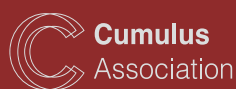


Cumulus  
Beijing  
CAFA 2023

Volume II  
Track 2  
Foresight  
Plan



中央美术学院  
Central Academy of Fine Arts

C A F A

爱的阐释

Narratives  
of Love

Narratives of Love

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11/2024 Beijing

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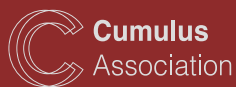
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# Preface



中央美术学院  
Central Academy of Fine Arts

C A F A

爱的阐释

Narratives  
of Love

# **Cumulus Beijing CAFA 2023 Conference Narratives of Love**

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Li Yufeng

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CAFA Conference:

Central Academy of Fine Arts, Beijing

Parallel Conference:

Sichuan Fine Arts Institute

Guangzhou Academy of Fine Arts

Xi'an Academy of Fine Arts

Hubei Institute of Fine Arts

Nanjing University of the Arts

Jingdezhen Ceramic Institute

Xiamen University

CAFA Conference: 11.22-11.24

Parallel Conference: 11.27-11.28

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## **"Crisis and Opportunity"**

Throughout the past three years of the COVID-19 pandemic, humanity has shown its remarkable resilience in the face of adversity. However, the relief felt at the end of the pandemic was short-lived as it was quickly overshadowed by the nervousness surrounding the ongoing world crisis. It is now more urgent than ever to re-examine our ecological foundation, lifestyle, production relations, and the meaning of life. The diverse advancements in artificial intelligence have created a dilemma for human self-understanding and the ethics of human-machine interaction, evoking a mixture of hope and fear. With the increasingly intensifying climate warming, cultural conflicts, economic fragmentation, and scientific iteration, how do humans react to standards of morality, ideas of design, thought of art, and methods of education? These common issues in the field of art and design will provide us with important references for strategic adaptation, structural reshaping, and redefinition of values.

## **"Ideology and Ideality"**

Over the ages, "Love", as the matrix of human sensibility and rationality, the enlightenment of ideology and idealism, is the harmony of Tao, nature, and human wisdom. Love permeates every aspect of human civilization. Chinese civilization, Greek civilization, Islamic civilization, Indian civilization, Egyptian civilization, and the Maya civilization, among almost all major cultural systems, unanimously cherish and emphasize the importance of 'Love'. From the symbiosis of humans and nature, the healing of collective traumas, the compatibility of heteroge-

neous perspectives, the stability of social structures, to the innovation of art and culture, "Love" has always been created, interpreted, applied, and disseminated through a harmonious beauty, providing solace to life and nurturing existence. We firmly believe that facing an uncertain future, "Love" will continue to be the immortal energy driving the evolution and progress of human civilization, enduring through the ages and persisting eternally. The current Cumulus Association International Art and Design Conference has chosen "Narrative of Love" as its annual theme. Through the means of art and design, the conference aims to explore and interpret the ideas and forms of "Love" in multiple dimensions, including the individual, family, ethnic group, nation, world, nature, even the supernatural. It will delve into the realms of thoughts and thinking, discussing interdisciplinary topics such as culture and ecology, society and education, policy and economy, science and ethics, philosophy and faith. The conference seeks to gather cross-cultural wisdom to explore the future directions and methodologies of art and design.

"East and West"

Beijing, as the capital of China, stands as a profound embodiment of rich historical heritage, serene ecological surroundings, avant-garde fashion districts, vibrant community life, efficient service systems, and endearing folk traditions. These multifaceted elements have forged a distinctive design culture with worldwide influence, making Beijing an indispensable gateway and an enchanting source of inspiration for global designers, artists, and scholars to experience the essence of Chinese culture and the grandeur of Eastern civilization. We eagerly anticipate the gathering of Cumulus members from around the world in Beijing in November 2023, where we can unite in our efforts to forge a sustainable future imbued with the essence of "Love," igniting passion, motivation, and hope.

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# **Narratives of Love: Towards Healing, Transformation, and Transcendence.**

Lorenzo Imbesi

Full Professor, Sapienza University of Rome

President, Cumulus Association

The Cumulus Beijing 2023 Conference, held at the prestigious Central Academy of Fine Arts, represented a significant milestone for the organization. Set against the backdrop of Beijing's rich historical and cultural landscape, the event was notably enriched through satellite conferences hosted at various prestigious institutions, including the Sichuan Fine Arts Institute, Guangzhou Academy of Fine Arts, Xi'an Academy of Fine Arts, Nanjing University of the Arts, Jingdezhen Ceramic Institute, and Xiamen University. This expansion of the conference's reach has significantly transformed it into a vibrant hub for cultural exchange and academic discourse, gathering a diverse array of participants from around the globe, all united by a shared commitment to exploring the intricate interplay of love, design, and social responsibility.

The overarching theme of the conference, "Narratives of Love: Towards Healing, Transformation, and Transcendence," provided a rich tapestry of insights and perspectives, prompting both the international and Chinese design communities to collaborate in efforts to forge a sustainable future imbued with the essence of love. In this context, the notion of love transcends mere emotion; it embodies a profound commitment to social justice, environmental stewardship, and cultural inclusivity.

The multifaceted challenges facing our planet, ranging from cultural conflicts and technological acceleration to social development, demand a heightened level of responsibility from designers and artists. They are called to reconsider how design can serve as a vehicle for positive change, challenging the status quo and addressing pressing global issues. Through thought-provoking discussions and reflections on critical dilemmas, including "Crisis and Opportunity," "Ideology and Ideality," and "East and West," the conference offered a unique platform that resonated globally.

The conference featured numerous paper presentations, panel discussions, keynote speeches, and networking opportunities, all of which collectively generated cross-cultural insights and social reflections on urgent topics, including environmental and ecological issues, societal and local cultural dynamics, policy, and economic considerations, as well as scientific, ethical, philosophical, and faith-based inquiries.

Humanity is currently undergoing unprecedented transformations. In the face of an uncertain future, design actions must increasingly prioritize human self-understanding and the ethics of human-machine interaction, while also providing positive references for strategic adaptation, structural reshaping, and the redefinition of values. Design, as a creative process aimed at solving problems, fulfilling needs, and creating value, must incorporate a multidimensional vision that informs today's actions. New paradigms in design innovation and technologies must reflect a responsibility toward future generations, fostering the blending and coexistence of Eastern and Western artistic and cultural traditions and promoting a flow of consciousness and mutual respect that ultimately nurtures love as a force for unity and understanding.

The proceedings compiled in this volume resonate the interconnectedness of these discussions, conveying a clear message to the global design community: design encompasses multifaceted responsibilities; every decision, ranging from product development to urban planning, carries ethical implications. The substantial attendance from around the globe demonstrated remarkable resilience in the face of adversity, underscoring the necessity to re-examine our ecological foundations, ethics, and values. This highlights the importance of fostering cross-cultural exchange, cross-border community development, and cultural inheritance, ultimately contributing to a new distinctive design culture in which love and design are perceived as catalysts for social change, inspiring individuals and communities to strive toward a more equitable and just society wherein a sense of belonging, diversity, and pluralism are celebrated and where the environment is preserved. Thus, the creation of a more inclusive, dynamic, and cherished global design landscape.

The insights collected in this volume encapsulate only a fraction of the meaningful contributions that the Cumulus Conference Beijing 2023 and its parallel events have offered to address the multifaceted crises of our time. The memories will undoubtedly resonate within the global design community, inspiring ongoing dialogue and collaboration in the pursuit of a better world.

-----  
*Lorenzo Imbesi is Full Professor of Design at Sapienza University of Rome, where he is the Director of Sapienza Design Research and the Chair of the PhD program in Service Design for the Public Sector. Currently, he serves as the President of the Global Cumulus Association ([cumulusassociation.org](http://cumulusassociation.org)), the President of the Italian Scientific Design Society SID ([societaitalianadesign.it](http://societaitalianadesign.it)), and a member of the Executive Committee of the European Academy of Design ([eadresearch.org](http://eadresearch.org)).*

# **Transferability vs. Repeatability: Consolidating the Ontological Nature of Design Research**

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## **Abstract**

Over time we have begun to build foundations for design ontology moving it away from efforts to align with a scientific rigour model based on reproducibility and generalisability towards a new direction supporting design's emergent and abductive qualities. Two of the key issues that have escaped our grasp has been a better understanding of design ontology and what equates to rigour in constructive design research. Recent work by the authors has positioned transferability as a candidate for a design ontology based on an ontological mirror along with a series of attributes addressing the rigour issues of future-forwards knowledge generation. Here we use two case studies to test the future forwards rigour of a transferability property for design knowing and speculate as to how researchers can build confidence and trust.

## **Author keywords**

Transferability; Design Ontology, Design Futures; Design Research

## **Introduction**

thinking by CP Snow (Snow, 1959) and Archer's claim for design as the third culture, (Archer, 1978) a number of design thinkers have suggested temporal relationships between forms of knowledge production across different domains. Herbert Simon "Design, on the other hand, is concerned with how things ought to be,..." (1969, p.115), John Chris Jones "...that which exists only in an imagined future" (1992, p.10) and finally Ranulph Glanville "...there is a third kind of knowledge that converts knowledge of into knowledge for..." (2005, p.112) explored the idea that design has a distinctly different temporal relationship to scientific and Arts & Humanities knowledge building. This culminates in Glanville's proposition of 'design for future transformation'. It aligns with work by many others positioning design as an abductive form (Douven, 2011) of thinking imagining new futures. The issue previously explored by the authors (Hall & Galdon, 2023) concerns rigour and more specifically how knowledge that is being generated for future transformation in a forever-forwards mode can be built upon and at some future stage perceived to be truthful and worthy of acting on. While the authors have explored theoretical avenues leading towards transformation, we also seek to test tangible examples.

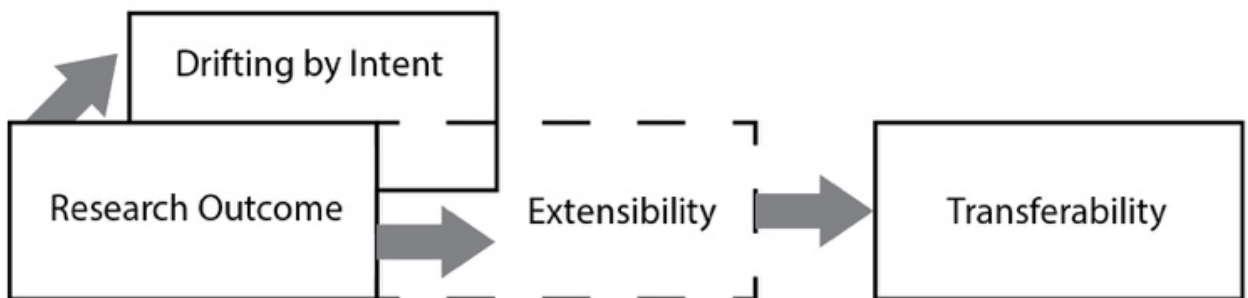
## **Towards a Design Ontology**

Several developments have come together for identifying the core foundations of knowledge generation in design research. These are substantially different to those of other domains of thinking and the call for distinct design foundations made most recently by Dixon "...with the potentially special approach to knowledge claiming in design, there is also the possibility that

the evolution might take on a different form here too.” (2023, p.127). Dixon identified the impossibility of reproducibility and generalizability as foundations for design research and opens the door towards several other approaches.

Gaver et al (2012, 2022) have identified emergence in the context of Human Computer Interaction (HCI) as an essential quality for design research where methodologies are rarely set in advance. This contrasts to the ‘preregistration movement’ in HCI which seeks to evaluate the outcome of research according to a prior public registration of research aims. Here design and the sciences clearly diverge in their expectation of rigour models where one appears to view divergence as suspect and the latter sees it as essential for investigation. Koskinen and Krough (2015) inspired by Gaver (2001) explore accountability in the context of constructive design research by way of the entanglement of theory and practice. They describe the tensions of design research that builds on practice and must navigate competing interests and multiple concerns. Building on this Krough and Koskinen (2020) consider the implications for moving from a practice based to a knowledge-based discipline and how this affects research outcomes. They explore through four different epistemic traditions using the concept of ‘drifting by intention’ and emphasise in line with Gaver that context is crucial, and that drifting is conceived within a constructivist design research tradition and would be out of place for example in an engineering context. Binder and Redström (2006) review the three traditions of design research and described how drift can emerge in research cycles as practice uncovers new opportunities and directions. They contrast the inside and outside view of design research programs to illustrate the projected verses the perceived research experience akin to Jacob’s research night and day (Jacob, 2001). Zimmerman, Forlizzi & Evenson (2007) propose relevance and extensibility as criteria for reliable knowledge production in design research. Earlier Guba and Lincoln (1985) in the social sciences point towards transformation as one of a series of trustworthiness attributes including credibility, transferability, dependability, and conformability. The context here is producing knowledge of the world via rich and thick descriptions of socio-cultural scenarios rather than knowledge for future transformation. Nowell et al (2017) extended this concept challenging that a researcher cannot know who, how and where their research may be transmitted or extended to hence a question arises as to how design researchers who initiate research can enhance their practice, anticipate transmitted context and extensibility capacity of their work. Interestingly Krough and Koskinen (2015) contend that design researchers build on the ideas, methods, and practices of other researchers rather than the objects that might be outcomes of their work indicating that ‘thingness’ has less influence in design research for transferability.

We can draw threads of similarity through a special approach to knowledge claiming (Dixon), emergence (Gaver et al), drifting by intent (Krough and Koskinen), extensibility (Zimmerman, Forlizzi and Evanson) and transformation (Guba and Lincoln) leading towards a proposition that if design’s purpose is to create knowledge for future transformation, then transferability becomes a contender to underpin ontology. Three of these concepts have spatial relations to research outcomes in terms of direction as illustrated below in Fig.1.



**Figure 1.** Candidates for core ontology attributes in the context of constructive design research.



## Methodology

In order to test transferability in concrete research examples we have reflected on two design research projects undertaken by the authors that deal with design futures and supports thinking that addresses the key issues above: a framework for prospective design (Galdon and Hall, 2019a), and a design for safety foresight review (Anderson, Hall, Ferrarello, Cooper and Ross, 2018). Reflecting across these publications has supported new thinking towards contributing to the ontological quality of design knowledge production, and a further consideration about what this means in terms of rigour for practice-based design research.

Case studies enable the exploration and investigation of applied research within a defined context by using a variety of data sources (Baxter et al., 2008). This methodology allows design researchers to develop and to enhance:

“...the capacity of comprehension and analysis of real problems, the capacity to propose and evaluate alternatives for the improvement of the problem considered, to work collaboratively, [and facilitates] their capacity of information management and synthesis of problems” (Herrera et al, 2016).

In this context, we will use comparative studies. According to Bukhari (2011) a Comparative Study analyses and compares two or more objects or ideas to examine, compare and contrast them to show how two or more subjects are similar or different.

## Transferability Case Studies

We have selected two case studies from the research projects of the co-authors to test diverse transferability motivations, methods, mediums, and audiences for research. Neither of the case studies were created with the express purpose of facilitating transferability or making a case for ontological significance and we have approached the comparison of the cases to operate on a critical basis to develop a preliminary set of criteria for considering transferability factors. Therefore, our approach is retrospective.

### Case Study 1 – Prospective Design

Prospective Design differs from other forms of future design studies, such as Critical and Speculative Design, in its focus on systematic and relational ideation. Prospective Design aims to design on behalf of the user to shape frameworks and mitigate unintended consequences. Its focus, building on Nigel Cross' s work (1983), is on building preparedness, readiness, and appropriateness. This methodology repositions the designer as an expert in future-led technological potentialities aimed at reducing risks and protecting citizens/users. The success of the output is determined by its potential to affect change, which depends on the weight of the actors involved within the system. This future-led, mixed-methodology aims to design trust and incorporates trajectories, probabilistic extrapolation, asymmetries, consequential analysis and counter-fictions to design novel strategies to mitigate unintended consequences in prospective technological developments.

The methodology was developed in the context of artificial intelligence (Galdon, Hall, & Wang, 2019a). Four publications (Galdon and Wang, 2019b; Galdon and Wang, 2019c; Galdon and Wang, 2019d; Galdon and Wang, 2019e) were submitted to the National Data Strategy board for review. The committee accepted all four publications as pieces of evidence to inform the development of the framework which will determine the use of artificial intelligence (AI) in the UK. This framework was synthesised, adapted, transferred, and implemented in the context of publication aimed at future covid-19 type events (Rodgers, Galdon, and Bremner, 2020) to build preparedness, readiness and appropriateness. Building from the work conducted in prospective design, the covid-19 work also made use of time via longitudinal studies, the adaptation of probabilistic extrapolations via evolutive traces, and the execution of a concrete output via the generation of a book supported by the Arts and Humanities Research Council in the UK. This adaptation mirrored the process developed in prospective design. This project is an example of the synthesis, flexibility, contextual adaptation, and transferability process in which design operates. Currently, we are implementing a new case study to further synthesise, adapt, transfer, and implement prospective design in the context of

regeneration and sustainability via the development of deep products (Galdon and Hall, 2022).

#### Case Study 2 – Design for Safety Foresight Review

The Design for Safety (DFS) Foresight review (Anderson, Hall, Ferrarello, Cooper and Ross, 2018) was a strategic design research project commissioned by the Lloyds Register Foundation (LRF) following the successful design for safety grand challenge that focussed on saving lives at seas working with ship’ s pilots and the Royal National Lifeboat Institution (RNLI) on the river Thames (Hall, Ferrarello and Kann, 2017). The LRF is a charity funded from profits derived from business operation by the Lloyds Register surveying ships with remit of improving safety and have commissioned and published a series of strategic reports on diverse safety areas from fishing and ferries to robotics and critical infrastructure. The DFS research team at the Royal College of Art were commissioned to develop a DFS foresight review that would identify the top global risks from the perspective of DFS and identify any gaps in knowledge and capability.

The foresight review consisted of an international questionnaire and a two-day symposium with an international representation of geographies and safety critical industries. The review was focussed through a DFS matrix which identified the capability gap. A series of strategic mapping exercises were conducted during the symposium including mapping safety case study examples from each expert to ask where should design operate and what is missing from design; design future scenarios based on future forecasting techniques, which outlined future global risks that cross-sectors experts need to tackle through design; a strategic session where experts prioritise future design risks. Following a second one-day symposium with lead researchers and the Lloyds register foundation an onion diagram was developed to communicate the gap in capability and knowledge related to future global DFS issues. These were a DFS gap in ethics and principles, safety culture and safety practices.

#### Comparison

Case study 1 (CS1) contains several transfers from the original project into four papers for the UK AI Data Strategy Review Board and separately another strand supports a research publication aiming to improve design systems response to future pandemics. Case Study 2 (CS2) has developed a number of publications including one on emergent methodology (Hall, Ferrarello, Anderson, Cooper, Ross, 2019). The DFS project informed a new research project also in the marine environment seeking to support a new economic model for the world’ s oceans.

Both case studies take a ‘knowledge for’ future transformation approach from different directions. The prospective design case study (CS1) develops a philosophical perspective on futures and develops a methodology for prospective design that encourages stronger feedback loops from future projections allowing us to ‘design in’ preferred futures taking a collaborative directional role rather than a passive anticipatory stance. Design for safety (CS2), on the other hand, takes an applied approach of evidence gathering and collaborative activity in a two-day symposium followed by a second one-day event with a group of around 40 participants transferring knowledge through socially facilitated sessions, foresight and documents.

Comparing the two case studies we have proposed an explorative comparison with criteria selected to identify rigour, type, medium, audience and indicators of transferability in the context of generating knowledge for future transformation. When comparing criteria, we see that the case studies diverge in their aims, building a new approach to design futures and uncovering design for safety issues and limitations of design methods for tackling future global issues. Neither form of knowledge calls for repeatability or a retesting of its findings, yet both place emphasis on forward facing future action for ‘knowing what to do next’ in the context of knowledge for future transformation. The intended audiences diverge between academics, practitioners, industry and government.

#### Discussion

The case studies take place in complex dynamic environments tackling wicked or even very wicked problems (Alford & Head,

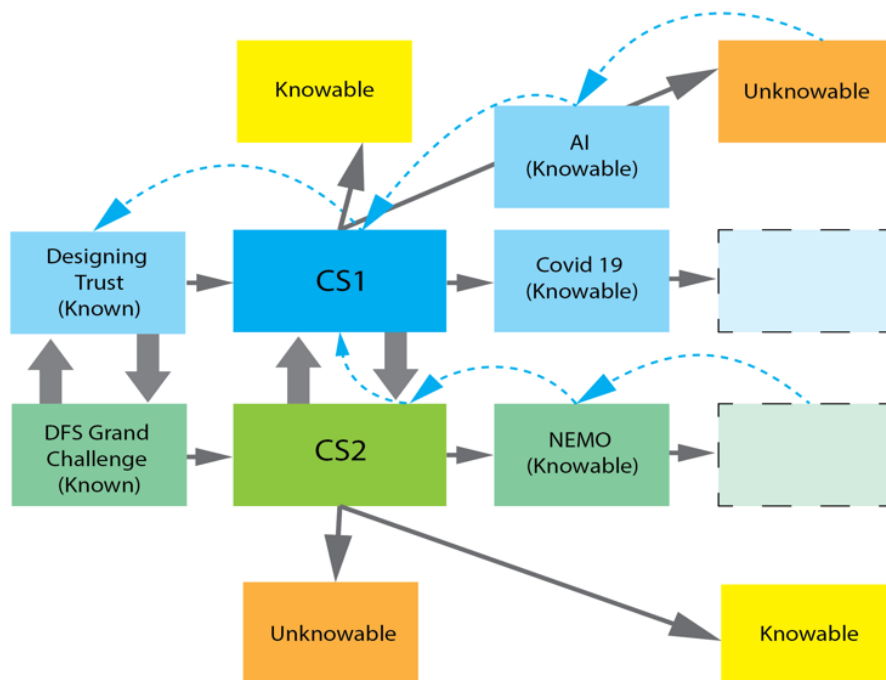
2017) and hence deal with ‘unknowable problems’ that prevent repetition. The intricacies of working with systems present a significant challenge for designers. Traditionally, these issues were framed around the concept of wicked problems, developed by Horst Rittel and Melvin Webber in the 1970’s to deal with complex social issues (Rittel & Webber, 1973) and led to the challenging of fixed step-by-step models of the design process. Wicked problems are complex and interconnected, sometimes they are nested or overlapping and often involve conflicting demands from various stakeholders with different perspectives making them impossible to fully solve.

As we look towards the future, we must also consider the critical role of contextuality. The output of a design projects will be subject to contextual forces such as economic, social, and environmental factors, and its value will be determined by a posteriori exchange based on these factors. Moreover, the intersection of complexity and contextuality gives rise to two additional variables: ambiguity and uncertainty. These elements prevent repeatability and create an environment in which contextual transferability demands design frameworks with flexibility to adapt to different contexts.

### Vectors

Based on the spatial and directional needs of transferability we propose vectors to understand the relationship of the core ontological design research practice and its fundamental differences to the sciences and arts and humanities. We envisage vectors describing the adaptability of knowledge and its transferability as a form of ‘future rigour in the making’ that could potentially satisfy the challenges that require design’s collaborative response to global challenges.

Specifically, we propose vectors for how we might understand the interactions between the future forwards potentials for more successful inter-domain collaborations. We make the case that a vector-based concept improves the potential for inter-domain collaboration. This leads us to the concept of transferability as directionality and a key domain knowledge quality for design which we compare (mirror) to repeatability in the sciences. In terms of rigour, we discuss the qualities of transferability that could address issues for practices which are often validated a posteriori. In our model rigour refers to integrity (collection of original data, material, findings), rather than being disciplined in the implementation of a method (repeatability).



We can see internal vectors from within the researcher’s projects in CS1 and CS2 moving into knowable transfers. Agreeing with Binder and Redstrom we can see transfer vectors that are internal and external to the project (knowable) and agreeing with Nowell recognise that some may be unknowable hence impossible for the researchers to build on, predict or trigger. We could also speculate that relevance (Zimmerman et al) provides a retro-speculative connection for both knowable and unknowable vectors.

**Figure 2.** describes an initial set of vectors emerging from the case studies.

Krough and Koskinen's assertion that design researchers tend to follow the ideas, methods and practices of other researchers rather than the objects indicates that we will have to revisit what we view as research outcomes and their influences.

Vectors that are knowable to the researchers are indicated by grey arrows while blue arrows show reverse retro-speculative trajectories linking to rigour claims. Further vector possibilities are indicated by the additional dashed boxes on the right to infinity. Many more cascading vectors and reciprocal transfers are possible even between indirect contact as in CS1 and CS2 where the authors who were not involved in both case studies yet exchanged other research activities.

Many questions remain and a more extensive analysis of the vectors from other more extensive research projects including knowable and unknowable transfers could provide greater confidence and trust in design research as a constructive special approach to knowledge claiming. Some of these questions include how we can navigate the knowable/unknowable transfer contexts, who decides what success looks like (if success is a consideration in a constructive context)? Are the outcomes traditional research forms (artifacts or the equivalent in practice-based research) or is the researcher practice influence, methods and concepts a 'cultural' research transfer? And how do vectors cascade through knowable, unknowable, external and internal to the researchers? Ultimately the vector network takes on the form of a cultural production.

Although it can sometimes seem like design research is continually flooded by adjacent fields and disciplines these also provide insights for shaping the foundations of design research. Most value seems to be gained for advancing the special approach to claiming knowledge in design research when we 'rub up' against related areas ranging from HCI to design engineering, philosophy, and the social sciences amongst many others.

## Conclusions

In comparing our case studies, we have found that diverse approaches to design futures research ranging from rigour, type, methods, audience, output, and indicators offer some potential in supporting an idea of knowledge for future transformation supporting an argument for an ontological design claim for transferability as a key ingredient. The concept of vectors allows us to begin to spatialise these relations of forward knowing whether the relations are past, present or future. In this context, we introduce the factors that make possible transferability; Synthesis, Flexibility, Contextuality, Adaptability, and Comprehensibility.

We offer this as a potential contribution to design ontology as an experiment emerging from a theoretical argument. There are of course alternative, contradictory, and complementary arguments for a design ontology and our thinking here is based on an initial set of comparative criteria applied to a pair of case studies. Other methods may elicit alternative arguments and propositions however we believe the temporal arguments made by Simon, Chris Jones, Glanville still hold and point towards a more radical position of design ontology which we support here. Further research is anticipated towards detailed investigation of the factors for successful transferability and how this can build towards a framework.

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## Advanced Design for human-non-human digital and creative ecosystem

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### Abstract

Contemporary societies are experiencing local and global challenges which have highlighted the complex nature of our present and its systemic problems; in this context, human actors find themselves collaborating and interacting with new technological tools which are becoming increasingly relevant in daily activities. The main changes concern the relationship between human/technology and human/environment, whose relations are in continuous transition and evolution. This new collaborative modality allows us to imagine new future scenarios and design spaces where human and non-human agents cooperate and interact, producing increasingly accurate information and artifacts. In this contribution we discuss possible strategies for integrating Advanced Design (AD) methodology with the growing availability of technological tools and data. In particular, we argue that the support of technology and the information it produces in design drive processes is helpful in establishing an empathic relationship with the heterogeneity of agents that inhabit the ecosystem and can foster more conscious and sustainable processes and innovations.

### Author keywords

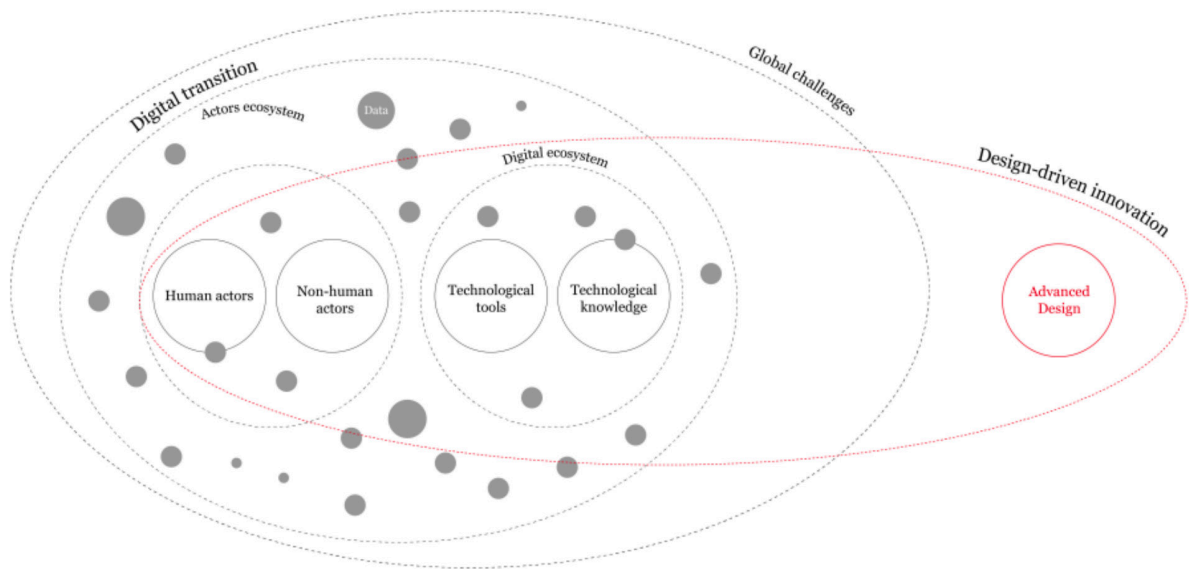
Advanced Design; Non-human Actors; Data; Methodology

### Introduction

Contemporary societies are experiencing social, environmental, and institutional challenges due to critical issues intertwined in complex and systemic problems, creating a confused and troubled present (Haraway, 2016), where different actors, such as individuals, public administration, companies, researchers and environment, find themselves collaborating in different contexts and relating to new technological tools and system which are becoming increasingly relevant in daily activities (Figure 1).

Climate change, increasing economic inequality, and the clear criticality of the current economic system, characterize today's society and identify it in the concept of "permacrisis" (Turnbull, 2022), or "polycrisis" (Lawrence, Janzwood & Homer-Dixon, 2022), which is defined as "a series of serious long-term challenges, now often labeled as global systemic risks". Due to its specific features, the concept of crisis offers a dual perspective: it can be conceptualized as an opportunity for progress, but at the same time it can be seen as a contradiction between opposites forces that allows for acceleration from past to future (Koselleck & Richter, 2006; Turnbull, 2022), observing how the resulting impacts are interconnected.

The topic of acceleration and overlapping, in turn, is identified by the increasing velocity at which transformations are happening across society, culture, and environment. Technology-driven transformation has a noticeable impact on human cognitive, creative and social skills and evolution (Hayles, 2012; Stiegler, 1998). Potentially, every aspect of human daily activity is mediated by interaction with technological interfaces. According to models of embodied and extended cognition, digital interfaces and media shape not only the way we think but also our bodies (Clark, 2008). On the other hand, the productive system struggles to adapt to such transformations due to its intrinsic inertia. Although initiatives such as Industry 4.0 support and finance technological innovation in the industrial sector, established manufacturing processes, especially in heavy industrial sector, still rely on significant amount of energy consumption, raw material extraction and cheap labor cost.



**Figure 1.**Background, actors and design approach

In order to address such challenges, community-based and shared vision presents itself as a possible opportunity to address such complexity and foster a transition to a more sustainable future (European Commission, 2019), including solutions derived from collaborative actions and integrated planning among the ecosystem of actors and tools, through multidisciplinary approaches (Akata et al., 2020).

Design cultures have developed design spaces and approaches to managing such complexity assuming different characteristics depending on the context; currently, digital technologies, such as machine learning and Internet of Things, have begun to permeate design-driven disciplines, leading the design community to ask different questions about the ways in which design is done (Giaccardi & Redström, 2020). Among these approaches, Advanced Design (AD) has focused on the time factor as a central parameter to consider in developing design-driven innovation (Celaschi, 2015; Celi, 2010, 2015). Together with the adoption of anticipatory and speculative practices (Celaschi et al., 2018; Celi & Formia, 2015), advanced designers engage with multiple specializations and disciplines to decode the complex structure of possible future scenarios.

In recent decades, the growing availability of electronic devices equipped with a variety of sensors and interconnected through mesh network and to the web, has generated a layered structure of digital georeferenced



information (Zannoni, 2018). Social transformation can be observed by applying computational methods on cultural data (Manovich, 2020) as well as climate change is studied through the analysis of environmental data. Over time, data has become a central aspect to consider during the design process. However, the complexity of connecting data between the global and the local dimension emerges due to both the heterogeneity of collected information and the definition of an appropriate knowledge structure (Cattabriga, 2022).

The successful or adverse relationships established among those participating in this transition are also constantly evolving, and one of the major changes concerns the relation between humans and technology, and between humans and the environment.

These interactions have enabled a process of consciousness-raising in relation to the diversity between individuals themselves, context and technological tools, where the concept of difference assumes the characteristics of an ontological source of societal empowerment which, however, allows for the connection of the individual with the collectivity itself (Haraway, 2018). The heterogeneity of society is reflected not only in the identity of individual people but also in the defining characteristics of the physical objects and technological systems with which people interact every day; this redefinition of the relationship between human and non-human, decreases the gap between physical and digital worlds, detaches itself from standardized ideals and accepts the fluidity of bodies (Ferrando, 2017). In fact, it is possible to identify a new space for the expression of the individual, of personal exploration and relationship with technological tools where corporeity is no longer defined by its material characteristics but assumes the definition of virtual corporeity (Braidotti, 2018). Human and artificial capabilities interact and define new forms of relationship, immateriality of bodies and overcoming of social patterns, according to the concept of glitch, that is an error in the corporeity of the binary society that is identified thanks to digital tools (Russel, 2020).

In this contribution we discuss the possible strategies to integrate the AD methodology with the growing availability of data. In particular, we argue that using data to establish an empathic relationship with the heterogeneity of agents that inhabit the ecosystem, can foster more context-aware processes and innovations.

### **Design-driven innovation in complex environments through Advanced Design**

The transformations taking place in the relationship between people and digital tools have made it possible to initiate a series of experimentations and identification of possible future scenarios related to the evolution of this interaction and to figure out what could be the ways to develop a multi-agent collaborative process, moving from the concept of "Human-machine interaction" to that of "Human-machine Cooperation" (Hoc, 2000) and heteromation (Ekbia & Nardi, 2014), introducing a collaborative and knowledge-sharing aspect.

Collaboration represents a human behavior naturally present in people's genes, but it is a capacity that must be exercised and deepened to foster an environment and context that can lead to open, cross-sectoral (Sennet, 2012) and responsible innovations (Blok & Lemmens, 2015). The theme of cooperation acquires particular relevance when included in the current process of digitization of our society, which is considered among the most relevant changes taking place and is an intrinsic condition of today's society (Escobar, 2018).

In fact, technological support to human, cognitive and operative capacities (Monari & Baraldi, 2020) can be an asset for policy making, public interest actions, and innovation of operational and project processes (Hoc, 2000),

stressing the need to identify hybrid spaces which allow the co-existence of human and non-human agents.

According to this perspective, technological systems, their development and the information it produces would no longer be neutral and indifferent from a functionally and ethical point of view (van de Poel, 2001) but becomes an agent who interacts and actively participates in the design process, initiating a context in which human actors design not for technologies but with technologies (Giaccardi & Redström, 2020).

The experience of these digital systems is undergoing a change. In fact, the industrial design artifact is created to perform a function in relation to an operator (Troncon, 2016), becoming a complex performance of object properties and senses according to the Donald Norman's affordance concept (Norman, 1988, 2007, 2011, 2013) and the relationship with the "ecological psychology" (Gibson, 1979) theme of the surrounding environment; technological systems and the data produced by them, become active agents of the process in the mode of "co-performance," (Kuijjer & Giaccardi, 2018; Giaccardi & Redström, 2020) i.e., an approach to design where such objects collaborate together with people, introducing the possibility of conceiving the artificial activities of things as a decentralized design practice in a hybrid mode based on intentionality and experience (Akata et al., 2020; Kamar, 2016). This 'co-productive' aspect introduces the field of socio-technology, a field of innovation in which complex technological systems have a political, ethical and environmental impact wherever technological development involves a heterogeneous combination of human and non-human elements. (Vermaas, 2011). Accepting this multi-agent collaborative vision, it is therefore necessary to inquire in what way design disciplines and cultures can evolve through the presence of non-human actors participating in the process, overcoming the limitations due to the current approach of a few methodologies, such as Human Centered Design.

As the human agent opens to new forms of co-operation, it is important to identify future scenarios and new design spaces based on the more-than-human concept, including technologies in the discussion.

Therefore, it is relevant to understand how the conceptual design space can change to a new modality of interaction with technologies and data, which become designing actors (Nicenboim et. Al, 2020) and address a further level of complexity of the reality around us where the cognitive flows of humans, animals and machines co-exist (Hayles, 2006); identifying new design-drive modes that are collaborative and declined in the multi-agent sphere, the figure of the designers also evolves, finding themselves interacting with actors of a different nature, and the role that is exercised in the relationship with digital tools also changes (Cattabriga 2020; Lim & Jung, 2018).

Starting with an in-depth analysis of some design driven methods and processes currently put into practice, it is possible to explore their characteristics and understand how they can be reshaped, according to the previously mentioned methods and tools.

### **Introducing non-human actors in Advanced Design methodology**

In order to introduce these theoretical models into design practice, the research proposes to use an Advanced-Design driven approach, trying to understand how and if it is possible to include non-human agents in this design framework.

Advanced Design (AD) is to be considered as an articulated system of design practices used to design processes,

products or services for complex scenarios set in the future (Celaschi, 2015), a systemic approach that is based on collaborative practices between multiple actors to drive transformative change within the realities in which it operates.

In the last 15 years, it has started to emerge how the concept of anticipation and future studies (Poli, 2010, 2019; Zamenopoulos & Alexiou, 2007) can be drivers to support an "advanced design approach" capable of responding to the complexity of the ever-changing dimension of innovation, trying to clarify the "relationship between the evolution of the time factor and design-led innovation" (Celi, 2010 cited in Celaschi, Celi & Formia, 2014, p.22).

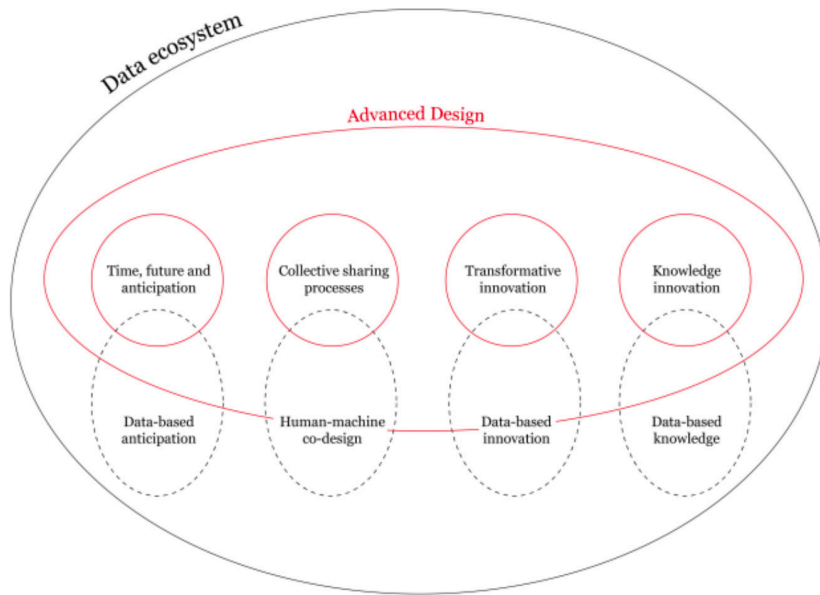
Over the years, this methodology has opened up the vision of industrial design to the concepts of anticipation (Celi, 2015; Formia, 2017; Iñiguez Flores et al., 2019; Celaschi et al., 2019) and has led it to propose itself as an approach that intervenes in the complexity of relationships linked to the changing context (Celaschi, 2015), and to innovation processes conditioned by environmental and social factors and lack of resources.

In the synoptic framework developed in recent years, which includes four main integrated and interconnected macro-fields of action in AD (Succini, 2022; 2023), the factor "Time, future and anticipation" has relevance to our reasoning. AD inserts the time factor as a field of action (Celaschi, et al, 2018) within the design process, linking past, present and future and seeking to "anticipate change and make it accessible through the materialization of processes, paths, artefacts and conjectures" (Celi & Morrison, 2019, p.807). It enables the ability to imagine possible, probable, potential futures (Celaschi et al., 2019) and applies to the context by reacting to change through continuous innovation.

Another macro-field is represented by Innovation of Collective Sharing Processes, in which people - the community and the territory - interacting through co-design processes and collective intelligence practices (Celaschi, Celi & Formia, 2014) - are considered actors and active agents for the development of new forms of design capable of responding to current challenges. The foundation is the idea that "the collective, social and shared construction of the vision is the key to success" (Celaschi et al., 2014, p.28) of more sustainable products, services, systems.

A third subject on which AD focuses its work is Transformative Innovation. It is based on three principles: i) adaptability (Mozota, 2006; Iñiguez Flores et al., 2014), which supports change, activates collective forms of learning, and allows design to transform critical issues into opportunities through anticipating practices; ii) sustainable transformation, which leads designers to reflect on responsibilities in transforming the behavior of individuals and communities; iii) cultural change, through iterative and continuous experimentation, creating forms of design that start from the future and lead to changes in the present (Celaschi et al., 2019).

Last but not least is Knowledge Innovation: in AD the sharing of knowledge and the activation of collective knowledge constitute forms of innovation (Celaschi et al., 2019) characterized by: i) interdisciplinarity and cross-fertilization between both academic and non-academic competencies; ii) forms of 'Reflection-in action' (Schon, 1983) in which design is read as a reflective practice; iii) 'learning by doing' training systems and by the collective (Iñiguez Flores et al., 2014) and co-produced learning processes.



**Figure 2.** Advanced Design and relation with data

## Conclusion

In this contribution, we hypothesises that a design approach such as AD, which already has in itself ingredients such as multi-stakeholder collaboration and cocreation, anticipation, collective intelligence and knowledge practices, and cultural change through continuous experimentation, can be thought of as introducing non-human agents to facilitate design problem-solving, using data as real active agents that can act on the outcome, thanks also to the mediation of designers who are able to manage this new variable.

The re-definition of the mediation roles considering the emergence of non-human agents in the Advance Design system can be addressed from two main directions. The first aspect concerns knowledge transfer and facilitation between specialized research and technology providers, companies, professionals and users. The second one is the definition of new tools and strategies to embed in the design practice in order to extract value from the continuous data collection and systematization that designers carry on.

Regarding the first aspect, design education is characterized by a significative multidisciplinary approach, as well as the professional practice articulates across multiple specializations. These intrinsic qualities, together with the capability of designers to build effective narratives around their research, give the designers the opportunity to build empathic connection between stakeholders and consumers. Also, through their mediation, designers have the capability to demystify preconceptions towards technology, but also to address and intervein in complex topics such as privacy and data use. Such mediation is of growing importance as new technologies, such as AI-based systems, raise concerns across professionals, institutions, consumers and regulatory bodies. Strategies to transfer information and vary depending on the targeted audience. Practices that are commonly used in AD and that translate complex data into more comprehensible and usable information include data visualization, scenario building, design fiction, and reports.

Such practices need to be developed in synergy with data collection and systematization tools. Since 2019,

the Advanced Design Unit of the University of Bologna has been developing a digital tool to systematize the continuous process of case studies collection. This custom system is built on relational connections between the database elements. This structure allows to highlight the emergence of patterns, relations and relevant insights.

As discussed so far, the framework proposed by Advanced Design addresses the complex challenges that the production system is facing. The development of a wider sensibility in respect to data and their interpretation appears to be relevant in design practice dealing with future and anticipatory scenarios. The ongoing development of design strategies and tools is a significant aspect of Advanced Design methodology, in which designers become mediators between different stakeholders, production sectors and customers (Celaschi, 2008). The mediating role of the Advanced Designers, we argue, is extending towards the new emerging technological and non-human agents.

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# Design Strategy for Agricultural Waste Recycling System Based on UTAUT2 Model Psychological Needs and Behavior Analysis

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## Abstract

Over time we have begun to build foundations for design ontology moving it away from efforts to align with a scientific rigour model based on reproducibility and generalisability towards a new direction supporting design's emergent and abductive qualities. Two of the key issues that have escaped our grasp has been a better understanding of design ontology and what equates to rigour in constructive design research. Recent work by the authors has positioned transferability as a candidate for a design ontology based on an ontological mirror along with a series of attributes addressing the rigour issues of future-forwards knowledge generation. Here we use two case studies to test the future forwards rigour of a transferability property for design knowing and speculate as to how researchers can build confidence and trust.

## Author keywords

Transferability; Design Ontology, Design Futures; Design Research

## Introduction

Background: In the face of ecological pressures arising from population growth, wastage of natural resources, and environmental degradation, finite resources cannot meet the future global demands. However, addressing global challenges necessitates an analysis of the psychological needs and modes of participation from a symbiotic ecological perspective, identifying issues and directions, and improving the construction and optimization of social innovation strategies while ensuring the preservation of ecological interests.

Subjects and Methods: Initially, a regional survey is conducted with a focus on the rural population, and, in conjunction with the 'UTAUT2' model, an analysis is undertaken from both the psychological needs and modes of participation perspectives. This analysis aims to identify the factors influencing the willingness and behavior of agricultural waste recycling. Ensuring the integrity and authenticity of the data, the study clarifies the direction of the research questions and further refines the design strategy for agricultural waste recycling and reuse while maintaining data accuracy and completeness.

Results: By conducting a comparative analysis of the obtained average scores, the factor with the highest mean is determined. Subsequently, each factor is reintroduced into the "UTAUT2" model to reconstruct the mechanism of agricultural waste recycling intention and behavior. In this process, "Expectation of Performance" is replaced with "Ecological Utility," "Expectation of Effort" is substituted with "Convenience," "Social Influence" is replaced



by "Public Awareness," "Facilitating Conditions" are substituted with "Infrastructure," "Hedonic Motivation" is replaced with "Subjective Initiative," "Price Value" is replaced by "Economic Income," and "Habit" is substituted with "Adaptability."

From a dimensional perspective, as "Gender" has no significant impact on behavioral intention, it is decided to retain "Age" and "Experience" unchanged, remove "Gender," and add "Education" and "Income" to the original "UTAUT2" model. Consequently, the dimensions with more significant influence are "Age," "Education," "Experience," and "Income."

Conclusions: Under the influence of psychological needs and behavior, a systemic interactive network should be constructed, centered around symbiotic ecology, while simultaneously addressing and optimizing three aspects: Energy Economy, Social Services, and Branding Culture. This forms the primary strategy for design. The aim is to encourage more people to focus on ecology and society, particularly in the face of global threats in the current Anthropocene era, ultimately contributing to interdisciplinary research for the future.

### Author keywords

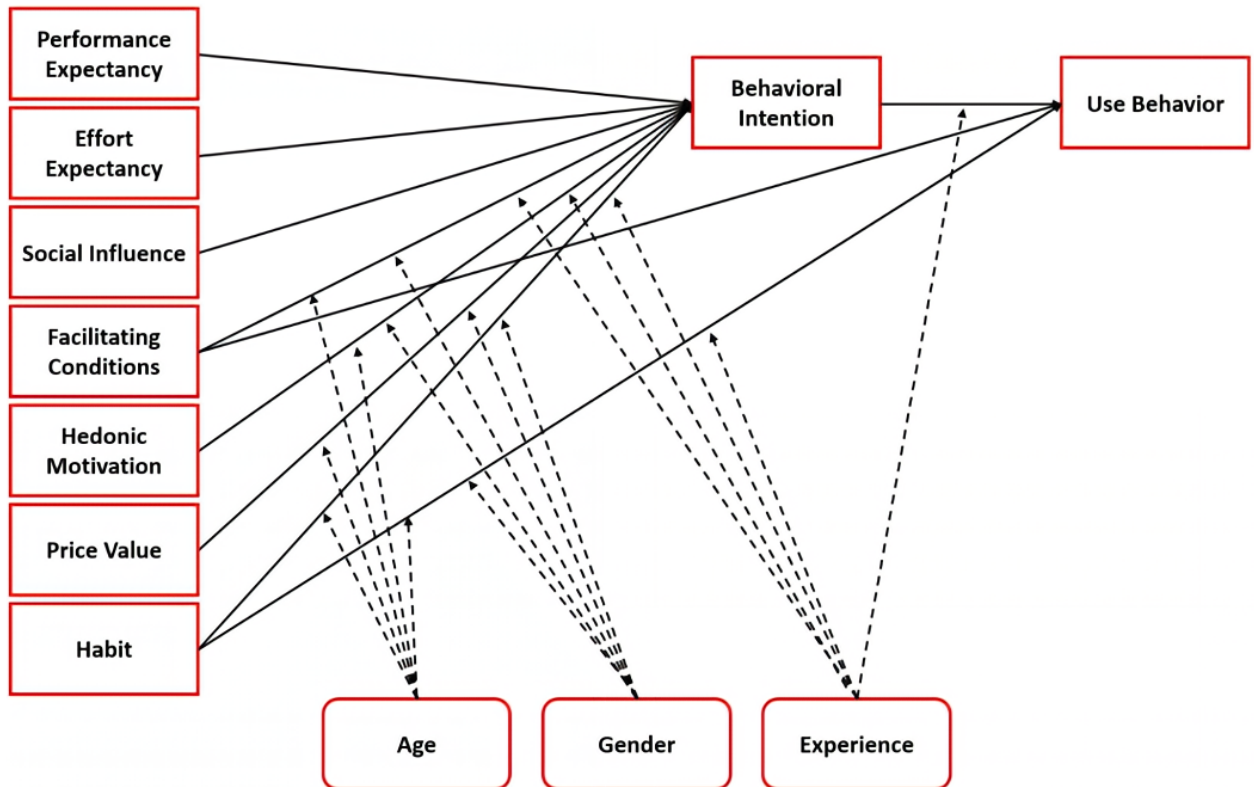
Ecology; Ecological Design; Social Design; Social Innovation, Psychological Needs

## 1. Introduction

The realization of ecological civilization and eco-economy construction can not be fully adopted by the government's mandatory management and the public's passive implementation of policies but needs to be carried out on the basis of respecting the farmers' individual wishes, supplemented by flexible policies. This can fully mobilize the farmers' will and drive the public's recycling behavior, which will play a positive role in agricultural waste recycling. However, the factors affecting the willingness to recycle agricultural waste are very complex. By searching for analytical models in the field of science and technology, we found that the Unified Theory of Acceptance and Use of Technology II (UTAUT2) in the IT field can analyze the factor conditions and clarify the target technical problems. Therefore, the construction of the strategy mechanism mainly refers to this model.

The Technology Acceptance Model (TAM), proposed by Fred Davis in 1989, is the prototype of "UTAUT2", which emphasizes the importance of perceived usefulness. The model emphasizes the impact of perceived usefulness and perceived ease of usage on technology adoption and use. However, researchers later found that the TAM model could not fully explain people's behavior toward technology adoption and use because it did not take into account other important factors, such as personal beliefs and social pressures[1]. Researchers began to develop and improve the TAM model, and finally in 2003, Venkatesh, Morris, and other experts proposed the "UTAUT" model, which is a further development and refinement of the TAM model, covering more decision-making factors, and has been widely used and validated in practice. In 2012, Venkatesh et al., added "Hedonic Motivation", "Price Value" and "Habit" variables to the "UTAUT" model in order to better adapt to the user's technological acceptance and usage context. Therefore, it is necessary to set up the questions of the questionnaire on the basis of the "Unified Theory of Acceptance and Use of Technology II" and analyze the results of the factors influencing the behavioral patterns of the current recycling process. The research model "UTAUT2" (Figure 1) was used for this study. 1) is an extension of the first-generation "UTAUT" model. The UTAUT2 model (Figure 1) is an extension of the first generation of the UTAUT model. Its core factors are: "Performance Expectancy", "Effort Expectancy",

"Social Influence", "Facilitating Conditions", "Hedonic Motivation", "Price Value", and "Habit" influence a user's "Behavioral Intention" and "Use Behavior", and are moderated by "Gender", "Age", and "Experience"[2]. Since the "UTAUT2" model can address the use and acceptance of technology based on the understanding of the user's "Behavior Intention", in order to better optimize the agricultural waste recycling system, "technology" as the subject of the study was replaced by "system mechanism", and then a series of related questions and dimensions were set up based on the "UTAUT2" condition. There were three types of questions: single-choice, multiple-choice, and matrix questions.



**Figure 1.** Unified Theory of Acceptance and Use of Technology II ( Unified Theory of Acceptance and Use of Technology II, or "UTAUT2") Source: A Acceptancelab.com

## 2. Materials and Methods

### 2.1 General Information

#### 2.1.1 Data Analysis of Behavior Intention and Use Behavior of Agricultural Waste Recycling Systems

As the main users, rural farmers are the backbone of agricultural waste recycling, and they are also the largest beneficiary group of this practical study. Therefore, around 1000 questionnaires were distributed indiscriminately to farmers in various regions of Shandong Province in China. After the questionnaire collection, a total of 1002 data from various cities and villages in Shandong Province of China were analyzed to find out the current status of agricultural waste. First of all, from the basic information portrait of the target population, it can be seen that there are more male farmers in Shandong Province; they are generally older and more than 45 years old; it can also be seen that the education level of the villagers is mostly in elementary school or junior high school; among the villagers, more than 5 years of farming experience is the main group; and those with an annual income of less than 50,000 yuan account for the majority of the villagers.

First of all, by comparing the average values of the matrix scale questions in the questionnaire (Table 1), we can rank the basic conditions of agricultural waste recycling Behavior Intention and Use Behavior, which is: Price Value > Habit > Effort Expectancy > Hedonic Motivation > Facilitating Conditions > Performance Expectancy > Social Influence. Therefore, from the perspective of agricultural workers, the four conditions that are closely related to their behavior are price value, habit, effort expectation, and Hedonic Motivation, in that order.

**Table 1.** Average Value of Conditions Underlying Agricultural Waste Recycling System Behavior Intention and Use Behavior

Factor	Average Value
Price Value	4.12
Performance Expectancy	3.3
Effort Expectancy	3.59
Social Influence	3.25
Facilitating Conditions	3.38
Hedonic Motivation	3.5
Habit	3.67

**Table 2.** Mean values of factors influencing the Behavior Intention and Use Behavior of agricultural waste recycling systems

Factor	Related Questions	Average Value
Price Value	Economic Income	4.26
Performance Expectancy	Ecological Utility	3.48
Effort Expectancy	Convenience	3.78
Social Influence	Public Awareness	3.37
Facilitating Conditions	Infrastructure	3.57
Hedonic Motivation	Subjective Initiative	3.62
Habit	Adaptability	4

On the basis of the above conditions by refining the questions in the base conditions and making further comparisons of the average scores (Table 2), it is sought to clarify the influencing factors of the willingness and behavior of the agricultural waste recycling mechanism by summarizing the key initiatives of the questions with high relevance to the agricultural waste recycling mechanism.

By comparing the mean scores of the previous questionnaires on agricultural waste recycling Behavior Intention and Use Behavior, we finally came up with the factors with the highest mean values and brought them into the "UTAUT2" model one by one to reconstruct the mechanism of agricultural waste recycling Behavior Intention and Use Behavior. Among them, "Performance Expectancy" is substituted as whether the utility of agricultural waste recycling reaches the standard required by the government in ecological issues, i.e. Ecological Utility; "Effort Expectancy" replaces the ease of agricultural waste recycling by farmers, i.e. Convenience; "Social Influence" replaces the policy direction based on the judgment of the government and the villagers, i.e. Public Awareness; "Facilitating Conditions" is replaced by "the need to consider the degree of perfection of the recycling site and recycling process, the maturity of the technology of agricultural waste treatment and secondary development of related wastes, as well as the popularity of recycling facilities and other related factors, i.e. Infrastructure; "Hedonic Motivation" is substituted for the mental positivity and emotional outpouring of the public, as well as the interest of farming villagers in agricultural waste recycling, i.e., Subjective Initiative; "Price Value" is substituted for the weighing of the degree of economic income generated by farming villagers from agricultural waste recycling, i.e. Economic Income; "Habit" is a proxy for the degree of acceptance of the whole recycling process by farmers within a certain time frame, i.e., Adaptability.

According to the user profile, the dimensions of agricultural waste recycling Behavior Intention and Use Behavior from the perspective of rural farmers are specifically in the five dimensions of "Gender", "Age", "Education", "Experience" and "Income". Therefore, by using the Multiple Linear Regression (MLR) model different factor variables in different dimensions are analyzed below.

In this model, one of the dependent variable is set as  $Y$ , and  $k$  independent variables, modeled as equation (1):

$$Y = \beta_1 \times X_1 + \dots + \beta_k \times X_k + \epsilon \quad (1)$$

In the model of Eq. (6) is the regression coefficient of the independent variables  $X_1, \dots, X_k$ , and  $\epsilon$  is the error term. Estimate and Test of the regression coefficients are used to determine whether different independent variables have an effect on the dependent variable and whether the effect is positive or negative. Least Square estimation is used to obtain the estimated regression coefficients and their Standard Error (Std. Error) and the test t-statistic (t value) is obtained from Eq. (2):

$$t = \frac{\beta}{se} \dots t = \frac{\beta_k}{se_k} \quad (2)$$

By using Eq. (7) to examine the test statistics for  $t$ , the test P-value for each regression coefficient can be obtained  $\Pr(>|t|) = p_1, \dots, p_k$ . The smaller the P-value, the more significant the effect of the independent variable on the dependent variable. The regression results are shown below (Table 3).

**Table 3.** Dimensional Regression Analysis of Pr (>|t|)

Pr (> t )	Gender	Age	Education	Experience	Income
Price Value	5.329290e-01	2.999181e-20	1.791594e-10	5.848821e-23	6.996346e-16
Effort Expectation	5.032379e-01	1.169367e-18	1.376094e-09	2.123983e-20	1.305238e-12
Performance Expectations	6.161710e-01	1.126503e-23	4.644049e-16	1.411483e-23	1.062317e-17
Facilitating Conditions	1.711051e-01	4.263002e-21	6.018358e-12	2.715126e-24	1.311945e-12
Habits	6.731635e-01	5.174873e-24	6.676264e-15	1.144299e-24	1.956919e-16
Social Influence	7.023360e-01	9.848884e-33	1.432071e-20	1.557119e-34	1.222002e-24
Hedonic Motivation	9.515001e-01	6.580629e-20	1.410087e-11	2.528577e-22	4.490753e-15

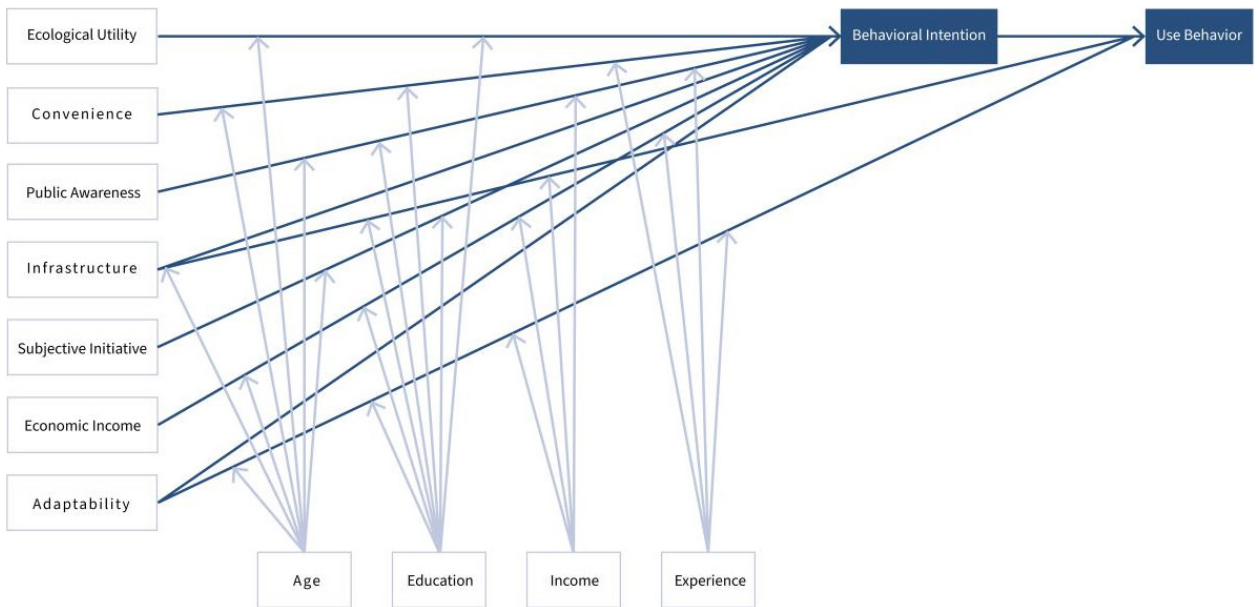
Furthermore, for the first row of regression coefficient estimates for the four variables with significant effects, namely age, education, experience, and income, the following can be observed. As age increases, the score for this question decreases, indicating less agreement. Conversely, a higher level of education results in a higher score, indicating more agreement. Greater experience leads to a lower score, indicating less agreement, while a higher income results in a higher score, indicating more agreement.The regression results are shown below (Table 4).

**Table 4.** Dimensional Regression Analysis of Estimate

Estimate	Gender	Age	Education	Experience	Income
Price Value	-0.03826857	-0.21172089	0.13750568	-0.21878979	0.17540137
Effort Expectation	0.06291619	-0.31067785	0.20021724	-0.31525335	0.23697433

<b>Performance Expectations</b>	-0.04116173	-0.30698997	0.23275529	0.29671186	0.24859158
<b>Facilitating Conditions</b>	0.1235489	0.3182136	0.2178567	-0.3313315	0.2276578
<b>Habits</b>	-0.03188051	-0.28461072	0.20579619	-0.27946427	0.21998146
<b>Social Influence</b>	0.02819831	-0.32439696	0.23826049	-0.32253848	0.26510346
<b>Hedonic Motivation</b>	-0.005949701	-0.334450307	0.231866266	-0.343700523	0.271811630

According to analysis, the middle-aged and elderly, low-income, basic education, and long-term farmers have larger bases and lower scores in many dimensions. On the one hand, more consideration should be given to these groups and their needs should be maximized in the development of social innovation strategies under the influence of Behavior Intention. On the other hand, the higher scores on multiple dimensions and the strong recognition of these groups can lead and influence the lower scoring groups, which is also helpful for strategy optimization. However, the gender dimension does not have a significant effect on Behavior intention. Therefore, age, Education, experience, and income were the more significant dimensions. Therefore, based on the original dimensions of UTAUT2, Age and Experience were kept unchanged, and Gender was eliminated. The "Gender" dimension was removed, and two new dimensions, "Education" and "Income", were added. The combination of dimensional analysis and factor analysis resulted in a new "Behavior Intention and Use Behavior Model of Agricultural Waste Recycling System" (Figure 2). The model became the main theoretical tool for social innovation strategies and practices.



**Figure 2.** Behavior Intention and Use Behavior Model of Agricultural Waste Recycling System

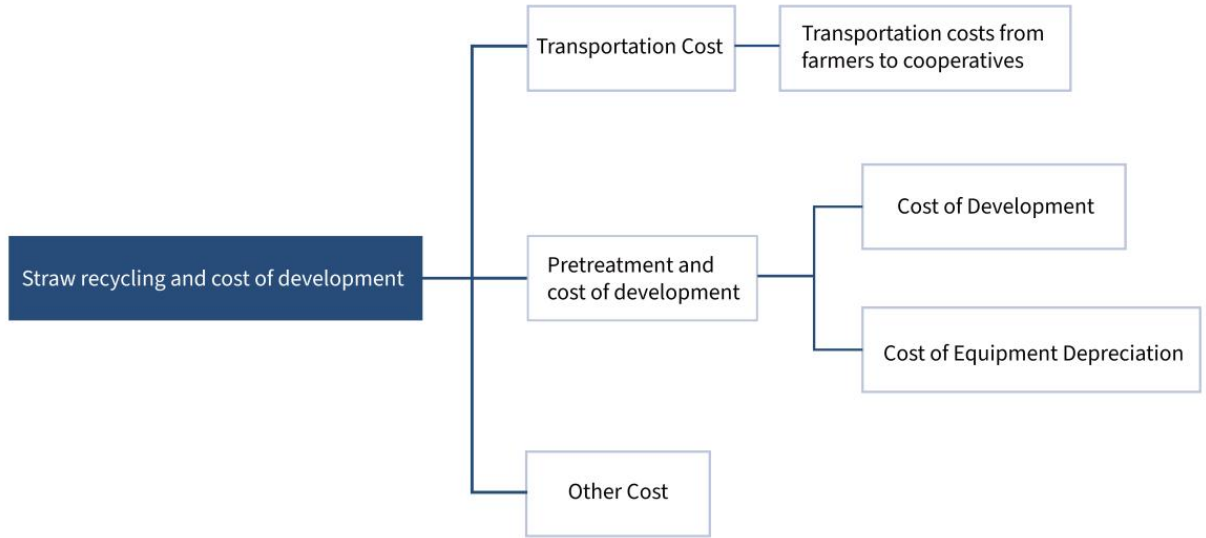
### 2.1.2 Feasibility Analysis of Energy Economy Mechanism

In collecting straw agricultural waste, the collection methods are not exactly the same, so there is a wide range of recycling and development costs. By investigating the transportation cost of straw recycling, it was found that the transportation cost varies with the distance of the collection place. Therefore, the straw within a certain area is transported to the cooperative by the farmers, and thus a model of straw recycling logistics is developed, which is to transport the straw within a specific area around the villages to the cooperative. The transportation cost mainly includes the cost of transporting the straw, and there is also the cost of loading and unloading. Due to the topographical differences in different straw collection areas, different factors affect the transportation costs, which are used as a basis for the analysis and assumptions. Firstly, the type of crops is not considered, and the collection of crops is targeted in the target area; secondly, the amount of straw is sufficient in terms of quantity and planting area to satisfy the cooperative's storage and development; furthermore, there is no need to pay attention to the seasonality and regionality of the crops; finally, there is sufficient capacity for transportation and collection; in addition to the above, the uncovered area is directly mortgaged by the villagers to the Cooperative. cooperatives directly.

Labour is present in the logistics stage of recycling, which is more common, and in order to materialize this labour in monetary terms, the labour is thus materialized, which is the logistics cost of straw recycling. The cost structure (Figures 3) contains not only the pretreatment and development costs of straw, but also transportation costs, and possibly some other costs. The first one is the transportation cost, which is the cost of transporting the mortgaged straw to the economic community. The transportation cost is incurred when the straw is transported by the farmers and villagers to the Economic Community. Secondly, there is the cost of straw pretreatment and development, which includes the processing of straw through different stages such as crushing, compression and baling, which results in processing costs, as well as the development of the straw from pretreatment products into biomass clean energy in order to facilitate its development and utilization, which requires a certain amount of costs; and there is also the depreciated cost of the whole process and development of the machinery and



equipment used in the development of the straw. Finally, a portion of the other costs, which are costs other than those mentioned above, are also included in the calculation. Other costs mainly include loading and unloading costs and labor costs. Since the value of other costs is relatively small, they are not included in the calculation.



**Figure 3.** Cost Structure of Straw Recycling and Development

Transportation cost of straw transported directly to cooperatives by farming villagers

In this case, it is assumed that the distribution of the stalks is within the radius of  $r$  and the density is  $\rho_i$ , then the transportation of the stalks is carried out by the farmers themselves and the place of transportation is the cooperative. The three figures  $C_h^{Ch}$ ,  $C_h^{Ch,1}$  and  $C_h^{Ch,2}$ , represent transportation cost, loading and unloading workers' cost, and transportation cost, respectively.  $\beta=\sqrt{2}$  They are mainly curvilinear parameters. The transportation cost of the farmers and villagers  $C_h^{Ch,1}$  is shown in Equation (3):

$$C_{h,1} = \int \int \rho_i r \beta c_n r d\theta d\theta \quad (3)$$

$t_n$  represents the unit transportation cost of a common tractor, including labor and fuel, in Yuan/(t-km).

The logarithmic score (4) is obtained:

$$\int_0^{2\pi} \int_0^r \sqrt{2} \rho_i r^2 t_n d\theta d\theta = \frac{2\sqrt{2}}{3} \pi \rho_i r^3 t_n \quad (4)$$

The service farmers and villagers load the straw onto the trucks first, and then unload the straw when they arrive at the cooperative, and the loading and unloading costs are as in Equation (5):

$$C_{h,2} = 2q_n \cdot \pi \cdot r^2 \cdot \rho_i \quad (5)$$

$q_n$  denotes the unit loading and unloading cost, i.e., the cost of labor income paid to working farmers for loading and unloading, unit: yuan/t.



The total cost of transportation for service farmers and villagers is shown in equation (6):

$$C_h = \frac{2\sqrt{2}}{3} \pi \rho_i r^3 t_n + 2q_n \cdot \pi r^2 \rho_i \quad (6)$$

Straw pretreatment and development costs

In the process of revaluing agricultural waste, it is necessary to calculate its cost, which includes the cost of pretreatment, such as compression, crushing and enzymatic digestion of straw, as well as the cost of development and conversion for upgrading. The cost of pretreatment and development is composed of the depreciation cost of the equipment and the cost of using the equipment. The operating cost is shown in Equation (7):

$$C_{d,o} = \pi \cdot \left( r^2 \right) \cdot \rho_i \cdot O \cdot C_o \quad (7)$$

O denotes unit fuel consumption, unit: L/t; CO denotes unit fuel price, unit: Yuan/L.

Representing mainly the specific costs applied in the process of acquiring equipment, the formula for calculating the average depreciation method is as in equation (8):

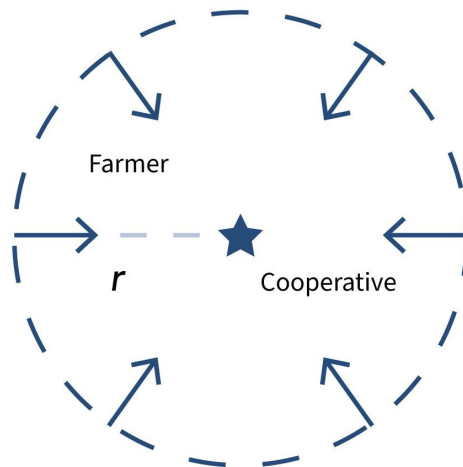
$$T_y = T \times \frac{(1 - RV)}{n} \quad (8)$$

Depreciable life is n; net salvage rate of fixed assets is RV.

Therefore the total pretreatment and development costs are as in equation (9):

$$C_d = C_{d,o} + T_y = \pi \cdot \left( r^2 \right) \cdot \rho_i \cdot O \cdot C_o + T \times \frac{(1 - RV)}{n} \quad (9)$$

The density of straw in the surrounding farmland of Xi Niuquan Village, Niuquan Town, Laiwu District, Jinan City, Shandong Province, China, is 95.9t/km<sup>2</sup>. It was found that the radius (r) of straw collection is 70km (Figure 4), and then when there are many crops within 70km radius of the cooperatives, the farmers and villagers transport



Note: Radius (r) of straw collection is 70km

**Figure 4.** Schematic diagram of straw collection area

the straw to the cooperatives. The related data information is shown in (Table 5), and the cost of straw recycling is obtained by bringing the data into equations (3), (4), (5), (6), (7), (8), and (9) for calculation (Table 6).

**Table 5.** Straw Cost Related Data

Indicator	Numerical value	Indicator	Numerical value
r	70	$\pi$	3.14
$\rho_i$	18.19	tn	1
o	0.85	qn	5
T	20	RV	0.5
$\beta$	$\sqrt{2}$	Co	7.72

**Table 6.** Extrapolation of Costs for Straw Variations

	Transportation Costs	Pretreatment & Development costs	Total Cost
Price/Million	11219.1	968.7	12187.8
Percentage/%	92.1	7.9	100

Using the above data, the total price of hydrogen energy sold is deduced. It is known that the radius of collection is 70km, so the total amount of straw in this area is 1476266t, which is calculated as in Equation (10):

$$r \times n \times \text{Straw Density (95.9t / km)} = 1476266t \quad (10)$$

By calculating that 1kg of straw can produce 34,541ml of hydrogen, 21078.82t of straw can produce about 51 billion liters of hydrogen, calculated as in Equation (11):

$$\text{Total Straw}(1476266t) \times 34541\text{ml H}_2 / \text{kg} = 50991703906l \quad (11)$$

Due to the volatility of the market price of hydrogen, reference is made to the price in the Yangtze River Delta region on November 21, 2022 from the Shanghai Environmental Energy Exchange (SEE), which is approximately RMB 33.69/kg. Therefore, the total selling price of hydrogen is approximately RMB154,405,796, calculated as in Equation (12):

$$\text{Total Hydrogen (50991703906L)} \times \text{Hydrogen Density (0.08988g / L)} \times \text{Hydrogen Price} 33.69\text{CNY / kg} = 154405796\text{CNY} \quad (12)$$

After deducing the costs, the total cost is deducted from the total selling price of the hydrogen energy to get the gross profit earned by the rural farmers is \$32,527,307. The calculation is shown in Equation (13):

Total Selling Price of Hydrogen (154405796CNY) -Total Cost (121878489CNY) = Gross Profit (32527307CNY)   (13)

Therefore, the prospect of economic transformation of biomass energy is very promising and feasible. Roughly estimated, the income of farmers and villagers can be increased by more than 30 million dollars. It can not only improve the behavior and willingness of the farmers and villagers, but also effectively help the farmers to generate income and improve the agricultural income. The project will be deepened in detail through practice in the future.

2.2 Research Methods

2.2.1 Systemic Construction of Social Innovation Strategies

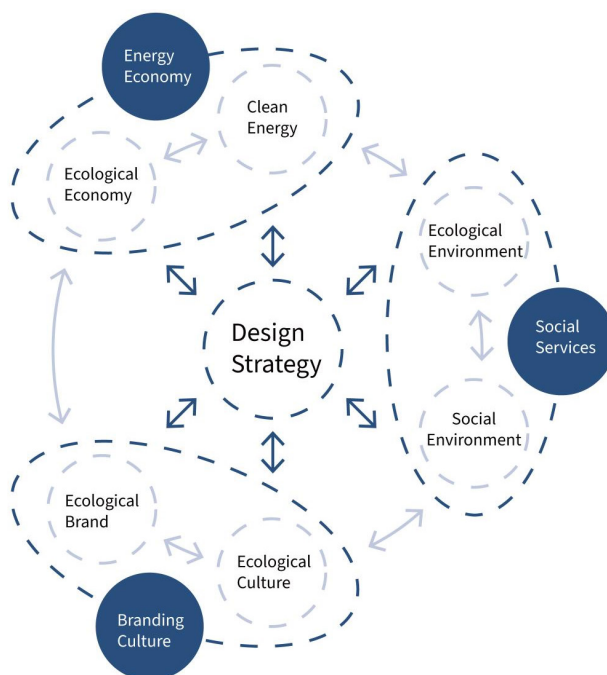
In the practice of design, the strategy is aimed at achieving sustainable innovation, fostering the emergence of new ideas, new processes, and new models, and stimulating creativity in new and interdisciplinary domains. According to Neri Oxman"s Krebs Cycle of Creativity ("KCC") theory[3] The four forms of human creativity are science, engineering, design and art. They generate "creative energy" through interconversion, where the role of science is to rationalize and analyze ecological phenomena and known data and information about agricultural waste, to conduct experiments on resource agricultural biomass waste, and to find experimental conclusions through questions. Engineering is the transformation of experimental methods into bio-processes where the experimental conclusions should be applied to the ecological problems of the agricultural waste recycling system. The design aims to provide a concrete presentation of social innovation strategies, radially expanding biotechnology to solve ecological problems in multiple ways, and transforming systemic applications into behavioral intentions. Art ("Art" in KCC refers to culture in general in this study) is to think about ecological attributes at the level of creativity and value, to observe ecological phenomena again to get information, to question them again, to form new behaviors into new ecological perceptions, and ultimately to move towards a scientific form, to start a new "KCC" cycle.

Based on the "KCC" principle, a holistic assessment of all aspects of the problem is required prior to the construction of a social innovation strategy. Therefore, on the basis of the analysis of the known problems mentioned above, the systematic participation in the design can fundamentally balance the relationship between society and ecology, and further optimize the ecosystem. By synthesizing the different dimensions of perception that farming villagers and administrators are in, specific directions for solutions were generalized (Table 7).

**Table 7.** Direction of Solution for Different Cognitive Levels

Factor of Behavior Intention and Use Behavior Model		Solution Direction
Economic Income	Ecological Utility	Energy Economy
Convenience/Adaptability	Infrastructure	Social Services
Subjective Initiative	Public Awareness	Branding Culture

The key to implementing a social innovation strategy is to combine the three aforementioned directions. Through a designed pathway, clean energy derived from agricultural waste can be applied as an ecological economic strategy, thereby promoting rural economic development. Secondly, to further drive multidimensional economic development, it is necessary to establish ecological facilities and a social service system for agricultural waste recycling, incorporating community service functions related to ecological and social environments. This will create comprehensive spaces and provide good hardware facilities. Ecological culture needs to be concretely presented, so in terms of enhancing the public's ecological literacy, it is essential to create ecological cultural products and ecological intellectual property (IP) as ecological brands. Additionally, disseminating the essence of ecological culture will contribute to the construction of ecological civilization. Based on these three directions, the service functions should be further refined, allowing each part to interact and mutually reinforce each other, thereby forming a networked interconnected system. (Figure 5).

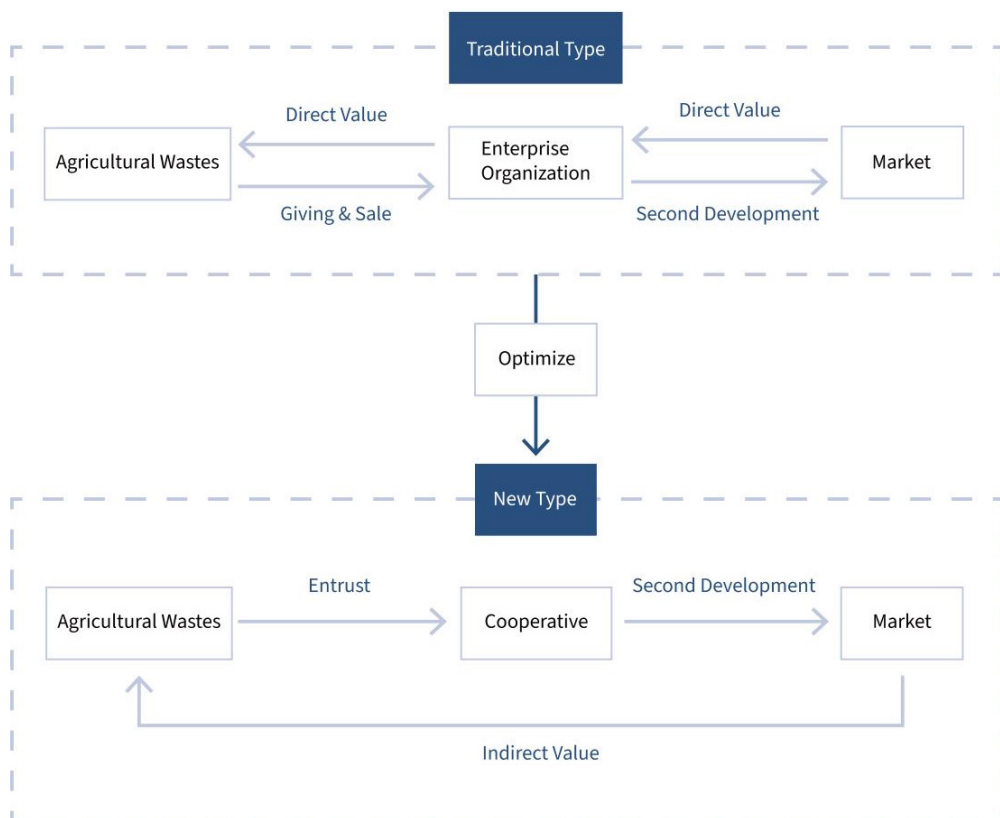


**Figure 5.** Mesh Interconnection Design Strategy Pathway

The sustainable utilization of agricultural waste is a primary direction in ecological economics. Currently, the main approach for the sustainable utilization of agricultural waste involves enterprises and related departments acquiring it and directly reimbursing the recycling costs to local farmers. The major drawback of this approach is its single-mindedness, high costs, and low returns. Enterprises, on the other hand, gain higher value by trading the reclaimed essential energy in the market, resulting in significant profits (Figure 6). Therefore, enterprises are the primary beneficiaries, such as thermal power stations, gas stations, chemical plants, and so on. While agricultural waste may not hold significant value for local farmers, it is still their private property. Starting from this perspective, a redesign of the economic mechanism is proposed, aiming to enhance the value of agricultural waste through biotechnology and shifting the focus of benefits back to the local farmers.

A new type of cooperative was established based on a newly designed eco-economic mechanism. Co-operatives are a form of economic organization based on co-operation and common ownership explored by socialists and

social reformers including Robert Owen, Charles Fourier, and Pierre-Joseph Proudhon as an alternative to the traditional capitalist enterprise[4]. One of the most important theoretical underpinnings is the labor theory of value, which states that labor is the only source of productive value[5]. The theoretical basis of cooperatives holds that laborers should share in the wealth they create and should have greater control over their own production processes. This can be achieved through the democratic management and common ownership of cooperatives[6]. The theoretical foundations of cooperatives also include the principles of solidarity, mutual aid and benefit, and social responsibility. These principles emphasize mutual support and cooperation among members and encourage members to contribute to the community and society[7]. Cooperatives develop a just, equitable and sustainable eco-economy based on the co-operative theories of co-operation, common ownership and democratic management, and require a certain amount of upfront technical and financial support from the government and infrastructure construction to kick-start the whole system. Here, the "cooperative" replaces the "enterprise organization" as the new intermediate link. The farmers and villagers use agricultural wastes as "collateral" and entrust the cooperatives to second develop the value of the products, either for "recycling" or "upgrading". The profits from trading the developed products to the market, after deducting the basic costs incurred by the cooperative, are fully returned to the villagers. In this way, the villagers receive indirect value gains (Figure 6). In this way, it can positively influence the agricultural waste recycling behavior of the farmers and solve some of the fundamental problems in the questionnaire and interviews, so that the farmers can earn something for their work in recycling and contribute to the development of the rural economy. While reducing the ecological burden of the country, it will also help the "Carbon peak and carbon neutrality" policy and better implement it in the lives of the public.



**Figure 6.** Eco-economic Design Optimization

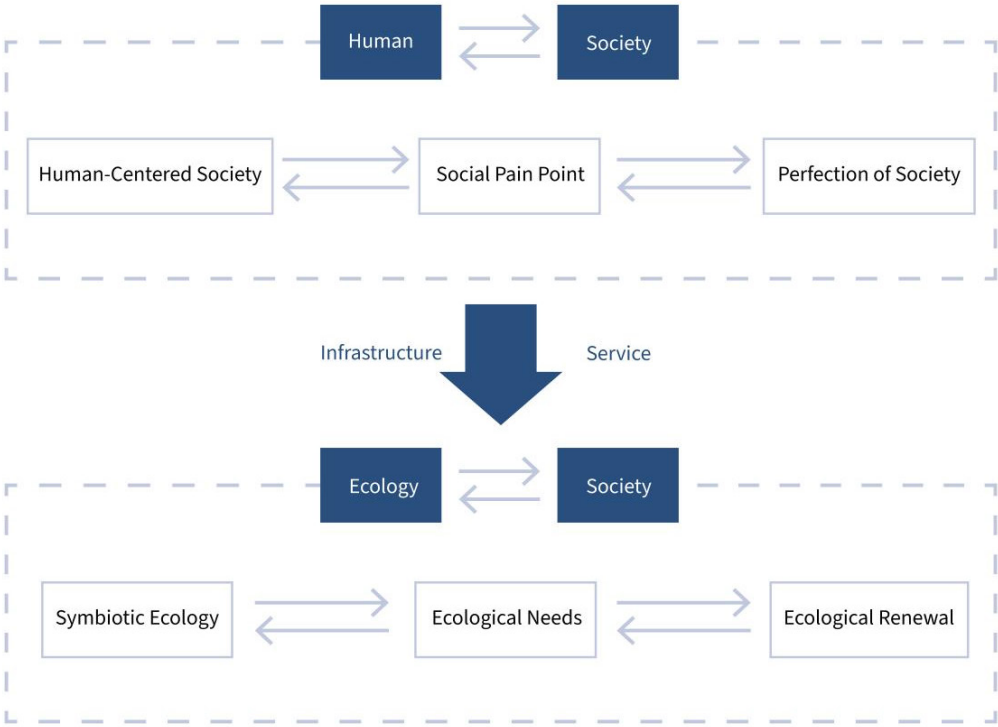
### 2.2.2 Ecological Strategy for Social Services

Although the transformation of clean energy is the mainstay of the rural eco-economy in this case, there is still a need to establish a networked value chain around the energy economy as the core, which can be linked to the development of multi-level value interactions. However, the strategic study of social services aims at "KCC", where economic utility is intervened by design optimization to change behavioral activities, which in turn affects the perception of culture. The ecological perspective of social services focuses on the relationship between the social environment and the ecological environment to achieve cyclical improvements and changes in the "symbiosis" between human beings and nature. Social service also interacts with two other levels, including the biomass of the ecological environment, which can be used as a raw material in the energy economy and serve the development of clean energy, and the social environment, which contributes to the promotion of ecological concepts in the brand culture.

Sociality is the behavioral and interactive attributes of human beings or a certain group of animals in a social environment. Therefore, social design usually involves the consideration of human behaviors, needs, and values, as well as integrated thinking with political, economic, technological, and environmental factors. As a pioneer of social design and eco-design, Mr. Victor Papanek believes that design is first and foremost about responsibility. Design is not only about creating goods or products, but also about taking social responsibility and paying attention to human needs and environmental sustainability. Secondly, the impact of design on economic development and consumption patterns cannot be ignored. Design should follow the principles of practicality, simplicity and resource conservation; furthermore, design should be integrated with local cultures and traditions, and designers should respect and understand the needs of people from different cultures; and finally, the importance of environmental protection, design should consider the impact of products on the environment, and advocate the use of recycled and renewable materials to minimize the pollution of the environment[8].

Social design is a design methodology that uses a creative and systemic approach to solving social problems. It focuses on how people interact and collaborate in social and economic systems, and aims to create fairer, more inclusive and sustainable societies. Professor Michael Porter of the Harvard Business School puts forward the idea of "Creating Shared Value". It includes: redefining the value chain: re-examining the value chain and considering how to meet social and environmental needs by improving the supply chain, optimizing the use of resources, and developing new products; focusing on social issues: looking at social phenomena, identifying problems that can be solved, and using innovative thinking to find solutions and strategies to increase profitability and productivity, thereby creating shared value. Shared value is created through innovative thinking to find solutions and strategies that increase profitability and productivity. This can be achieved through more efficient use of resources, waste reduction, and energy conservation, etc.[9] The practice is therefore based on the above theory. Therefore, in this practice, based on the above theories, the social design needs to be further updated and iterative, with a change in dimension from the relationship between the human individual and the social set to the relationship between the social set and the ecological whole (Figures 7). The center of social design in the Anthropocene is the human being, i.e., the human-centered society. That is to say, from the perspective of human beings, social pain points are discovered, and the society is shaped by the ability of human beings to make the society complete, and the final destination is to serve human beings. The center point of the iterative social design is the ecological whole, i.e. the symbiotic ecology. This includes clarifying the ecological needs from the ecological perspective, and utilizing the ability of social service to carry out ecological renewal, which ultimately serves the ecological whole. The renewed and iterative social service strategy, as the basis of the whole social innovation strategy, will be designed

and improved in two aspects, namely the spatial design of the infrastructure and the optimized design of the service system. In the design process, the hard condition of infrastructure construction and the soft condition of service system optimization will be coordinated with each other. This is to realize the overall synergy of cross-disciplinary "sociality".

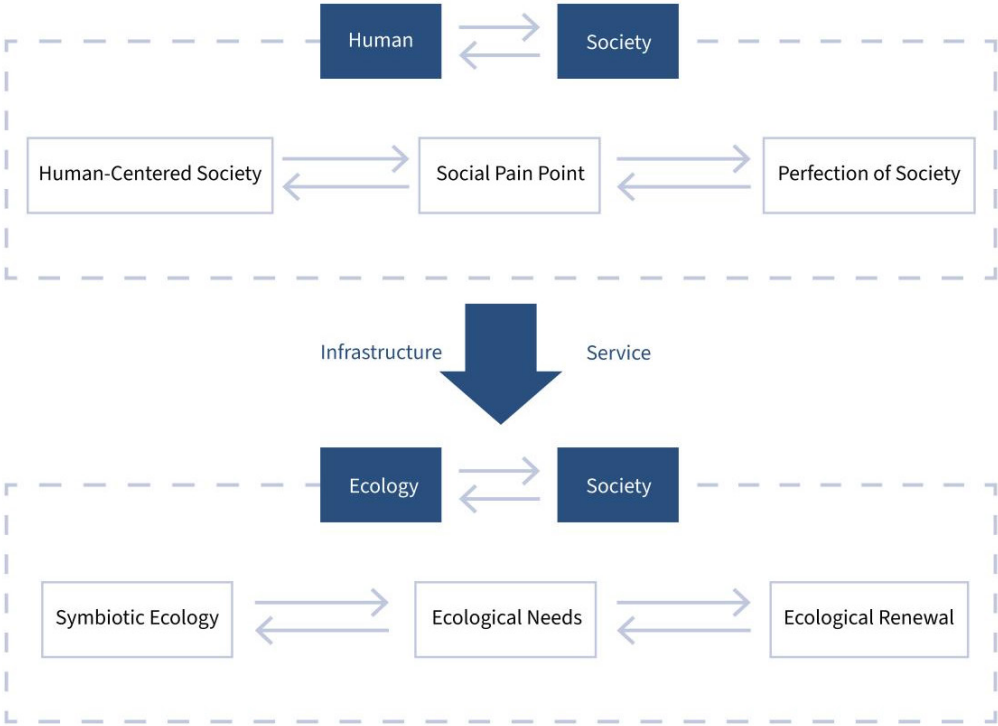


**Figure 7.** Iterations of the Social Innovation Concept

Based on the concept of social innovation after renewal and iteration, according to the previous questionnaires, although the state has promoted the development of ecological civilization and economy with the collaboration of policies, regulations and administrative management. However, farmers agrees that the current agricultural waste recycling process still has problems at the social and ecological levels, especially in terms of Convenience, Adaptability and Infrastructure. This is due to the weak "Affordance" of the original process. Therefore, in addition to strengthening the administrative management, it is necessary to explore the availability between the ecological and social environments in the design process and to highlight the ecological value and social services through the interplay of facilities and services.

2.2.3 Social Design and Social Services

Through the ecological needs and social pain points derived from the previous problem analysis, the scope of the front-end service content of the cooperative is firstly categorized based on the principle of availability at the social service level (Table 8), so that the value of services for the high-level population and the service needs of the low-level population can be realized in multiple dimensions as much as possible.



**Figure 7.** Iterations of the Social Innovation Concept

**Table 8.** Scope Breakdown of Available Service Content

Scope of Services	Business Economy	Ecological Activities	Rural Community	Brand Culture
Services Project	Market and sale of clean energy, sale of community DIY eco-products, and sale of eco-derivatives	Eco DIY Handicraft Experience, Eco-Design Workshop, Biotechnology Laboratory, Eco-Lecture, Bio-Art Creation	Sharing of environmental tips, online and offline mutual aid, sharing of eco-activities, and opening of environmental exchange meetings.	Creation of eco-IP, created eco-visual elements, internet operation, promotion of eco-culture, multi-media presentation



Combining the dimensions of the questionnaire and the service contents, the high scoring groups are summarized (Table 9). From this, it can be understood that the high scorers can provide service assistance to the low scorers based on their own strengths, realizing the integration of service resources and creating shared value to match the needs.

**Table 8.** Scope Breakdown of Available Service Content

Crowd Classification	Knowledge-based	Experienced	Affluent & Prosperous	Youth & Prime of Life
Service Capability	Not interested in recycling waste personally, but concerned about low-carbon environmental protection and sustainable development. Interested in knowledge of ecology and biology, and willing to popularize various activities related to environmental protection and eco-education; able to promote	More experience in agricultural waste recycling; longer time in farming; ability to effectively utilize specific waste materials and is ongoing. For agricultural activities, the police have	Have a certain economic base and purchasing power, and have the ability to invest in eco-environmental conservation or help others to advance funds to invest; have transportation tools and automated recycling equipment and resources, in addition to personal use, there is a sufficient amount of surplus	Participate in environmental protection activities with high enthusiasm, and hope to play an effective role in improving the ecological environment, cultivate life interests, or like to buy eco-cultural products, IP and derivatives; advocate a healthy and

**Table 8.** Scope Breakdown of Available Service Content

	eco-culture to influence others.	invested relatively more time and energy to deal with issues such as straw recycling and waste disposal.	to be used for sharing or renting to others; can help to introduce some eco-environmental technology.	organic lifestyle, and regard low-carbon environmental protection as the quality of life and enjoyment of interest; and contribute to the ecology through physical action.
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Combining the service content and service capacity, it can be seen that since part of the service content of the commercial economy focuses on the purchasing power of commodities and the degree of liking for derivative commodities, it can be accomplished with the capacity of the young, middle-aged and well-off people, thus stimulating the development of the eco-economy; in terms of the eco-activities, basically, they are based on the popularization of knowledge and educational experiences, so the knowledge- and experience-type people can share their experience and help the audience create value. The rural community is a communication and sharing platform for the public, which exists in the form of online forums and offline exchanges, so young and experienced people are the mainstream. Young and experienced people can inject enthusiasm and vitality into the social platform, while experienced people can share practical tips on environmental protection in their daily lives; and finally, the brand culture, which is based on knowledge. Culture is based on knowledge, and branding is based on business, so the knowledge-based and well-off groups are the main drivers. Knowledgeable people have relatively good education, which can enrich ecological and cultural creativity, and operate Internet content professionally. The well-off have relatively strong resource capacity, which can promote the rapid multi-channel dissemination of the brand.

Maximizing the value of eco-services, as described by Professor Michael Porter's "Creating Shared Value", is also embodied in "sharing". Therefore, no matter how one divides up the dimensions and equalizations, people are

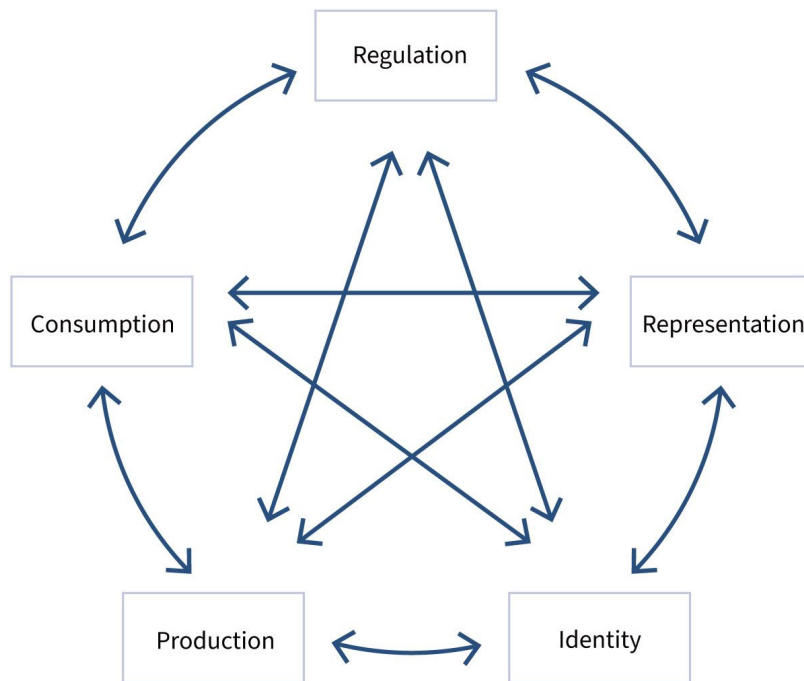
both the service providers and the served, creating shared value for ecological services in a complementary way.

#### 2.2.4 Branding Strategy for Ecological Culture

In the whole mesh interconnection, the brand culture mainly contains eco-brand and eco-culture. The formation of an ecological culture needs to be based on an ecological outlook. Ecology is a concept of ecological benign value that adopts sustainable development and steps into symbiotic ecology. Ecological culture is more inclined to the ideological system of ecological aesthetics of inter-subjectivity. Although it is difficult to be fully realized in the era of anthropocentric humanity, the concept of symbiosis is the most ideal goal of cultural connotation and guides human behavioral activities. Therefore, eco-culture relies on the ecological brand to spread its ideas, and the core of eco-cultural ideas is the philosophical theory of eco-aesthetics. Italian futurist Aurelio Peccei firstly put forward the concept of "eco-culture", he thinks that "due to the erosion and over-exploitation of the natural environment by human beings through technological progress, we have destroyed the foundation of our future life. In order to save ourselves, we need to carry out a cultural revolution that meets the requirements of the times and creates a new form of culture, namely ecological culture. This is our only option"[10]. Ecological culture starts from the nature of human beings and nature, and explores the fact that nature itself has value just like human beings, and not only because of the existence of human beings. Through this new perspective, on the one hand, eco-culture reinterprets the species relationship between nature, including human beings, and guides human beings to construct the value concept of coexistence and co-prosperity with the natural ecology. On the other hand, ecological culture believes that all living and non-living things in nature, except human beings, have their own forms of existence and are not subject to the control of human will. Therefore, in order to survive and develop, human beings must recognize and respect the rights of nature. This view is based on the idea that nature has a clear objective value, and that mankind should be cognitively aware of this. This also coincides with James Jerome Gibson's "Affordance" in ecological psychology[11]. In the process of brand design and construction, the theory of "Affordance" is still used to visualize the connotation of ecological culture.

#### 2.2.5 Basic Connotation of Ecological Culture

The connotation of rural ecological culture refers to the interactions and influences between human beings and the natural environment, as well as the values, beliefs, knowledge systems and behavioral patterns that result from them. It needs to be analyzed on the basis of cultural theory, combining the ecological research background of this practice and the context of symbiosis in ecological aesthetics. The study of eco-culture is informed by the theoretical approach of cultural studies. Raymond Henry Williams, a pioneer of the Birmingham School of cultural studies, recognized culture as a holistic way of life, marking a new era in cultural studies[12]. On this basis, contemporary cultural researcher Stuart Hall inherited the Birmingham School's view that "culture is a process of material production" and "culture is a symbolic system of social relations". He believes that representation, identification, production, consumption and regulation constitute the process of culture, and thus proposes the theory of "Circuit of Culture" based on the theory of coding/translation (Figure 8). And any analysis of a cultural theme or cultural product must pass through this circuit[13]. In the "cycle of culture" there are intertwined and relatively independent aspects, each of which can serve as a starting point, and the relationships between them are non-linear and complex. Thus, representations, identities and rules are attributes that carry the symbolic system of social relations, while production and consumption are manifestations of material production processes.



**Figure 8.** The Cycle of Culture

For the study of eco-culture, it is important to rely on the five aspects in the theory of the "Cycle of Culture" to study the basic connotations of the construction of eco-culture. These five steps can start from any one of them and end up in a closed loop. These steps will be divided into different modules, each of which is random, complex, overlapping and intertwined, which is the core concept and feature of the "Cycle of Culture", thus generating a three-dimensional complex structure.

In the cycle of culture, "Regulation" have an impact and influence on people's life sphere. These "Regulation" can be interpreted from a macroscopic point of view in the context of the cycle, including the context of the times and ecological policies. At the same time, new technological structures, production systems and knowledge structures play an important role in transforming symbolic ecological meanings into ecological awareness and practices. Eco-branding is a contemporary product that is closely integrated with social innovation strategies and needs to combine the characteristics of rural lifestyles with the advantages of biotechnology. Through product design, visual communication, digital media and participatory activities, eco-cultural connotations can be disseminated, empowering "representations", enhancing a sense of identity while increasing subjective initiative, and facilitating consumption to help the eco-economy.

"Representation" refers to cultural meanings and expressive practices. From a structuralist standpoint, the value and function of "Representation" is emphasized. The products derived from eco-brands are consistent with the characteristics of "Representation", in that the image, sound and language of the product are not the main focus, but rather the functionality, sustainability and semantic meaning of the product, i.e. the meaning of the specific reference. On the one hand, the derivative products with symbolic language not only epitomize the eco-brand,

but also show the cultural connotation of the eco-ecology, and construct the path of rural eco-identity. On the other hand, the representational function of derivative products focuses on the design level, which is the result of cross-disciplinary cultural and creative representations. It is jointly participated by farmers, administrators, scientists, designers, engineers and artists, and represents their common vision of ecological values. Through this creative representation, an ecological and cultural value interchange of their own is established and maintained. In this context, "Identity" refers to the value recognition of the concept of ecological culture. This value identity is a shared expectation across the globe, nations, societies, classes and races. However, due to the influence of factors such as technological structures, production relationships and knowledge frameworks, each individual's perception of ecology is unique. In this study, the main focus is on value recognition in rural areas. Based on the analysis of the questionnaires and interviews, more consideration will be given to the lifestyle, cognition and behavior of the villagers when designing the products in order to find a better way to convey the value recognition of ecology. Ecological culture is not only about values, but also about the requirements, positioning and functions of the product, which affects people's perception of the product. This is reflected in the authenticity of the product, respect for folklore and traditions, and reasonable price setting. It is important to note that people often do not recognize products not because they have different concepts, but because they are not communicated in the right way. The significance of eco-branded products lies in the use of their natural attributes to convey eco-cultural identity.

The "Production" of eco-cultural products needs to be organically integrated with the "consumption", and the "Production" of eco-cultural products is studied from the perspective of "consumption", in order to explore the medium behind the sales and production. This study examines the "Production" of eco-cultural products from the perspective of "consumption", explores the medium behind sales and production, and explains the relationship between "Production" and "consumption" from the perspective of design. In the production of eco-cultural products, design is the core of branding and culture, and plays a strategic role by closely integrating with the ecological culture of the target population and rural folk customs. Product design mainly involves marketing and product production, in addition to specific product design styles, to better convey the concept of ecology through the product is also the key to design. How to promote and sell eco-cultural products, so that they are closely related to consumers, all of which require in-depth thinking. The function of design is not only limited to the use of existing technology to increase the value of products, but it is also closely related to consumption and manufacturing, which undoubtedly becomes a key element of product innovation.

In the actual "consumption" segment, eco-cultural products have unique cultural typicality. The consumption of such products not only emphasizes their "exchange" function and "use" value in the economic aspect, but also promotes the active pursuit of ecological sustainability and conveys the value connotation of ecological culture. In other words, the cultural value of eco-cultural products is not only in their "exchange" or "use" value, but also in their "recognition" value. Commodities for the villagers should not only have natural attributes, but also cultural attributes. This demand will continue to evolve with the changes in ecological concepts, until the final ecological culture in the true sense of the word is formed, and the eco-brand is expanded beyond the countryside. Mature eco-brands target the needs of mass consumers other than villagers, and tend to be more cultural in nature. Obviously, consumer demand cannot be pre-fixed to a certain pattern of demand, and it is closely related to people's differences. Individuals and groups of consumers often form inconsistent responses to the same material culture. In the development process of eco-cultural products, it is necessary to fully understand the consumer needs and enhance them in order to realize the optimization of the design. Consumers are therefore

proactive, and in this way contribute to the development of production.

In summary, by analyzing the interrelationships among the five elements of the cyclical concept of culture, namely "Regulation", "Representation", "Identity", "Production" and "Consumption", each of them has its own unique way of meaning exchange and interaction. By analyzing the interrelationships among the five elements of the concept of cultural cycle, namely "Regulation", "Representation", "Identity", "Production" and "Consumption", each of them has its own unique way of meaning replacement and interaction. The cultural cycle provides a theoretical framework and cognitive thinking for the construction of eco-culture, clearly explaining the basic principles. In addition, there is a need for easy-to-understand publicity and education in the form of ecological culture, so as to strengthen rural people's awareness of ecology, establish a benign ecological outlook, and promote a harmonious relationship between human beings and nature as well as sustainable development, thereby helping to strengthen the construction of ecological civilization.

## Conclusion

Combining social design strategies can expand impact and diversify attributes. Based on the questionnaire of the farmers, seven aspects of economic benefits, Ecological Utility, Convenience, Adaptability, Infrastructure, subjective motivation, and Public Awareness were examined to identify the rural needs and social pain points in both directions. Combined with the "Integrated Technology Acceptance and Use Model II", the design strategy is tailored to build a cooperative that is energy-economy oriented, accompanied by social services and brand culture. In terms of energy economy, it is necessary to optimize the industrialization of biomass energy production and the construction of a new eco-economic mechanism. On this basis, the corresponding income and expenditure should be projected to prove its feasibility. On the social service level, it is necessary to discuss the relationship between social design and community service in terms of people's participation and resource sharing, as well as the relationship between social design and community space in terms of "spirit of place"; on the perspective of brand culture, it is necessary to use the "Cultural Cycle Theory" to discuss the relationship between social design and community space in terms of "Spirit of place". In the perspective of brand culture, with the help of "Cultural Cycle Theory", we summarize the connotation of ecological culture to construct the cultural output of brand design.

The design strategies for agricultural waste recycling systems involve further integration of theoretical and empirical rationales with the research on the system. Finding a research direction for the construction of ecology and society requires more theoretical construction and practical innovation, and we hope that more research will continue and more bio-design innovations will be born, so as to enrich the bio-design system, serve the ecology and society, and ultimately contribute to the future of interdisciplinary research. We hope that in the face of global threats in today's Anthropocene, more people will pay attention to ecology and society.

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## Nature-based solutions: Understanding the value and limits for the promising future

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### Abstract

Urban development has proposed globally significant challenges to the environment. Fortunately, nature-based solutions have emerged to effectively address and overcome these challenges, supporting sustainable development and fostering resilience. Hence, awareness of the potential of nature-based solutions as a promising trend for the future is growing. However, it is important to note that in the context of China, the widespread implementation of nature-based solutions is not yet commonplace.

The author used the method of research by design to develop a profound understanding of NbS and insights to inform decision-making and future development. In this study, the author acquired valuable insights into NbS for future development by examining the prototypes of the post-design project results in the Modaomen estuary. The conclusion showed that NbS presents several advantages over engineering-based projects, as highlighted in this study. It offers multi-functional benefits with ecological, social, and economic values, providing flexible and sustainable long-term solutions. NbS can adapt to changes in ecosystem dynamics, generating long-term benefits.

### Author keywords

Nature-based solutions (NbS); research by design; Pearl River Delta, Modaomen estuary;

### Introduction

#### Background

Recent studies revealed globally significant environmental threats proposed by urban development (Bouwer et al., 2010). The prevailing response to address challenges has been the deployment of traditional engineering (Vörösmarty et al., 2021), which employs engineering principles and scientific techniques, commonly known as engineering-based solutions (Gagnon et al., 2012). Engineering-based solutions often construct still and everlasting structures, such as preventing hurricanes by building higher dams. However, there are still many deficiencies shown in these solutions. Many researchers considered engineering-based solutions insufficient for



the increasing risks (Meng et al., 2022), especially for sites with specific geographical features and dramatically complex dynamic natural processes, such as the estuary.

### Nature-based solutions

Hence, persistent shortfalls of engineering-based solutions result in increasing attention to alternatives, such as Nature-based solutions (NbS) (Vörösmarty et al., 2021). NbS are approaches for addressing and tackling various environmental challenges while promoting sustainable development and resilience (Bennett et al., 2009; Cohen-Shacham et al., 2016; O'Hogain & McCarton, 2018; Seddon et al., 2021). These solutions are designed to conserve, restore, and sustainably manage ecosystems (Seddon et al., 2021) while benefiting humans and the environment and providing other co-benefits (Cohen-Shacham et al., 2016).

NbS often involves working with nature and enhancing nature to provide ecological services or tackle societal issues (Bennett et al., 2009). Successful examples of NbS include Qingcaosha Project (Y. Gu et al., 2008; J. Gu et al., 2009), Marker Wadden (Kolb, 2020; Riel et al., 2017), etc. For example, the Qingcaosha Project managed to store fresh water and avoid salt water by using the timetable of saltwater intrusion of the Yangtze estuary (Y. Gu et al., 2008). It provides over half of the water supply for Shanghai province, benefiting more than 10 million people (Xinhua, 2009). In the project of the Marker Wadden, those natural dynamic processes are assisted in shaping the landscape upon them. For example, water level fluctuation at the Marker Wadden will cause additional water flow into the swamp, promoting natural processes such as erosion and sedimentation, further shaping the local landscape.

There is a growing awareness that NbS is the trend of a promising future. However, the common and conventional solutions to address environmental challenges are based on engineering projects, especially on sites with specific geographical features and dramatically complex dynamic natural processes in the context of China, such as the estuary.

### Methodology

The main method of this study is research by design. Research by design is a methodological approach combining design thinking principles with research methods (Roggema, 2016). It often involves interdisciplinary collaboration, human-centered design, and prototyping to explore possibilities and validate assumptions.

The study area is in the PRD (Pearl River Delta), Zhuhai province, Modaomen estuary. The Modaomen Estuary is a productive landscape with a long history of reclamation. 20% of the marshland in the Modaomen estuary is replaced by aquatic dyke ponds. The author used the iterative design process to generate and test hypotheses, gather insights, and develop solutions (Roggema, 2016) to complex problems of the site. Hence, by thoroughly examining post-design results, the author developed a profound understanding of NbS and insights to inform decision-making and future development.

### Result

The author used interdisciplinary knowledge to explore an NbS to solve multiple problems of urban, agricultural, and ecological issues. Therefore, by analyzing the outcomes after the design phase, the author acquired valuable insights into NbS for future development from the prototypes of post-design results as follows:

### Shaping the landscape by nature

The limitation of engineering-based solutions lies in their inability to adapt to the ever-changing nature of processes. Unlike static objects, natural processes involve interactions with and are influenced by natural conditions, leading to continuous changes. However, NbS presented a completely different scenario. The natural dynamic processes (for example, wind, waves, currents, water level, and ice tilt) that were originally regarded as resistant are assisted in the project. Hence, natural processes can be harnessed by NbS to streamline the project construction process, making it more efficient and cost-effective.

NbS projects could be executed with enhanced efficiency and simplicity by capitalizing on ecosystems' dynamic and ever-changing nature. In this project, the primary strategy proposed was the implementation of a system featuring two new dykes. The outer dykes would be initially

constructed to create brackish and freshwater wetlands. Over time, the natural erosion process would gradually reshape the landscape between the outer and intermediate dykes, ultimately utilizing the once-formed delta landscape to establish a more adaptable and feasible continuous wetland. These approaches demonstrated a conscious understanding of nature's capabilities, as the project relied on natural processes and integrated NbS to construct the landscape in harmony with the surrounding environment.

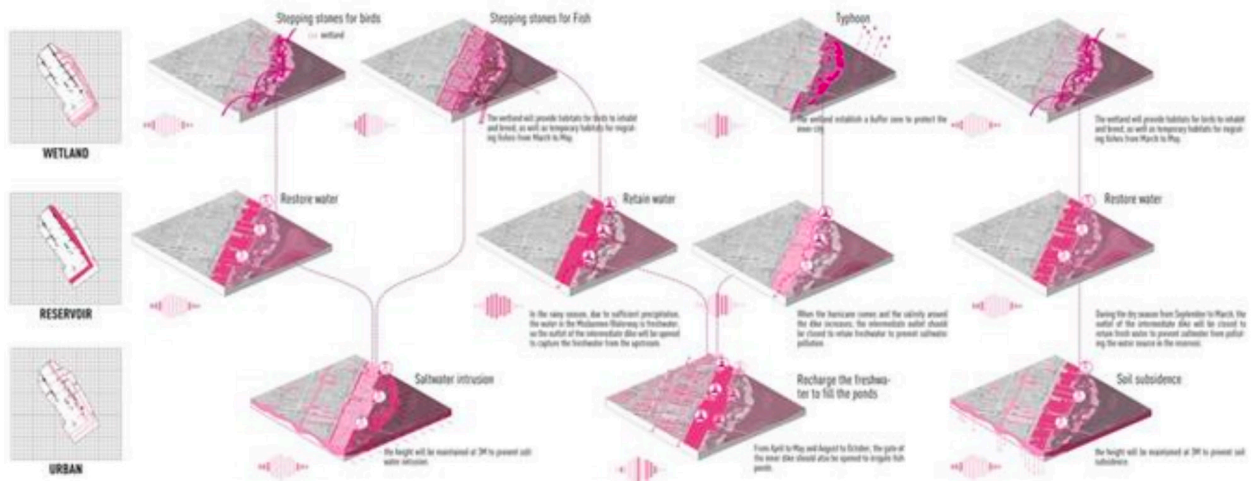


**Figure 1.** The succession of project phases

Moreover, it is worth highlighting that NbS projects hold significant potential for cost-effectiveness, particularly in specific contexts such as flood risk reduction along coasts and river catchments. In these scenarios, NbS minimized the need for expensive human interventions, thus optimizing the project's budgetary aspects. Seddon et al. (2021) also emphasize that NbS can be estimated to be two to five times more cost-effective than engineered structures for coastal defense (Seddon et al., 2021), particularly in less extreme hazard scenarios. This highlights the superior cost-effectiveness of NbS, further reinforcing its viability and practicality in various applications.

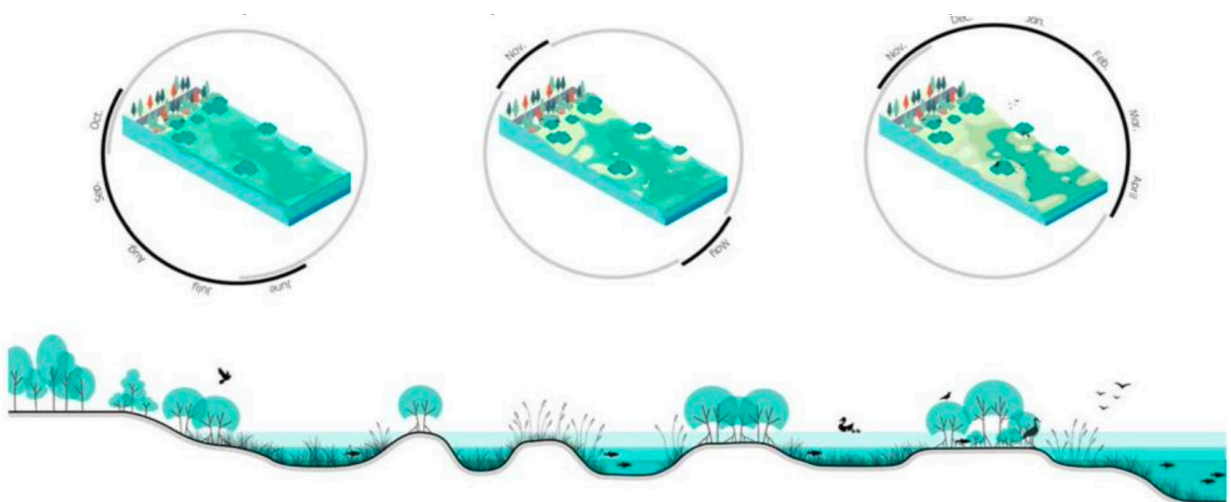
### Living in harmony with nature

Engineering-based solutions often exhibit shortcomings regarding the negative and long-lasting impacts on humans and the environment. In contrast, NbS offers an alternative approach that leverages the power of nature to not only enhance the landscape but also address social concerns. Seddon et al. (2021) highlight that NbS projects can collaboratively work with nature, leading to an adapted environment that benefits both nature and humans in the long term. This holistic approach created a sustainable and harmonious relationship between humans and their natural surroundings.



**Figure 2.** Advanced Design and relation with data

NbS strategies are primarily rooted in the utilization of existing environments, enabling them to adapt to the surrounding conditions effectively. In the case of this project, the operational design of the system serves a dual purpose as both a reservoir and a protective barrier. This design allows the system to seamlessly align with the fluctuations in salinity levels within the Modaomen waterway, as shown in the above figure. As a result, the system possesses the capability to adapt and synchronize with the changes in salinity, ensuring its functionality remains in harmony with the natural dynamics of the Modaomen waterway.



**Figure 3.** The wetland in the diverse periods

In addition, NbS strategies bring simultaneous benefits to both humans and the environment, offering long-term advantages beyond their primary purposes. In this project, the NbS provided multi-function with ecological, social, and economic values to provide more flexible long-term solutions. For instance, during the wet season from April to September, when the salinity of the Modaomen estuary decreases, the dyke can be opened to capture fresh water from the Modaomen waterway and replenish the reservoir. As a result, the strategy optimizes the utilization of freshwater resources, ensuring a consistent water supply for the surrounding area throughout

the year, thereby benefiting local communities. Besides the ecological value, the proposed NbS approach holds significant economic value by improving the ecological environment and enhancing resilience against natural disasters in transitional areas. This creates favorable conditions for urban transformation and provides opportunities for residents to engage in entertainment, education, cultural activities, and community building. Overall, NbS strategies offer a holistic approach that serves both ecological and human needs, delivering substantial benefits to the environment, society, and the economy.

## Conclusion

This study revealed various advantages of NbS, especially compared with engineering-based projects. The NbS provided multi-function with ecological, social, and economic values to provide more flexible long-term solutions than engineered/grey infrastructure. Hence, they could adapt to ecosystem dynamics, climate change, and other stressors, offering long-term benefits. The proposal, strategies, and principles of this study could provide insight into the landscape of the project and other promising landscapes worldwide for the future.

It is also worth noting that synergies between NbS and engineered approaches could be more advantageous than framing them as alternatives. Integrated solutions that combine green (NbS) and grey (engineered) infrastructure can address various climatic impacts while considering diverging stakeholder needs.

However, even though NbS has the potential to provide low-cost, effective, and sustainable solutions to multiple impacts, there are still barriers to NbS improvement. The potential of NbS to provide the intended benefits in addressing climate change-related impacts has not been rigorously assessed or fully monetized in appraisals (Seddon et al., 2021). There are concerns over their reliability and cost-effectiveness compared to engineered alternatives and their resilience to climate change.

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## Evolving scenarios of AI in the design practice

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### Abstract

This contribution concentrates on how the design work may be enhanced by generative Artificial Intelligence (AI) tools as well as the roles that designers and AI play in their collaboration, considering ethics of human-machine interaction. Recent developments in AI tools foreshadow fundamental changes in the future of the design practice, with concurrent effects including both an increase in the efficiency of creative professionals, and the democratisation of producing creative outputs by non-experts. While AI can be a component of designed solutions, this research focuses the design process itself, examining how AI can be a transformative force of not only for content generation, but also user research and conceptual development. Therefore, we aim to analyse existing generative AI tools for designers and describe potential "AI + Designer" strategies within currently widespread workflows. Initially, this article explores the potential of AI in creative fields, where the authors identify possible roles of AI to improve design work, such as AI as mediator between creative languages, or AI as a facilitator of user participation. Subsequently, the research describes a mapping and benchmarking activity of available AI tools for Designers, categorised by output type (3D, Graphics, Raster, Text, Utility, Vector, Audio & Video) and critically assessed according to the stages of the Design thinking process (Empathise & Define, Ideate, Prototype & Implement, and Validate). The mapping is organised to provide a multi-level perspective, and is divided into four main sections: a list with output-based clusters, info sheets (a product specification document), a map (a visual summary of the tools), and an introduction page. To evaluate the effectiveness of the AI tools during the design process, these were tested by replicating the processes of several projects and their output obtained by repeating tasks using AI tools. Thus, the mapping and testing showed interesting potential of AI tools in some phases of Design Thinking, but also a limited utility in the phases of empathising and validation.

Ultimately, the study focuses on the opportunities and issues of human-machine interaction and raises questions about ethics and copyright, bias and discrimination, errors and the impact on creative processes. The potentially transcendental power of AI over the thinking process poses urgent risks and opportunities, evident already today in various creative domains. Therefore it is crucial to build a strategic foresight and hence a positive vision of AI-enhanced design in order to understand how the role of the designer will change. Among possible scenarios, we conclude with the hope that the innovation model of "AI + Designer" can alleviate technical tasks, help connecting knowledge areas, and understand better people, this enforcing the Designer in the role of "sensemaker" who shapes the culture of everyday life.

**Author keywords**

Generative AI; Design Thinking; Creative skills; Design tools; Mapping; Benchmarking.

**Introduction**

The recent developments of Artificial Intelligence tools anticipates a significant change in future design, starting with an apparent democratisation of the creative process, giving non-experts an opportunity to produce creative content, while also facilitating certain tasks in the professional design process. Such phenomena can be seen as an opportunity for a more widespread diffusion of design efforts, but also as a menace to certain professional roles, raising issues about how effective (and meaningful) the "efficient" AI-enabled Design is.

These advances open up opportunities for generative AI to become trusted teammates alongside Designers (Figoli, Rampino and Mattioli, 2022), as experimented also within the ideation process of fashion design (Jeon et al. 2021). AI can be beneficial not only in the initial phases of the design process but also in the prototyping through monitoring and forecasting based on data coming from sensors and equipment (Arinez et al. 2020), such as real-time error detection and correction in 3D printing (Brion and Pattinson, 2022). In a similar vein, designers can leverage AI to enhance user experience, thereby fostering technology drive innovation at both the system and service levels (Yildirim et al. 2022). It is crucial that design works aided by generative AI are adequately aligned with human interests, including not only the short-term interests of a designer or client, but even more importantly the long-term interests of humanity, such as sustainable development or social justice, therefore, this contribution focuses also on potential ethical issues and mitigation strategies of collaboration between design and technology. In particular, we aim to offer a better understanding of currently available Generative AI tools that are useful to design work, evaluating how they can be integrated into the design process, and critically assessing the potential of the innovation model of "AI + Designer".

**Participation and Creative Work with AI**

While Generative AI in design is still in its infancy, we could already outline four interesting roles it may fulfil in the creative process, ranging from AI as an intermediate between creative languages and the democratisation of visual quality to a facilitator of user participation.

Firstly, AI can serve as a mediator between creative languages, and translate from one creative language to another. Creative languages in this context assume various means of expressing creativity; in design there are mainly visual (such as images, drawings, sketches, diagrams, renderings). However, with the emergence of AI, it became possible also to translate text into visual content without special design knowledge.

This leads to another possible role of AI in the creative field, namely AI as a means of democratisation of quality visual content through direct "prompting" and advanced non-expert design tools. This trend is enabled by low-code and no-code AI as a result of recent advances in the conversational AI sector, driven by interest in improving human-machine interaction. New projects are emerging also to make AI more understandable to users, such as eXplainable AI for Designers (XAID), which can be supplemented by a human-centred approach to focus on a specific user group (Zhu et al., 2018). In addition to the technical availability of AI, the work of the professionals themselves has become more accessible, because AI has made some of the design duties easier to perform, therefore their work will require less time.

The democratisation of AI, in turn, leads to the possibility for non-experts to co-produce creative AI output (e.g. graphics), allowing economic actors or social groups on tight budgets to have decent quality design interventions, even if limited in terms of originality.

The last role is the use of AI as a facilitator of participation in the design process, especially during user research. Initially, AI can function as a user research agent, interacting directly with people and using standard methodologies such as interviews, questionnaires, and so on. After collecting user data, designers can benefit from AI that processes user generated content and identifies their needs and preferences, such as patterns of user behaviour. Based on these patterns it will be possible to develop a user simulator for designers to receive quick feedback during the design process, so follow the Human-centred approach in all the phases.

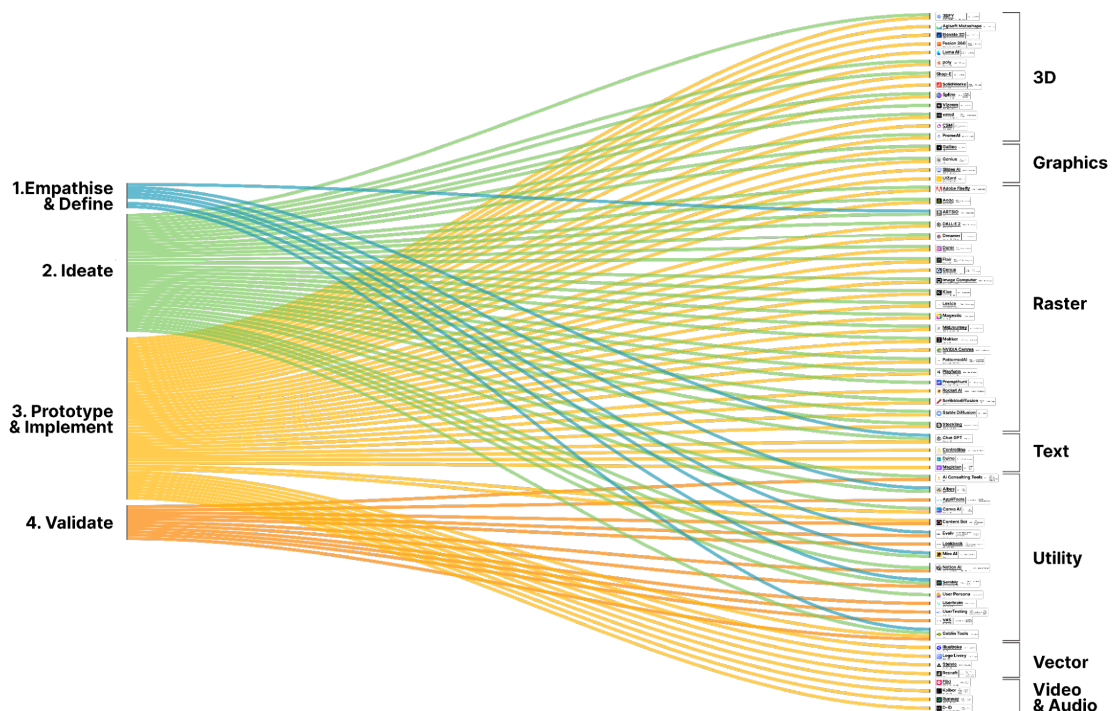
### Mapping AI Tools for Design

As already mentioned, this paper aims to provide an overview and critical reflection about the current state of Generative AI tools useful for creative design activities.

There are numerous methodologies to conceptualise the structure of the design work, but, due to its widespread popularity, Design Thinking has been chosen as a way to structure the mapping of Generative AI tools.

As promoted by IDEO founders and later Stanford University, Design Thinking is a problem-solving approach structured in 5 steps: empathise, define, ideate, prototype, and test.

Due to the overlap observed between the first and second, the final four groups of the AI tools are Empathise & Define, Ideate, Prototype & Implement, and Validate.



**Figure 1.** Map, Alluvial diagram. The collection can be explored on an open Figma board



Moreover, the possible AI outputs were classified into 7 categories:

- 1.3D. Topology optimisation or generating 3D models, including capabilities for texturing, rendering, and animating 3D assets.
- 2.Graphics. Combination of images and text, providing output suitable for UI design development and presentations, creating graphics by integrating pictures and text elements.
- 3.Raster. Useful to create visually captivating raster images, including the creation of mood boards, intermediate or final product pictures, as well as designing patterns and backgrounds to complement them.
- 4.Text. Ability to generate text content and code, making it a valuable tool for various design stages, whether it's assisting in conceptualisation, ideation, or refining final drafts.
- 5.Utility. Streamlining and systematising communication within working teams, as well as optimising work processes, facilitating efficient collaboration, while including user needs investigation through Desk and Field analysis, data collection, and in-depth insights to ensure comprehensive problem-solving approaches.
- 6.Vector. Generation of high-quality vector images, including illustrations, icons, and logos useful to create individual images or produce whole batches of vector-based graphics, allowing for scalable and versatile designs.
- 7.Audio & Video. Create and edit audio and video content to support presentations or prototype demonstrations. Whether it's adding background music, voiceovers, or assembling video footage, this feature enhances multimedia production capabilities and facilitates effective communication.

To begin, we built a database to store all the tools found, tracking costs, benefits, drawbacks and input/output they produced. The final collection is organised to offer a multi-level perspective, and may be broken down into four primary sections: a list, info sheets, a map, and an introduction page. The map (Fig.1) provides a visual summary of the tools gathered about processes and outputs they offer, while dedicated simplified tool cards also display the crucial information.

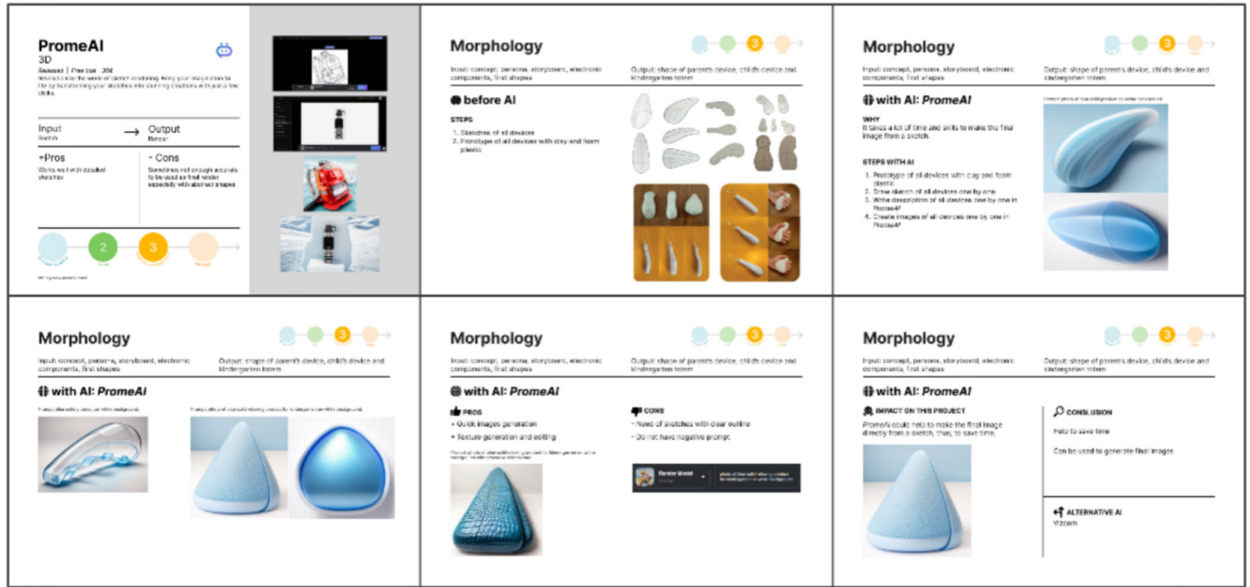
Each tool is discussed in depth in the info sheet, a product specification document of each tool that includes functionality and unique characteristics, an analysis of advantages and disadvantages, and showcasing images. Finally, the list consolidates all the tools into distinct output-based clusters, enabling users to easily locate the desired tool for their intended outcomes. While omitting redundant or unproductive tools, our research at the time of writing found a total of 66 tools, and out of those is possible to identify 7 for Empathise & Define, 37 for Ideate, 51 for Prototype & Implement, and 11 for Validate, but it should be noted that some of them are useful for multiple steps.

From this subdivision emerged that there are only a few tools available that can help during the phases of process structuring, stakeholder engagement, preliminary research and final validation. Additionally, even though the majority of the tools are focused on the Prototype & Implement step, they frequently also assist the designer during the Ideate phases. Output clusters include instead 13 for 3D, 4 for Graphics, 22 for Raster, 4 for Textual, 15 for Utility, 4 for Vector, and 4 for Video & Audio. Here, it is evident that Raster outputs are among the most popular, but there is also a growing interest in Utility tools. The collection can be explored on an interactive Figma board, or in the table below.

**Table 1.** List of the AI Enabled Tools selected, with clickable hyperlinks.

3D & texture	Graphics	Raster		Text	Utility	Vector	Audio & Video
<a href="#">3DFY</a> <a href="#">Agisoft</a> <a href="#">Metashape</a> <a href="#">Elevate 3D</a> <a href="#">Fusion 360</a> <a href="#">Luma AI</a> <a href="#">poly</a> <a href="#">Shap-E</a> <a href="#">SolidWorks</a> <a href="#">Spline</a> <a href="#">Vizcom</a> <a href="#">vmod</a> <a href="#">CSM</a> <a href="#">PromeAI</a>	<a href="#">Galileo</a> <a href="#">Genius</a> <a href="#">Slides AI</a> <a href="#">UIZard</a> <a href="#">Design.AI</a> <a href="#">Tome AI</a>	<a href="#">Adobe Firefly</a> <a href="#">Ando</a> <a href="#">ARTSIO</a> <a href="#">DALL·E 2</a> <a href="#">Dreamer</a> <a href="#">Durer</a> <a href="#">Flair</a> <a href="#">Genus</a> <a href="#">Image</a> <a href="#">Computer</a> <a href="#">Kive</a> <a href="#">Lexica</a> <a href="#">Magestic</a> <a href="#">Mokker</a>	<a href="#">MidJourney</a> <a href="#">NVIDIA</a> <a href="#">CanvasPatter</a> <a href="#">nedAI</a> <a href="#">Playform</a> <a href="#">Prompthunt</a> <a href="#">Rocket AI</a> <a href="#">Scribblediffus</a> <a href="#">ion</a> <a href="#">Stable</a> <a href="#">Diffusion</a> <a href="#">Stocking</a> <a href="#">Clipdrop</a>	<a href="#">Chat GPT</a> <a href="#">Controllino</a> <a href="#">Duino</a> <a href="#">Magician</a>	<a href="#">Ai Consulting</a> <a href="#">Tools</a> <a href="#">Albus</a> <a href="#">AppliTools</a> <a href="#">Canva AI</a> <a href="#">Content Bot</a> <a href="#">Evolv</a> <a href="#">Lookback</a> <a href="#">Miro AI</a> <a href="#">Notion AI</a> <a href="#">Sembly</a> <a href="#">User Persona</a> <a href="#">Userbrain</a> <a href="#">UserTesting</a> <a href="#">VAS</a> <a href="#">Goblin Tools</a>	<a href="#">Illustroke</a> <a href="#">Logo Livery</a> <a href="#">Stelvio</a> <a href="#">Recraft</a>	<a href="#">Fliki</a> <a href="#">Kaiber</a> <a href="#">Runway</a> <a href="#">D-ID</a>

To test the effectiveness of the tools during the workflow, case studies were carried out where we tried to replicate the process of two projects output in the field of Product and Interaction Design by repeating the tasks using AI tools (Fig. 2). Initially in Empathise & Define, experiments were carried out in the User Research and Desk Research phases using Albus to create a vision board while researching information and images. During the Ideate phase, Chat GPT was used to create the concept taking advantage of its work speed and adaptability, even if in some cases it lacks human empathy. Next, the User Persona tool was employed, which effectively created a Persona from the project description and then the Recraft tool for Storyboard illustrations. For the Prototype & Implement phase, PromeAI transformed sketches directly into final renderings with relevant textures and then Adobe Firefly helped to add the background to them. The Interaction Design project benefited from Controllino AI



**Figure 2.** Tool testing: a task is carried on with the use of AI tools. The first image is the tool info sheet, the other images illustrate the process and notes about pros and contra.

to write an MQTT enabled code, while for video presentation of both of the projects Fliki tool was useful thanks to its ability to find appropriate stock video from text and generate voice overs. Finally, during the Validate phase, Chat GPT played the role of an agent that provided feedback and possible improvements that selectively made sense. AI can already assist designers in many phases of their work, despite the fact that good quality tools have not yet been found for User Research, creation of 3D models, IoT systems and websites, which could be the basis for future projects and research.

Despite the rapid growth of AI-enabled tools, it is possible to highlight some usability shortcomings. The first point of intervention is the development of a new form of incremental prompting that allows the user of the tool to make small gradual changes, instead of requiring a new prompt for each output. Secondly, for the tool to actively participate in the process, the collaboration dimension must be investigated, allowing the tools to see beyond the specific task and understand the overall context of the design process. Finally, considering the inherent empathic nature of Design, it must be taken into account that AI has limitations in understanding and expressing emotions (Bakpayev et al., 2022). The toolkit was created with educational application in mind, providing a special opportunity to investigate and put design thinking concepts supported by AI into practice. Recent rise in popularity of AI models has opened up new perspectives for students to experience the potential of these tools in Design (Bozkurt et al., 2023). However, it is important to understand potential negative consequences and rethink the roles of technology and human educators. Our collection aims to contribute to this discussion by providing the necessary tools to explore the potential of AI in educational use.

### **Issues and Mitigation Strategies**

The benefits offered by Artificial Intelligence are numerous and extensive. However, there are various potential and practical issues already uncovered by past research. Algorithms often conceal risks, overlooked in the pursuit of innovation and cost-efficiency. AI's ethical implications stir debates in science and society: professionals in the creative fields feel attacked by the democratisation of AI tools that give free access to creative content to the general public, reducing their possibilities of employment; while, the scraping tools behind the generative tools appropriate their contents, raising issues with copyrights. Yet, some (Aziz, 2023) even propose to include AI as a copyright-worthy author. This complex issue deepens AI's societal disparities. However, limiting the fair use of machine learning might interfere with its progress (Sobel, 2017). Ethical principles alone will not ensure responsible AI; additional support and governance mechanisms at the organisational and social levels are required (Sanderson et al., 2023), such as the EU guidelines' aim to provide safe, transparent, traceable, non-discriminatory, eco-friendly AI, emphasising human supervision (European parliament, 2023).

A second risk in the use of Artificial Intelligence is that of bias: in fact, human-sourced data contaminated with sexism, racism, ableism, and religious prejudices result in corrupt and discriminatory intelligence. We are already witnessing tools such as chatbots, machine translation, and speech recognition, or generative tools that can encode and perpetuate gender stereotypes (Suresh, 2021) and ethnic discrimination (Buolamwini, 2016). Having diverse and representative data is thus essential for creating realistic and inclusive AI systems: responsible AI requires not only technical interventions but also changes in Societal recognition (Waelen & Wiczorek, 2022). An accurate and uncorrupted source is essential, as it is established that AI needs human-sourced data. Otherwise, the risk is the phenomenon of "AI hallucination", as illustrated by Alemohammad and colleagues (Alemohammad et al., 2023), who reached the condition of Model Autophagy Disorder (MAD) by repeatedly feeding the generative AI with cycles of synthetic data. Leaving complete control to algorithms is thus still counterproductive and

unpredictable, and it is thus necessary to supervise and, most importantly, cooperate on an equal footing between users and AI (Larsson et al., 2022).

AI, like previous technological advancements, threatens employment due to its wide-ranging automation potential (Su, 2018). Creative jobs were once considered immune to AI, relying on intuition and human qualities hard to replicate (Birtchnell, & Elliot, 2018). However, as AI grows more sophisticated in generating top-tier content, concerns arise about artists and designers losing relevance, shrinking job opportunities, and devaluing man-made labour (Zhou & Nabus, 2023). Despite these risks, the authors have concluded that collaboration between creatives and AI generates fruitful outcomes, backed by research showing AI's positive impact on computer-intensive fields, boosting employment and productivity (Georgieff & Hyee, 2021). Nevertheless, AI can't replace creative minds in the present and near future, as it lacks the creative capabilities (Horton et al., 2023) and eco-spiritual values (Cooney, 2023) essential to replace humans.

### **Discussion and Conclusions: new designer roles**

In his book "Fully automated luxury communism" (2019), Bastani sees technology as a potentially liberating force that could emancipate people from alienating repetitive work and enable them to pursue creative and cultural interests. This poses the question: In a scenario of AI-driven design, what are our creative margins and how to shift creative capabilities and education?

With the potential of AI to participate in creative and innovative processes, it is crucial to understand how the role of the designer will change. According to Verganti and colleagues (2020), the designer-AI symbiosis may elevate the designer to the role of leader, capable of identifying a problem and providing instructions on how to solve it, thus shifting the focus on sensemaking. This strategical adaptation positions designers as vital actors in shaping the creative and general culture. Here, designers take a keen interest in how users perceive their creations and how seamlessly they integrate into users' lives and stories (Krippendorff, 2005). This perspective transforms design into a discipline that fosters not only cross-field collaboration but also between products and their users, as well as between designers and stakeholders (Cross, 1982).

The collaboration between Artificial Intelligence and Creative Intelligence (or "the acts of the imagination, ingenious reasoning and problem-solving, and curiosity, play, and exploration," (Shevlin, 2021)) will pave the road to a "Hybrid Intelligence" fostered through continuous human-AI interactions (Jarrahi et al., 2022). The authors suggest that the new competencies of designers should be associated with the ability to effectively use AI and, in addition, develop creative thinking that will allow them to operate on high-level concepts and curation.

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# **Design Comedy: Shaping Speculative Design with the Power of Humor**

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## **Abstract**

Based on the evident challenges and issues in promoting speculative design in China, this article introduces the concept of design comedy, using the power of humor to reshape speculative design. While preserving the critical aspects of speculative design, it aims to broaden the audience, enhance the potential for dissemination, and mitigate the risk of speculative design becoming formulaic.

## **Author keywords**

Speculative Design; Design Fiction; Critical Design; Chindogu

## **Introduction**

In recent years, Speculative Design, as a unique and promising design approach, has garnered attention from Chinese art institutions. However, The promotion of speculative design in China encounters some challenges. This paper shifts its focus to a variant of speculative design known as "Design Comedy." It explores the concept, characteristics, and potential of design comedy, as well as its role in addressing the challenges faced by speculative design in China. Initially, the background and motivation behind design comedy are introduced, highlighting its distinctions from common speculative design. Subsequently, the paper delves into three key advantages of design comedy: concealing didactic elements, having strong sharing potential, and employing "Hutopia" as an alternative to dystopia. Finally, the application and potential impact of design comedy are illustrated, demonstrating how it can expand the horizons of speculative design in China.

Speculative design, proposed by Anthony Dunne and Fiona Raby, is a design approach aimed at exploring possible futures and social issues through the design of fictional products, scenarios, or concepts. Essentially, it stimulates thought experiments through design, allowing people to engage in discussions about contexts or topics(Dunne & Raby, 2013).

Around 2017, some art schools in China began introducing the concept of speculative design into their teaching methods. Especially in the last two or three years, speculative design works have frequently appeared at graduation exhibitions in art schools like the Central Academy of Fine Arts and the China Academy of Art. While this design method has been spreading and developing in China, it also faces some noticeable challenges.

Firstly, there is an issue with the exhibition and presentation methods. Many speculative design works, in addition to their visual forms, are accompanied by extensive explanatory texts, following a typical standard paradigm of research-based art. These works are usually disseminated through art and design exhibitions, reports, and specialized media. Although these works may receive discussions within these channels, they rarely make appearances in mainstream culture. In Western countries, due to



the well-established development context of art and design (with speculative design seen as an extension of radical design), the general public is more accepting of these kinds of design works. Additionally, visiting exhibitions is a common entertainment, allowing some speculative design works to stimulate social discussions. However, in China, resources in terms of art galleries and museums are highly concentrated, with many regions lacking appropriate exhibition spaces. Even in cities like Beijing and Shanghai, where exhibition resources are relatively abundant, there is limited attention given to design for debate. Only a few representatives like the Hyundai Motorstudio in Beijing and Chronus Art Center in Shanghai, which have organized related exhibitions, show interest in such works. For most residents in many areas, visiting exhibitions is not a daily entertainment choice. What's popular are primarily art exhibitions focused on "aesthetic spectacle" because they are more likely to appeal to the masses as they serve as ideal photo backgrounds. Furthermore, within the professional field, acceptance of this type of design is also limited. Except for a few art colleges, the general public has a hard time encountering speculative design works, which limits widespread discussion.

Secondly, there is an issue with the accessibility threshold for viewers. Speculative design, as a form of practice as research, faces many challenges common to research-based art. Claire Bishop, in her article *INFORMATION OVERLOAD*, points out the problems associated with research-based art due to the abundance of text and information, mentioning that "Many of these pieces convey a sense of being immersed—even lost—in data" (Bishop, 2023, para. 27), and "When large amounts of text are deployed in an installation, it is more likely to be experienced as a continuation of data overload rather than as a sensuous respite" (Bishop, 2023, para. 31). Speculative design, due to its goal of raising questions, places a strong emphasis on logical deduction in design, requiring a substantial amount of rigorous research as the foundation for "world/context-building." The research increases the threshold for understanding, and the complexity and specialization add to the burden on the audience. The audience is typically composed of design students and researchers, meaning that speculative design cannot reach a broad audience, thus limiting its potential impact.

Thirdly, there is the issue of the formalization and routinization of speculative design. In their book *Speculative Everything: Design, Fiction, and Social Dreaming*, Anthony Dunne and Fiona Raby explained why they introduced the concept of speculative design after proposing critical design. After the introduction of critical design in *Hertzian Tales*, it gained attention and recognition and gradually became "a design label rather than an activity" (Dunne & Raby, p. 34). Speculative design, introduced roughly a decade later, faces a similar predicament. After extensive practice, speculative design has generated many standard paradigms. For audiences familiar with speculative design, these paradigms fail to provide fresh stimulation. Many works use speculative design as a label or design trend, emphasizing aesthetics over the establishment of a solid foundation. Deliberately constructed dystopias cannot effectively provoke criticism and reflection and may even come across as forced or lacking depth. In recent years, Anthony has shifted his research focus away from speculative design after leaving the Design Interactions of Royal College of Art. This is not to declare that speculative design is outdated but rather to call for more contemplation in the face of this trend.

The development of speculative design in China is facing several challenges, with the need to lower the accessibility threshold and reach a broader audience being a key concern for practitioners. To avoid elitism and ensure that speculative design doesn't become a self-entertainment game of academia, the internet provides the ideal platform. There are numerous media platforms in China such as TikTok, Bilibili, Xiaohongshu, WeChat, and Kuaishou, with hundreds of millions of users. Leveraging these platforms, speculative design has the potential to genuinely reach the masses. However, for speculative design to thrive on these platforms, it may need to adapt to online communication. Handy Geng, a highly popular video blogger in China with over 7.5 million followers on Bilibili, has created numerous useless inventions such as the "Broken Boat Treadmill" and the "Fully Automatic Upside-down Hair Washing Machine." These humorous creations have gained immense popularity on the internet



and have been covered by mainstream media. Handy Geng's success can be attributed to the fact that the general public typically associates design, especially product design, with solving practical problems and serving a clear purpose. Handy Geng's useless inventions defy conventional expectations, creating a sense of humor and novelty. Similar content creators like He Tongxue, who designed a "keyboard that types automatically," and "switch lights controlled by throwing a ball," regularly garner tens of millions of views for each video. She Lu Yun, a graduate of the China Central Academy of Fine Arts, created a "Contemporary Art Generator," a simple device that combines high-frequency vocabulary from contemporary art to generate seemingly profound sentences. This prop alone has sold thousands of units on Taobao, an online marketplace. Clearly, humor wields significant power on social media platforms.

There are many inventors worldwide who engage in similar endeavors. In the United States, Steven M. Johnson began experimenting with such designs as early as the 1980s. In Japan, these inventions have received considerable attention and affection. Groups like Maywa Denki, DIY DEPT, and individuals like Marina Fujiwara have embraced these creations. In Japan, such designs are referred to as Chindogu, a concept introduced by inventor Kawakami Kenji. Kawakami Kenji has created numerous Chindogu and developed a serious philosophy and set of rules behind them. He views Chindogu as subversive and opposes the commodification of certain products in consumerism. One of his ten tenets, "The creation of Chindogu is fundamentally a problem-solving activity. Humor is simply the by-product of finding an elaborate or unconventional solution to a problem"(Kawakami, n.d.). It emphasizes that the purpose of Chindogu is not simply to evoke laughter; humor is a means rather than the predefined goal. When humor is introduced as a tool for rethinking speculative design, it still shares the same foundation as speculative design, rooted in critical thinking, with humor serving as an external expression.

Most of time, speculative design is expressed through design fiction. When reshaped through the power of humor, fiction transforms into comedy. Therefore, the concept of "Design Comedy" is introduced here. Design comedy is a design approach that is built on humorous narratives. Its purpose is to stimulate the audience's imagination and provoke thoughts on technology, culture, and societal issues through humorous and absurd storytelling and visual presentation.

Design comedy is a variation of speculative design, maintaining the same form of design fiction. However, when emphasizing "the power of humor," design comedy offers three advantages that speculative design often lacks:

Firstly, concealing the critique and didacticism of the work. In their book *Design Noir: The Secret Life of Electronic Objects*, Anthony Dunne and Fiona Raby introduced the concept of "Design Noir." The term "Design Noir" is derived from the concept of "Film Noir" in cinema, conveying a deep, complex, and sometimes slightly dark way of thinking. Film Noir often explores themes such as crime, moral dilemmas, and social injustice, and Design Noir attempts to delve into the relationship between design, technology, ethics, and societal issues. This concept sheds light on some of the challenges faced by critical design and speculative design. These types of designs often present a dark scene, especially in speculative design, where constructing dystopian scenarios is a common approach. Such methods can come across as aggressive and preachy to many viewers. Design comedy can effectively avoid this issue. Comedy often takes a humble approach, with viewers initially focusing on humorous situations rather than the deeper issues within the design. Humor can create a relaxed and joyful atmosphere, making viewers feel at ease during the viewing process. This helps break down tension and defenses in the audience, reducing the discomfort that can arise from overly direct critical viewpoints. Design comedy uses a progressively revealing approach to guide the audience to think deeper, conveying more information and perspectives in an easily digestible manner, gradually leading the audience to accept and understand the critical elements within the design.

MorrowAgent in 2018. During that time in China, social media often featured posts about "Things Boyfriends Should Do" or "Things Girlfriends Should Do," which set various standards for intimate relationships, often pointing towards specific consumer behaviors. Responding to this quantification and commodification of emotions, the project engaged in a discussion through the lens of Design Comedy. In the project, the male character is an extremely unromantic individual who possesses various contraptions to hinder his girlfriend's affectionate gestures. For instance, there's a machine that causes him to sweat excessively to avoid arm-touch, and a helmet that automatically sprays makeup remover on his girlfriend's face. The male character's lack of romance is portrayed through absurd props, resulting in narratives and comical scenarios that defy conventional norms. These scenarios sharply contrast with the prevailing standards of a "good boyfriend" as defined by contemporary media. However, perhaps this awkwardness is precisely what makes the other person endearing, and it might have been the initial reason they were attracted to each other. MorrowAgent exaggerated the awkward and uncomfortable aspects of intimate relationships to explore whether we should view our partners as real individuals or as objects providing experiences for ourselves.



**Figure 1.**Mr. Boring

Secondly, having strong sharing potential. Due to its appeal, design comedy may attract a broader audience, including those who typically don't pay much attention to design. This can help disseminate the ideas and concepts from design fiction into a wider society. Furthermore, happiness is a positive emotional expression, and on the internet, people tend to share and spread content that evokes emotional resonance. Humorous content often has a high degree of shareability, and design comedy presents interesting and comical elements and situations. People share such content to showcase their sense of humor or to share joy with friends, and this sharing behavior helps content spread rapidly on the internet. Design comedy, with its humor and absurdity, can spark conversations and discussions among the audience. People often share these designs and comment on them or express their own opinions on social media, which can expand the influence of the design.

Thirdly, using htopia as an alternative to dystopia. The construction of dystopias in speculative design often leads to a sense of despair and can become cliched, mirroring conventions found in movies, literature, and games. Many times, these extreme scenarios are not effective pathways for sparking thought experiments. "Hutopia" is an alternative reality constructed through critical thinking. In contrast to the real world, htopia is characterized by absurdity and humor, serving as a tool for critiquing and reflecting on the real world. Htopia can be seen as the initial state of a dystopia, where society has not yet spiraled out of control but exhibits trends that appear absurd when viewed through the perspective of our present reality. Thus, htopia can present a non-committal vision of the future, showing irrational tendencies within a non-extreme hypothetical, which aligns better with the realistic progress of technology and societal development. In the context of design comedy, htopia can help shape the concept of the work, making it both creative and effectively critical. For example, by rigorously researching and speculating on a corresponding htopia, one can create design comedy that exaggerates, satirizes, or humorously portrays the potential consequences of technological and scientific advancements. This encourages the audience to think about how to wisely address these consequences.

## Conclusion

In summary, design comedy has the potential to address the challenges faced by speculative design in China. Through humor and absurdity, it can expand the audience, promote online dissemination, and avoid the trend of labeling and standardization in speculative design. It offers a more relaxed and friendly way to communicate and engage with the general public. As professionals, it's important to recognize the current challenges of speculative design and the trend of becoming a self-indulgent practice within academia. By adjusting and promoting it according to the specific context of China, speculative design can truly harness its expected power.

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# Conceptualizing Digital Humans: A Historical Overview of Existing Design Practice

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## Abstract

With breakthroughs in simulation technologies and artificial intelligence, computer-generated digital humans are continuously emerging and expanding into interdisciplinary research fields. While the terminology related to digital humans has not yet undergone systematic clarification and differentiation. What exactly is a digital human? What are their core attributes? How will digital humans maintain their presence as an emerging media over the long term? In this article, we begin with a discussion on the concepts of ‘virtual’ and ‘digital’ to analyze the inherent nature of digital humans. Next, we provide an overview of the literature and existing practice on constructing digital humans from various disciplinary perspectives. We found that scholars and designers employ inconsistent definitions across their working process due to different research objectives and paradigms. In this regard, we endorse a more generalized definition to provide clear conceptual and operational instructions for future research and practice. Finally, we engaged in a discussion regarding future research directions and propose that researchers consider digital humans not merely as interfaces in the realm of digital communication, but also as emerging approaches that catalyze media integration and transformation.

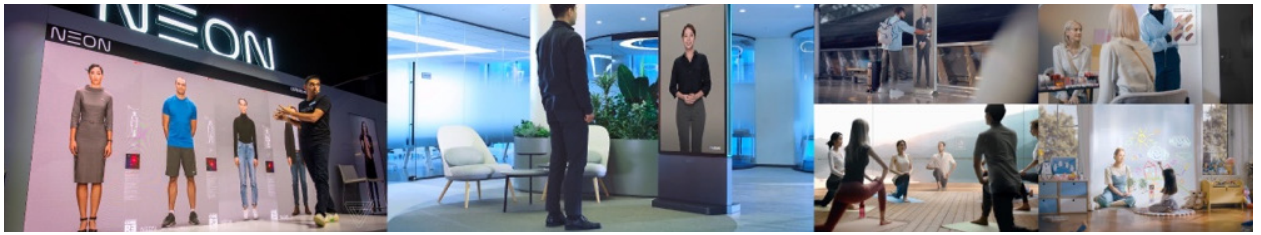
## Author keywords

Digital Humans; Digitization; Virtual Humans; Literature Review.

## Introduction

Digital humans, also known as virtual humans or metahumans, can be technically defined as realistic computer-generated human images created through computer graphics, motion capture, and 3D rendering techniques (Hussain et al., 2011). With rapid advancements in artificial intelligence, cloud rendering, and information technologies, digital humans have ventured into multidimensional explorations within virtual environments. For instance, photorealistic digital actors employed in film and television productions can be modified and enhanced to improve visual effects (Alexander et al., 2010); virtual influencers, such as fashion brand endorsers featured in advertising campaigns, have introduced new opportunities for brands to engage with their audience in immersive ways (Lee & Park, 2022). Moreover, virtual guides used in museums can provide real-time information to visitors, serving as a highly humanized communication interface.

From the examples mentioned above of digital human applications, we can identify two interconnected concepts related to digital humans: ‘digital’ and ‘virtual’. Given that these two concepts have varying impacts and implications across the realms of technology, culture, and society, clarifying the distinctions between them can aid scholars in more accurately delineating technologies, innovations, and phenomena. It can also help in



**Figure 1.** NEON, SAMSUNG Realtime AI-powered digital humans project, 2020. Source: neonlife.ai

understanding the functions, responsibilities, and identities inherent to digital humans. Such clarity and precision are necessary because existing research demonstrates that these differences go beyond semantics (Nowak & Fox, 2018), they are primarily influenced by variations in research objectives and paradigms.

### Key concept clarification

The term ‘digital’ or ‘digitization’ was first used by mathematician George Stibitz in 1942, aimed at establishing precise calculations for targeting and launching anti-aircraft artillery positions during military conflicts (Booch, 2018). Over more than half a century of development, the term ‘digital’ has become widely employed to describe various aspects of 21st-century societal, economic, and design practices. In its basic form, a digit is a number (Ritter & Pedersen, 2020). The term ‘digital humans’ underscores their existence as written programs consisting of numerous fundamental data units such as “0” and “1” and executed on computing devices. It is evident that digitization constitutes the fundamental mode of existence for digital beings, American computer scientist Nicholas Negroponte, in his book “Being Digital” (Negroponte, 1995), emphasized the role of digitized interactions in blending virtual and real worlds in a multidimensional manner. This viewpoint was further extended by Han Byung-Chul, a German philosopher who portrayed digital beings as a “survival tableau of human digitization” (Han, 2017). Han’s aesthetics of digital beings signify a profound integration of digital technology and human essence (Xian, 2021).

The distinction between “virtual humans” and “digital humans” lies in their primary focus and attributes. “Virtual humans” emphasize the virtual identity and interactive capabilities of the characters. They are often digitally customized with specific appearance for identification in particular application scenarios (Takano & Taka, 2022) and equipped with perceptual abilities, expressive capabilities, and interactive capabilities (Cheng et al., 2022). However, at their core, they remain digital simulations of physical entities. It can also be seen as a phenomenon that closely approximates real human presence in particular spaces or scenarios (Lee, 2004), delivering an experience equivalent to human interaction through technological means (Yang et al., 2022). For instance, virtual idols and virtual assistants fundamentally represent digital beings with predefined functions and appearances. Thus, we are looking for a more generalized definition and argue that digital humans are digital representations of the human user that facilitate interaction with other users, entities, or the environment, this definition highlights the media attributes of digital humans, emphasizing their role as intermediaries for human interaction within digital contexts.

### The evolution of digital humans

Following the clarification of pertinent concepts, we proceeded to delineate the historical development of digital humans. Tracing the origins of digital humans assists in positioning our study and comprehending its relative

context. It also entails an exploration of the interplay between digital human research and fields such as design studies, computer graphics, and medical simulation while establishing connections with evolving knowledge (Neuman, 2007). According to our review, the evolutionary progression of digital humans can be categorized into four distinct phases (Table 1).

**Table 1.** List of the AI Enabled Tools selected, with clickable hyperlinks.

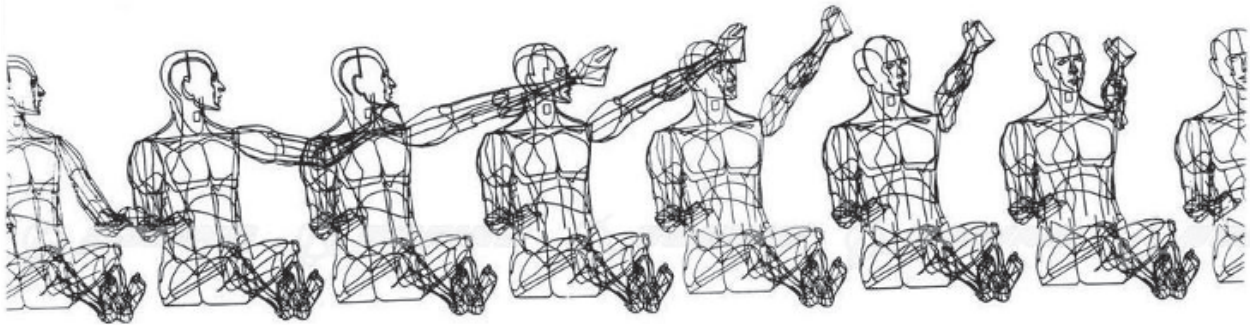
	Phase 1	Phase 2	Phase 3	Phase 4
Time	1964–1980s	1980s–2001	2001–2021	After 2021
Phenomena	Early Computer Graphics Human Figure	Visible Human Project	High Fidelity Metahumans	Real-time Avatars
Main focus	Gesture Simulation	3D Visualization Human data set	Personalized Image Expression	Embodied Interaction, Identity Construction
Driven Technology	Computer Perspective Animation	Super–Sampling Visualization Algorithms	Communications Technology	Artificial Intelligence, Mixed Reality
Leading discipline	Computer Graphics, Industrial Design	Computer Graphics, Medical Image Analysis	Information Technology, Communication	Social Science, Communication

Early Computer Graphics: Exploring Visual Representations of Human Figure  
In the mid-20th century, driven by the demands of industrial engineers and technicians, computer graphics (CG) research began to explore the potential of computer-generated visual representations (Jones, 1990). During this period, the exploration of computer-generated human figures evolved from simple line drawings to more realistic depictions (Wu, 2016).

Accurately describing the structure, functionality, form, and inherent connections of the human body has been a common goal pursued by humanity for millennia (Zhong et al., 2002). The idea of constructing human models can be traced back to ancient civilizations or even earlier. In terms of technological exploration, the initial concern of modern scholars was how to create flexible and lifelike digital avatars to simulate human motion (Wu, 2016). However, the realism of character depictions and drawing precision heavily relied on the advancement of computer technology. Early digital humans were often composed of symbols or simple lines (Fetter, 1966). In 1964, the first full-body digital human figure, known as the “Boeing Man” , was ‘born’ in the design



laboratory of Boeing Company in the United States. This digital human model consisted of seven movable segments, enabling articulation at the pelvis, neck, shoulders, and elbows. It was utilized to simulate a series of postures performed by pilots (Fetter, 1982).



**Figure 2.** Boeing Man, developed by William Fetter, 1964. Source: Boeing Image Archive

The digital image of the “Boeing Man” served as one of the early examples of converting data into images through computers, yet its limited geometric wireframe outline was still far from resembling a realistic human figure. In the early 1970s, the University of Utah’s Computer Graphics Research Group made remarkable breakthroughs in simulating human walking movements, facial expressions, texture mapping, and more (Gaboury, 2016). By the early 1980s, with significant improvements in overall computer performance and the invention of several important algorithms, the quality of computer-generated characters experienced remarkable enhancements (Wu, 2016). In 1980, the first digitally generated character with volume and shading, named Adam Powers, made a public appearance in color 3D imagery at the ACM SIGGRAPH Electronic Theater. Although Adam’s facial features and body movements were relatively stiff, his realism had greatly improved through the 3D reconstruction system compared to the line-based “Boeing Man” (Demos, 2005). For instance, Adam’s skin tones were composed of smoothly shaded colors, closely resembling the appearance of real humans. The attempt to simulate different materials’ textures on clothing and props also contributed to improved realism. These visual enhancements were primarily attributed to the achievements in the field of computer graphics algorithms in the 1970s, such as in occlusion culling, texture mapping, and rendering (Wu, 2016).

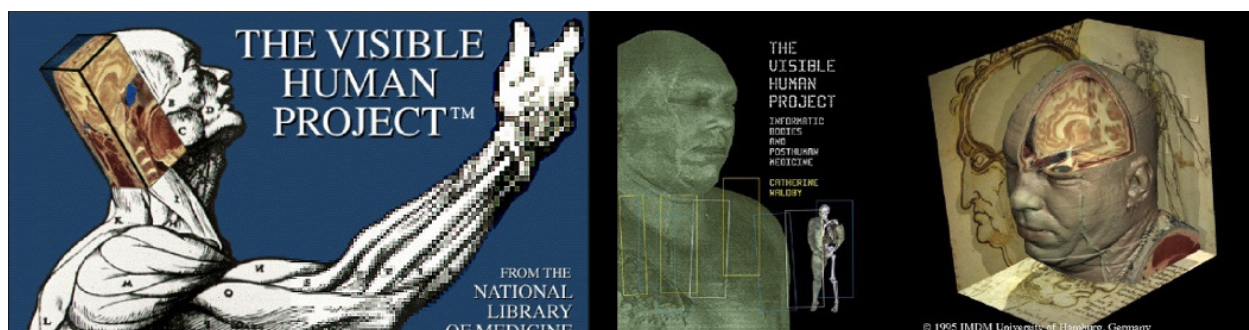


**Figure 3.** Adam Powers, computer animation created by Information International Inc., Source: [www.imdb.com](http://www.imdb.com)

#### Visualization of Medical Research: Precise Replication of the Human Body

Since the 1980s, with the gradual maturation of computer graphics, medical research conducted numerous experiments in the field of human body simulation with the aid of computer imaging technology. Initiatives

including the Human Genome Project (HGP), the Visible Human Project (VHP), the Virtual Human Project (VHP), the Human Brain Project (HBP), and so on (Sandelowski, 2023). These endeavors aimed to digitally replicate human anatomical features, marking a significant fusion of computer graphics technology with medical visualization research (Zhong et al., 2002). In this context, digital humans, presented as three-dimensional anatomical models, were employed to represent internal structures for concentrated observation and study of organs within the human body (Hong, 2022). Displaying anatomical features in three-dimensional form entails capturing size, shape, position, and spatial relationships among organs, thus achieving the digitization of human anatomical structures through the utilization of human body information. This approach found significant applications in medical education and clinical diagnosis by offering a visual means of teaching and understanding human anatomy.



**Figure 4.** The Visible Human Project, Source: <https://www.voxel-man.com/gallery/visible-human/>

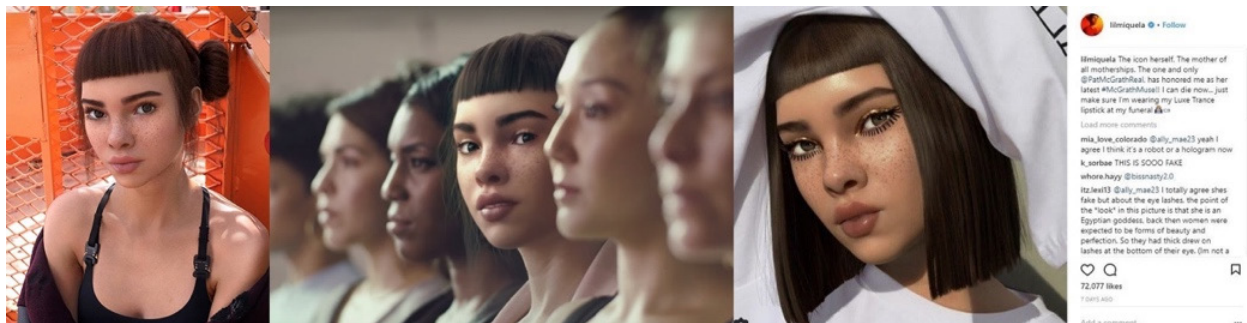
In 1989, the NATIONAL LIBRARY OF MEDICINE (NLM) initiated the ‘Visible Human Project’, aiming to construct a comprehensive virtual dataset of the human body utilizing computer image reconstruction techniques. By combining interactive classification and super-sampling visualization algorithms, this project significantly enhanced the realism of three-dimensional reconstructions of human body data (Schiemann et al., 1997). This initiative transformed the established pattern of medical visualization and created a digitized three-dimensional anatomical atlas (Ackerman, 1998). The Visible Human Project laid the foundation for using computer image reconstruction techniques to build virtual human models, sparking a global trend in the development of visual human data (Zhang, 2003). With advancements in information acquisition and processing technologies, future digital humans will simulate human body functions and behaviors with increasing accuracy and comprehensiveness. This holds crucial scientific significance as it promotes progress in the field of human body simulation and enhances our understanding of human nature.

#### Advancing Simulation: Realism and Multidimensional Interaction

As 3D modeling techniques and societal demands continue to evolve, the simulation of digital humans has progressed beyond visual realism and accurate replication. It now encompasses the need to adapt to the real world and engage in interactions within it. After the millennium, the endeavor of designing digital humans has initiated a transition from ‘like in form’ to ‘like in spirit’. As animation technology undergoes successive updates, digital humans have gradually evolved from static poses to free movements, from passive adaptation to active interaction with the environment, and from the separation of form and intelligence to their integration (Wu, 2014). Consequently, people are no longer satisfied with simple 3D reconstructions of the human body. Instead, they are exploring more personalized characters and differentiated modes of expression, imbuing digital humans



with richer cultural connotations. This evolution is made possible by updated algorithms and also derived from the shifts in societal aesthetics (Chen, 2018).



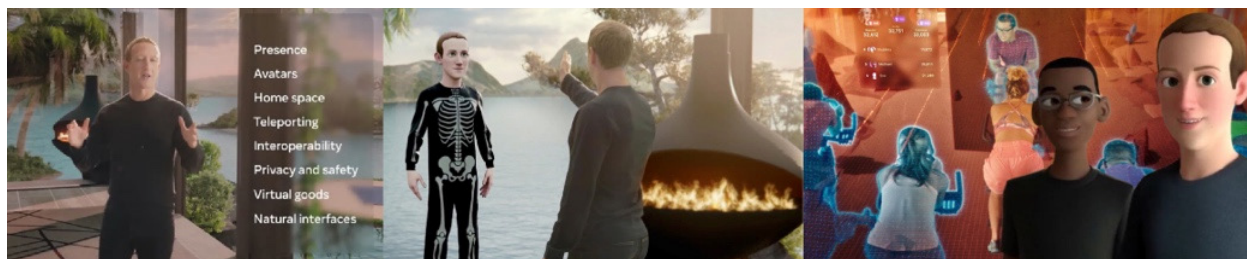
**Figure 5.** Lil Miquela, Virtual Social Media Influencer. Source: medium.com

At the beginning of the 21st century, Artificial intelligence has become more efficient in creating realistic 3D characters, texturing and animating human characters with realistic body language, facial expressions, lip sync and so on. (Singh & Kaur, 2023). Many digital humans exhibit comprehensive character designs, unique personalities, and finely detailed emotional portrayals. These foundational aspects endow digital humans with heightened emotional significance. For instance, Lil Miquela is a virtual influencer created by the American company Brud. She serves as a fashion blogger, model, and singer, amassing a substantial fan base across global social media platforms which disrupts conventional social networking paradigms (Drenten, 2020). With increasing attention and a broadening scope of involvement, Lil Miquela has given rise to a relatively complete virtual KOL (Key Opinion Leader) digital matrix centered around her. Such digital humans are actively engaging in information exchange through social platforms, introducing new research avenues to explore the novel shifts in interpersonal communication in the digital era.

#### Building Connection: The Evolving Role of Digital Humans in Digital Era

Amidst the trend of the automated and refined development, the essential attributes and connectivity methods of digital humans as users' digital representations still require further conceptual clarification and application guidance.

In 1995, social scientist Sherry Turkle defined digital human avatars as users' expressions of identity on screens in her book "Life on the Screen: Identity in the Age of the Internet" (Turkle, 1995). Digital beings represent users' self-presentation and means of dissemination in digital environments. The visual representation of these digital entities' bodies evokes an embodied visual experience for observers. As the digital world continues to expand, humans require assistance from digital humans to achieve embodied interactive experiences (Xiao et al., 2021). Alongside the ongoing development of societal demands, emerging social technological systems have established a novel and intricate relationship between individuals and digital humans (Freeman, 2020), significantly transforming the ways people engage in online socialization and interaction (Hardey, 2002). Under the vision of the "metaverse", the series of transformations and connections triggered by digital humans have paved the way for new communication modes, relationships, contexts, and spaces within novel social domains.



**Figure 4.** The Visible Human Project, Source: <https://www.voxel-man.com/gallery/visible-human/>

## Conclusion

Across the literature and existing practice, we find that scholars from various disciplines have focused on three overlapping aspects: Digitization, Anthropomorphism and Interactivity.

### Digitization

The first dimension of conceptualizing digital humans relates to their existence mode. Combined with the clarification of key concepts in the introduction section of this article, digital humans are virtual embodiments of the participants engaging in the era of digital communication, consisting of high-level behavior, perception, animation and graphic systems. (Magenat-Thalmann & Thalmann, 2005). At its core, digital humans are presented as virtual interactive imaging systems that involve simulations of physical entities across multiple data dimensions (Jones et al., 2020). The attributes of digitization provide digital humans with the capability for remote interaction, enabling them to be “inhabited” in shared multimedia environments.

### Anthropomorphism

Throughout the evolutionary process, the gap between digital humans and real humans is gradually narrowing. Concerning physical appearance, some scholars define digital humans in terms of physical realism, how lifelike they appear or how similar they are to human morphology or behavior (Nowak et al., 2009). From the perspective of participants, digital humans are perceived as virtual entities created through computer graphics technologies, possessing a human-like external appearance that can be accurately recognized (Yuan, 2022). However, merely offering a flat and generic visual presentation is far from satisfactory in digital communication. Nakamura (2002), described a digital human avatar as “a visual digital representation of a self in cyberspace”, emphasizing the crucial role of digital humans in enhancing digital communication and fulfilling individuals’ need for self-expression. As the most basic attribute of digital humans, anthropomorphism enhances the visual appeal of emerging media, enabling participants to interact with digital humans in a more natural way and building emotional connections (Sestino & D'Angelo, 2023).

### Interactivity

The final dimension in defining digital humans pertains to their interactivity, that is one’s ability to perform actions and engage in the environment (Huang & Jung, 2022). Given the diverse driving technologies and application scenarios, digital humans vary in their interactive abilities, sensory apparatus and richness. People expect more interactions with digital humans on a daily basis which is reshaping our social experience and challenging the ontological concept of authenticity. (Turkle, 2007; Huang, & Jung, 2022). The “2020 Virtual Digital Human Development White Paper” points out that digital humans possess the ability to express themselves through language, facial expressions, and body movements, as well as the ability to perceive the

external environment and engage in communication and interaction with participants. These abilities enable digital humans to transmit and collect information such as text, audio, and images. On the basis of possessing humanoid characteristics, to some extent, replicating human thought or behavior, and interacting with humans are among the assessment criteria for digital humans.

While researchers have varied in their ways of conceptualizing digital humans, we contend that certain key factors must be incorporated to reach a consensus and promote the ongoing development of digital human research. Based on the preceding discussions, we propose that the definition of digital humans should encompass the following three aspects of attention:

1. Presentation as interactive digital image systems.
2. Visual resemblance to human characteristics, including appearance and physique.
3. Capable of simulating and replicating human behavior to a certain extent, along with the ability to convey information through language, facial expressions, and body movements.

In light of our review, we suggest that both conceptualization and theorizing about digital humans would be more generalizable (Nowak & Fox, 2018) instead of constraining specific disciplines such as computer graphics, industrial simulation, medical anatomy, and others. This shift is essential because digital humans represent both a novel research topic and a means to comprehend the evolution of existing digital communication processes. Such an approach seeks to bridge the currently isolated and fragmented single-disciplinary research and to collectively view them as efforts towards accurately simulating human appearance and behavior.

In conclusion, considering digital humans as a multidimensional media concept holds contemporary significance as it enhances people's engagement with increasingly complex virtual experiences. We eagerly anticipate the continued growth and integration of this research field into everyday life and various industries.

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## Designing the future of society: from the participatory scenario perspective

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### Abstract

To effectively contribute to social change in the complex and dynamic present, designing for social innovation necessitates a systematic, holistic, and long-term approach to drive social change. Scenario planning stands out as a tool capable of fulfilling this requirement. This study discusses the relationship between foresight and design, explores several participatory scenario planning methods through some cases, and suggests how social innovation design could use participatory scenario planning to cultivate a shared vision.

### Author keywords

Foresight; Design for social innovation; Scenarios; Participatory scenario planning.

### Introduction

There has been a long tradition of thinking the future and future events. People have always been curious about what lies ahead. As an achievable attempt by people to alter the world, design is similarly future-oriented.

Design is considered by Herbert Simon as a creative activity that solves problems. It means the design process is identifying the problem in the present or the past and proposing a solution that allows the problem to be solved or to move towards a better situation. That is problem-oriented design.

Many academics have discovered that many of today's challenges are chaotic, complex, and poorly structured as a result of the development of "wicked problems" (Farrell & Hooker, 2013). It is often that the solution space evolves along with the problem space and the stakeholders involved become more complicated and diverse (Bijl-Brouwer, 2019). Problem-oriented design is insufficient when the issue space is ambiguous and chaotic since there is a great danger of creating unintended side effects that could lead to a disaster (Manzini, 2015). To investigate the issue, we must design from a comprehensive, systemic, and long-term perspective.

This is valid in the design for social innovation in particular. Manzini defines design for social innovation (DSI) as



all the activities that professional design could do to activate, sustain, and influence society toward sustainability (Manzini, 2015). Intending to prioritize social connections, sustainability, and local knowledge, DSI places a higher priority on social change and intervention than advances that place a greater emphasis on profitability or efficiency. Manzini emphasizes the significance of a shared vision in social innovation, which may inspire the creativity of various stakeholders and foster social interaction while guiding design choices. (Amatullo et al., 2021; Manzini, 2015)

In this study, the relationship between foresight and design is explored, along with several types of participatory scenario planning methodologies. It is believed that participatory scenario planning would be effective in DSI to create a shared vision.

### **Foresight and design**

One of the early definitions of foresight was offered by (Coates, 1985), who described it as "a process by which one comes to a comprehensive understanding of the forces that shape the long- term future and that should be taken into account in policy-making, planning, and decision- making." But at first, forecasting was more frequently utilized by futurists or strategic planners to foresee technological advancement. Foresight was accepted and swiftly spread after a future- focused strategic planning effort in which academics adopted the term as an alternative to predicting (Martin, 2010). Although each of these notions has unique qualities, (Cuhls, 2003) suggested that planning, foresight, and even forecasting have many similarities. In actuality, all three of them overlap and are frequently used in the same sentence. Over decades, the term "foresight" gained popularity and is used frequently by academics, researchers, policymakers, consultants, and others worldwide. Designers are also included. Future thinking in design has given rise to many new design directions, such as speculative design, design fiction, strategic design, and others.

Tony Fry also mentions in his article on Design Intelligence that the ability to presuppose is the essence of design competence... The extent to which design becomes a full-fledged cognitive act in itself determines the ontology (and subjectivity) of the designer, but it remains crucial to recognize that all humans can design. The exercise of design competence is inextricably linked to the ability to shape and change one's own and others' worlds (Willis, 2005).

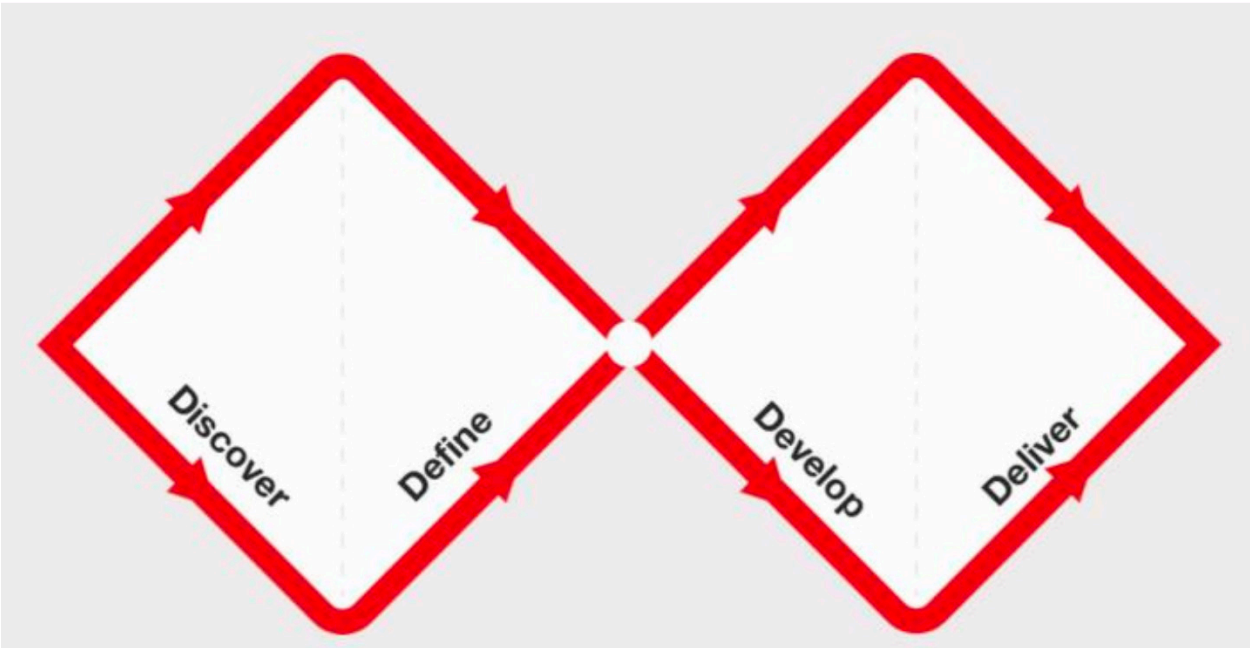
Both fields (design and foresight) involve systematic efforts to make sense of uncertain futures by using scenarios as a common tool for imagining, inspiring, and communicating desirable directions.

The growing collaboration makes a lot of sense given that generic frameworks that foresight and design use to carry out their work are quite similar (Hines & Zindato, 2016).

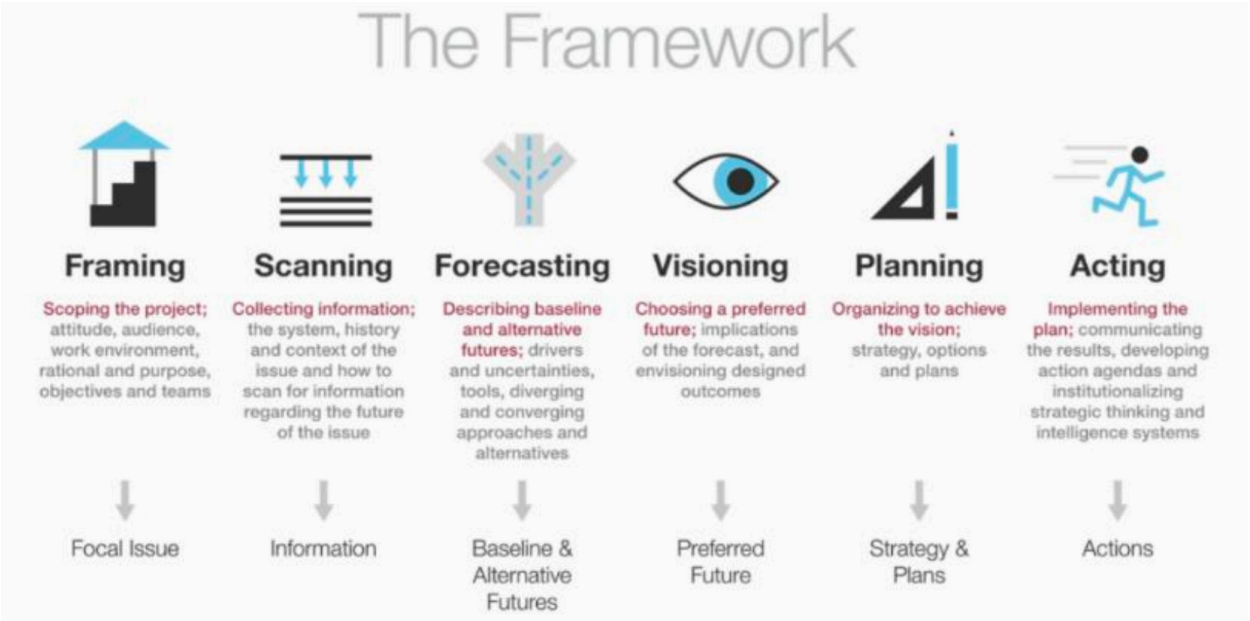
The Double Diamond is a visual representation of the design process. It describes the four steps taken in any design and innovation project (Figure 1). It can be seen that the overall process can be divided into two phases. The first diamond helps people understand what the problem is. The second diamond encourages people to give different answers to the clearly defined problem, seeking inspiration and co-designing with a range of different people (The Double Diamond - Design Council, n.d.).

For the generic foresight framework, we have chosen a foresight framework from Bishop and Hines' s study,

which has six steps: framing, scanning, forecasting, visioning, planning, and acting(Bishop & Hines, 2012). The six activities can also be grouped into two phases: mapping and influencing. Mapping is aimed at constructing alternative futures, and influencing is about taking action to shape the future(Hines & Zindato, 2016).



**Figure 1.**NEON, SAMSUNG Realtime AI-powered digital humans project, 2020. Source: neonlife.ai



**Figure 2.** A foresight framework

The first diamond of design, with discovery and defining steps, is similar to the mapping phase of foresight with its framing, scanning, and forecasting steps. Similarly, the second diamond is similar to the influencing phase of foresight with its visioning, planning, and acting steps.



Scenarios, which originally referred to the plot summary of a stage production, film script, or television program, are diagrams representing some aspect of the future. Scenarios are explanations of potential outcomes and sequences of events that enable individuals to transition from the present to the future. Early scenarios were used in public decision-making and the military, as well as later made a way into company planning (Bradfield et al., 2005). This concept has a wide range of applications, from global models to user scenarios (such as in the design of human-computer interactions (Carroll, 2003)). Scenarios are frequently built as a combination of a future vision and a plan for achieving that future from the present, in which several goals for the future are outlined.

There are similarities and differences in when and how scenarios are used in design and foresight. In foresight, scenarios are applied at the macro level (a whole system), presenting a variety of future alternatives, generally in the form of storytelling and reporting, with the outcome being strategies, policies, initiatives, etc. In design, they are applied on a micro-scale (focused on a specific theme, a product or a service), they present feasible solutions and are materialized by design solutions/prototypes or maps (Hines & Zindato, 2016).

Overall, the difference between futurists' and designers' use of scenarios can be seen as the difference between scenario planning, which analyzes systems from a macro perspective, and scenario construction, which is more specific to creating stories with possibilities from a micro perspective.

As the two fields learn from each other, the use of scenarios in the design process expands that be used in all phases within design process and transfers the emphasis from the design object to the communication and interaction process. It could be exploring problems context, building a common vision, generating new concepts, supporting decision-making.

### **Participatory scenario planning**

Another similarity between these two fields is that both have been influenced by participatory thinking and have new developments in methodology. And scenarios-the tools they share-seem to be a natural combination with participatory thinking.

In fact, Participatory Scenario Planning (PSP) has become a new development in scenario planning, and be used across multiple disciplines. Participatory Scenario Planning (PSP) is a procedure in which participants, frequently with the help of a researcher, engage in a highly collaborative process and take the initiative at some or all stages of a scenario production process to look into potential futures.

PSP is a transdisciplinary area, and other academic fields have contributed knowledge to its growth.

Four scenarios (Figure 3) that were reasonable and appealing to many stakeholders were produced by ecological scientists using participatory scenario planning to investigate potential strategies to promote human-wildlife cohabitation (Jiren et al., 2021). (López-Rodríguez et al., 2023) have created and used a visual tool in a PSP process for a national park to encourage direct communication and reflection among many stakeholders and to bring various conservation strategies to life (Figure 4). In a series of citizen-participatory low-carbon energy visioning workshops in Suita City, (Uwasu et al., 2020) introduced a new participatory scenario design process in which participants took on the roles of hypothetical future generations to engage in decision-making (Figure 5).

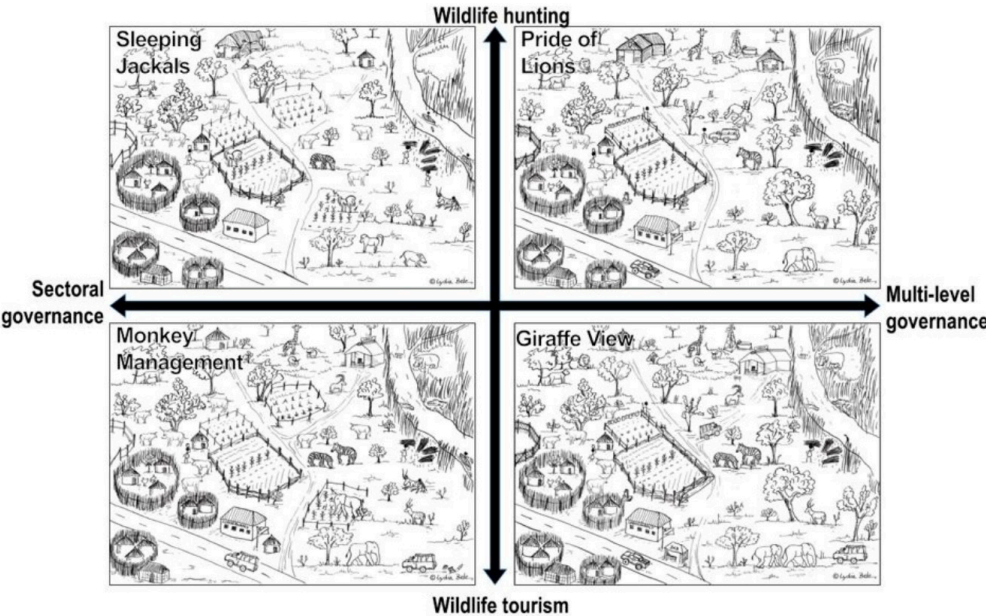


Figure 3.

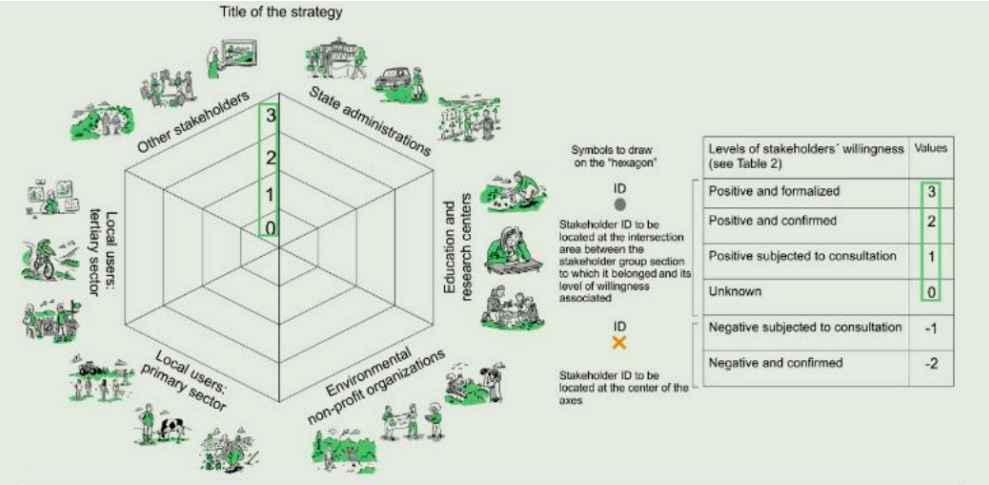


Figure 4.



Figure 5.

According to (Ratti & Claudel, 2016) a participatory approach to speculative scenarios encourages group imagination, experimentation, and the development of the most ideal future. This is exactly the force needed to drive social change in social innovation design.

Indeed, the field of social innovation is also using scenarios to explore new futures, like the CITY- ECO-LAB that Mancini mentioned in his book which asked six households to use "what if..." statements to imagine how their lives would change if they started to reduce their energy and water use (Manzini, 2015). One benefit of this is that it creates direct, rich, and open scenarios that help with comprehension and communication. Nevertheless, the disadvantages are also evident; the main among them is the absence of clear boundary conditions and key drivers, which limits further development into potential futures.

As previously stated, design may learn some approaches from foresight. Macro perspectives, clear problem boundaries, trend analysis, and key drivers are what futurists are good at. The benefit of this is that the essential drivers are highlighted, which increases the credibility and consistency of the generated scenarios and facilitates the following formulation of strategic decisions in many circumstances. While at a later stage of development, it could use various methods of design, so that a little bit of possible future can be seen and touched on the basis of reality.

PSP needs to be open and rich, while also taking into account the fact that implementation and impact generation need to be clearly bounded by regulating and driving factors, otherwise it would be no different from science fiction, given the complexity and uncertainty of the problems faced in design for social innovation (Buehring & Bishop, 2020). Local knowledge is necessary for social innovation as well, and participatory scenario planning in the community offers the chance to combine scientific and local knowledge, maybe allowing access to social or cultural memory (Mistry et al., 2014; Oteros-Rozas et al., 2015).

## **Discussion & Limitation**

The use of scenarios in design is not new; in fact, the method has been around for quite some time. When used in design practice, boundary conditions and key drivers are often not considered deeply enough because there is a lack of a systematic and logical way to think about how complicated the problem is. Rich scenarios are produced as a result; but they lack support for subsequent implementation and development. Therefore, we raise the possibility that PSP could be used as a new strategy for social innovation by bringing together several fields that use scenario planning.

The paper's limitation is that it merely analyzes this method's potential from the literature and there is no evidence of feasibility from practice yet; this will be the focus of our further investigation. We are currently running a workshop in a village to test the use of participatory scenario planning to promote social innovation. We hope that this approach will lead to some new developments in design for social innovation.

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## **Fashion Futuring: Fashion Curation as a Critical Medium**

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### **Abstract**

In a time of uncertainty and once-in-a-century change, thinking about and critiquing the future sustainability of fashion is intimately connected to our daily lives. Fashion curation serves as a critical platform to address the future of fashion, analysing the cultural values ingrained within it and utilising them to drive the conception of innovative fashion ideas. This involves the amalgamation of imaginative strategies, critical reflection, and proposing solutions to issues pertaining to aesthetics, society, politics, environment, and philosophy. Critical and discursive curation of fashion, as a means of producing knowledge, generates discourse while visually showcasing and advertising fashion culture. This approach captures the viewers' interest, allowing them to observe, experience, engage, and participate in dialogue. Furthermore, in the context of fashion in a globalised culture, the evaluation of the fashion system's relevance, local and national identities, fashion education, and industry carries substantial significance in museum fashion curation. Therefore, this paper presents a fundamental literature review of the academic progression of home and international fashion curation.

### **Author keywords**

Museums; materiality and culture; fashion curation; sustainability; technological innovation; foresight.

### **I. History of dress, fashion and cultural studies**

Roland Barthes's *The Popular System: Semiotics and Dress Symbols* decodes the language of dress in popular magazines using linguistic and semiotic research methods. Simmel's *The Philosophy of Fashion* examines the role of fashion in defining class identity in capitalist society. British scholar Elizabeth Wilson's *Dressing to Dream* also explores the relationship between dress and society. "Fashion and Modernity" is a significant contribution to the field of fashion studies. In his book "The Culture of Clothing," French historian Daniel Roche extensively explores the history of dress in Enlightenment-era Paris, delving into the rise of consumerism and style-focused dress culture. Additionally, costume historian Lou Taylor's "Establishing Dress History" (*Studies in Design*, 2002) traces the history of costume displays, emphasizing that the primary aim of museum exhibitions featuring fashion is to ensure accurate portrayal, scholarly analysis, and careful interpretation of historical contexts. Agnes Rocamora and Anneke Smelik's "The Enlightenment of Fashion: A Guide to Key Theorists" provides an objective examination and categorization of notable fashion theorists and their work. "Fashion Cultures: Theories, Explorations and Analysis" is a collection of essays authored by Stella Bruzzi and Pamela Church Gibson, first published in 2000. It offers a comprehensive insight into a wide range of fashion theorists, from those concerned with high-end fashion to those analyzing fashion in broader contexts such as popular culture; The book amalgamates theoretical research on space, consumption, gender and the body politic within contemporary fashion culture; it examines catwalks, malls, fashion photography, cinema screens, and art museums; James Lavelle and Amy de la Haye's "A Brief History of Clothing and Fashion" offers a factual account of clothing and fashion origins beginning



with the Roman period and continuing up to present day. Dick Hebdige's "Hidden in Bright Lights" is an additional resource that can be used to expand on these topics. *Images and Objects in Popular Culture* employs semiotics, popular culture theory, and postmodernism as theoretical frameworks to analyze the production and consumption of popular images in visual culture via popular objects and cultural phenomena. In *Fashionable Bodies: Fashion, Clothing and Modern Social Theory*, Joanne Entwistle examines the relationship between fashion and the body by combining sociological theories with the body; *Lauterich's Guide to Fashion Research*, edited by Eugenia Paulicelli, Veronica Manlow, and Elizabeth Wissinger, offers a wide-ranging, interdisciplinary set of research essays regarding fashion across the globe. This volume examines fashion's disciplinary boundaries, covering its history, theory, and practice, as well as its relationship to the body, identity, the fashion industry, globalisation, and media such as literature, magazines, television, and film. Research materials on fashion also comprise *The Art and Criticism of Fashion* by Adam Geczy and Vicki Karaminas; *Fashion and Modernism* by Louise Wallenberg and Andrea Kollnitz; and *Fashion and Materiality - Cultural Practices in a Global Context*, an anthology edited by Huck Jez and Viola Hoffman. The book *Fashion and Materiality - Cultural Practices in a Global Context* by Huck Jez and Viola Hoffman explores the relationship between fashion as material culture on a global scale and its impact on society. It provides an in-depth analysis of the issues related to this subject. Besides, *Fashionology: An Introduction to Fashion Studies* by Yuniya Kawamura is also a significant reference for further understanding this topic.

## **II. Research on clothing and fashion museolog**

Julia Petrov's monograph, 'Fashion, History, Museums', explores the development of historical costume exhibitions in museums during the twentieth century. It offers a critical analysis of trends in museum fashion exhibition practices over the past century, and discusses the variations between historical fashions showcased in museum exhibitions in the United Kingdom and North America. The book provides a theoretical framework for the study of historical costume exhibitions in the history and curation of museum exhibitions. Morre Marco Pecorari's essay in 'Beyond the Museum' challenges the predominance of physical costumes in fashion exhibitions, offering a new approach to fashion curatorial practices and discourses. The book 'Fashion and the Museum' by Marie Riegels Melchior and Birgitta Svensson further explores this topic. *Theory and Practice* presents research conducted by scholars and fashion curators regarding the reasons for the rise of fashion within museums in the twenty-first century, and the significance of fashion for museum organizations. The authors explore the shift in research focus from clothing to fashion in museology resulting from fashion's influence on museums. The author examines the change from fashion museology to fashion museology resulting from fashion's integration into museums. It is argued that fashion museology represents a "new museology" with significant importance; Chapter 5 of Stella Bruzzi and Pamela Church Gibson's *Theories, Explorations and Analyses of Fashion Culture*, Fiona Anderson's article examines multiple exhibitions at the V&A, the Judith Clark Costume Gallery and the Atlantis Gallery in the UK. These investigations serve as case studies for Anderson's exploration of the museum as a fashion medium; Fiona Anderson's article, 'The Museum as a Fashion Medium,' delves into the methodological and critical approaches to fashion as a medium by taking case studies from the V&A Museum, Judith Clarke's Costume Gallery, and Hussein Chalayan's exhibition at the Atlantis Gallery in the UK. The article specifically focuses on the effects of 'new' fashion history and 'new' museology on the presentation and study of fashion during the 1990s. Professor John Potvin's 'Fashion and the Museum of Art' is also included. The article examines the Giorgio Armani retrospective hosted at the Guggenheim Museum in New York in 2000, using it as a case study to explore how a prominent living designer like Giorgio Armani has established himself in the fashion world. This study examines how a prominent designer can organise a major solo exhibition by funding a museum, while also

critiquing the impact on the cultural, conceptual, and scholarly principles established by the Museum of Modern Art; A particular focus of Daniel Roche's *The Culture of Costume* is the museum's fashion history, and there are several other relevant documentary works, including Valerie Steele's *The Quality of Museums*.

Steele's *Museum Quality* text is of particular note. *The Rise of Fashion Exhibitions* explores the history of museum fashion exhibitions, examines factors behind the current increase in such exhibitions, and addresses related issues including corporate sponsorship and curatorial independence.

### **III. Fashion Curatorial Research**

Amy de la Haye and Judith Clark's study, *Fashion Exhibitions around 1971*, centres on the Victoria and Albert Museum's influential exhibition *Fashion: Selected Works of Cecil Beaton*, and traces the evolution of fashion exhibition curation and presentation in and around 1971. Annamari Vanska and Hazel Clark's work, *Fashion Curating*, further explores this topic. *Critical Practices in and out of the Museum* collates a collection of academic essays investigating the present condition of fashion and fashion exhibitions as a means of critical contemplation, study, and analysis of fashion culture. It argues that "critical fashion curation as a mode of knowledge production" has emerged. Dr. Nadia Buick of Queensland University of Technology, in her 2012 Doctoral thesis 'Constructing Fashion Curatorship', blends an exploration of the art field with the examination of fashion curatorship. *Theoretical and Historical Perspectives*, she links the definition of curatorship in the art field to the multiple facets of curatorship in the field of fashion, and proposes a study of a third model of 'part-time fashion curatorship', in addition to institutional and independent curators, as well as a theoretical and historical discourse on fashion curatorship, and models of fashion curatorship and their collaboration with museums, and a detailed description of the author's own practice of fashion curatorship; There are several journal articles on the topic, such as Valerie Steele's 'A fashion museum is more than just a bag of clothes'. Steele argues that clothing is a crucial object of knowledge and that specific exhibition criticisms do not imply fashion museums are subservient to commercial gains. Moreover, she emphasises that fashion museums play a vital role in the historical and aesthetic development of fashion. Sarah Scaturro's essay, 'Curating Clothing/Exhibiting Fashion,' examines changes in fashion curation over time, with a focus on the impact of electronics and media on fashion display. The essay also critically evaluates the relationship between fashion and popular literature, music, film, and television in the context of museum exhibitions; 'Image, Touch, and Heterotopia in Fashion Curatorship' is the seventh chapter in Chapter 2 of Lauterich's *Guide to Fashion Research*. The chapter explores the advancement of fashion exhibitions and their curatorial modes in the 21st century, utilizing six exhibitions from the Metropolitan Museum of Art's Costume Institute and the Antwerp Fashion Museum as subjects. The examination of the development of exhibitions and their curatorial modes is carried out through six exhibitions at the Costume Institute of the Metropolitan Museum of Art and the Fashion Museum Antwerp. The authors assert that the exhibition design serves as the medium, enabling the museum as a "heterogeneous space" to connect the viewer to the exhibition's narrative, thereby creating an immersive experience. The authors also emphasize the significance of interdisciplinary collaborative curatorial approaches in fashion curation. Hazel Clark's book 'Curating and Exhibiting' examines the objective discourse surrounding "the end of fashion" in the context of post-2000 fashion trends. Additionally, the question of whether fashion is modern is explored extensively throughout the work. Drawing on the "Anti-Fashion" exhibition, the book argues for a shift towards the curatorial and dematerialised aspects of fashion; Thomas Walter Dietz's *Fashion Curating* briefly describes the history and theory of fashion curation, analyzing the practice as well. The author argues that further research and discussion regarding fashion curation should take place on a national level. The author argues that the development of



fashion curating can be divided into three historical phases, primarily based on the establishment of the Fashion Museum. The first period encompasses the development, transformation, and dissemination of curatorial practice before the Second World War until the end of the 1950s. The second period spans from the 1960s to the 1990s of the 20th century, and the third period begins at the end of the 20th century. However, the paper's chronological division is primarily centred on the establishment and progression of fashion museums, with no initial focus on the curatorial examination of fashion exhibits.

There are no Chinese monographs on fashion curation. In her article, "Narrative Strategy and Situational Experience of Fashion Curatorship," Lu Ying delves into the essential importance of exhibition display and fashion communication in regards to fashion curation. Through the examination of fashion exhibition cases, Ying explores the narrative of fashion curatorship and the situational experience resulting from spatial design. However, the article neglects to discuss the curation process and solely focuses on the commercial brand fashion exhibition as the research case, leading to a biased viewpoint. On the other hand, Chen Yuanyi's "The Evolution and Future of Museum Fashion Exhibitions" examines the growth of museum fashion exhibitions and their cultural and social significance from the perspective of fashion communication. Cao Shuai's master's dissertation "An Investigation into the Collaborative Relationship between the American Museum of Clothing and Enterprises" examines the concept and nature of the American Museum of Clothing, the interconnection between the Museum of Clothing and Enterprises, and discusses the Museum of Clothing's development, and concludes with recommendations for promoting development of Chinese clothing museums and improving enterprise partnerships. However, the statement in the article that suggests the emergence of independent curators specialising in costume in American museums in the 1980s, according to the authors, is inaccurate; Zhang Huiwen's master's thesis, "The Evolution of China's Modern Costume Exhibition and Revelation", examines the history of modern costume exhibitions in China. The thesis analyses the growth of these exhibitions in tandem with changes in Chinese society, particularly during the reform and opening up period. However, the article primarily focuses on costume performances, with comparatively minimal attention given to exhibition content. Shadong Qing's master's thesis, titled "Planning for the Content of Chinese Fashion Museums," outlines a collaborative effort between institutions and Greenland Group enterprises to create a fashion museum project. It encompasses research, practical concepts, and exhibition content planning. The paper primarily presents data statistics and charts, but lacks theoretical depth. Wang Haoran and Li Xinhua's paper, entitled "Digital Fashion Curation: An Exploration of its Role in Constructing and Disseminating Clothing Brand Culture", investigates the fashion industry's utilization of digital fashion curation to construct and disseminate clothing brand culture. In addition, the study examines the development of digital fashion curation; Shi Yajuan's article "Exploration of Digital Fashion Curatorship in the Cultural Construction and Communication of Fashion Brands" published in *Art and Design Research* opens a philosophical discussion on the themes of "time" and "continuity" in the Metropolitan Museum of Art's 2020 fashion exhibition "About Time: Fashion and Continuity". Fashion and Extension exhibition held at the Metropolitan Museum of Art in 2020 discusses the intrinsic connection between fashion and time, arguing that transience, periodicity, and novelty are essential characteristics of fashion. The author asserts that it is these characteristics that determine that extension is the way of existence, novelty is the way of manifestation, and imitation is the way of representation.

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## How artificial intelligence could reduce inequalities in human society

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### Abstract

Unequal social systems have always existed in human society since human appearance. With the development of the times, some unequal systems have either died or continued their existence in different forms. This paper starts from the roots of the inequality system, and studies the causes of inequality system from the aspects of science and morality and why the combination of design and artificial intelligence technology is beneficial eliminate or reduce the inequality in human society.

### Author keywords

Artificial Intelligence; social equality; human morality; technology; Design

### Introduction

Some views hold that an important reason for the inequality system of human society is that the demand for basic living resources, such as water, food, and energy, is not fully met, and human beings need to maintain a socialized way of living to ensure the existence of the population. However, the limitation of productivity causes that each individual in the group is not likely to have sufficient resources. The absolute average redistribution of living resources cannot guarantee the existence of the group, so sometimes the necessary inequality guarantees the existence and smooth operation of the population. However, artificial intelligence is different from any tool invented by humans in the past. by using AI, the development of productivity can no longer limit the human body's own capabilities. Obviously, the increase in productivity will undoubtedly bring more living resources to human beings. In addition, artificial intelligence can completely replace the attributes of human work in some aspects and also make some traditional inequalities and exploitative systems has no meaning of existence. This paper is divided into three parts. First, we talk about the causes of social inequality and the role that technology and morality play in it. Second, we talk about the relationship between technology and morality. Third, we discuss the combination of design and artificial intelligence and its impact.

### The social inequalities

Equality is the basic feature of modern society, a vital measure of human progress, and a cherished ideal. It

signifies that despite individual differences, all members deserve fair treatment and opportunities. Society must recognize everyone's equal humanity and social status, ensuring uniform care and respect for their survival and growth. This embodies the essence of modern societal equality. Although the value pursuit of “equality” has existed since ancient times, the connotation of equality is not eternal. According to Friedrich Engels, the meaning of equality is constantly changing with the development of history (Marx & Engels, 1871/1883). Currently, this concept of Equality in the modern sense has become something natural and self-evident.

### The Origins of Inequality Social System

In the natural state, there is no mind interaction between people, and they do not affect each other in their respective worlds. In Rousseau's work *Discourse on the Origin and Basis of Inequality Among Men*, there is such a point of view that from the time a person needs the help of others, it is beneficial to feel that he has two people's food. From then on, equality between people does not exist (Jean-Jacques Rousseau, 1712). And this view can also find evidence support in the study of history. Researchers at Washington State University and 13 other institutions have found that the arc of prehistory bends towards economic inequality.

Through Rousseau's views and historical research, we seem could think that social inequality stems from human needs for more and a stable source of living materials or wealth, and that one manifestation of this demand is the degree of the complexity of human society keep increasing. The origins of social inequality are complex. On the other hand, the smooth operation of the system requires group members to adhere to a common code of conduct. Morality as a code of conduct can play a role in maintaining the system. The level of morality also affects the views of group members on inequalities. From this we can see that the two elements of technology and morality are closely related to social inequalities.

### Social inequality and Technology

In the previous section we analyzed the causes of social inequality, and in this part we explored what is the role of technology in the development of social inequality systems. When the technology practitioners shouted “make the world a better place,” did the world really get better? The international non-governmental organization Oxfam, published on January 18, 2016, stated that the world's richest 1% of the population has more wealth than the remaining 99%, and in 2010 the world's half of the world's poorest 3.6 billion people It is equivalent to the wealth of the richest 388 people, 159 in 2012, 80 in 2014, and 62 in 2015... (Oxfam Briefing paper, 2016). However, when wealth is accumulating, is the share of each person's share fair? The famous physicist Hawking warned in October 2015: “The outcome will depend on how things are distributed. Everyone can enjoy a life of luxurious leisure if the machine-produced wealth is shared, or most people can end up miserably poor if the machine-owners successfully lobby against wealth redistribution.” (Bolton & Doug, 2015)

So, is technology really a demon that exacerbates poverty? Economists do believe that technology plays an important role in getting rid of poverty. In the well-known Solow-Swan model of macroeconomics, the rate of technological progress is an important factor in economic development. The higher the productivity, the faster the economy develops.

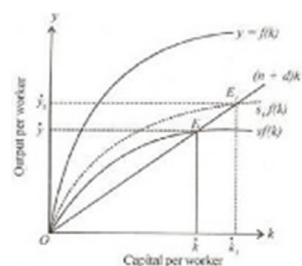
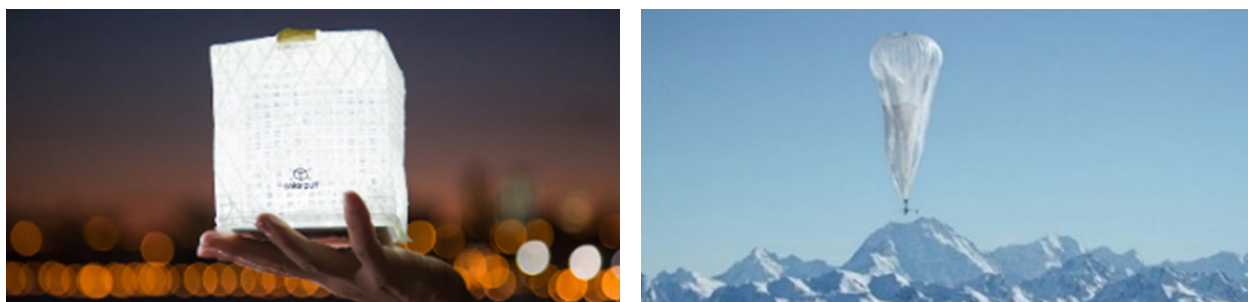


Figure 1. Solow-Swan model

The advancement of science and technology has also brought about an increase in Total social wealth and improvement. The living conditions of human beings. The United Nations released the Millennium Development Goals Report 2015 in July 2015. It shows That the number of people living in extreme poverty has dropped from 1.9 billion in 1990 to 836 million in 2015, and the number of extremely poor people has been halved. The under-five mortality rate has fallen by more than half and the maternal mortality rate Has fallen by 45%. In 2015, 91% of the world' s population had access to improved drinking water sources, which was 76% in 1999 (United Nations, 2015). In addition to the various types of data we can read in various reports, in fact, many techniques teams are working to improve the lives of people in underdeveloped areas and reduce various types of social inequality. At present, 1.4 billion people around the world do not have access to electricity, and the GravityLight team invented the electric light generated by gravity, which cost less than five dollars. In 2015, Panasonic launched a portable solar cell for poor areas. Team Solight launched the more lightweight SolarPuff this year, a folding solar light. There is no network in poverty-stricken areas, and the Google Balloon Project will release nitrogen balloons with precision instruments such as solar cells, network receivers, and height controllers, bringing network connectivity to poor areas, enabling people to use the network more Affordable. reduce the negative impact of information inequality.



**Figure 2.** SolarPuff and Google Loon Project

Obviously, social inequality has existed before technology emerged. There are many reasons for social inequality, eliminating inequality can' t only relying on technological advancement alone. Bringing these cutting-edge scientific research to the places most needed in the world is more meaningful.

### Social inequality and Morality

In fact, social inequality is not just a matter of resources and wealth. As mentioned above, the increase in the total amount of resource wealth alone will reduce social inequality, most of times because of the unequal redistribution system which increase the degree of social inequality. In addition to the material progress like science, technology and economic progress, social progress is also related to people' s inner world. In short, it is people' s perception and practice of morality. Morality can play a positive and negative role in social inequity, but it should be noted that eliminating or reducing social inequality is a complex problem, relying solely on the power of morality cannot accomplish this arduous task. The power of science and technology cannot be ignored when solving this huge problem. Guang Zhong, a politician in China during the Spring and Autumn Period, said: "Up her barns solid and know etiquette, well fed, well bred." (Guang Zhong, 2009) When people do not need to worry about basic food and clothing, the moral level of society can be improved accordingly. Therefore, we have reason to believe that with the development of technology and morality, social inequality can be reduced.

## **Technology and Morality, two elements closely related to social inequalities**

The unique significance of technology for humans

“Relying on tools” awareness is produced by breakthrough (Jane Goodall Institute, 2013). It brings the directivity progress for tools and human body structure change, make the human body structure adaptation tools and culture. The separation of humans from other primates is the separation of the sense of tool behavior. The consciousness of “relying on tools” produces directional changes in the structure of the human body, gradually forming the structure of erect humans and modern people. That is to say, the: “relying on tool or technology” has made human beings human. In addition, “Relying on tools” awareness of human has great significance for the artificial intelligence industry. Artificial intelligence has great potential, which makes it possible to greatly improve productivity and bring a better life to human beings. On the other hand, the powerful potential of artificial intelligence is also daunting. Concerning the dangers of artificial intelligence is also increasing day by day. However, because of the existence of “Relying on tools” awareness, we have reason to believe that human beings will not give up or stop developing because of the dangers at hand. Instead, because artificial intelligence is a powerful tool, human beings will overcome various difficulties to promote, and keep developing the artificial intelligence industry.

Why human morality is unique

There are many opinions that morality is not unique to humans, because a large number of altruistic or mutual help behaviors can be observed in other animal groups other than humans. They believe that morality is the mutually beneficial behavior that originated from these social animals or human ancestors. Fundamentally, the essence of these mutually beneficial behaviors It is for each Animal individual to have more opportunities for survival and reproduction, and when we extend these behaviors to humans we call it morality.

Behaviorally speaking, the altruistic behavior in animal groups is more biased towards a survival strategy. It is sporadic, and there is no persistence in the process of evolution, but human altruism adds cultural factors in addition to purely beneficial considerations, such as the consideration of “good” and “evil” and the judgment of ethical behavior in the same social group clearly have roughly the same standards, and from now and past, both in the Eastern and in the Western culture. There are praise for self-sacrificing behavior.

How technology and morality affect each other

Scientific activities are not a “pure” activity process involving only scientific facts and scientific goals, but a rich moral connotation. The moral principles, norms and concepts formed in scientific activities have greatly improved and enriched the human morality system. In some sub-sectors, the advancement and promotion of the moral system by scientific and technological progress cannot be ignored, for example, in the medical world, although the original Hippocratic Oath is no longer used, it has no legal effect, but as a spiritual contract recognized by the medical community, The Hippocratic Oath still has an impact on the modern vow. It can be seen that the development of science and technology not only promotes the emergence of other social professional ethics, but also forms all of its own professional ethics, which greatly expands the research field of morality. The values of humanitarianism should also be taken into account when doing scientific research. Only then can science and technology not become purely technical problems, but can also be given more intrinsic value, reflecting human dignity. Science is guiding the advancement of society, and the development and advancement of science and technology requires sufficient ethical and moral incentives.

By understanding the interrelationship between technology and morality, we have reason to believe that like any advanced technology in the past, artificial intelligence as a representative of the current advanced technology will also greatly promote the development of productivity, and the resulting social changes will lead to an improvement in the moral system. From this point of view, relying on artificial intelligence to reduce social inequalities is possible.

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### Artificial Intelligence and design

What is artificial intelligence technology?

Artificial intelligence, often abbreviated as AI. the word is made of two words. The word artificial is easy to understand and is defined in the dictionary as used or produced by a human and especially social or political agency. However, the intelligence is indeed more complicated. Here we use the definition from “Mainstream Science on Intelligence” (1994), “A very general mental capability that, among other things, depending the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and Learn from experience. It is not only book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—” catching on,” “making sense” of things, or “Figuring out” what to do.” (Gottfredson & Linda S, 1994) So, in simple terms, AI is a program or machine created by humans that can do the above.

How artificial intelligence can affect design process and productivity?

If we want to explore how AI can affect the design working process, we have to analyze both of the advantages and disadvantage of AI. Firstly, artificial intelligence, as software running on hardware, is tireless; it can work continuously 24 hours a day. At the same time, compared to humans, AI is more precise in its work, and its processing speed for data far exceeds the capabilities of humans. Therefore, artificial intelligence can bring significant improvements in design efficiency and productivity. Additionally, AI's powerful data collection and processing capabilities give it another advantage, the possibility of global optimization. In simple terms, the application of artificial intelligence can greatly enhance productivity, help us make design decisions faster and better, assist various disciplines in better development, and directly or indirectly make our lives better.

However, everything has two sides. Like any technological innovation in history, the development of artificial intelligence has brought fear to many people and has also generated a lot of opposition. Stephen Hawking said: "The development of full artificial intelligence could spell the end of the human race.” (Rory Cellan-Jones, 2014) Automation equipment is directly responsible for the continued increase in unemployment, it is undeniable that the widespread use of computer-controlled devices is one of the reasons for the continued increase in the number of unemployed. In this regard, Erik Brynjolfsson and Andrew McAfee believe that the development of digital technology has weakened the close link between GDP and employment (Erik Brynjolfsson & Andrew McAfee, 2012). Specifically, the arrival of the AI era has brought about not only new design workflows and new modes of thinking but also an impact on the labor force involved in real-life design and production. The automation and

computational processes brought by artificial intelligence are poised to replace a significant amount of repetitive and mechanical labor. This could potentially lead to a severe polarization in future employment structures, exacerbating societal inequality.

In summary, the development of artificial intelligence is a double-edged sword. While it can enhance design efficiency, optimize design outcomes, and improve societal productivity, it also carries certain risks from a societal perspective.

Why designer should embrace artificial intelligence?

By analyzing the advantage and disadvantages of AI, we could take the advantages of AI and potentially avoid the disadvantages. If we keep the eye on the use of AI in Design field, it do brings significant benefits. From the perspective of creativity generation, AI can serve as a valuable tool for designers to boost their creativity, which could extend the imagination of human brain; from the perspective of efficiency and productivity, AI can automate repetitive and time-consuming assignments; from the perspective of prototyping and testing, AI can assist in creating digital prototypes and conducting simulations, enabling designers to test and refine their ideas before committing to physical production. This reduces the risk of wasting time and resources; from the perspective of competitive advantage, embracing AI can give designers a competitive edge in their field. As AI becomes increasingly prevalent in various industries, designer who a proficient in AI tools and techniques are in high demand. As Landon Winner said, “Technologies are not directly aids to human. Activity, but also powerful forces acting to reshape that activity and its meaning.” (Langdon Winner, 2010) The most important thing is how we take the advantage of the AI tool.

In conclusion, embracing AI can empower designers to be more creative, efficient, and informed their work, ultimately leading to better design outcomes and a competitive edge in the rapidly evolving design landscape.

Why design should be integrated with artificial intelligence?

Humans' unique "relying on tools" awareness makes us different from other species, and in addition to physical tools, tools in the sense of thought also play an important role. Modern design originated from the Arts and Crafts Movement in the 19th century. In the long process of design development, design has gradually expanded from the scope of arts and crafts to become an important thinking tool for human beings to recognize and transform the world. Zhou Zhi, a professor at Tsinghua University, said that the ultimate point of design is not just formal aesthetics, but is constantly enriched and expanded with the development of the times(Zhou Zhi, 2019). So we can see that new design disciplines such as innovative design, discursive design, and social design continue to emerge. The purpose of design has changed from simply "making things" to "solving problems" in a broader sense, and designers are a group of people who rely on this tool of thought to carry out practical activities.

Wang Yangming, a Chinese thinker of the Ming Dynasty, put forward the idea of “the unity of knowledge and action” , believing that the unity of thought and action can enable people to gain moral wisdom (Jiang Yishan, 2019). Therefore, in order to achieve the ambitious goal of solving or reducing social inequality, it is necessary to closely combine the physical tool of "artificial intelligence" with the thinking tool of "design".



## Conclusion

In the first chapter, we first explored the unique “relying on tools” awareness of human beings, explaining why humans can stand out from other animals that also use tools. Secondly, we explore the unique moral system of human beings, and the relationship between morality and technology, sometimes they play a negative role to each other, sometimes they promote each other’s development. In the second chapter, we focus on social inequality and explore the origins of inequality. From the source, the social inequality originates from the needs of the early human population for more living materials or wealth with stable source. With the development of science and technology, social productivity and human living conditions are constantly improving, social structure is constantly changing, and the moral system is constantly challenging and adapting to the development of the times. In the third chapter, we analyze the working principle of artificial intelligence, its advantages and how will it beneficial design. At the same time, the social crisis that the technological revolution may bring also cannot be underestimated, but we can see solutions to crisis is exist, and governments and civil society are constantly striving to eliminate the negative effects of the technological revolution.

In general, the “relying on tool” awareness engraved in human genes makes it unlikely that we will reject the advancement of technology and the development of the times, and with artificial intelligence beginning to take place of human to take more labor and intellectual work, human beings can get enough time, energy and resources to engage in design, a future-oriented innovation activities. In this process, the social moral system will continue to self-adjust, and some social inequalities that are developed by the inadequacy of the times and material resources will gradually disappear. Therefore, we have reason to believe that with the development and application of artificial intelligence, social inequality will be reduced, and humanity will usher in a better future.

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## **Perceived Value of Design Thinking tools and Future of Design Education: A Case Study of Xi' an Jiaotong-Liverpool University**

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### **Abstract**

Design Thinking is gaining popularity in teaching practice. Despite the literature review showing a high degree of interest in the topic, there is a gap concerning how university students of design disciplines perceive Design Thinking (DT) tools in their learning experience. This article provides insights on this question by sharing the results of a survey conducted at Xi' an Jiaotong-Liverpool University as a case study. The findings indicate room for improvement in teaching, as the research identified the most challenging design tasks perceived by the students and the reasons why these tasks are challenging. The article will discuss the relationship between creative confidence and perceived difficulties in design stages, tasks, and DT tools. The findings supported by the literature review suggest that DT might be an insufficient methodology for creative achievements. The article will contribute to the track Foresight Plan by indicating a direction for future research that will allow us better adapt design education and support students' needs in current and future design challenges.

### **Author keywords**

Design Thinking tools, Design Education, Design Process, Students' Perception

### **Introduction**

Design educators more and more often reference and apply Design Thinking in their teaching practice (Dell' Era et al., 2020; Micheli, 2019). Xi' an Jiaotong-Liverpool University (XJTLU) is not an exception. This article will present the students' learning experience at the Design School at XJTLU as a case study. Design thinking is a holistic approach to innovation that gained popularity in the business environment thanks to its universality and it allows anyone seeking innovation to practice it (Dell' Era et al., 2020). Various authors and schools described the Design Thinking model as a tool for business innovation. The article "Comparative Framework of Models of Design Thinking Process" (2020) highlights the following models as the most representative: the one described by Tim Brown (2008, 2009) for IDEO, the version developed by the Institute of Design at Stanford (2010), the model by Liedtka (2015) for the Darden Business School, and Lockwood (2009) for the Design Management Institute. Despite differences in how the process is described, it is commonly organized into stages that lead to innovation (Silva et al., 2020). Each stage has some tools facilitating the process, helping the design team progress and achieve results. Examples include such tools as "Persona", "Empathy Map", "User Journey", and more. In this article, Design Thinking tools are at the focus of the study. Despite the popularity of Design Thinking among design educators, the current literature review has identified a gap concerning how design students at universities perceive Design Thinking tools. The research on Web of Science using the keywords "design thinking", "perception", and "design students" in the publication years 2019-2023 in the field of Educational research revealed 828 results. However, only 16 were related to the mentioned question in one way or another. Similar research in Google Scholar showed 20k results, with few related in some way to the research

question. Those relevant research pieces assess Design Thinking and its impact on students' creativity in various fields. For instance, the use of Design Thinking by architecture students (Taneri & Dogan, 2021), engineering students (Clark et al., 2020; Rodriguez et al., 2020; Xu et al., 2023), science students (Noh & Hyeok, 2021), Design Thinking taught in STEM education (Li et al., 2019), entrepreneurial education (Lynch, 2021; Sarooghi, 2019), and in health professions (McLaughlin et al., 2019; Farrar, 2020; Park et al, 2022; Padagas, 2021), or by the school-level students (Ladachart et al., 2022; Rao 2020; Latorre-Coscolluela, 2020, Varanasi, 2023). Several articles discuss Design Thinking from teachers' perspectives (Baran & AlZoubi, 2023; Bressler & Annetta, 2022; Gunter & Kenny, 2021; Retna, 2019; Woo & Sil, 2021). Overall, it shows a high degree of interest in the topic. Interestingly, there are no studies analyzing design students' perceived value and efficiency of Design Thinking and its tools in their learning experience, even though it is very typical to practice it. That is why there is a need to collect feedback from this methodology's direct recipients to fill the knowledge gap and potentially find room for improvements. This project aimed at contributing to filling the gap using XJTLU as a case study.

The research followed the Human-Centered Design approach (Norman, 1986 and 2010) and conducted primary research targeting UG and PG students of the Design School at XJTLU to get insights on the question. In particular, this article shares the results of a survey that collected data on students' perception of the Design Thinking tools in learning experiences at XJTLU and future jobs. The collected results will form the grounding for proposing more integrity and coordination in teaching and applying these tools at XJTLU. In the following paragraphs, the author will guide the reader through the methodology and discuss the results and conclusions.

## Methodology

To answer the research question of how design students perceive the value of Design Thinking and its tools in their learning experience, the author organized the research process following the Human-Centered Design approach. It means that the author placed the users (of the design tools) at the core of the research in order to identify their needs in the learning experience to find room for improvements in teaching. The users in this research were UG and PG students of the Design School at XJTLU. The Design School has four Departments: Industrial Design, Architecture, Civil Engineering, and Urban Planning. It was assumed that the Department of Industrial Design students would provide most of the data for this research. The Department of Industrial Design practices project-based learning, which means that almost all the modules, both taught modules and studio-based, require students to produce a design project, mainly following the Human-Centered Design approach. However, if interpreting the design process as planning and as "the culture of the project" (Julier, 2022, p. 213), we can expect many similarities in perception, interpretation, and application of the design methodologies by all the Departments mentioned above. Thus, the author prepared a survey published online to collect the data. The survey included bibliographic, multiple-choice, and open-ended questions, with a total of 25 questions. The survey was chosen as a medium as it helped obtain a holistic picture of how the Design School students perceive Design Thinking as part of their learning experience.

As mentioned in the introduction paragraph, Design Thinking is characterized by dividing the design process into stages that lead the design process toward innovation. Table 1 shows a comparative framework of models of the Design Thinking process (Silva et al., 2020):

**Table 1.** Comparative framework of models of Design Thinking process. Source: Silva et al., 2020.

<b>Design Thinking Model</b>	<b>Stages of innovation process</b>			
	Needs finding	Concept generation	Concept validation	Concept development
IDEO	Inspiration	Ideation	Ideation	-
d.school	Empathize and Define	Ideation	Prototype and Test	-
Darden School	What is	What if	What wows	What works
IBM	Observe	Reflect	Make	-
Continuum	Discover deep insights	Create	Make it real: prototype and test	Deploy
DMI	Understand and Observe	Conceptualize	Validate	Implement

These models are designed to serve businesses. In the educational environment, it may vary as teachers organize the design process concerning the expected learning outcomes or other factors that may transform the model in one way or another. The other difference is that students' works would typically reach the level of models and prototypes, which implies that the learning process would generally stop at the "Concept validation" stage. Keeping in mind these considerations as well as the local experience in the School, in preparation for the survey, the author focused the research on the following design phases:

**Table 2.** Design phases used in the survey. Source: author.

<b>Design Thinking Model</b>		<b>Stages of innovation process</b>			
-		Needs finding	Concept generation	Concept validation	Concept development
XJTLU Design School	Design	Secondary Research and Primary Research (User Needs)	Ideation	Testing (User Feedback)	-

The survey preparation involved several steps: writing the research plan, creating the list of questions, seeking approval from the University Ethics Committee, and publishing the survey online.

Considering the research question, the author hypothesized that the students might depreciate the value of the Design Thinking tools due to a lack of confidence in understanding the meaning and purpose of such tools and, thus, in conducting design activities. Therefore, the purpose was to test this hypothesis through multiple-choice questions where students could select from answers depicting different degrees of their knowledge and confidence in relation to the design stage. In addition, the survey included questions where students needed to write lists of design tools related to a specific design stage or task (e.g., identifying user needs or generating ideas). Additional questions asked whether the students appreciate the value of such design methodologies in

developing their projects in the university or future jobs. Ultimately, the expected result was to identify the design phase/activity where students feel most and less confident about what they should do, how, and why.

The invitations to participate were distributed throughout internal University channels (e.g., emails, internal Learning and Teaching platform). The participation was anonymous, and the collected data was stored online and on a private device under a password.

The author chose content analysis to analyze data collected via the survey. The analysis of the multiple-choice questions allowed observing quantitative dynamics in answers. In particular, the purpose was to quantify the occurrence of certain answers (e.g., degrees of confidence in relation to the design phase or activity). Open-ended questions aimed at exploring students' opinions that may go beyond the hypothesis.

In the next paragraph, the author will report and discuss the survey results.

## Results

The total number of respondents was 47, all non-native English speakers: UG and PG students from the Design School. Students had to express their degree of confidence in relation to the design stages, as mentioned in the Methodology paragraph. Also, they had to name some design tools and methods they usually use in those stages. There were identical options they could choose as an answer for each design phase, starting from the most confident to the less confident option. The hypothesis was that students might depreciate the value of the Design Thinking tools due to a lack of confidence in understanding the meaning and purpose of such tools and, thus, in conducting design activities. However, the results show that students feel confident about the design tools as a part of the design process. The summary percentage of answers showing students' confidence is:

- Secondary Research – 80% of the respondents reported that they know what to do in this design phase,
- Primary Research – 78%,
- Ideation – 72%,
- Testing – 70%.

When naming the tools, students would often write “internet” , “interview” , “software” , and other generic words. Nonetheless, they have provided quite a long list of tools that cannot be reported here due to constraints 38 different design tools for Secondary Research,

- 20 for Primary Research,
- 35 for Ideation
- 9 for Testing.

From these numbers, we can see that students would approach “Secondary research” and “Ideation” with a greater variety of design tools and methods. At the same time, “Testing” is only limited to 9 design tools.

The students were also given a list to pick the design tools they had heard about and know them. The list was built based on the design tools frequently taught by the Department of Industrial Design colleagues. Design tools reported as most familiar were (descending popularity):

- Mind Map (85% of the respondents),
- Interview (81%),
- Brainstorm (81%).

Many other tools, including some popular design tools such as “Empathy Map” , “Affinity Diagram” and “Analogous Inspiration” received little recognition (below 20%).

One of the expected results of this study was to identify the design phase or activity where students feel most and less confident in terms of what they should do, how, and why. When answering the relevant question, students reported as most challenging design tasks the following:

- “Collecting data from users” (43% of the respondents),
- “Synthesizing the findings into a clear picture” (43%),
- “Coming up with interesting ideas” (49%),
- “Proceed from ‘thinking’ and ‘discussing’ to acting and developing the project” (43%), Mentioning “I don’t know how to start” and “lack of relevant examples” as reasons for their difficulties. Other design tasks in the survey that received fewer points were “research on the Internet”, “finding books/articles”, “identifying users/target audience”, “explaining my findings to others”, and “collaborating and communicating with peers”. In the next paragraph, we will further discuss the results in relation to the previous studies, mention the limitations of the Research, and indicate future work.

## Discussion and conclusions

The research on students’ opinions of our Design School has identified four groups of findings that can be discussed in this paragraph:

- The four most challenging design tasks as perceived by the students;
- Reasons for why these tasks are challenging as perceived by the students;
- The overall degree of confidence in relation to each design stage;
- Students’ vocabulary concerning the design tools and design stages.

As explained in the methodology paragraph, the survey was organized according to the following design stages: Secondary Research, Primary Research (User Needs), Ideation, and Testing (User Feedback). Students had to respond to various questions reflecting their degree of confidence in each design stage, their knowledge about the design tools suitable to solve relevant design tasks or the difficulties they meet throughout the learning process.

The research identified the four most challenging design tasks as perceived by the students: collecting data from users, synthesizing the findings into a clear picture, coming up with interesting ideas, proceed from thinking to developing the project. Students pointed out that a lack of understanding of how to begin the task and the lack of examples are the key reasons for their challenges.

We can infer that the knowledge related to the design tools should be organized according to the design stages and steps and presented to the students in a structured, visually intuitive, interactive manner that would allow them to easily configure the toolset for every design task, such as, e.g., ideation. The efforts of teachers in assisting students should be placed at the beginning of each task and supported with examples. The importance of introducing design steps as a vital part of the learning process is supported by Taneri and Dogan (2021) in their study on the perception of the design process by architecture students. In particular, they found that one of the reasons why students feel frustrated with learning at a school how to design was due to the focus of the design studio on designing products rather than learning design steps or processes. Kavousi, Miller, and Alexander (2019), in their article “Modelling Metacognition in Design Thinking and Design Making,” refer to the work of Powers (2017), stating that the open-ended nature of design can “make its learning confusing and frustrating, especially for design students, which in turn, can reduce their motivation and willingness to engage”. They argue that metacognition can help students overcome this problem, especially in the ideation phase.



On the other hand, in their famous book, David and Tom Kelley state that confidence is the factor that supports creative thought and helps turn ideas into reality (2013). Beghetto, Karwowski, and Reiter-Palmon's (2021) work studies the relationship between creative confidence and creative behavior. Their findings show modest correlations between creative confidence and creative achievements. Similarly, the survey results conducted in our Design School support these findings: students reported quite a high degree of confidence and, at the same time, challenges in ideation and moving "from thinking to action" and realizing their projects. The same study by Beghetto et al. argues that the willingness to take intellectual risks enhances the link between creative confidence and creative behavior. Thus, we can observe that the research on the success factors in creativity continues and proposes different strategies, besides Design Thinking, to stabilize creative achievements, e.g., through metacognition or willingness to take intellectual risks. Such direction as exploring methods and strategies to support students in ideation and project realization could be taken for further research.

Design Thinking is a well-recognized methodology for developing creative confidence, and we as teachers often refer to that and its facilitating design tools when organizing the educational process. Students identified "collecting data from users" as challenging, and the overall perceived confidence did not help them in this task. Interestingly, students did not mention "identifying users" as challenging. Again, we can observe a perceived obstacle between thinking and making, which supports the idea of the necessity of further research on the strategies that lead toward creative behavior and achievements.

The difficulty factors may be inferred as follows:

- Lack of accessibility to the relevant users,
- Lack of confidence prevents students from interacting with the users.

To facilitate collecting data from users, the School could employ research and industry collaborations with strategically relevant stakeholders to engage them in the design projects to provide situational expert feedback on the matter. The universities often receive a critique that the skills students obtain during their studies need to match the expectations of the industry. To address this issue, and not only, XJTLU launched a new educational model called Syntegrative Education that implies a strong collaboration between the academy and industry to develop educational programs. Standing at the very beginning of this process, we can envision how to apply this educational model to the design discipline. For instance, we could engage our partners from industry, culture, etc., to develop design briefs and, therefore, closely collaborate on the different stages of the design process. One of such stages relates to collecting data from users, and the "users" could be the industrial partners and their clients. Through the continuous feedback from the industry, we can faster adapt to the constantly changing technological, economic, and market demands and support students with structured and regulated access to the users and knowledge.

Eventually, let us discuss this research's final group of findings on students' vocabulary concerning the design tools and stages. As was mentioned in the introduction, design educators more and more often reference and apply Design Thinking in their teaching practice (Dell' Era et al., 2020; Micheli, 2018). In parallel, design models, methods, and tools have multiplied significantly in quantity in recent decades. Some websites have open-access resources dedicated to design process and facilitating tools, for example, [www.interaction-design.org](http://www.interaction-design.org), [www.designcouncil.org.uk](http://www.designcouncil.org.uk), [dschool.stanford.edu](http://dschool.stanford.edu), [designkit.org](http://designkit.org), [servicedesigntools.org](http://servicedesigntools.org), [thisisservicedesigndoing.com](http://thisisservicedesigndoing.com).

The first formula of the creative process was proposed in 1926 by Graham Wallas, who emphasized that an idea comes unexpectedly but only after preparation and focused thinking of a problem (Wallas, 2014, republished). Starting from there, design researchers focused on enhancing the efficiency of thinking. The interest increased

with the world's growing complexity, where simple drawing and model-making techniques were not enough to address wicked problems, and more models started to appear (Jones, 1992 (second edition from the 70s); Buchanan, 1992; Norman, 2010). By 2004, in the work of Dubberly Hugh, "How do you Design? A compendium of Models." , we can find over 80 design process models. Today, many Ph.D. dissertations in Design disciplines have as outcomes new design methodologies, tools, canvases, and more. Educators adapt the existing methods and develop new ones that would better fit their needs in teaching. It is relatively common for the same concept or principle to use different words for its description and naming. Such a plurality of names of the design tools may result in poor memory in learning them, which can be of interest for further research. Learning the students' vocabulary could be helpful in teaching activities and the development of teaching materials. It may be worth developing a resource for students, such as a manual or a website, that would organize the existing design tools according to the principles of their use and application in each design stage and thus shift the focus from the tools' names to the working principle, e.g., "analytical tools."

To sum up, based on the conducted literature review, the survey, and the analysis, the author would like to write down the three directions for further research that would positively contribute to the design education:

1. Research new/other methodologies and strategies to implement in teaching and enhance creative behavior and achievements.
2. Explore opportunities for engaging University partners, such as industrial partners, in collaboration on the design projects to support the educational process with expert feedback and better adapt to constant technological and economic changes and market demands.
3. Build a vocabulary and systemize the design tools according to their working principle and the relevant design stage to improve learnability.

In his article "Changing Design Education for the 21 Century," Don Norman discusses skills required for different challenges addressed by design. He mentions Human-Centered Design and DT tools, teamwork, management, and leadership as the most necessary. Through thorough research, as described in the three points above, we hope to develop an approach to learning these complex skills and making steps toward future education in design.

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# **Picturing A Utopian Countryside: The Rural Settlement Recomposition Framed by the Urban-rural Continuum**

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## **Abstract**

It has become the mission of contemporary Chinese cities to break the long-standing dichotomy between urban and rural areas and establish a harmonious urban-rural human settlement full of love. Coincidentally with the idea, the urban-rural continuum defines this stable state of urban-rural integration. This article takes the urban-rural continuum as a theoretical derivation, aiming to depict a harmonious and cohesive future rural life picture. By interpreting the enlightenments of the urban-rural continuum, the article puts forward the idea of reshaping rural settlements based on the framework under the urban-rural continuum. The article proposes three prototypes of the future urban-rural settlements revived from the local culture and fully transformed to build a utopian urban-rural community full of warmth and care.

## **Author keywords**

Social equality; The urban-rural continuum; Settlement recomposition; Rural revitalization; Utopia; Countryside

## **Introduction**

The United Nations' 2030 Sustainable Development Goals Agenda—issues such as poverty, social inequality, climate change, and environmental degradation—pose challenges to the development of human societies worldwide (Persaud & Dagher, 2021). In contemporary China, people's demand for a better life contrasts sharply with the unbalanced and insufficient rural development. "Chinese modernization" has brought rural revitalization to a new orientation (L. Wang, 2021). Eliminating social inequality, healing and transforming rural areas with Chinese characteristics, and creating a new type of rural community full of harmony, tolerance, environmental friendliness, equality, and justice has become the mission of the times for Chinese designers. For this reason, the urban-rural continuum uses historical laws to repair the unbalanced urban-rural gap, trying to build an urban-rural community that transcends history and reality, and provides a path for creating an ideal community that blends rural and urban features in the future.

## **The blurred urban-rural boundaries resulting from the urban-rural mutual stimulation**

Urbanization has led to the disappearance of the boundaries between urban and rural areas, and the urban-rural dual structure is disintegrating. Terry McGee, a scholar from University of British Columbia, named this regional urbanization phenomenon in rural areas with the Indonesian compound word Desakota (McGee, 1998; Ginsburg, Koppel, & McGee, 1991), which means "village (Desa)-city (Kota)."

Such an urban-rural mixed state, similar to Desakota, has also appeared in Chinese cities' urban-rural border under the rapid urbanization process. The city's high-speed absorption of the countryside does not fully cover the quality of upgrading rural settlements, and therefore there emerge urban villages—residential areas that are enclosed by the city but retain rural essence in terms of social nature (See Figure 1a). The vast rich-poor gulf makes these areas lag far behind the surrounding urban development and gradually decline into urban slums (Zhang & Zhao, 2007).

However, the impact of the urban-rural boundary is not a one-way expansion from the city to the countryside but also the phenomenon of reverse penetration from the countryside to the city. In response to the necessary intervention in the global ecological and food crisis, the city begins reclamation and recultivation and re-exported agricultural land to the city, forming a blend of the urban-rural landscape at the city's peripheries (See Figure 1b).

The countryside is a pure land for contemporary recall of Chinese traditional history and culture, and it has also been gifted as a spiritual home for people to escape from urban life, pursue differences and individuality, and return to nature (Y. Wang & Li, 2016). The boundary between the city and the countryside is becoming increasingly blurred, and the urban and the rural will eventually move towards a post-urbanization equilibrium (Westlund, 2014). The new societal structure has resulted in a new spatial logic (Bolchover & Lin, 2013). The changing urban-rural relationship is redefining the architecture, planning, and design related to rural issues.



**Figure 1.** The epitomes of the urban-rural blending in Chinese cities. Source: Internet <http://news.ifeng.com/50472359/news.shtml?&back#imgnum=1>, [https://www.hangzhou.gov.cn/art/2023/3/28/art\\_1229633756\\_59077260.html](https://www.hangzhou.gov.cn/art/2023/3/28/art_1229633756_59077260.html)

### **China's urban-rural continuum, not only a mix status but an invisible connection network**

The urban-rural continuum became “Chinese Desakota,” which scholars proposed to explain the concept of China's urban-rural development structure. It is considered a model neither rural nor urban but a combination of the two, a state of mixed rural and urban areas with indistinguishable boundaries (Guldin, 2001).

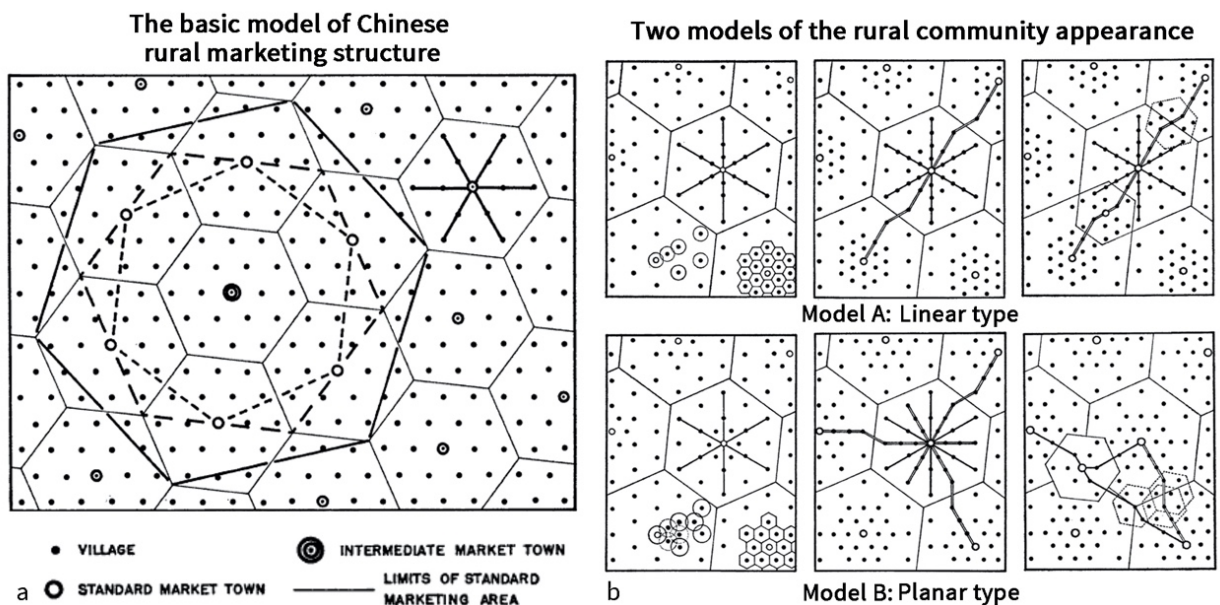
In addition, as early as the 1930s, American scholar William Skinner described the urban-rural continuum of Chinese rural society as a borderless but economically and functionally interconnecting city and village (Skinner & Baker, 1977). This connection reveals the urban-rural unity of traditional clans, kinship, and blood ties. At each town level, there were yamen (government), zumiao (ancestral hall), xuegong (school), and temples, uniting urban and rural areas in a top-down and bottom-up manner. These institutions were public and geographically coupled with the market towns.



Skinner put forward a theoretical model for the standard market hierarchy in China's rural areas by investigating the traditional rural areas in China and described the structural state of the urban-rural continuum combined with the theory of polycentric places. A basic stable hexagon represents a small rural community with 18 villages evenly distributed around a central standard market town. Superior conditions can turn the standard market town into a more advanced intermediate and even central market town, with its accordingly-upgraded service scope and level. At the same time, adjacent market towns have different market days and activities to facilitate people choosing optional dates to take different life activities, invisibly forming another marketing structure (See Figure 2a) (Skinner, 1964).

Based on the principle model, the formation of villages and market communities is restricted by transportation costs and distances under different topographical conditions (Skinner, 1965). Two distribution patterns were drawn—planar (plain) with relatively fewer restrictions and linear (mountain) with relatively more restrictions, further affecting the overall spatial form of the urban-rural continuum structure (See Figure 2b). In plain areas, where the environmental conditions are relatively loose, rural settlements spread out based on the surface, and each settlement occupies a relatively average area of agricultural land. In contrast, settlement distribution in mountainous areas is the opposite, with a strip distribution based on valleys. Additionally, due to the influence of the cultivated land area, the distance between settlements is relatively large.

However, some scholars questioned Skinner's theory, believing that each region in his theory was too isolated and inconsistent with historical reality, and tried to revise his conclusions (Rozman, 1976; Rozelle, Huang, & Benziger, 2003; Sands & Myers, 1986). For us, the inspiration for Skinner's theory lies in its fundamental logic of emerging from the village to convey the method of community organization.



**Figure 2.** The models drawn from William Skinner's theory on the urban-rural continuum. Source: G William Skinner (1964,1985)



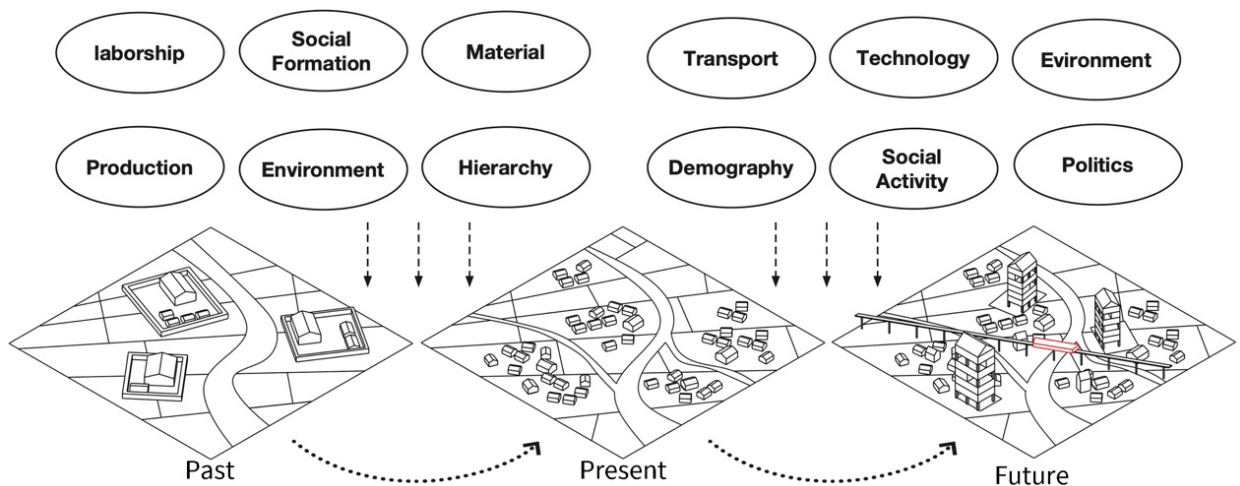
### The ideal design method transforming the urban-rural continuum

The urban-rural continuum theory is no longer a simple description of history, and it shows us an orderly intermingling relationship between the city and the village, an ideal utopian rural community organization framework, originating from the logic of the natural formation of human settlements (see Figure 3).

Skinner's theory shows that the scale of rural settlements in line with the anthropological laws is the basis for forming urban-rural stability and maintaining the healthy growth of villages. Although Skinner uses a hexagon as an ideal form to express, the scale of the hexagon model is different in actual geographical conditions, and the degree of population densification varies greatly. The relative distance between settlements and cultivated land area impacts the population. The four km walking distance becomes the yardstick for measuring the area of each community, whose distance can be bear to reach the market within one hour's walk.

The mutual dependence relationship between settlements helps to form a stable urban-rural continuum. In Skinner's theory, this interdependent relationship is reflected through "going to the market." Blood ties, beliefs, and ideological needs break down boundaries and link villages and market towns. The urban-rural continuum emphasizes not a single village but considers the whole influence between settlements. It activates each settlement from the roles of villages in the network from the perspectives of function, location, and scale. This connection is a continuous bidirectional exchange of elements through complementarity rather than a one-way flow of elements.

The settlement development is inseparable from the guarantee of transportation conditions. Skinner's theory emphasizes that transportation conditions determine whether a settlement can develop into a higher-level community form. Only villages with high transportation accessibility and low costs can provide the primary conditions for the healthy growth of settlements.



**Figure 3.** The transformation interpretation of the rural settlements. Source: Mao Lin (the first author)

Village connections are centered on communal architecture. Skinner's theory shows that markets, ancestral halls, yamen, academic palaces, and temples were integrated with the will of governance and the high solidarity degree of social beliefs. The commonality they share is the physical embodiment of the spiritual unity of the villagers.

### Morphological proposals to the utopian countryside image

When urban and rural landscapes blend, rural residents are equal to the urban, the way of life and work changes, people are no longer obsessed with urban agglomeration, the Internet removes geographical restrictions, and the countryside has complete living facilities, what will the countryside appear? In this regard, we propose three representative urban-rural continuum prototypes to describe the future rural landscape.

#### Plain Type – Scattered Settlements – Linpan settlements in Pidū, Chengdu, Sichuan

Linpan, a traditional residential form in which houses coexist with trees, is a typical settlement unit in the Chengdu Plain. The Dujiangyan irrigation system brought rich water resources to the Chengdu Plain, giving the land a relatively uniform distribution of scattered settlements under the flat geographical advantage. However, this scattered feature has contradicted contemporary suburban planning, causing a conflict between traditional style and centralized housing construction in Chengdu (Lin, 2021). Because the composition of Linpan accommodates natural elements, the salvation of the Linpan settlement is a response to the ecological crisis.

In this regard, to protect the cultivated land, we propose to establish an outside-in urban-rural continuum with the extension of the elevated monorail line, an environmental-friendly and avant-garde transportation tool, from the train station as the skeleton. Targeted densification of settlements is carried out around the stations, with the new set-up of various public buildings that meet the needs of rural residents and urban users. Dilapidated homesteads are upgraded to increase the residential density to meet the population of nostalgia. The picture presents a new type of community with both rural and urban characteristics (See Figure 4).



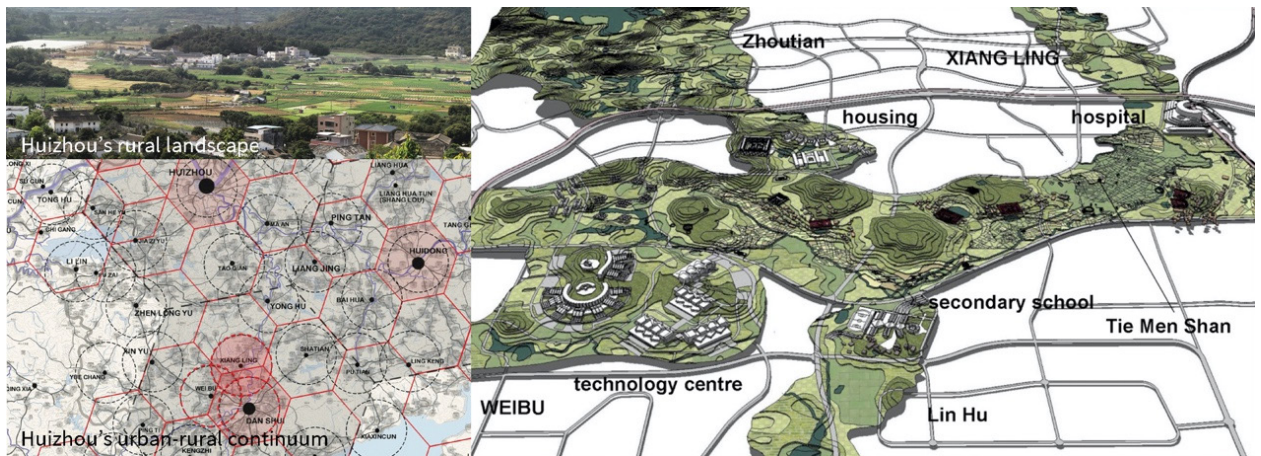
**Figure 4.** The human settlement design of Linpan. Source: Mao Lin (the first author)

#### Mountain type – Agglomeration Settlements – Hakka settlements in Huiyang, Guangdong

The mix of urban and rural areas in the coastal areas of Guangdong has become an ordinary cityscape. Different historical migrants group lived there, leaving their traditional agglomeration villages full of this area and causing the place a hybrid architectural vision. Due to the hilly and irregular terrain, traditional settlements, Tulou, Weiwu, and other Hakka traditional dwellings are intertwined with the cityscape (Meriggi, 2018).

Given the compact state of the urban-rural mix, we propose a rural upgrading model from the inside out by enhancing the basic service infrastructure. The village space to improve land use efficiency is densified by

using typology as the architectural design method to consolidate the connection of the inside traditional public buildings, which forms a new type of rural community with a perfect communal architecture medium as the framework by enhancing the endogenous power of the village (See Figure 5).



**Figure 5.** The human settlement design of Hakka settlement area. Source: Meriggi (2018, 2017)

#### Abnormity Types – Agglomeration Settlements – Taobao villages in Kandun, Zhejiang

Kandun Town is located in Cixi, a city near to Hangzhou Bay, where the government is rebuilding the area to support the economic strip from Shanghai to Hangzhou. The area forms linear rural settlements distributed along the artificial canal perpendicular to the coastline. In recent years, online e-commerce has become the pillar of the rural economy, and the small-scale cottage industry has been a main local characteristic from history to present (Fang, 2006). Filled with urban activities, Kandun has highlighted the characteristics of urbanization in villages. Kandun's geographical environment and industrial needs lead to an urban-rural continuum solution tailored to local conditions to reconcile urban planning in construction. We took the planned train station as the core, used the growth of the strip system to extend from the built-up space to the farmland, and transformed the low-level residential buildings into a supplement to the future high-density built-up area. Commercial space in the lower corridor was set up to provide joint production to accommodate overflow orders from cottage workshops. The strip space is the skeleton to compound the public space, which is the core of reorganizing the community groups (See Figure 6) (Meriggi, Chen, & Chu, 2022).





**Figure 5.** The human settlement design of Hakka settlement area. Source: Meriggi (2018, 2017)

## Conclusion

The urban-rural continuum theory expounds on the anthropological logic of traditional Chinese rural communities' organizational structure, revealing the secrets of the close connection between villages and urban settlements. It is not only an explanation of the law of historical development but also a utopian prototype for the future spatial form framework of rural settlements; it expresses a mixed state of urban and rural areas and an orderly connection between urban and rural hierarchy.

The specific recommendations of the UN-Habitat' s final draft of the Strategic Plan 2020-2025 for reducing spatial inequality and poverty in the urban-rural continuum are to enhance access to essential services, sustainable transportation, and public space, increase housing security, and consider long-term settlement growth and regeneration (UN-HABITAT, 2018), which coincides with the spiritual connotation shown in the ideal rural picture proposed under the framework of the urban-rural continuum. The urban-rural continuum provides a reference for the new design of a rural community in China. It reflects the past human settlements' trauma and transcendence of reality.

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## **Study on Elderly Mobility in the Digital Age — Research Report Based on 835 Elderly Residents from 7 Communities in Beijing**

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### **Abstract**

Since the 21st century, the aging population has been increasing, and the declining cognitive abilities of the elderly have prevented them from enjoying the convenience brought by the development of smart technologies, leading to negative emotions among the elderly. How to care for the elderly through design means and thus improve their quality of life will become a key factor in societal development.

Ride-hailing services have become a common mode of transportation in cities, but currently, only a minority of the elderly use these services. This research report focuses on elderly residents in Beijing, surveying 835 elderly individuals from 7 communities and 3 ride-hailing service companies to investigate the issues related to elderly people using ride-hailing services. Factors affecting the willingness of the elderly to use ride-hailing services were analyzed from three perspectives: ride-hailing policy relevance to the elderly, basic characteristics of the elderly population, and the elderly-friendliness of ride-hailing service technology. The study found that the implementation of policies relevant to elderly-friendly ride-hailing, the physical condition and education level of the elderly, and the elderly-friendliness of ride-hailing services were the three main influencing factors. In the recommendations section, it is suggested to increase the coverage and utilization of ride-hailing policies, enhance the elderly-friendliness of ride-hailing service design, and improve the user experience for elderly passengers.

Furthermore, efforts should be made to expand the reach of digital literacy training for the elderly, enhancing their digital skills to help them establish a sense of self-identity and social belonging.

This research report deeply analyzes the challenges faced by the elderly in using ride-hailing services, addresses barriers to service adoption, and through design means, cares for the elderly, creating an elderly-friendly transportation model that encourages the elderly to venture out of their homes and actively participate in social life.

### **Author keywords**

Aging, Digital Technology, Elderly Travel, Ride-Hailing, Age-Friendly Design

### **Mobility Challenges for Urban Elderly in the Digital Age**

Mobility is an integral aspect of elderly individuals' lives in urban settings. Data reveals that 35% of urban elderly residents travel distances of 3 to 5 kilometers on a daily basis, indicating a demand for medium to long-distance



transportation. However, a majority of elderly individuals still opt for traditional modes of transportation, such as walking. The main reason for their reluctance to use ride-hailing services is the barriers they encounter in accessing these services. Among elderly individuals who have attempted to use a smartphone to request a ride, only 20% can do so independently. Additionally, physical limitations prevent elderly individuals from enjoying the convenience offered by ride-hailing services [1]. Given these challenges, our research team has chosen ride-hailing services as the focal point of investigation. Through research, we aim to identify the obstacles faced by the elderly when using ride-hailing services, analyze the factors affecting their utilization of these services based on survey data, and subsequently provide recommendations for making ride-hailing services more elderly-friendly, thereby enhancing the quality of their travel experiences.

Our research team conducted interviews with 835 elderly residents from seven communities in Beijing to gain insights into the motivations and challenges faced by the elderly when using ride-hailing services. The research encompassed basic information and usage patterns among elderly residents, characteristics of elderly users of ride-hailing companies, and an examination of ride-hailing service policies.

### The Development Dilemma of Ride-Hailing Services for Elderly Residents in Beijing

**Policy Dilemma:** The policy framework for ride-hailing services for elderly individuals needs improvement.

Beijing has initiated the "Smart Elderly Assistance" campaign, and as of May 2023, 430 taxi pick-up stations across the city have been upgraded and transformed. These upgraded taxi pick-up stations now feature QR codes for elderly passengers to conveniently call nearby taxis using WeChat [2], as shown in Figure 1.



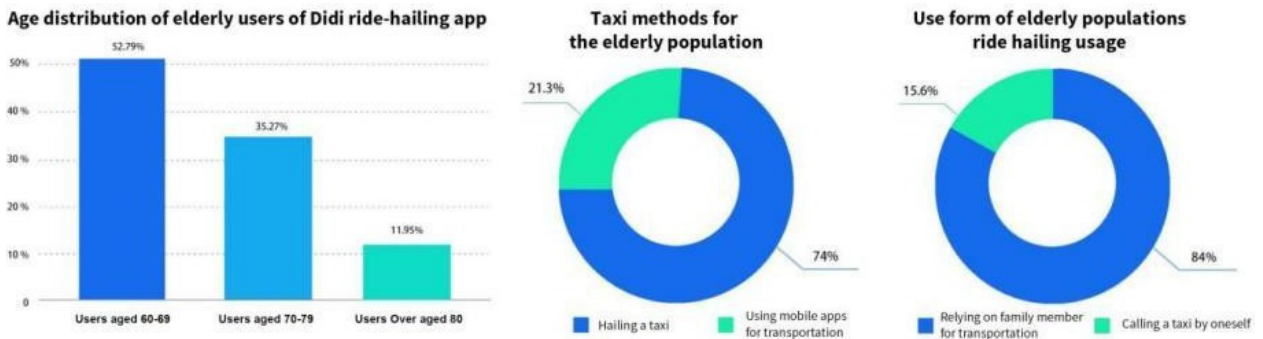
**Figure 1.** Implementation Status of Policies Related to Elderly Ride-Hailing Services.

Through on-site investigations, it was observed that there are few "Heartwarming Stations" in the vicinity of the communities, which many elderly individuals are not particularly aware of in their daily lives. The research team conducted random interviews with 10 elderly individuals and found that only two of them were aware of the existence of "Heartwarming Stations." Most elderly individuals are not familiar with services such as "One-Click Ride" designed to assist elderly travel, and they are unsure about how to access such travel policy benefits. Elderly individuals have limited channels for accessing information, and it is crucial for various government departments and enterprises to promote these new social welfare policies among the elderly community. This will raise awareness and ensure that elderly individuals enjoy improved travel services.

### individual Challenges: Characteristics and Issues of Interviewed Elderly Individuals' Mobility

In terms of the characteristics of elderly mobility, the significant decline in sensory capabilities such as vision, hearing, and touch poses substantial challenges for elderly individuals [3]. This often results in a relatively singular purpose for elderly travel. Through collaboration with Didi Chuxing, the research team obtained relevant data. Platform data indicates that elderly users have an average trip distance of approximately 7 kilometers, with

primary destinations being residential neighborhoods, shopping malls, and markets. Furthermore, the utilization rate of "Didi Senior Version" is not high. Among the interviewed elderly individuals, the majority (74%) still prefer hailing taxi on the roadside. Currently, the majority of elderly individuals using ride-hailing services still rely on their children or friends for assistance in booking rides, accounting for 84%, as shown in Figure 2.

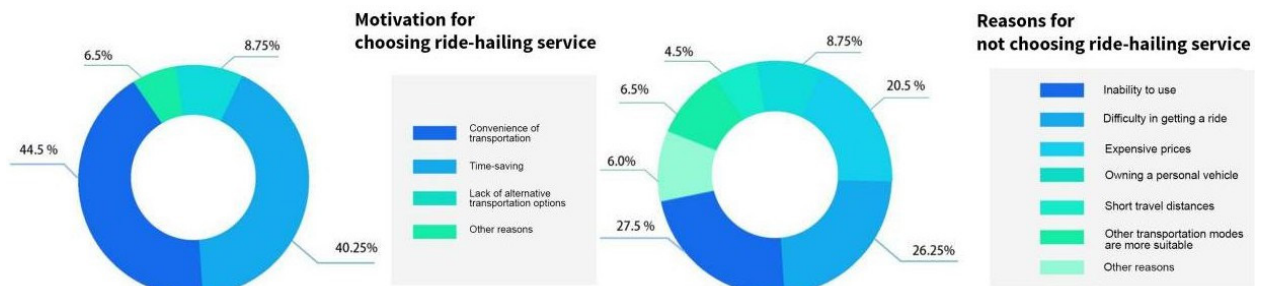


**Figure 2.** Data Related to Elderly Users of Ride-Hailing Software.

Additionally, the research team investigated the motivations behind elderly individuals' choice of ride-hailing services. Among elderly individuals willing to use ride-hailing services, comfort and convenience are the two main factors, as depicted in Figure 3. For those elderly individuals who are unwilling to use ride-hailing services, two significant factors are their lack of familiarity with ride-hailing apps and economic constraints.

From the data above, on the one hand, ride-hailing services have greatly facilitated elderly travel, but on the other hand, software usability barriers have limited elderly individuals from using ride-hailing services.

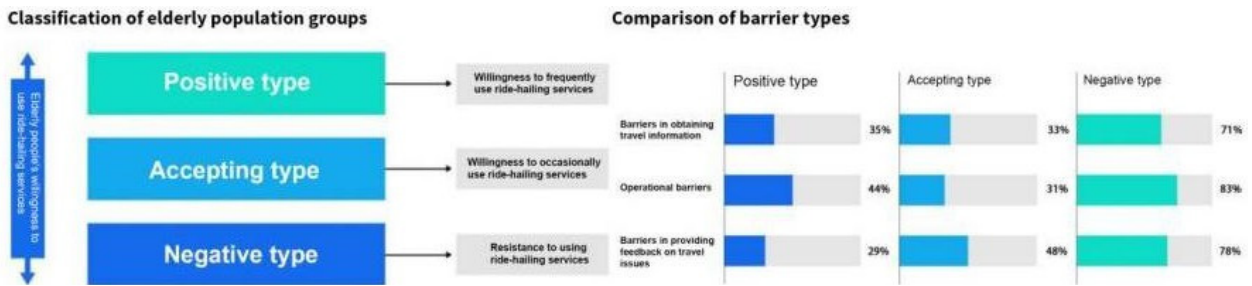
Technological Challenges: Analysis of Age-Friendly Design Issues in Ride-Hailing Services



**Figure 3.** Survey of Motivations for Elderly People Using Ride-Hailing Services.

Based on the differences in elderly residents' willingness to use ride-hailing services obtained in this research, they can be classified into the following three groups, as shown in Figure 4.

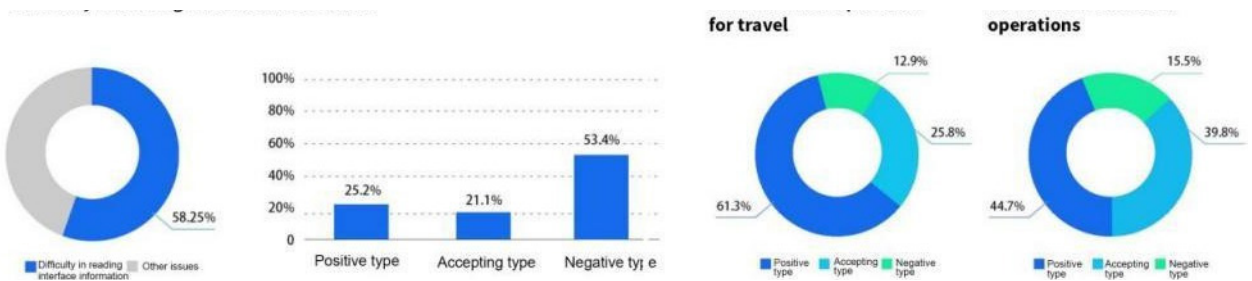
Most elderly individuals encounter barriers in information retrieval when using ride-hailing services. Information barriers are divided into recognition information barriers and comprehension information barriers. The data indicates that, in terms of recognition information barriers, "difficulty in reading visual information" and "difficulty in hearing voice information" are the two predominant issues. In the context of comprehension information barriers, the focus lies on difficulties in understanding specialized transportation terminology. In the case of "difficulty in understanding travel information," negative-oriented elderly individuals outnumber positive-oriented and accepting-oriented elderly individuals. "Slow interface operation" and "interface misoperation"



**Figure 4.** Classification of Elderly Interviewees' Willingness to Use and the Percentage of Different Types of Barriers Data.

are the primary issues faced by elderly individuals when using ride-hailing services. Accepting-oriented elderly individuals significantly outnumber positive-oriented and positive-oriented elderly individuals in both of these problems, as shown in Figure 5.

Information retrieval barriers affect the willingness of elderly individuals to travel and the acceptance of ride-



**Figure 5.** Percentage of Ride-Hailing Service Usage Barriers Among Interviewed Elderly Individuals.

hailing services. These barriers make most elderly individuals unwilling to engage with emerging technology and create distrust, including in smart technologies like ride-hailing services. Consequently, this impacts elderly individuals' willingness to use ride-hailing services.

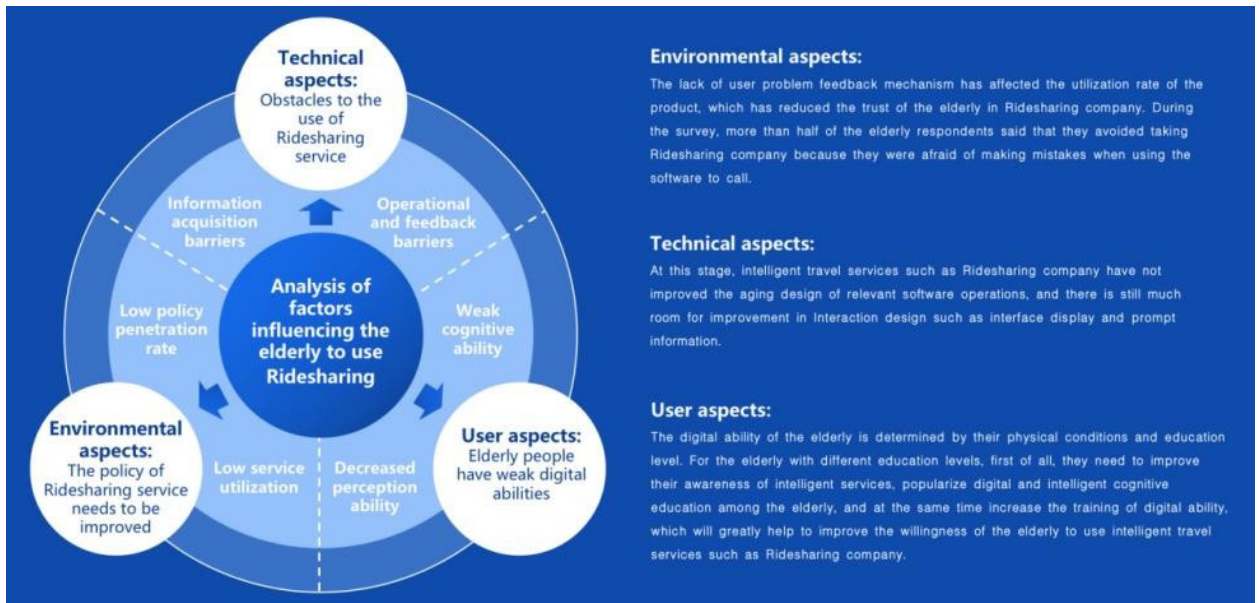
### Factors Influencing Elderly Use of Ride-Hailing Services

Based on the data obtained from the research, further analysis of the factors influencing the use of ride-hailing services by elderly individuals can be categorized into three aspects: policy, personal, and technological, as shown in Figure 6.

**Policy Aspect: Efficiency Constraints in Ride-Hailing Services Impact Usage Intent** Through interviews, it was concluded that relevant policies suffer from issues such as low coverage of taxi pick-up stations, low utilization rates, and high prices. The low coverage of pick-up stations is primarily attributed to extended collaboration periods and high construction costs. The irrational planning of stations and their distant locations from residential areas are key factors contributing to low utilization rates. Inadequate implementation and difficulty in obtaining subsidies for elderly travel by the government have also reduced the willingness of the elderly to use ride-hailing services.

#### Individual Aspect: Physical Health and Education Level Affect Usage Intent

Elderly individuals' willingness to use ride-hailing services is correlated with their physical condition and level of education. On one hand, the decline in physical health and cognitive abilities among the elderly, coupled with difficulties in reading interfaces and comprehending information, diminishes the overall ride-hailing experience.



**Figure 6.** Analysis of Factors Affecting Elderly Individuals' Use of Ride-Hailing Services.

On the other hand, higher levels of education among the elderly result in fewer barriers to using smart technology products like ride-hailing services and a higher willingness to use them. Additionally, high prices can lower the enthusiasm of the elderly population to use ride-hailing services.

#### Technological Aspect: Cognitive and Usage Barriers Pose Safety Risks

The design of ride-hailing software often necessitates assistance from others for many elderly individuals, reducing their willingness to use such services. Furthermore, frequent software updates make it challenging for the elderly to keep up with these changes. During the research, over half of the interviewed elderly individuals expressed fears of making errors when using the software to request a ride, and difficulties in finding the ride-hailing interface after software updates were common issues.

#### Strategies to Promote Elderly Use of Ride-Hailing Services

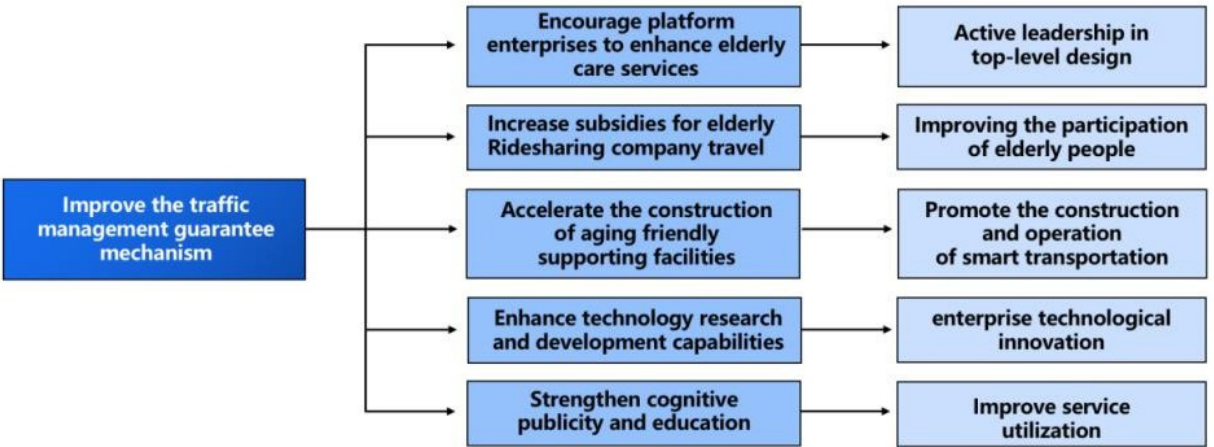
##### Policy Level: Government and Business Collaboration for Innovation

Through communication with the transportation management department of the Beijing municipal government and surveys conducted in seven communities, the research team has proposed policy development recommendations, as shown in Figure 7.

Firstly, relevant government departments at all levels should increase subsidies for elderly travel through policy incentives, encouraging companies to improve the quality of ride-hailing services. Additionally, regulatory bodies should guide ride-hailing platforms in enhancing the "One-Click Ride" functionality. Furthermore, relevant authorities should work towards establishing a legal framework for ride-hailing services that aligns with the national context. Lastly, there is a need for strengthened awareness campaigns and educational initiatives that allow the elderly to experience cognitive scenarios through approaches they find engaging.

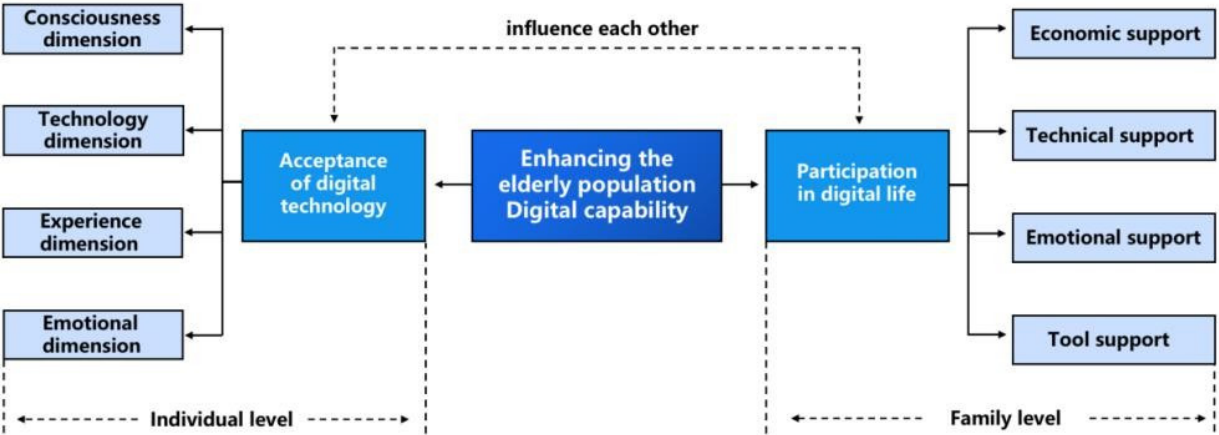
##### Personal Level: Enhance Digital Technology Awareness and Promote Elderly Digital Empowerment





**Figure 7.** Recommendations and Strategies for Age-Friendly Development of Ride-Hailing Services.

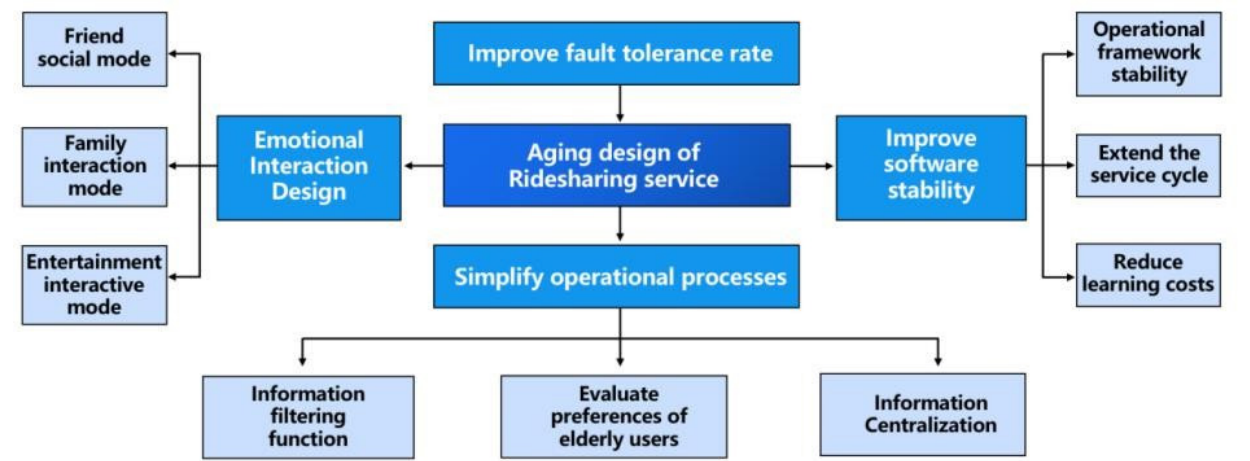
At the household level, children should provide economic support, technical assistance, emotional support, and tool support to enable digital engagement and enhance the participation of the elderly in digital life. On an individual level, encouraging elderly individuals to participate in community activities and digital literacy training can help them gain a sense of digital inclusion and value creation, as shown in Figure 8.



**Figure 8.** Recommendations for Improving Digital Literacy Among the Elderly Population.

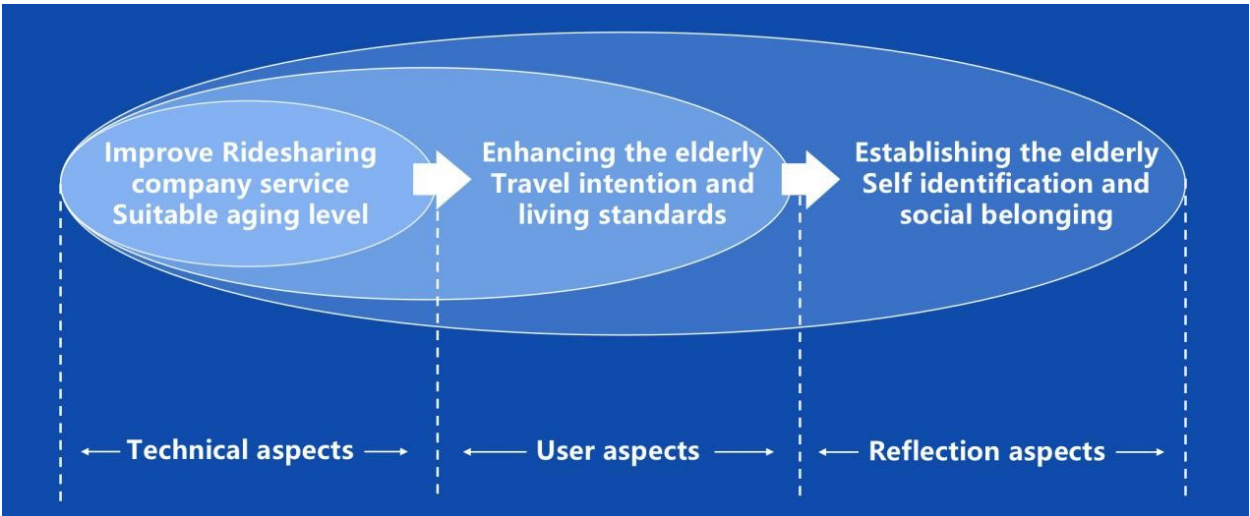
**Usage Level: Focusing on Convenience to Improve Age-Friendly Ride-Hailing Service**  
The research team interviewed elderly individuals in the community and engaged with ride-hailing companies such as Didi and Cao Cao to understand the pain points of elderly users. They constructed a model for an age-friendly ride-hailing service system, as shown in Figure 9.

Firstly, in terms of software stability, the system should maintain the stability of operational logic, increase fault tolerance, and reduce the learning curve. Secondly, in the ride-hailing software process, there should be information filtering to assess the information preferences of elderly users and refine critical operation interfaces. Concerning the user experience of ride-hailing, ride-hailing platforms should enhance communication between elderly users and their friends and provide driver training for serving elderly passengers, such as offering assistance with boarding and disembarking and providing exclusive guides for elderly passengers. Furthermore,



**Figure 9.** Age-Friendly Design Model for Ride-Hailing Services.

the report suggests addressing operational errors from both the user and customer service sides through a "multi-level confirmation" approach. The research report, by analyzing the factors affecting elderly ride-hailing, provides reasonable development recommendations for ride-hailing services, offering a better travel experience for the elderly and highlighting its significance, as depicted in Figure 10.



**Figure 10.** Building the Significance of Age-Friendly Design in Ride-Hailing Services.

**Conclusion**

Based on the data obtained through the research, the investigative team found that ride-hailing services have yet to establish a comprehensive age-friendly management system and have overlooked the usage requirements of elderly users in their software user experience design.

The research report, through on-site investigations and interviews, identified the barriers faced by elderly individuals when using ride-hailing services and collected relevant data on their attitudes towards using such services. It analyzed the factors influencing the use of ride-hailing services by elderly individuals, providing development recommendations for age-friendly design in ride-hailing services from three aspects: ride-hailing

policies, the elderly population, and age-friendly design in ride-hailing. These recommendations aim to address issues faced by elderly users of smart products, offering the elderly a better travel experience.

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## Designing Healthcare Services for Longevity

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### Abstract

Adults 85+ years and older have become the fastest growing global population, representing a new paradigm of longevity economics, service innovation, and experience-driven business. In summer 2023, the authors conducted a study to identify longevity-related challenges and frame questions in the context of healthcare services. The two-month study, which consisted in the planning and implementation of a 3-hour co-creation workshop to explore longevity-related needs of healthcare services and 1 post-workshop survey to capture insights, was a collaboration between an academic research institute in the US and a government-level design research center in Asia. The research proposes a new framework to assist in a longevity-informed design process: the 4Es (ensure, evolve, empower, and enjoy) framework. This framework is based on 35 expert interviews (Anonymous, et al., 2023), from which we derived 12 keywords associated with longevity and aging: health, family, mobility, care, home, communication, trust, community, risk, investment, education, and future. We applied the framework in the creation of an ideation toolkit for the co-creation workshop, consisting of 12 Design for Longevity (D4L) cards and 4 participatory posters. We recruited 27 participants from the healthcare industry, including three categories: 1) healthcare service providers, such as doctors, nurses, and pharmaceutical leadership teams, 2) healthcare service recipients, such as patients and their families, and 3) workshop facilitators including UX and UI designers. Overall, the study was beneficial to healthcare services for longevity. Two key learnings are demonstrated from the study: 1) By providing a series of accessible verb-based questions, the 4Es framework helped facilitate conversation and ideation among diverse participants and 2) Touching and sharing the D4L cards and posters enabled participants to discuss abstract concepts and complicated topics more easily.

## Author keywords

Design for longevity; service design; healthcare; design process; longevity economics

## Introduction

Most developed countries are already in a stage of a super-aging society (World Health Organization, 2022). Our society is transforming to adapt to multi-generational and inter-generational cultures, workforces, and other environments. Due to established economic structures, advancing technologies, better education and medical systems, and stable social infrastructures, people can live longer and want to live healthier to maintain a good quality of life.

As a result, the demands of longevity economics have led to a paradigm shift, especially service- and experience-driven business strategies. Consequently, an interest in designing healthcare services for longevity has emerged across various industries and academia. Our project was a 2-month multi-disciplinary research initiative among



**Figure 1.** Original poster design paired with 12 D4L cards from co-creation workshop.

data scientists, an industrial designer, and interaction designers from University Research Lab A, University Research Lab B, and Research Institute, a government-level organization that promotes design for social impact and service innovation. Our goal was to identify critical research questions concerning healthcare services for longevity by using the proposed keywords and 4Es (ensure, evolve, empower, and enjoy) framework applied in 12 Design for Longevity (D4L) cards and 4 participatory posters (figure 1). We recruited 27 participants, including healthcare service providers (doctors, nurses, and pharmaceutical leadership) and service recipients (users and their family members), conducted a 3-hour co-creation workshop, and designed a post-workshop survey to capture participant's reactions and responses.

## Literature reviews and case studies

Longevity economics

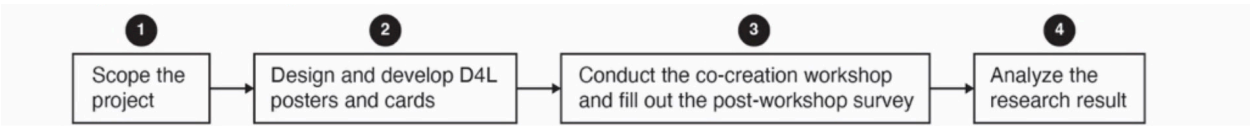
In the era of an aging society and the fourth industrial revolution (Schwab, 2016), our economic structure has shifted dramatically from a product-centered model and mass-production focus to a more service- and experience-driven approach that considers longevity and sustainability. Golden (2022) notes that our society has changed from the traditional 3 stages (born, earn, and retire) to multiple stages, and this change directly affects our social infrastructure systems. Golden’ s five-quarter (5Q) framework demonstrates that people’ s age represents not only several years, but also— implicitly and explicitly —a life stage. Anonymous (2019; 2017) proposed the 8,000-day framework, which looks at the expected 8,000 days of retirement as “four retirements” : manage ambiguity, make big decisions, manage complexity, and live solo. By centering the 4 retirements, longevity economics can influence how we rebuild and shape healthcare services for future AgeTech cities, where human aspects and emotions are integrated into making critical decisions and cultivating sustainable behavior and mindsets (Etkin, 2021).

Design for Longevity (D4L)

Design for Longevity (D4L) has been an emerging idea that influences us not only financially and economically but also technically and socially. Since we are in a multigenerational environment, people have started to focus on agism issues across many industries and organizations, including education, culture, and policies. Customers have become more sophisticated as their needs have changed (Anonymous, et al., 2023). Instead of manufacturing more products, in the context of D4L, we need to consider more service-oriented experiences that tie to the desirability of people and social impact (Anonymous, et al., 2023). For example, MIT AgeLab proposed a D4L studio to envision longevity services and journeys to shift the roles and responsibilities of financial advisors to those of longevity coaches (Anonymous, et al., 2023). D4L is a cross-disciplinary domain that has academic value and industrial potential to be applied in many arenas, including healthcare. In this study, we applied the frameworks developed as part of the D4L studio to conduct an experiment on healthcare services.

Research methods and 4Es framework

The 2-month research project included four key steps: scope the research area, design applied assets for the



**Figure 2.** The research process consists of four steps

4Es framework, conduct a co-creation workshop, have participants complete a survey, and analyze survey data (Figure 2). Step 1 included research into challenges related to longevity and consisted of 35 expert interviews (Anonymous, et al., 2023). Interviews were analyzed using ATLAS.ti, a computer-assisted qualitative data analysis software, to come up with 12 keywords and the 4E framework. In step 2, authors developed a toolkit to be used in the workshop: the D4L cards, 4 participatory posters, and a survey to document participants’ backgrounds, demographic information, and perceptions of longevity and service design, including the relevancy of the keywords in the healthcare sector. Step 3 involved conducting the 3-hour workshop, which concluded with participants filling out the survey. And in the final step, we analyzed the survey results.

We recruited 27 participants from three expertise areas: healthcare service providers, healthcare service recipients, and workshop facilitators with expertise in design. Doctors (n=2), nurses (n=3), and pharmaceutical



**Figure 3.** The 4 posters are used to identify research questions in healthcare services for longevity.

leadership (n=7) are defined as healthcare service providers. Users (n=7) and their families (n=4) belong to healthcare service recipients. The rest of the participants and designers are included as facilitators (n=4). Participants were grouped into 6 diverse teams.



**Figure 4.** The 12 D4L cards combined with 4 posters help explore healthcare services for longevity.

The posters (Figure 3) were created to emulate the design process: 1) Define audience: Who is your D4L persona? Participants used this poster to create a persona. 2) Clarify objectives: What values are relevant to D4L? Participants ranked keywords by importance in relation to their persona. 3) Identify design opportunities: When and where can D4L integrate with healthcare services? Participants used the four probing questions from the 4Es framework to brainstorm healthcare services for their persona. 4) Visualize concepts: Why does longevity matter to healthcare services? On this board, participants storyboarded their final idea. Throughout the workshop, participants used the 12 D4L cards as a supporting tool to enable them to have more constructive, meaningful, and engaging discussion (Figure 4).

The 4Es framework is a tool to help people brainstorm concepts and ideas for products, platforms, and services that address issues of longevity. There are four stages to the framework: ensure, evolve, empower, and enjoy. Each stage offers a question to guide participants to think more dimensionally about the challenges and opportunities of longevity. (Table 1).



**Table 1.** List of the AI Enabled Tools selected, with clickable hyperlinks.

4Es	Ensure	Evolve	Empower	Enjoy
Explanation	Foundation	Transformation	Extension	Outcome
Guiding questions	What do you need to <b>ensure</b> ? What is basic to your future wellbeing?	What needs to <b>evolve</b> with you? What transforms with you over time?	What can <b>empower</b> you? How can you extend your impact?	What do you <b>enjoy</b> ? What outcomes do you benefit from?
Associated Keywords	<i>Mobility, Home, Community</i>	<i>Education, Health, Family</i>	<i>Future, Investment, Risk</i>	<i>Trust, Care, Communication</i>
Examples	<b>Mobility</b> is imperative for an independent lifestyle. The design of automotive safety features can ensure mobility into later ages.	<b>Education</b> services need to accommodate changing social and professional needs and be relevant and stimulating to seniors.	Designed systems need to minimize <b>risk</b> and help people’s daily behavior make positive social impact.	Products and platforms that allow us to demonstrate <b>care</b> for each other and the environment.

The workshop ended with a 5-minute presentation from each group to share their 1) D4L persona, 2) D4L-relevant values, 3) D4L-integrated healthcare services, and 4) their expanded understanding of longevity. Most teams were interested in exploring long-term healthcare services such as coming up with human-centered approaches to take care of dialysis patients or people with diabetes. Figure 5 demonstrates a participant using the 4 posters, combined with 12 D4L cards, as an effective inspirational tool to develop and communicate their scenario.



**Figure 5.** Participants used 4 posters to facilitate the discussion about healthcare services for longevity.

Research result

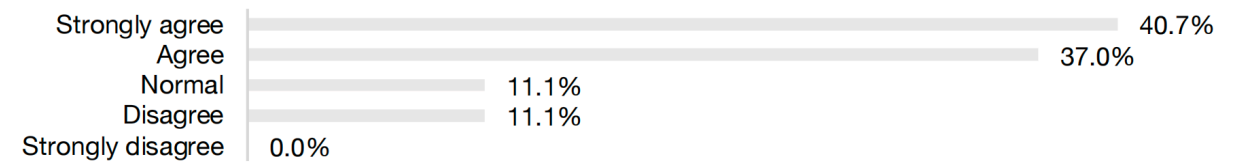
Analysis of D4L cards and keywords

One of our research goals was to determine if the 12 keywords, visuals, and proactive questions on each of the D4L cards were relevant to longevity concerns in healthcare, as well as if the set itself could serve as a conversation facilitation tool. As part of our survey, we asked participants to rank the keywords from 1 to 10 based on their importance in the context of longevity. The ranking result from top to bottom showed (the value in parentheses is the average number, n=25): health (1.48), family (3.68), mobility (5.04), care (5.16), home (5.44), communication (6.4), trust (6.92), community (7.6), risk (8.4), investment (8.92), education (9.04), and future (10). Unsurprisingly, aligning with the participants’ backgrounds, health was the most important factor. Family was second, followed closely by mobility, care, and home. Interestingly, the more abstract words, like future and

investment, were ranked lowest. Participants also contributed other keywords—happiness, financial wellbeing, physiological and psychological health, meaningful and delightful lifestyle, companionship, sharing, learning, active, and being alone— to help co-build the D4L cards’ content.

Analysis of co-creation workshop experience

The following survey results (n=27) can help us not only better future design workshops, but also receive



**Figure 6.** Results from 27 participants to survey question, “Using 4 posters with 12 D4L cards unlocked my creative thinking during the team discussion and enhanced the level of comprehensiveness of the topics.”

feedback on D4L cards and posters. Overall, more than half of the participants (88.9%) were satisfied with the co-creation workshop experience. This workshop and discussion helped most participants (83.1%) paint a picture of what a healthy lifestyle looks like and helped the majority of participants (92.5%) understand the importance of considering needs from multiple dimensions and how to use a design process to envision future scenarios (88.9%). Most importantly, it helped most of them (85.2%) identify innovation opportunities from different aspects. Figure 6 demonstrates that 4 posters combined with 12 D4L cards are effective and useful tools for most (77.7%) participants.

Discussion and next step

Complexities of the term “longevity”

From the in-person workshop observation and post-workshop survey, we found that perceptions of longevity varied among participants. This could be because of different East-West cultural interpretations of the term “longevity” , or due to experiential differences between healthcare service providers, healthcare service recipients, and workshop facilitators. It could also be because concepts of longevity and D4L are still relevantly new, with limited exposure in the field of service design and social innovation. Therefore, as demographic trends continue to shift, it is critical to continue to develop design methods around longevity within healthcare and beyond.

Future uses for a longevity toolkit and co-creation workshop

With the success of applying the 4Es framework and D4L cards in this study, what are other research areas that could benefit from a similar longevity workshop? We are considering public transportation systems, corporate organizational structures, educational services, AI-relevant ethical issues, and other complicated and systemic socio-technological challenges. As a next step, the 4Es framework and D4L cards can be considered as experimental materials. We aim to extend the applications of both by applying them to various research areas to build a more comprehensive and impactful toolkit for longevity and service design.

Conclusion

The development of Design for Longevity (D4L) tools for healthcare service design

The purpose of the workshop was to explore longevity-related challenges in healthcare services. We created the posters and D4L cards, based on the 4Es framework, to facilitate conversation and ideation. We tested these artifacts in the co-creation workshop to help participants (doctors, nurses, users, and designers) brainstorm and identify untapped opportunities for the redesign of healthcare services across levels of individuals, communities, and countries. Having synthesized the data captured from the survey result, poster information, and observation notes, we demonstrated that the 4Es framework, posters, and D4L cards foster open-ended conversations concerning complicated, private, sensitive, and challenging healthcare services. This is because the 4Es framework was designed with 4 relatable questions to inspire participants to quickly build mind-maps related to longevity. And the physical artifacts—the posters and cards—were designed to make abstract or complex concepts tangible, and therefore easier to work with. We concluded that the 4Es framework, posters, and D4L cards, raised participants' curiosity, enhanced their engagement level, and enabled them to have constructive discussions around healthcare services even though they were from very diverse backgrounds.

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## Envisioning narrative scenarios for alternative futures: heuristic cards and design tools for critical design

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### Abstract

Critical design serves as a practice method that holds greater significance in today's rapidly evolving technological landscape and accelerated social transformation. This article presents a collection of heuristic cards and design toolkits for critical design, aiming to provide valuable resources, guidance, and assistance to practitioners in creating narrative scenarios during the concept generation phase. We have identified a four-step creative process, established eight case-oriented content segments, and developed a guided design framework. Content segmentation of the design case was performed to extract 60 main cards, and 20 side cards were extracted from philosophical, scenario and character archetypes. The design toolset includes the canvas and content template. Following initial testing, the potential of the card set and toolkit to enhance the efficiency, completeness, and quality of initial design proposals has been successfully demonstrated.

### Author keywords

Critical Design; Card-based Design Tools; Narrative Scenarios; Archetypes; Design Framework

### Introduction

The continuous expansion of the design discipline in breadth and depth has led to the development of design from tangible fields such as industrial design to more intangible design domains (speculative design (Dunne and Raby, 2013), design fiction (Bruce, 2005; Lindley and Coulton, 2015), transitional design (Irwin, 2015), etc.) (Angheloiu et al., 2020). Among them, speculative design, design fiction, and critical design, as practical methods, focus on proposing "carefully designed problems" instead of problem-solving (Dunne and Raby, 2013). Critical design emphasizes ethical aspects, reveals hidden agendas, and explores alternative values (Bardzell et al., 2012). Such practices use fictional objects to explore future scenarios, stimulate imagination, and debate implications of emerging technologies (Felt et al., 2009; Heidingsfelder et al., 2019). Therefore, in today's fast-paced tech development and social transformation, critical design has become increasingly significant in terms of real-world impacts.

In other design fields (aging design (Wang et al., 2021), design education (Kheirandish et al., 2020), HCI (De Ruyck et al., 2023), food design (Lee et al., 2020), etc.), heuristic design tools or card-based design tools (Haritaipan, 2019) are often used to stimulate creativity, encourage communication among groups, and provide rich resources for design. These tools have been proven to prevent repetitive work and inspire creativity in the most effective areas. However, in critical design, such tools are limited due to its emerging nature and interdisciplinary traits. Elliott's design landscape (Anon, n.d.) divides design into a spectrum: art (unconstrained) on the left and

strategy (constrained) on the right. Art is personal and creative, while strategy relies on tools and frameworks. Critical design, in the middle, combines both, and practitioners retain both artistic thinking and self-expression in their creative habits while projecting their perspectives onto issues such as potential futures, technological meanings, and socio-culture. The development of scenario narratives is a complex task requiring substantial expertise and resources (Burnam-Fink, 2015). Developing heuristic card sets and design tools for critical design requires considering its general process, providing rich content, and building a guided framework. It should also incorporate practitioners' creative habits and artistic thinking (Whitaker, 2016), allowing for dialogue and review. By combining both aspects, we aim to fill the current lack of relevant tools in the field.

This paper outlines the general creative process of critical design, sets up case content segments, and develops a guided design framework. We extract the main and side cards, forming guided canvas and content template. The proposed tools are then validated through testing, resulting in enhanced efficiency, completeness, and quality in initial design creations.

### **The Guided Design Framework on Creative Process and Content Structure:**

#### General Creative Process of Critical Design

Critical designers challenge norms, legitimizing and problematizing different design approaches (Malpass, 2013). Methods include speculative design (Forlano, 2019), design fiction (Dunne and Raby, 2013), and discursive design (Fordyce, 2021). We aim to optimize Lutz's (Lutz, 2023) speculative design process, merging last two stages into a four-step strategy:

- Step 1: Identify "Signals" of Emerging Technologies and Trends: Recognize peripheral technologies and cultural trends, looking for "weak signals" in emerging technologies and experimental applications.
- Step 2: Conceptualize Future Artifacts: Envision future Artifacts using design tools.
- Step 3: Storify: Design a diegetic artifact addressing future challenges. Ensure its form and function convey a compelling story, inspiring audience imagination.
- Step 4: Sharing to Spark Discussion: Facilitate easy interpretation and encourage feedback on personal preferences, potential impact, and alternative concepts.

#### The Content Structure of Critical Design

It has been recognized for quite some time that narrative is one of the primary modes of knowing for humans (Milojevic and Inayatullah, 2015). Examining the content structure of critical design can offer valuable insights from existing cases and improve the comprehensiveness of design proposals. Using Ramos' categorization (Ramos et al., 2019), this study refines and formalizes the structure, yielding the following content segments (Table 1).

**Table 1.** The Content Structure of Critical Design with 6 content segments

Segments	Summary	Explanation
1- Definition	Overall Design Description	A comprehensive view of the designer's actions, context, and outcomes, including environment, participants, methods, and achievements. Similar to an abstract and design explanation.
2- Backgrou nd	Background &Perspective	The social, technological, economic, ecological, and political contexts of the design, along with the designer's personal experiences or knowledge system. Also includes critical issues identified from the designer's perspective.
3- What	Design Type &Content	Examples of the type of artificial object, product, business action, artwork, vision, or conceptual innovation in the design.
4- Why	Design Issues	Specific problems, confusions, or pain points addressed by the design. These issues can be seen as smaller topics within a larger
Responses		potential impacts.

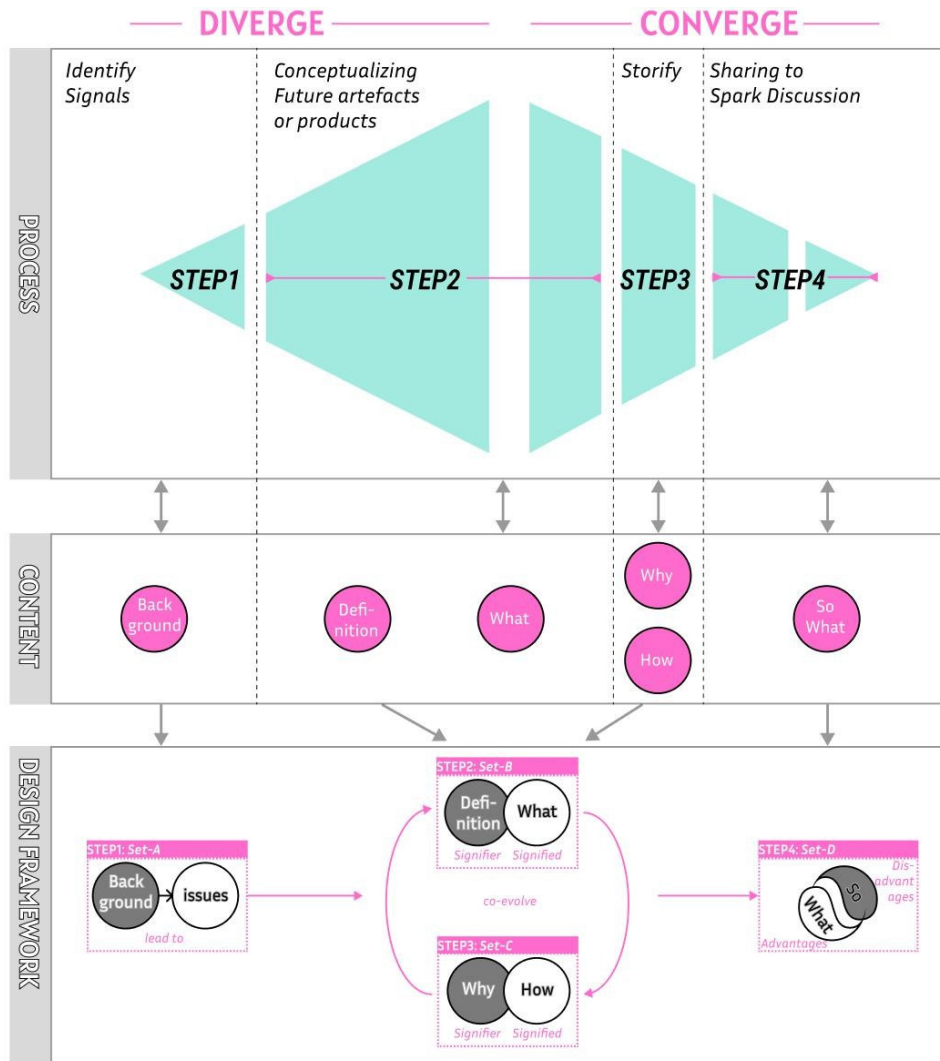
**The Guided Design Framework for Critical Design**

The guided design framework for critical design consists of two parts. First, align the process with content segments to facilitate the reconstruction of design case content within each process: (i) "Identify Signals" with "Background", which pertains to the process of uncovering signals from the design context. (ii) "Conceptualize Future Artefacts" with "Definition" and "What", indicating the determination of the specific definition and type of future products. (iii) "Storify" with "Why" and "How" , focusing on the solution scenario within the design problem space. (iv) "Share to Spark Discussion" with "So What". aiming to elicit responses while maintaining inter-subjectivity and openness and implies the author's preconception of the anticipated impact (Figure 1). Second, explore relationships among segments and logical connections among steps to further the understanding of the processes: (i) "Background" and "Issue" form set-A, where the former precedes the latter. (ii) "Definition" and "What" form set-B, representing the relationship between the signified and the signifier. (iii) "Why" and "How" form set-C, establishing a question and answer relationship. (iv) "So What" form set-D, encompassing future benefits (positive) and risks (negative). Product conceptualization and storytelling are a mutually promoting process, needing contemplative space and external stimuli for users to refine concepts and enhance proposal completeness. This inspired us when we were developing the cards (Figure 1).

**Critical design-oriented heuristic cards and design tools development**

**Card Composition and Extraction Process**

Main card: Main cards, derived from case studies, are used throughout the process (Step 1-Step 4). Jakobsone (Jakobsone, 2019) argues studying existing design projects can liberate designers' methods. The extraction process involves four steps: acquiring sources, segmenting, reorganizing content, and designing main cards. First, relevant cases are selected, scored, and ranked from 111 case studies. Second, content is segmented according to "Definition- Background-What-Why-How-So what". Then, according to rules in Section 2.2, content corresponding to the 4 design process is converted into 4 Sets: Set-A (front: background, back: Issues; 1 card), Set-B (front: Definition, back: What; 1 card), Set-C (front: Why, back: How; 1 card), Set-D(front: So what, back: Advantage/Disadvantage; 2 cards). Finally, 60 cards are obtained, providing valuable design content resources for practitioners (Figure 2).



**Figure 1.** The guided Design Framework for Critical Design

Side card: Side cards, sourced from literature research, enhance design proposals and facilitate a leap in thinking during artifact conceptualization and story development (Step 2-Step 3). The side card extraction process involves acquiring sources, extracting content, and designing side cards. The side card is composed of three types: philosophical archetypes (P.A.), scenario archetypes (S.A.), and character archetypes (C.A.), providing abstract materials for artifact storytelling. Content is sourced from futurology and scenario planning literature. This content is either derived from previous research findings obtained through grounded theory in film-oriented studies (Fergnani and Song, 2020), adapted from important theoretical frameworks in the expected field (Dator and Dator, 2019), or quoted from previous summaries (Gregory and Laverty, 2022). For example, philosophical archetypes include 'The Ship of Theseus', 'The Brain in a Vat', 'The God Paradox', etc., which are classic philosophical topics; scenario archetypes include 'Continuous Growth', 'Collapse', 'Stabilized', 'Coming back', and 'Transformation', which are further improvements on general scenario archetypes; character archetypes include 'Achilles', 'Circe', 'Romeo & Juliet', etc., which are representative story protagonists. These contents are eventually made into three types of cards, totaling 20 cards (Figure 2).

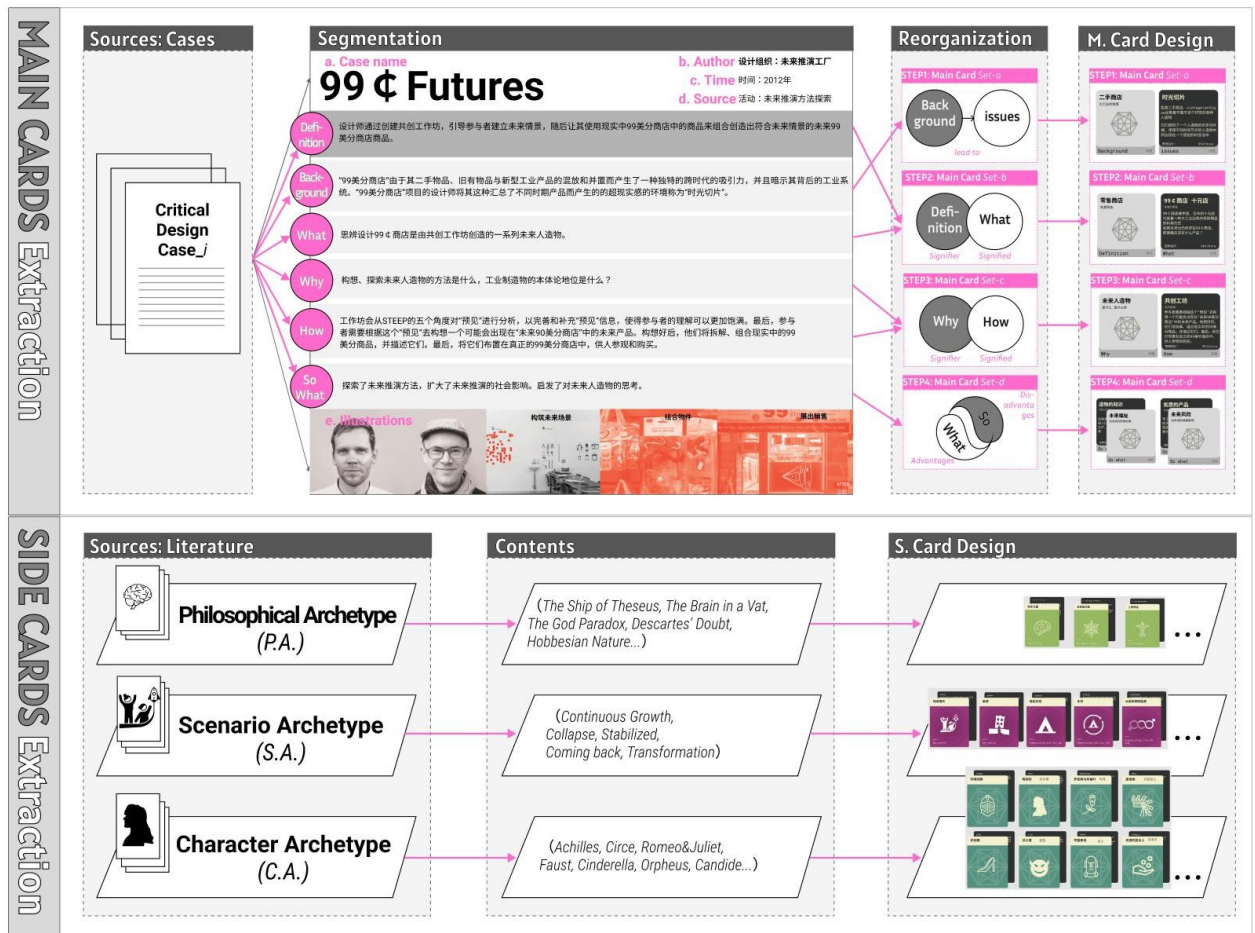


Figure 2. Main cards (top half) side cards (bottom half) extraction process and card design

### The Canvas, Guided Processes, and the content template

The canvas is a platform for positioning main and side cards (Li and Zhao, 2021), based on the guided design framework. By strategically placing cards, a preliminary design plan can be formed easily. Side cards (P.A., S.A., and C.A.), located in the center, provide space for thought and facilitate adjustments to main cards, enabling creativity and optimization. Blank areas can be used to record insights, leading to a comprehensive concept and design. Figure 4 is a template for critical design. After completing the canvas, participants transfer the card content and inspired ideas to the template, forming a complete design. The template's bottom requires visual materials, such as AI-generated illustrations. In summary, the canvas serves as a main platform for design and creativity (for teams and individuals), while the content template represents the transcription and standardization of canvas outcomes. Using the canvas, main and side cards, and the content template, a quick initial concept draft for critical design can be created.

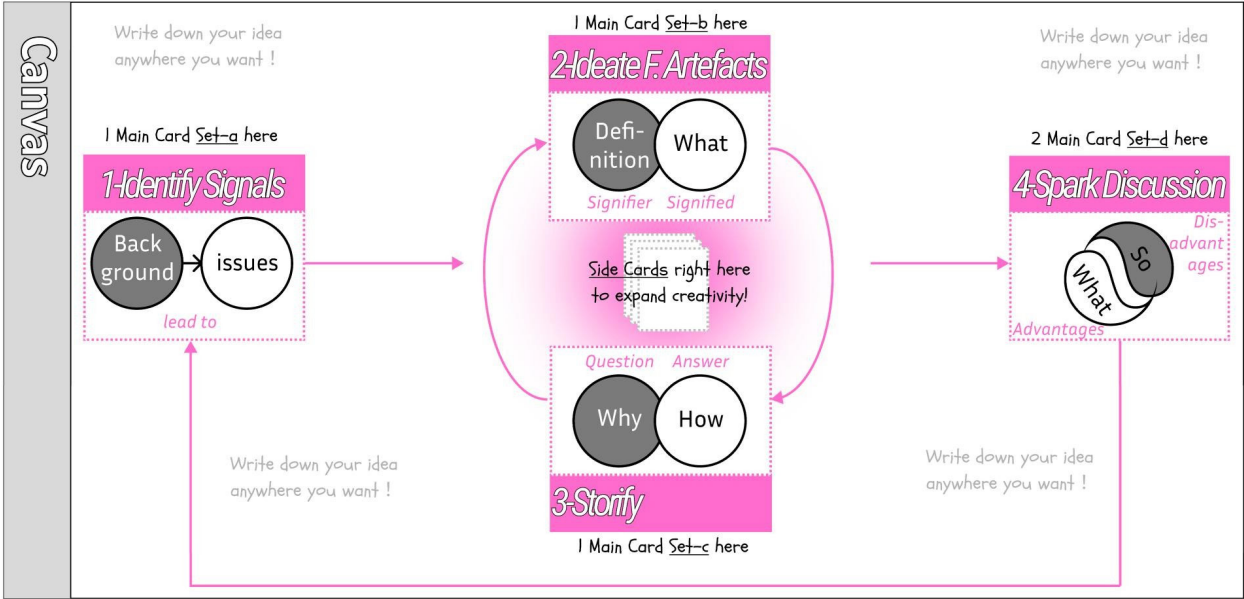


Figure 3. The Guided Canvas for Critical Design

a. Case name		b. Author _____	
		c. Time _____	
Definition			
Back-ground			
What			
Why			
How			
So What			
e. Illustrations			

Figure 4. 4 The Content templates for critical design



## Application

We held a workshop to evaluate the proposed tool's effectiveness. 14 participants from the Department of Information Art and Design at Tsinghua University, including postdoctoral fellows, Ph.D. students, and master's students, attended. They used a critical design toolkit pre- placed on Figma's online whiteboard to work in small groups and complete tasks. The workshop had five groups, each with 2-3 people, and the testing process took about 1 hour (excluding facilitator's guidance time). The workshop focuses on creative generation. It begins with an introduction to main/side cards, canvas, and templates. Participants then follow a guidance process, starting with identifying background issues, envisioning product concepts, narrativizing the product, and considering potential impacts. They can choose from pre-made cards or modify them. Upon conclusion of the canvas development (which could be done simultaneously), participants were required to fill into the template and use 'Dream Studio' to generate illustrations. The Definition was further refined, with an aim to encapsulate the essence of the plan in a single sentence.



**Figure 5.** Proposals for some of the groups in the workshop (Left: The robot of the great compassionate universe; Middle: Gene Technology Copyright Store; Right: Experience Exchange)

The results (Figure 5) showed that the critical design proposal was completed by all groups. We observed three key benefits of using the tool. First, it enhances creative efficiency, as all groups finished the task in under an hour, demonstrating its novice-friendliness. Second, the tool improves the completeness of initial proposals, as its structurization compels participants to consider all design aspects, fostering continuous improvement. Third, the tool raises the quality of works, especially given the tool's integration of critical design spirit, the open-ended forms of “inventive problem making” (Michael, 2012), and provision of self-review space, aligning with artistic thinking (Whitaker, 2016) and facilitating proposal evolution.

## Conclusion, limitation and future avenues

This article outlines the creative process of critical design, consisting of 4 steps and 8 content segments. It also introduces a design framework. Then, the initial extraction of 60 main cards and 20 sub-cards was carried out, and the canvas, content templates were formed. The Application showed improvements in the efficiency, completeness, and quality of initial creations. Limitations and future directions include diversifying the medium, accommodating more practitioners, incorporating new content, and developing more Chinese character prototypes or historical propositions.

## Acknowledgments

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## **Towards a Resilient Future: Improving living Street resilience in Small and Medium-Sized Towns in the Jiangnan Region, China, Based on Soft Systems Methodology**

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### **Abstract**

In an era of escalating global uncertainties, forward-thinking concepts such as resilient cities, smart communities, and shared streets have garnered substantial attention in urban development. However, research and practical exploration of these concepts have mainly concentrated on mega-cities, such as China's bustling metropolises of Beijing, Shanghai, Guangzhou, and Shenzhen. The immense developmental potential inherent in small and medium-sized towns, particularly those nestled in China's Jiangnan region, often endowed with unique natural landscapes and rich historical heritage, has regrettably remained inadequately acknowledged. Despite their rapid growth in recent years, the spatial configurations of these towns demand urgent rectification and improvement. There needs to be more than the prevailing focus on physical level refurbishments, rooted in the past, to align with contemporary and future demands.

Recently, guided by many policies, the revitalization of streets has gained more attention in urban renewal endeavors. Among these, living streets, intricately linked with the well-being of residents, bear particular relevance. However, living streets tend to be ignored compared to the well-acknowledged emphasis on historic streets. This paper, guided by resilience principles, takes the case of living streets in Yixing, Jiangsu Province, China, as an illustrative example through a comprehensive on-site investigation dissecting four issues. At the macro level, the existing renovations need more comprehensive consideration. Meso perspective, revealing the uneven distribution of space-time utilization in neighborhoods. Micro level, ignoring human-scale considerations catering to diverse population segments. Temporal dimension: lacking flexible spaces to adapt to changes. Delving into how the living streets can attain a "resilient balance" amidst a complex urban system involving multi-stakeholders, this paper applies Checkland's Soft Systems Methodology, an integrated approach encompassing socio-economic and environmental factors, to analyze the soft issues pertinent to resilience within living streets. It ultimately forges a systematic approach for enhancing the resilience of living streets in small and medium-sized towns. At the macro level, aligning with urban development objectives. Meso dimension, applying intelligent technologies to calibrate street space allocations. Micro-level, implementing participatory workshops to harmonize the demands of diverse stakeholders. Moving to the temporal dimension, planning a phased renewal plan. These innovative strategies offer actionable design guidelines, preparing a forward-looking agenda for future uncertainties.

### **Author keywords**

Small and Medium-Sized Towns; living Streets; resilience Concepts; Soft Systems Methodology.

Introduction

Living street refers to streets primarily serving residents by providing housing, small to medium-sized life-service businesses, and public service facilities as their main functions along the route(Bain, Gray, & Rodgers, 2012). Scholars have explored living streets' humanization, regional characteristics, and spatial vitality(Huang and Dai 2009). However, there needs to be more comprehensive research on how living streets, particularly those in smaller towns, can become more adaptable to dynamic changes and enhance their resilience to drive urban development. Furthermore, there needs to be more exploration into future demands and trends driven by new technologies.

Renewing living streets in small to medium-sized towns is crucial in achieving high-quality urban and economic development. Yixing, located at the geographical center of Shanghai, Ningbo, and Hangzhou, is a historic and culturally significant city in China and one of the most economically robust county-level cities(Zhu, 2003). The living streets in Yixing represent the challenges and characteristics of living streets in the Jiangnan region's small to medium-sized towns. Therefore, this study uses a case study of Yixing's main urban living streets. Through on-site research and problem identification, it aims to improve resilience in living streets under the guidance of resilience concepts and the Soft Systems Methodology (SSM).

Resilience, Living Streets and Soft Systems Methodology

Urban Resilience and Resilience of Living Streets

In today's increasingly unstable world, urban resilience has gained significant attention. It is defined as "the ability of urban systems and their residents to maintain normal functioning under various shocks and pressures, actively adapt, and transition towards sustainable development"(Meerow, Newell, & Stults, 2016). However, resilience issues in living streets have received relatively less recognition. Building upon the dimensions of urban resilience research and considering the time dimension, this paper attempts to establish resilience objectives for livable streets, overcoming the limitations of a singular spatial scale (Figure 1).

Living street resilience in different scale	Key Feature	Target	Temporal Dimension
Macro Level: Urban Resilience	Robustness, Risk management, Redundancy, Relative stability	Climate change, Environmental shifts, Economic downturns, Long-term technological developments	Pre-renewal: the present and future development directions
Meso Level: Neighborhood Equilibrium	Self-organization, Agility, Efficiency, Collaboration	Tidal traffic, Microclimate disruptions, Sudden events, Extreme weather, Community planning adjustments.	Current phase: spatial adaptability to activities across seasons
Micro Level: living Street Flexibility	Adaptability, Diversity, Fairness, Modularity	Non-routine Activities, Conflicts among users, Temporary occupations, Random events, seasonal variations	Post-renewal: Assess transformation impacts for the next phase

Figure 1. Multi-level Resilience Objectives of Living Streets.

Soft Systems Methodology (SSM) in the study of resilience in living streets

Resilience concepts offer the advantage of harmonizing multi-level contradictions in living streets. However, the term "resilience" is multifaceted and vague, lacking a well-defined guiding framework for its application in improving street space environments. Therefore, based on identifying resilience objectives, this paper employs

the Soft Systems Methodology (SSM) to analyze multiple influencing factors. SSM, developed by British scholar Peter Checkland in the early 1970s, aims to address ambiguous, human-related issues and possesses flexibility, adaptability, and scientific rigor when dealing with complex social problems(Checkland, 2000).

Application of SSM in the analysis of resilience systems in living streets

This research employs on-site inspection, questionnaire surveys, expert symposium and in-depth interviews to collect and organize information on the status of 83 living streets, user needs, and planning objectives within the research scope. Subsequently, following the seven steps of the Soft Systems Methodology dissected the issues and ultimately constructed a conceptual model.

Perception and Expression of Problem Situations

- Macro level, lack alignment with multi-level urban development objectives.
- Meso level, uneven distribution of temporal and spatial utilization of street in neighborhoods
- Micro level, Lack consideration for humanization, especially for vulnerable groups.
- Temporal dimension, lack flexible development space oriented towards the future.

Root definition of resilience system in living streets

Following the steps of SSM, the root definition was clarified by analyzing the six CATWOE elements to determine what should be done in the problem context of insufficient resilience in living streets in small and medium-sized towns (Table 1).

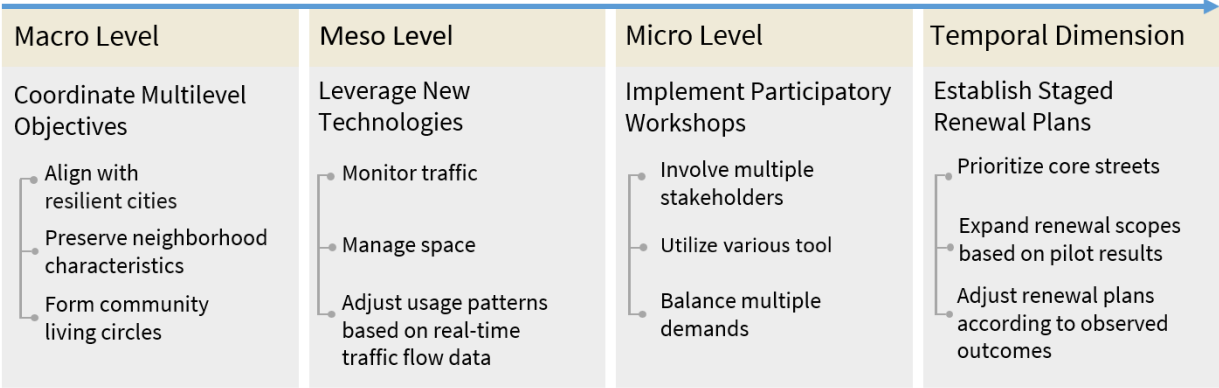
Table 1. CATWOE root definition.

CATWOE Elements	Customer (C)	Actor (A)	Transformation (T)	Worldview (W)	Owner (O)	Environment (E)
Description	Residents, tourists, local government, and other stakeholders.	Urban planners, community and government representatives, non-profit organizations, etc.	Enhance the resilience of living street in terms of space, operations and other aspects, based on an analysis of the demands of	Resilient city objectives, environmental sustainability, preservation of local cultural characteristics, etc.	Government and relevant planning departments.	The social, cultural, and economic environment of the city, external factors such as climate change and global

Conceptual model of resilience enhancement in living streets

Based on the previously proposed resilience goals model for living streets and the specific element analysis derived from the root definition, a conceptual model for enhancing resilience in the spatial environment of living streets was constructed (Figure 2).





**Figure 2.** Conceptual model of living street resilience in small and medium-sized towns

**Macro-Level: Coordinating resilience objectives across multiple aspects**  
Living streets are part of the overall urban system, connecting neighborhoods and cities at the higher level and focusing on the interaction between people and space at the lower level. Therefore, the resilience objectives of living streets need to be coordinated with goals at three progressive levels(Sharifi, 2019). It is crucial to align with current and future resilient city development goals, reserve space for adjustments and preserve cultural heritage. For instance, "Four Streets Eight Alleys" in Yixing holds cherished memories for residents and should integrate traditional functions with new ones. Living streets should be coordinated with the planning of community life circles to create convenient living environments.

**Meso-Level: Using smart technology to adjust the allocation of various functional zones in street**  
New technologies like big data, IoT, and autonomous vehicles provide opportunities for creating more flexible streets(Riggs, 2018). In the context of intelligent streets, online controls can complement and optimize onsite processes, enabling dynamic management around the clock and reducing labor. Intelligent connectivity platforms and AI sensing technology allow real-time monitoring of street capacity, traffic congestion, and parking space usage. This data can be used to make targeted real-time adjustments to speed limits, space usage patterns, lane directions, and quantities. Control essential pedestrian zones while flexibly adjusting others. Integrating resilience and sharing concepts with evolving technology can enable living streets to better adapt to the fast-paced lifestyles and the emerging trends that may arise in the future.

**Micro-Level: Participatory Workshops coordinating diverse demands**  
Amid the prevailing trend of demand-driven urban renewal, numerous grassroots initiatives have underscored the pivotal role of public engagement throughout the process(Dell’ Anna & Dell’ Ovo, 2022). In the age of data, various technologies have facilitated information collection. Participatory workshops can effectively harmonize the demands of various stakeholders, utilizing both traditional and digital tools. Virtual Reality (VR) technology can create immersive experiential scenarios to assess the impact of transformations, subsequently allowing for direct adjustments to street spaces based on specific issues or indirect alterations through urban furniture(Ahmed & Rani, 2018).

**Temporal dimension: Implementing phased update strategies**  
Segmenting the plan into parts allows for alterations to different streets or locations during different periods.

Phased updates by region are more likely to be accepted by the community. Streets with significant problems and high demand should be prioritized for renovation, as their improvements carry more excellent value and influence. Their exemplary role can facilitate the smooth progress of long-term development. Strategic adjustments can be made as necessary by evaluating the results of initial pilot area updates, and the scope of updates can be expanded. This approach minimizes redundancy during the updating process.

## Conclusion

In the current context of challenges and opportunities, the inherent issue of insufficient resilience in livable streets has brought about a chain of problems, including reduced urban vitality, limited adaptability, inability to meet the multi-tiered demand. We aim to identify resilience objectives across multiple levels and seek a balance among diverse stakeholder demands. Proposing a forward-looking guide combining rigidity and flexibility, integrating traditional and new technologies, and unifying long-term and short-term goals. This vision is directed towards fostering more resilient, living streets, ultimately driving the enhancement of urban resilience.

This study can provide valuable insights for addressing the potential emergence of various ambiguous issues in future cities. It encourages urban areas to contemplate transformation amidst changing circumstances, transcending traditional development models and striving to construct urban systems that are more sustainable, resilient, and adaptive.

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# Knowledge Graph Analysis of Traditional Village Cultural Heritage Research

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## Abstract

This paper aims to analyze the history and hot frontiers of traditional village cultural heritage research. This study takes 6225 Chinese literatures and 7538 foreign literatures collected by CNKI and Web of Science from 1998 to 2023 as the research objects, and uses Citespace software to analyze the knowledge map from the dimensions of research overview, research process, research authors and publishing institutions, and keyword development path. This paper discusses and analyzes the research results of traditional village cultural heritage at home and abroad, and summarizes and prospects the research direction.

## Author keywords

Foresight Plan;Traditional Village;Cultural Heritage;Knowledge Graph;Citespace

## Introduction

The traditional village used to be the main place for people to engage in various production activities. It is the cultural carrier and symbol of agricultural civilization. The cultural heritage connects the historical memory and folk culture of the place, and breeds the local culture. Nowadays, with the rapid development of industrialization and urbanization in various countries of the world, the villages on which people once depended are facing problems such as continuous decline and separation of old and new areas.

Traditional villages have become a topic of concern around the world, and relevant research literature has also increased year by year.

With the development of information visualization, more and more academics use scientific knowledge maps for research. In 2005, mapping knowledge domains began to be used in academic research in China. Scientific knowledge map is an image that shows the development process and structural relationship of scientific knowledge based on knowledge domain. In the face of a large number of documents, the use of software tools to visualize the literature data will improve the efficiency of learning and research, and the conclusion will be more accurate. Therefore, this study will use Citespace as a tool of bibliometric analysis to analyze the knowledge map of traditional village cultural heritage, construct a visual knowledge map, grasp the research status and progress of traditional village cultural heritage as a whole, and carry out research review and prospect, so as to provide reference for the follow-up research of traditional village cultural heritage.

Research Methodology and Literature Data Collection

Knowledge Graph is a fast way to present data in today's big data era. At present, the tools commonly used in academic circles to draw graphs are Citespace ,SPSS , Ucinet ,VOSviewer and so on. This article mainly uses Citespace software ( V6.2.R4 ( 64-bit ) ) to extract network maps and timeline maps of researchers and publishing institutions for visual analysis.

First, Chinese literature and English literature were collected from China National Knowledge Infrastructure(CNKI) and Web of Science. Searched by ‘subject’ with ‘all years’ as the time span. Due to the different appellations of traditional villages in China, ' 传统村落 ', ' 古村落 ' or ' 传统聚落 ' are selected as the search terms, and ' 文化遗产 ' is added as the search term to search the process. Unrelated items such as conference notices, conference drafts, newspaper reports, and results introductions were deleted. A total of 6225 articles were obtained. Each article contains information such as author, institution, keyword, abstract, and publication date. In the collection of English literature, the source of literature is limited to all the literature in the 'Web of Science Core Collection '. The combination of ' traditional village ' + ' cultural heritage ' or ' ancient village ' + ' cultural heritage ' or ' traditional settlement ' + ' cultural heritage ' was used for retrieval, and ' theme ' was used as the retrieval approach. The retrieval time of the literature was ' all years ', and a total of 7538 articles were obtained. Subsequently, 6225 Chinese literature and 7538 foreign literature valid samples were transferred.

Research Overview

Overview of overseas research

As shown in Figure 1, the research on the cultural heritage of foreign traditional villages has been published since 1998, until 2017, it continued to grow slowly, and the number of publications increased rapidly after 2017. Overall, foreign related research is generally greater than domestic research.

From the source of international journals, Sustainability is the most published journal abroad, with 185 articles, followed by Journal of Ethnobiology And Ethnomedicien.Foreign traditional village cultural heritage research areas involve China, the United States, Japan, Italy and other places (Figure 1.), of which the volume of Chinese traditional villages is the largest, followed by the United States. From the keywords of foreign literature, the content of foreign traditional village research includes ' land use ', ' climate change ', ' thermal comfort ' and ' traditional ecological knowledge '.

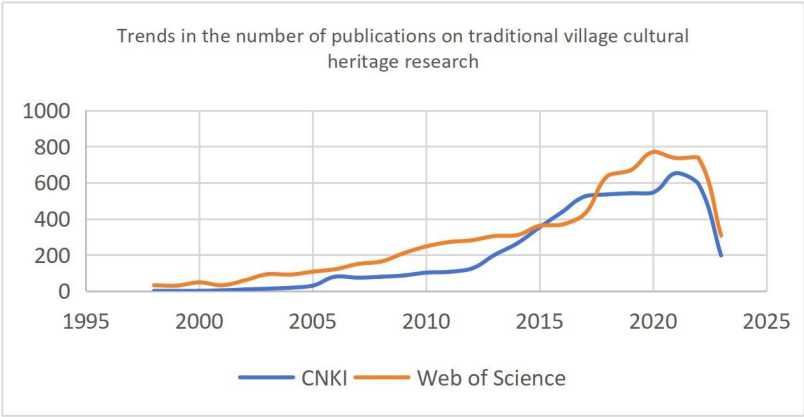


Figure 1. Trends in the number of papers published on traditional village cultural heritage research

## Overview of domestic research

### Research history

From the perspective of domestic literature as a whole (Figure 1.), the number of documents issued by traditional village cultural heritage in China has increased steadily, especially after 2012, the number of documents issued has increased significantly until 2017, and the growth rate has slowed down. So far, it has shown an increasing trend ( as of August 2023 ) and reached its peak in 2021. The research stage of traditional village cultural heritage in China can be divided into three stages :

#### ① Emerging and starting stage (1998-2012)

From the policy point of view, in 2006, the first professional cultural forum on the theme of protecting ancient villages was held. Under the initiative of Mr. Feng Jicai, all walks of life launched an investigation and collation of the cultural heritage of traditional villages, and the literature on the cultural heritage of traditional villages subsequently increased significantly ; in 2008, the " Regulations on the Protection of Famous Towns and Villages of Historical and Cultural Cities " was issued to promote the systematization, standardization and legalization of cultural towns and villages ; at this stage, a total of 646 traditional villages were included in the first batch of traditional villages. The guiding documents issued by have laid the foundation for policy support for the next stage of literature 's explosive growth.

From the perspective of academic research, compared with foreign research on the cultural heritage of traditional villages, China is in its infancy, with a total of 728 articles published between 1998 and 2012. In the 1980 s, China 's academic circles began to shift from traditional dwellings to the study of traditional villages. The research contents involved ' ancient villages '( 古村落 ), ' settlement protection and development ' ( 聚落保护与发展 ) , ' rural tourism ' ( 乡村旅游 ) , ' ancient village renovation ' ( 古村整治 ) and ' human settlement environment construction ' ( 人居环境建设 ) . 'Ancient village ' is a very vague concept, and traditional villages are not equivalent to ancient villages in the general sense.Later, ' traditional village ' has a clear definition : it refers to the ancient architectural community with the value and overall inheritance of traditional culture and national culture. At this stage, the scope of research topics on traditional village cultural heritage is relatively narrow, mainly focusing on topics such as protection planning and development strategy. In addition, under the policy of ' protecting ancient towns, building new areas, developing economy and opening up tourism ' proposed by Ruan Yisan, Wang Yuan, Wang Yinyin,Han Fei and others explored the evolution of village forms under the influence of rural tourism. At this stage, the national policy level has issued many guiding documents, which provide policy support for the next step to better promote the development of traditional villages. The academic research focuses on ancient villages, settlement protection and development, rural tourism, ancient village renovation and human settlement environment construction. The research methods at this stage are relatively simple, mainly based on fieldresearch, in-depth interviews and case analysis as the main qualitative research methods.

#### ② Rapid growth stage (2013-2017)

From the perspective of policy release, in 2013, the Ministry of Housing and Urban-Rural Development issued the “Basic Requirements for the Preparation of Traditional Village Protection and Development Plans (Trial)” and announced a list of 915 second-batch traditional villages; in 2014, the Ministry of Housing and Urban-Rural Development issued the “Guiding Opinions on Effectively Strengthening the Protection of Traditional Villages in China” and announced the list of 994 third batch of traditional villages; in 2015, the Ministry of Housing and Urban-Rural Development issued a notice on the protection of traditional Chinese villages. In 2016, a list of 1598

fourth batches of traditional villages was determined. The successive releases of relevant policies showed that the state attached great importance to the research work of traditional village cultural heritage at this stage. From the perspective of academic research, there were 1750 documents published in 2013-2017, which was more than twice the previous stage, and the number of documents had increased significantly. At this stage, domestic scholars introduced multi-angles such as religious culture, cultural ecology, and landscape genes to study the cultural heritage of traditional villages. The keywords included ' digitization ' (数字化) ' activation ' (活化) , ' landscape gene ' (景观基因) ' organicity ' (有机性) , and the research areas involve ' Guangdong Province ' , ' Anhui Province ' , and ' ethnic minority areas ' . Combined with the literature, the research methods of this period included the trend of combining qualitative and quantitative research methods.

The release of national policies had promoted the development of research, so the number of documents at this stage showed explosive growth, and the research content had enriched the historical, cultural, scientific and other diversified content on the basis of traditional rural protection. The study area involved ethnic minority areas; in terms of research methods, the traditional qualitative analysis had been transformed into quantitative analysis using tools such as remote sensing, GIS, and digital models.

### ③ In-depth development stage (2018-present)

From the perspective of policy release, in 2018, the CPC Central Committee promulgated the " Opinions of the State Council on Implementing the Rural Revitalization Strategy " and the " Rural Revitalization Strategic Plan ( 2018-2022 ) " to provide policy support for rural development and protection. Subsequently, a large number of scholars participated in the research, and the number of publications reached a peak in 2021. At this stage, the Ministry of Housing and Urban-Rural Development and other departments announced the fifth and sixth batch of national traditional village lists, a total of 8155, which provided a rich reference sample for scholars ' research on traditional village cultural heritage.

From the perspective of academic research, there has been 3856 articles published since 2018. The first two stages had laid a solid theoretical foundation for this stage with the support of national policies and the participation of the whole population. The research hot topics at this stage added local landscapes, heritage protection, and rural revitalization. The research topics focus on the 'integration of culture and tourism in traditional villages' ( 传统村落的文旅融合 ), 'the optimization and renewal of traditional landscapes' ( 传统景观的优化更新 ), and 'the application of digital technology in cultural heritage' ( 数字技术在文化遗产中的运用 ). The research content has changed from the previous horizontal expansion to the vertical deepening of different elements of the same sample. There are also innovations in research methods. For example, Li Bohua et al., using space syntax and cognitive image theory, combined with field research data, interpreted the internal relationship between spatial morphological characteristics and spatial cognition in Qinchuan Village. Based on Heritage Impact Assessments ( HIAs ), Xiao Hongwei et al. expounded the relevance and coupling between heritage impact assessment and traditional village cultural landscape protection, and proposed the significance and value of applying heritage impact assessment to traditional village cultural landscape protection.

The academic research content of this stage has changed from the previous horizontal expansion to the vertical deepening of the total factor ; the scope of research has shifted from the spatial pattern and morphological evolution of traditional villages to the endogenous culture of more in-depth traditional villages ; the research methods are more diverse, involving quantitative research methods such as spatial syntax, impact assessment,



digital model technology, and even qualitative and quantitative mixed research methods.

Analysis of researchers and cooperative networks and publishing institutions

The author is the main body of scientific research. Through the analysis of the structural characteristics of the author and his cooperation network, the core author group and its cooperation relationship in this field can be reflected. The number and size of nodes in the figure represent the co-occurrence frequency of the core author group. The lines and thickness reflect the author 's cooperative relationship and cooperation intensity. They together form the knowledge map of the author group and the cooperative network.In the figure (Figure 2.), it can be seen that a total of 258 nodes and 19 links appear, and the network density is 0.0023.From the frequency point of view, the authors with the highest number of occurrences are Liu Peilin, Feng Jicai and Deng Yunyuan, and the number of publications has reached more than 10, which are 25, 11 and 10 respectively, followed by Li Bohua, Zhang Jie and Dou Yindi.The node connection reflects the cooperative relationship between the authors. From the diagram, it can be seen that the research on the cultural heritage of traditional villages has initially formed two core research teams, that is, the research team with Liu Peilin, Deng Yunyuan, Dou Yindi, Li Bohua as the core, and the research team with Sun Zhiguo, Xiong Wanzhen and Liu Hong as the core (Figure 2.). From the perspective of cooperation intensity, there is a certain degree of cooperation among the issuing agencies in China, but the research differences between the teams are large, and the cooperation intensity is very weak.

The number of papers issued by scientific research institutions shows their achievements and investment in this research field. Through Citespace software, the research status and actual contribution of the publishing institutions to the cultural heritage of traditional villages were analyzed, and the cooperation map of the publishing institutions was obtained. It can be seen from the figure (Figure 3.) that the research on the cultural heritage of traditional villages is mainly concentrated in colleges and universities. The university with the largest cumulative number of publications is Xi 'an University of Architecture and Technology, with a number of 202 articles. Followed by South China University of Technology, Taiyuan University of Technology, Kunming University of Science and Technology. At present, most colleges and universities explore the sustainable development of traditional villages from the perspective of cultural protection and optimization. Due to regional differences, most universities adopt the principle of proximity when selecting samples, and explore different paths for the protection of cultural heritage in different regions. The research team of South China University of Technology pays close attention to the way of traditional village activationand the texture of landscape formation. In recent years, Hengyang Normal University has made great progress in the fields of digital protection and application of traditional villages, landscape gene mining and so on.

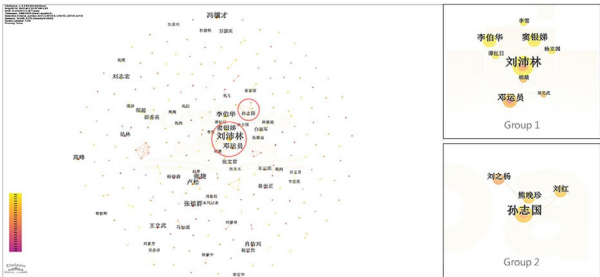


Figure 2. Co-occurrence knowledge map of traditional village cultural heritage research institutions

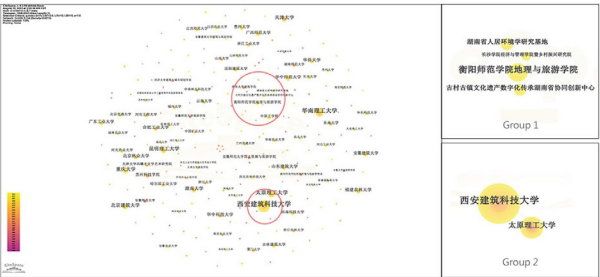
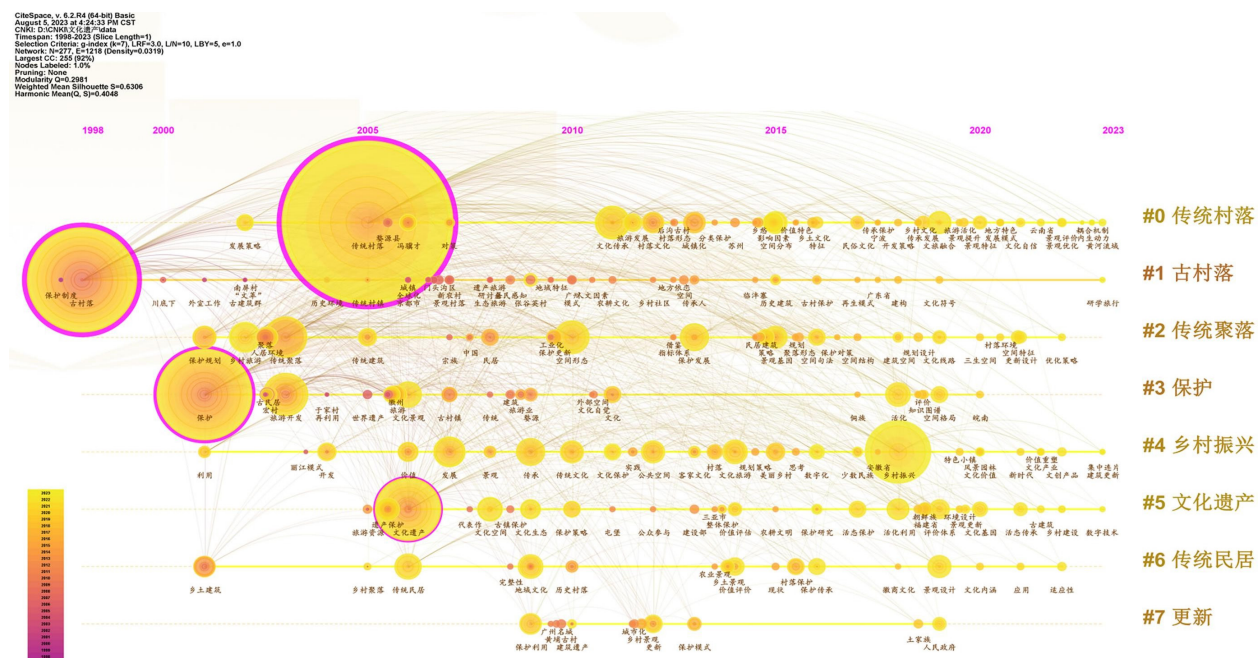


Figure 3. Knowledge map of co-occurrence of authors of traditional village cultural heritage research

Figure 1. Trends in the number of papers published on traditional village cultural heritage research



**Figure 4.** Time-line cluster map of keywords in raditional village cultural heritage research

## Keywords development path analysis

The time-line cluster map was generated by Citespace software (Figure 4.) . We can see that the keyword co-occurrence map of traditional village cultural heritage research is roughly developed in eight directions, which are Traditional Villages, Ancient Villages, Traditional Settlements, Preservation, Rural Revitalization, Cultural Heritage, Traditional Dwellings, and Renovation.

## Conclusion

This paper uses Citespace software to visually analyze 6225 Chinese literatures and 7538 English literatures on traditional village cultural heritage research from 1998 to 2023 in CNKI and Web of Science databases, and draws the following conclusions:

1. From the perspective of the number of publications, the number of publications on the research literature of traditional village cultural heritage at home and abroad is increasing year by year. The domestic traditional village cultural heritage has experienced three stages: the initial stage (1998-2012), the rapid growth stage (2013-2017), and the in-depth development stage (2018-present). From the perspective of the annual number of publications, it can be explained that the time distribution of the number of publications on the research literature of traditional village cultural heritage in China reflects the positive relationship with the national policy orientation to a certain extent.

2. From the perspective of the number of publications, the number of publications on the research literature of traditional village cultural heritage at home and abroad is increasing year by year. The domestic traditional village cultural heritage has experienced three stages: the initial stage (1998-2012), the rapid growth stage (2013-2017), and the in-depth development stage (2018-present). From the perspective of the annual number of publications, it can be explained that the time distribution of the number of publications on the research literature of

traditional village cultural heritage in China reflects the positive relationship with the national policy orientation to a certain extent.

3.From the perspective of keyword co-occurrence map, the research on traditional village cultural heritage in China mainly focuses on eight aspects: ' traditional village ', ' ancient village ', ' traditional settlement ', ' protection ', ' rural revitalization ', ' cultural heritage ', ' traditional residence ' and ' renewal '. With the change of social environment, China has paid more and more attention to ' living inheritance ', ' cultural integration ' and ' renewal design ' in recent years. The research content and hot spots have been closely following the national policy, from the initial research on ancient villages and tourism to the development of multi-field and multi-disciplinary research. On the whole, all research directions will return to the same goal of protection and development of these sites.

4.From the perspective of keyword co-occurrence map, the research on traditional village cultural heritage in China mainly focuses on eight aspects: ' traditional village ', ' ancient village ', ' traditional settlement ', ' protection ', ' rural revitalization ', ' cultural heritage ', ' traditional residence ' and ' renewal '. With the change of social environment, China has paid more and more attention to ' living inheritance ', ' cultural integration ' and ' renewal design ' in recent years. The research content and hot spots have been closely following the national policy, from the initial research on ancient villages and tourism to the development of multi-field and multi-disciplinary research. On the whole, all research directions will return to the same goal of protection and development of these sites.

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## Future of Textile: Sustainable Design via ChatGPT

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### Abstract

This short paper will forecast the role of ChatGPT in promoting sustainable design in the textile industry and its ensuing benefits. Research on ChatGPT in the textile industry could focus on how this artificial intelligence (AI) tool can be used to optimize material selection, improve resource efficiency, foster a circular economy, and inspire design innovation. For instance, it will help enterprises optimize the production process, assess and improve environmental, social and economic impacts across the supply chain. Overall, the future of textile will become more environmentally friendly, efficient and ethical, and AI tools such as ChatGPT will play an important role in its sustainable design practices.

### Author keywords

ChatGPT; textile; sustainable design; trend analysis

### Introduction

The expansion of textile industry, over the past few decades, has brought serious environmental issues such as water pollution and consumption, chemical usage, and greenhouse gas emissions. With the increasing concern for environmental issues, the textile industry, while significantly contributing to the global economy, pays more attention to sustainable development. The ultimate goal of sustainable development is to balance the needs of society, the economy, and the environment, which means the practice of meeting the needs of the present without compromising future generations to meet their own needs. To be specific, the sustainable design of textile denotes the adoption of comprehensive strategies and methods in the production process of textiles and clothing, aiming to minimize negative impacts on the environment and society, and promote the sustainable utilization of resources and social responsibility. In the long term, textile enterprises must adopt more environmentally friendly production and processing methods to reduce resource consumption and waste generation. At the same time, consumer demand for sustainable textiles will also increase, driving the development of the sustainable textile industry.

### ChatGPT's role in fostering sustainable design

ChatGPT is an advanced language generation model developed by OpenAI, which has three noteworthy features that show its sustainable potential. Firstly, it can integrate resources to generate plans or suggestions. By drawing from a broad knowledge base acquired from diverse web sources, it formulates pertinent and contextually aware responses. Secondly, it exhibits a capacity for analysing and understanding subtle differences. Harnessing its mastery over language, ChatGPT maintains the contextual thread in conversations, interpreting

complexities and nuances that many other models struggle with. This enables it to provide relevant responses and engage in authentic, meaningful interactions. Lastly, it can provide data predictions and gain insight into trends. Through patterns inferred from extensive training data, it can anticipate possible directions in dialogue or predict likely outcomes, increasing the utility of its interactive capability.

ChatGPT's role in fostering sustainable design can be summarized in three core aspects: material selection and usage, design principles and strategies guidance, as well as environmental impact assessment.

#### Material selection and usage

The textile industry consists of a highly complex and massive supply chain, which includes multiple stages of production, raw material sources, and distribution networks. The supply chain begins from sourcing and gathering raw materials, such as cotton, silk, linen, and wool. This production involves harvesting and processing the raw materials, which then can be turned into yarn, fabrics, and textiles through spinning, weaving, dyeing, knitting, and finishing.

As a result, selection of raw materials is a key aspect of sustainable design, manufacturers are actively seeking new ways to produce textiles sustainably – making use of renewable materials and energy sources, reducing their impact on the environment. Through its understanding of material selection and robust knowledge base, ChatGPT can recommend sustainable materials for enterprises, such as organic cotton, recycled fibers, or biodegradable materials, as well as chemicals and dyes used to produce the aesthetic look of the product. It can also suggest optimal fiber blends that enhance durability and longevity, leading to greater resource efficiency.

#### Design principles and strategies guidance

In addition to optimizing material selection, enterprises also need to consider the environmental, social and economic impacts of their processes at each stage, including resource efficiency, product life cycle, circular economy, and so on. For example, during the raw material extraction and production stages, enormous amounts of water resource will be consumed. Furthermore, synthetic materials made from petroleum-based sources, such as nylon, polyester and acrylic, will create additional pollutants and cause water pollution, soil erosion and air pollution. ChatGPT contributes to the formulation of design strategies that prioritize circular economy principles, offering creative ideas and innovative techniques for textile and fashion design.

By facilitating the development of recycling and upcycling initiatives, as well as extending product life cycles, ChatGPT ensures that sustainability is woven into the design process from the outset. For instance, ChatGPT can suggest ways of reclaiming the waste and converting it in to viable materials through advanced techniques. It can also help enterprises to reduce water usage in their manufacturing processes and design processes that are more viable in the long run, by suggesting and evaluating different ways of efficient use of resources and water. Moreover, ChatGPT can assist designers in envisioning innovative approaches that support circular economy principles. By facilitating the development of recycling and upcycling processes in textile production, as well as offering creative ideas for garment design that prioritize reuse and extend product life cycles, it can help inspire designers to create with long-term sustainability in mind.

#### Environmental impact assessment

ChatGPT's ability to analyze data and provide insights helps designers and manufacturers evaluate the



environmental consequences of their choices. Reviewing the entire supply chain by ChatGPT, enterprises can analyze performance and identify areas of improvement while meeting their sustainability goals. On the one hand, the textile industry's supply chain can be assessed, monitored and improved through various models, such as the Environmental Impact Matrix or the SocialFingerprint system. The former is a tool that used to assess and improve the environmental, social and economic impacts throughout the supply chain. It helps to identify potential issues and offer solutions effectively. The latter is another tool that operates similar function. This tool not only helps improve the sustainability of textile production, but also helps increase transparency, accountability.

On the other hand, ChatGPT can identify subtle changes in the data, such as anomalies in the production line or a decrease in power usage, and alert technicians to take quick action. This can help prevent time wasted and production disrupted, making operations in the textile industry more efficient and sustainable. Furthermore, it can identify bottlenecks at specific stage of the production line, raise optimization solution, and predictive maintenance and real-time tracking.

## Conclusion

Overall, ChatGPT combines resource integration, subtle difference understanding, and data prediction to provide a text-based data interactive solution for textile industry. Firstly, ChatGPT's robust knowledge base and context-aware suggestions aid in the selection of sustainable materials, promoting resource efficiency and the use of eco-friendly alternatives. Secondly, its ability to guide design principles and strategies ensures that sustainability is an integral part of the design process. In addition, its data-driven insights help designers and manufacturers assess the environmental impact of their choices, enabling them to minimize waste and reduce pollution. Additionally, the AI's capacity to stay abreast of global trends in sustainability allows industry stakeholders to remain informed and competitive.

ChatGPT provides a clear path towards a more sustainable future of textile, by optimizing material selection, encouraging a circular economy, and advancing resources efficiency. It will be a vital tool for driving the textile industry towards a more sustainable, intelligentized, and responsible future.

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## Exploring the transformation from tradition to ‘living tradition’ within Textiles

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### Abstract

A general opinion holds that ‘the modern’ is the opposite of ‘the traditional’. The term non-traditional is employed here as if modernity and tradition are merely opposing concepts in terms of time. In this paper I investigate the dichotomy between the traditional and the non-traditional, as well as the continuation of ‘living traditions’ by looking at the evolving history of Qipao (Chinese traditional women’s garment) and Interview analysis based on the innovative use of traditional decorative motifs by traditional craftspeople. This paper offers theoretical exploration and interview data to support the ongoing revival of traditional crafts in both western and Chinese culture.

The development of textile craft and traditional modes of making (and the traditional motifs used) have faced a challenge within modern culture. The underlying significance of traditional patterns have arguably been lost along with the related craft skills. Therefore, certain modifications are required to fit within modern culture and contribute to the revival of tradition. What can be done to allow aspects of these “disappearing” traditions to become once more ‘living traditions’? Such an endeavour will require the participation of designers, traditional craftspeople, and government agencies, which many have begun to explore the possibilities for transformation at various levels.

### Author keywords

traditional; non-traditional; transformation; textiles

### Introduction

If ‘tradition’ is only defined as, or associated with, the past (Yang, 2007), then the opposite of tradition, non-tradition, means ‘modern’. Gyekey (1997) argues that tradition and modernity are not in conflict but rather that opposition comes from an incorrect interpretation of tradition, which sociologists and anthropologists regard as being resistant to change and related to a vision of the past. In anthropological studies, the term ‘tradition’ is frequently linked to depressing notions of ‘disappearance’, ‘vanishing,’ or ‘residual’ phenomena (Varutti, 2015) and, as such, has been considered a barrier to innovation. However, some scholars believe traditions are inherited and can be changed to fit the times (Hobsbawm, 1983; Eicher & Sumberg, 1995, quoted in Yang, 2007). They also have certain forms, including beliefs and norms, that can be passed down from generation to generation (Gyekey, 1997) or could then be seen as a ‘living tradition’. Tradition should be a socio-cultural practice that ‘assigns temporal meaning’ (Shoham, 2011), providing a possibility for ongoing exploration and expansion (Petrucelli & Albino, 2012). Wall (2015) further defines this model of passing on a tradition whose

meaning changes with time and acknowledges the various inheritors' differing interpretations of it as a 'living tradition' .

In brief, the way to determine whether non-tradition is a living tradition or modern, is to analyse whether it is an 'inheritance' , based on the preservation of traditional materials and processes, and whether the definition of tradition is static (Beckstein, 2017). Hills argues that a practice or belief that lasts for at least three generations is considered a tradition (Fleischacker,1994). Therefore, some of the adjustments made to traditions by the present generation in order to meet current personal, social or institutional needs (Yang,2007) may not evolve into a 'tradition' . I define such adjustments as 'non- traditional' . This non-traditional is manifested in the adaptation of the various elements involved in the production process of traditional crafts, including production, content, technology, and concept.

These dichotomies between traditional and non-traditional give a theoretical foundation for the revitalization of traditional crafts from their origins, whilst offering the potential to turn traditional crafts into 'living traditional crafts' that are more suited to our modern society. This paper, which is part of my PhD research, focuses on a theoretical perspective and the analysis of some interviews I conducted with masters in the provinces of Guangxi and Guizhou. It takes an interdisciplinary approach to traditional crafts and explores possibilities for the development of traditional crafts.

### **The traditional and non-traditional dichotomy within Qipao as a case study**

Active or reactive social change causes non-traditional transformation. Liu (2017) noted the non-traditional nature of the Qipao is due to the influence of the modern movement and the adaptation to mainstream Western fashion. By the late 1910s, and inspired by societal change (Cox, 2019), women began to reject typical gender roles that had been given to them in the past. The Qipao developed as a non-traditional style that hid differences between genders (Zhuang,1921; Huang,1921, cited in Liu, 2017). The fabric design of the Qipao was influenced by Western art trends and the interaction between Eastern and Western culture, which led to a transfer from the programmed tradition of the Qing Dynasty (Zhang et al., 2022).

When the reign of the Qing dynasty ended, animal motifs, symbolising power and status, were incompatible with the Republican ideology of freedom and democracy and were therefore used much less frequently. Western decorative arts contributed Qipao fabric motifs turn auspicious symbolic meanings into decorative aesthetics and use geometric and floral designs (Cox, 2019; Huang, 2015), shifting to colourful fabrics and imitating Western garment construction (Liu, 2017). We could draw the conclusion from this that cross-cultural communication and learning can also make something non-traditional. According to Deleuze and Guattari (2016), some authors write in non-native languages to remove cultural boundaries and achieve a deconstruction of cultural domination and forms of authority through the de-territorialisation of language. The same process has been applied to the craft field. By incorporating motifs, resources, and experiences from other languages, one could reconsider how art language is currently expressed and create something new and valued in different cultural contexts (Veiteberg, 2005). Bhabha (2012) declares that the hybridisation of two distinct species is a form of cultural progress. Hybrids in cultural forms could also be manifested in the process of craft making, where different species are understood as different cultures, and this hybridisation expands the space for the creation of craft practices. On the other hand, hybridisation can also occur within craft making. Craft art's own definition refers to a traditional Western dichotomy: between hand and intellect, body and spirit, object and meaning (Weimarck,2003, cited in Veiteberg,

2005). In terms of object and meaning, anthropologist Michael Thompson (2017) classifies the value of objects as "durable and transient", but he argues that the value of things can be transformed under certain conditions, from losing value to reusing it to get it back. In brief, the role of cross-territory, cross-cultural interaction based on the local culture is regarded as breaking down authority while extending the original cultural composition, according to French theorists Deleuze and Guattari and the post-colonial theoretician Bhabha. This could be seen in the Qipao's cross-cultural development and the following example of Mr. Pan's cross-disciplinary creations that integrate modern design with traditional dyeing.

Traditional crafts need to be transformed due to changing lifestyles and new manufacturing methods in modern time (Kolay, 2016; Lin & Watada, 2009; Yang et al., 2018). Currently, although traditional textile craft and design are frequently associated with luxury handmade products, symbolising high standards and complex techniques, in other cases, time-consuming handmade textile production remains incompatible with the low-cost, high-efficiency production demanded by mass production (Ebert et al. 2016), which caused the market for a large number of traditional handicrafts to be replaced by other mass-produced items (Yang et al., 2018).

In China, craft activities are positioned under the Culture-related Industry Policy Framework. The State Council of China listed 629 traditional crafts and arts as national intangible cultural heritage in 2021, including 84 dyeing and weaving crafts like embroidery, hand printing and dyeing, and brocade weaving. This emphasises the value of traditional crafts but also the challenges of post-20th-century craft production.

## Methodology

I am using qualitative research methods in my research. Rather than relying on a single data source, I will collect data from several sources, including field observations, semi-structured interviews, and photography. My analysis draws on the theoretical perspective outlined in my literature review above in the introduction, but also on epistemological approaches that consider research to be an iterative spiral-like process rather than a linear process carried out in progressive cumulative stages. This means that analysis is not a separate and subsequent stage of the research that takes place after the gathering of data, but an ongoing process that informs the design and conduct of research as it goes forward. Hence, data gathering, and analysis will be ongoing, and will be put in close conversations with the research questions.

## Discussion and conclusion

The research questions that guide this paper are:

- Has the meaning and usage of decorative motifs from the late 19th century to the early 20th century continued within Chinese textiles? If so, is there a role for decorative motifs in current creative practice?
- What role do these textile motifs still play in Chinese culture? What is their modern purpose? What has been lost in their modern development, and why are traditional craftspeople still making them? Could such textile motifs be considered or potentially become a 'living tradition' ?
- 

The target groups of this part of my research are traditional craft makers who have been involved in or are in the process of reviving craft in China. To make the research data comparable, I defined the following conditions for participant recruitment. I interviewed traditional craftspeople with more than ten years of experience in traditional craft-making, whose income comes mainly (more than ninety percent) from direct sales of their products, i.e., from traditional craft. All my interviewees are based in southwest China.

Preliminary data of such interviews indicate that all three interviewees have innovated modern applications of traditional motifs, but only to varying degrees and in different forms, and have retained tradition in differing proportions.

Ms Jiang who is engaged in the traditional craft of paper-cutting for generations mentions that she uses traditional motifs that have been passed down from her ancestors, such as the Hmong heroine figures Maoxi Wu and Xiumei Zhang and the story of Mother Butterfly. However, she also creates new motifs according to market demands and the needs of the embroiderers. She thinks traditional patterns should be combined with contemporary designs to increase sales. She would like a designer to collaborate with, because of her limited education in this area. She indicates that to lower the cost and be able to sell more products, she cut some of the processes involved in the traditional way of making them. The evidence from this study suggests that she actively draws from traditional motifs and crafts due to the development of modern demand and to meet the challenge from the influence of mass production, which could be described as the transformation from pure tradition to a living tradition. However, it is still essential to consider what is lost in this shortening of the making process. I will explore this aspect in a further study.

The tension between traditional and modern is showed in an anecdote told to me by Ms Jiang in which a young girl started her apprenticeship but only lasted three days due to her uncertainty about the future development of traditional crafts in modern societies. This also speaks of the challenges posed to knowledge.

The line of intergenerational knowledge transmission, apprenticeship, etc., is on the verge of breaking down, eventually leading to such knowledge's disappearance. Mr Pan mentioned that there are very few traditional apprenticeships still available to young people and that the traditional crafts he currently carries out are taught on a paid basis. This kind of transformation can be defined as non-traditional, as the participants only concentrate for a short period, and there is no particular answer as to whether what has been learnt can be applied in everyday life afterward. I am planning to research these topics further by conducting future interviews with participants paid to learn traditional crafts. In general, therefore, it seems that the mode and form of passing on the traditional craft have transformed. The reason for it, in Mr Pan's view, is that in a modern economic society, teaching traditional crafts must be profitable and economically relevant to take place. We can conclude that traditions need to be adapted to contemporary society to be sustainable, thus becoming a living tradition. The current study found the necessity to make transformations from traditional to a living tradition. However, many primary and secondary schools in China have taken measures to incorporate elements of intangible cultural heritage to pass on traditional crafts. I consider the incorporation of intangible cultural heritage in schools as an approach to adapting traditional apprenticeship to modern society in its rights, which could last for a relatively long period. But there is still a long way to go in exploring ways to pass on traditional crafts.

Ms Jinhua further mentioned that the main reason for motif innovation is a change in taste in the mainstream consumer population. She believes that we need to conduct innovation on traditional elements of the motifs to create new designs, adjusting the colours of the pattern to be more muted and to improve the comfort and breathability of the fabric.

Mr Pan has a deeper understanding of how traditions can be applied to innovation because he was formally trained in design at an undergraduate and postgraduate level. He believes that combining tradition and

modernity does not mean applying directly traditional motifs to new forms, as many traditional craftspeople may think, such as the transformation from garments to bags. He believes that the format should not constrain the continuation of tradition to copy the traditional motifs completely. He disagrees with traditional craftspeople painting batiks only with traditional motifs, and he believes that being overly influenced by a sense of responsibility to pass on tradition would lead to being unable to innovate.

Mr Pan believes that traditional craftspeople should first selectively discard traditional elements and then allow other disciplines, such as painting and design, even chemistry, to intervene and engage in inter-professional and inter-disciplinary innovative manufacturing. He mentioned, "In addition to applying the patterns directly to our clothes and bags, we are also expanding it to a new way of thinking and intervening in the traditional industry. We are not stuck in the old ways. We are adapting and evolving. "We can conclude that this is the role of cross-disciplinary interaction in breaking down traditional stereotypes while expanding the original cultural composition and transforming traditional motifs into 'living traditions.'

In this paper, I have started a theoretical exploration of the notion of "tradition," highlighting some initial elements that could help the revitalization of traditional crafts. Having clarified the terms "tradition," "non-tradition," and "living tradition," I then analysed the transcripts of three Chinese interviewees in the light of theory, exploring how these terms are used. Analysing the practices of traditional craftspeople who carry out innovative practices of traditional motifs shows a positive outlook for revival and an example of a tradition transforming into a living tradition. Future research is needed that includes more practice, and more in-depth interviews are required in order to delve deeper into the process of transformation from traditions into living traditions, where the specific contributions of traditional craftspeople to the innovation of traditional craft techniques and motifs could be identified and left as heritage to future generations, thus becoming a truly living tradition.

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# The Design-Driven Symbiotic Innovation of Plants' New Roles under the Sustainable Dialogue - Take Phytoshpere as an Example

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## Abstract

Enormous human activities and the continuous expansion of man-made environments poses unprecedented challenges to the sustainability of the plant world and, ultimately, the human world. As an irreplaceable part of nature, plants are increasingly being presented in various artificial environments. Inspired by Pollan's theory of plant intelligence for survival and reproduction motivation, we argue the necessity to reconsider a self-consistent interactive system centered on plant perspective and aims to explore the new role of plants in artificial environments and discuss their survival strategies. The major research methods include secondary research and case study. As an output, we expand the previous idea of the PCI typology under the framework of Design for Sustainability (DFS) (Su & Liu, 2022), and introduce in a practical way the radical but plausible opportunities and possibilities for plants to adapt to, evolve, and achieve sustainable development for their species.

## Author keywords

Plant-Computer Interaction; symbiotic design; sustainability; new roles of plants.

## Introduction

Conflicts between artificiality and plant territories

Humankind has never ceased to transform and influence nature. Since the industrial revolution, the rapid increase in manufacturing capacity has led to rapid growth in artificialities. Enormous human activities and the expansion of the built environment are continuing, leading to the destruction and encroachment of natural territories on which plants rely for survival.

According to the Food and Agriculture Organization of the United Nations, 12 million hectares of forest are lost yearly, declining at 0.3% per year (FAO, 2020). It poses challenges to both ecology and plant biodiversity. Around three-quarters of the planet's land has been severely altered by human activity (IPBES, 2018). Besides, habitat loss and fragmentation due to urbanization are also increasing the threat of plant species extinction (Aronson et al., 2014; Beninde et al., 2015).

The secondary role of plants

Plants have been used as a natural resource that keep creating value for humans in terms of nutrition, aesthetic experiential and other needs (Aspling, 2016). Human beings have never stopped using plants, but the claims and rights of plants have been more neglected than animals. Plants may be mostly defined as the secondary role in the current hierarchy of artificial environment (e.g. in the interior space), compared with humans and animals as

primary roles. As Marder (2013) uses 'the margin of the margin' to describe our neglect of plants. The main reason may be that humans, as animals, have a vastly different way of being and temporal dimension from plants, and our arrogance prevents us from appreciating the wisdom of plants and their success (Pollan, 2013). Adequately 'understanding' the plant becomes a prerequisite for this study.

#### Unexpected intelligence, perception & collective survival strategies of plants

Plants have been seen as passive and primary producers. Nevertheless, several advancements in plant science show that plants are more intricate, sophisticated, and even "smart" than previously known and conduct cerebral behaviour without an actual brain (Pollan, 2013). Mancuso & Viola (2015) find that plants can use electronic and chemical messaging systems for memory and are capable of cognition, communicating, learning and even manipulating other species. Plants are also thought to have different-formed senses, including sight, hearing, taste, smell and touch.

Although individual plants are mostly immobile and fragile, they can interact between species to form plant communities characterized by 'distributed computing', 'swarming behaviour', and 'iteration'. 'Stress Gradient Hypothesis' demonstrates that environmental pressure is positively correlated with interspecific facilitation (Maestre et al., 2009). It supports the idea that plant communities show intelligence in response to environmental challenges. For example, some plants, like *Arabidopsis thaliana*, secrete gases such as ethylene to warn other individuals to activate their defense systems when being attacked by herbivores or insects (Zhang et al., 2012), which exemplifies a collective strategy within the plant species. This makes it possible to exploit inter-plant interactions that contribute to the population flourishing.

#### A New Perspectives - New Roles of Plants

Despite a variety of exotic survival strategies, the extinction of some species and the sudden drop in vegetation area imply that plant groups are showing difficulty adapting to the rapid environmental changes caused by modern artificial activities. It never has the survival of plants required human intervention and help so urgently. It is worth noting that, as Pollan points out, this kind of help must be provided in the way plants want it to be. As Mancuso (2015) defines intelligence as "the ability to solve problems", plants can be seen as intelligent creatures due to their various survival strategies and effective response to the environment. Thus, an ethical question needs to be answered: When the natural objects they represent are increasingly in conflict with industrialization, do plants, as intelligent lives, have the same equal rights as human beings to pursue the independent and sustainable development of the population? We believe the answer is yes. Because the flourishing of plants is greatly beneficial to the sustainability of people and nature, whether in terms of biological egalitarianism or the importance of biodiversity to human civilization. When we stop treating plants as mere automatons or mindless machines and can instead look at, and even learn from, plant systems on equality, this will change our understanding of life on Earth and help us draw more inspiration from nature to address sustainability challenges. In summary, considering the above-mentioned context, a research question was formulated as: What is the new role of and how do plants adapt to/evolve in a future world where human-centred environments gradually invade their natural territory?

#### Method

We conducted a three stages method for answering the RQ: 1) Background research (literature review); 2) Prototype development; 3) Insights/theory Building (a retrospective analysis)

### Strategies review & Conceptualization

Plant-Computer Interaction (PCI) can be understood as a branch of Animal-Computer Interaction (ACI), which is a new discipline extending from Human-Computer Interaction (HCI) theory. ACI was prompted by multispecies ethnography (Kirksey et al., 2010) to reflect on the complex relationships and interdependencies between humans and other species. It is considered to enrich the HCI framework in terms of methodological and theoretical aspects and interface solutions (Mancini, 2013). ACI claims to re-think non-human species as "users," which enables us to understand better and build symbiotic relations with other species to create sustainable societies. The recent advances in plant science mentioned above also increase the potential for plants to become users of digital technologies. However, we still find a distinct gap in the discussion of plants compared with animals when discussing the interaction of non- humans with machines.

Some interactive designs have been discussed as the hybrid of integrating plants and machines and have been analyzed and summarized by scholars. Su & Liu (2022) preliminarily defined a PCI typology under the framework of Design for Sustainability (DFS), classifying it into four types: environmental-based sustainable endocyclic systems, sustainable sensory extension, empathetic interactor based on emotional values, and systematical-mutualistic symbiosis. It provides a reference for the designer to study the new coexistence relationship among plants, artificial objects, and people in the context of sustainable development and PCI. However, most research and practice focus on sustainable value from the perspective of human beings. This means that when we ask about the new role and value of plants in today's and future society, the actual result is still pulled back to discuss the added value and function of the new integration of plants and machines to people. For example, although PotPet and MyGreenPet are cases around caring for plants, it is also based on the need to ask for help from human beings or please the owners emotionally. They also cannot be ruled out that it contains the suspicion of preventing human beings from spending more energy to care for the plant. Similarly, some systems that emphasize the symbiosis between plants and humankind mostly consider human comfort, which is why in Vertical Forests, plants are passively arranged in buildings to absorb traffic pollution and noise attacks for people. We can conclude that when looking at the sustainable development issues from the perspective of plants, it is easy to see that the rights and role of plants are not sufficiently valued and responded to. There is also a clear gap in the study of plants as a primary role in the interactive systems framework.

Thus, based on Su and Liu's study (2022) and inspired by Pollan's theory of plant intelligence for survival and reproduction motivation, we argue that it is necessary to upgrade the research phase and to reconsider an interactive system center on plant perspective. In fact, there have been some related preliminary explorations, but we are still waiting for a response to our questions. For example, in Plantas Nómadas, plants are simply used as the secondary role of a circulation system; similarly, Elowan and hortum machina B only address the issue of plant mobility and do not respond to the needs of plants in other ways. Therefore, we introduce the design strategy of speculative design (SD) in order to assist us in developing new explorations. Speculative Design (SD) aims to explore possibilities of future scenarios by reflecting on the problems of today's society (Dunne & Raby, 2013). The significance of SD is that it provides a new perspective to speculate and conceptualize the potential possibilities of the future and develop corresponding design suggestions. SD temporarily abandons problems solving practically and in favor of asking broad social questions. It assists design practitioners in broadening their cognitive dimensions and thinking boundaries, moving beyond short-term goals, and implementing pioneering systems and prototyping designs. In fact, many examples of SD can inspire the conceptualization of this project. For example, the logic of Designs for An Overpopulated Planet: Foragers (Dunne & Raby, 2010) can be understood

as: humankind imitating the behaviour of animals through artificial objects. Then this project can offer a reverse construction, that is, plants imitate human behaviour through artificial objects.

### Integrating PCI and SD

As mentioned above, PCI theory was adopted as the technical support for the project. The approaches of speculative design practice may be a helpful guide to enhance and complement the reference value of this typological analysis. As the thought support, SD, based on PCI techniques, guides the project with theme setting and conceptualization methods and idea communication that complements the practical approach of PCI.

As Dunne and Raby (2013) argue, SD focuses on macro issues and challenges that orthodox designs cannot address. Most previous cases seem to be "humans helping plants", but they are still another form of "humans manipulating and using plants." The intervention of the speculative concept offers an excellent opportunity to inquire about what will be the future impact if the issue of artificial spaces affecting plants continues to be ignored.

The SD introduction clearly outlines the project's results and outcomes and the assessed value. Multiple critical practice methods are available to be used, such as Thought Experiments (Dunne & Raby, 2013), that are evaluated as helping designers think through tricky problems. In particular, Counterfactual, as an exciting way of creating another possibility of existence, coincides with the previous idea of plants mastering intelligence beyond our expectations. As with the Floppy Legs, a portable floppy drive designed by Attenborough Design Group, using a strategy of product personification, the creation of an extra-perceptual situation is effective. The What-if scenario is another approach that inspires us to imagine what we could achieve with the development of bio-machine interaction technology. On a more macro level, we can envisage a future in which how will plants survive by interacting with machines when artificial environments have entirely taken over the natural territory. The method helps us clarify the direction of the conceptual building and design practice and the aims of drawing attention to plants by PCI. Consequently, a design assumption was formulated as "Plants can form a community to collaborate and support each other (similar to human societies) when facing the uncertainty of the artificial environment."

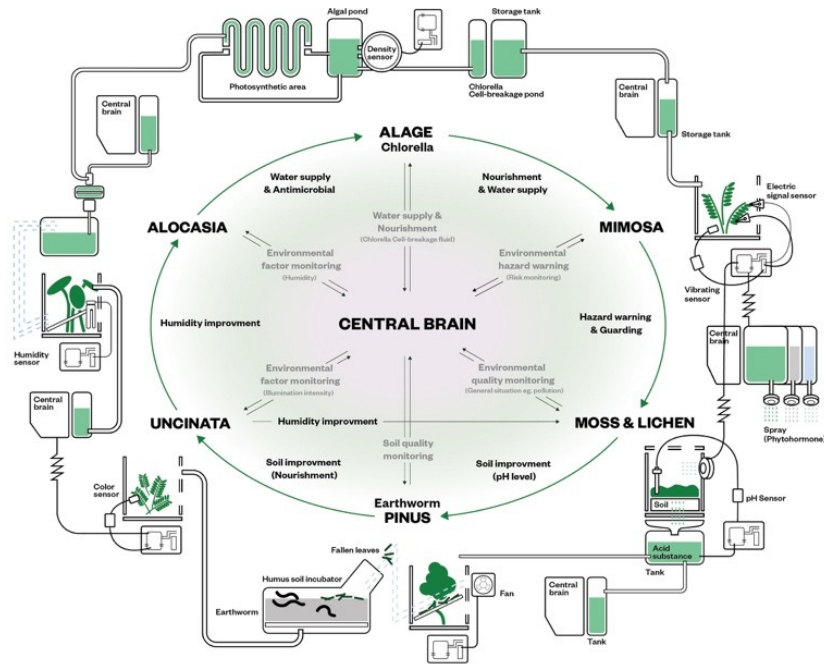
### Result: The Phytoshpere Project

#### Project Description

Phytosphere is an experimental, speculative design project that aims to explore the new roles of, strategies and opportunities for plants, as a specie group, in the expansion of artificial environments in the future. It also discusses the possibilities for plants to evolve and form a "social symbiosis" to achieve sustainable development in the face of various unnatural- environmental challenges. The name "phytosphere" stems from a botanical phrase that describes the micro-ecosystems that exist within plants (Yang et al.,2013). In this project, it acts as a metaphor for a new interactive symbiotic relationship among plants or community of plants that are interdependent and mutually improving.

Based on the strategy and technology of PCI, the project depicts a new mechanism that diversified plants can be mutually beneficial to each other, and a new symbiotic system for plant populations. Individually, six representative plants, including chlorella, mimosa, moss and lichen, pinus, uncinata and alocasia, are symbiotically fused with machines, forming six plant- machine hybrids, which are controlled and driven by





**Figure 1.** The symbiotic system map of mutual benefit among diversified plants within the Phytosphere project.

the plant' s 'intelligence'. Each plant is given the new ability to take the initiative to explore, optimize its own surrounding environment and develop self-identity. From a community perspective, these different plant species interact with each other through technology to form a self-operating, self-sufficient symbiont which comprises a self-perpetuating system and a micro-ecosphere of plants.

The microsystem starts with Chlorella hybrid, which supplies the whole system with water and a nutrition and organic fertilizer (chlorella cell-breaking fluid). The second hybrid is an environmental vigilante. When mimosa senses an external threat, it controls the machine to spray various phytohormone as alerting. The Moss & Lichen Hybrid uses the acid it produces to help other plants improve their soil environment. For example, when pinus (the next plant) detects that its soil has become alkaline, it notifies the Moss & Lichen Hybrid and requests acid for itself to raise the pH of its own soil. Meanwhile, the humus cultivated by pinus leaves and earthworms provide nutrients for the uncinata. The uncinata is sensitive to environmental factors such as light intensity, they control the humidification and shading of the alocasia and moss and lichen. Finally, the sap secreted from the tips of the alocasia leaves will be collected and processed (e.g. filtered). The processed water will be sent back to the Chlorella Hybrid for use as a plant-derived fungicide and water supply. Please find details of the project in Figure 1.

#### Innovation and Reflection

The fifth type of PCI: Autonomous evolutionary symbiosis

This project (see figure 2) is an experimental innovation that can be understood as an update of Su and Liu's research (2022) through design practice. We summarize and propose a fifth type of PCI under the DFS framework - Autonomous evolutionary symbiosis, which is defined as plants- intelligent controlled PCI systems that focus on how plants “think” and (directly) benefit themselves by symbiosing with (and supported by) machines, promoting enhanced autonomous capability of plants to interact and high-intensively connect with the outside world. Plants are considered the primary role of the interactive system, empowered by biodata technology to

be 'intelligent' and proactive in this type of PCI. The core is an emphasis on considering plant species as equal, intelligent beings and viewing PCI and sustainability, especially in environmental and socio-ethical aspects, from their perspective (rather than the dominant human perspective).



**Figure 2.** The final prototyping and engineering of the project.

As mentioned earlier, this concept is based on confidence in the plant's "intelligence" to cope with the environment. Plants can express their needs when controlling machines as primary users and master different capabilities by extending the technology. During the testing, the vital data of plants we collected confirmed that plants benefit from interaction with machines.

#### Values and Implications: A Mutually Supportive Strategy among Plants

A key innovation of the project is the construction of a mutually improving mechanism of symbiosis, that socially connects different plants based on their biological characteristics, and assisting and supporting plants in information sharing, democratic decision-making and helping each other with interactive technologies. Just as Harari (2014) suggests, large-scale collaboration and collective wisdom based on communication ability may be a key advantage for Homo sapiens, that is, us, to become highly adaptable creatures and stand out in the biological competition. If this holds true, it is also possible for plants to accelerate their speed and efficiency in adapting to new environments by mastering the ability, and to improve the potential for sustainable population development. Although plant species tend to compete in most cases in nature, the facilitation that exists between certain species also attests to this potential. Therefore, in this project, mutual improvement and collaboration become the heart of the symbiotic system that will benefit all plants while each plant satisfies its own needs. As a result, six different plants spontaneously unite to cope with the uncertainty of the artificial environment. It paves the way for a discussion on how plants can present themselves and coexist with artificiality and nature sustainably in the future, thus answering the second key research question.

In this project, plants are the primary role. We discuss the relationship between putting individual plants into the community and accelerating individual evolution in relation to collective competence. In the synergy of the distributed system of plants, this symbiosis shows animal-like mobility and greater adaptability to unnatural environments. As radical speculation, the system simulates a potential direction of plants' collective evolution

in a way that tentatively excludes humankind and interprets how to position plants for a new role in this environmental change.

## Conclusion

As a response to the trend of biology-human-science integration, the study is seen as an innovative strategy or a solution for the (collective) evolution of plants within the barriers of ever-expanding artificial resources. It also conveys a perception of the similarity and equal symbiotic potential of humans and plants. We discuss the dangerous situation, secondary role and potential new roles of plants. By introducing speculative design, we complement Su and Liu's typological analysis with a project and case study to enrich the theoretical framework of PCI.

We present the design project and demonstrate its feasibility and potential for development. The proposal to consider plants as active and intelligent media and to think from their perspective will not only provide idea on future sustainable development, but also on understanding the role and position of human beings. In the future, we intend to conduct deeper interdisciplinary explorations, such as the deeper integration of PCI with big bio-data and ecological conservation.

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## Study of Fashion Intelligent Design for Future

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### Abstract

A study is being carried out of application of smart textiles design in the future life. Abundant examples from many different fields, such as fashion, products, architecture or even environment were collected. This paper introduces the following several inspirational works that can broaden our thinking in this fields. In the context of the development of the new era, China has entered the era of science and technology information, which is characterized by the use of artificial intelligence technology. It is necessary to integrate the technologies with fashion design to find the focus of design innovation. At the same time, the related processing methods of smart fashion were summarized. It provides a framework for further research in the future. The paper's contribution to the "NARRATIVES OF LOVE — — TOWARDS HEALING, TRANSFORMATION AND TRANSCENDENCE" conference themes.

### Author keywords

smart fashion; innovation design; artificial intelligence

### Introduction

Nowadays with the continuous development of science and technology, smart fashion and textiles have gradually appeared in our daily life. In the past two decades, there have emerged a plenty of intrigued design works while the multi-disciplinary research has collaborated between science and design. In the direction of fashion design, the paper discusses the fusion mode of artificial intelligence and fashion design, hoping to provide more design ideas, cooperate with intelligent technology, propose design schemes, and actively respond to the times a new challenge. In a study of application of intelligent fashion design for the future, abundant examples from many different fields, such as fashion, products, architecture or even environment were collected. This paper introduces the following several inspirational designs works that up-to-date cases can broaden our thinking in this fields.

### Case Study

Interactive dresses

The two interactive dresses entitled (No)where (Now)here, have photoluminescent thread and embedded eye tracking technology made into them that was activated by the glances of spectator. The dresses were made from lightweight super organza that slowly moved about as someone stares at it. When the lights were out, the dresses became illuminated [9]. See Figure 1.

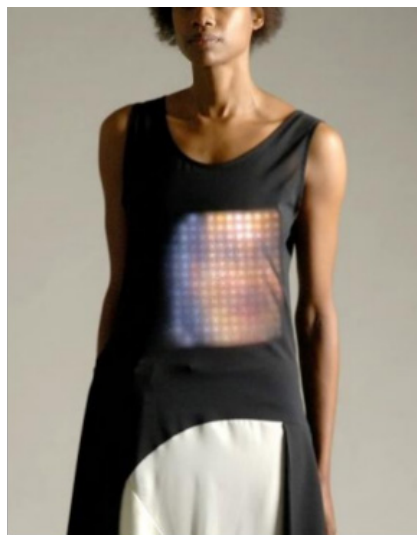
Lumalive

This is the first time that a fashion designer has used Lumalive textiles and it is part of Philips vision for a future

where our surroundings and the clothes we wear become more intelligent, and interact with the environment around us. As early as 2005, Philips has developed a light-emitting textile called Lumalive. Beneath the outer fabric is a layered system that contains a flexible array of color light-emitting diodes (LEDs). It can only be seen from the outside when the screen is turned on. The idea was to integrate the flexible array of multi-color LED into the fabric without affecting the softness of the fabric, thus gave life to inert objects. Clothes, pillows, curtains and even interior decorations can all be illuminated by using the new technology. This fabric is very strong and wear-resistant and can be washed. See Figure 2.



**Figure 1.** Interactive dresses.



**Figure 2.** Lumalive.

#### SonUmbra

SonUmbra was a light and sound device with umbrella-like frame of canopy made of electroluminescent fibers. These diffuse luminescent fibers respond to surrounding activities and provide a pattern in the canopy. In the daytime, it provides shade and shelter from the rain. At night it can be illuminated to match the environment and generate electricity from solar energy. See Figure 4.

#### Blip Electronic Textiles Project

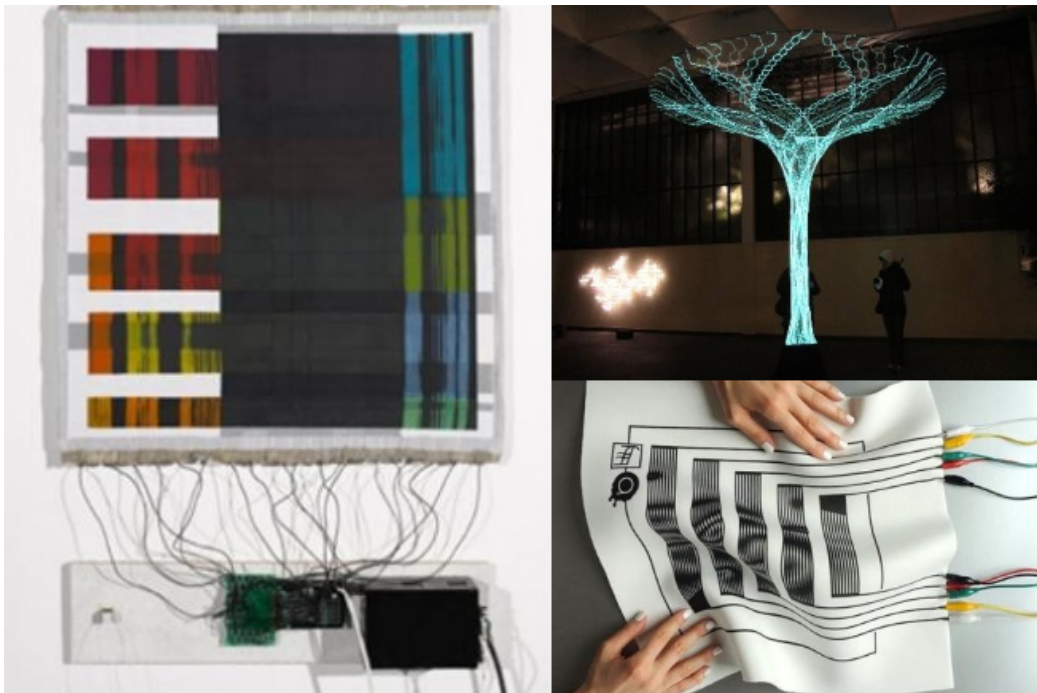
Blip was one of seven pieces series of Electronic Textiles project by Maggie Orth. The textile was changed from monochrome black in the cold state to bright colors in the heated state. Color-changing textiles were a combination of custom electronics, hand-woven electrodes and thermochromic inks that changed color when heated. In these Maggie's works, electronic devices sent a current to the resistance wire woven into the fabric, heating the resistance wire and changing the color of the thermochromic ink. See Figure 3.

#### Highly conductive e-Textiles

Electronic textiles (e-textiles) involve electronics and interconnections knitted or printed onto or into textiles, which enable the integration of electronic functions and attachments. Components and interconnections are natural to the fabric structure, which decrease the chance to be seen, twisted together or tore apart by the surroundings. Electronics that can be hanged over a vehicle or a tank is achievable using textile fabrics. The ideas for e-textiles have been around for decades, but with increasing commercial focus in the last 30 years. They are of great interest as they have various industrial applications such as health monitoring, sports training data



acquisition, tracking the position, and status of soldiers in action, monitoring pilot or truck driver fatigue, and so on. See Figure 5



**Figure 3.** Blip Electronic Textiles. **Figure 4.** SonUmbra. **Figure 5.** Highly conductive e- Textiles

### Integration mode of artificial intelligence and Fashion design

#### Automatic Operation

When AI technology is integrated into the field of fashion design, the main development direction is to reduce the difficulty with the help of modern technology, integration of design parameter information, reduce the daily work of designer's stress. For example, many designers today often choose to use software to perform fashion simulation stitching operations. At the same time, it will be set in advance different clothing patterns, store the corresponding data, and then cooperate with the use of machinery chemical equipment for mass automated production. The promotion of this technology in order to allow designers to apply more energy to fashion style, pattern design work, so that the clothing with novelty, more fit the aesthetic demand of the wearers in the new period. In addition, the task in fashion design to use of big data technology can also sum up work experience for analysis the advantages and disadvantages of the design work, find the direction and method to improve the design level. See Table 1.

#### Virtual fitting

In fact, the virtual fitting function is a new product of the combination of artificial intelligence and clothing design, which represents the effective integration of the two. The feature of this function is that virtual image information can be drawn through information technology to facilitate the audience to experience the upper body effect of various clothes on the Internet, so that the audience can decide whether to buy this dress. This can meet the needs of online marketing work in the new era, and can broaden the sales scope of clothing. At present, how to do a good job of optimizing the design of relevant functions is a key issue for designers to deeply study, which will directly affect the steady development of the fashion design industry. See Table 1.



Table 1. Integration of intelligence fashion design

Integration mode	Work of integration	Dedicated software
<ul style="list-style-type: none"><li>•Automatic Operation</li><li>•Virtual fitting</li><li>•Intelligent Prediction</li></ul>	<ul style="list-style-type: none"><li>•Building a Database</li><li>•Person module data</li><li>•Model data</li><li>•Data of fabrics and accessories</li></ul>	<ul style="list-style-type: none"><li>•Use of 3D virtual clothing software</li><li>•3D printing technology and design</li></ul>

Intelligent Prediction

In the process of comprehensively promoting the development and progress of clothing design work, we should correctly predict the future development prospects of the industry, understand the changes in market demand, and adjust the design ideas in advance. In particular, it is necessary to analyze the change law of different design styles. This involves the integration of artificial intelligence technology and clothing design. Through modern technology, data analysis should be carried out to intelligently predict the trend and specific reasons for the changes in people's aesthetic views, find the subsequent direction of clothing design, and occupy the clothing market first. Avoid designing some outdated clothing patterns and styles, resulting in unsalable clothing and waste costs. In addition, many designers in the new era are also studying the use of artificial intelligence technology for personalized customer style preference analysis and prediction, the goal is to tap potential customers.

Work of intelligent fashion design integration

Building a Database

In the actual optimization of the fusion mode of artificial intelligence and clothing design, it is necessary to standardize the work flow, usually the first task is to complete the construction of the database, to do a good job in the classification of data information storage management.

Person module data

Designers to collect people's height, weight and other basic data, the data will be used to build a database, the goal is to complete the construction of the human body model with the help of the database, the real use of virtual technology online fitting. This link involves the construction of the common template of the standard human body model and the non-standard human body template, because each audience will have physical changes in the process of growth and development, and it is impossible to use a single model to complete the virtual fitting operation. This requires the designer to first analyze what factors will affect the fitting effect, generally including high and low shoulders, flat chest, hips and other key information parameters of the human body, should be used intelligent technology to collect and process information. In addition, to successfully complete the construction of the database, but also with the use of professional software and hardware facilities,

the human body information scanning, input into the system.

#### Model data

When using artificial intelligence technology to design clothing patterns, the data information of existing patterns should be collected, and a special database should be built to facilitate reference to the characteristics of other patterns. After completing the task of making the design drawing, the design drawing is put into the database for information comparison to avoid the problem of duplicate version. At the same time, the different versions are categorized by style. On this basis, and then according to the design time to sort, it is convenient for designers to summarize the general law of version type changes, find out the key reasons for data changes, and then targeted to adjust the clothing design ideas, innovative design schemes.

#### Data of fabrics and accessories

After the staff has completed the design of the version, it is necessary to think about what kind of fabric is suitable for the production of this clothing style, the sag and feel of different fabrics are different, and the types of clothing suitable for production are also significantly different. Based on this, designers must establish a database of fabrics and accessories in time, and systematically introduce the material characteristics and precautions of different fabrics. Including the weight of the fabric, whether it can be washed and other aspects of the content. See Figure 6.



**Figure 6.** Work of intelligent fashion design integration

#### Dedicated software for fashion design

##### Use of 3D virtual clothing software

Three-dimensional technology is a key technology to be used in the integration of clothing design and artificial intelligence, which can display virtual models of clothing from multiple angles and simulate the effect of real clothing on the body. We should try to install the plug-in of the virtual clothing tool in the production software to convert the plane interface into a three-dimensional interface. Focus on adjusting the clothing size for some wearers with enlarged abdomen, or broad hipbone, scientifically calculate the appropriate height and weight range of different sizes, and observe the actual clothing wearing effect with different sizes with the corresponding model diagram.

### 3D printing technology fashion design

In the innovative development of intelligent replication design work, to promote the use of 3D printing technology. The principle of the technology is that the special printer is connected to the computer system, and after the input of the parameter information of the design drawing, the solid clothing can be printed out through the special material, which has environmental protection properties and meets the requirements of energy conservation and environmental protection in the new era. This helps to improve the novelty of clothing design work, attract the attention of more audiences, and drive the sustainable and healthy development of the industry.

### Conclusion

In the research on the integration of intelligent fashion design, it needs to build on human module data, pattern data, fabric and accessories database. It should be installed special CAD software, three-dimensional virtual clothing software, fabric scanner and so on. It also needs to work on intelligent aided design, innovative style design, collocation design. Complete intelligent information processing on the network, draw plans and stereo models, and improve the design effect. In addition, designers also need to consider the beauty and comfort of clothing, to ensure the adaptability of integration between technologies, but also from the perspective of information security management, to improve the security of information transmission, processing, storage work, and ultimately to comprehensively promote the long- term healthy development of intelligent clothing design technology.

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## Cultural application and value of traditional lacquer art in modern design

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### Abstract

This paper aims to discuss the cultural application and value embodiment of traditional lacquer art in modern design. As an important part of Chinese traditional art, traditional lacquer art has a long history and rich cultural connotation. With the development of the times and the progress of science and technology, traditional lacquer art can also be combined with today's new materials and new technologies to seek a broader space for development. In modern design, traditional lacquer art, with its unique artistic charm and craft value, has gradually become a favorite creative element for artists and designers. This paper illustrates the importance of traditional lacquer art in modern design by elaborating on its historical origin, artistic characteristics, cultural connotation and application cases in modern design. By understanding the unique charm of lacquer and the traditional excellent craftsmanship, combining with the modern design concepts and techniques, this paper also puts forward some prospects for the future application of lacquer in design, with a view to better integrating lacquer into modern design, and providing useful insights into the inheritance and development of traditional lacquer in modern design.

### Author keywords

Traditional Lacquer Art; Modern Design; Artistic Characteristics; Cultural Value; New Materials and Technology; Application Embodiment.

### Historical Origin and Artistic Characteristics of Traditional Lacquer Art

Historical origin

Traditional lacquer art has a long history in China, which is the treasure of Chinese traditional art. The historical origin of traditional lacquer art can be traced back to the Neolithic Age in ancient China. In archaeological excavations, some Neolithic lacquer ware has been unearthed, which proves that the production of lacquer ware has a very long history in China. According to the latest archaeological discovery, an 8,000-year-old lacquer bow unearthed at the Cross Lake Bridge site in Xiaoshan, Zhejiang province, is the earliest lacquerware ever found in the world. During the Shang Dynasty, the production of lacquerware was already quite developed, which was widely used in the life of nobles and religious ceremonies. In the late Shang Dynasty, the production technology of lacquerware was further developed, and more exquisite and detailed lacquerware works appeared. With the evolution of history, the techniques of lacquerware production were gradually inherited and developed. During the Qin and Han Dynasties, the production of lacquerware reached new heights and became a very important work of art for the nobility and the royal family. Actually, lacquerware production gradually became a specialized profession, and the craftsmen produced numerous exquisite lacquerware works through their traditional skills and experience.

Over time, the art of lacquerware making spread to other countries and regions, such as Japan and Korea. During the Song Dynasty in China, lacquerware production had reached its peak and became popular in the art market at that time. The inheritance and development of traditional lacquerware production techniques has continued to this day, forming a unique artistic style that has influence and spread in China and other countries and regions.

In general, the traditional lacquer art has a very long historical origin, and after a long period of accumulation and inheritance, the traditional lacquer ware production techniques have gradually developed and perfected, becoming an important part of the traditional Chinese crafts. Lacquer art works are rich and colorful, which have formed a unique craft characteristics and cultural connotations, and has profound inspiration and reference significance for modern design..

#### Artistic characteristics

The artistic characteristics of traditional lacquerware are mainly reflected in the following aspects:

Firstly, the unique material: the main material used in traditional lacquerware is the lacquer liquid from the lacquer tree, which is refined and processed through many procedures. The lacquer film formed after the drying of the lacquer sap is characterized by anticorrosion, moisture resistance, acid and alkali resistance, and also strong toughness and durability, which can be used to make all kinds of artifacts, and can be combined with other materials, such as wood, metal, jade and stone. The uniqueness of the traditional lacquer craft is that the lacquer coating process needs to be coated and polished many times to make the surface of the lacquerware achieve the ultimate luster and soft touch, forming a unique natural beauty.

Secondly, exquisite craftsmanship: the production process of traditional lacquerware is very complicated and complex, which requires multiple procedures, including the production of base tires, lacquer coating, carving, color painting, etc.. Every link needs to be carefully operated to ensure the quality and artistic effect of the final work. The production of base tires requires the use of different body materials according to different rendering effects, and the same body materials can also be achieved through different production processes to achieve different shapes, such as wood tires, in terms of wood species can be divided into hardwood and softwood. Hardwood, including cherry, oak, elm, birch, beech, etc., usually higher prices, but the quality is excellent compared to softwood. Softwood, including tung, camphor, pine, cedar, etc., a wide variety of prices can be accepted by most people. In the production process can be divided into mortise and tenon splicing, hand-carved and plank splicing, etc., mainly based on different rendering effect using different production processes. After the tire is made, it is painted and polished many times to make it smooth and solid. The craftsmen need to master the technique of painting and the consistency of the lacquer, and when drying, they need to control the temperature and humidity of the surrounding environment to ensure that the lacquer dries naturally and forms a strong lacquer film. Carving and painting require the craftsmen to be highly skilled and delicate. Traditional lacquerware is very meticulous in its attention to detail, with every detail carefully designed and finely crafted.

Whether it is the treatment of the edges of the lacquerware, the presentation of the decorations, or the embellishment of the decorations, all of them reflect the craftsmen's pursuit of details and the pursuit of aesthetics. The detailing of traditional lacquerware is not only reflected in the decoration on the front, but also in the parts that are not directly displayed, such as the back and the bottom. Craftsmen pay attention to the meticulous treatment of each part, which can present a perfect overall effect.

Thirdly, unique decorative techniques: the decoration of traditional lacquerware adopts a variety of techniques, such as carving lacquer, color painting, inlay and so on. Carving techniques are usually applied to the surface of lacquerware to create various patterns and motifs through carving or relief carving. Painting, on the other hand, creates colorful patterns and colors by using different colors of lacquer, and the painting technique can show vivid images and delicate color changes. The carving process of traditional lacquerware is very elaborate, which can show delicate texture and three-dimensional sense. In addition, traditional lacquerware often adopts the inlay technique, jewelry, shells, keels and other materials on the surface of the lacquerware to increase the decorative effect and texture.

Traditional lacquer works usually use colorful colors and lines to express artistic emotions. The natural pigments used in the production of lacquerware, such as danstone and vermilion, can present unique luster and vivid colors through special craft techniques. At the same time, the lines of traditional lacquer works are carefully designed and drawn to express the author's feelings and understanding of life, nature and humanities through the smoothness and changes of the lines. In a word, traditional lacquerware expresses the imagery and symbols of traditional culture in artistic techniques, conveying the essence and aesthetic concepts of traditional Chinese culture.

### **Cultural Connotation of Traditional Lacquer Art Sections**

Traditional lacquer art also has deep cultural connotations. In traditional Chinese culture, lacquer is regarded as a symbol of nobility and elegance, and a manifestation of power and status. Therefore, lacquer art is not only a handicraft but also a cultural symbol in traditional society.

Traditional Lacquer Art is closely related to folk culture

Many lacquer works embody folk customs and beliefs, such as lacquer furniture and lacquer sacrificial vessels. Traditional lacquer works are usually presented with delicate lines and gorgeous colors, conveying the author's perception and understanding of life, nature and humanities through unique shapes and forms. Traditional lacquer works are not only on the level of art, but also closely related to life, showing distinctive regional characteristics. Lacquerware works from different regions often reflect the local culture and national characteristics. For example, the lacquer works in the north are mostly characterized by atmosphere and heaviness, while the lacquer works in the south are known for their delicacy and gentleness. The formation of these regional characteristics is closely related to the local history, culture and social background.

Traditional Lacquer Art Contains Philosophical Ideas

Traditional lacquer art is also rich in philosophical ideas, such as Taoism's "unity of heaven and mankind" and Confucianism's "mediocrity and harmony", etc., which are reflected in the lacquer art works and form a unique aesthetic. Traditional lacquer works are often used in furniture, utensils and other practical everyday objects to integrate art and life. This fusion reflects the ancient Chinese culture's idea of "literature with the road", combining art and practicality, so that people can feel the beauty of art in their daily lives. As a treasure of Chinese traditional culture, traditional lacquer art carries rich historical information, and is an important physical material for the study of ancient Chinese society, culture and living customs, etc. It has precious artistic value.

Unique Aesthetic Characteristics of Traditional Lacquer Art

Traditional lacquer art has its unique aesthetic characteristics, and there are many varieties, including wooden



tires, lacquer pots, lacquer bottles, lacquer plates, lacquer bowls and so on. These vessels have their own characteristics in shape, texture and color. For example, the conch shell and bump gold craft of Han and Tang dynasties, and the stripped and modeled color craft of Ming and Qing dynasties are all important parts of traditional lacquer art. These techniques not only demonstrate the deep cultural heritage of the Chinese nation, but also show the exquisite skills and creativity of the skilled craftsmen of the past generations. The color of lacquer is deep and glossy, giving people a sense of elegance and solemnity. Its unique texture and texture make lacquerware have a high aesthetic value. Whether it is a living thing or a work of art, traditional lacquer attracts people's attention with its unique artistic charm and has unique aesthetic characteristics.

### **Application and Value Embodiment of Traditional Lacquer Art in Modern Design**

Application of traditional lacquer art in modern design

Traditional lacquer works are not only a kind of art, but also closely related to daily life. Traditional lacquer works are often used in furniture, utensils and other practical daily objects, combining art with daily life. In modern design, traditional lacquer art is widely used in the fields of architectural decoration, interior design, furniture design, product design and artwork production. It injects unique charm and taste into modern design with its exquisite skills, rich cultural connotation and unique artistic expression.

First of all, traditional lacquer art plays an important decorative role in interior design. The use of traditional lacquer techniques and patterns can not only add unique artistic value and ornamental furniture, but also add a unique artistic atmosphere to the interior space. For example, using traditional lacquer techniques on the walls of the restaurant, it can create exquisite lacquer murals, combining traditional cultural elements with modern design to create a unique dining environment. Another example is the application of lacquer tea set in life. Through careful production and lacquer decoration, the lacquer tea set not only fulfills the function of tea, but also enhances the atmosphere of the whole tea culture, so that people can enjoy the beauty of art in the process of tasting tea.

In addition to interior design and furniture design, traditional lacquer is also widely used in the production of artworks, and its unique artistry and exquisite craftsmanship have made it one of the most important means of artwork production. For example, in the manufacture of the screen, the traditional lacquer technique can be used to draw exquisite landscape painting patterns or flower and bird patterns on the surface of the screen, thus making the whole screen a piece of artwork with ornamental value. Besides, traditional lacquer techniques can also be used in ceramics production. For example, painting traditional Chinese patterns on the surface of ceramics, such as cloud patterns, birds and flowers, landscapes, etc., can make the ceramic works become both vivid and interesting, with more artistic sense and cultural connotation.

In addition to the areas mentioned above, traditional lacquer art can also play a role in various fields such as clothing design, jewelry design and handicraft production. In clothing design, traditional lacquer techniques and patterns can add unique artistic elements to fashion, making it more artistic and unique. In jewelry design, traditional lacquer can be combined with modern materials to decorate the surface of jewelry, adding artistic and ornamental qualities to jewelry. In the production of handicrafts, traditional lacquer art can add unique decorative effects to handicrafts, making them more collectible and culturally connotative.

### The value of traditional lacquer art in modern design

Traditional lacquer art is constantly innovating and developing while inheriting the traditional production process, and it incorporates modern aesthetic concepts and artistic techniques on the basis of retaining traditional features, forming a unique artistic style. For example, more abstract and modernist elements have appeared in modern traditional lacquer art works, while combining the application of new materials and new technologies. This is an innovative form, which makes traditional lacquer art have a richer and more diverse expression and a broader space for artistic expression.

The value of traditional lacquer art in modern design mainly includes the following aspects. The first is to combine traditional lacquer art with modern design to create works with both traditional flavor and modern aesthetics; the second is to use traditional lacquer art as the basis for innovative design to form new forms of design expression. Lacquer art has its own way of application in different fields, which has a high design value. The fusion of traditional lacquer art and modern design can make the works have deep cultural heritage and unique artistic charm. Therefore, the problems and challenges faced by lacquer art in design at present require us to take effective measures to solve them. For example, strengthening the inheritance of skills, expanding market applications, innovative design concepts, etc., so as to promote the sustainable development of lacquer art in modern design.

### Conclusion

All in all, traditional lacquer art, as one of the representatives of Chinese traditional crafts, has a long historical origin and unique artistic characteristics. It shows colorful patterns and colors through exquisite craftsmanship and unique decorative techniques, conveying the essence of traditional Chinese culture and aesthetic concepts. This paper analyzes the application scenarios and design value of lacquer art in different fields and points out the problems and challenges faced by lacquer art in design by exploring the history, current situation and future development trend of lacquer art. By deeply exploring the rich connotation of traditional lacquer art and combining traditional lacquer art with modern design, we can better inherit and carry forward this traditional craft, and inject deep cultural connotation and unique artistic charm into modern design. It is hoped that this will help promote the prosperity of the lacquer industry and contribute to the inheritance and promotion of Chinese culture.

### Acknowledgments

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## Experimental study of the morphology of mixed waste fabrics and ceramic residues

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### Abstract

**Problem** To explore feasible solutions to realize the recycling and sustainable application of waste materials in response to the existing problem of large quantities of discarded textile fabrics and ceramic residues accumulating unused. **Methods** Through the experimental method, we explored the feasible methods of new material modeling from two perspectives: material properties and traditional Chinese fiber craft. **Results** Two ideas for creating forms that can amplify the advantages of the materials were explored. **Conclusion** Based on the experimental results and later market research to find four suitable directions for the development of the material, to provide a reference model for future modeling creations in the field of art and design, which can help to realize the recycling of waste fabrics and ceramic residues sustainable use.

### Author keywords

sustainable design; waste porcelain powder; waste fabrics; mixing experiments; fiber-ceramic composite clays

### Introduction

Due to the rapid economic development and improvement of living standards, people create a large amount of garbage in their life, which leads to environmental pollution and waste of resources. In the clothing industry, people mass production and consumption of resources, all kinds of clothing edge cutting waste is increasing day by day. Relevant information shows that 46.5% of families have more than 30 pieces of large pieces of waste clothing stored. According to the industry's rough estimate, the renewal cycle of clothing for three years, every three years after the value of more than 200 billion yuan of waste clothing will be eliminated. Similarly, China's ceramic products in the use of the process also produces a large number of waste materials, such as architectural ceramic waste, daily life ceramic waste, etc. [1-3]. However, due to the low profit of the waste ceramic recycling industry, most of the waste ceramics are disposed of in landfills and piles, which causes great pollution to the environment. Therefore, in the face of such a large number of fabrics and ceramics, the study of how to sustainably apply waste materials has become a crucial task for the country at present.

The majority of researchers, artists and designers have carried out in-depth studies on this issue. In the 1980s, ceramic art was created by using fabric as a structural support and dipping it in mud to create ceramic works. The ceramic works created by this technique are commonly known as "paper clay" in the field of ceramics [4]. If this kind of creation method is combined with waste treatment and applied to the future art design field, it will be conducive to the integration of high-value resources and recycling of waste materials. Therefore, the purpose of this paper is to combine the slurry made of waste porcelain powder with waste fabrics to study the possibility of morphological creation. To lay the foundation for future entry into the design market, so as to better realize the integrated sustainable use of waste materials.

### 2 Experimental results on morphology

Experimental results on morphology

Natural texture

In the course of our experiments, we discovered a number of unexpected textural patterns, and these seemingly accidental effects were in fact based on changes in the fluidity of the mud, the degree of absorption of the fabric, and the morphology of the support. When the combination of fabric and mud is saturated, the new ceramic material looks visually like ordinary fabric, perfectly replicating all the structural details of the fiber fabric. This is due to the fact that the mud soaks into and surrounds each yarn without a trace of excess mud. After firing in a kiln, the fiber portion is reduced to ash by fire, leaving only the ceramic portion to naturally replicate the texture of the fiber fabric. The structure of knitted, woven, nonwoven, jacquard and interlining fabrics is clearly visible when the new ceramic material is exposed to light, as shown in the picture (Fig. 1 / column a).

When there is slightly more slurry than the fabric can handle, a small amount of excess slurry remains on the surface of the less absorbent fabric and forms cracks. The shape of the cracks varies according to the location of the slurry build-up, the fabric structure and the drying rate (Fig. 1 / column b).

When there is more mud than the fabric fibers can absorb, the excess mud flows down the seams of the fabric to the underside of the fabric, where it solidifies against the fabric in an interesting mud texture pattern. This texture changes depending on the material and shape of the support and the flow of the mud. (Fig. 1 / column c).

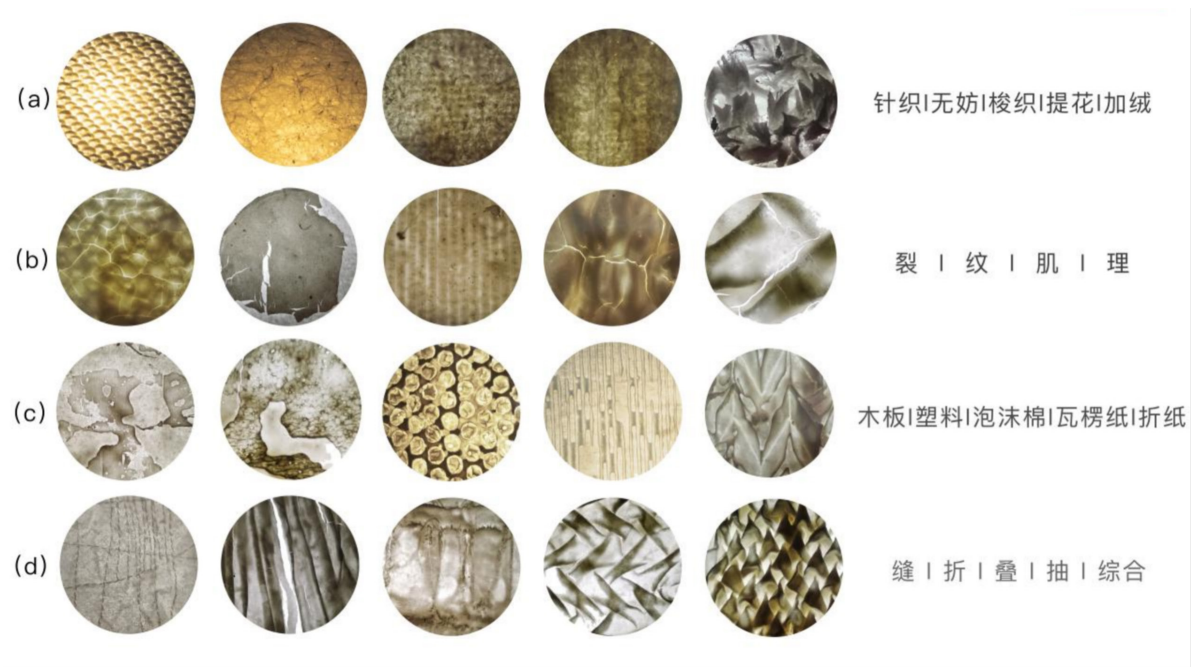


Figure 1. Effect of natural texture and artificial texture under light.

Artificial Texture

In addition to naturally formed texture, man-made creation forms with rules and regulations are also indispensable. The traditional Chinese fiber craft has a history of thousands of years, and is qualified enough to be the source of creative texture. The author believes that we can draw nutrients from the fiber craft, deconstruct the production idea of the craft, and integrate it into the creation of new material forms. For example, the



traditional fabric treatment process is to embroider, sew, fold, fold, draw and so on to create different texture forms on the fabric, and after combining these with the new material, it can produce a lot of light and shadow effects (Fig. 1/d column).

The deconstruction of the tie-dye process into new materials was found to be the most representative creative process during the experiment [8]. Tie-dye is mainly divided into two parts: knotting and dip-dyeing. Imitating the tie-dye process, colored paste is used instead of pigments for dyeing to produce tie-dye-like patterns. These patterns are created by piling up the mud, which ultimately results in regular, slightly raised, and unique mud textures (Fig. 2).

In addition to dyeing, the shapes formed during the tie-dye process can also be used as a source of creativity. It is worth mentioning that the new material preserves these beautiful shapes very well. Since the mud is malleable, it is possible to freeze the instant shapes from the untying process after drying. (Fig. 3)



**Figure 2.** Physical picture of the texture of the ceramic sample after tie-dyeing



**Figure 3.** Experimental samples of tie-dyed ceramics under light

### 3The development prospect of materials

The experimental investigation of materials should be applied to practice as the fundamental starting point, which is also in line with the core concept of contemporary material art, "starting from the material body, returning to the creation". Through the waste porcelain powder and fabric repeated mixing experimental process,



found that the material has the potential in many aspects, in the future applied to a wide range of art and design creation also presents a great deal of when for the nature and feasibility.

#### Extend the ceramic art and design field modeling new space

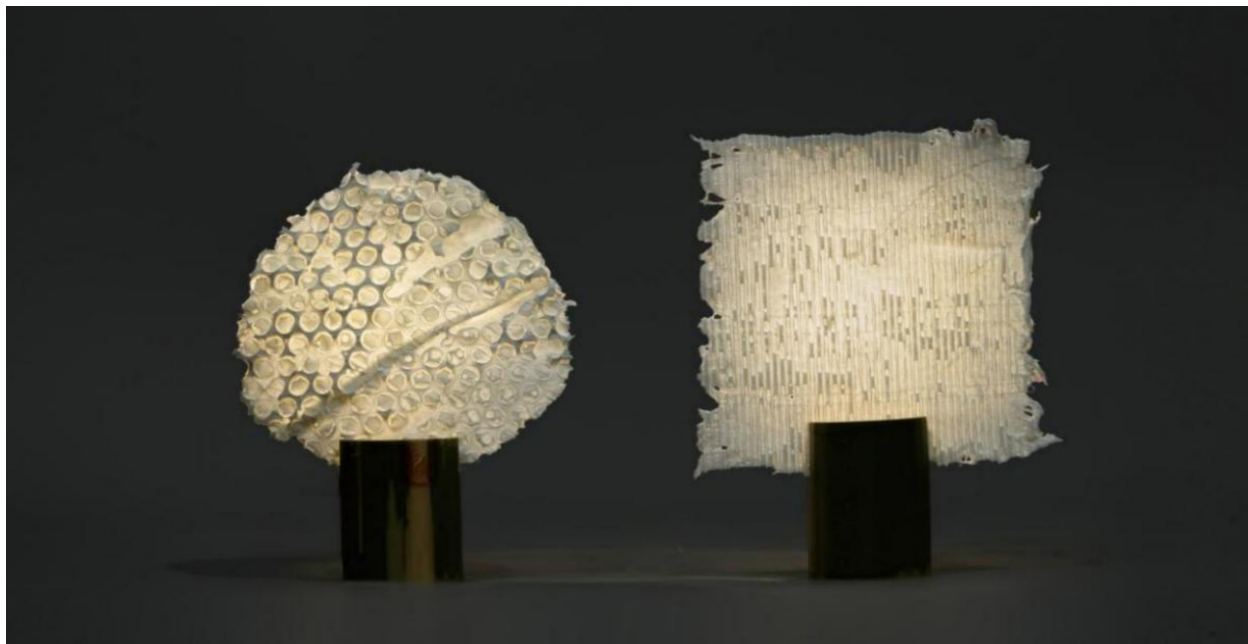
Compared with traditional ceramics, hybrid materials can produce more shapes in a more labor-saving way. Because of the supportive fiber structure, it can be made into any organic form in a wet or semi-wet state. This facilitates artistic creation, extends new space for modeling pottery, sculpture, wall decorations, vessels, etc., and injects vivid elements into contemporary pure pottery creation. In addition, the mixed material modeling advantages, will provide new ideas for the future development of industrial ceramics. Such as sanitary ceramics, architectural ceramics, industrial ceramics and other fields, in the shape of more or less by the limitations of the material process, mixed materials can be more powerful to improve this problem.

#### Promoting the development of industries in the field of ultra-light ceramics

The weight of the new ceramic material is much lighter than common ceramics, which is suitable for ceramic areas that are sensitive to the weight of the product, such as ceramic jewelry. At present, some of the ceramic jewelry on the market is heavy and not suitable for consumers to wear for a long time. Although there are new ceramic materials on the market with lighter and stronger characteristics, the material cost is higher and less used. New ceramic materials can solve these problems.

#### Enrich the artistic language of light and shadow ceramic products

Hybrid materials ultra-thin, ultra-light, high light transmission properties, suitable for light art ceramics field. Traditional ceramic products are mechanically thinned to achieve the effect of light transmittance, this practice not only restricts the shape of the product, but also limits the final display effect of the product, so that the ceramic products can not improve their own artistic appreciation value. However, our mixed materials not only have good light transmittance, but also have rich and diverse textures. Designers can change the texture of the mixed material by adjusting the adsorption of the clay, the structure of the fabric, the speed of drying, the shape of the support, etc., and can also produce products with more artistic aesthetics through sewing, folding, pleating, embroidery, tie-dyeing, weaving, and other fiber processes. This hybrid material inherits the advantages of ceramics and fibers, and when exposed to light, it exhibits the warmth of ceramics and the unique texture changes of fiber materials, with unique aesthetic characteristics. This aesthetic feature can be used as a new language of expression in ceramics for artistic creation and design applications (Fig. 4).



**Figure 2.** Application of experimental samples in the design

## Conclusion

This paper focuses on the possibility of recycling waste fabrics and waste porcelain powder from the perspective of sustainable design, utilizing the thinking of material science. The research results of this paper are as follows: Based on the material properties, two ideas of form creation that amplify the advantages of the material are explored. First, the natural texture formed by adjusting the consistency of the mud and the material and shape of the support, highlighting the natural texture effect of the material and the unique aesthetic of light and shadow; second, the deconstruction of the traditional Chinese handicrafts and draw nourishment from them, and the production of handicrafts into the creation of new material forms.

Based on the results of the experiment and the market research, we have found four directions suitable for the development of the material.

Through rethinking and re-innovating the new material, this experiment provides a feasible reference idea for future artistic creation and design application, a new solution for sustainable resource integration and application, and a new thinking paradigm for traditional ceramic craft research.

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# The Evolution of New Media Art Driven by Artificial Intelligence: An Interpretation and Application of Deleuzian Multiplicity

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## Abstract

New media art, under the influence of artificial intelligence, manifests an intricate interplay of multiplicity and virtuality, resonating profoundly with Deleuze's Multiplicity. The article explores, from the perspectives of digital technology and algorithmic logic, how new media art achieves a transition from the real to the virtual, thereby constructing a multifaceted, open, and ever-changing ecosystem. The intervention of artificial intelligence further propels this multiplicity; its continuously iterative algorithmic models and generative logic based on real-world data have an intrinsic connection with Deleuze's notion that 'the multiplicity precedes the actual.' This evolutionary process not only expands the expressive means of art but also enriches its connotations and diversities.

## Author keywords

Deleuze Philosophy; New Media Art; Artificial Intelligence; Multiplicity; Virtuality.

## Historical Origin and Artistic Characteristics of Traditional Lacquer Art

In the ever-evolving landscape of new media art, the intersection of philosophy and technology offers a fertile ground for academic inquiry and artistic innovation. This paper delves into the application of Gilles Deleuze's philosophical concepts, particularly multiplicity and virtuality, in the realm of new media art. With the advent of Artificial Intelligence (AI) as a transformative medium, the paper explores how Deleuze's philosophy not only provides theoretical underpinnings but also enriches the diversity and creativity in new media art. The paper is structured to first elucidate Deleuze's key philosophical ideas, followed by their practical applications in new media art, especially in the context of AI-driven algorithms and data types. We aim to construct a bridge between philosophy and art, offering new perspectives for both theoretical and practical dimensions of new media art.

## Deleuze's Multiplicity and the Actual

In Gilles Deleuze's philosophical framework, the notion that "the multiplicity precedes the actual" (*la multiplicité précède le réel*) serves as a cornerstone. In Deleuze's philosophical system, the term "actual" is commonly used to describe a state of reality or actual existence, in contrast to "virtual." He posits that reality is not a singular, fixed entity but is constituted by a multiplicity of possibilities and potentials. This implies that multiplicity exists as a latent, virtual state, offering generative and transformative possibilities for things and phenomena in the actual world. As an a priori, foundational state, multiplicity provides an open, indeterminate space for the genesis and transformation of things.

Deleuze further associates multiplicity with virtuality. In his view, multiplicity and virtuality are not isolated concepts but interact and transform each other in a dynamic, non-linear process. Multiplicity, as a complex structure or system, intrinsically contains elements of virtuality, representing a latent, unrealized potential. Virtuality is the product of intensities between differences, determined by the differential relations among concepts, which are themselves constituted by diversity. Together, they form a dynamic, open system. Within this system, virtuality continuously transforms into the actual through various mechanisms and pathways, while the actual constantly generates new virtualities. Therefore, multiplicity provides structure and possibilities for virtuality, and virtuality realizes its latent changes and developments through multiplicity.

### **New Media Art and Artificial Intelligence ( AI)**

New Media Art is an art form based on digital or emerging technological platforms such as computer technology, the Internet, and virtual reality. In his seminal work, *The Language of New Media*, Lev Manovich explicitly outlines five fundamental elements of New Media Art: Numerical Representation, Automation, Modularity, Variability, and Transcoding. These five elements collectively constitute the foundational framework of New Media Art. Unlike traditional artistic mediums like painting and sculpture, New Media Art is characterized primarily by interactivity, multimedia, temporality, and spatiality. This form of art is innovative not only in terms of medium and technology but also in its conceptual, thematic, and expressive diversity.

As a technological medium, AI's application in the field of New Media Art has matured, extending its influence beyond singular art forms to span multiple sub-domains. Specifically, from image generation (Figure 1) and music composition (Figure 2) to interactive art, AI offers unprecedented experiences and creative spaces for both artists and audiences.

#### **Image Generation**

Utilizing Generative Adversarial Networks (GANs) and other deep learning algorithms, artists can create works that transcend the boundaries of traditional visual art. These algorithms can autonomously learn and mimic various artistic styles, even generating entirely new visual elements and structures.

#### **Music Composition**

AI's application in the music domain is equally noteworthy. For instance, through Recurrent Neural Network (RNN) models, artists can generate complex musical structures and melodies, which are challenging to achieve through traditional music composition methods.

#### **Interactive Art**

AI can produce not only static or linear artworks but also highly interactive pieces. These works can adjust and change in real-time based on audience behavior and reactions, thereby offering a novel, dynamic artistic experience.

It is particularly worth mentioning that the advent of advanced algorithms like GANs and deep machine learning has opened up greater possibilities and flexibility for artistic creation. These algorithms not only simulate and extend human creativity but also, in certain cases, generate works that surpass human imagination.



Figure 1. Mario Klingemann's "Memories of Passersby I"

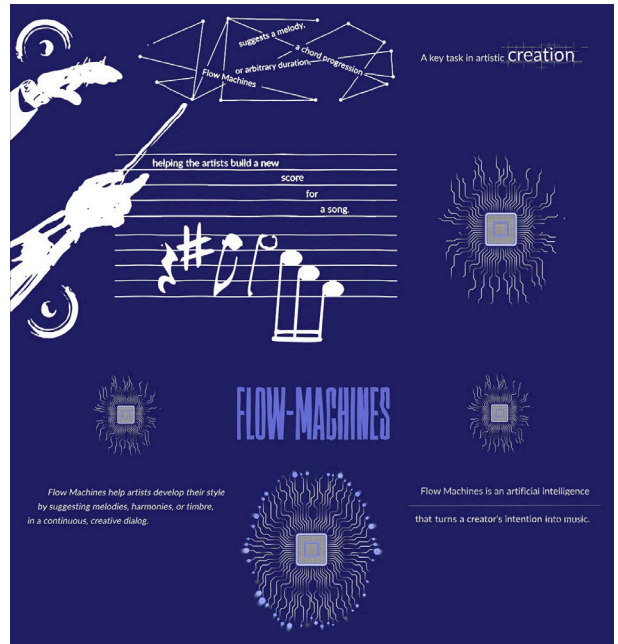


Figure 2. SKYGGE's "HELLO WORD"

## The Evolution of Multiplicity in New Media Art through Deleuze's Philosophy

### Virtuality and Multiplicity: The Transition from the Actual to the Virtual

Deleuze's philosophical stance, which emphasizes that "the multiplicity precedes the actual," finds profound resonance in New Media Art. Unlike traditional art forms that are merely displays of material and form, New Media Art transcends these boundaries. Through digital technology and algorithmic logic, it undergoes a transition from the actual to the virtual, thereby constructing a diverse, open, and ever-changing ecosystem. This transformation not only broadens the expressive means of art but also enriches its content and multiplicity, organically aligning with Deleuze's concept of "multiplicity."

### AI-Driven Multiplicity in New Media Art

The intervention of AI further amplifies the multiplicity in New Media Art. When AI, as an avant-garde technological medium, is incorporated into New Media Art, the utilization of algorithms and the sourcing of data become pivotal aspects of artistic creation. Specifically, AI continuously acquires an incessant stream of diverse data (Table 1) and employs various algorithmic models (Table 2) for ongoing learning and adaptation. This creates a genuinely automated and perpetually evolving transcoding system for New Media Art. Such continuously iterative AI algorithmic models, along with the accumulating real-world data, form a generative logic that intrinsically aligns with Deleuze's notion that "the multiplicity precedes the actual."



**Table 1.** Common AI Algorithm Models Used in the Field of Artistic Creation.

Algorithm Model	Primary Application Areas	Description
Generative Adversarial Networks (GANs)	Image/Video Generation	Composed of a generator and a discriminator, the generator creates new images while the discriminator evaluates their resemblance to real images.
Convolutional Neural Networks (CNNs)	Image Recognition/Classification/Style Transfer	Primarily used for image recognition and classification, also applicable for style transfer, i.e., applying one artistic style to another image.
Recurrent Neural Networks (RNNs)	Text /Music Generation	Capable of remembering previous inputs, making them highly suitable for sequence data.
Autoencoders	Data Dimensionality Reduction and Feature Learning	In artistic creation, autoencoders can be used to generate new images with specific features.
Reinforcement Learning	Game and Robot Control, Music and Animation Creation	Primarily used for game and robot control, but artists have also experimented with it for music and animation creation.
K-Means Clustering	Image Segmentation and Color Analysis	In artistic creation, this algorithm can be used for image segmentation and color analysis.
Support Vector Machines (SVM)	Classification and Regression, Feature Extraction	Primarily used for classification and regression, but also applicable for feature extraction in images and audio.
Deep Belief Networks (DBNs)	Image Recognition and	This is an algorithm model used for image recognition and generation, also applicable
	Generation/Audio and Text Data Processing	for audio and text data.
Genetic Algorithms	Optimization and Search,/Generation of New Works with Specific Attributes	This algorithm simulates the natural selection process and is used for optimization and search problems. In artistic creation, it can be used to generate new works with specific attributes.

**Table 2.** Common Data Types for Algorithm Models Used in the Field of Artistic Creation

Data Type	Primary Application Area	Description
Image Data	Computer Vision	Used for object recognition, style transfer, and art generation.
Text Data	Natural Language Processing	Used for generating poetry, stories, or scripts.
Audio Data	Music Synthesis	Used for music composition, sound design, and audio synthesis.
Time-Series Data	Animation, Motion Capture	Used for predictive models such as animation, motion capture, and interactive installations.
3D Model Data	3D Sculpting, Architecture	Used for creating 3D sculptures, architecture, and virtual environments.
Sensor Data	Interactive Art Installations	Used when art pieces respond to environmental factors like light, sound, or movement.
Social Media Data	Sentiment Analysis, Trend Prediction	Used for creating art pieces that make social or political statements.
Geospatial Data	Maps, Location Triggering	Used for art pieces that include maps, location triggering, or geographic environmental information.

Refik Anadol, a Turkish-American New Media artist, has garnered widespread attention for his works grounded in data-driven and machine learning algorithms. His piece "Machine Hallucination" (Figure 3) serves as a quintessential example, demonstrating how AI and big data technologies can integrate multiplicity and virtuality into New Media Art. In "Machine Hallucination," Anadol employs a vast array of publicly available image datasets of New York City. These data originate from diverse perspectives and temporal points, encompassing various social, cultural, and historical contexts, thereby infusing the work with rich multiplicity. Through machine learning algorithms, particularly GANs, Anadol successfully transforms this diverse data into an abstract, dream-like artistic form.

From the perspective of Gilles Deleuze, Anadol's work is not merely a concrete artistic object; it is a multiplex, open, and ever-changing ecosystem. The piece not only embodies Deleuze's theoretical viewpoints on multiplicity and virtuality but also, through the utilization of AI and big data technologies, accomplishes a transition from the real to the virtual. This enriches the multiplicity and complexity of New Media Art further. Compared to other New Media Art pieces based on artificial intelligence, Mario Klingemann's "Memories of Passersby I" (Figure 4) stands out for its distinctiveness, particularly in the realm of "real-time creativity." As

the audience gazes at the screen, AI continuously generates unique portraits. These portraits possess both immediacy and ephemerality: each one is singular and never to be repeated once displayed. The work captures and reconstructs the facial features and expressions of passersby through neural network technology, thereby illustrating the fusion of multiplicity and virtuality. This resonates profoundly with Deleuze's philosophy of multiplicity.



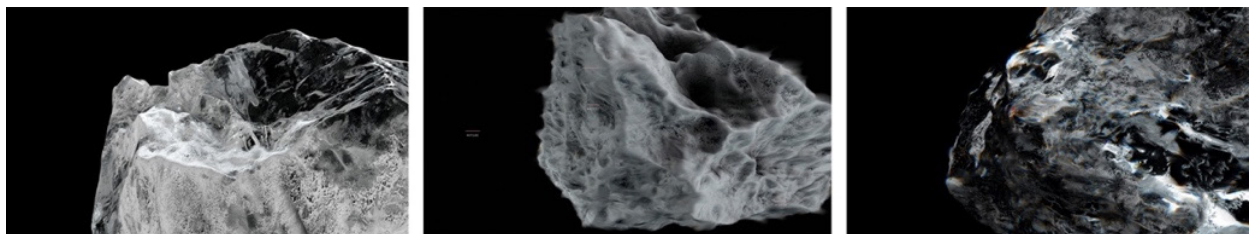
**Figure 3.** Refik Anadol's "Machine Hallucination"



**Figure 4.** Mario Klingemann's "Memories of Passersby I"

"12Bit Alchemy" (Figure 5) is a new media art work created by Berlin's Waltz Binaire studio in 2017. This piece delves into the perpetual evolution of digital matter and the genesis of novel forms through real-time coding and computer graphics rendering. Viewed through the lens of Gilles Deleuze's philosophy, the work encapsulates the notions of multiplicity and virtuality. It employs algorithms to engender a perpetually mutable and evolving artistic state. This manifestation of diversity and virtuality not only aligns with Deleuze's philosophical tenets but also exemplifies the heterogeneity of new media art in the age of artificial intelligence and algorithmic drive.

By employing experimental digital material manipulation, the work disrupts conventional coding practices to generate new physical behaviors. This process of "digital alchemy" resonates with Deleuze's conceptual shift from the actual to the virtual.



**Figure 5.** Waltz Binaire's "12Bit Alchemy"

### **Explanation and Application of Deleuze's Philosophy**

Deleuze's philosophical perspective emphasizes the importance of multiplicity and virtuality, which hold particular significance in the realm of New Media Art. Multiplicity, encapsulated in the notion that "multiplicity precedes reality," suggests that before any given reality, there exists a plethora of possibilities. The application of AI in New Media Art serves as a manifestation of this multiplicity. AI algorithms, through data and learning, can generate diverse artistic works, each of which stands as a concrete embodiment of multiplicity. Virtuality extends beyond multiplicity; it is not merely a simulation of reality but transcends it. In New Media Art, AI, through the manipulation of algorithms and data, can create artistic forms that surpass the constraints of reality, epitomizing the concept of virtuality.

In the context of New Media Art creation, the author offers the following reflections on the application of the concepts of multiplicity and virtuality:

#### **Data-Driven Multiplicity:**

Artists can utilize AI algorithms to generate a diverse array of artistic works through extensive data. This not only embodies the concept of multiplicity but also imbues the artwork with heightened innovation and diversity.

#### **Algorithmically Generated Virtuality:**

Artists can employ intricate algorithmic logic to create artistic forms that transcend reality. For instance, deep learning algorithms for image generation can produce images entirely distinct from the real world.

#### **Cross-Media Multiplicity and Virtuality:**

Artists can also maximize the concepts of multiplicity and virtuality through the integration of multiple media, such as combining music, images, and text.

In summary, Deleuze's philosophical perspectives offer a new lens and conceptual framework for New Media Art creation. By applying the concepts of multiplicity and virtuality, New Media Art can not only achieve diversity in form and content but also attain a higher artistic realm.

### **Conclusion**

This article delves into the application of Deleuze's philosophical in New Media Art, focusing particularly on the

core concepts of multiplicity and virtuality. We find that Deleuze's philosophical perspectives not only provide theoretical underpinnings for New Media Art but also foster diversity and innovation in the field. Especially with the advent of Artificial Intelligence, New Media Art exhibits remarkable dynamism in terms of multiplicity and virtuality. Therefore, the primary contribution of this article lies in its construction of a bridge between philosophy and art, offering new perspectives for both the theory and practice of New Media Art.

Despite the beneficial explorations made in the intersection of Deleuze's philosophical and New Media Art, there are some limitations to this study. First, due to constraints in length and depth of research, the theoretical discussion on multiplicity and virtuality is not exhaustive. Second, the article mainly focuses on the application of Artificial Intelligence in New Media Art, without covering other potential technologies and methods. These issues could not only trigger further academic research but also stimulate new thoughts among art creators and technology developers. Overall, the cross-disciplinary study of Deleuze's philosophical and New Media Art is a promising and meaningful field that warrants our continued attention and in-depth exploration.

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## Research on the design of "Trunk Bazaar" for youth groups based on the 4E theory of experience economy

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### Abstract

Influenced by the downgrading of consumption, many traditional consumer complexes face difficulties attracting consumers. New types of consumer space have been attracting the attention of young consumers, among which the "boot bazaar" has triggered heated discussions. "Boot Bazaar" is a kind of commercial activity in which car owners spontaneously use the boots of unused vehicles as retail space, but there are still many problems. To cope with the challenges posed by consumers downgrading to traditional commercial spaces, the boot bazaar is used as an example to update its business model and design a set of new commercial spaces that fit the consumption concepts of young groups. This paper adopts the 4E model of experience economy theory, analyses three typical cases, summarizes the elements that can enhance the sense of experience of young consumers, and puts them into the design. At the same time, it is concluded that the change in consumer demand has prompted the change of consumer space; how to enhance the consumer experience of young groups is the focus of designing new consumer space in the future. This paper is dedicated to improving the space planning and business model of the Trunk Bazaar. Also, it plays a specific role in promoting the exploration of new consumer spaces in the future, which aligns with the theme of this conference - the Foresight Plan.

### Author keywords

Experience Economy, 4E Model, Boot Bazaar, Consumer Space Transformation

### Introduction

Consumption downgrading is generally regarded as a negative and passive consumption phenomenon, and consumer psychology cannot be accurately expressed through consumption downgrading behavior. Consumption downgrading usually manifests as weak consumption capacity and insufficient incentive for residents to consume. (14) Under the sluggish environment of economic downturn, young people reduce their willingness to consume at a high level and lack the motivation to consume. However, the boot bazaars spontaneously established by young people have created a unique consumption atmosphere in a low-cost form, thus becoming a substitute for high-quality consumption places for young people. Therefore, as an informal place for buying and selling activities, the trunk bazaar challenges the traditional large-scale retail industry with its simple, convenient, and flexible trading methods, breaking the inherent trading circle. (13) The rise of boot bazaars means that traditional commercial spaces face a significant dilemma of transforming. Previous research has been carried out on the dilemmas traditional commercial spaces face. Therefore, in the face of the strong impact of online consumption on community physical commerce caused by the rapid development

of the digital economy, how to improve the shopping and experience advantages of offline physical stores has become an urgent topic of research (5). Shoppers tend to enter offline physical commercial spaces for six purposes: to enjoy the aesthetics, to escape routine and boredom, to explore a new product or shop, to enter a state of absorption, to gain new information about the shop and its products, and also as social interactions and relationships. The main design point of commercial space transformation is how consumers experience offline commercial space that online shopping cannot replace. Furthermore, Young people are spatial and social agents with different lifestyle habits than middle-aged people and play an essential role in creating or changing the city landscape (11). Therefore, paying attention to the consumption characteristics of young consumers and designing commercial space to meet their consumption experience is another crucial design point. The term “experience economy” describes a person perceiving experience when an individual participates in an event either physically or emotionally and comprehends a memorable experience (12). Pine and Gilmore’s model distinguishes two experience dimensions: customer participation and connection with the environment. Customer participation may go from passive, with customers not involved in any performance, to active involvement, where customers play critical roles in creating the experience. Along the connection axis, the experience may move from absorptive, occupying the person’s attention by bringing the experience into the mind, to immersive, where the person becomes physically or virtually a part of the experience. Consequently, experiences may be classified into four realms:

Entertainment (passive, absorption), educational (active, absorption), aesthetic (passive, Immersion), and escapist (active immersion). (6) From early on, Abbott emphasized the relevance of customer experiences, as “what people desire are not products but satisfying experiences.” Pine and Gilmore (1) took up this theme, defining the experience as a distinct economic offering, different from services, goods, and commodities, and suggested the progression of economic value towards the experience economy (3). Research on the experience economy in most fields focuses on increasing consumer experience. Experience economy theoretical models (4E) have been researched in tourism management, hospitality management, digital media, etc.. Hosany and Witham employed it in cruise travel (3), and Mehmetoglu and Engen in a music festival and museum. (6) However, there is a paucity of research on urban spaces based on the experience economy theory. Jacobs and Appleyard have identified the study of the experience economy in the urban sphere as an essential goal towards better urban living and quality environments. (4) Marjana Johansson and Jerzy Kociatkiewicz explore the intervention of urban festivals in shaping urban space from an experience economy perspective. (4)

These previous studies provide examples of how to use experience economy theory to examine other areas of research and have demonstrated in several cases that satisfying experiences have a significant effect on increasing consumer willingness. Current research on urban space focuses on explaining the significance of experience economy theory for urban planning and development from a macro perspective. To cope with the impact of consumer downgrading on commercial space, this paper fills the research gap in applying experience economy theory in retail space design. In addition, this study also emphasizes the importance of meeting the consumption characteristics of new consumer groups, thus improving the business model structure of the backup bazaar, which is also lacking in the transformation of current commercial spaces.

Therefore, the research content focused on in the article can be summarised as follows: using the experience economy theory as a lens, perfecting the business model and spatial design of the boot bazaar, and exploring new ideas for the transformation of urban commercial space.

The article first conducts field research on three boot bazaars with the theory of the 4E model and then perfects the design of the boot bazaar in Changsha to explore the following issues:

- 1.How can the trunk bazaar derived from consumption downgrading enhance the sense of experiential consumption for young consumer groups?
- 2.How can the new consumer space represented by the trunk bazaar become a new direction for transforming traditional consumer space?

The findings of the article not only provide empirical evidence for the improvement of the current boot bazaar but also provide a new theoretical basis for the transformation of traditional commercial space.

### **Conceptual framework**

As the fourth largest economy, after the agricultural, industrial, and service economies——The term “experience economy” describes a person perceiving experience when an individual participates in an event physically or emotionally and comprehends a memorable experience (10) . In line with the experience economy logic (Pine & Gilmore, 1999), experiences are co-produced affairs where participants are perceived as active agents, not passive spectators (Ellis & Rossman, 2008). Pine and Gilmore first introduced the concept of the "Experience Economy" and the 4E model - dividing experiences into four key elements: entertainment, education, escapism, and aesthetics, with the intersection of all four areas forming a "sweet spot." A "sweet spot" is formed at the intersection of all four areas. It also explains how experiences can be an engine of economic growth and suggests that economic value should be shifted towards experiential value. (9) ; Holbrook and Hirschman reveal how consumption fantasies, emotions, and pleasures influence consumer behavior (2)

This paper focuses on the "Trunk Bazaar" from the experience economy perspective, uses the 4E model to explore its characteristics, and improves the "Trunk Bazaar" from the four dimensions of entertainment, educational, escapist, and esthetic.

#### **Entertainment**

Entertainment as an essential form of experience stimulates participants to enter experiential scenarios progressively, but compelling entertainment must capture and occupy the attention of individuals and allow them to participate in it; typical entertainment venues tend to lead participants to a sense of participation and experience through a sense of context and atmosphere: atmosphere is often created through the use of lighting and music; context is often created through the establishment of a theme for the venue based on the unique cultural landscape of the area. An effective theme is simple, compelling, and does not need to be overtly expressed in writing. However, the theme must drive all the design elements and the experience of the staging event, with a unifying storyline that completely engages the target audience.

The leading target group of the bazaar - young consumers show a significant tendency towards memory-rich entertainment products or services, in addition to sensory stimulation through music, stage, lighting, etc., focusing on the theme concept of the bazaar's regional characteristics is also a way to increase the memory points of young consumers.

In this study, the entertainment experience precisely corresponds to the four elements of the Trunk Bazaar's music: stage, lighting, and event theme.

### Educational

Educational experiences enable tourists to increase general and specific skills and knowledge while actively participating in events or activities at a tourism destination (7). In contrast to entertainment experiences, educational activities tend to confer a more positive sense of engagement. How the experience gives participants a sense of engagement in acquiring knowledge is an essential measure of the educational experience dimension; for example, the craft beer-themed tour categorized the source of knowledge acquisition for the participants as twofold: as there are many types of beers introduced into the marketplace, giving knowledge of the product encourages the participants' need to buy it. However, knowledge does not only come from the beer stand but also from interaction and communication with other people (10); in other words, the purpose of the educational experience is to encourage participants to acquire knowledge both during consumption and socialization and to motivate participants to actively socialize and consume through the experiential sense of knowledge acquisition. Educational experiences require participants to be more active, and young consumers consume them for psychological satisfaction, social interaction, identity, and individuality. Therefore, the article focuses on how to focus on intellectual output in the conception and scenario creation of the bazaar, guiding consumers to participate in the bazaar with a sense of knowledge acquisition and, at the same time, providing them with places where they can get to socialize.

The educational experience in this study precisely corresponds to the three main elements of community interaction, information communication, and social space in the boot bazaar.

### Esthetic

Distinguishing it from the other three dimensions of experience, the aesthetic experience allows the consumer to immerse themselves in the sensation but does not require active participation. Engaging in this experience is to lose themselves in appreciating what they see. For example, Rangson Chirakranont and Sirijit Sunanta's discourse on craft beer tourism discusses how the construction of scenarios can be used to increase the aesthetic experience of the participants, which can be provided using artificial elements that reflect the event's theme. (10) Products or scenarios that are beautiful and unique in appearance tend to capture the attention of the younger demographic. Therefore, a unique aesthetic experience will attract young consumers to participate in it. Bazaars form a unique language system through design, providing consumers with a unique aesthetic experience while forming visual symbols that represent the culture of the bazaar.

The aesthetic experience in this study corresponds to four significant elements: bazaar logo, IP image, stall decoration, and overall style.

### Escapist

The escapist experience is similar to other domains of experience that provide different measures of amusement and relaxation. However, the escapist experience requires high immersion and participation; in contrast to the other dimensions, the escapist experience focuses on encouraging an escapist experience for travelers through real-life scenarios of different lifestyles and societies, where they will be free from their daily lives. (7) The different identities and environments from everyday life give the participants a sense of psychological escape, which greatly satisfies the need for psychological relief for most stressed people.

The boot bazaar provides the consumer with two central identities - buyer and seller - that distinguish him from

the everyday and break class. The order and uniqueness of the consumer's everyday life are briefly escaped, and the consumer takes on a new identity and exists in the bazaar. The experience of "buyers" and "sellers" communicating as equals in the bazaar is the main reason the bazaar provides a sufficient understanding of escapism.

In this study, the experience of escapism corresponds to the three main elements of bazaar order, immersion, and participation.

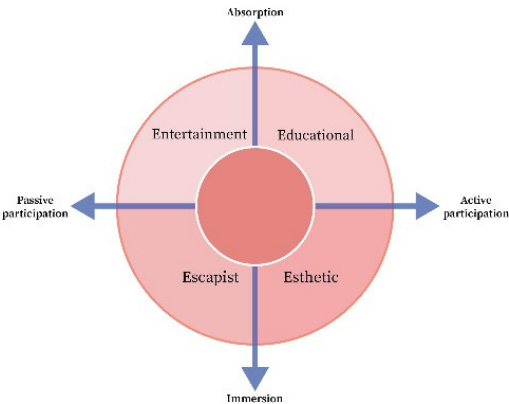


Figure 1. Experience Economy 4e Theory

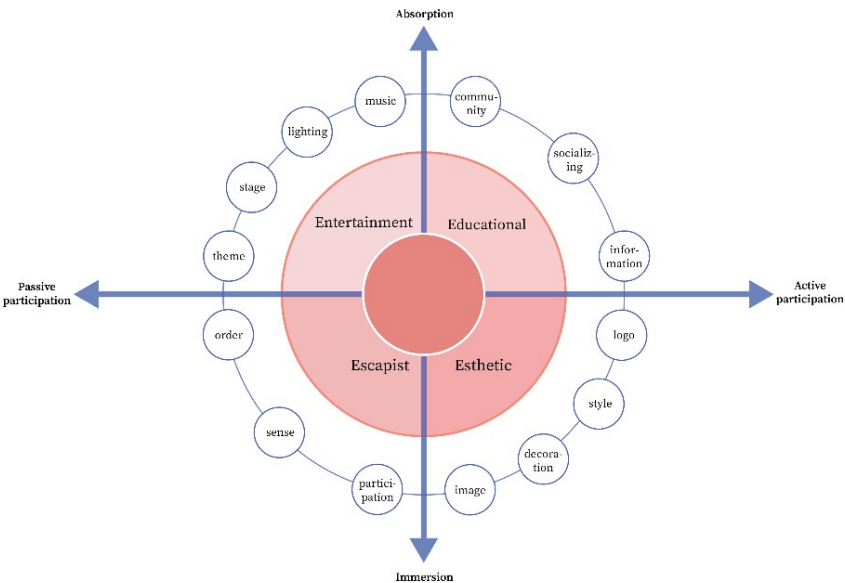


Figure 2. Translation of 4e theory in research

Boot Bazaar Research

Case Study

Aiming at the existing boot bazaar research, from the four dimensions of entertainment, education, aesthetics, and escape to analyze the specific components of the typical bazaar, to discover the positive elements of each bazaar tends to the "sweet spot," to provide a theoretical basis for the improvement of the boot bazaar.

### Wumadu Bazaar

Wumadu Bazaar is located in China, Jiangsu, and Nanjing. The area has a long history and culture and is also the birthplace of Nanjing Trunk Bazaar. Different from other boot fairs, Wumadu Trunk Fair, under the government's decision, tries to build a new IP of the city, which is rich in the cultural characteristics of Nanjing.

According to the theory of the 4E model, Wumadu Trunk Bazaar mainly adopts the experience mode of "Entertainment Experience + Education Experience" to build up the bazaar. From the dimension of entertainment experience, Wumadu Trunk Bazaar tries to attract consumers to participate in the cultural space to experience Jinling culture through lighting and other forms, and the bazaar activities themed on regional culture meet the experience needs of the young group, but it lacks large-scale stage equipment at present; from the dimension of educational experience, Wumadu Trunk Bazaar emphasizes on the experience that consumers can acquire knowledge within the bazaar and has held several events to popularise local culture to give educational experience. Educational experience to organize themed cultures, such as popularising local silk culture and promoting anti-fraud knowledge, enhances consumers' educational experience. However, the bazaar has neglected the importance of aesthetic experience and escape experience for the participants in the 4E model. Coordinating and enhancing the bazaar's overall aesthetic feeling and giving consumers an immersive spatial experience through design is the main problem in constructing the cultural IP of Nanjing Bazaar nowadays.



**Figure 3.** Insert a caption below each figure and number all figures.

### Square Box Project Bazaar

The Box Project Bazaar is located in Chengdu, Sichuan, China. The bazaar focuses on brand promotion and brand community building and tries to carry out "flash mob" brand marketing in the form of a boot market.

According to the 4E model theory, the analysis of the experience form of the Square Box Project Bazaar shows that the Square Box Project Bazaar focuses on the experience mode of "educational experience + escapist experience" to build the bazaar. From the dimension of escapism experience, the bazaar focuses on the concept of consumers' expression, giving them a sense of participation in a self-constructed lifestyle; from the size of the educational experience, the bazaar emphasizes the combination of design and corresponding product concepts, stimulating consumers to consume after obtaining a sense of knowledge acquisition, to build up a brand image in the target group gradually.

However, in terms of the four experience dimensions, the Box Project Bazaar still lacks in the dimensions of



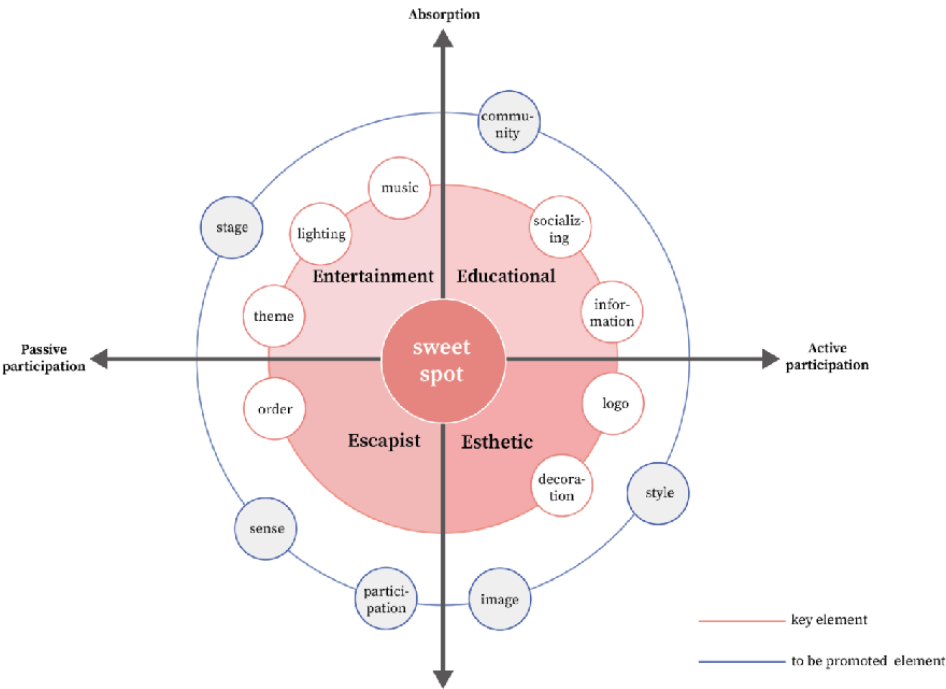


Figure 4. Analysis of the Wumadu Bazaar

entertainment experience and aesthetic experience, so how to quickly stimulate consumers' sensory and psychological feelings and attract the target group to participate in the bazaar actively is a problem that needs to be solved urgently.

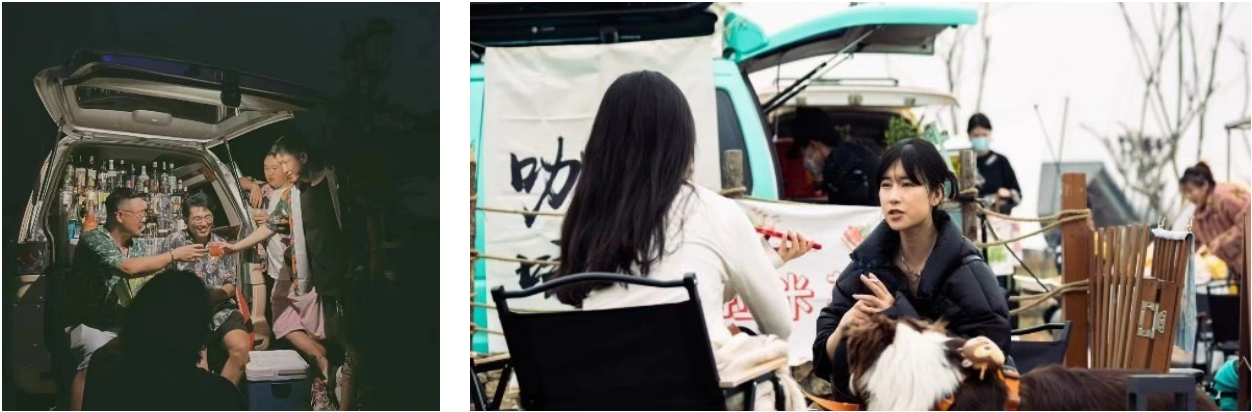


Figure 5. Insert a caption below each figure and number all figures.

Big Fish Bazaar

Located in Changsha, Hunan Province, China, the Big Fish Market was built as a boot market for young people who wanted to participate in their primary or secondary careers after the epidemic.

According to the 4E model theory, the experience form of Dafu Trunk Bazaar is analyzed, and Dafu Bazaar is constructed with a focus on the experience mode of "Entertainment Experience + Escape Experience." From the dimension of entertainment experience, the Big Fish Trunk Bazaar stimulates consumers' senses by incorporating stage activities, music, and other elements so they can enter the bazaar quickly. From the perspective of escapism, each stall in the market provides camping chairs for "buyers" and "sellers" to sit down

and communicate, giving consumers an experience that is difficult to obtain in their daily lives through equal and comfortable exchanges.

However, according to the theory of the 4E model, it is difficult for consumers to obtain the two dimensions of educational experience and aesthetic experience in the Big Fish Trunk Bazaar. In terms of educational background, Big Fish Trunk Bazaar neglects the importance of giving consumers knowledge of the products in the bazaar, which not only weakens the consumers' experience but also is not conducive to the marketing of the bazaar; in terms of aesthetic experience, the lack of unity and uniqueness in the overall visual planning of Big Fish Trunk Bazaar weakens the aesthetic experience of the participants when they are viewing the bazaar.

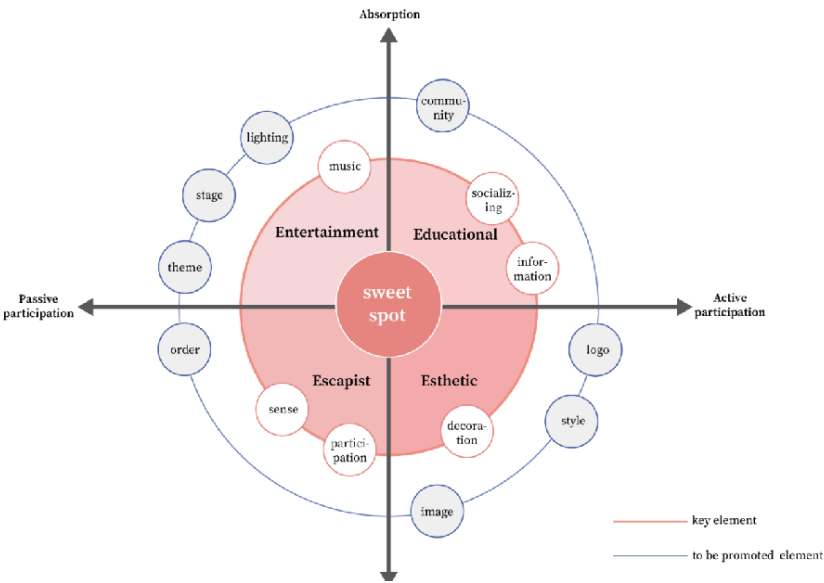


Figure 6. Analysis of the Square Box Project Bazaar



Figure 7. Insert a caption below each figure and number all figures.

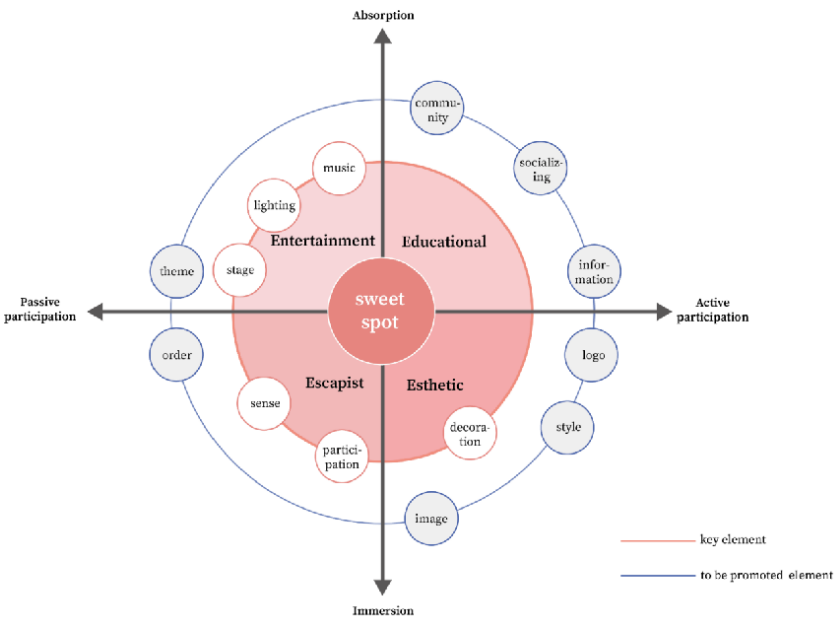


Figure 8. Analysis of the Big Fish Bazaar

Comparative analysis

A side-by-side comparative analysis of the above cases yields the following results:

Table 1. Comparative analysis

The 4E model	Specific elements	Wumadu Bazaar	Square Box Project Bazaar	Big Fish Bazaar
Entertainment	Music	Strong sense of musical ambiance	Relying on music to enhance the atmosphere of the fair	Netizen singers often frequent the marketplace
	Lighting	Lighting to set the mood Problems of incoherence	Setting the mood for the fair in the form of a bonfire Too little application of light	Lighting to set the mood Problems of incoherence
	Stage	Large-scale stage Occasional building	Hardly a stage at all	The scale of staging varies according to the format of the event; Small overall size
	Theme	Reflecting the historical and humanistic characteristics of the Nanjing area	Co-branding lack of market characteristics	Lack of a theme
Educational	Community	Fixed community not yet established	A settled community not yet established	A settled community not yet established

	Socializing	Large social space	Not conducive to the formation of social circles within a fixed area	The lower flow of people
	Information	High efficiency of information transfer; It contains intellectual transmission	Focus on messaging for relevant brands Inefficient transmission of information	Weak transmission of information related to the bazaar; Poor access to information for consumers
Esthetic	Logo	Marked to represent the bazaar	No sign representing the bazaar	Honored to represent the Bazaar Lack of memory points
	Style	Lack of uniformity of style	Lack of uniformity of style	Lack of uniformity of style
	Decoration	The boot of the vehicle is decorated	The boot of the car is decorated	The boot of the car is decorated
	Image	Neglect to build the image of the bazaar	Neglect to construct the idea of the bazaar	Neglect to construct the idea of the bazaar
Escapist	Participation	Too much commercialization reduces young consumers' engagement with self-identity	Pursuing freedom meets the young consumers' sense of participation in the bazaar.	A relaxed atmosphere satisfies young consumers' sense of involvement in the bazaar.
	Sense	Difficult to quickly stimulate consumer immersion An atmosphere full of fireworks	Difficult to stimulate swiftly consumer immersion It fits consumers' need for a sense of psychological freedom	Difficult to stimulate swiftly consumer immersion Giving consumers a relaxed psychological feeling
The 4E model	Specific elements	Wumadu Bazaar	Square Box Project Bazaar	Big Fish Bazaar
	Order	Focus on the establishment and maintenance of order under government administration	lack of order	lack of order

#### On-the-ground research

After the case study, the authors conducted focused research on the Dafu Bazaar in Changsha to gain an in-depth understanding of the current situation of boot bazaars and to identify further the problems of boot bazaars at the design and operation levels.

#### Overview of the research

Located in Changsha, Hunan Province, China, Dafu Bazaar is a typical boot bazaar in the Changsha area and



is currently tiny in scale, with about 15-20 stalls per bazaar. The bazaar manager and his team are responsible for constructing and promoting the entire bazaar. Because the bazaar is currently focused on joint activities with large shopping malls, many activities are now located near large shopping malls in the Changsha area. Still, according to feedback from the bazaar's stallholders, the highest returns are generated by the activities at Tongcheng Commercial Plaza, located in the vicinity of the University City in Changsha's Yuelu District.

The stakeholders involved in the Dafu Bazaar are government departments, bazaar managers, stall owners, consumers, event organizers, and online operators. The B-side of the population: Bazaar managers, stall owners, event organizers, and online operators serve the C-side's main population, young consumers, with the assistance and management of the G-side. During the field research, the author conducted interviews with the bazaar manager, stall owners, and consumers, and the discussions were as follows:

The primary manager of the Big Fishing Bazaar, who is also the initiator of the bazaar, is currently facing the central problem of the bazaar's difficulty in attracting customer traffic on a sustainable basis. To solve the problem, the bazaar owner tried to increase the marketing efforts of the bazaar through live broadcasting, but the effect was not significant. Also suffering from unstable customer traffic are the stallholders of the bazaar. Two post-95s stallholders who were starting their businesses expected to gain the opportunity to promote their online shops to consumers by joining the boot bazaar, but the desired results were not achieved. In this regard, a randomly interviewed Post-00s consumer believes that the real purpose of entering the bazaar is not to consume but to socialize.



**Figure 9.** Field research photos

## Survey and Research Summary

After research, it was found that the current process of constructing the Dafu Bazaar is as follows:

(1) With the approval of relevant government departments, the bazaar manager and the event organizer agree on the time, theme, and venue of the bazaar; the workers responsible for the operation of the bazaar release the information about the bazaar and recruit bazaar stall holders; the stall holders interested in participating in the activities of the bazaar will prepare their vehicles and products for sale and submit their applications for joining the bazaar to the bazaar manager through the online platform; after the manager completes the selection of the stalls for the bazaar, the activities of the bazaar will be carried out on time (excluding exceptional circumstances such as weather changes, etc.). After the selection of stalls by the bazaar manager, the bazaar will be held on time (excluding exceptional events such as weather changes);

(2) During the bazaar activities, while the stallholders sell their products, the workers in charge of online operations will conduct live broadcasting activities to gain more online exposure.

(3) After the bazaar, the manager will evaluate the event and prepare for the next one.

Dafu Trunk Bazaar has unlocked a new form of the night-time economy in Changsha. Still, how to stimulate the consumption vitality of Changsha to a greater extent has become a significant problem that needs to be solved urgently; in other words, only by attracting potential consumers of the bazaar to the most significant area possible - young groups can we give full play to the role of the economy driven by the boot bazaar, and the following will be an analysis of the bazaar. The reasons why it is difficult to attract consumers are analyzed below:

(1) When choosing market stalls, managers often avoid homogenizing market categories and product safety as important considerations while neglecting that an overly monotonous business format can quickly lower consumers' expectations in the bazaar.

(2) The bazaar format ignores the consumption preference of young groups, and the interactive form is often more popular, such as DIY, cat jerking, and so on.

At present, there are many problems with the basic establishment process of the bazaar:

(1) Before the bazaar is launched, the lack of creative themes and information lagging are essential reasons why attracting young people is difficult.

(2) The single format in the bazaar and the confusing visual presentation reduce the consumer experience.

(3) The flexibility of boot bazaars is the main feature distinguishing them from ordinary bazaars. However, the uncertainty of carrying out bazaars (uncertainty of time, location, etc.) also reduces the expectations of young consumer groups to a certain extent.

This shows that increasing the experience of the leading young groups in the bazaar is a crucial issue in fulfilling the economic driving role of the boot bazaar.

## Design assumptions

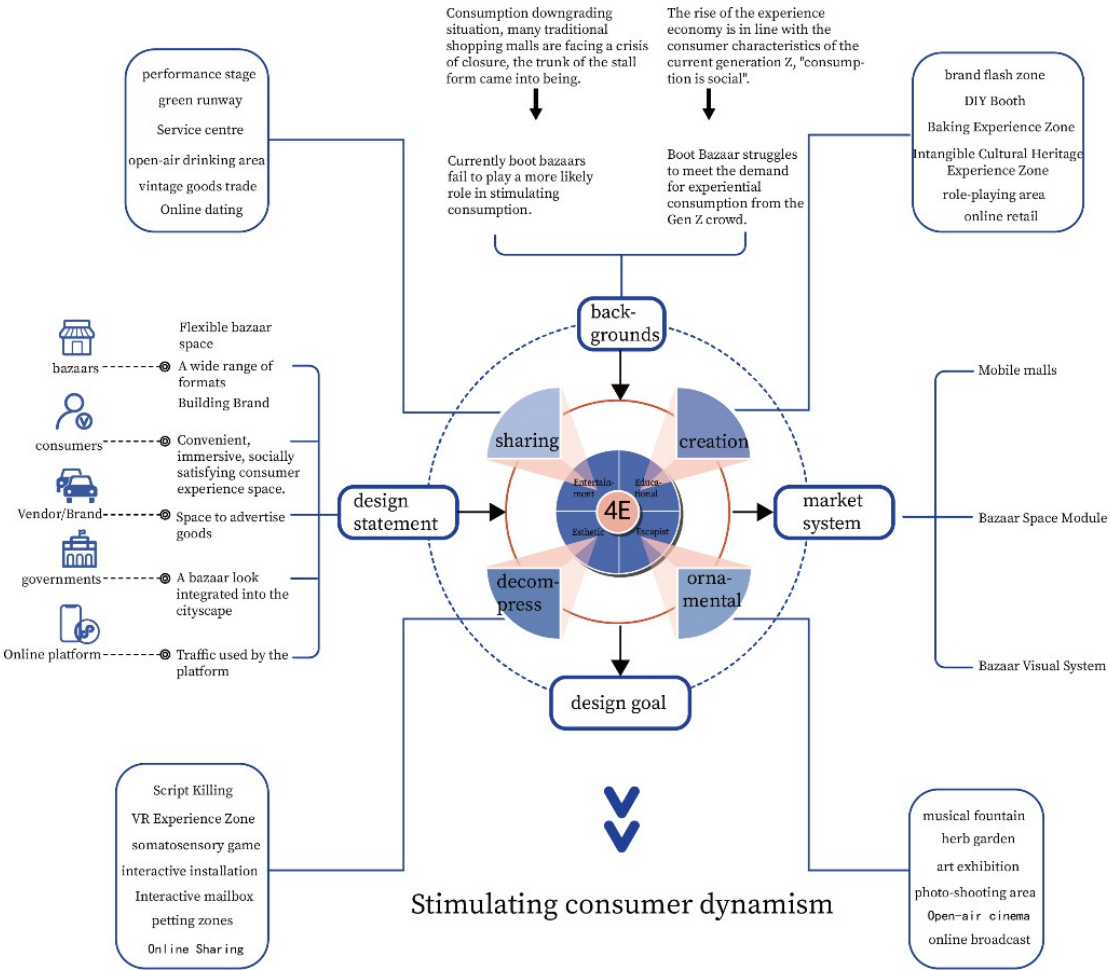
### design strategy

The authors update the Trunk Bazaar from the four dimensions of the 4E theory, proposing a design strategy centered on sharing, creating, unpacking, and viewing.

### sharing

Sharing corresponds to the entertainment experience in the 4E theory. The key to enhancing the entertainment experience of young consumers lies in establishing a shared space that can attract young consumers. Enhancing the entertainment experience in 4E mainly plays the role of strengthening consumer attraction. For young consumers, a social environment shared by them and triggering emotional resonance is an important driver to





**Figure 10.** Insert a caption below each figure and number all figures.

attract them to the bazaar. Therefore, sharing is the first core word of this design strategy.

creation

Creating an educational experience corresponds to the 4E theory. The key to enhancing the educational experience of young consumers is to satisfy the demand of young consumers for independent creation; the educational experience in the 4E theory requires the active participation of consumers; in other words, the acquisition of knowledge by consumers is not a passive acceptance but a dynamic creation. Therefore, creation is the second core word of this design strategy.

decompress

Decompression corresponds to the escape experience in the 4E theory. The key to enhancing the experience of escape is to create an atmosphere of decompression. The post-pandemic economic downturn has increased stress in many ways, especially among young people who have difficulty finding employment. To escape from daily life, young consumers spontaneously seek out places where they can relieve stress and immerse themselves briefly. Unwinding is, therefore, the third keyword.

## ornamental

Viewing corresponds to the aesthetic experience in the 4E theory. The key to enhancing the aesthetic experience is attracting young consumers' attention through the bazaar's ornamental nature. Nowadays, young consumers pay more attention to aesthetics; enjoying services or spaces that meet their aesthetics is a pleasure and a way to express their personality. Therefore, ornamental is the fourth keyword.

## Business model update

### Stakeholder

The design of this study follows the roles of the current bazaar and refines the work of some of the people, as described in the following refinements:

Event organizers are mostly developers of large shopping malls, who are responsible for providing venues close to the malls for the bazaar, and at the same time, need to assist the bazaar in constructing a bazaar image in a fixed and changing area and providing a buffer for the transformation of traditional commercial spaces to new ones; bazaar managers are responsible for the deployment of the bazaar, who determine the theme of the bazaar after consulting with the event organizers, and adjusting the theme and deployment of the bazaar promptly according to the online feedback information from consumers; online operators are responsible for the release of the bazaar information; online operators are responsible for the release of the bazaar information. The bazaar manager determines the theme of the bazaar in consultation with the event organizer but also makes timely adjustments to the music and deployment of the bazaar based on consumer feedback;

At the same time, new roles have been added, such as designers and bazaar managers, to better serve consumers.

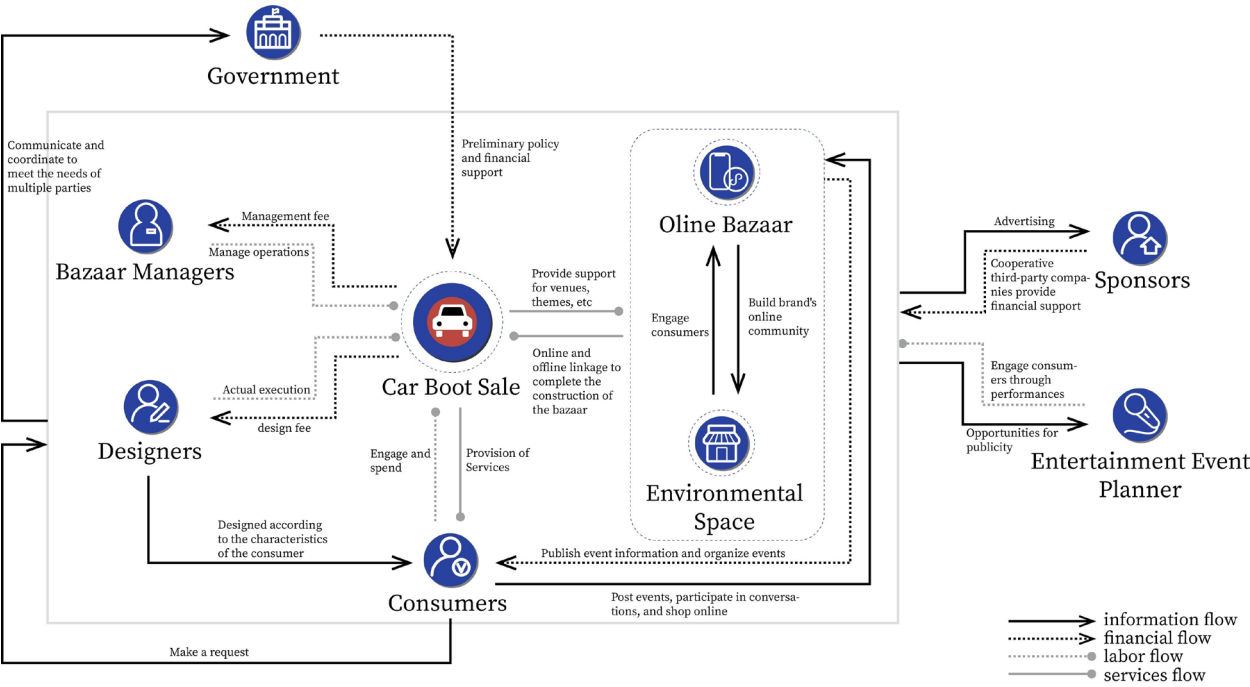
Designers are responsible for the design of the bazaar and assist the bazaar manager in completing the formation of the bazaar. Designers design the bazaar according to the theme of the bazaar, including booth design, space use, color matching, etc., to convey the brand image and value of the bazaar and, at the same time, maintain the innovation and competitiveness of the design through market research. Bazaar managers are responsible for offline space construction and order maintenance. They must effectively manage all affairs in a complex environment while paying attention to details to ensure the smooth running of the activities and enhance consumer satisfaction.

## System Map

The perfected backup bazaar system adopts the "online + offline" mode, which builds the online community of the bazaar and guides consumers to the offline bazaar by leveraging the real-time interaction and communication functions of online. The theme of the bazaar is established by analyzing the consumer preferences of the consumer groups through big data and combining the unique regional characteristics. The offline bazaar is built around the keywords "sharing, creating, relieving stress, and viewing." This model requires online platform construction, operating costs, labor costs, and facility construction. However, this model stimulates young consumers' willingness to consume, so the primary source of income for the market comes from consumer fees and sponsorship.

## 5.3 Design Update Ideas

### 5.3.1 Space system



**Figure 10.** Insert a caption below each figure and number all figures.

Based on the four keywords of "sharing, creating, decompressing, and viewing," the space planning and design has increased the number of interactive installations, brand flash mobs, and role-playing modules; at the same time, it has given full play to the mobility of the Trunk Bazaar and combined it with the regional characteristics to form a systematic and assemblable spatial system.

Online system

Building an online community for the Back Box Bazaar provides a convenient way for Back Box Bazaar consumers to find people with similar interests, and at the same time, provides the Bazaar with broader exposure and promotion opportunities to enhance brand awareness and influence by establishing a connection with the target. To establish an online community for the bazaar, first of all, it is necessary to set a clear goal based on the needs and interests of the young group; then, it is essential to choose a suitable online platform to convey the core values of the community through sharing and communication; in short, to establish a thriving online community system, it is necessary to always focus on the user, provide valuable content and interactive experience, and actively maintain the activity and development of the community.

Visual system

Constructing the brand visual system of the bazaar is conducive to enhancing brand recognition and image so that consumers can connect with the brand emotionally and cognitively, specifically including the brand logo, font selection, graphic elements, and so on. Establishing a brand vision needs to fully consider the target audience, brand positioning, market environment, and other factors and ensure that the brand's visual elements and core values are consistent to form a coordinated and unified visual style. Through the standardization and consistent application of brand vision, the brand can better communicate and interact with consumers and establish long-term brand loyalty of young consumer groups to Trunk Bazaar.

## Conclusion

This study aims to explore how the commercial space in the city under the background of consumption downgrading can be transformed from traditional to build a new type of retail space with integrated consumption and social interaction functions for new consumer groups. Through the study, the authors have a deeper understanding of achieving experiential consumption in commercial areas. According to the study results, the following points are noted: the requirements of young consumer groups for boot bazaars are more focused on the richness of the industry, the unity of the vision, and the specialty of the theme. Meanwhile, in terms of the four dimensions of the 4E model, the satisfaction of entertainment experience and aesthetic experience can attract the attention of the young consumer group. Still, the group looks forward to the satisfaction of educational expertise and escape experience. In conclusion, the transformation of traditional commercial space to new retail space essentially reflects that the consumption purpose of the leading consumer group is changing from high-quality to experiential.

The results of this study are mainly twofold:

- (1) based on studying the four elements of the experience economy theory: entertainment experience, educational experience, escape experience, and aesthetic experience, the boot bazaars are analyzed and improved. In the research process, the 4E theoretical model of the experience economy theory is used for case analysis. The field research focuses on the trunk bazaar in Changsha to discover and improve the boot bazaar's essential problems and improve it.
- (2) Current research on commercial space transformation discusses the interventional role of urban space for urban development and consumer activities. Still, there are fewer studies aiming at enhancing the experience of consumers. This paper takes the boot market as a model to demonstrate that the transformation of traditional commercial space needs to pay attention to the change in consumer groups. To better meet the needs of new consumers, this paper finds that the new retail space should not only be limited to the design of physical space but also improve its business model structure.

However, there is still room for improvement in this paper, and it remains to be seen whether the results of this study can be replicated in other second- and third-tier cities due to the large number of cities in China and the significant differences in the development of boot bazaars. Future research can gain a deeper understanding of how to optimize the spatial configuration of boot bazaars through follow-up studies. In addition, the insufficient segmentation of consumer groups and the insufficient sample capacity in this article may lead to some errors in the results of the study, and it is necessary to expand the sample and strengthen the quantitative analysis in future studies to provide more comprehensive and scientific research data for the design of new commercial spaces in cities.

The new urban commercial space exemplified by the Trunk Bazaar provides empirical evidence that the consumer population induces the transformation of urban commercial space, and how to successfully realize the change of urban retail space through multi-party collaboration on this basis is the goal of the next stage. At the same time, the attention to the experiential consumption needs of young groups still needs to be strengthened to highlight the purpose of stimulating consumption vitality. Therefore, the future design of urban commercial space needs to promote experiential consumption for in-depth exploration and improve the new urban commercial space system, which can help the urban retail space cope with the transition crisis, seize new development opportunities, and achieve healthy and efficient development.

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## **Walls as resilient functional interfaces for the last-mile delivery of gated communities in response to the public health crisis**

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### **Abstract**

This research focuses on how the wall boundary space can act as an interface for the material distribution system in the context of community closed management. During COVID-19 in China, community isolation made last-mile distribution of supplies problematic, thus placing communities under extreme pressure to prevent epidemics. Through field observations, this study has identified the emergency phenomenon of using wall boundaries as staging areas, a spontaneous community solution for material distribution during the epidemic. This autonomous utilization of space is a prototype for future distributed space systems integrated with emergency situations. Community boundaries are both a barrier to the exchange of materials between inside and outside, as well as a new medium and place. By combining modular devices with the wall boundary space and introducing them into a community material distribution system, the research creates flexible distribution interfaces that enable the flow of material in enclosed scenarios, while being able to provide diversified daily service. The study offers a way to transform unused space under closed community construction into a resilient interface for communities to respond to the public health crisis.

### **Author keywords**

gated community; last mile delivery; public health crisis; wall boundary space.

### **Introduction**

The rise of the e-commerce economy and the spread of internet technology has led to logistics gradually becoming an important part of people's lives. Particularly during a pandemic, urban restrictions on going out made online shopping the main choice of many consumers, and a variety of takeaway, and grocery shopping businesses experienced a surge (Movarrei, R., et al. 2022). Last-mile delivery became an important lifeline to ensure people's basic livelihoods during the epidemic. However, the policy of closed management adopted by Chinese communities during the COVID-19 pandemic became an obstacle to last-mile logistics delivery, making it impossible for community delivery to be completed properly, thus exposing many problems during the epidemic. For example, supplies were left stranded in open spaces outside community gates, prone to lose and spoilage. People shuttled through makeshift delivery ground stalls, exacerbating the pressure on community preparedness. Current research on material distribution mainly focuses on urban management at the macro level, such as urban logistics distribution and emergency logistics system design under emergency scenarios, and lacks research on community space design at the micro level. Community design also rarely considers logistics distribution in emergency scenarios.



Therefore, the research hopes to promote a more resilient community design in the future to address the distribution challenges posed by unexpected future public health crises. Taking the closed community in China as the typical research object, this research will construct a material distribution response strategy based on the special city construction background.

### **The value of the wall boundary space to intervene in last-mile delivery**

The epidemic has seen a dramatic change in the way residential community space is used due to the emergence of the concept of isolation and containment. Many of the formal changes based on the distribution of materials occurred mainly at the boundaries and around the building interfaces.

#### **Public space between inside and outside**

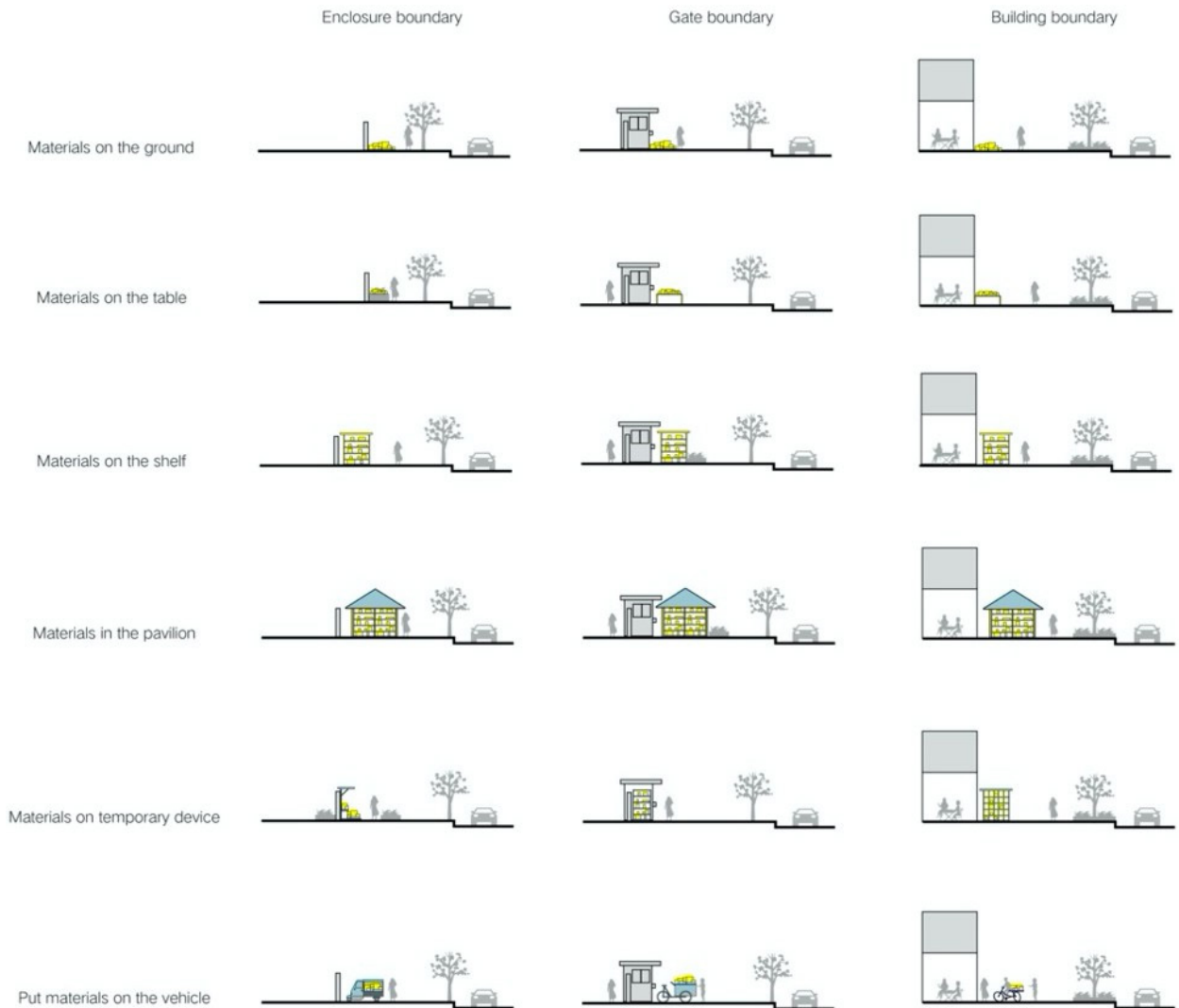
The wall boundary space is an important transition interface between the city and the residential closed community (Chen, et al.,2013). It is an important public space located between the internal settlement space and the external urban space. Therefore, the existence of flexible borders is essential to ensure the normal flow of goods distribution services while ensuring the closure of communities. Especially when the community has experienced the closed management period, the wall boundary space has the potential to meet the needs of internal and external material exchange and enhance the resilience of the community.

#### **Compound place to accommodate multiple behaviors**

Community boundaries have played a huge role in this epidemic. Different boundary types have distinctive behavioral and functional characteristics that can fit within a range of human behaviors. For instance, during the epidemic, materials distribution detention places near the border space, such as materials detention grounds, materials detention racks, materials detention kiosks, and other diversified forms of material distribution have spontaneously combined with the boundary space. (Figure 1)

#### **Redundant urban space resources for emergency**

Currently, the boundaries of residential communities are frequently abandoned. This is based on the red line regions specified in the settlement plans, which call for the construction of structures to be situated within the red line areas, leaving the border areas around the red lines frequently in a dilapidated state (Chen, 2019). At the same time, the boundaries of residential areas are distributed throughout the city. It has the ability to be repurposed in order to fully harness the boundary's potential economic and social impacts, giving the material foundation for continued resilient and sustainable community growth.



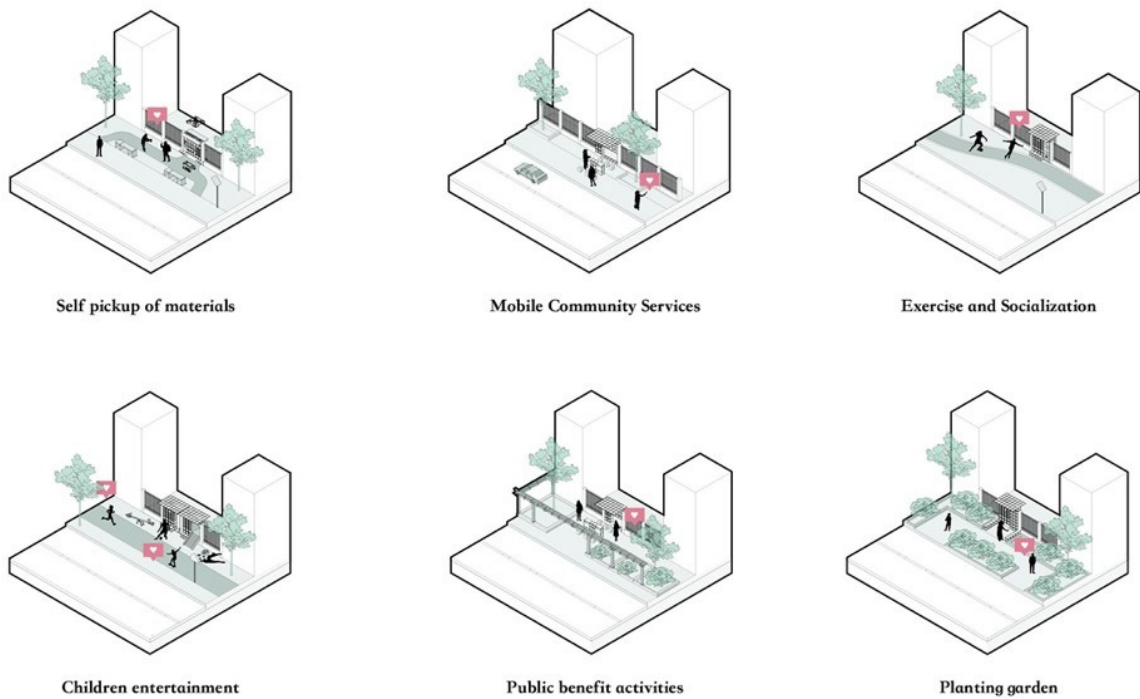
**Figure 1.** Multiple distribution behaviors near the boundary space of the community.

### Design of the wall boundary space as a flexible interface for distribution

Thus, this study proposes to use the wall boundary space of the gated community, which is unique to China, as a place of interaction interface, providing a function of internal and external material exchange in an isolation scenario during the epidemic.

#### Distribution module based on wall boundary space

The walls of the gated community can behave like cell membranes that may selectively let through people and items. Through the use of modular docking devices linked to the interface, the community can achieve a combination of daily and emergency use for last-mile distribution, leveraging the unused community's wall interface as a mediating field to facilitate the rapid construction of community emergency distribution. In the post-epidemic normalization period, such space can also be expanded into diverse spaces with community social and recreational attributes, transforming emergency interface installations into flexible urban furniture based on residents' needs. (Figure 2)



**Figure 2.** Docking module for enclosure boundary space and function switching.

#### Online and offline community logistics circle

The boundary space resources between each residential area can be linked and shared, so as to realize its emergency function at the level of the entire urban space system. The community logistics circle based on the interface can also be established, utilizing community services and distribution that are originally active near the interface space, such as second-hand furniture and trouser repair. This enables the diversification and collaboration of the interface space, making the boundary an inclusive and resilient place of the community.

#### Intermediary field of unmanned distribution

The wall boundary space module also serves as an intermediate interface to facilitate the rapid popularization of unmanned delivery. The wall-boundary module is equipped with a parking platform for docking the UAV. Spatial changes can be quickly realized through the update of prefabricated modules, so as to realize the connection between unmanned logistics and communities through spatial micro-renewal. (Figure 3)



**Figure 3.** The intermediary interface of future unmanned logistics.

## Conclusion

This research has carried out field investigations on the possibility of the wall boundary space as an emergency distribution space under the construction of closed communities in China. It identified the community's spontaneous use of the enclosure boundary space and a range of behavioral changes, pointing out its potential as an emergency material distribution space. Then, the study proposes to realize the flexible use of daily and emergency scenarios through the modular update design of the wall boundary space. It can serve as a place for daily distribution and social activities as well as an emergency space for material distribution and supplies during special periods. At the same time, the wall boundary space can also provide a flexible interface for communities to connect future distribution equipment. Finally, the study hopes that the renewal of enclosure space can be used as an interface for the construction of resilient communities and promote the resilience of communities to deal with disasters.

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## **The Mushrooms of Plato's Cave**

**Francesca Brunetti**

I am an artist and scholar, and feminist theory and ecocriticism informs my studio art practice while my artworks provide additional elements to my theoretical investigations into feminism and ecology (Braidotti, 2019; Mellor, 2013; Plumwood, 1993; Shiva, 2014; Sturgeon, 2016, 2009; Warren, 1997). In my previous projects I focused on Italian culture to reflect on the relationship between female subjectivity and her material existence, the ecocritical approach to visual culture, and the representation of women in cultural productions. In the creative project that I discuss in this paper I adopt an interdisciplinary approach to eco-feminism, new materialism, and drawing to create a visual counternarrative of Plato's Myth of the Cave. In my narrative the protagonist of my redesigned myth is a woman which instead of leaving the material world represented by the cave, as the male protagonist in Plato's myth, creates a deeper connection with it by understanding its underground life populated by fungi.

### **Objectives:**

Plato discusses the Allegory of the Cave in the Republic. This text has been interpreted by thinkers as emblematic of Plato's philosophy and western thinking and its anthropocentric, controlling, and technocratic approach to reality (Heidegger, 2014; Nietzsche, 1994). In my project I intend to transform this myth into an alternative visual narrative where the protagonist of my transformed myth instead of going up, in the direction of the sun and abstract thinking, as the male prisoner in Plato's myth, goes down, underground, in a world populated by fungi, worms and bacteria. This fictional character engages in eco-dialogues and interactions with the beings that she meets: she learns about how understand, interact, and care about them. By doing this she gains knowledge that increases her happiness and resilience. By proposing this narrative, I intend to question current values about social organization based on aggressive competition and exploitation. I do this by visualizing how care and cooperation can benefit both the human being and the environment (Estévez-Saá & Lorenzo Modia, 2020; Sevenhuijsen, 2003; Shiva, 2014; Woodly, 2021). In this artistic project care is intended as an ethical and political practice that has the potential of orienting people to new ways of living, relating, and governing. According to this perspective the ethics of care is a method, a political thought, and an action that moves beyond the liberal approach which situates care as a finite resource to be distributed among individuals, or as a necessarily feminine virtue. Instead, I intend care as a survival strategy, a foundation for political organizing, and a theoretical framework for imagining a world in which humans and non-humans can live and thrive.

### **Problems:**

To visualize this alternative way to imagine human/non-human relationships I decided to reinterpret The Myth of The Cave according to an eco-feminist narrative. I choose this text because it is representative of western thinking and its way of intending human intelligence and its relationship with environment (Irigaray, 1974). In the myth of the cave Plato narrates about the philosopher's cognitive journey. In the story the philosopher researches the truth by detaching from the sensitive world to contemplate the world of the philosophical abstract ideas. The cave is understood by Plato as a place that is not worthy to be explored and investigated. It is described as

dark emptiness, a flat obscurity that the human being wants to leave. The sun, instead, and the external world outside the cave, represents the individual's liberation, overcoming, emancipation from the material world which is opposed to the immaterial incorporeal intellect of traditional intellectual knowledge. In Plato's myth the immaterial intellect and the philosophical thinking capable of abstraction can be learned by the prisoner only by refusing and leaving the sensitive world represented by the cave (Irigaray, 1974). This way of understanding existence presupposes the illusion of the superiority of intellect over the body and it has been adopted during western history to justify the superiority of humans over nature, man over woman, and of Western society over all other people (Shiva, 2014).

### Responses:

By using imagination, watercolours, and digital painting I create a visual description where the protagonist of my transformed Plato's myth discovers a way to relate to her material world that challenges traditional western anthropocentric approach to reality. By establishing a dialogue with eco-feminism, post-humanism, new materialism, and ethics of care explored by thinkers such as Vandana Shiva, Rosi Braidotti, Karen Warren, Mary Mellor, Noel Sturgeon, and Val Plumwood, I visualize how nature's agency and creativity provide the protagonist of my myth energies and resources to transform her material existence (Braidotti, 2019; Mellor, 2013; Plumwood, 1993; Shiva, 2014; Sturgeon, 2016, 2009; Warren, 1997). According to the theoretical frameworks that I adopt in my research, the same dynamics of power that created environmental crisis also generated women's and other minorities' marginalization. Women, other minorities, and environment have been understood by traditional western culture as irrelevant, passive, and exploitable, a background for men's actions (Plumwood, 1993). To find solutions to the crises generated by this attitude, we need to reconsider our general way to understand life in a way that privileges care, collaboration, and connections instead of exploitation, competition, and individualism (Woodly, 2021).

To imagine this alternative scenario, I refer to recent research related to fungi by authors such as Merlin Sheldrake and Anna Lowenhaupt Tsing which address how fungi force us to see reality from a different non-anthropocentric perspective (Sheldrake, 2020; Lowenhaupt Tsing, 2021). Fungi are inside and outside us and they generate, preserve, and protect everything that makes possible our existence on this planet. Fungi create an interactive network composed by ninety per cent of the world's plants, they nourish the soil, digest polluted substances, eat rocks, survive in the space, provoke hallucinations, influence human and animal behaviors, and establish metabolic relationships with organism such as trees and animals. By creating underground nets that are used by living beings to exchange information they challenge our understanding of concepts such as intelligence, and identity.

In my project I connect fungi's capability of being interconnected and exchange energies and information with other beings to how the feminist philosopher Rosi Braidotti interprets Spinoza's concept of *potentia* (Spinoza, 2010; Braidotti, 2019). According to Spinoza, a person's lack of understanding of her relationship with the totality weakens her power and diminishes her ability to impact reality. Contrariwise, a mind that is capable of understanding how its body lives, moves, is connected to other bodies, and interacts with the rest of matter, is a mind that does not succumb to the oppressive narratives of its social environment because it is capable of relating with the whole by remaining an embodied singularity. The mind that understands the desires and passions that connect her to her collectivity is a mind capable of expressing all its power. This power is called by Spinoza *potentia* (Burdon, 2022; Tamboukou, 2018). Braidotti connects Spinoza's *potentia* to feminist discourse



and she understands potentia as a vital, creative energy capable of creating change and producing social transformation (Braidotti, 2019, 2019, 2021).

### **Outcomes:**

In my artistic project I visually convey how the protagonist of my story learns from fungi to expand her potentia by connecting to other living beings. In my feminist counter-narrative my protagonist understands the possibilities of her actions and interactions, and she finds energies and strength to transform the reality where she lives. The outcomes of this project constitute of twenty artworks made with watercolors and digital painting.

### **Methodologies:**

These outcomes are obtained by adopting an arts-based research where I engage in a holistic dialogue between artistic practice and theory where theory informs my practice, and my artefacts contribute to develop theoretical investigations related to eco-feminism.

### **Dissemination**

I intend to show my artworks at Coffee Craft Café in Beijing from January 5th to February 28th. Coffee Craft Café is a hybrid space composed by a bar, seating areas, meeting rooms and exhibition spaces. It has been designed by United Units Architects, a practice based in both Beijing and London. CC café plays a significant role in northwest Beijing's cultural landscape. It presents contemporary artists, art, and ideas to local, national, and international audiences by providing an environment for creativity and cultural exchange. It is an easily accessible and welcoming intellectual place for reflection, education, and creativity.

### **Impact**

By producing artworks in addition to a scholarly article, my purpose is to reach and engage with a large academic and non-academic audience. My research is academically rigorous in terms of investigation and publication. At the same time, my artworks are accessible to a non-academic audience. This accessible research output has the advantage of producing and disseminating ideas related to gender equality and environmental issues in a more impactful way than academic language alone.

### **Collaborations:**

I am undertaking this project in collaboration with the Posthumanities Hub at Linköping University in Sweden. The Posthumanities Hub is an incubator of new humanities and more-than-human humanities, and a feminist “collaboratory” for symbiotic art, arts and science networks aiming to build-bridges and create new alliances. It is a testing ground for new shared ideas on how to co-exist, work and think better together in a troubled world. This project has also been selected for The New York Times Illustration Portfolio Review 2023. As the recipient of this award, I will have the opportunity to meet two art directors of the New York Times which will provide me feedback and advice about how to complete and disseminate my project.

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## Practical application and research of foresight thinking model in design discipline

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### Abstract

With the continuous development of today's society, design, as an open and inclusive discipline, is exerting its great value and energy. Today, design foresight has become an important topic constantly mentioned by design practitioners, innovators, entrepreneurs and opinion leaders in different countries. With the development of science and technology and the continuous development and awakening of human consciousness, it is increasingly important to accurately predict and plan the future development of mankind in the process of globalization. Relying on this background, the far sighted thinking model in the design discipline can provide an efficient, powerful, systematic and scientific framework system to help mankind better understand, predict and solve the challenges from the future. This paper will discuss the concept, advantages and how to apply this thinking model to solve practical problems.

Design discipline is a comprehensive discipline that integrates innovation, problem finding and problem solving, observation and understanding. It not only involves aesthetics, ergonomics, sociology, psychology and other disciplines, but also needs to analyze the dialectical balance between the functionality and feasibility of the design scheme. The design discipline contains the foresight and response to the future development trend. In the design discipline, foresight is a core ability, which requires designers to have keen insight and in-depth understanding of the development of society, technology, culture, environment and human psychology, so as to predict and create design solutions that meet the needs of future development.

### Author keywords

Design vision, thinking model, future challenges, core competencies, prediction and planning

### Text

The Chinese people's understanding of foresight is unforgettable, and many idioms have been condensed from Chinese history, such as "taking precautions against the rainy day, being born in distress and dying in peace, being farsighted, and having cold lips and teeth." these stories all emphasize the importance of foresight.

Design foresight thinking model is an interdisciplinary method, which integrates the knowledge of design thinking, innovative technology and future speculation. The advantage of this thinking model is that it provides a systematic and scientific framework, which can help human beings better understand and predict the future trends and challenges of human society. By using design thinking and innovative technology and other tools, we can predict and analyze the future from multiple perspectives. This forward-looking way of thinking is conducive to the development of effective strategic deployment and action plans to meet the uncertain challenges in the future.

Design thinking is a unique way of thinking, which can guide people to solve complex problems through creation and innovation. In this way of thinking, foresight thinking is an important part, which emphasizes the foresight and strategic thinking of the future. Crises are everywhere. The virus in 2020, the war in 2022, the nuclear pollution in 2023, and human life will never be easy. It fulfills an old Chinese saying: "born in misery, died in happiness." human beings need to maintain a state of alertness to better face the future and deal with environmental, food, health, education and other issues.

The core of design foresight thinking model lies in its flexibility and extensibility. It can be adjusted and expanded according to different needs and situations to adapt to various industries and fields.

## **1.Design foresight in urban planning at home and abroad**

### **1.1Design foresight in Copenhagen planning, Denmark**

The British life magazine *monocle* rated Copenhagen as one of the world's 20 best cities, which topped the list with factors such as high quality of life and environmental protection. Copenhagen plans to become the world's first carbon neutral city by 2025, reducing carbon dioxide emissions to 0. In this city, more than half of the municipal waste will be recycled, making waste valuable. The government advocates that residents ride and build a perfect public transport system network.

### **1.2Design vision in urban planning of Beijing, China**

In China, the government also attaches importance to issues related to carbon neutrality. Taking Beijing as an example, the rapid development of bike sharing has made a certain contribution to reducing carbon emissions, and the sharing economy has been brought into full play. However, when shared bicycles entered the market a few years ago, they also caused many social problems, such as affecting the income of the taxi industry, and the confusion of bicycle parking positions led to the blockage of bicycle lanes and sidewalks. This requires the foresight of design thinking to predict the problem in advance and then solve the problem. Now there is a shared bicycle handling profession. By analyzing the locations with large demand for transportation, more shared bicycles are provided to the designated areas.

### **1.3Design vision in urban planning of Paris, France**

Designers' foresight thinking can be well reflected in their sensitivity to social culture and values. We can understand human desires and needs by observing and interpreting cultural phenomena, and then use design as the main medium to shape and convey these messages. The vision of Paris' urban planning and design is reflected in its architecture and public space design, urban environment and sustainable development. The Paris municipal government encourages and promotes urban greening and builds many parks and gardens. Monet's "sunrise" depicts a "gray city" full of dust and car exhaust, which has become a fresh, green and environmentally friendly city. This design vision is a milestone in the history of urban planning, which has changed the image of Paris.

### **1.4Design vision in urban planning of Dalian, China**

Coincidentally, the urban greening in Dalian, Liaoning Province, China also relies on the new concept of modern urban planning and design, effectively applies and implements the methodology of the design foresight thinking model, and builds a "Park City". In 2022, the whole city of Dalian will add 112 pocket parks, and build pocket parks in various regions, so that people can enjoy the livable happiness brought by urban greening. Therefore,

the concern for environment and sustainable development is also part of the designer's vision. While meeting the current needs, reduce the impact on the environment and build a sustainable design scheme.

### 1.5Summary

The design foresight thinking model emphasizes openness and inclusiveness, and encourages interdisciplinary cooperation and innovation. By cooperating with experts and stakeholders in different fields, we can understand and solve future challenges more comprehensively. The foresight of design is reflected in many aspects of society, from micro to macro, from abstract to concrete, showing the designer's unique views on the future. First of all, designers need to understand and use a variety of design tools and technologies. From traditional Adobe design series and other software to artificial intelligence chatgpt and midjournal and other software, designers can use more and more new tools. When designers begin to carry out user analysis, user portrait, user research, data analysis and processing, prototype design and testing, they can dig the key points and solve the existing problems. Secondly, designers need to have interdisciplinary knowledge and thinking, such as understanding of biology, psychology, computer science, engineering, sociology, logic and other disciplines, and then apply different thinking logic principles and skills to their own design.

## 2.Application of design foresight thinking model in different fields

The design foresight thinking model emphasizes the uncertainty, unpredictability and strategic thinking of the future. This thinking model can help humans understand the future trends and challenges, so as to prepare for the future. The design foresight thinking model has a wide range of applications, including business, science and technology, science, culture, art and other fields.

### 2.1Application of design foresight thinking model in the business field

In the business field, foresight thinking can help enterprises predict future market trends and competition patterns, and specify more effective strategic plans. A successful company may predict that the market demand for a product will increase, and then prepare a production plan in advance to meet the future market demand; According to different competition patterns, we have a good sense of confidentiality, and unexpectedly launch our own company's new products to occupy market share. For example, China's Huawei directly launched the new mobile phone product mate60 series without a new product launch on August 29, 2023, making the competitive landscape more favorable. This is the practical application of foresight thinking in the business field.

2.2Application of design foresight thinking model in the field of science and technology In the field of science and technology, foresight thinking can help scientists and technicians predict the future technology trend and development direction. For example, experts in the field of artificial intelligence have begun to predict the development trend of smart cars and smart homes in the future, so they will devote more energy to the research in these fields. For example, Tesla Motors of the United States has launched the autopilot system, which has three levels of basic autopilot BAP, enhanced autopilot EAP and full autopilot FSD. Among them, the FSD full autopilot system can realize the functions of automatic driving on urban roads, identifying traffic lights and parking.

### 2.3Application of design foresight thinking model in the field of Science

In the field of science, foresight thinking can help scientists predict future scientific trends and social changes. By predicting the importance of science and sustainable development in the future society, scientists put forward safer environmental protection schemes and scientific development strategies. For example, on August 25, 2023,

China's new generation of man-made sun "China circulation No. 3" realized high constraint mode operation for the first time. The breakthrough of these key scientific and technological problems marks the gradual realization of human access to unlimited clean energy.

#### 2.4 Application of design foresight thinking model in the economic field

In the economic field, foresight thinking can help people understand and discover the laws of the economic cycle. As cities in many countries declare bankruptcy, this is a warning to China. It reminds us to face the debt risk and issue more prudent policies to deal with the uncertainty in the future.

#### 2.5 Application of design foresight thinking model in medical field

In the medical field, foresight thinking can help doctors better treat patients. Cardiac resuscitation has always been regarded as an effective first aid method for patients with cardiac arrest. Since 2015, AED automatic external defibrillators have gradually appeared in public places in China. Better help patients grasp the "golden 3 minutes" in the absence of a doctor.

#### 2.6 Summary

Foresight thinking is the concentrated embodiment of human wisdom. It can not only guide individuals to success, but also promote the continuous progress of society. In the history of mankind, many great achievements and progress are derived from the inspiration of far sighted thinking. Therefore, it is of great strategic significance to explore the foresight thinking for social change and development.

### **3. The role of foresight thinking in social change and development is shown in the following aspects:**

#### 3.1 Innovative thinking

Foresight thinking can stimulate people's innovative thinking ability and guide people to find new solutions. This innovative thinking can be applied to science and technology, culture, education and other fields, so as to promote social progress and development. Just as Ms. Tu Youyou, the winner of the 2015 Nobel Prize in medicine, extracted artemisinin to create a new treatment for malaria, and became the preferred drug for anti malaria in the world, benefiting all mankind.

#### 3.2 Forecasting the future

Foresight thinking can help people better predict the future and make response measures in advance. This ability can help decision makers to formulate more scientific and effective policies to meet future opportunities and challenges.

#### 3.3 Leading change

Foresight thinking can lead social change and promote the development of society in a more advanced and better direction. Guided by visionary thinking, people can better grasp the opportunities of the times and promote the realization of social change. Just as the rapid development of artificial intelligence in 2023 has made people aware of the convenience brought by the digital economy and digital city, it is precisely because of the high recognition of human thinking that the whole society has become more united and beautiful.

#### 3.4 Enhance confidence

Foresight thinking can enhance people's confidence and make people more confident in their goals and ideals.



This confidence can make people more firm in the face of difficulties and challenges, so as to achieve success.

#### **4.Foresight thinking and development of design discipline**

In the design discipline, foresight thinking plays a vital role. It is not only the ability to formulate strategies or predict the future, but also a more far-reaching and grand perspective; A perspective that can transcend the appearance phenomenon and explore the essence and development potential of design discipline. Visionary thinking enables artists, designers and scholars to grasp the development trend of the design discipline calmly, so as to maintain a leading position in the changing design context.

##### **4.1Foresight thinking and design innovation**

Foresight thinking plays a key role in design innovation. Through a visionary perspective, designers can gain insight into new artistic forms and expressions that others cannot perceive. Designers should be at the forefront of the times and integrate novel design concepts and new technologies into their design works. Artists with visionary thinking will not follow the rules, but dare to challenge the existing boundaries of art and design and explore a broader field of design. Just like the teaching reform of the school of design of the Central Academy of fine arts, it is based on the foresight thinking of Mr. songxiewei, the dean of the school of design, to integrate all disciplines of the school of design, break the barriers between disciplines, and make the design major all inclusive and rejuvenated.

##### **4.2Foresight thinking and design understanding**

In the design discipline, the understanding and appreciation of design need to have foresight thinking. Design is not only the beauty or shock on the surface, but also carries profound social, historical and cultural connotations. Designers with visionary thinking can deeply understand the complexity of design, and through in-depth research, analysis and interpretation, the internal meaning of design works can be clearly transmitted to the public. At the same time, designers can predict and interpret the changes of design trends, so that people can better understand and appreciate design works.

##### **4.3Foresight thinking and Design Education**

Foresight thinking is also indispensable in design education. Design teachers need to have foresight thinking to guide students to explore and understand the deep meaning of design, and stimulate their innovative thinking and critical thinking. Foresight thinking can help design teachers predict and respond to the development trend of the design discipline, so as to timely adjust educational strategies and methods, and ensure that students acquire the most cutting- edge design theory knowledge and skills. Just like the "no future - International Education Forum" opened by the Design Institute of the Central Academy of fine arts on April 1st, 2023, to enable more design students and designers to better understand the global cutting-edge design theoretical knowledge and stimulate more innovative thinking in the process of enriching their minds, which is the original intention of design education.

##### **4.4Fusion of foresight thinking and design discipline**

The integration of foresight thinking and design discipline helps designers grasp the market trend and future direction from a macro perspective. Foresight thinking emphasizes the prediction and strategic thinking of the future, which enables designers to better understand user needs, market dynamics and social development trends. On this basis, designers can use innovative methods and tools to create design works in line with the spirit

of the times.

#### 4.5 Specific application of foresight thinking in design discipline

##### 4.5.1 Product design and foresight thinking

Under the guidance of visionary thinking, product designers can predict the future trend of products and user needs, so as to design products more in line with the needs of the market and users. For example, in the field of smart home, designers can use foresight thinking to design products by understanding users' needs for intelligence, comfort and environmental protection. The final product not only has advanced technology, but also can meet the long-term needs of users and achieve sustainable development.

##### 4.5.2 Environmental design and visionary thinking

Environmental designers can predict future urban development and ecosystem changes through foresight thinking. By understanding the needs of urban planning and ecological protection, environmental designers can use the concept and methods of sustainable development to create a more livable urban environment. For example, in urban planning, designers can combine green building and intelligent city technology to create low-carbon and livable urban space to meet the needs of future population.

##### 4.5.3 Interaction design and visionary thinking

Under the guidance of visionary thinking, interaction designers can predict the future interaction mode and user experience. By understanding the development trend of technology and the changes of user behavior, interaction designers can use innovative interaction methods to improve user experience and product value. For example, in the field of virtual reality (VR), interaction designers can develop more natural and convenient interaction methods through in-depth understanding of user needs and technologies, so as to improve users' immersion and satisfaction.

## Conclusion

The design discipline foresight thinking model provides us with an efficient thinking framework, which can better help us understand and predict the future trends and challenges. The future is both opportunities and challenges. By using this thinking model to predict, we can specify more efficient and innovative strategies and action guidelines, and this action plan can meet the challenges in all aspects in the future. In the future, we look forward to the continuous development and improvement of this thinking model to provide more accurate and usable predictions and solutions for human beings around the world.

Foresight thinking is a key ability in the design discipline. It not only allows designers to solve current problems, but also creates the possibility to solve future problems. The vision of designers is reflected in their understanding of new tools and technologies, interdisciplinary knowledge reserves and sharp thinking, sensitivity to different social cultures, values and ideologies, and attention to the environment and sustainability. Therefore, the foresight of designers is not only a professional skill, but also a social responsibility. Only designers with these visions can truly create design solutions that meet future needs and make corresponding contributions to human development.

Foresight thinking is of great value in the design discipline. It helps designers, scholars and teachers grasp the development trend of the design discipline and maintain a leading position by providing in-depth insight into

design innovation, understanding and education. In order to better cope with the challenges and opportunities in the future design field, we must pay attention to the cultivation and improvement of our foresight thinking ability, and continue to explore, innovate and surpass, so as to promote the sustainable development of the design discipline.

In the future, with the development of science and technology and the continuous change of market demand, foresight thinking will be more widely used in the design discipline. Designers need to constantly cultivate and improve their foresight thinking ability to cope with the changing market environment and social needs. At the same time, by strengthening interdisciplinary cooperation and exchange, designers can expand their horizons and absorb the essence of other fields, and further enhance the practical application effect of foresight thinking in the design discipline.

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# A Virtual Exhibition Design Guideline: Coordinating 3D Roaming and Efficiency

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## Abstract

More and more virtual exhibitions have chosen to add 3D roaming system to enhance immersion. We assert that excessive pursuit of 3D roaming will affect users' information acquisition efficiency and reduce their experience. In this paper, we critically discussed the paradoxical relationship between 3D roaming and efficiency in the virtual exhibition, and proposed strategies for coordinating 3D roaming and efficiency to comprehensively improve user experience. We created two different forms (3D roaming and 2D webpage) based on the same exhibition content and conducted extensive user study. According to experimental observation and user feedbacks, we concluded several general trends towards coordination. We extracted design guidelines that are conducive to coordinate 3D roaming and efficiency in the virtual exhibition through a focus group (7 experts). Further, we conducted validation experiment and the results proved the effectiveness of our design guidelines.

## Author keywords

3D roaming system; virtual exhibition; information acquisition efficiency; user studies; design guidelines.

## Introduction

With the development of 3D modeling and rendering technology, many virtual exhibitions choose to construct 3D scenes with roaming system to bring visitors stronger sense of immersion (Carmo & Cláudio, 2013). This form changes the way visitors watch, allowing them to simulate walking, feel spatial relationship, control distance and viewing angle. However, this kind of interaction also lead to a decrease in the efficiency of user information acquisition during the watching process: Being in a part of space, it is not easy for visitors to get a sense of the overall situation; the need to rely on walking makes visitors slowly when trying to get somewhere in the space; the viewing angle causes visitors to adjust frequently to see clearly. All these situations increase the burden on the visitors when acquiring information (Richards & Taylor, 2015), and prevent them from exploring and searching for what they need (Modjeska & Waterworth, 2000). In contrast, the 2D webpage is generally considered to be efficient in obtaining information. If there is a way to maintain 3D roaming while guaranteeing efficiency, the overall user experience (UX) will improve. Therefore, the question that motivates this work is: How to coordinate 3D roaming and efficiency in the virtual exhibition?

## Related work

Visiting a virtual exhibition is essentially a media experience rather than a real one (Mintz & Thomas, 1998), in which both authenticity and spatial sensation are lost (Wolf, Reinhardt, & Funk, 2018). With the development of technology, 3D virtual exhibitions are believed to be able to realize the full functionality of physical exhibitions in

the future (Cong & Chen, 2010). Moreover, virtual exhibitions have more responsibilities in conveying information and communicating (Kim, 2018). Zhang provided a way to build virtual exhibitions using the Unity3D engine to improve the passivity of information reception (Zhang, 2022). Elmqvist proposed a navigation technique based on motion constraints to guide users through predefined trips in the environment in order to solve the problem of information overload (Elmqvist, Tudoreanu, & Tsigas, 2008). In addition, according to Kim's research, 2D displays are more effective than 3D in communicating with visitors (Kim & Hong, 2020). Experience and information have always been issues that researchers concern about. With this paper, we intend to comprehensively discuss the relationship between both of them.

### Research question

While creating a sense of immersion, 3D roaming system also brings problems of information acquisition efficiency. Therefore, our first research question is: Is the information acquisition efficiency a key factor affecting UX in 3D virtual exhibitions? (RQ1)

How to create a 3D virtual exhibition with better UX is a question worthy of attention and continuous thinking. We asset that coordinating 3D roaming and efficiency is a good point, so our second research question is: What contents or methods may be appropriate to coordinate 3D roaming and efficiency in the virtual exhibition, providing users with immersion while ensuring their information acquisition efficiency? (RQ2)

### User study

We conducted a user-centered study in which participants experienced a virtual exhibition while facing both forms of 3D roaming and 2D webpage. It aimed to better understand user needs during the watching process and get qualitative feedback on UX as well as ideas for achieving coordination.

#### Experiment design

We studied user screen behavior through observation, and further discussed RQ1 and RQ2 through two consecutive interviews.

The first interview based on the observation results, which included visitors' first choice between two forms, choices changing during the watching process and the total watching time, so as to understand the real motives and needs that drove their different screen behavior (RQ1), mainly with the following two questions:

1. Why do you choose to use 3D roaming (2D webpage) initially?
2. Why do you switch between the two forms (only use one form/sequentially use both forms) during the watching process?

We obtained further user feedbacks through a semi-structured interviews to collect ideas about coordination concepts that may improve the UX (RQ2) and asked the following questions:

1. Which form do you prefer as the main form of the virtual exhibition, 3D roaming or 2D webpage?
2. What do you think are the advantages and disadvantages of 3D roaming?
3. What do you think are the advantages and disadvantages of 2D webpage?
4. Did you feel like the immersion was broken during the watching process?
5. What possibilities that improve experience could you image for future 3D virtual exhibitions?

## Participants

A total of 22 participants (15 females & 7 males) were recruited, aged 20-38 (mean=25, SD=3.93), and 12 of them had relevant experience in visiting virtual exhibitions. We conducted open recruitment through email and social platforms to obtain a more diverse sample of participants. Participants in the experiment received certain financial rewards as compensation.

## Settings and apparatus



**Figure 1.** Experiment settings (a) the 3D virtual exhibition space, (b) content presentations in 3D exhibition space, (c) the 2D webpage, (d) the split-screen experiment environment.

We deliberately chose a small collage exhibition, which included four different themes, with a total of 43 image works and corresponding text, as it avoided the interference of special preference for presentation forms and too long research time.

For the 3D roaming form (<https://hongtioops.net/galleryRoaming/>), we used Unity3D to build an exhibition space, which was kept moderate in size and complexity, as shown in Figure 1(a). All image works were placed in photo frames and all texts were ensured readability, please refer to Figure 1(b). Participants visited from a first-person perspective, and were allowed roaming freely. In this case, participants used the keyboard and mouse to control movement and viewing angle. For the 2D webpage form (<https://hongtioops.net/galleryweb/>), we used the JavaScript to build a pure webpage. Information in the menu bar on the left was arranged in a hierarchical manner, and the content area on the right displayed detailed texts and images, as shown in Figure 1(c). Participants could use mouse clicks and scroll wheels to browse and jump through hyperlinks. These two forms were split on the same screen, as shown in Figure 1(d), to ensure that visitors could choose either of them fairly during the watching process.



## Procedure

Before the experiment started, each participant filled out a questionnaire with basic information and signed a consent form. The experimental task was to use the computer freely explore the virtual exhibition, facing two forms (3D roaming and 2D webpage) at the same time. Participants adjusted their computers to a state suitable for the experiment under our remote guidance, and then shared screen and sound through online meetings tools. We told them that the two forms were completely consistent in terms of content, and they could choose how to use them all according to their own choices and interests, without any special tasks and requirements. We expressed that we valued their personal exhibition experience. After participants clarified all the premises and were familiar with the operation, the experiment was carried out. We observed their screen behavior in real time remotely.

When all conditions were completed, we invited participants to answer the questions of the semi- structured interview under RQ1 and RQ2 via the online voice system.

## Results and analysis

According to the observation results, 15 participants chose 3D roaming form firstly, and all the participants switched between two forms during the watching process.

In the first interviews, we found that participants did not simply switch because of interface juxtaposition or curiosity, but with a clear goal based on their needs. When participants chose 3D roaming, they wanted to get more immersion and spatial experience, but when they needed to get a preliminary understanding of the exhibition content and framework, quickly retrieve information, check whether missing information and observe a clearer picture, they would choose 2D webpage. It was proved that information acquisition constituted an important part of the entire exhibition watching process.

Furthermore, we qualitatively analyzed user feedback according to the questions set in the broad-line interview outline, and found general trends described below. In addition, we also emphasized individual perspectives when participants' responses were particularly relevant to our research questions:

- 15 out of 22 participants expressed their preference to 3D roaming, except when they intentionally obtained or backtracked information. Among 7 participants who preferred 2D webpage, 3 of them clearly stated that it was because they could find information they wanted more quickly.
- Participants said they felt better in 3D roaming form as it brought an exhibition atmosphere and they could better observe the details and browse all the works on a wall as a whole. Moreover, they felt more interesting, which made them curious and have a stronger desire for exploration. Most participants felt difficult in reading contents because of viewing angle, spatial perspective, rendering effect. 16 participants feared missing information. 8 participants had feelings of getting lost and didn't know the route of watching. Participants also mentioned that they felt confused about partitions of works in the space.
- All participants felt 2D webpage more intuitive and clearer, which helped them quickly obtain general contents. 2 participants felt more familiar with 2D webpage. One participant mentioned that he could start browsing from anywhere. However, participants felt bored with 2D webpage because the experience was similar to reading a textbook. They regarded the work as just pictures rather than artworks. Some participants mentioned that 2D webpage was easy to know contents without any mystery and surprise and the logical performance of the exhibition was simple.

- All participants switched between two forms while watching. 11 participants said it did not break immersion and 5 of them said that having better access to information actually brought more immersion. In addition, 7 participants indicated that their immersion affected by the unsmooth split-screen operation and the sense of immersion would be better in the same interface.
- Participants hoped to add auxiliary methods in the 3D virtual exhibition to help them obtain information or better view contents. One participant directly said that it would be better to combine 3D roaming with 2D webpage. Some participants would like to have more navigation aids. 3 participants emphasized that they did not want to add too much interaction, because they thought 3D roaming was enough. 6 participants would like to have sharing and communication functions.

In summary, participants expressed interests in the virtual exhibition with 3D roaming, but a better spatial experience could not replace their desire to obtain information quickly. Therefore, it is necessary to coordinate 3D roaming and efficiency in the virtual exhibition, which can better meet user needs in different aspects and improve the overall UX.

### **Design guidelines**

Combined with the experimental observation and interview conclusions, we organized the experimental data and conducted a focus group with 7 experts. We finally proposed 5 generalizable design guidelines. These guidelines are aimed at the 3D virtual exhibition and give suggestions from the perspective of coordinating 3D roaming and efficiency to improve UX.

- At least provide one way for visitors to get information quickly. Our study showed that in addition to space experience in the 3D virtual exhibition, efficiency is also indispensable. Providing at least one way to quickly obtain information can ensure visitors browse exhibition contents in time when they need.
- Let visitors have a sense of the overall situation both in space and content. The sense of immersion brought by 3D roaming makes visitors pay more attention to details and parts but loses control of the overall situation, and causes confusion, whether in space or content. Therefore, it is necessary to provide visitors with appropriate hints in both aspects of space and content to help them gain a more overall sense.
- Provide a more focusable method when users need to view content. When visitors find a work they like, they often want to observe more carefully or obtain more information. At this time, they pay more attention to the content than the form. A method that is easier to focus help visitors read conveniently or see clearly when they need.
- Provide proper guidance particular in virtual exhibitions that emphasize narrative logic. We found that visitors not only enjoyed roaming freely, but also concerned the connection between the exhibition works and the space, especially in virtual exhibitions that emphasize narrative logic. Complete roaming way may lead to missing information or not being able to understand the narrative line.
- Do not add new un-captivating interaction. Complicated interactions may result in poor browsing experience and increase study time. However, switching between 3D and 2D during the watching process will not reduce the sense of immersion. Designers should ensure that new methods of interaction added to virtual exhibitions will not let visitors feel burdensome or pointless.

### **Further experiment**

We improved the original 3D roaming version based on the design guidelines, and combined the advantages of both 3D roaming and 2D webpage in an appropriate way. Please refer to Figure2(a) (<https://hongtioops.net/>

GalleryRoamingPlusWebFinal/). We added a map that allowed visitors to identify location and understand partitions of works; a menu bar that helped visitors to browse and retrieve information; cards that displayed clearer contents and provided a way to quickly check information.



**Figure 2.** Improved version of the 3D virtual exhibition (a) all functions added to coordinate 3D roaming and efficiency, (b) Accessibility hides when not needed.

We tested it with the previous 22 participants and asked them to score the options we raised with the Likert scale. The results are shown in Table1.

**Table 1.** Acceptance of the improved version which coordinated 3D roaming and efficiency.

Options	Range	Min	Max	Mean	D(X)	SD
You have a better overall experience	1	4	5	4.64	0.231	0.481
You still feel immersed	2	3	5	4.05	0.588	0.767
The map gives you a better understanding of space	3	2	5	4.55	0.884	0.940
Pop-ups help you pay attention to contents better	2	3	5	4.5	0.339	0.583
Lists help you get information quickly	4	1	5	4.18	1.329	1.153
Proper guidance allows you to visit the virtual exhibition better	2	3	5	4.36	0.594	0.771

Based on the data provided previously, the results of the virtual exhibition satisfaction survey conducted by 22 participants were comprehensively analyzed and summarized. In terms of overall experience, users gave very satisfactory ratings to the final version of the virtual exhibition, with an average score of 4.64, which shows that users are very satisfied with the overall experience of the exhibition. In addition, the standard deviation is low, indicating that users’ evaluation of the overall experience is consistent. Our validation experiment has proven that our design guidelines to coordinate 3D roaming and efficiency are effective. These results provide a valuable reference for us to further improve and optimize the virtual exhibition, helping to create a better user experience and meet user expectations.

## Conclusion

Although 3D virtual exhibitions have been greatly developed under the impetus of technology, there are still many problems. In this paper, we critically discussed the paradoxical relationship between 3D roaming and efficiency in the virtual exhibition. The necessary conditions for immersion brought by 3D roaming also affect the efficiency of information acquisition during the watching process. We proposed strategies for coordinating 3D roaming and efficiency to comprehensively improve user experience in the way of combining advantages of 3D roaming and 2D webpage. Through extensive user study, we collected feedbacks in different aspects of use needs and user experience that helped to achieve coordination. As a result of the focus group, we produced 5 generalizable design guidelines that coordinate 3D roaming and efficiency in the virtual exhibition. Our guidelines were proved effective in the further validation experiment.

Our study is meaningful because it helps to understand the different aspects of user needs between experience and efficiency during the watching process, and provides guidelines for designing and planning virtual exhibitions from the perspective of coordinating 3D roaming and efficiency. These guidelines can help researchers rethink the relationship between 3D roaming and efficiency in the virtual exhibition and help designers create 3D virtual exhibitions with better user experience.

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## Backcasting for a preferred future: A Review of the Literature

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### Abstract

Backcasting offers a systematic approach for envisioning an ideal future, especially in global sustainable development and national ecological civilization construction contexts. This study uses methods like bibliometric analysis, literature review, categorization, and summarization to comprehensively analyze Backcasting research progress and future prospects. Currently, Backcasting research is growing rapidly, led by developed countries in Western Europe and North America, such as Sweden, the Netherlands, the UK, and the US. They focus on areas like energy management, climate change, and urban planning, all aligned with sustainable development. However, a standardized system and application tools are still in early stages and require further investigation and expansion.

### Author keywords

Transforming a Preferred Future; Backcasting; bibliometrics; Literature review

### 1 Introduction

Envisioning the future is a key human skill, but turning these visions into reality is challenging and requires specialized learning and training. Backcasting (Fig.1) is a methodology that effectively transforms future visions into concrete actions, offering a rational perspective for achieving an ideal future(Hao & Gu, 2021). Internationally, Backcasting has gained extensive academic and practical attention since the 1970s when it emerged as a novel approach to futures studies. It involves working backward from a desired future scenario (often 25-50 years ahead) to the present, generating normative policies and distribution plans to reach those goals (Quist & Vergragt, 2006; Robert, 2005; P. Vergragt & Quist, 2011).Backcasting helps us scrutinize the present by asking, "What actions must be taken today for future success?" It strengthens the connection between the present and envisioned future, aiding in human future planning(Hao & Gu, 2021) . Specifically, Backcasting assists government officials, planners, designers and others in breaking free from current constraints and addressing issues like conflicting goals and resource limitations. It enables the creation of long-term sustainable solutions(Carlsson-Kanyama et al., 2013).Compared to visions and scenarios that clarify future directions, Backcasting helps us achieve those visions.



## 2 Methods

This study conducted a comprehensive review of Backcasting-related research using bibliometrics and literature analysis. Initially, bibliometric techniques were used to analyze publication volume, journal distribution, institutional affiliations, and keyword networks in Backcasting research. Subsequently, pivotal literature was examined in-depth to categorize and summarize principal viewpoints into thematic clusters, revealing research interests and emerging directions. The data source comprised international journal articles from the Web of Science database's SCI, SSCI, and AHCI citation indexes. The study encompassed articles up to December 2022, using "Backcasting" in the "Title" field, yielding 394 articles. After excluding non-journal and non-conference publications, 371 articles remained.

## 3 Literature publication status

### 3.1 Annual Publication Volume in Literature

From the perspective of Backcasting's annual publication count, a noticeable positive growth trend is evident over time, with notable spikes in 2007 (13), 2011 (23), and 2021 (38) (Fig.2). Examining the trend of paper quantity growth, it is apparent that over the past decade, research related to Backcasting has gradually gained popularity and broader application. This trend may be attributed to the global emphasis on sustainable development, energy crises, environmental degradation, climate change, and related concerns. However, it is important to note that overall, the volume of literature in this field remains relatively limited, with a total of only 394 publications over a span of 49 years. Even during the period of notable growth from 2011 to 2022, with 11 to 13 years, the average annual publication count was only 25.7 papers. This signifies that Backcasting research has enormous research potential.

### 3.2 Publication Journals and Institutions

Looking at journal publications, 394 papers on foreign Backcasting research are distributed across 175 journals, averaging 2.25 papers per journal (Fig.3). The top 5 journals (Futures, Journal of Cleaner Production, Sustainability, Technology Forecasting and Social Change, and Energy Policy) collectively account for 33.5% of the total output, with "Futures" leading with 42 papers (10.7% of the total). These journals reflect different aspects of Backcasting research: "Futures" and "Technology Forecasting and Social Change" are key journals in Futures Studies, while "Sustainability" emphasizes sustainability. "Journal of Cleaner Production" and "Energy Policy" relate to energy management and planning, the original context for Backcasting.

Regarding author affiliations, 633 research institutions from 65 countries/regions participated in publishing papers. Western European and North American countries like Sweden, the UK, the US, the Netherlands, Canada, Germany, Australia, Japan, France, and Spain had the highest publication frequencies at the national level (Fig.4). Prominent institutions with 10 or more articles included the Royal Institute of Technology, Delft University of Technology, and others playing a central role in Backcasting research (Fig.5).

## 4 Current Research Status and Hot Topics

From a keyword analysis (Fig.6, Tab.1), the top 10 frequently mentioned keywords in Backcasting research, besides "Backcasting," are "Sustainability," "Scenarios," "Climate change," "Forecasting," "Sustainable development," "Participatory backcasting," "Futures," "Futures studies," "Stakeholders," and "Governance." Based on this, we draw from related typical literature to explain Backcasting's basic processes, methodology, and application tools.

#### 4.1 Basic Process of Backcasting

Backcasting, as a methodology for envisioning and shaping the future, has been approached by scholars and organizations across various domains, resulting in diverse operational processes. These processes have been classified, as shown in Tab.2.

In summary, the STD Backcasting approach, the backcasting method proposed by Höjer et al., the SusHouse project, and the method proposed by G. Király et al. all include a separate step of backcasting. In these cases, backcasting represents a specific action of looking from the future to the present, while in other processes, the entire process is referred to as backcasting, which is treated as a noun denoting the method. Moreover, in the mentioned processes, the development of a vision or goal is first established in a separate step, and then, through analysis, assessment, collaboration, and other means, the vision is gradually brought into the present (Haslauer et al., 2012). Although there are currently various application processes for backcasting, they exhibit distinct domain-specific characteristics and have not formed a universal and widely accepted consensus. Moving forward, it is necessary to conduct more macro-level, standardized, and modular process research on backcasting. Further refinements should also be made based on the specific characteristics of the practical application domains.

#### 4.2 Methodology of Backcasting

Backcasting can be defined narrowly as the backcasting steps within methodologies or broadly as the entire methodological system (P. Vergragt & Quist, 2011). Current research on the backcasting methodological system primarily considers backcasting as a distinct step within the methodology and explores its integration with other methods to enhance its utility.

##### 4.2.1 Participatory backcasting

Participatory Backcasting, an approach to integrating diverse perspectives and knowledge into scenario development, has gained momentums (Wangel, 2011). It aims to foster consensus, identify conflicts, and enhance scenario and strategy legitimacy. This collaborative and reflective learning method offers advantages over expert-driven processes (Camilleri et al., 2022). It was initially applied in government policy projects in the 1990s, starting with the Dutch Sustainable Technological Development project (P. J. Vergragt, 2005). Since then, its utilization has expanded across various fields, leading to continuous refinement of the methodology.

Carlsson-Kanyama et al. (2008) applied backcasting with local stakeholders from five European cities, effectively stimulating long-term sustainability discussions among participants. Robinson et al. (2011) proposed a participatory second-order backcasting method where participants choose their ideal future and receive feedback, though it might limit explaining goal differences. The study integrated tools, standards, indicators, and stakeholder analysis for complex envisioning and pathway development. Andreotti et al. (2020) envisioned a more sustainable transportation system for Malta (2050) using participatory backcasting methods through stakeholder workshops. This facilitated discussions on transportation forms to mitigate climate change on the island. Camilleri et al. (2022) explored the use of participatory backcasting methods to envision a sustainable future transportation system for Malta (2050) through stakeholder workshops focused on climate change mitigation. However, involving stakeholders in participatory backcasting may have negative outcomes, such as path dependence driven by vested interests and reluctance among participants to assume responsibility as stakeholders (Hisschemöller & Bode, 2011). Wangel (2011) stressed aligning participant selection with research goals, emphasizing that for policy or practice influence, stakeholder involvement promotes investment, social learning, and empowerment.

However, for exploring innovative or radical future scenarios, stakeholder participation might be limiting.

#### 4.2.2 The integration of backcasting with other methods

In addition to participatory backcasting, studies have explored integrating backcasting with methods like exploratory scenarios, system dynamics, future design, and ecological design. Van Vliet & Kok (2015) combined exploratory scenarios with backcasting to develop robust strategies addressing uncertainties. Their research shows that this approach generates more innovative strategies compared to using exploratory scenarios or backcasting alone. Mendoza et al. (2017) introduced the BECE framework, combining backcasting and eco-design for the circular economy. Backcasting sets long-term goals, while eco-design helps achieve product and service performance targets for implementing circular economy requirements. Musse et al. (2018) presented a comprehensive approach combining backcasting and system dynamics in the case of urban housing planning for low-income citizens in Florianópolis, Brazil, to support complex decision-making for sustainable development. Emodi et al. (2019) used a combined backcasting and exploratory scenario analysis approach to mitigate greenhouse gas emissions in the Australian electricity sector. Hori et al. (2020) integrated participatory backcasting and multi-objective optimization methods to develop optimal future renewable energy plans, combining mathematical modeling and local stakeholder input. Timilsina et al. (2020) advocated integrating future design methods with backcasting and scenario planning to guide individuals in envisioning their future and considering future generations' perspectives in sustainable development strategies.

#### 4.3 Application tool of Backcasting

Tools act as structured, visual representations of methodologies, expediting professionals' focus on core issues over methodological usage, aiding rapid learning and non-expert adoption. Backcasting presently relies on unstructured thinking, linked to particular domains. While limited in number, efforts to develop backcasting application tools are ongoing.

Quist & Vergragt (2006) outlined a participatory backcasting framework consisting of four toolkit groups: participatory tools and methods, design tools and methods, analytical tools and methods, and management, coordination, and communication tools and methods. These groups serve distinct roles in stakeholder engagement, scenario development, assessment, and process management. Ashina et al. (2012) applied the AIM/Backcasting model, based on backcasting principles, to assess the feasibility and roadmap for achieving a low-carbon society in Japan by 2050. This analysis considered technology roadmaps, CO<sub>2</sub> emission trajectories, and energy structure transitions. Kanter et al. (2016) introduced a practical backcasting approach from the ATP initiative, helping countries align their agricultural sectors with SDGs. The beef sector example in Uruguay demonstrates how local tools and expertise integrate with backcasting to set production and environmental targets for transformative policies. Okada et al. (2022) proposed a backcasting-based roadmap design method to facilitate decision-making and planning for a sustainable future. This method involves a two-stage process: defining a sustainable vision and outlining pathways to realize it, utilizing the "Four Arrows Model" as a roadmap template, as shown in Figure 7.

## 5 Conclusions

Backcasting, a pivotal framework with ideologies, technologies, and methodologies, plays a significant role in global societal progress, and its research is rapidly increasing. Developed nations in Western Europe and North America, including Sweden, the Netherlands, the United Kingdom, and the United States, lead in this field. As

Backcasting integrates into various domains, contextualizing and standardizing its procedural aspects for specific application areas is essential. This enhances our understanding of how Backcasting can be effectively applied across different sectors. The development of structured and visual tools embodying Backcasting methodologies is vital for improving operational efficiency and enabling non-experts to utilize Backcasting effectively.

Design is a purposeful creative activity that shapes human society, involving the construction of a better reality, akin to Backcasting. Designers continuously refine their creations against ideal images. Zhang's (2022) "shared vision orientation" and "meaningful strategic intervention" exemplify Backcasting in design by setting visions and implementation. However, design often lacks Backcasting awareness, necessitating research integration. As sustainability and well-being gain importance, there's a need for theoretical guidance on Backcasting and design integration, sparking research in design studies. This convergence explores design's role in Backcasting and how Backcasting enhances design, boosting general design competence in an era of widespread participation in design (Manzini, 2015).

### Acknowledgments

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Appendix



Figure 1. Backcasting

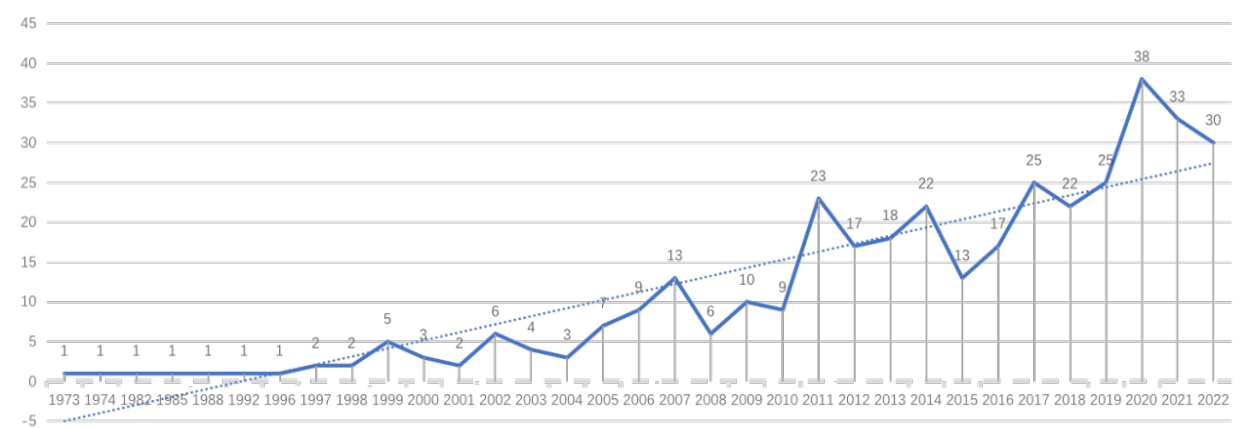


Figure 2. The distribution of annual publication volume of Backcasting research papers

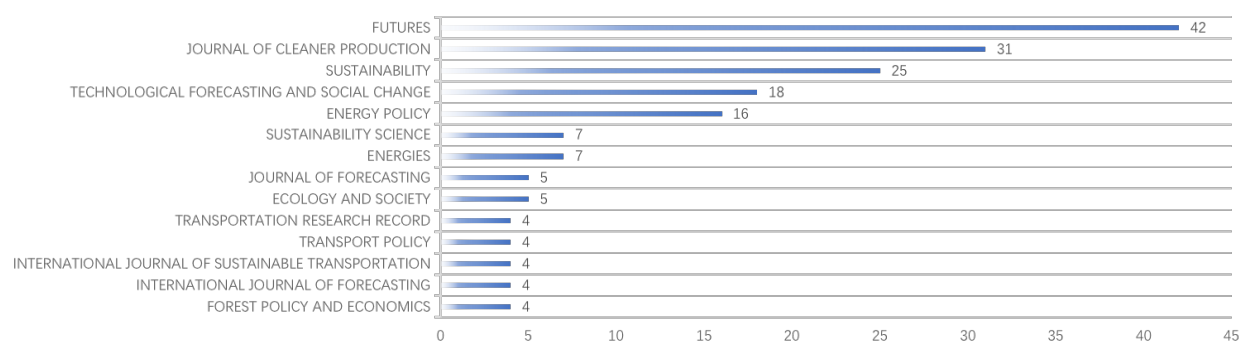


Figure 3. Journals related to Backcasting





Figure 4. Distribution Map of Countries to Which Backcasting Research Papers Belongs

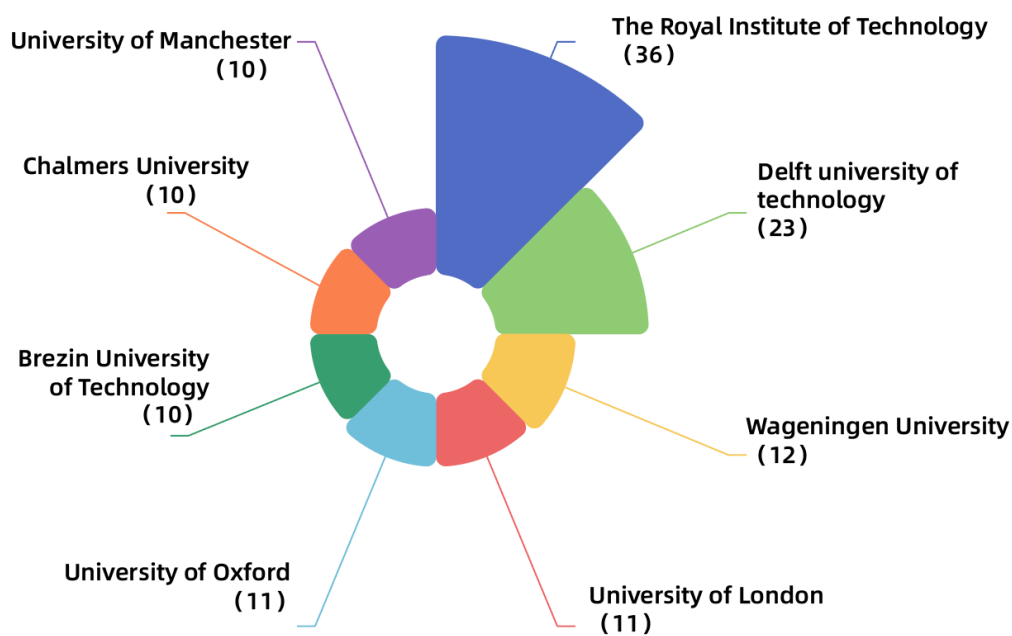


Figure 5. The proportion of research institutions ranked among the top 8 in the frequency of backcasting research papers



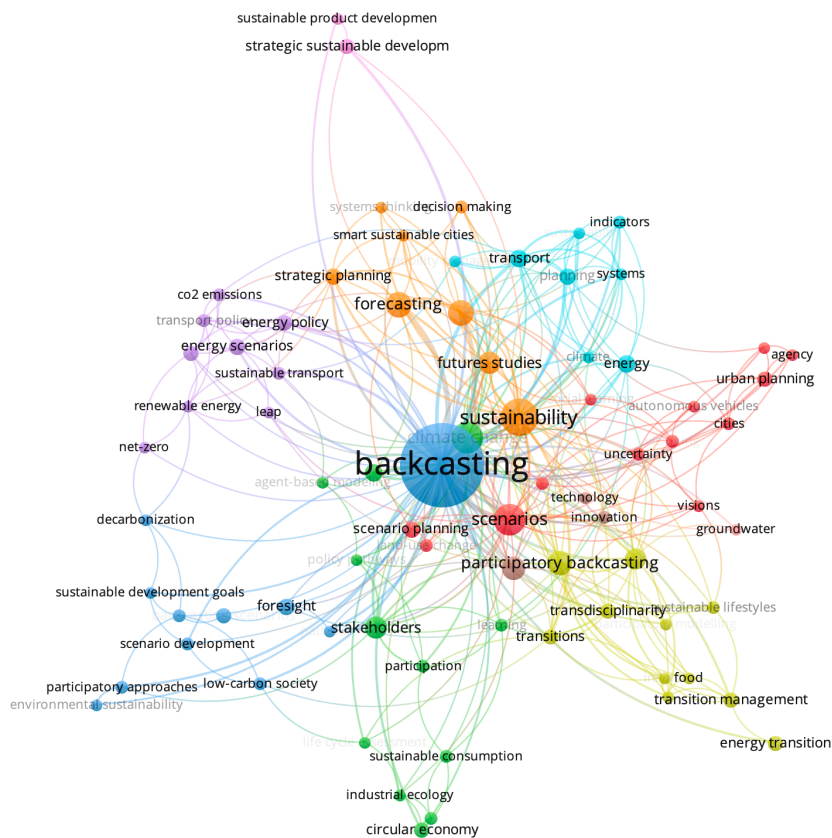


Figure 6. backcasting research keyword co-occurrence graph

Table 1. High frequency keywords for Backcasting research

No.	Keyword	Occurrences	Total link strength
1	Backcasting	154	93
2	Sustainability	32	26
3	Scenarios	23	35
4	Climate change	22	18
5	Forecasting	15	15
6	Sustainable development	15	12
7	Participatory backcasting	14	14
8	Futures	12	19
9	Futures studies	11	16
10	Stakeholders	11	13
11	Goverance	10	14
12	Transport	7	16
13	Ecosystem services	7	9
14	Energy	7	9
15	Strategic planning	6	13

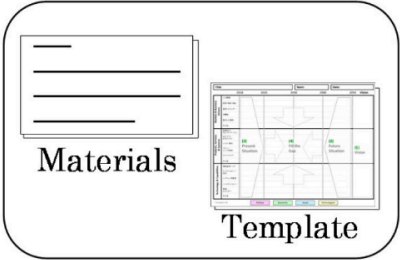
**Table 2.** Basic Process of Backcasting

Name	Author(s)	Procedure
Backcasting approach as proposed by Robinson	Robinson ( 1990 )	<ol style="list-style-type: none"> <li>1) the definition of future objectives</li> <li>2) the creation of future scenarios based on an analysis of the present situation</li> <li>3) socio-economic evaluation of scenarios</li> <li>4) the assessment of technical feasibility.</li> </ol>
The Natural Step backcasting approach	Holmberg (1998), Nattrass and Altomare 1999, Holmberg and Robèrt (2000)	<ol style="list-style-type: none"> <li>1) definition of sustainability criteria associated with a specific issue</li> <li>2) analysis of the present situation, as well as present activities and competencies of the company</li> <li>3) creation of future visions in cooperation with employees</li> <li>4) development of progress strategies in order to reach an ideal state</li> </ol>
STD backcasting approach	Weaver et al. (2000) and Aarts (2000)	<ol style="list-style-type: none"> <li>1) Strategic problem orientation and definition</li> <li>2) Develop future vision</li> <li>3) Backcasting</li> <li>4) Explore solution options</li> <li>5) Select among options: set up action plan</li> <li>6) Set up cooperation agreement–define roles</li> <li>7) Implement research agenda</li> </ol>
Backcasting approach as proposed by Höjer & Mattsson	Höjer & Mattsson ( 2000 )	<ol style="list-style-type: none"> <li>1) the definition of visions and desirable future states</li> <li>2) the definition and comparison of visions and forecasts</li> <li>3) scenario building and as a separate step</li> <li>4) the Backcasting analysis</li> </ol>

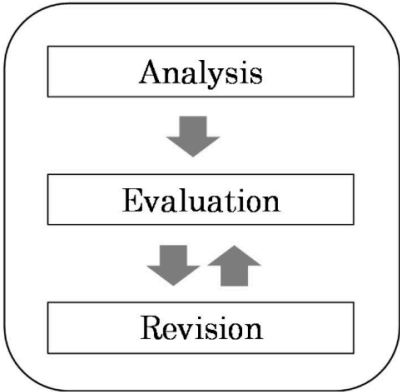
SusHouse backcasting approach	Vergragt (2000, 2005), Quist et al. (2001a), and Green and Vergragt (2002)	<ol style="list-style-type: none"> <li>1) Problem Orientation</li> <li>2) Stakeholder Analysis &amp; Involvement</li> <li>3) Stakeholder Creativity Workshop</li> <li>4) Scenario Construction</li> <li>5) Scenario Assessment</li> <li>6) Back-casting Workshop &amp; Stakeholder Consultation</li> <li>7) Realisation and Implementation.</li> </ol>
Participatory backcasting	Jaco Quista, Philip Vergragtb (2006)	<ol style="list-style-type: none"> <li>1) Strategic problem orientation</li> <li>2) Construction of sustainable future visions or scenarios</li> <li>3) Backcasting</li> <li>4) Elaboration, analysis and defining follow-up and (action) agenda</li> <li>5) Embedding of results and generating follow-up and implementation</li> </ol>
GIS-based Backcasting	Eva Haslauer ( 2012 )	<ol style="list-style-type: none"> <li>1) problem analysis and analysis of the present situation</li> <li>2) creation of an “optimal future solution” (vision)</li> <li>3) determination of endogenous and exogenous indicators</li> <li>4) development of future scenarios including a SWOT analysis,</li> </ol>
		<ol style="list-style-type: none"> <li>different values (best-case, worst-case scenarios) and integration of stakeholders’ interests</li> <li>5) Leitbild development and further guideline principles and indicators</li> <li>6) development of a stochastic model in ArcGIS</li> </ol>

		<div>7) implementation of a Backcasting analysis of the case study on urban sprawl</div> <div>8) setting up the agenda and milestone scenarios</div> <div>9) iterative reframing.</div>
Backcasting process as proposed by G. Kira ´ly et al.	G. Kira ´ly, Gy ´rgegy Pataki, Alexandra K ´ovacs, Ba ´lint Bala ´zs. ( 2013 )	<div>1) determining the topic</div> <div>2) determining the method</div> <div>3) selecting the participants</div> <div>4) briefing</div> <div>5) backcasting event(s)</div> <div>6) normative vision</div> <div>7) backcasting policy steps</div>

1. Preparation

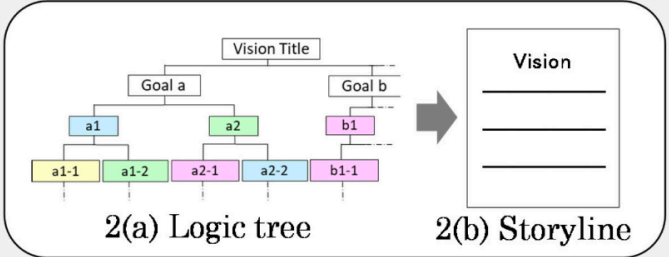


4. Post-workshop activities



Workshop

2. Developing visions



3. Developing pathways

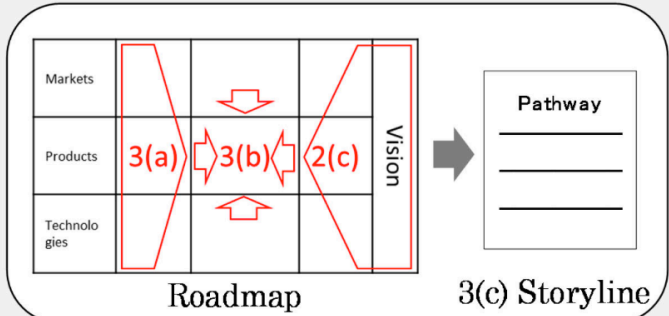


Figure 7. Four Arrows Model: Backcastin-based method for designing roadmaps to achieve a sustainable future

## **Steps to Well-being: Nurturing Personal, Social and Environmental Well-beings through an Urban Walking Practice**

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### **Abstract**

This image-rich presentation explores the ways in which an evidence-based concept of well-being, commissioned by the UK government, manifests itself in a community-based urban walking event. Born out of my evolving art practice and as a means to critically explore my enjoyment of walking in the city, in 2016 I invited three friends to join me in walking a circuit of central Osaka, Japan where I was living. What was intended as a one-off event with those three friends has become an annual event open to the public with more than 20 people joining 2023's walk. The walks are semi-scripted, semi-improvised communal performances; our navigation of the urban space is interspersed with game-playing, story-telling, the reading of short texts and other interventions. This presentation first introduces the origins and cultural contexts of the walks before outlining The Five Ways to Well-being, the evidence-based report developed by the New Economics Foundation (NEF) for the UK government's Office for Science. The presentation then explores how those five ways to well-being outlined in the report manifest themselves within the walks themselves.

### **Author keywords**

Wellbeing; urban walking; psychogeography; research-creation; interdisciplinary practice; Situationist International.

### **Introduction: Origins and Contexts of a Walking Practice**

Creative practice, research, pedagogy; walking is at the centre of each of these and is a common thread between them. Group walking has become a form of dynamic curation and social interaction while my solitary walking is a time for thinking; creative, reflective, and critical. And the places I walk are rich in learning and teaching potential. The streets are classrooms, laboratories, studios, galleries and museums if we allow ourselves to see them as such. (See figure 1.)

The circumstances from which my walking practice emerged are twofold and entangled. Firstly, as an artist with a background in drawing and painting I felt a growing sense of rupture with a creative practice centred on object-making. I can still be seduced by the material and formal qualities of drawing– the paper surface, the quality of a line– but I felt increasingly restless while in the studio. I felt the knowledge I was seeking was out there, beyond the studio walls. This leads me to the second circumstance from which my practice emerged. At this time, I was walking a lot in the city. I became aware of myself walking in the city, and I soon became aware of my awareness of myself walking. My walking was becoming critical and my interests were moving away from a practice based in material forms and towards one pursuing social and spatial encounters. My mind, my body, the space: what is

the relationship between my body and the space through which it moves? What is the relationship between this movement of body-through-space and the spaces of my mind? These and other questions began to interest me.



**Figure 1.** Three modes of walking: community walking; solitary walking; walking as a site of learning and teaching.

A whole ecology of walking practices revealed itself to me as I explored the many other individuals and collectives addressing similar questions for a long time. Historical precedents and contemporary influences, and local practitioners and distant collectives, all brought together through interests close to my own. There were the Situationists in Paris whose psychogeographic drifts through the streets attempted to reclaim the city from the forces of production and consumption. In Japan where I was living at the time I learned about Akasegawa Genpei, and High Red Centre collective whose motivations were similar to those of the Situationists. I also learned of Rojo Kansatsu, (the Street Observation Society) and other modernologists who sought to document the unnoticed and everyday aspects of Japan's fast-changing urban life.

Perhaps the most important influence on my practice has been contemporary practitioner Phil Smith whose method of mythogeography he has set out in a manifesto. Mythogeography is, among other things, “a geography of the body, a philosophy of perception, an experimental approach to the site of performance,” that recognises the agency of space and place (2010: 113). Smith's ideas have helped shape my own practice, most notably by introducing me to the idea of group walking as a way to complement the solo walking I was already engaged in. It is one of these group walking projects that I will outline below but before I do I will offer a brief overview of the research-creation framework, the overarching structure within which I situate my praxis.

Springgay and Truman define research-creation as “the complex intersection of art practice, theoretical concepts, and research. It is an experimental practice that cannot be predicted or determined in advance” . Research-creation is, they continue, “attuned to processes rather than the communication of outputs or products” (2016). Research-creation's emphasis on processes rather than outcomes, and the shift from a practice based on forms to one exploring encounters (as described above) provided me with the structures I needed as I sought a creative approach that was dynamic, interdisciplinary and in a continuous state of flux.

Group walking in the city is a concrete application of the practical and theoretical contexts outlined above and the sections below explore one such application. After offering a broad outline of my Widdershins Osaka! walking project this paper discusses the ways in which that project enters a dialogue with ideas of wellbeing.



### **Widdershins Osaka!: A Community-walking Project**

Widdershins Osaka! is a community-walking event I established in my home of Osaka, Japan. Initially seen as a one-off event for friends it has grown, developing into an annual public gathering. We walk on February 23rd each year as part of Terminalia, an international walking festival that commemorates Terminus, the Roman God of boundaries.

In an act that projects an autobiographical narrative onto a more public one, my Widdershins Osaka! walk maps the city of Leeds England onto the streets of Osaka, Japan. This mapping of one place onto the terrain of another is performed through a method I call re-placement.

The re-placement method began when I encountered an anecdote in my reading of the Situationist International. Guy Debord wrote, “[a] friend recently told me that he had just wandered through a region of Germany while blindly following the directions of a map of London” (1981). On first reading, this act of walking London with a map of Germany sounds irrational and absurd and indeed Debord dismisses it as such. But is he right to do so? I’m not so sure. New Materialist thinker, Jane Bennett suggests that in our dealings with the world we are too quick to jump to a rational critique. She asks us to insert a pause before such critique, to employ a “methodological naïveté” through a return to “discredited philosophies of nature” (Bennett, 2010). Meanwhile Phil Smith in his manifesto states that he “does not discriminate between respectable and non-respectable forms of knowledge” (Smith, 2010). In these terms Debord’s anecdote is not irrational but pre-rational and can be seen as a method for the production of knowledge. This knowledge is unlikely to be propositional and may, in Smith’s terms, be “non-respectable” (2010). Indeed it may invite “a whole realm of complex, finely nuanced meaning that is embodied, tacit, intoned, gestured, improvised, co-experienced, [and] covert” (Conquergood in Loxley, 2007, p. 152). This then is my re-placement method– it is the reading of one phenomena in terms of another as a means to disrupt habituated ways of encountering and knowing the world.

Before I address the benefits that might come from such a disruption of habits I should explain the meaning of the term Widdershins. Widdershins is an archaic English term meaning motion in a direction contrary to the direction of the sun. It has connotations of deviance, transgression and otherness. When I first encountered this term I realized my project could not be called anything other than Widdershins.

Early in my project I had vague notions that somewhere in my project was an engagement with wellbeing, but it is only very recently I have begun to tease out what that term wellbeing really means and how it might enter a dialogue with my walking practice. Social sciences repeatedly state that wellbeing is hard to define, suggesting that it is hard to separate wellbeing from the framework of health while also acknowledging that qualities other than health make a significant contribution to whatever wellbeing might be (la Placa et al., 2013; Dodge et al., 2012).

In 2008 the UK Government Office for Science commissioned the New Economics Foundation (NEF) to develop a wellbeing framework for their Foresight report into mental capital and wellbeing. The NEF created an evidence-based structure they called Five Ways to Wellbeing. As the title suggests they outlined five simple actions that can make significant contributions to an individual’s wellbeing. Those five ways are connect, be active, take notice, keep learning and give (Aked et al., 2008). It is this framework that has enabled me to understand and communicate my project in terms of wellbeing.

## Widdershins and The Five Ways to Wellbeing

The NEF's Five Ways has provided me with a simple but nuanced structure with which to consider the relationship between wellbeing and my creative walking. At this stage I do not wish to make explicit connections or draw conclusions about that relationship but instead to use this essay as an opportunity to begin to tease out threads between the two. To do this, in the section that follows I will alternate between brief snapshots of my project and the NEF's descriptions of each of their ways and I will ask the reader to draw their own connections between each of these threads.

The first Widdershins Osaka! walk in 2016 was intended as a one-off event as a means for me to reflect upon and share some of the early research I had been doing into place/ space and urban walking. As we walked we read prepared texts, played games and, most importantly, tried to interact with the environment in such a way as to suggest the space through which we moved was an active participant with agency equivalent to our own. Unplanned occurrences such as the sound of a sudden police siren would be triggers for our actions, perhaps forcing us to change direction or to stop and perform a reading or some other task. In this way we entered a dialogue with the environment through which we moved. (See figure 2.)

“Be active. Go for a walk or run. Step outside. Cycle. Play a game. Garden. Dance. Exercising makes you feel good. Most importantly, discover a physical activity you enjoy and that suits your level of mobility and fitness.” (Aked et al., 2008)



**Figure 2.** Widdershins Osaka! and the five ways to wellbeing

My friends and I had found 2016's walk enjoyable and fruitful and I soon decided that I would repeat it the following year. What was most interesting on this second walk was how memory of the previous year's event was layered, like a sediment, within our walk. As we arrived at certain locations or moved on particular lines we would notice how in the intervening months, things had changed— often dramatically— or had not changed at all. This co-mingling of past and present is a quality that has become richer with each subsequent iteration of the event.

“Give. Do something nice for a friend, or a stranger. Thank someone. Smile. Volunteer your time. Join a community group. Look out, as well as in. Seeing yourself, and your happiness, linked to the wider community can be incredibly rewarding and creates connections with the people around you” (Aked et al., 2008).

In 2018 I made a conscious attempt to make the walk more diverse. I wanted more local people involved and more people who I did not know directly. I tried to stretch the age group and offer a fully bilingual encounter with the translation into Japanese of as much of the written and spoken material as possible.

“Take Notice. Be curious. Catch sight of the beautiful. Remark on the unusual. Notice the changing seasons. Savour the moment, whether you are walking to work, eating lunch or talking to friends. Be aware of the world around you and what you are feeling. Reflecting on your experiences will help you appreciate what matters to you” (Aked et al., 2008).

In 2019, as the walking group continued to grow I felt an important shift. I no longer saw the project as an artwork with me, the artist, at its centre, but instead saw it as an act of perambulatory curation, with me, the curator, moving from its centre to its margins, inviting others to bring their ideas and interventions to the project.

“Connect. With the people around you. With family, friends, colleagues and neighbours. At home, work, school or in your local community. Think of these as the cornerstones of your life and invest time in developing them. Building these connections will support and enrich you every day” (Aked et al., 2008).

In February 2020 we walked in the final weeks of a world that did not know the term COVID 19. On the banks of the canal at the end of the walk I phoned two friends– one in Chengdu, China, the other in Florence, Italy– already experiencing strict lock-downs. Together, we by the canal and they on the phone, voiced a simultaneous reading (in four languages) from a prepared passage of Boccaccio’s Decameron reflecting on the quality of friendship. (See figure 3.)



**Figure 3:** Widdershins Osaka! 2020: On the banks of the canal the walking group (right) connected online to friends in China and Italy to read a passage from The Decameron (left).

“Keep learning. Try something new. Rediscover an old interest. Sign up for that course. Take on a different responsibility at work. Fix a bike. Learn to play an instrument or how to cook your favourite food. Set a challenge you will enjoy achieving. Learning new things will make you more confident as well as being fun.” (Aked et al., 2008)

In 2023, Widdershins Osaka! returned after a 2-year hiatus and again the project made a significant shift. In an attempt to further manoeuvre myself from centre to margins I established an informal committee to contribute to the event’s planning. Discussing and delegating aspects such as theme, route and curation of performances was rewarding for me and enriched the walk itself. I began to feel that Widdershins Osaka! might take on a life of its own.

### Conclusion

My conclusion is unconventional and might not function as a conclusion at all. And that's ok. I want to return to the opening expert addresses of last week’s conference in Beijing, and an idea that I’ve been thinking about since then. The eminent professor of design Enzo Manzini discussed relationships and said we cannot design relationships but we can design the conditions in which they might occur (2023). He showed an image of people dancing in the street. Middle-aged couples, smiling and embracing as they swayed between the buildings. Prof. Manzini said we cannot design that these people become friends or that they fall in love but we can design the conditions in which such relationships may take place. He said that in order to dance in the street we must first allow for the streets to be closed to traffic, we must provide the music, and we must teach the steps to those who want to dance but don't know how. Here, he said, are the conditions in which relationships may flourish (2023).

Just as we cannot design relationships, we cannot manufacture wellbeing. But just as we can design the conditions for relationships we can also manufacture the conditions in which wellbeing might flourish. I thought that there were two such conditions- time and space. But I’m starting to see there are five: connect, be active, take notice, keep learning. And give.

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## Research on the integration trend of emerging application technologies and automotive design

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### Abstract

The history of automotive design is one full of innovation and technological progress. From the earliest steam cars to the internal combustion engine cars of the past, to the self-driving electric cars of the future, cars will become smart mobile terminals and even reshape urban space. Automotive design is constantly evolving to adapt to social needs, technological advances, and environmental challenges. Under the impact of emerging application technologies, automotive design thinking and methods are in urgent need of updating and reconstruction. Research on the integration of technology and design will help the rational and effective use of emerging application technologies in automobile design while promoting innovation in the automobile design industry to meet future transportation and travel needs.

By exemplifying some cases with distinctive characteristics, the author me sorted out the development trends of automobile design at present and shortly, focusing on various phenomena in automobile design and even automobile design ecology in the context of emerging application technologies, and tried to explore patterns and raise questions. Through methods such as historical combing, case analysis, trend forecasting, surveys, and interviews, the intersecting content and integration relationship between application technology and automotive design are sorted out and studied, and research samples from several perspectives are formed. At the same time, core issues are discussed in the article.

This article sorts out the development trends of automobile design in a changing environment, provides dialectical thinking on travel design and transportation design for the conference theme "Narrative of Love - Towards Healing, Transformation and Transcendence", and derives the trend that future intelligent car design will be dominated by technology. Present a visionary plan for this area of design. The research aims to consider the opportunities and problems arising from the current integration of technology and design and explore how the two can find appropriate development paths for intelligent car design in the context of emerging application technologies.

### Author keywords

Intelligent car design, automotive design trends, technology and automotive design, automotive design reconstruction

### Iteration of emerging application technologies drives changes in automotive design

With the popularization of driverless technology, people can gather, eat, work, and live in cars for a long time [ Toyota E-Pattle, a variety of interior space modules have been designed <https://40ton.net/bus-z-autopilotem->

potracil-niedowidzacego-sportowca-toyota-przeprasza-za-e-palette/]. Humanity's concept of time and space will be changed; parking lots will become commercial or residential spaces, roads will become narrower, and urban areas will become larger. Large, traffic lights and street signs will disappear, and cities will be reorganized; as car accident rates decrease, hospitals and the financial and insurance industries will shrink; logistics prices will decrease, and commodity prices will decrease; humans will walk less, and shopping habits will change; cars Using more efficiently, energy and sectors will be redesigned... and this is just the beginning of the AI revolution.



**Figure 1.** Toyota E-Pattle

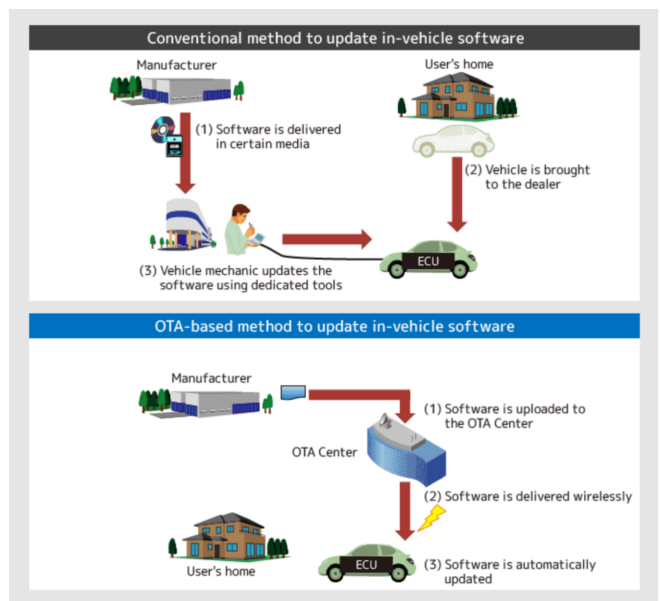
### 1. Development of autonomous driving application technology

Thanks to rapid advances in mobile robotics, combined with faster computers, reliable hardware sensors, and a new generation of artificial intelligence software (deep learning), cars can drive autonomously and safely in unpredictable environments.

In terms of internal automotive hardware, some key technologies and hardware are mentioned, such as AR HUD augmented reality technology head-up display, multi-function large-size display, etc., as well as the use of flagship SoC system-on-chip from chip manufacturers such as Qualcomm and HI Silicon. The main chip of the domain controller. These hardware support data processing capabilities, 5G networks, OTA wireless upgrade technology[ Over-the-Air Technology (OTA), This picture shows how software update for vehicles.

<https://www.hitachi.com/rd/sc/story/ota/index.html>], and in-vehicle ADAS advanced assisted driving systems.

In terms of software, it was mentioned that mid-to-high-end models of luxury brands of traditional car companies no longer are equipped with physical AI assistants, but instead use intelligent voice assistants to interact with vehicle occupants. In addition, some models may choose domain controller main chips from suppliers with better cooperation to reduce costs at the expense of



**Figure 2.** Comparison of car software update



computing power. Some models may directly purchase overall solutions provided by third parties such as Huawei, Samsung Harman, and Fuzhijie.

## 2. Autonomous driving technology leads to changes in car design trends

The exterior of the car is equipped with many radars, cameras, ultrasonic sensors, and other sensors. Some of them are integrated with the original free space of the vehicle, while others are independent to form new styling features. Graphic display technology suppliers, represented by NVIDIA, have significantly accelerated the development of open-environment autonomous driving by integrating and upgrading AI image recognition hardware and software.

The development of autonomous driving technology has promoted the integration and modularization process of automobile design, making automobile design gradually become intelligent products. At the same time, the shape and language style of the car have also changed accordingly, tending to be simpler and more integrated to cater to the sense of technology and the future.

The evolution of automobile design has shifted from focusing on the integrated interior and exterior style in the past to paying more attention to interior cockpit design under the current intelligentization process.

## 3. Intelligent car cabin

In the past, car design focused on integrating exterior styling with the interior. Now, with the development of intelligence, design pays more attention to the user's experience and efficiency in the car. Interior design is the key point for direct interaction with people[ Creating a mobile home with smart cockpit is the core of Li-Auto product design.<https://www.geekpark.net/news/304201>].

### 3.1 The impact of human-machine interaction on automotive design

In the early days, vehicle control mainly relied on physical buttons, and the concept of a "smart cockpit" only appeared in film and television works, and the "intelligence" of the cockpit was mostly reflected by in-vehicle AI. For example, the Cyber System in the Japanese animation "Cyber Formula" can talk to the driver, complete assisted driving, and learn. It wasn't until 2012 that Tesla released the Model S, which for the first time adopted a cockpit design based on an intelligent connected car system in a mass-produced vehicle. Although some early models adopted multimedia interactive car-computer systems, for more complex human-computer interaction and applications, they still need to use plug-ins such as smartphones.



**Figure 3.** Li-Auto L9 Interior

Today, the smart cockpit is one of the core functions of the vehicle's electronic and electrical architecture. With the intelligent networked vehicle system as the core, it meets the needs of drivers and passengers for intelligent

interaction with multi-channel information inside and outside the vehicle. With the support of chip performance, artificial intelligence algorithms, and Internet of Things technology, smart cockpits continue to improve various intelligent interactive experiences. Mainstream models on the market are also equipped with various smart cockpits according to needs.

In the future, it is expected that the electronic and electrical architecture of the entire vehicle will develop into a strip architecture based on domain fusion, requiring SoC chips to integrate the different requirements of multiple functional domains. The smart cockpit will also evolve into the "third space", applying C-V2X cellular network car networking technology to realize intelligent interaction between the vehicle and other external objects. However, this requires first completing the construction of intelligent transportation systems and improving smart city infrastructure and may also require adjustments to relevant laws and regulations.

### 3.2 The dissolution of traditional interior design

The impact of factors such as space design, interaction design, and human-centered design care on automobile interior design, as well as the changes in traditional interior design caused by changes in hardware technology. The development of space design and interaction design has transformed automobile interior design from ancillary design matching the mechanical structure to interior space-led design values.

In terms of the development of the design field, automobile design in the 20th century was mainly led by design artists. It was the creative result of an individual or a team and had a professional and complex process. However, with the emergence of professional design software (such as Adobe, Autodesk, Blender, etc.), the process of automotive design has become simpler and more visual, allowing everyone to produce relatively complete projects. This makes automotive designers more like clothing designers, able to demonstrate results using completely virtual designs.

In the future, the popularization of art may lead to a lowering of the professional threshold for design. With the development of NFT and virtual digital art, the interior and exterior styling of cars may be presented through visual media. This could lead to a cadre of independent car designers who can create designs with a strong personal style under their names or as brands. The interior of the car may relate to reality in the virtual world, with scene and even collection value, like virtual fashion.

## 4. Automobile body intelligence

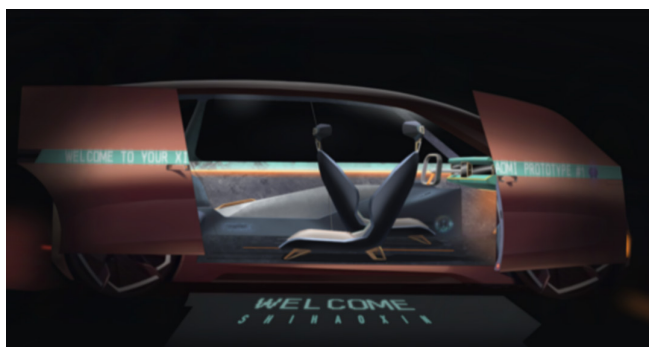
The intelligent exterior design of automobiles aims to improve the overall performance, safety, and interaction ability of the vehicle with the environment to create a smarter, safer, and more environmentally friendly travel experience.

### 4.1 The impact of connectivity on automotive design

To cope with the trend of the Internet of Everything, visual work status display has become very important, so some concept cars integrate interactive screens on the internal and external surfaces. From mechanized buttons to smooth large screens, and then to the integration of screens into smart surfaces, a new simple design style has been formed, which is not only a novel evolution of design, but also the inevitable release of mental stress due to technological progress. The screen displays complex information, and dense information may cause stress to the driver, so a visual work status display helps improve the driver's comfort and sense of security.

## 4.2 Innovation in Emerging Exterior Designs

Intelligent exterior design often considers the integration of autonomous driving systems into the vehicle, including the clever integration of lidar, cameras, and other sensors to maintain the aesthetics of the overall appearance. Car exterior designs tend to adopt more intelligent design languages to accommodate advanced technologies, including streamlined shapes, dynamic lines, and aerodynamic designs to optimize fuel efficiency and reduce wind resistance. Using LED technology, car



**Figure 4.** Xiaomi NERONE designed by Shi Haoxin

exterior designs can achieve interactive lighting effects[ In August 2021, author me provided the design solution NERONE for Xiaomi Motors during his internship. Through cooperative research with corporate designers, we believe that the vehicle's external interactive display reflects the sense of technology and is also a must-have for future smart cars. The picture shows the surround screen on the side of the vehicle when the door welcomes guests and the AR projection effect at the bottom of the side skirt.]. These light systems can be used to communicate with other drivers and pedestrians, for example by displaying driving intentions, warning other vehicles, or demonstrating vehicle status.

## Intersection analysis of smart car design and emerging application technologies

Artificial intelligence will also challenge the boundaries of traditional human ethics and morality: tens of millions of full-time drivers around the world will face unemployment; the public transportation industry will wither as a whole; the energy and manufacturing industries will be forced to transform; the automobile industry and the insurance industry will be subverted; human beings It may be necessary to sacrifice personal privacy in exchange for travel safety and convenience; how will self-driving cars make decisions when encountering emergencies...

### 1. Analysis of interaction design methods of cars as intelligent vehicles

The advancement of technology shows that cars are becoming autonomous robots, emphasizing individual self-closed loops. The implementation process of autonomous driving technology mentioned above includes three main parts: perception and positioning, decision planning, and control execution. Perception and recognition capabilities are the basis of the system, and decision planning includes routing, behavioral decision-making, and action planning. Finally, the control execution stage accepts the output trajectory points of the action module and converts them into vehicle acceleration, braking, and steering wheel signals through dynamics calculation to achieve automatic driving. In this process, the interaction between smart cars and individuals and systems is indispensable.

#### 1.1 Interaction between car exterior and slow-moving pedestrians

The interaction between cars and slow-moving pedestrians is mainly divided into two senses, namely vision and hearing. Because during highly intelligent driving, radar and cameras can quickly identify slow-moving pedestrian units, visual warnings can be provided through changes in lighting, changes in the shape of the side lights (daytime running lights), AR projection content, etc. Warning and communication functions for slow units. The propagation efficiency of sound is far less than that of light, and when the car is traveling at a certain speed, the effect of sound prompts is very subtle. However, the General Electric drive of cars will lead to a reduction in

the sound of mechanical operation. In many scenarios, pedestrians cannot pay attention. It is like a traditional internal combustion engine vehicle that realizes that there is an electric car driving behind it. In this case, the sudden lane change or stop of the slow-speed unit will increase the risk of collision caused by misjudgment or delayed response of the fast unit.

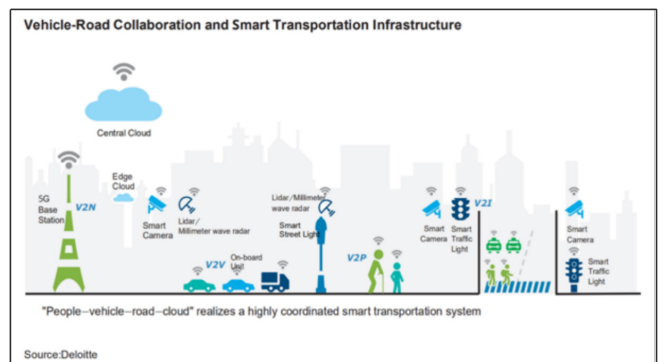
### 1.2 Interaction of car exteriors and fast units

During fast driving, the outer surface of the car is an important medium for information transmission and interaction, that is, important information is displayed in the visible area of other drivers and other car cameras outside, which can satisfy most human-machine needs in intelligent transportation. Communicate and communicate. Electric vehicles cancel the air intake design of traditional cars and have large-capacity batteries. Therefore, the closed-air intake grille panel at the front of the car and the taillight panel at the rear can be used as interactive media to display information. At the same time, the lights serve as the trend line and exterior shape. The embellishments make up for the lack of details on the smooth body, forming a new design trend.

### 1.3 Vehicle-road-machine collaboration in urban systems

As an individual means of transportation, cars are moving toward internal interconnection from bottom to top, which also promotes the development needs of smart roads. In the future, the deployment of overall traffic by road systems[<https://www.linkedin.cn/incareer/pulse/vehicle-road-collaboration-smart-transportation-ivan-xie>] will strengthen the interconnection between individuals, the interconnection between systems and individuals, and the transportation system.

It will also become an intricate and organically operating ecological whole. This means that every individual vehicle and the smart road must communicate with invisible programs and visible visual signals. The disappearance of traffic lights and signs is not a crude replacement, but an efficient transformation. When roads become clean and tidy, necessary traffic information and interactive instructions will be transferred to moving vehicle units. Integrated display arrays composed of single or multiple mobile units assume the responsibility of the media, and the intelligent exterior surface of the vehicle also emerges.



**Figure 5.** Vehicle-Road-Collaboration scene

## 2. Analysis of the human-machine symbiosis problem of automobiles as smart mobility products

In future smart transportation, people transform from drivers to passengers served by cars, resulting in the transfer of vehicle control rights. This involves changes in ethical responsibilities. People no longer directly control the car through personal will but gain limited control within specific scenes or areas. Cars are about to become autonomous robots to which we entrust our lives, which means that humans must entrust their lives to them. In this change and transfer of human-machine power, the analysis of the issue of human-machine symbiosis has certain far-sighted significance.

### 2.1 Compression of control

The rise of technology has the vision of making life better, but people are spending more time addicted to

the virtual world. Regarding Facebook's name change to "Meta" in 2021, Liu Cixin expressed doubts about the concept of the Metaverse, believing that people's life in the invisible world may lead to emptiness and fragmentation, and mentioned that the number of people living in the invisible world exceeds the tangible world. He also emphasized the appeal of the invisible world to people, likening it to a drug-like experience.

There is a divide between those who support technology fanaticism and those who are concerned about the human rights crisis on the question of "for whom technology is for". From this, the author raises an ethical question: Should people hand over power to non-existent objects? In traditional usage scenarios, people have control over items, but in highly intelligent and automated situations, people seem to be unable to intervene in the control of items, resulting in distortion of the power relationship between people and things. Due to the high intelligence of machines, human control over machines may be elevated and reconstructed.



**Figure 6.** 2022 graduation design of the author Shi Haoxin

## 2.2 Transfer of disposal rights

Looking back at the current technological boom, in the process of product design and use, people are more of a guide, and are even overly considerate and caring in the act of "designing". In addition, as individual products, or systems themselves are highly closed and interconnected, there is almost no channel for people to establish pure interaction with items[ The author's undergraduate graduation project, Speedster' 2030, is based on the overheating phenomenon of current emerging technologies and reflects on the problem of solidification of mobility in the context of machine intelligence. ]. In the past, people's use, transformation, maintenance, and even dependence on traditional items were all about the balance of power maintained between people and things in coexistence and symbiosis. In addition to the harmony of the relationship, people also have the power to change the shape, characteristics, or uses of the product according to their preferences. This is a controlled disposal power based on the traditional mechanical and physical categories. Today, this controllability is becoming illusory - Virtual things have transferred the meaning of some physical things, and the corresponding values have also been subverted to a certain extent. The smart cars of the future belong to humans, but they are abstract enough that it is difficult for people to define their cars. In the context of the sharing economy, cars have even become a service beyond human disposal.

## 2.3 Redistribution of rights of way

In smart city transportation, right of way can be mainly classified into two categories: right of way selection and rite of passage. Just like the right-of-way issue in the technologically advanced context involved in the American TV series "Westworld", smart cars can of course match the high-precision positioning service with the smart road system to obtain the best path at a certain moment, that is, time. The shortest option, but the control rights of L5-level vehicle occupants are handed over to road system managers by highly intelligent cars, and the question arises: What kind of vehicle can have the right to occupy a certain road resource? What is the occupancy rate? Everyone hopes to save unnecessary time in traffic, so what is the threshold for enjoying the dividends of efficient traffic? What are the defining criteria? When encountering an emergency, how to reasonably evaluate the traffic

priority for special vehicles, what is the threshold for the number of priority vehicles on a road, and whether the matching of hardware and software can achieve the ideal traffic deployment state... These issues are worthy of our consideration and Exploration, and this is not only a practical issue in transportation, but also an ethical issue that subverts human traditional concepts of time and space.

## Conclusion

Cars play the role of constructing urban space in future scenarios, first as a private space and secondly as a mobility tool. With the extensive and rapid development of emerging application technologies and smart driving-related technologies, technological iteration has promoted changes in automotive design methods and design trends and has also given rise to new crises and opportunities in the process of cross-integration with smart car design. Through cross-analysis and research on the integration trend of emerging application technologies and automobile design, the author concludes that future smart automobile design will be dominated by technology. At the same time, in the context of design reconstruction, the integration practice of emerging application technologies and automotive design on the production side has promoted the design system's pursuit of functional aesthetics, first principles, and design for the real world. Therefore, automotive design has developed modular, flat, and open design features, and a problem-oriented scenario-based design flow has been formed in the process of pursuing efficiency and experience.

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# Resilient Cities: Exploring the Transformation and Iteration of Living Spaces from the Perspective of Love and Healing

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## Abstract

A resilient city refers to an urban environment capable of reducing losses caused by disasters based on self-governance while possessing the ability to swiftly recover and resume its developmental processes through effective resource allocation. In an era marked by global public health crises, the imperative of resilient growth and self-revival in cities becomes a practical escape route in the face of human survival challenges. Cities are no longer just physical spaces; they are intricate systems comprised of various smaller units, prompting us to reconsider the ecological foundations, lifestyles, production relationships, and the meaning of life upon which human existence depends.

This article, based on research and analysis of three exemplary cases: the Dutch Findhorn Ecovillage, the Chinese Dali Sufang Ark Future Space, and the Green City Chunling Taoranli, delves into the construction of a "human, nature, and society" care system within cities and the cross-domain integration of diverse industries. It explores this from three dimensions: self-care and healing communities, ecological and natural farming, and social care and intergenerational healing. Furthermore, it elucidates how, in the era of trauma, individuals can embark on visionary plans for the transformation and iteration of living spaces, all stemming from the perspectives of love and healing.

## Author keywords

Healing Communities; Living Environments; Social Design

## Introduction

On May 5, 2023, the World Health Organization declared that the COVID-19 pandemic no longer constituted a "Public Health Emergency of International Concern." As the world gradually transitions into a post-COVID-19 era, a new outbreak of monkeypox has emerged. Global public health has officially entered an era fraught with crises. Concurrently, three looming challenges—geopolitical events, extreme climate conditions, and economic instability—catalyze cities' resilient growth and self-revival. People are reconsidering the ecological foundations, lifestyles, production relationships, and the meaning of life upon which human existence depends.

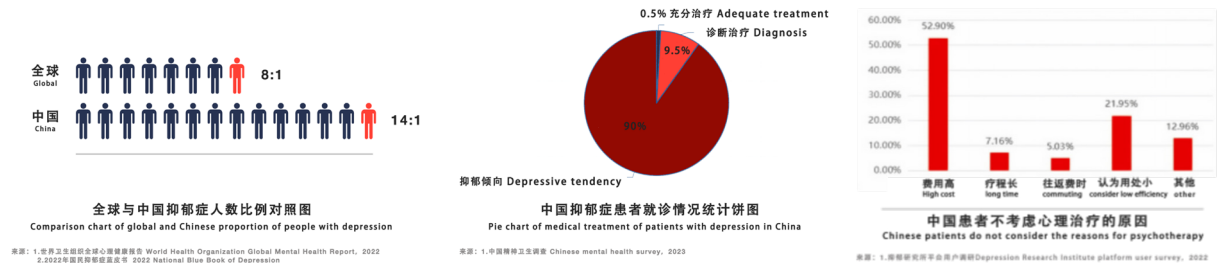
"At the heart of human societal culture lies 'love'." This article will elucidate how, in an era characterized by trauma, individuals are embarking on a visionary plan for transforming and iteration of living spaces, starting from the perspective of love and healing.

## I. Self-Care and Healing Communities

In 1914, Margaret Naumburg founded the "Walden School" in New York City, pioneering innovative artistic

activities like painting and art analysis to help children express emotions, problem-solve, and foster self-growth. It became a crucial early hub for art therapy.

In 1949, Hazelden emerged as the world's first healing community in Minnesota, USA, offering comprehensive addiction recovery, mental health support, rehabilitation, and social assistance programs. Its success inspired the establishment of numerous similar centres, shaping the modern rehabilitation and healing movement.



**Figure 1.** Current situation of Chinese society (Chart made by the author)

In both cases, we witness the continuous need for care across different stages of life, from childhood to adulthood. According to China's latest mental health survey, over 95 million individuals suffer from depression in China, with a treatment rate of less than 10%. Among them, only 0.5% receive adequate treatment. The treatment rate indirectly reflects the low societal acceptance of mental illnesses, high treatment thresholds and costs, and the underdeveloped social care system. Faced with the substantial population of urban mental sub-health individuals, the urgent need for the "deinstitutionalization" of psychiatric and psychological support is evident. Establishing a life care system based on living environments will be the optimal solution for public health issues. Shen, S. (2022). Art and Therapy in Action: Participatory Practice and urban regeneration. Shanghai Culture (12),20-25.(Figure 1)

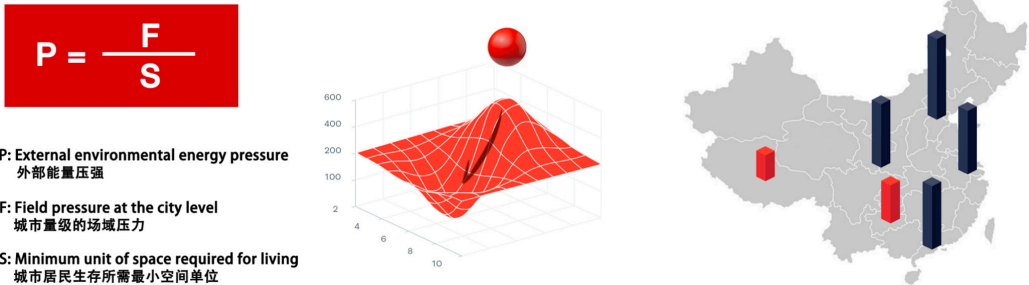
In the annals of human history, the Dutch pioneered the earliest experiment in sustainable living in 1962 with the establishment of the ecovillage of Findhorn. This village, comprising approximately 500 residents across two districts, champions a holistic, enduring lifestyle encapsulated in the "Fourfold Meaning" concept: personal and spiritual development, social life, ecological conservation, and economic stability. There's a "utopian haven" in China. Nestled in Dali, Yunnan, the Veggie Ark Future Space connects residents through a vegetarian lifestyle, embracing eco-friendly, sustainable living principles and seamlessly integrating organic wellness into daily life. Walking through the community's corridors, one encounters diverse art workshops, meditation rooms, and individuals from various religious backgrounds who congregate here. Amidst the verdant foliage, dedicated practitioners can pursue artistic and spiritual pursuits. The community fervently encourages residents to embark on artistic journeys, including yoga, ceramics, sound bowl therapy, meditation, self-healing practices in martial arts, music therapy, and Thangka healing. This rich tapestry of healing dimensions engenders an unspoken harmony within this bustling community. We can objectively comprehend the underlying logic behind this trend using the pressure formula  $P = F/S$ , where  $P$  represents pressure,  $F$  signifies vertical force (pressure), and  $S$  denotes the area under force. (Figure 2)



**Figure 2.** Community life in Veggie Ark Future Space (Photo taken by the author)

The high-pressure F emanates from the resource and developmental demands of large-scale urban environments characterized by high density. Under objective conditions, the minimum spatial unit required for urban residents' living can be considered as S, the area under force. The external energy pressure exerted on residents is directly proportional to the scale of the urban environment's pressure field and inversely proportional to the minimum spatial unit required for living. In the same spatial unit, the greater the pressure, the higher the external energy pressure, and the lower the energy released within individuals under restraint. Consequently, people tend to flow towards lower-pressure living environments, allowing their bodies to regain resilience and elasticity against external energy pressures. (Figure 3)

$$P \text{ (External Energy Pressure)} = F \text{ (Pressure of the Living Environment)} / S \text{ (Minimum Spatial Unit Required for Survival)}$$



**Figure 3.** Urban energy difference and people flow diagram (Chart made by the author)

In light of this, we have identified two novel approaches to addressing this phenomenon. First, starting from individual self-care needs, urban planners and implementers can employ design strategies rooted in art therapy to foster community-wide healing. In the living environment, they can construct life care mechanisms that grow naturally, like plants, aiding individuals in recognizing their self-worth and finding healthier lifestyles, thus facilitating the restoration of every visitor within the community. Second, the core of an effective mass healing mechanism lies in the hierarchical differences in external energy pressure. Spatial configurations can be structured based on the distinct attributes of different industries, allowing healing spaces to radiate reasonably within high-pressure cities, catering to low-energy groups.

In summary, from virtual healing mediums to city-level wellness complexes, as public health awareness extends from the physical to the psychological realm, the efficacy of spaces on individuals transcends the practical value of physical areas. Commencing from individual care, catalyzing self-love within individuals is the foundation for significantly enhancing the collective mental health index.

## II. Ecological Care and Natural Farming

Kaplan and Kaplan, in their work "The Experience of Nature" (1989), introduced the Attention Restoration Theory (ART), the core idea of which is that engaging with nature helps us mentally recover from states of depletion or cognitive overload. [ [ [ Rachel Kaplan, Stephen Kaplan - The Experience of Nature\_ A Psychological Perspective- Cambridge University Press (1989) ] ] Ecological care provides another perspective within the framework of life care mechanisms. In urban spaces, gardening can be viewed as a smaller-scale form of forest therapy. Individuals who have the opportunity to reconnect with society, joy, and health through gardening practices and a reconnection with nature in the wilderness can restore their perception of these essential aspects of life.

Self-care and ecological care are often inseparable in a comprehensive life care system. Research indicates that Findhorn is one of history's most resource-efficient and ecologically friendly human communities. Achievements within the community include eco-homes equipped with solar panels and other sustainable energy devices, widespread use of "Living Machines" (a form of wastewater treatment that mimics wetland self-cleaning and restoration functions), and organic food production combined with the utilization of new energy sources. Relying on wind turbines, solar water heating systems, and waste recycling programs, Findhorn Ecovillage's carbon footprint is only half the UK national average. Yet, the residents' happiness index far exceeds societal norms. [ [ [ Copeland Claire, MacKerron Gordon & Foxon Timothy J.. (2023). Futures for Findhorn: Exploring challenges for achieving net zero in an ecological intentional community. Futures. doi:10.1016/J.FUTURES.2023.103155. ] ]

The life care system is integral to human socialization, influencing individuals' socialization through social interactions, cultural transmission, and social support. Within this system, individuals learn how to interact with society, adapt to social norms and cultural values, and develop social skills and identity. In ecological care, discussing therapeutic activities fostering a higher level of social connection and service finds a successful example in the Vegetarian Ark's organic farm. The organic farm constitutes the second major component of the Veggie Ark Future Space, spanning over 500 acres of land and cultivating specialty crops like organic Valencia oranges, coffee, moringa, wild Yunnan olives, bananas, and passion fruit using "natural farming methods. With annual fruit orchard revenues in the millions, representing only 10% of the total revenue, the Vegetarian Ark, primarily operating as an inn, leverages the organic farm and estate within its agricultural system. It complements this with a vegetarian restaurant, farm activities, food e-commerce, custom travel services, and cultural dissemination, ultimately creating a unique green life ecosystem that offers substantial returns on capital. (Figure 4)



**Figure 4.** The organic farm in Veggie Ark Future Space (Photo offered by Veggie Ark)

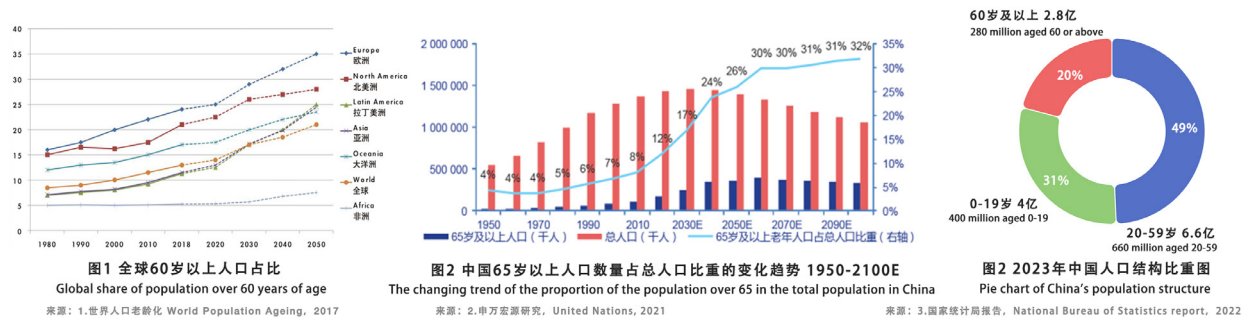
Furthermore, the farm encourages its user community to cultivate organic food themselves. Each year, the farm regularly sends customers non-genetically modified seed varieties. It provides cultivation guidance, effectively institutionalizing the unique healing mechanism of the space as a seed to be sown worldwide through people's actions, genuinely transforming the lifestyles of the masses. the Veggie Ark's organic farm serves as a significant

practical space where human-nature interaction translates into life care, and it has found a win-win approach in ecological conservation and economic development.

Within ecological care, the green agricultural industry becomes a benchmark for the iterative transformation of traditional production industries. Similarly, small-scale residential environments in urban areas can foster physical, mental, and spiritual care and healing through participatory practices in green agricultural industries. Examples include shared farmsteads, community gardens, and vertical garden plots on balconies. Moreover, derivative industries such as urban home organic farming courses, agricultural-sharing markets, cultivation study programs, and enthusiast clubs can develop, thereby igniting the vitality of traditional industries shifting towards the ecology care industry.

### III. Social Care and Intergenerational Care

Since the late 20th century, the number and proportion of elderly populations have continued to rise. According to data from the National Bureau of Statistics, as of the end of 2022, China had 280 million people aged 60 and above, accounting for 19.8% of the total population. Moreover, people aged 65 and above reached 210 million, constituting 14.9% of the population. According to estimates from the National Health Commission, by around 2035, the population of those aged 60 and above is expected to exceed 400 million, comprising over 30% of the total population, signifying a profound shift towards a heavily aged society in China.(Figure 5)



**Figure 5.** World and Chinese population ageing (Chart from the Internet and the author)

Social care, as a component of life care, draws from the social support theory. It refers to maintaining one's identity and acquiring emotional, service, and informational support through the network of relationships constructed among individuals in society. In an ageing society, the attention given to older people diminishes with increasing age and generational levels. Therefore, assigning new social functions to older people can enhance social care for this ageing demographic more effectively.

Located in Hangzhou, the Green Town Chunjing Taoranli project has iterated the traditional model of elderly care clusters with a system that combines "city-based care for the elderly, intergenerational communities, and medical and elderly care integration." Kindergarten children become the youngest caregivers in the community as they enter the elderly care centre. In contrast, active elderly individuals enter the kindergarten to become shared caregivers, assisting working parents in caring for their children. Additionally, the community offers loft-style housing units for independent living, encouraging elderly individuals to rent the upper floors to young college students promoting a sense of social responsibility for mutual assistance between generations. [ ] Guo Rongli & Wang Haoyan.(2023).A Study of Community-based Elderly Care Services for Older People from a Social Support



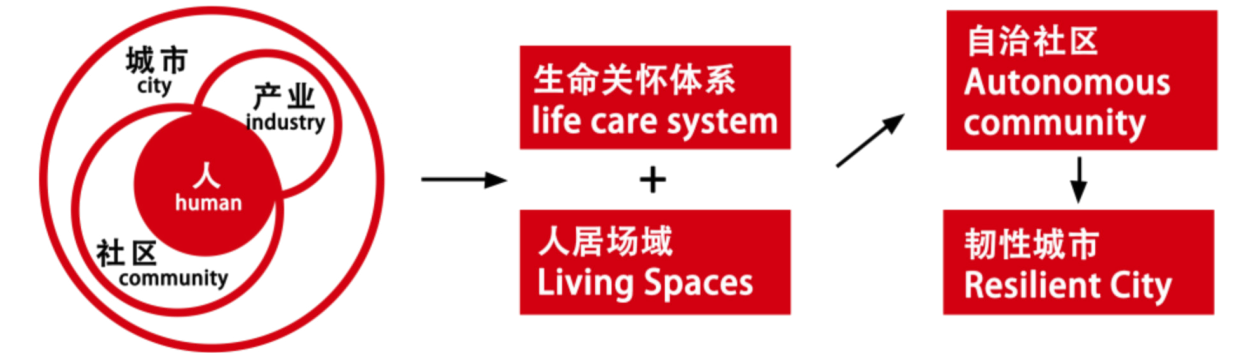
Perspective. Academic Journal of Humanities & Social Sciences(11). doi:10.25236/AJHSS.2023.061104.]]

Whether CCRCs (Continuing Care Retirement Communities) or CCKCs (Continuing Care Intergenerational Communities), these two cutting-edge care models focus on empowering vulnerable groups to be self-reliant and proactive. The Taoranli community provides an urban gardening platform that differs from typical community flowerbeds or green spaces. They offer "elevated vegetable gardens" that don't require bending over, catering to the preferences of elderly urban dwellers. Furthermore, the sales process uses a "referral system," addressing the social needs of the elderly and striving to create a highly collaborative care community. Sustainable social care in resilient cities helps residents achieve autonomy and self-sufficiency rather than merely meeting their needs through service-based industries.(Figure 6)



**Figure 6.** various community life in Tauranli (Photo offered by Taoranli and the author)

Highly autonomous communities are essential units in the cities of the future. In the town of Fenhorn, regardless of age or identity, every resident is obligated to participate in the maintenance and operation of the community. The continuous transformation of the fruits of their labour creates a virtuous cycle of social care. The high level of autonomy is closely related to the comprehensive literacy of the residents. Traditional communities should utilize the internet to break down information and platform barriers, reducing the lag in the impact of new technology industries on living spaces. Initiatives should start from the needs of people, actively establishing a linkage between "industry, community, and individual." Physical architectural spaces can only fulfil functional requirements; participatory design is what breathes life into living spaces. Today's urban public management is moving towards a more people-centric direction, with management teams of living spaces shifting their focus from individual services to community building. They help more residents in need find their role and value, experiencing love, understanding love, and creating love while being self-reliant.(Figure 7)



**Figure 7.** How to build autonomous communities and resilient cities (Chart made by the author)

#### **IV. Conclusion:**

The future development of resilient cities is no longer confined solely to the traditional renovation and improvement of physical architectural spaces. Instead, it increasingly focuses on constructing a more human-centric social ecosystem. At the core of this social ecosystem lies intelligent management based on artificial intelligence algorithms and the cross-domain integration of diverse industries. The aim is to enhance the quality of life for urban residents and meet their ever-evolving needs.

As an author, I am currently working to facilitate self-care among urban residents through forest therapy and expressive therapy. In the future, my efforts will be dedicated to researching the co-creation of an art therapy system and urban development. Public health issues will continue to deepen in significance alongside the evolution of societal consciousness. An awareness of social design centred around love and healing will lead us towards a brighter future.

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# Empowering Sustainable Fashion Consumption: NurtureDenim Campaign for Generation Z Consumers Combines Digital Technology and Trend-Centric Elements

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## Abstract

Every second, large quantities of textiles are being disposed of in landfills or incinerated worldwide, necessitating changes within the fashion industry and the development of innovative business models. This study aims to examine the significance of consumer behavior patterns and consumption concepts in driving the implementation of sustainable fashion. Focusing on denim as the subject of investigation, a foresight plan called the "NurtureDenim Campaign" is proposed from a consumer-centric standpoint. This campaign seeks to engage young consumers and cultivate their positive perception of sustainable consumption patterns through the establishment of an online platform comprising the Low-carbon Selling Area, Remake Recycling Area, Interact Zone, and Cattle Farm. Furthermore, this paper employs a questionnaire-based empirical analysis, which demonstrates that the program effectively encourages Generation Z consumers to adopt sustainable fashion consumption behaviors. By bridging the gap between current "sustainable fashion" business models that primarily emphasize manufacturing while neglecting the consumer aspect, this study aims to provide valuable insights for both sustainable fashion practice and research.

## Author keywords

Sustainable fashion; sustainable business models; circular fashion; upcycling design.

## Introduction

5 million tonnes of clothing discarded each year in the European Union(EU), however, 1% of material in clothing is recycled into new clothing(EU, 2022). EU consumption of textiles has, on average, the fourth highest impact on the environment and climate change, after food, housing and mobility. It is also the third highest area of consumption for water and land use, and fifth highest for the use of primary raw materials and greenhouse gas emissions(EU,2022).The global fashion industry, driven by the 'fast fashion' business model has contributed to an increased volume of products with shorter life cycles(Stella Claxton & Anthony Kent,2020).However, when the next fashion trend comes along, these garments face the fate of landfill or incineration.

The Ellen MacArthur Foundation released its first report, Towards a Circular Economy: The Economic and Business Case for Accelerating Transformation, in 2012. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, re-manufacture, recycling, and composting(Ellen MacArthur, 2020). Since the concept of circular economy was introduced, circular economy models with different focuses have been proposed. It is clear that in the face of rapid climate change and environmental issues, the fashion industry is in dire need of more contemporary, low-carbon, consumer-accepted foresight plans. And this study focuses on the creative business model of sustainable fashion with denim as the

main focus.

### **Why denim ?**

inception in 1853, denim has always served as a non-verbal medium to explain various concepts and lifestyles in different contexts. Initially, denim was used as a workwear for miners and cowboys because of its durability and longevity; then it spread to the subculture of Western clothing as a symbol of freedom and rebellion; and later on, it became popular as a fashion item for all ages, classes and social identities due to the iconography of glamorous denim-clad movie and TV heroes and artists(C. Regan, 2015) . Nowadays, can denim play its role as a symbol of sustainable fashion?

Anyone who has seen the documentary *The Cost of Denim*(*Der Preis der Blue-Jeans*, 2012) will associate denim with unfair social labor and water pollution. Analyzed objectively, denim possesses characteristics such as wear-resistance and low maintenance, making it a material that can be worn for extended periods. Additionally, denim records the wearer's daily habits through its naturally formed "creases," "fading marks," and "holes," allowing denim garments to act as a means of self-expression. Furthermore, denim provides a solid foundation for innovative remake designs, including patchwork, tie-dye, and graffiti. From an industrial perspective, denim stands out as a single category with a vast audience, high production volume, and simple fiber composition, making it a powerful focal point for driving sustainable development in the textile and garment industry.

The initiative known as *The Jeans Redesign*(*The Jeans Redesign Insights report*, 2021-2023), introduced by the Ellen MacArthur Foundation, aims to establish a paradigm of circular economy jeans. This endeavor entails specific requisites such as enhanced utilization, remanufacturing capacity, and the incorporation of safe, recycled, or renewable materials. Correspondingly, MUD jeans, a Danish denim enterprise, has formulated a comprehensive ten-step course of action harmonized with the principles of circular economy(De Nardo & Enrica,2021). These encompass strategies pertaining to toxic-free production, transparent procedures, seasonless designs, and others. Both *The Jeans Redesign* and MUD jeans exemplify a shared emphasis on augmenting the manufacturing and product design processes to optimize denim recyclability and minimize carbon footprints. While it is also crucial to recognize that effectuating sustainable consumption necessitates a fundamental shift in consumer behavior and attitudes. However, challenges persist within the purview of *The Jeans Redesign* and MUD jeans initiatives, chiefly owing to limited consumer engagement and cognitive capacities.

Raw denim enthusiasts constitute the initial cohort of individuals who willingly engage in prolonged wear of denim garments for at least three to five years, despite the absence of a sustainability-driven motive. Among denim enthusiasts, there is a kind of belief that raw denim has to be "tortured" to get perfect fades(Rahmandani, F. & Sari, R. P. , 2020). Through the fade "break in" process, raw denim users create the best fades they can think of as a form of struggle and their personal unique story with raw denim. Inspired by the above case, *NurtureDenim* Campaign represents a groundbreaking business model that leverages the century-old heritage of denim apparel culture, whose primary objective is to utilize digital technologies and incorporate trends, entertainment, and personalization concepts to attract a larger cohort of Generation Z consumers into the community of long-term denim wearers.

NurtureDenim Campaign

NurtureDenim Campaign is implemented through a WeChat mini-program (A WeChat mini program is a lightweight application that can be accessed and used within the WeChat app itself), with the aim of promoting low-carbon fashion and targeting Generation Z consumers. To prioritize platform functionalities, the campaign incorporates the Kano model to classify consumer demands and assign priority levels. Based on the results obtained from applying the Kano model, the NurtureDenim Campaign consists of four sections: Low-Carbon Selling Area, Remake Recycling Area, Interact Zone, and Cattle Farm.

Low-Carbon Selling Area

Low-Carbon Selling Area is a platform that sells low-carbon denim clothing, addressing the challenge of limited availability on other e-commerce platforms. It connects sustainable manufacturers with consumers seeking eco-friendly products, ensuring reliability through certifications, sustainable labeling, and transparent production. Notably, all products have electronic labels for traceability.

Remake Recycling Area

Remake Cycling Area operates within the Customer to Manufacturing (C2M) model, whereby remake customization involves designing and manufacturing based on the user's original garment and delivering it back to the user(Fig 1). As such, remake customization does not necessitate measuring and pattern making processes, but instead focuses on creating new designs using the existing garment.

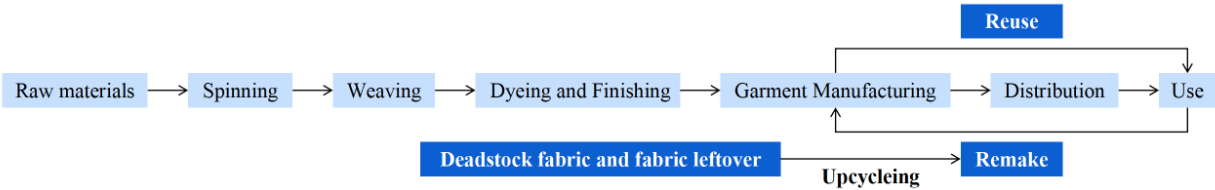


Figure 1. NurtureDenim campaign cycle flow.

Previous research has identified several reasons why consumers discontinue the use of denim clothing, including 24.63% citing damage or stains affecting normal wear, 50.32% finding the clothing pattern loose or ill-fitting, and 25.05% expressing dislike for outdated styles. Addressing these concerns is assumed to significantly prolong the usage cycle of denim clothing. Past experiences with denim remake, whether undertaken by consumers themselves or through offline stores, have often been accompanied by inconveniences such as unsatisfactory results, complex procedures, long distances, and the need for repeated communication. In response to these pain points, Remake Cycling Area has developed a modular customization system to streamline the consumer remake process(Fig 2).

Following the remake, 68.15% of consumers reported decreased urgency to purchase new clothing since their existing garments were being reused. Moreover, wearing remake clothing elicited positive perceptions among consumers regarding the prolonged use of denim clothing, including unique clothing personality, cost-effectiveness, enjoyment derived from the behavior, and the ability to share experiences with friends(Fig 3). These findings suggest that incorporating elements such as personalized customization, enjoyment, and trendiness can effectively enhance the appeal to Generation Z consumers.

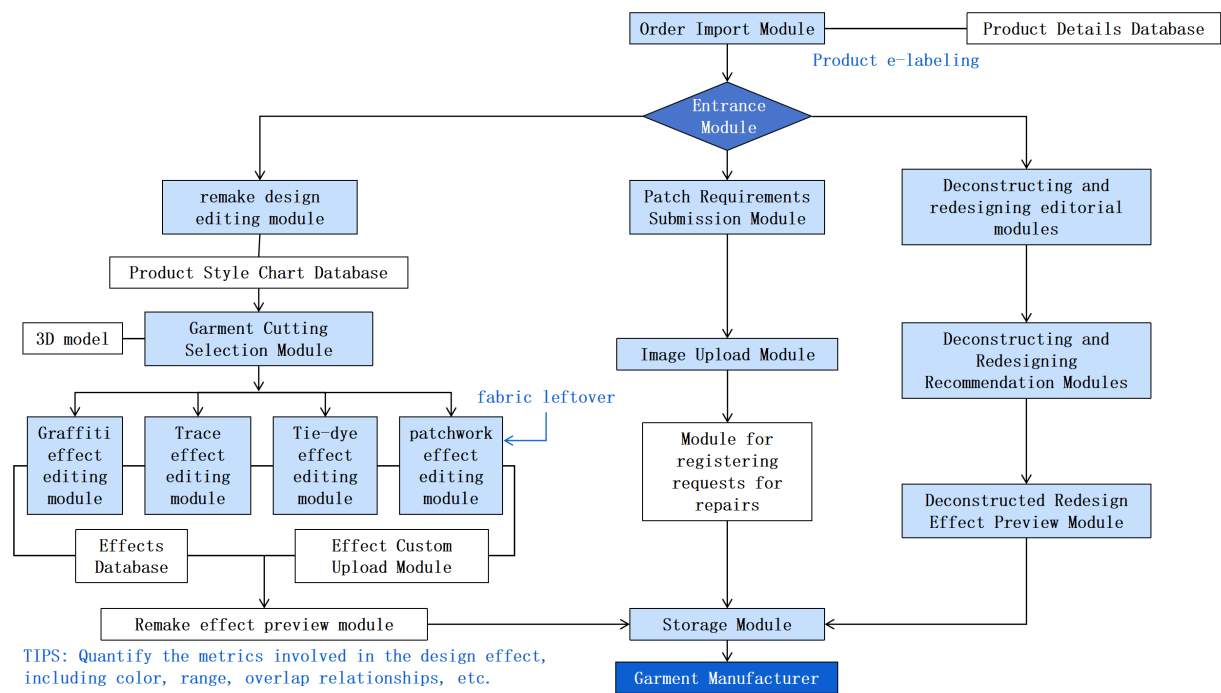


Figure 2. Remake customization system workflow framework diagram.

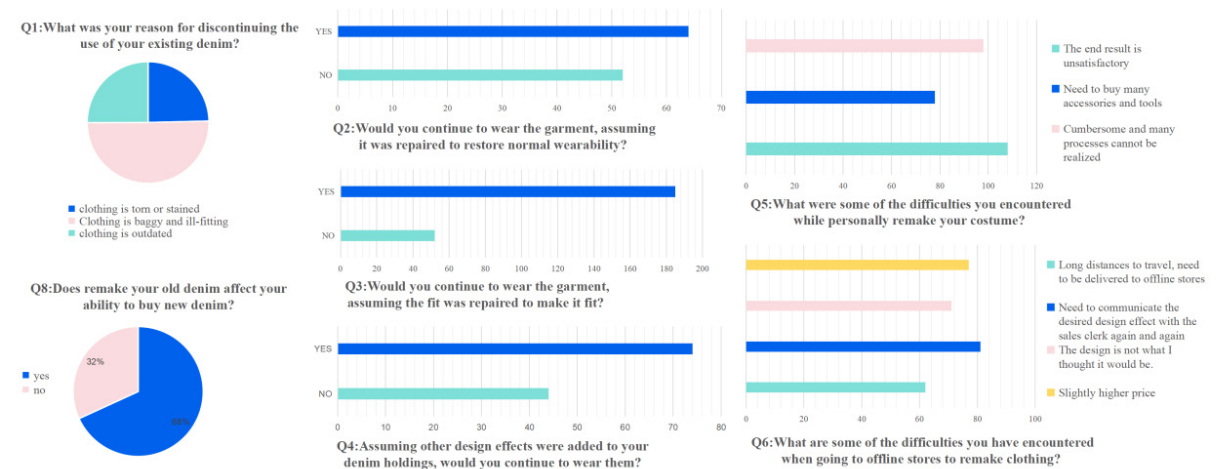


Figure 3. Questionnaire survey results.

Interact Zone

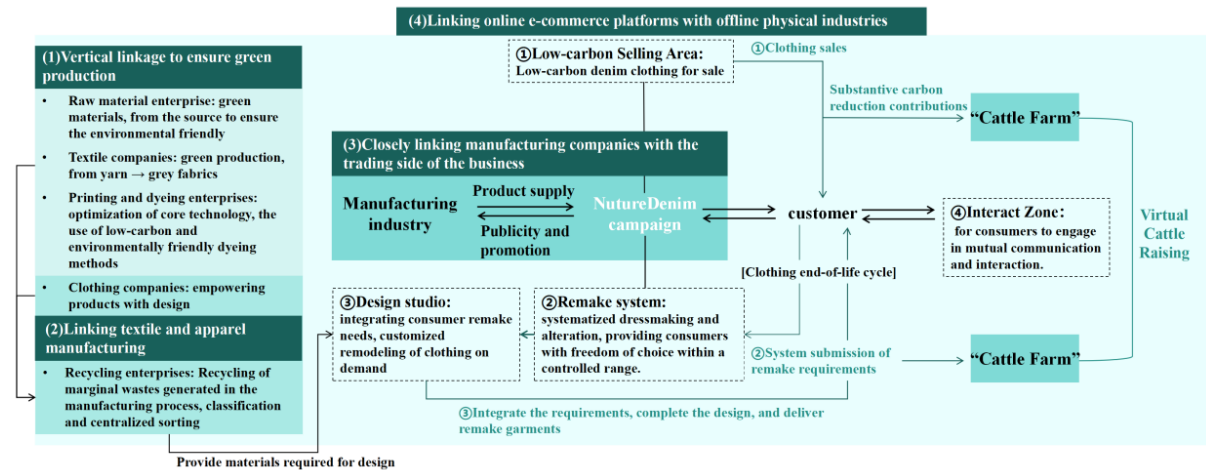
Interact Zone serves as a platform for consumers to engage in mutual communication and interaction. Under the NurtureDenim Campaign, individuals employ denim apparel as a medium to narrate their personal preferences and share interesting anecdotes related to wearing denim garments. Moreover, the Interact Zone actively promotes low-carbon lifestyles and introduces sustainable manufacturing processes, thereby instilling sustainable awareness among consumers and alleviating concerns regarding the reliability of the products.

Cattle Farm

Cattle Farm metaphorically represents the prolonged use of denim garments, mirroring the practice of



rearing cattle. The Cattle Farm quantifies the substantial carbon reduction contributions made by users in the NurtureDenim Campaign, including the purchase of low-carbon denim clothing and the recycling of old denim clothing, into feed for the growth of calves. As a result, users can receive positive feedback through the gamified experience of raising calves. Simultaneously, by enabling users to perceptibly apprehend the implications of their own carbon footprints, this experience prompts introspection and critical examination regarding their personal lifestyles.



**Figure 4.** NurtureDenim campaign framework flowchart.

According to Eunsuk Hur (2019), the implementation of sustainable consumption faces challenges at three levels: individual, social, and cultural. The NurtureDenim campaign addresses these challenges by offering remake design services that cater to the hedonistic desires of individual consumers, providing an Interact Zone for communication and interaction to foster a sense of belonging within social circles and alleviate peer pressure on the social level, and initiating a low-carbon fashion trend among Generation Z consumers, associating long-term denim wear with trendiness to resist the allure of fashion marketing strategies on the cultural level.

## Conclusion

This paper has elucidated the NurtureDenim sustainable fashion project in the context of denim apparel. Through the integration of digital intelligence, this project effectively fosters a semantic shift in contemporary denim culture, catering to the demands of young consumers and attracting a wider audience to engage with and explore these innovative initiatives. Moreover, with its implementation strategy emphasizing a seamless transition and practicality, NurtureDenim serves as a valuable conduit between the prevailing era of "fast fashion" and the impending transition towards a more ecologically conscious paradigm of "eco-friendly fashion".

NurtureDenim Campaign has established an internal test version platform and successfully collected over 1500 questionnaires. Drawing from the consumer perspective, this study conducts empirical research to confirm that interventions such as personalization, product electronic labeling, and gamification can effectively enhance Generation Z consumers' attention and stimulate their engagement in sustainable fashion consumption practices. The findings of this study provide valuable insights for the development of sustainable fashion strategies and low-carbon marketing initiatives.

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# Engaging with the Other: Participatory Curatorial Models, Weaving Perception, Action, and Relation to Confront Digital Biopolitics through Embodiment Performativity.

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## Abstract

This study responds to the survival challenges posed to all life in the era of artificial intelligence technological transformations. Examining the impacts of Intelligent Artificials and Artificial Intelligence, we explore the construction of a symbiotic model based on the "NARRATIVES OF LOVE —TOWARDS HEALING, TRANSFORMATION AND TRANSCENDENCE," delving into the opposing facets of love – loneliness and fear. Drawing from profound experiences in the life situations of East Asian women and the existential patterns entailed by becoming hostages to the AI era, the research confronts the intensifying individual competition driven by a new wave of technological revolution, potentially leading all life to the plight of being forsaken.

The study questions whether design and curation, utilizing AI technology and participatory curation models, can interconnect evasive and isolated individuals. The aim is to counteract digital biopolitics, touching the Other and conspiring for coexistence, rather than employing technology to oppress and expel collective life. The emergence of technology prompts a reevaluation of the essential differences between humans and machines, urging a shift towards an embodied perspective to reconstruct the Turing test for humans. To Confront Digital Biopolitics through embodiment performativity, the study seeks to construct a participatory curatorial model spanning from perception and action to connection.

## Author keywords

Participatory curatorial models; Digital biopolitics; Perception; Action; Relation.

## Introduction

This study aims to address a range of challenges faced by the contemporary curatorial field, including issues of exhibition inactivity, diminished real-world responses, collective public absence, audience homogenization, and a lack of dialogue with society. These challenges are largely influenced by the atomization of social experiences, leading to feelings of loneliness and fear, culminating in societal fragmentation. The primary theoretical foundation draws from the philosophical aesthetics debate on participatory art highlighted by the American scholar Claire Bishop. This study aligns with the "antagonism" pathway in the Social Turn (Bishop, 2006) of participatory and socially engaged art, supported by the "aesthetics of dissensus" proposed by the French philosopher Jacques Rancière. In the context of biopolitics, all life gradually finds itself in the precarious existence outlined by Judith Butler based on Agamben's notion of "Bare life."

Facing the new wave of automation technology, particularly artificial intelligence, propelling humanity into an

intensified individual competition within a marathon-like process of modernization, all life faces the prospect of becoming forsaken. This entails collective unemployment, societal exclusion, and a soft expulsion into invisibility, even to the extent of societal death, as a consequence of dehumanization techniques employed by mainstream society. Beyond becoming forsaken and excluded from mainstream discourse and socio-economic structures, individuals are left with self-exploitation and emotional exploitation, prompting exploration into alternative possibilities. The study questions whether design and curation, utilizing artificial intelligence and participatory curation models, can interconnect evasive and isolated individuals, counteracting the societal differentiation under the lens of digital-biopolitical perspectives. This inquiry seeks to engage with the Other and collaborate for coexistence, challenging the narrative of technology-driven oppression and expulsion of collective life.

### **Key Contributions:**

- The study shifts from the conventional emphasis on knowledge and information production in curatorial models to a progressive perspective encompassing perception, action, and connection.
- In the field of relational aesthetics, the study utilizes an embodied perspective to confront digital identity politics, thoroughly analyzing the power dynamics, identities, and political movements within social groups.
- The study contributes to the exploration of ways in which perception, action, and connection can counteract social loneliness and group fragmentation, constructing a participatory curatorial model based on embodied cognition to address identity and life politics.
- The research offers a supplementary response to the emphasis on knowledge production and value judgments in academic curatorial models, promoting innovation and transformation in curatorial practices to meet contemporary societal needs.

The "Participatory Curatorial Model" targets the masses potentially trapped in the survival predicament of forsaken existence, subjected to the biopolitical control of life and reduced to behavioral patterns within the data matrix landscape. The essence of the "Participatory Curatorial Model" lies in participation and connection. It serves as a sensory mobilization organizational model, addressing the core appeal of inner connection and extending outward as a motivation for societal cohesion.

The design of the "Participatory Curatorial Model" is rooted in generative curatorial models, utilizing general artificial intelligence applications such as AIGC. It is based on the performativity of embodiment, encompassing a participatory curatorial model transitioning from perception and action to connection.

Through "Participatory Curation," the author attempts to design participation patterns from levels of "perception-conscious subject" to "action-negotiation and resistance-conscious subject" and further to "connection-generating new subject." These participatory levels progress and mutually reinforce the individual socialization process, encouraging individuals to transition from perceiving and understanding emotionally and sensorially to taking action and forming connections. In a world still marked by isolation, division, fracture, and alienation, it is the awareness of the vulnerable and fragile nature of bare life and human flesh that compels us to assume ethical responsibilities toward others. Seeing the face of the Other, engaging with the Other, and seeking yet-to-be-healed boundaries.

The specific methodological model includes, in addition to conventional multisensory and multimodal integrated participation, various aspects such as atmospheric design in the field, generating events to construct situations,

sensory substitution based on the principles of brain plasticity, and expanding the realm of perception through biotechnology to coexist with the natural biological system. The study also explores how to create societal ripples from re-enacting scenes to eliciting social dynamics.

The author is dedicated to researching participatory curatorial models constituted by perceptual interaction, action patterns, and connection modes. The aim is to reconstruct the meeting status, dialogue relationships, and collective memories when audiences encounter creative and curatorial practices in various social metaphorical contexts.

### Engaging with the Other: A Practical Study of Participatory Curatorial Models in the Context of Biopolitics, Illustrated by the Virtual Exhibition "Sanctuary"

In the preceding sections, we introduced a multi-tiered participatory curatorial model designed to address challenges posed by social atomization and power dynamics and identity politics among groups. Now, we apply this model to an actual curatorial practice case study - the virtual exhibition titled "Sanctuary." Through this case study, we illustrate how to construct a participatory curatorial model, combating digital-biopolitics through embodied performativity, progressing from perception to action and connection.



**Figure 1.** Wang, Y., 'Sanctuary' Virtual Exhibition Concept, May 2023. Image generated by AIGC.

The final project for the virtual exhibition "Sanctuary" presents visualizations of the anticipated exhibition effects. The exhibition is divided into zones - "Ruin," "Matrix," and "Respite." Various media such as crowds, lighting, imagery, interactive installations, immersive landscapes, and behavioral patterns and performance modes, interventions, and events are utilized to create scenarios. The curatorial theme revolves around tears as the smallest unit of shelter self-constructed by the human body. Tears, being a universal language and connection method, are explored as a behavior of seeing the faces of others in empathy. Tears weave through our lives - from crying at birth to pivotal moments, joyous weddings, and mournful funerals. The curation traces these clues, from atmospheric design to generating events that construct scenarios.



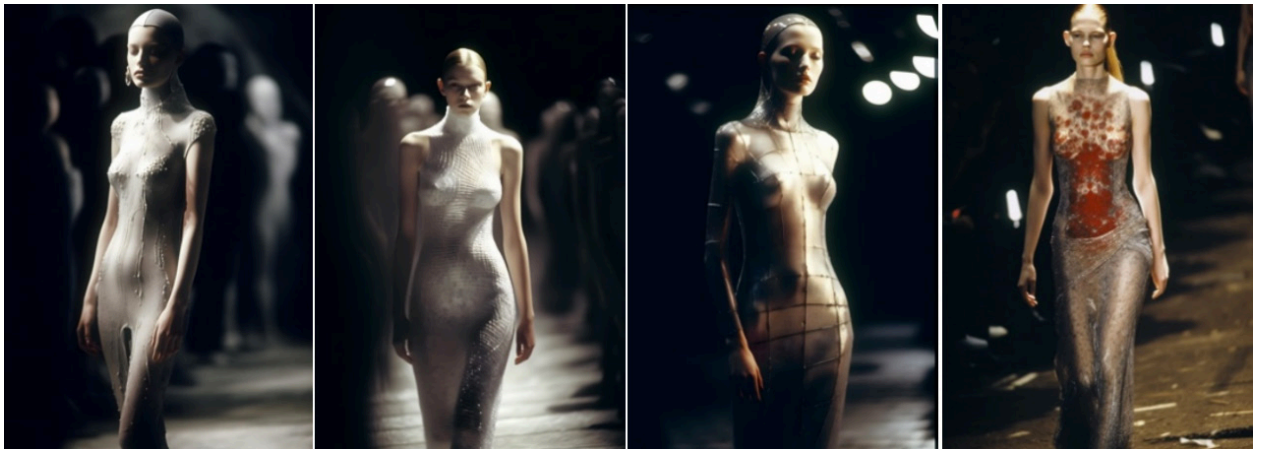
**Figure 2.** Wang, Y., 'Sanctuary' Virtual Exhibition Concept, May 2023. Image generated by AIGC.



The "Sanctuary" exhibition attempts to construct a shelter through the ritual of "tearing." Crying and shedding tears are presented as a collective ritual for individuals to return to calmness, bridging interpersonal relationships through tears, advocating from self-care to collective care, and ultimately to mutual dependence. Tears signify vulnerability and form an essential component in establishing connections among humans. Through multi-layered and deeply logical participatory embodied practices generated by embodied performativity, the study aims to acquire the intrinsic connections and interdependence in the survival state within the social context.



**Figure 3.** Wang, Y., 'Sanctuary' Virtual Exhibition Concept, May 2023. Image generated by AIGC.



**Figure 4.** Wang, Y., 'Sanctuary' Virtual Exhibition Concept, May 2023. Image generated by AIGC.



**Figure 5.** Wang, Y., 'Sanctuary' Virtual Exhibition Concept, May 2023. Image generated by AIGC.

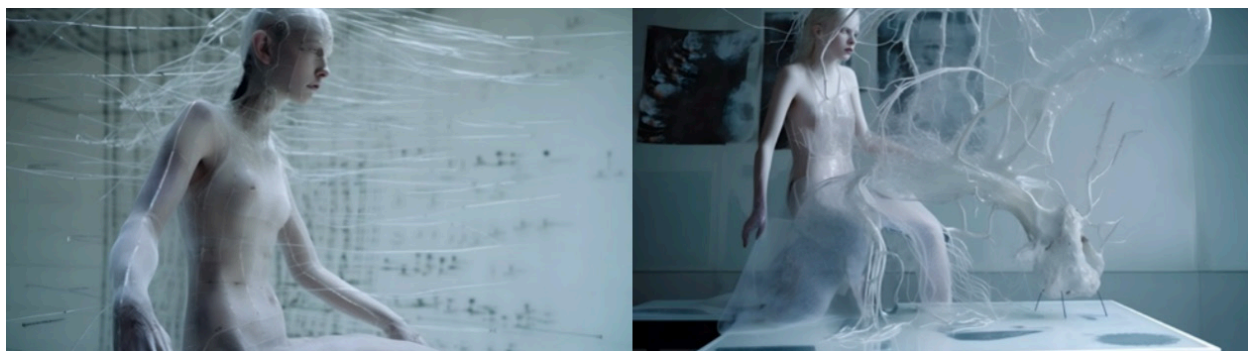
In this work, performers, who are everyday essential workers such as delivery personnel, security guards, and janitors, take center stage. These workers, like the air we breathe, become nearly invisible laborers when donning their work uniforms. In daily life, we tend to filter out their faces, obscured by the societal roles represented by



their uniforms - a form of segregation and expulsion, a form of societal loss of language. Following Levinas's logic, faces enable discourse and possibility. When we ignore their faces, we may be denying their social survival space. The study invites these workers, concealed by uniforms, to leave their familiar living spaces, enter public institutions such as museums and art galleries, spaces rich in tools reinforcing hierarchy, and encounter the conventional audience represented by the middle class. The endeavor aims to reclaim public institutions like museums and art galleries, which construct cultural identities and consolidate societal consensus, for all living individuals. It not only physically places the socially unseen Other in institutional spaces but also elevates their value on par with exhibits.

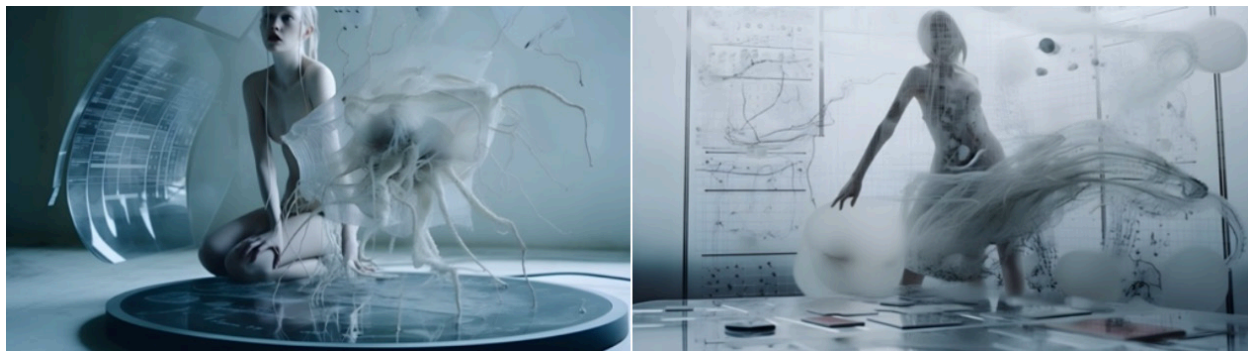
In the "Sanctuary" exhibition, the challenge is to make their faces visible, their voices heard, transitioning from a state of social silence to vocal expression and resonating with others. Performers, after removing their work uniforms and donning their regular attire, blend into the crowd. Both performers and participants remain unaware of each other's identities, connected by strings tied around their necks. Every individual has an equal right to vocalize through the strings' vibrations, creating a resonating echo when one speaks. Simultaneously, when an individual walks, moves, or crouches, it causes tension in the strings, creating discomfort, breathing impediments, and tearing sensations for other individuals. Collective action and collaboration require responsibility for the actions of others, a metaphor for our interdependent lifestyle.

Distinct from relational aesthetics, which tends to lean towards a post-colonial perspective, often centered around Euro-American institutional centrism, participatory curation, through embodied performativity, can be seen as an intervention against digital-biopolitics. It not only encourages independent thought and action among the audience but also endeavors to create temporary action communities, jointly exploring ways of coexistence. This can be viewed as a critique of the mass state, as it seeks audience autonomy and collective action, rather than passively accepting influences from elites or mobs. This model helps balance power relations among different groups in society, promoting the diversity and equilibrium of social order. In the face of challenges such as social division, political polarization, and information overload, participatory curatorial models using embodied performativity explore the metaphorical relationships between art, design, society, and politics. By embedding the masses in the framework of biopolitics and identity politics through participatory curation models, it awakens the sensory and bodily involvement of the audience, prompting them to transition from passivity to active participation, from individual actions to collective engagement.



**Figure 6.** Wang, Y., 'Sanctuary' Virtual Exhibition Concept, May 2023. Image generated by AIGC.

In the face of prevalent biases towards crying, tears have departed from everyday contexts and the implicit signals of empathy. They are obscured by gender biases, stereotypes, and structural deviations. Simultaneously,



**Figure 7.** Wang, Y., 'Sanctuary' Virtual Exhibition Concept, May 2023. Image generated by AIGC.

this departure aligns with the numbing survival state within the landscape of society, becoming a residual numb existence. Perhaps in the not-so-distant future, we might entirely lose the instinct to produce emotional tears, the instinct of empathy, and the courage to establish trust and connections with others.

Within the framework of the "Sanctuary" exhibition, the author envisions a future where crying and shedding tears become a scarce resource. To pursue the instinct of tears and the emotions and human nature it encapsulates, the narrative introduces a concept of cyborg enthusiasts and techno-determinists who believe in genetically modifying the body. This group gathers scientists, engineers, synthetic biologists, and other experts in the field of life sciences. They clone and genetically edit women who still possess the ability to shed emotional tears and keep them as precious research specimens in the Tears History Museum.

Through the collection of their tears, the scientists analyze the chemical composition and quality of emotional tears, continuously synthesizing biological genes for bio-iterations. These tears are then mass-produced for the market, where consumers hope to regain the ability to cry and metaphorically reconnect with their humanity. The synthetic tears produced carry the collective vulnerability of techno-determinists and the desire for technological advancements. The cloned female bodies, treated as farms, parallel the societal position of the weak, represented by women, in a capitalistic society that values strength. It echoes the plight of delivery workers trapped in algorithmic systems, using their physical bodies to fill the gaps in those systems.

The project intervenes from a perspective of technological ethics, aiming to rethink how we perceive the Other and establish connections with the surrounding world. The use of a technological ethics lens prompts reflection on the societal positioning of cloned individuals and the ethical implications of exploiting their tears as a commodity. This narrative challenges the boundaries of ethical considerations in a future where technological advancements may redefine the very essence of human experience.

## Conclusion

In summary, the integration of digital-biopolitics, relational aesthetics, bare life, and participatory curatorial models provides a new perspective for understanding social relationships and political dynamics. Through the revival of sensory mobilization, bodily participation, and collective memory, the model guides the audience from individual actions to collective engagement, building shared experiences, eradicating group differentiation, and dispelling the loneliness and fear dispersed among the masses. The core concept of this model is the "interpretation of love," filling the void in social connections through perception, action, and connection -

"Towards Healing, Transformation, and Transcendence."

### Acknowledgments

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## Research on the application of ceramic figures formed by clay tablets in ceramic art

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### Abstract

Clay tablet molding is a kind of molding technique widely used in contemporary ceramic art. It combines many kinds of expression forms of eastern and western ceramic art creation. The clay figurine is an art form of creating figure sculpture with clay figurine technique, in which the clay figurine is utilized and brought into play by the clay character and Clay language, at the same time, it shows the aesthetic value in accordance with the Chinese traditional culture, and its artistic effect is unique in many ceramic art forms, and has received a lot of attention and love. The creation technique of clay tablets and the meaning expressed in the works are similar to those of Chinese freehand brushwork, it emphasizes the aesthetic characteristics of drawing form by God, forming images with each other, coloring according to the category, using the Law from the nature, and pursuing the meaning beyond the image, the aim of this paper is to discuss the applied value of clay figure in ceramic art from my own feeling in the process of creation. Law from the nature

### Author keywords

clay tablet molding; figure; ceramic art

### Introduction

Ceramic art creation, as a creative form of artistic expression, requires the creator not only to have a more acute and profound feeling of ceramic art, but also to have a more novel and unique artistic concept, and more creative forms. The formation of ceramic art works has many different forms of expression, and the open comprehensive thinking is also an important factor to achieve an excellent work. As one of the molding methods of ceramics, clay sheet molding has different application scenes and performance characteristics in different periods. With the development of Chinese traditional ceramic art, the use of clay is becoming more and more skillful. The clay tablet molding technique developed from serving the practical application of the original pottery to mastering the clay tablet skillfully, and formed the red-tape decoration style in the later stage. At present, with the influence of modern art concept, artists begin to return to the characteristics of the material itself, through the traditional ceramic molding method of clay molding to explore, giving clay art a new look, the unique aesthetic language has been discovered. The clay tablet molding also transforms from a simple ceramic molding technique into a modern ceramic art creation method.



### The clay chip molding technique

ceramic is a man-made object with a long history, it has been accompanied by the progress of human civilization. The techniques and means of ceramic forming are very clear and systematic in the different stages of ceramic history. There are various methods of ceramic molding, there are: wheel method (Fig. 1) , Coil method (Fig.2) , Clay tablet method (Fig. 3) , kneading method (Fig.4) , mold molding method (Fig.5) , 3D printing molding (Fig.6) and so on. Different ceramic molding techniques have different applicable scenes, serving the production of different ceramic works.



**Figure 1.** Wheel method



**Figure 2.** Coil method



**Figure 3.** Clay tablet method



**Figure 4.** kneading method



**Figure 5.** mold molding method



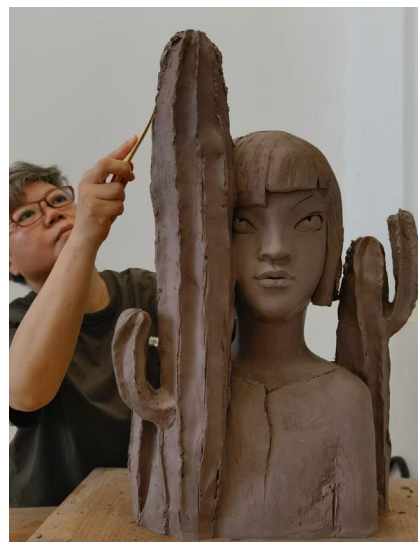
**Figure 6.** 3D printing molding

As one of the important ceramic molding techniques, sliver molding method can be traced back to the Neolithic age. The clay tablet molding method originated from the actual needs of the ancestors. From the unearthed artifacts, most of them are living pottery. Although the extant archaeological documents and evidence can not restore the original pottery scenes at that time, and there are differences on the original appearance of the prehistoric pottery scenes, however, the unearthed pottery pieces still give us a reference on the origin time of clay tablets molding technology. In addition to its use on earthenware, the clay can also be seen in large sculptures such as the armour of the terracotta warriors (Figure 7) . In the song and Yuan dynasties, the application of clay tablet forming technology in ceramic sculpture became mature, and some works appeared, such as sitting statue of Kuanyin (Figure 8) , statue of Kuanyin, etc. . It can be seen that in the development of ceramic technology, the clay forming techniques developed from simple collage and bending on utensils to skillfully using, imitating and gradually forming a cumbersome decorative style in the later stage, after the low-level to high-level, rough to fine transformation process.

### **Figure Clay tablet molding technique in ceramic art form**

In the clay sheet molding technique, the clay sheet curl molding method is relatively more flexible and free, and also easy to combine with other molding techniques. In the space sense and modern sense of ceramic art works, clay sheet curl has its unique language charm. The clay sheet curl molding has a relatively independent artistic expression in the clay sheet molding. The manufacturing technology of clay sheet curl molding is different from other ceramic molding methods. The roll-up of the slime needs to start from the kneading and processing of the whole slime, first of all, in the process of mixing and processing the slime, according to the degree of softness and hardness of the slime itself, carry on a moderate processing to the dry humidity of the mud material. Secondly, in the process of slime forming, there are certain requirements for the softness and viscosity of the slime, which need to reach certain standards in the treatment of the slime. Then, in the process of clay sheet curl molding, it is necessary to use cutting, curl, paste and other performance techniques to shape the body for decorative treatment. Especially in the production of relatively complex characters, the first need for the creator to figure structure, perspective of the three-dimensional space have a certain understanding, but also need to figure facial expression effect decoration, even with the help of make-up clay or glaze to be auxiliary treatment, in order to highlight the physical characteristics of the work as well as its own material advantages, make the work more vivid and natural.





## Conclusion

To sum up, the creation phenomenon of ceramic figure sculpture by clay piece shows two kinds of aesthetic interest: freehand expression and concrete expression. Freehand expression tends to play clay abstract and flexible modeling ability, release the personality of clay and retain the natural texture of clay, the image space of “Likeness and unlikeness” and the ideological spirit of “The unity of heaven and man” are pursued in the creation, while the concrete expression tends to realize the balance between technique and clay, and has a strong purpose in the use of clay tablets for modeling, it presents a more rational and professional beauty of realistic meaning, and has the artistic effect of both spirit and form. But generally speaking, no matter which kind of expression form, the image style and artistic language of the ceramic figure sculpture formed by clay show the unique Chinese traditional aesthetics, such categories as “Tao”, “Miao”, “Image”, “Qi Yun” can be found in many works, reflecting the unique views of domestic artists on clay art, and different from the aesthetic system of Western art, modern ceramic art concept and the combination of local traditional culture is an excellent model.

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# Unveiling New Horizons in Chinese Environmental (Art) Design Education through Design Thinking Transition: A Case Study on the "Design Your Campus" Workshop

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## Abstract

From the 1950s through the 21st century, the design field has seen pivotal shifts encapsulated in five distinct trends, transitioning towards strategy, intangible values, and interdisciplinary collaboration, with a profound emphasis on "Design Thinking (DT)" (Lou, 2017). This research, drawing upon the frameworks of Corss (2023) and Johansson - Sköldböck (2013), systematically categorizes design thinking into three distinct paradigms. Addressing Chinese Environmental (Art) Design Education (CEADE), the research highlights the outdated primacy of interior decoration, underscoring the need for reform towards a more holistic, forward-thinking approach emphasizing interdisciplinary cooperation and societal responsibility. Using the "Design Your Campus (DYC)" workshop at the Beijing Institute of Fashion Technology as a case study, the research illustrates the transformative potential of collaborative learning in molding "design-driven innovators." Echoing the inclusive principles of Mah ā y ā na Buddhism (大乘佛法), the research advocates for an expansive

application of design thinking, envisioning it as a pivotal tool to address complex societal challenges, championing a renewed, comprehensive perspective in design thinking, enriched by the spiritual universality intrinsic to Mah ā y ā na Buddhism's doctrines.

## Author keywords

Design thinking; Chinese environment (art) design education; Spatial design education; Design-driven innovator; Mah ā y ā na Buddhism

## Introduction

Over the decades, the design paradigm has transitioned from "style creation" to "design-driven innovation", experiencing five significant trends that reposition design as a driver of innovation (Lou, 2017; Kimbell, 2011; Buchanan, 1992). In China, the Environmental (Art) Design discipline, originally rooted in interior decoration, has expanded its purview to include a holistic understanding of indoor and outdoor spaces, integrating urban planning, architectural, landscape, and furniture design (Zheng, 2019; Yu, 2020; Song, 2020). Yet, with evolving societal demands, there is a growing emphasis on interdisciplinary skills, collaborative innovation, and social responsibility in design, rather than mere aesthetics (Piotrowski, 2013). Addressing these "wicked problems" necessitates a transformation in design education, particularly within the CEADE curriculum (Rittel & Webber, 1973).

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interdisciplinary DT3 (table 1). This research addresses DT's ongoing transformation and underscores its journey towards a cross- disciplinary essence pivotal for 21st-century challenges.

The academic realm recognizes DT as a robust tool beyond mere aesthetics, incorporating it as a unique cognitive approach in education (Dell'Era et al., 2020). Global educational initiatives, exemplified by partnerships like the Global Innovation Design project, harness DT, amalgamating creativity, business, and engineering. These initiatives emphasize holistic, interdisciplinary learning, preparing designers for intricate real-world scenarios (Lou & Ma, 2015). Contemporary studies stress the need for a paradigm shift in design education, advocating for adaptability and social responsibility in response to evolving global challenges (Meyer & Norman, 2020; Friedman, 2019).

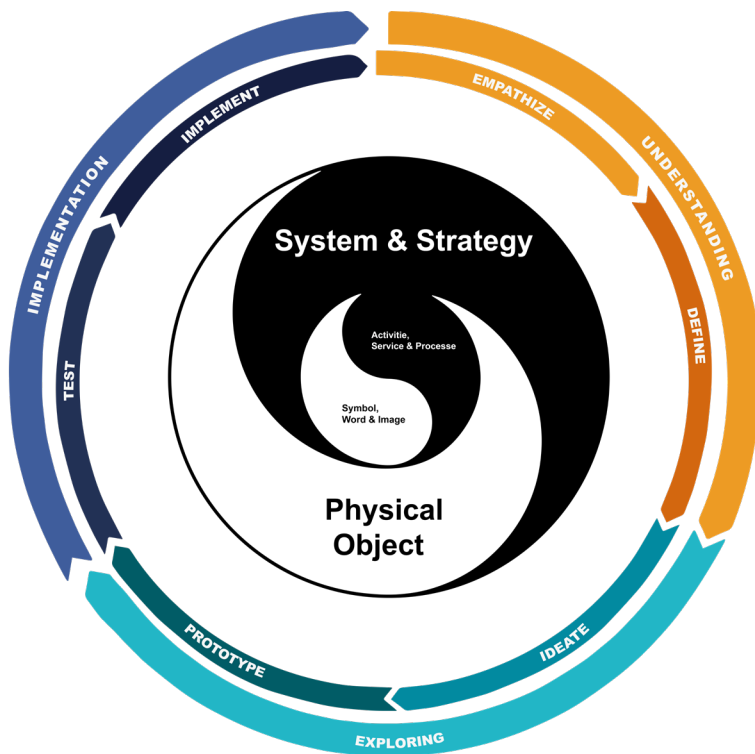
**Table 1.** 3 visions of DT.

Name	Note	Description
DT1	Also called Designerly thinking (Johansson-Sköldberg et al., 2013), original version of Design Thinking	This version of DT focuses on the academic development of a professional designer's practice, encompassing their practical skills, competence, and the theoretical reflections surrounding the interpretation and characterization of their non-verbal abilities. Designerly thinking bridges the gap between theory and practice from a design perspective, rooted in the academic field of design (Johansson-Sköldberg et al., 2013).
DT2	Simplified version of 'designerly thinking ' (Johansson-Sköldberg et al., 2013) grand version of Design Thinking	In this interpretation, the term "design thinking 2" is used specifically when design practice and competence are applied beyond the traditional design context, including areas such as art and architecture, to collaborate with individuals without a scholarly background in design, particularly in management. DT can be seen as a simplified version of "designerly thinking" or a way to describe a designer's methods integrated into an academic or practical management discourse (Johansson-Sköldberg et al., 2013).
DT3	based on design thinking1 (Nigel Cross, 2023)	This new version could extend DT out of the making paradigm of professional design practice, towards a competency, a way of thinking and working that embodies a broader form of strategic, adaptive, co-operative intelligence for engaging with wicked problems (Nigel Cross 2023).

However, Design thinking's role in spatial design education is a relatively untapped field with scarce literature and research. In his 2018 doctoral research, Pham Tu Ngoc argued that conventional models fail to capture the

intricate interior design process, leading him to establish a design thinking-based educational methodology recognized for its human-centric, cross-disciplinary, problem-solving, and exploratory traits. In 2019, Annalinda De Rosa identified fresh challenges in spatial design due to global shifts, promoting a "space + service" cross-disciplinary strategy. This strategy affirms Muratovski's 2016 claim that modern design extends beyond physical entities to designing systems, strategies, and experiences. Moreover, in recent years, Tongji University's DESIS group has fused spatial design with social innovation theories by Ezio Manzini (2015), implementing several community micro-renewal projects in Shanghai, including "NICE 2035" and "Open Your Space". They've also contributed to the creation of several FabLabs in the Tongji neighborhood, collaborating with institutions like the MIT MEDIA LAB, Aalto LAB from Finland, and Aston Martin LAB.

Over its seven-decade trajectory, the CEAD has evolved significantly, delineating a shift from a focus on art pieces and murals (1956-1978) to embracing broader infrastructure designs and current space-based social innovations, with a profound influence from China's socio-political landscape (Zhang, 2019; Zhen, 2019; Song, 2020). Officially termed "environmental design" by China's Ministry of Education in 2011, it fosters the integrated study of diverse environments aiming to optimize human habitats, despite the ongoing discourse balancing "art" and "design" in its descriptor (The 6th Discipline Evaluation Group of the Academic Degrees Committee of the State Council, 2013; Cai, 1999). The field, mirroring global spatial design trends, urges graduates to pursue careers in spatial and interior design, and architecture (Zhang, 1986; Song, 2020). Nevertheless, it confronts dilemmas like the lack of a distinct paradigm, ambiguous focus, and a fragmented academic landscape, accentuated by historical and cultural differences within the Chinese context (Winch, 1958; Kuhn, 1962; Yu, 2020; Lou, 2019; Song, Yu & Li, 2019; Che, 2022; Cai, 1999).



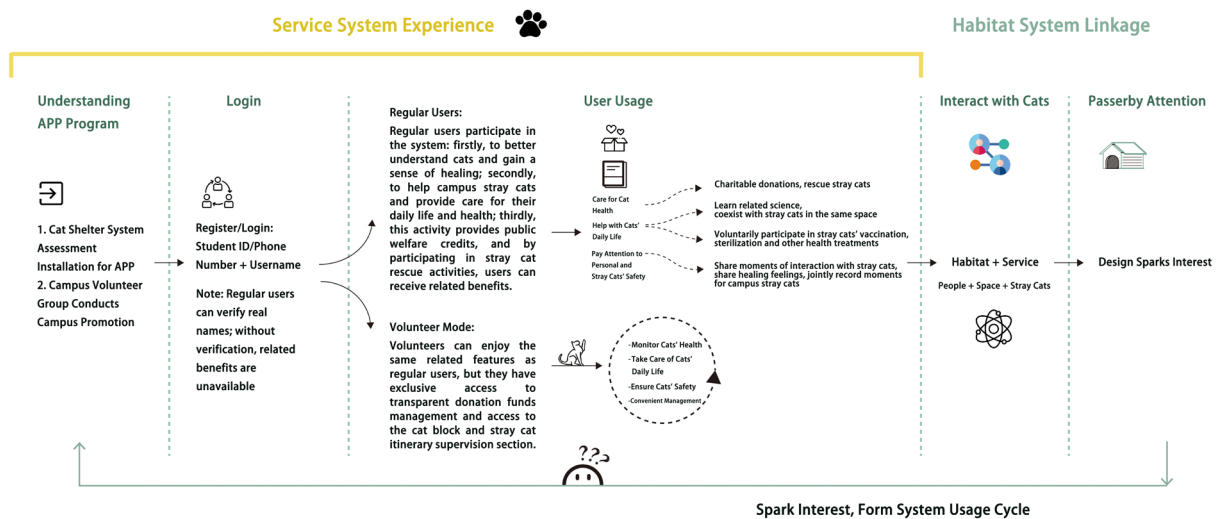
**Figure 2.** New concept and process model of CEAD



Building on this historical backdrop, the author (2023) revisits the term "Environmental (Art) Design" offering a deeper understanding rooted in the unique linguistic nuances and traditional Taiji philosophy prevalent in the Chinese cultural context. The new model (figure 1) conceptualizes design not as isolated elements but as a harmoniously intertwined and continuously evolving entity, emulating the principles of Yin and Yang, which denote the material and immaterial elements, respectively. It showcases an alignment with Buchanan's four-order design model formulated in 2001, which categorizes design into symbols, physical objects, activities, and systems, promoting a vision of symbiosis and transformation that can potentially guide the future trajectories of the CEADE in a way that honors its foundational philosophies while innovating for the contemporary era.

### “Design Your Campus” Workshop

During the four-day "DYC" workshop, three interdisciplinary groups aimed to improve campus environment and lifestyle through new environmental design concepts, emphasizing user needs and sustainable solutions. Focusing on Group B's initiative (figure 2), they devised a multifaceted approach to the stray cat issue on campus, intertwining online and offline resources to foster a symbiotic human-animal environment. The project proposed an integrated strategy featuring smart shelters and safety systems, highlighting a deep understanding of the “physical + non-physical” design object, rooted in community engagement and stakeholder needs.



**Figure 3.** Stray cat campus service system + habitat system design (completed by Group B)

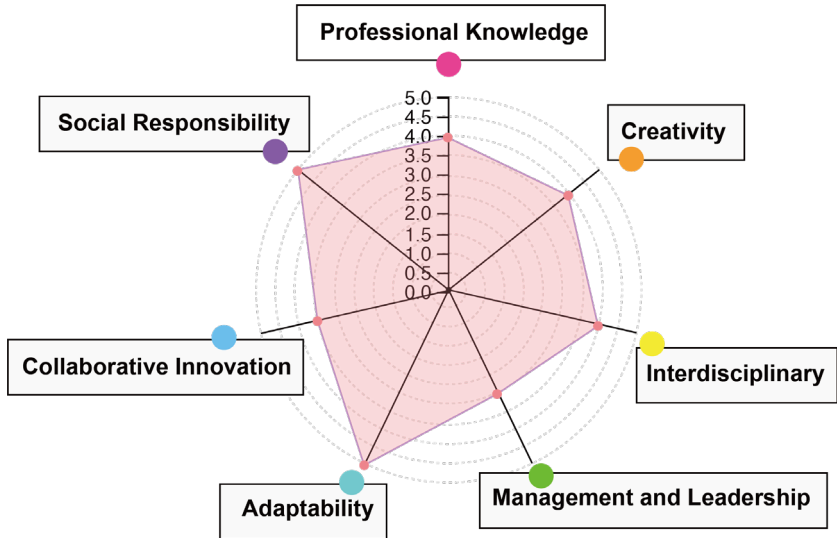
During the final stage of the workshop, the author designed a questionnaire distributed to over 10 experts for project evaluation based on seven competencies (professional knowledge, creativity, interdisciplinarity, management and leadership, adaptability, collaborative innovation, and social responsibility). The results were visually represented using a radar chart with "spiderweb lines" extending from the center, representing different competence levels (figure 3).

For Group B's campus stray cat project, the scores were as follows: professional knowledge (3), creativity (5), interdisciplinarity (5), management and leadership (3), adaptability (3), collaborative innovation (4), and social responsibility (5). A deep analysis of these scores highlighted the project's strengths in creativity, interdisciplinarity, and social responsibility, achieving the highest score of 5 in each. The project also performed

**Table 2.** Workshop details.

Target	The workshop leveraged the familiar campus environment as an exploratory ground, aiming to identify and address complex issues embedded in the daily academic lifestyle. This endeavor not only represents a pilot reform in environmental design education but also heralds an innovative educational strategy that shifts away from the traditional "outcome-oriented" teaching methodology to emphasize systemic "DT".
Group B. Stray Cats Habitat and Service System Design	Stray cats represent a complex systemic issue. While many people appreciate their cuteness and vitality, the severe conditions they live in are often overlooked. Despite the joy they bring, stray cats can pose significant safety and hygiene risks. The group's campus research connected stray cats to healing and raised concerns about their living conditions and their impact on the environment. Addressing health, survival, safety, and management issues of the cats, they created a sustainable online-offline integrated habitat + service system. Collaborating with campus cat enthusiasts, they established an interactive system for transparent philanthropy, sharing, and virtual cat adoption coupled with physical habitats, aiming to supervise and aid the stray cats adequately.

well in collaborative innovation with a score of 4. However, there was room for improvement in professional knowledge, management and leadership, and adaptability, each scoring 3. To enhance the overall project quality, it was suggested that group B augments their expertise in the respective fields, improve project management strategies, and boost adaptability and flexibility. Despite the areas for improvement, the project established a strong foundation with potential for reaching higher standards through continued effort.



**Figure 4.** Group B’ s 7-compency assessment radar chart

## Discussion and Conclusion

In the evolving landscape of DT transformation, this research engages with Friedman's 11 designated design challenges to underline the imperative of endowing contemporary designers with seven pivotal competencies. The investigation utilizes an empirical case study strategy to authenticate the approaches proposed in the nascent paradigm of CEADE, extracted from prior academic explorations. The innovation heralded by the nascent CEADE framework in the Chinese context can be summarized as follows:

1. It centralizes a design-centric methodology, cultivating an interdisciplinary, systematic, and fresh perspective that ventures beyond the established paradigms of architecture and art-driven philosophies, thereby filling a conspicuous void in the discipline's central tenets.
2. While traditionally seen as a pronounced vulnerability, the expansive and somewhat ambiguous borders of CEADE can be harnessed as an asset, allowing for a greater level of openness and converting known weaknesses into potential strengths through the embracing of its inherent fluidity and uncertainty.
3. Despite the persisting deliberations regarding the segregation of design as an independent discipline and the complications accentuated by the superficial diffusion of DT2, the nascent CEADE posits itself firmly within the spatial design sphere. This commitment not only validates its disciplinary locus but facilitates synergistic and collaborative advancements with allied academic realms.
4. Moreover, the study facilitates an enriched understanding of the divergent discourse around design thinking — a debate still vibrant in scholarly circles. The discussion leverages the insights of Cross (2023) and Johansson (2013), adopting three different lenses to DT, each finding a parallel in the dichotomous interpretations of ancient Indian Buddhist philosophies. The narrative further intertwines with the metaphoric reference to the Chinese epic "Journey to the West ( 西游记 )", contemplating the transformational journey of DT, akin to the Buddhist doctrinal shift from Theravada ( 小乘佛法 ) to Mahayana ( 大乘佛法 ).

Projecting forward, it is anticipated that DT3 will act as a linchpin for fostering a wider and more efficacious platform for interdisciplinary collaborations, mirroring the inclusive vision of Mahayana Buddhism. This anticipatory vision hinges on the potential of DT3 to arm designers with a comprehensive lens, thereby enhancing their capacity to address expansive and intricate societal dilemmas, echoing the universal essence encapsulated in this philosophical doctrine.

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