. London, New York, NY: Phaidon Press Limited.

Mau, Bruce. 2020b. New Wicked Problems Demand New Wicked Teams. In The MC24 design principle, New Wicked Problems Demand New Wicked Team," speaks to the need for "Renaissance Teams," diverse group of individuals, with different skills, working together towards a shared goal.

The seven "rules" for becoming a Renaissance Team player correspond to seven character traits that the best designers possess and constantly work on developing: expertise, curiosity, empathy, confidence, humility, independence, and courage. If you were to create a Renaissance Team for your project or business, what skills and knowledge would be most needed?, edited by BruceMau.MC24: Facebook.

Niedderer, K., G. Ludden, S. J. Clune, D. Lockton, J. Mackrill, A. Morris, R. Cain, E. Gardiner, M. Evans, R. Gutteridge, and P. P. M. Hekkert. 2016. "Design for Behaviour Change as a Driver for Sustainable Innovation: Challenges and Opportunities for Implementation in the Private and Public Sectors." *International journal of design* 10 (2):67-85.

Service, Owain, Michael Hallsworth, David Halpern, Felicity Algate, Rory Gallagher, Sam Nguyen, Simon Ruda, Michael Sanders, Marcos Pelenur, Alex Gyani, Hugo Harper, Joanne Reinhard, and Elspeth Kirkman. 2014. "EAST: Four simple ways to apply behavioural insights."53.

Smith, Mat. 2020. "Bruce Mau Know How – Make Fact-Based Optimism Your Mantra." Phaidon. https://brucemaustudio.com/press/bruce-mau-know-how-make-fact-based-optimism-your-mantra/#:~:text=Fact%2Dbased%20optimism%20is%20a,important%20contribution%20designers%20can%20make.

Kiwi Kai, from the Soil to your Plate: Designing Educational Tools for Pro-environmental Communications

Authors:
Fabiola Cristina Rodríguez Estrada[1]
Catriona MacLeod[1,2]
Garth Harmsworth[2]
Antonio Alfonso Rodríguez Rosales[1,3]

Institutions:
[1]CICTEG- Centro de Investigación Científica y Tecnológica de Guerrero (Mexico)
[2]Manaaki Whenua – Landcare Research, Dunedin (New Zealand)
[3]Manaaki Whenua - Landcare Research, Palmerston North (New Zealand)

Abstract

This paper outlines the design process for Kiwi Kai – an online educational tool aiming to inspire and enable young New Zealanders to think critically about how their food is produced. The tool invites students to experience real-world challenges that New Zealand farmers face when growing food. Through game-based play, users learn about the interconnected relationships between humans, biodiversity, and the environment. They also develop science abilities and long-term competencies, while starting to learn about traditional knowledge and values held by Māori society (indigenous New Zealanders).

The tool was codesigned with its intended users and an interdisciplinary team involving specialists in education, design, te ao Māori (Māori world view), science communication, educational game design, programming, agriculture, and ecology from various institutes within New Zealand and abroad. Directly involving students in the design process allowed us to understand to their needs and incorporate their ideas into the tool design. To help teachers apply the tool in the classroom, supporting resources were co-designed with education and indigenous knowledge experts.

Here, we focus mainly on the designer's perspective and role in constructing this educational tool. We show how a successful collaboration between a designer, end users and other disciplinary experts can create engaging educational tools that hold potential to change users' attitudes and behaviours towards sustainable practices.

Keywords: Critical thinking, sustainable agriculture, biodiversity, educational tool, ecosystem, indigenous knowledge

Introduction

Our world is facing a wide range of health, environmental and social crises (Díaz 2019). To address these issues, 193 countries agreed in 2015 to work towards 17 Sustainability Development Goals (SDG) including: eliminating poverty and hunger, reducing inequalities, rescuing climate, and sustaining life on Earth by 2030 (Editorial 2023). However, recent SDG assessments signal that our current progress towards addressing these challenges is too slow and most targets will not be met. Hence, the International Science Council (2023) and others (Abson et al. 2017; Díaz 2019) are calling for changes to how scientists work, so that science can play a much greater and effective contribution to society's needs. This includes a call for scientists to work in closer collaboration with other disciplines and stakeholders to deliver creative solutions to society's most immediate problems.

The 'First Things First' Manifesto 2000 (Adbusters 1999) recommends that professionals in creative areas reassess and redirect their goals to help address these challenges. With the introduction of new artificial intelligence tools, it is even more important to reflect on and understand the essential role that creative professions can contribute. For example, designers can help change people's attitudes toward environmental problems, by creating better awareness of non-specialist audiences needs and facilitating the involvement of all in the design of educational resources. Environmental issues are often complex, and so must address many different aspects including social, cultural, economic, and political factors.

Furthermore, the task of changing attitudes is difficult and often limited by (Bernal 2004):

- Inefficient communication
- Lack of appreciation of different perspectives
- Distortion of the information
- Lack of cultural sensitivity

Thus, design can be a critical element in helping specialists from other disciplines generate tools to communicate efficiently. Designers can recontextualize the specialists' message for a non-specialized audience (Luzón 2013). Designers are experts in analyzing a problem, understanding, and empathizing with, users and all the stakeholders to create communication bridges to reach the intended audience.

Here, we focus on understanding how designers can work as part of an interdisciplinary team to help to build pro-environmental educational tools to help address such complex problems. We present a case study centred around the development of an interactive learning tool – Kiwi Kai (kiwikai.nz) – which aimed to inspire young New Zealanders to think critically about how their food is produced and whether it is nature friendly. Our goal was to design an online educational tool for students to experience the real-world challenges that New Zealand farmers face when growing food, whilst also learning about interconnected and varied relationships that humans have with nature, and the environment.

Interdisciplinary Approach

Complex socio-ecological problems require innovative solutions informed by different ways of knowing and doing (International Science Council 2023; Norström et al. 2020), as well as a dynamic approach (Andrade et al. 2014). Like any specialists confronted with multi-faceted challenges, environmental and conservation researchers tend to have "discipline-induced selective attention areas and blind spots" (Andrade et al. 2014) and a narrow world view informed by their respective discipline's methodologies, specialized lingo and problem-solving approaches.

Involving a team of diverse specialists, including the designers, from the beginning allowed us to draw on different capacities and skills to the construction of the problem statement. Integrating insights from design theories and practices can be a crucial element in addressing such socio-ecological problems. Designers can offer more than producing objects of use (Dorst 2011), as they specialize in finding solutions to complex problems by looking at different options until reaching the appropriate solution, depending on the social and cultural order to which it belongs (Maldonado s.f., in Sexe 2001). Designers can also learn from different paradigms by working in interdisciplinary teams to generate new options: "The interdisciplinary nature of Design thinking also ensures that innovation is naturally balanced between the technical, business, and human dimensions" (SAP Design Service Team, in Melles et al. 2011:163). Hence, a higher quality outcome stems from an iterative process involving diverse specialists (Wilson 2013), helping us to gain a holistic view of complex problems and designing innovative solutions.

In the case of Kiwi Kai, our challenge was to design an educational tool that not only successfully engaged its intended audience but also integrated information about New Zealand's farming system with scientific evidence on biodiversity and te ao Māori (New Zealand's indigenous people's worldview including Māori concepts, knowledge, values, practices, language and terms), whilst also supporting game-based learning and school curriculum needs. Hence, from the outset, our project team involved experts from diverse disciplines including agriculture, ecology, te ao Māori, education, science communication, design, game design and programming from various institutes within New Zealand and abroad. This allowed us to work together define the problem statement and ultimately deliver a free online educational tool that:

- Invited the player to manage a virtual farm and try to balance care for nature, grow healthy food and care for community, without overspending. Players experiment with diverse farm management strategies giving them a sense of autonomy and creativity, challenge, and purpose (Bolstad and McDowall 2019), as the tool includes 240 farm scenarios and 140 chores that reflecting the real-world social, economic and environmental context of New Zealand farming.
- Reflected the essence of te ao Māori respectfully by subtly highlighting Māori's (indigenous New Zealanders) (w)holistic relationships (inter-connection and inter-dependency) with the environment as well as their traditional knowledge, practices, and values (Harrison et al. 2020; Harmsworth 2022).

- Included nature-based quests designed to help the player appreciate what it means to practise kaitiakitanga (guardianship), with good choices revealing hidden taonga (values, treasures) and rewards. These quest designs were informed by an existing biodiversity assessment for NZ farms (previously co-designed with NZ farmers, stakeholders, and biodiversity experts; MacLeod et al. 2021).
- Used an existing novella-style game framework to give us a fast start, with five unique reward rooms to visualize changes on the farm, and bespoke artwork for New Zealand's unique biodiversity and environment. The tool also had an agile design enabling us to easily specify changes in the game text, graphics, and triggers via Google Sheets.
- Ensured that the browser-friendly tool was optimized for use on the devices available in most schools (i.e. Chromebooks) and it was feasible to complete the game within a classroom session.
- Embedded the learning experiences aligned with New Zealand's school curriculum. Supporting resources were available via an educational platform commonly used by teachers nationally (Science Learning Hub, n.d.). These resources demonstrate how to use Kiwi Kai as a springboard for deeper learning in the classroom, helping students to develop their science proficiencies, understanding of te ao Māori concepts and enduring relationships and capabilities.

We also co-designed the tool with its intended audiences – students aged 8 to 12 years old. Over 200 students from five schools (mainly in Dunedin) helped name, test, and refine the tool. We initially worked closely with two classes, but then progressively invited novel users from other classes and schools to join the project. This iterative design process helped us to not only understand and respond to the intended audience's needs (Stanford d. School at The Irish Times., s.f.), but it also integrated their ideas into the tool design, which included:

- Developing and refining our storylines for introducing the virtual farm, interacting with the key characters in the game, and solving farm management issues.
- Allowing the player to save the game, tailor their farm and avatar to match their own interests, and easily see the outcomes of their decisions through the use of visual effects and changes in their farm environment as well as their score bars and various reward systems
- Helping to select graphic designs and improve the user interface layout.

This user-centric design approach helped to deliver a user interface that was agile, inclusive, ethical, visually engaging, ergonomic and fit-for-purpose. In user-centred design, the user's viewpoint was critical in shaping the process including the planning, design and development phases. The user-centred design included: active participation of users, collaboration with the design solutions and multidisciplinary teams for tackling a specific task (Pelta 2007 in Rodríguez-Estrada et al. 2015). It helped us to understand the user's needs and wants. To create communication bridges linking the users to the natural world, requires a team that can share communicative codes. It is a process where there is a continuous practice of asking, challenging assumptions, listening, and understanding, requesting information that may seem obvious to an expert in that domain, knowing that others can contribute, recognizing differences in what people know and how they communicate, take personal responsibility to be an effective collaborator (Dall' Alba's, n.d.; in Adams et al. 2011 in Rodriguez Estrada n.d.). Our team's challenge was to integrate our diverse skills and knowledge to produce a tool that inspired the students think critically about how their food is produced, our relationships with the natural world and each other. The Kiwi Kai project provides a working demonstration of how design can help facilitate social transformation. Design has been shown to improve practical decision-making in other fields, in innovation and social impact projects, and has the capacity to contribute to the developing of tools to communicate and change users' attitudes towards socio-ecological problems.

With the introduction of new artificial intelligence tools, it is even more important to reflect on and understand the essential role that creative professions can contribute.

Kiwi Kai, A Multimodal Text

Figure 1: Kiwi Kai introduction. October 5, 2023. Kiwikai.Nz. App.Kiwikai.Nz. https://app.kiwikai.nz

Along with working in interdisciplinary teams to create communications with the capacity to transform the attitudes and behaviours of the users towards environmental matters, we need to modify how messages are usually constructed. Particularly in environmental communication, the teams responsible for generating educational materials must work on elaborating messages through multiple sign systems and use different strategies (Serafini 2011). When designing Kiwi Kai, we aimed to deliver a tool that helped students interpret, critique, and create knowledge; hence, it was decided to design a multimodal text (Table 1).

Multimodal text is constructed by combining two or more semiotic systems, which can be linguistic, visual, gestural, spatial, and auditory (Kress and Van Leeuwen, 1996 in the Department of Education WA, 2013). It recognizes that the definition of literacy now goes beyond the use of oral and written language. Nowadays, we use complex texts that contain elaborate visual images, unusual narrative structures, complex design elements and unique formats (Goldstone 2004; Kress 2003; Serafini 2011). We require greater capacity and speed of adjustment to the technologies that come into our lives at a speed never seen before. We find new ways of acquiring information through interaction with various multimodal texts, such as video games, applications, interactives, virtual reality, and interactive books, to name a few.

Figure 2: Initial explanation. October 5, 2023. App.Kiwikai.Nz. https://app.kiwikai.nz

Figure 3: Icon for care for the community. October 5, 2023. App.Kiwikai.Nz. https://app.kiwikai.nz

Semiotic system	Definition and code examples	Examples from Kiwi Kai's design
Linguistics	Oral and written language (use of vocabulary and grammar).	– Keeping text simple and short with a popup glossary for complex terms. – Highlighting key messages using a different colour font. – Phrasing to reflect character personalities. – Integrating key phrases and words in te reo Māori with a popup translation. – Providing popup information cards to inform user decisions.
Visual	Refers to static and moving images.	– Player can customize their avatar. – Moving images draw attention to change in seasons, gain/loss of points, and key rewards stored in a notebook. – Visual appearance of farm changes to reflect player choices and changes in season and production cycles. – Bespoke graphics designed mainly for species unique to NZ.
Audio	Includes music, sound effects and silence.	– Bird calls reflect NZ farm environment. – Celebrate player achievements. – Player clicks active elements.
Gestural	Contains facial expressions and body language.	– Characters reflect different roles, cultures, and intergenerational aspects of NZ farm communities. – Changes in character expressions give visual feedback on player choices.
Spatial	Includes the position, layout, and organization of objects in space.	– Layout of habitat and species images reflect NZ farming landscapes and species niches. – Farm map allows user to move between different habitats. – Each habitat functions as a 'reward room'. – User interface layout is consistent, with changing button formats to reflect their status (locked, unlocked).

Table 1: Definition of the five semiotic systems (Department of Education of WA, 2013:2), with examples from Kiwi Kai's design.

Producers and receivers of communications must be able to read multiple types of texts. (Unsworth 2001, in the WA Department of Education 2012). In the education system, literacy is changing so that it now goes beyond the use and production of traditional texts and includes new communication technologies, such as the use of different multimodal texts. Accordingly, Kiwi Kai's team wanted to allow students to engage in constructing this multimodal text. This aided in generating a tool that can engage the target users.

Figure 4: Interaction kiwi Kai. October 5, 2023. App.Kiwikai.Nz. https://app.kiwikai.nz

Close collaboration occurred between specialists and each semiotic system to craft appropriate codes. For better biodiversity comprehension, sustainable farming, and agriculture, the expertise of environmental scientists and farming professionals played a pivotal role. For Indigenous New Zealanders' codes, the participation of the experts in Māori knowledge, culture, language, and terms was imperative. Indigenous Māori are understandable very sensitive to how Māori are represented or portrayed through iconography, images, symbols, graphics, language, and in general. Developing the Kiwi Kai game considered these sensitivities from start to finish by engaging with Māori experts to guide the whole process. Indigenous data sovereignty and ethics are crucial considerations in which experts guided us to follow the appropriate protocols. Educators working with community members helped to understand the local epistemologies and the value of the students' observations (Balazs and Morello-Frosch 2013 in Andrade et al. 2014).

The design specialists' assignment was to work with the subject-matter experts and understand their codes and recontextualize them for the target users. As the act of communicating is a social process, every time a new piece of communication is developed, the discourse needs to be recontextualized (Rodríguez-Estrada et al. 2015).

- To generate the appropriate codes.
- Design the user interface with the programmers, who were specialists in narrative design.

Figure 5: Explanation with the inclusion of Maori language. October 5, 2023. App.Kiwikai.Nz. https://app.kiwikai.nz

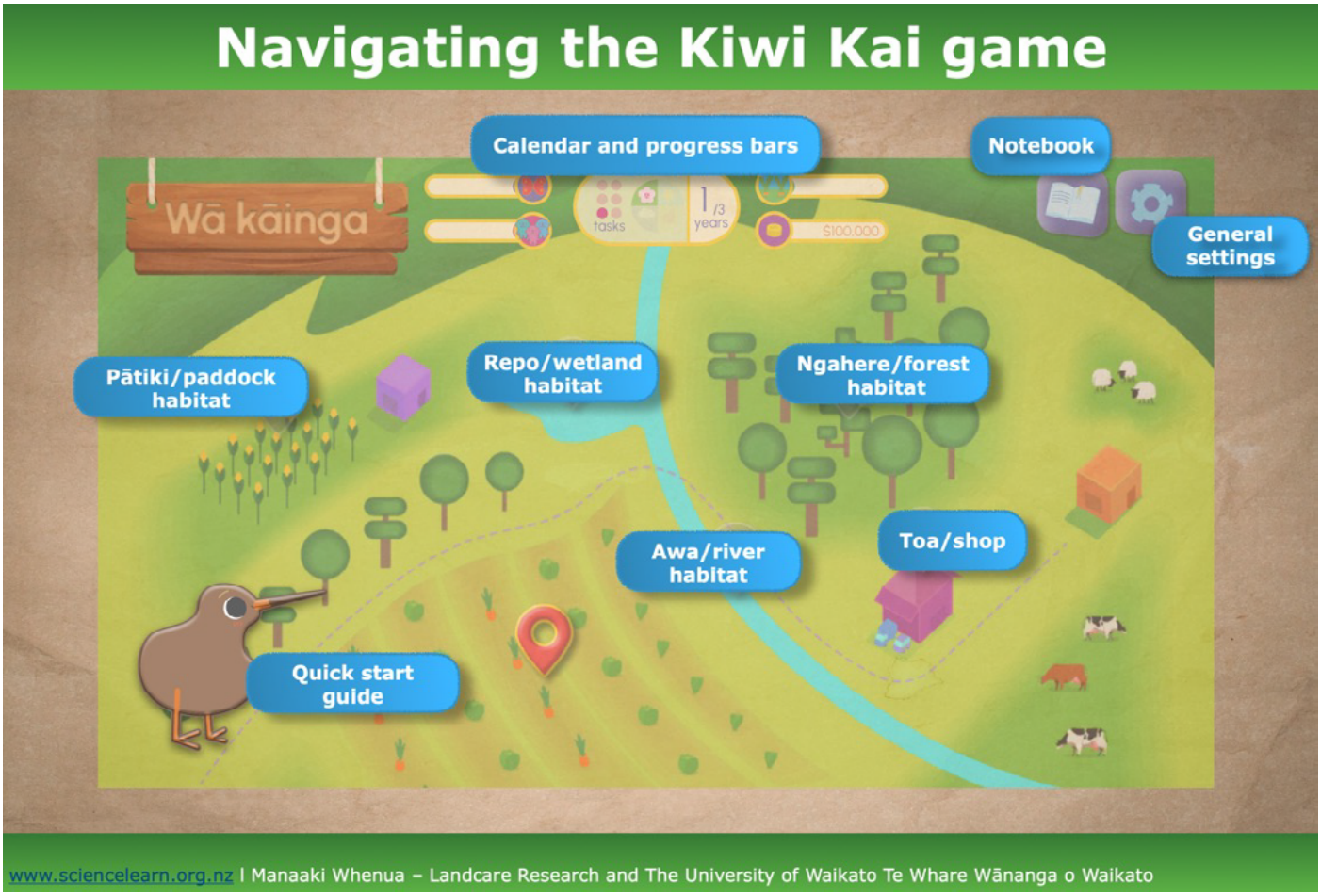


Figure 6: Map Navigating the Kiwi Kai game. October 5, 2023. App.Kiwikai.Nz. https://app.kiwikai.nz

As designers of pro-environmental communicative tools, it is essential to understand that conveying all these codes into one multimodal text is not only about generating each code individually but also designing all of them together to engage with our users and communicate the targeted message. For Kiwi Kai's design process, we understood that the interdisciplinary process requires patience; as Andrade et al. (2014) mentioned, it was a process of adaptation where we all learned the conventions and specialized communications of other disciplines. Design proved helpful in confronting a complex problem – in this case , the challenge of Kiwi Kai's design to reflect multiple dimensions of a complex socio-ecological system in a way that would successfully engage young New Zealander's (of all cultures and ethnicities) to think critically about how their food is produced and help them envisage different pathways for achieving sustainable farming. Within five months, Kiwi Kai's website has reached a global audience of 2500 people, with 1800 players (including students, educators and caregivers) across New Zealand and 22 other countries engaging directly with the educational tool and many providing positive feedback.

Acknowledgements: *This project was funded by New Zealand's Ministry for Business, Innovation and Employment's Unlocking Curious Minds and Biological Heritage National Science Challenge programmes as well as the Strategic Science Investment Fund for Crown Research Institutes (Manaaki Whenua – Landcare Research). It was also supported by generous in-kind support from the Science Learning Hub, Enviroschools (via Otago Regional Council), New Zealand Association for Environmental Education, Horticulture and Agriculture Teachers Association of New Zealand, New Zealand Association Resource Management and Deer Industry New Zealand.*

Students and teachers from Carisbrook School, North-East Valley Normal School, Ōpoho School, Musselburgh School and Laingholm Primary School who helped us co-design and refine our educational tool. Our core project team involved Geo AR Games, WI Links and Carisbrook School, with additional expertise provided by The AgriBusiness Group, EFS Initiatives, New Zealand Council for Educational Research and Science Learning Hub.

References

Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C. D., Jager, N. W., & Lang, D. J. 2017. "Leverage Points for Sustainability Transformation." *Ambio* 46: 30–39. doi:10.1007/s13280-016-0800-y.

Andrade, K., Corbin, C., Diver, S., Eitzel, M. V., Williamson, J., Brashares, J., & Fortmann, L. 2014. "Finding Your Way in the Interdisciplinary Forest: Notes on Educating Future Conservation Practitioners." *Biodiversity and Conservation* 23: 3405–3423.

Bernal Stoopen, J. F. 2004. *Binational Collaboration in Recovery of Endangered Species: The Mexican Wolf as a Case of Study*. Texas: Office of Graduate Studies of Texas A&M University.

Bolstad, R., & McDowell, S. 2019. "Games, Gamification, and Game Design for Learning: Innovative Practice and Possibilities in New Zealand Schools." New Zealand Council for Education Research Report.

Buchanan, R. 1992. "Wicked Problems in Design Thinking." *Design Issues* 8 (2): 5-21.

"Design Thinking workshop with Justin Ferrell of Stanford d. School at The Irish Times." n.d. YouTube. Retrieved August 22, 2023, from https://www.youtube.com/watch?v=Z4gAugRGpeY.

Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Arneth, A., Balvanera, P., Brauman, K. A., Butchart, S. H. M., Chan, K. M. A., Garibaldi, L. A., Ichii, K., Liu, J., Subramanian, S. M., Midgley, G. F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., Zayas, C. N. 2019. "Pervasive Human-Driven Decline of Life on Earth Points to the Need for Transformative Change." *Science* 366 (6471): eaax3100. doi:10.1126/science.aax3100.

Dorst, K. 2011. "The Core of 'Design Thinking' and Its Application." *Design Studies* 32 (6): 521–532.

Editorial. 2023. "The World's Goals for Saving Humanity Are Still the Best Option." *Nature* 621: 227–229.

"Exploring Enduring Competencies with Kiwi Kai." Science Learning Hub. Accessed September 15, 2023. https://www.sciencelearn.org.nz/resources/3241-exploring-enduring-competencies-with-kiwi-kai.

"Exploring Your Local Environment." Education resources. Accessed October 10, 2023. https://www.doc.govt.nz/get-involved/conservation-education/resources/exploring-your-local-environment/.

"Feature: First Things First Manifesto 2000." Eye Magazine. Accessed November 15, 2023. http://www.eyemagazine.com/feature/article/first-things-first-manifesto-2000.

Harmsworth, G. 2022. Soil Security: An Indigenous Māori Perspective from Aotearoa-New Zealand. Discussion paper. MBIE project 'Soil Health and Resilience: Oneone Ora, Tangata Ora'.

Harrison, S., Baker, M. G., Benschop, J., Death, R. G., French, N. P., Harmsworth, G., & Murdoch, D. R. 2020. "One Health Aotearoa: A Transdisciplinary Initiative to Improve Human, Animal, and Environmental Health in New Zealand." *One Health Outlook* 2 (1): 1–6.

International Science Council. 2023. Flipping the Science Model: A Roadmap to Science Missions for Sustainability. Paris, France: International Science Council. doi:10.24948/2023.08. Retrieved from https://council.science/publications/flipping-the-science-model.

Kiwi Kai. Accessed October 5, 2023. https://app.kiwikai.nz/.

Luzón, M. J. 2013. "Public Communication of Science in Blogs: Recontextualizing Scientific Discourse for a Diversified Audience." *Written Communication* 30 (4): 428–457. Print.

MacLeod, C. J., Brandt, A. J., Collins, K., Moller, H., & Manhire, J. 2022. "Behavioural Insights for Improved Uptake of Agricultural Sustainability Assessment Tools." *People and Nature* 4 (2): 428–444.

Melles, G., Howard, Z., & Thompson-Whiteside, S. 2012. "Teaching Design Thinking: Expanding Horizons in Design Education." *Procedia - Social and Behavioral Sciences* 31: 162–166.

Norström, A. V., Cvitanovic, C., Löf, M. F., West, S., Wyborn, C., Balvanera, P., Bednarek, A. T., Bennett, E. M., Biggs, R., de Bremond, A., Campbell, B. M., Canadell, J. G., Carpenter, S. R., Jouffray, J.-B., Leach, M., Le Tissier, M., Martín-López, B., Louder, E., Loutre, M.-F., ... Österblom, H. 2020. "Principles for Knowledge Co-Production in Sustainability Research." *Nature Sustainability* 3: 182–190. doi:10.1038/s41893-019-0448-2.

Rodríguez Estrada, F. C., & Davis, L. S. 2015. "Improving Visual Communication of Science Through the Incorporation of Graphic Design Theories and Practices into Science Communication." *Science Communication* 37 (1): 140–148.

Rodríguez Estrada, F. C. 2015. Diseño de la Comunicación Visual: Construcción de Narrativas para las Comunicaciones Pro-Ambientales. Doctoral dissertation, Universidad Autónoma Metropolitana. Unidad Xochimilco.

Sexe, N. 2001. Diseño.com. Buenos Aires: Paidos.

"Te Aka Māori Dictionary." n.d. "Whakapapa - Te Aka Māori Dictionary." Retrieved from https://maoridictionary.co.nz/search?idiom=&phrase=&proverb=&loan=&histLoanWords=&keywords=whakapapa.

Special Thanks

We would like to acknowledge and thank the many individuals and institutions who supported us throughout this process and enabled the successful execution of this event:

WDO WORLD DESIGN ORGANIZATION

World Design Organization (WDO)®
455 St-Antoine Street West, Suite SS10
Montreal, Quebec, H2Z 1J1 (Canada)
WDO.org