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Craft-Based Methodologies in Human–Computer Interaction: Exploring Interdisciplinary Design Approaches

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Abstract: Craft-based methodologies have emerged as a vital human-computer interaction (HCI) approach, bridging digital and physical materials in interactive system design. This study, born from a collaboration between two research networks focused on affective design and interaction design, investigates how diverse professionals use craft-based approaches to transform design processes. Through carefully curated workshops, participants from varied backgrounds worked to identify specific problems, select technologies, and consider contextual factors within a creative framework. The workshops served as a platform for observing participant behaviors and goals in real-world settings, with researchers systematically collecting data through material engagement and visual problem-solving exercises. Drawing inspiration from concepts like Chindogu (Japanese "unuseless" inventions), the research demonstrates how reframing interaction design through craft-based methodologies can lead to more intuitive and contextually aware solutions. The findings highlight how interdisciplinary collaboration and sustainable and socially responsible design principles generate innovative solutions that effectively address user requirements. This integration of creative frameworks with physical and digital materials advances our understanding of meaningful technological interactions while establishing more holistic approaches to interactive system design that can inform future research directions in the field.

Keywords: human-centered computing; interaction design process; user-centered design methods; human–computer interaction; craft; rich pictures; makers; sustainability

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1. Introduction

Craft-based approaches have emerged as a dynamic research method in human–computer interaction (HCI), where probes serve as tools to comprehend users' experiences, needs, and behaviors through tangible, handmade artifacts. As Dormer points out, contemporary craftsmanship transcends mere handicraft; it embodies knowledge that empowers makers to take command of technology, even as digital tools become increasingly central to craft processes [1].

In terms of sustainability, HCI researchers and practitioners are increasingly employing methods that engage users and promote ecological responsibility. This research focuses on two methods—rich pictures and maker practices—investigating their potential to enhance sustainable design processes that account for environmental, social, and economic impacts.

The intersection of art, design, and HCI provides a productive ground for exploring new creative forms. As digital technologies permeate modern art practices, designers and artists are embracing craft-based methods and Chindogu principles to create interactive installations that challenge traditional ideas of utility and user interaction.

This paper explores the relationship between craft, makers, and HCI through two detailed case studies. The research investigates how craft-based probes can inform sustainable, user-centered design processes, presenting findings that enrich our understanding of creative problem-solving within technological contexts.

2. Theoretical Framework: Understanding Maker Practices, Rich Pictures, and Chindugo in HCI and Sustainable Design—A Literature Review

In this section, I will explore the key concepts underpinning my research, focusing on three fundamental approaches, maker practices, which emphasize hands-on creation and participatory design in digital and physical contexts; rich pictures, a visual methodology that helps capture complex systemic relationships and stakeholder perspectives; and Chindugo practices, all within the intersecting domains of human–computer interaction (HCI) and Sustainable Design. These conceptual frameworks have been strategically chosen to investigate how participatory methods, visual representation, and traditional practices can enhance our understanding and development of sustainable interactive systems. By examining these approaches, I aim to establish a theoretical foundation that bridges technological innovation with sustainable design principles while referring to diverse methodological traditions.

2.1. Maker Practices in HCI and Sustainable Design

The intersection of maker practices and human–computer interaction (HCI) has emerged as a significant area of research, particularly in sustainable and user-centered design. Maker practices, deeply rooted in the "do-it-yourself" (DIY) philosophy, have become fundamental to modern design approaches, emphasizing hands-on experimentation and collaborative creation [2]. This movement has transformed traditional design paradigms by enabling users to actively participate in and control the design process, leading to more personalized and sustainable outcomes [3,4].

The integration of maker practices into sustainable design offers numerous advantages. Users can experiment with eco-friendly materials and techniques, developing innovative solutions that reduce environmental impact. This approach empowers individuals to create personalized, meaningful products with extended lifespans [5]. Furthermore, the collaborative nature of maker practices facilitates interaction among users, designers, and stakeholders, fostering a collective commitment to sustainable outcomes. Recent research has demonstrated that these practices significantly enhance user engagement and create a stronger sense of ownership over the design process, ultimately supporting sustainability goals [6–8].

Critical making, as conceptualized by [9], provides an essential bridge between theoretical frameworks and practical design implementation. This approach has been particularly influential in developing interdisciplinary methodologies that combine digital fabrication, user-centered design, and creative problem-solving. Research by [10] has shown that collaborative maker practices substantially improve technological literacy while promoting more inclusive design strategies. These findings complement growing evidence that craft-based research approaches in HCI can produce more meaningful and contextually aware technological solutions [11,12].

The synthesis of maker practices with HCI methodologies represents a fundamental shift from conventional design approaches. When professionals from diverse fields—including the arts, sciences, and social sciences—collaborate using maker-oriented techniques, they generate more innovative and user-centered design solutions [13,14]. This interdisciplinary approach has proven particularly effective in addressing complex sustainability challenges while maintaining a strong focus on user needs and preferences [15].

2.2. Rich Pictures in HCI Research and Practice

Rich pictures have emerged as valuable tools in HCI research and design, offering a systematic yet flexible approach to understanding complex socio-technical systems. Originally developed as part of Checkland's Soft Systems Methodology (SSM), [16] rich pictures have evolved into an essential technique in participatory design and user research within HCI. These visual representations enable researchers and practitioners to capture the intricate relationships between people, processes, and technologies in ways that traditional documentation methods often cannot achieve.

The application of rich pictures in HCI has proven particularly effective in several key areas. First, they serve as powerful communication tools during the requirement-gathering phase, helping stakeholders visualize and understand complex system interactions [17]. Recent studies have shown that rich pictures facilitate more effective stakeholder engagement and problem identification compared to conventional documentation methods [18,19]. For instance, Berg and colleagues demonstrated how rich pictures enabled design teams to identify hidden user needs and system constraints that were not apparent through traditional interview techniques. Studies by Williams et al. [20] highlight how these visual tools can transcend language barriers and cultural differences, making them especially useful in global technology deployment scenarios. The technique has been successfully adapted for various contexts, from healthcare system design to educational technology development [20].

The integration of rich pictures with maker practices and sustainable design has created new opportunities for participatory design. Recent research indicates that combining these approaches enables a more comprehensive understanding of user needs while facilitating creative problem-solving [21]. In the context of sustainable crafting, rich pictures are instrumental in uncovering technical requirements and environmental and social considerations that might otherwise be overlooked in traditional design approaches [22]. By enabling users to visualize their needs, concerns, and interactions with a system, rich pictures facilitate a deeper understanding of the sustainable impacts of design choices.

In this research, it is shown how designers successfully mapped complex ecological relationships and material lifecycles using rich pictures, leading to deeper insights into environmental impacts. The maker practices component enabled these communities to experiment directly with sustainable materials and circular design approaches, moving beyond theoretical concepts to practical implementation. These case studies demonstrated how the synthesis of rich pictures and maker practices bridges the gap between environmental principles and practical implementation, resulting in products and systems where sustainability is seamlessly integrated into core functionality and user experience.

2.3. Chindogu and Maker Practices: Relationships and Inspirations in Interactive Design

Chindogu can be considered a conceptual tool. Chindogu, the Japanese art of creating "unuseless" inventions, offers an intriguing perspective on the relationship between creativity, play, and utility in design. These inventions, often humorous or absurd, aim to solve everyday problems in impractical or exaggerated ways [23]. While they might not be intended for mass production or practical use, the philosophy behind Chindogu resonates deeply with maker practices, particularly in the context of interactive installations and user-centered design.

Maker practices, rooted in the "do-it-yourself" (DIY) culture, encourage hands-on experimentation and the creation of objects that are often personalized, unique, or adapted to specific needs. Like Chindogu, maker culture values creativity and the process of making as much as the final product. Both approaches share a focus on problem-solving and

play, allowing creators to explore unconventional ideas that may push the boundaries of conventional design thinking [24].

In this sense, Chindogu serves as a form of creative prototyping in the realm of maker practices. It encourages designers to embrace failure, imperfection, and absurdity as part of the design process, which can lead to unexpected innovations in interactive installations. By thinking beyond functional or commercial constraints, both Chindogu and maker practices foster a playful, experimental environment where new interactions and user experiences can emerge.

3. Craft-Based Probes as Platforms for Conceptual Development Makers

Sustainable practices and user-centered design are becoming key elements in human–computer interaction (HCI). With growing environmental awareness, HCI experts are adopting methods that involve users and promote ecological responsibility.

Rich pictures and maker approaches are gaining popularity, offering unique opportunities for designing sustainable products and services. Craft-based techniques allow designers to explore the physical and sensory qualities of materials, enhancing user experiences.

Craft-based probes are initial physical items used to test new ideas and gather insights on user interactions [25]. These probes emphasize making and materiality, enabling design improvements. Understanding the physical aspects of materials helps designers enhance the tactile experience of interactions [26].

Craft knowledge and design experience are essential in HCI, aiming to improve how humans interact with computers [27–29]. Raune's model for handcraft-based projects considers the entire research process, highlighting the interaction between artifacts and the outside world to generate valuable qualitative data through craft-based HCI probes [30].

Table 1 shows examples of methods and tools as components of the described research process. These elements enable the exploration of users' experiences in a hands-on, creative manner, eliciting rich, qualitative data [31].

Table 1. Craft-based probes emphasis.

Methods	Tools	Paradigms
Artifacts include probe, wood, fabric, etc	Scissors, paper, sewing, kits, glue, etc. (hands-on. . .)	Participatory design.
Sensitivity	Affordances (different meanings and intentions)	Collaboration.
Tactile and sensory qualities. (Evoke memories and emo-tions)		Co-creation.
		Qualitative inquiry

The Maker of the Practices: The term "maker practices" in the context of HCI refers to the activities and methodologies associated with the maker movement and its intersection with HCI [32,33]. The maker movement is a cultural trend that involves individuals or groups of people creating and designing things using various tools and technologies, often emphasizing DIY (do-it-yourself) and DIWO (do-it-with-others) approaches [34]. In the presented studies, the makers were professionals with different backgrounds who intended to present their ideas for research in the field of HCI. In the context of HCI, maker practices can be relevant in several ways:

Prototyping and User-Centered Design: Makers often create prototypes and tangible interfaces, allowing designers to iterate and test ideas quickly. This approach aligns with

user-centered design principles, where prototypes can be tested with real users to gather feedback and improve the design [35].

Participatory Design: Maker practices encourage active participation and collaboration among users, designers, and developers. Participatory design methods, directly involving the users in the design process, resonate with the collaborative ethos of the maker movement [36].

Tangible Interaction: Makers often use physical materials and technologies like sensors, actuators, and microcontrollers. This expertise can be valuable in designing tangible interfaces where physical objects interact with digital systems, offering unique and engaging user experiences.

Innovation and Creativity: Maker practices promote innovation and creativity by empowering individuals to experiment with technology. HCI researchers and designers can draw inspiration from the creative solutions and novel interfaces developed within the maker community [37].

Makers' craftsmanship in design emphasizes attention to detail, a deep understanding of materials and tools (both physical and digital), and a commitment to creating high-quality and user-centered products or interfaces [38]. Craftmanship plays a significant role when leading and capturing interactions with peer designers [39].

Incorporating maker practices into sustainable design processes offers several benefits. First, it fosters innovation by allowing users to experiment with eco-friendly materials and techniques that reduce environmental impact. Second, it empowers users to develop personalized solutions, which can lead to products that are more sustainable, meaningful, and longer-lasting [40]. Third, maker practices encourage collaboration among users, designers, and other stakeholders, creating a shared responsibility for sustainable outcomes.

Recent studies in HCI have shown that maker practices can lead to increased user engagement and a stronger sense of ownership over the design process, which supports sustainability [41]. By focusing on user-centered design within the maker framework, HCI researchers can promote sustainability in ways that are both practical and innovative, ensuring that the product aligns with users' environmental values.

4. The Studies

Craft-based research approaches in HCI have gained significant importance as an innovative methodology for exploring interactive system design. This research presents two distinct studies focused on affective design and HCI, conducted at a university in the United Kingdom.

The first study concentrated on affective design, where participants were tasked with creating affective artifacts using available materials, emphasizing emotional expressiveness in product design.

The second study comprised two workshops exploring future directions in HCI research. In the first workshop, participants visited two external locations, where they observed and experienced their surroundings, later using craft-based methods and rich pictures to represent potential future HCI research topics inspired by their journeys. The second workshop utilized the Chindogu approach, with participants employing available materials in the workspace to construct artifacts that represented their concerns and interests for future research investigations.

The participant selection process was deliberate, with network coordinators inviting experts whose varied expertise would enrich the collaborative exploration of human–computer interaction (HCI) challenges. Throughout the workshops, the researcher assumed an observational role, systematically collecting and analyzing data from participants' in-

teractions and creative outputs. These observational data were then examined to identify emerging patterns and insights that could inform future research directions in HCI.

In the first workshop's study, the facilitator presented a challenging prompt that encouraged participants to deeply consider emotional eloquence in product design, asking them to reflect on the following:

> "*What product senses (visual, auditory, [...]) environments do you think could benefit from being more emotionally eloquent? Which things are emotionally adequate now? If you think about the effective design of anything, what should it be? It might be something that you have experienced in your own life, or it might be something you saw other people experience*."

Participants were strategically divided into four teams of four to five individuals. Each team arranged around a table to facilitate knowledge sharing and collaborative creation through writing and drawing.

The first exercise, "The axes of control and excitement", challenged teams to analyze items from an Argos catalog (specifically kitchen appliances, telephones, or power tools), requiring them to plot these items along axes of control and excitement within a ten-minute timeframe (Figure 1).

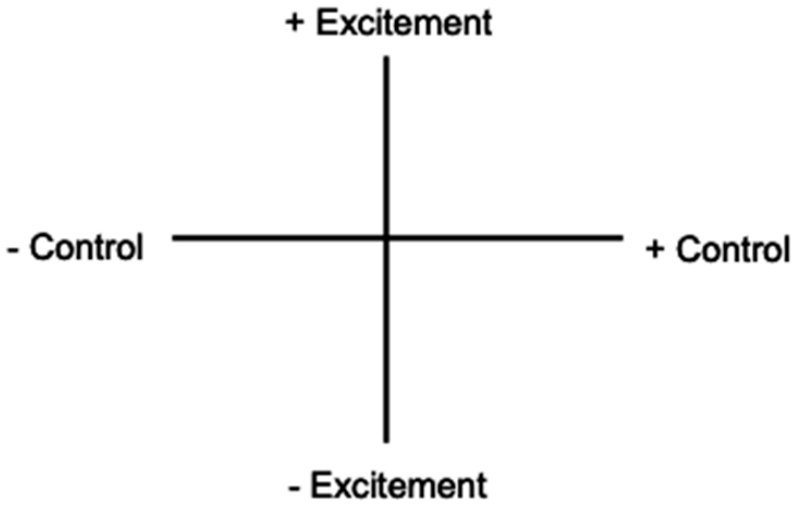


Figure 1. The axes of control and excitement.

The first workshop of the second study highlights how designers connect with the outside world to acquire ideas for future technology [42]. Workshop topics included communicating and being creative, how people interact with products, and the tools to assess impact. The main aim was to gather motivation from past visits, create drawings, and identify themes to guide future research [43].

Participants came from diverse backgrounds, including multimedia, the arts, literature, music, architecture, and engineering. They formed four groups of three, either by their connections or by their seating arrangements. The groups developed project ideas based on three factors from workshop organizers: a significant problem to research, a relevant issue to explore, and a technology or technologies to consider. Instead of creating a physical product, participants were encouraged to think and develop their design concepts [44].

Table 2 presents an excerpt of the three components that would be considered. The choice should be picking one technology, a context, or a problem/issue.

Table 2. Technologies, contexts, problems/issues.

Technologies	Contexts	Problems/Issues
Remote surveillance	Museum	Pets' management
Mobile phones	The beach	Energy consumption
Robots	Shopping center in the mountains	Social exclusion
Reality TV	7 years old dog mistreated by owner	
...		

Each group had fifteen minutes to express their ideas through drawing. The resulting artwork needed to convey a technological story, be related to human–computer interaction (HCI) and be interactive. Participants had to select a technology, a context, and a problem from a list and sketch their integration, which led to finding technological solutions. At the end of the workshop, the teams identified five research areas at the crossroads of HCI and the arts, generating questions about technology's future, including its benefits and how it will evolve.

Their analysis revealed several compelling areas for investigation that could significantly impact both fields.

The resulting discourse highlighted fundamental questions about technology's role in human experience. A primary concern emerged regarding the universal applicability of technological solutions: while technology often presents itself as inherently beneficial, participants questioned whether this assumption holds across all contexts and situations. This led to a deeper exploration of how we might critically evaluate and implement technological interventions in ways that truly serve human needs rather than simply advancing technology for its own sake.

The future of wireless technology emerged as another crucial area of inquiry, particularly in how it might evolve to support artistic expression and human interaction. Participants envisioned possibilities where wireless technologies could facilitate new forms of creative expression while maintaining meaningful human connection. This discussion was enriched by considering the role of physical tools and tactile experiences in achieving balance and harmony—a perspective that bridges traditional artistic practices with emerging technologies.

A significant insight emerged regarding the integration of historical and contemporary tools. Participants emphasized the importance of learning from ancient tools and techniques while developing modern solutions, suggesting that innovation need not discard historical wisdom. This perspective was particularly relevant when discussing museums as spaces of memory and connection, highlighting their potential role in bridging past and present through technological interventions.

The concept of spatial awareness and navigation also emerged as a crucial research area, particularly in how location-based technologies might enhance artistic experiences and cultural engagement. This raised questions about how we might design more intuitive and meaningful ways to navigate both physical and virtual spaces in artistic contexts.

In the second workshop of the second study, the organizers introduced Chindogu as a conceptual framework to inspire participants' creative problem-solving processes. This Japanese concept of "unuseless" inventions served as a provocative context that encouraged participants to think beyond conventional utility-driven solutions.

As digital technologies become increasingly integrated into contemporary art practices, a framework proved particularly relevant, allowing designers and artists to explore craft-based methods that challenge traditional approaches to user interaction. The Chindogu context liberated participants from purely practical constraints, enabling them to

develop interactive installations and solutions that questioned established notions of utility while maintaining meaningful technological engagement. This intentional framing by the workshop organizers created a unique space where craft-based methods could intersect with playful innovation, leading to more experimental and thought-provoking approaches to interactive design.

The Chindogu approach inspired designers to challenge conventional notions of practicality by pushing the boundaries of absurdity in design. The result was an interactive cake that resembled a familiar Microsoft Windows interface, an object not typically associated with food. This unexpected application invited users to engage with the cake through playfulness and curiosity, leading to discussions about the design's intent and prompting reflection on the interaction design itself.

A significant outcome of using Chindogu-inspired practices is the ability to evoke emotional responses in users. The absurdity of eating a Windows interface created a sense of surprise and delight, key components of user engagement that go beyond functional interaction. This aligns with previous studies highlighting how playful and absurd designs encourage deeper interaction by provoking curiosity and thought [45,46].

5. Research Methods and Methodologies

This section outlines the methodological framework adopted in this research, which aligns with the complex nature of investigating craft practices and technological integration in natural settings. Given the focus on understanding human experiences, creative processes, and design implications, a qualitative interpretative approach was selected as the most appropriate research paradigm [47].

Through craft-based probes and material engagement, this methodology enables a deep exploration of participants' narratives, emotions, and perceptions while interacting with crafted artifacts. The approach particularly emphasizes visual problem-solving and hands-on engagement, allowing for rich data collection that captures the nuanced relationships between makers, materials, and technological interventions in the design process.

5.1. Observation and Rich Pictures: Visual Tools for Understanding Complex Systems

The qualitative inquiry in these studies: Craft-based probes generated qualitative data, focusing on participants' narratives, emotions, and perceptions associated with the crafted artifacts. Qualitative analysis methods, such as thematic analysis, were employed to identify patterns and themes within participants' responses, providing in-depth insights into their experiences.

Qualitative, interpretive research was chosen to connect with designers in their environment, offer detailed verbal descriptions, emphasize communication as a selective process, incorporate the researcher's subjective evaluation, and focus on reflecting the reconstructed views of designers' experiences [47].

Observation: The observation process involved carefully watching participants collaborate in their teams and taking detailed notes on their interactions, communication patterns, and problem-solving strategies. The researcher moved among the teams, maintaining a neutral presence that allowed participants to engage naturally in their creative processes. She recorded verbal exchanges, documented physical interactions with design materials, and captured the nuanced ways teams approached their design challenges.

When necessary, the researcher would approach teams to seek clarification, asking targeted questions to help illuminate the reasoning behind their design choices without disrupting the creative flow. These strategic interactions were brief and aimed at deepening the understanding of the participants' thought processes and collaborative dynamics.

The documentation method was comprehensive, combining written observations, occasional video recordings, and visual documentation of the artifacts and diagrams created during the workshop. The researcher paid special attention to non-verbal communication and the ways teams interacted, distributed work, and navigated creative challenges.

The primary goal was to capture the authentic, unfiltered behavior of participants, recognizing that what individuals do is far more revealing than what they say they intend to do. By maintaining an extended presence in the research environment, the observer could capture the subtle nuances of collaborative design processes, the emergence of creative ideas, and the complex interactions within interdisciplinary teams.

This approach allowed for a rich, detailed exploration of the workshop's dynamics, providing insights that went beyond surface-level descriptions and capturing the intricate ways professionals from different backgrounds collaborate, communicate, and generate innovative design solutions.

Rich pictures: Rich pictures are graphical representations used in the early stages of systems design to help designers understand complex situations. They are called "rich" because they are detailed and encompass various aspects of a situation [22]. Rich pictures can include symbols, text, and images to represent different elements of a system or a situation, which was the case in these studies [21].

They were useful for capturing the perspectives of different designers and understanding their concerns, goals, and interactions within a particular context. Rich pictures facilitate communication among team members, helping them gain a shared understanding. They are detailed and encompass various aspects of a situation. Rich pictures employ a multifaceted visual approach, incorporating symbols, textual annotations, and diverse imagery to represent complex systems or complex situational dynamics comprehensively, a methodology exemplified in these research studies.

The introduction of rich pictures as a methodological tool complements the maker practices approach by providing a structured yet flexible way to visualize and understand complex system interactions. This combination of methodologies represents a powerful toolkit for modern HCI researchers and practitioners, enabling them to address both the technical and social aspects of design challenges while maintaining a strong focus on user needs and sustainability goals.

5.2. Craft-Based Methodologies in HCI: Material Engagement and Visual Problem-Solving

Craft-based approaches in HCI research have emerged as powerful tools for designing and developing interactive systems. Marshall et al. [32] demonstrated this through a study where participants created artifacts that represented their relationships with technology, using these tangible creations as catalysts for discussion. This methodology proved particularly effective when combined with rich pictures, as participants crafted physical artifacts that generated detailed qualitative data for future research applications.

The materiality of the process played a crucial role, with participants utilizing common tools like paper, scissors, glue, and various visual elements. This hands-on, DIY approach not only facilitated the creative process but also influenced the depth and nature of the data collected. The physical engagement with materials served as a bridge between conceptual thinking and tangible outcomes, offering designers valuable insights into how physicality can inform digital design development.

These studies revealed how everyday experiences and objects can inspire the design of interactive installations. By drawing parallels between familiar activities, such as baking or using household tools, and technological interactions, designers created more intuitive and naturally engaging user experiences. This approach emphasizes the importance

of understanding user context while promoting technology that enhances rather than complicates daily life.

The effectiveness of the methodology arises from its ability to combine data collection with analytical problem-solving. When given physical materials and time constraints, participants engaged in a process that demanded concrete decision-making while documenting their thoughts through the artifacts they created. This material-driven approach democratized participation by facilitating the visual expression of complex ideas and overcoming potential barriers in verbal or written communication.

The resulting artifacts served as comprehensive data sources, capturing both final solutions and the underlying decision-making processes through material choices and arrangements. This innovative methodology effectively combined ideation, problem-solving, and data generation, with each crafted piece revealing multiple layers of information about participants' conceptual approaches to their assigned challenges.

6. Results and Discussion

The workshops were designed with a comprehensive approach to problem-solving, where participants engaged in a thorough analysis of their specific contexts. Teams began by carefully examining their situations, working systematically to identify and define concrete challenges within their unique circumstances. This initial phase required careful consideration of existing constraints and limitations, ensuring that the problem definition was precise and actionable.

Following the problem analysis, teams entered the technology selection phase, where they evaluated various technological solutions based on their specific contextual requirements. This process was deeply influenced by each team's unique perspective on problem resolution while remaining grounded in practical constraints and possibilities. Teams worked within a creative framework to develop responses that were both innovative and feasible within their given situations.

By focusing on user-centered design within the maker framework, HCI researchers can promote sustainability in ways that are both practical and innovative, ensuring that the product aligns with users' environmental values.

The results show the leading and apprehension of interactions with peers' designers, and participants, in an environment of craftsmanship.

Inspiration and Leadership: Designers who demonstrate exceptional craftsmanship inspire their peers. By creating innovative and well-crafted designs, they set high standards for the quality of work.

Knowledge Sharing: Craftsmanship involves a profound understanding of design principles, user behavior, and technology. Designers with strong craftsmanship became natural leaders in knowledge sharing. They mentored and guided their peers, sharing their expertise and insights, which fosters a collaborative and supportive design environment.

Critique and Feedback: Craftsmanship allowed designers to articulate their design decisions effectively. When giving feedback to peers, they provided specific, constructive, and actionable criticism. This kind of feedback was important for the designers, as it helped them understand not only what needed improvement but also why and how to improve it.

Attention to User Needs: Craftsmanship in design often translates to a deep empathy for users. Designers prioritized craftsmanship to create products that truly meet users' needs. When discussing designs with peers, they focused on user-centered approaches influencing the entire team, ensuring that all interactions were grounded in empathy for the end-users.

Creating a Positive Work Environment: Craftsmanship fostered a culture of respect and appreciation for the work of peers. Designers acknowledged and celebrated the skills

and efforts of their colleagues, creating a positive work environment. Such an atmosphere encouraged collaboration, open communication, and mutual respect among team members.

In summary, craftsmanship in design not only improves the quality of work but also plays a crucial role in shaping interactions among peer designers. It inspired, guided, and nurtured a culture of creativity, collaboration, and continuous learning within the design community.

6.1. Crafting Innovation: Rich Pictures and Chindogu in Sustainable HCI Design

Chindogu, the Japanese art of creating "unuseless" inventions, was implemented as a methodological tool in workshops combining playful interaction and sustainable design. Research [43] shows that such playful frameworks enhance user experiences through humor and surprise, with additional studies [24,42] demonstrating their effectiveness in creating user-centered solutions.

A workshop output was an "electrostatic meditation device" made from household materials (kitchen foil, carpet pieces, and CD cases), exemplifying Chindogu's ingenious yet impractical design philosophy. Through its creation, participants engaged deeply with materials and physical principles.

The value of Chindogu in HCI stems from three main factors: Freedom from practical constraints, enabling unconventional solution exploration; integration of playfulness, leading to engaging user experiences; and creative reuse of everyday materials, promoting sustainability. The methodology bridges design thinking and doing, helping identify hidden assumptions about user needs and technological solutions.

The workshop results showed how this seemingly impractical approach can generate meaningful insights for HCI design while maintaining a focus on sustainability and user engagement.

6.2. A Piece of Interactive Art: Example of Design Creativity

This section presents the results obtained from the investigation into maker practices, the creation of an ephemeral cake as an interactive art piece, and the implications for sustainability in human–computer interaction (HCI). The research focuses on how engaging with absurdity in design and creativity [24], hands-on making, and temporary artifacts can foster innovation in interaction design, particularly within everyday life contexts.

The journey from creating watercolor designs on A3 paper to transforming those designs into an interactive application like the Microsoft Windows environment serves as a case study in creative innovation. This process was driven by a series of motivational elements that pushed the project beyond conventional expectations, leading to something unexpected: a cake that visually mirrored the digital interface of Windows.

The familiar digital visuals combined with comestible things, this approach surprised conference delegates and provided a memorable, interactive experience that explored the relationship between art, design, and user engagement. Like a Mondrian picture, the composition consisted of squares and rectangles made from different lines (the image on the left was made with cardboard). Glue and card were used in this prototype. Icing sugar and cream were used on the cake.

Although the materials are very different, the texture was almost the same, paper/card as opposed to icing sugar on top, creating a very smooth and sweet piece of art.

The final artistic installation was presented in a conference exhibition, as well as the several design process phases in which the cake was an element.

By recontextualizing the watercolor designs into something as unexpected as a cake, the design team aimed to provoke surprise and curiosity among the audience. In design,

recontextualization is a common motivational strategy for rethinking how familiar visuals can take on new meanings when placed in unfamiliar settings [32].

A cake embodied the concepts considered in the design process: Using color, shape, and purpose, designers communicated with users. There was a sense of relationship among the designers and a sense of collaboration. Team members' creativity resulted in the cake. Finally, it encompassed the culture of giving, the tradition, and the value placed on something in a particular period. In the second phase of the artwork, the images in squares based on Microsoft and the cake represented elements linked to the sea, as expected.

6.3. Workshop Outputs and Analysis

The workshops generated rich qualitative data through participants' visual representations, capturing analytical thinking and proposed solutions. These outputs worked as artifacts for understanding how participants conceptualized the relationships among technology, social factors, and business considerations.

Participants created visual mappings that highlighted key technological themes, particularly the connections between machine learning, user interaction, and innovation. Their representations demonstrated an understanding of the interconnections among different technological elements and their potential applications.

The outputs revealed patterns in how participants perceived the social dimensions of technology, emphasizing behavioral aspects and organizational structures. Technical considerations, such as AI capabilities and virtual environments, were represented as foundational elements. Business factors like productivity enhancement and cost reduction appeared as supporting elements, suggesting that participants viewed them as significant but secondary to technological and social aspects. In particular, participants consistently portrayed technology as deeply intertwined with human needs, behaviors, and social structures rather than as an isolated element. This holistic perspective emerged across different teams and problem contexts.

Terms related to creativity, mutual learning, and cultural context appeared in the outputs, highlighting human-centered design in technological innovation. The varying emphasis on concepts created a comprehensive visual representation of how these elements interact, aiding in the understanding of the complex relationships between technological development and societal impact.

6.4. Bridging Art, Technology, and Sustainability: Emerging Practices in HCI Design

The integrated approach of visual thinking tools with hands-on maker practices showcases the potential to advance sustainable HCI design. When developed through structured yet adaptable methodologies, playful concepts can lead to meaningful innovations that prioritize user experience and environmental responsibility.

Rich pictures facilitated the design process, transitioning from watercolor sketches to an interactive edible art piece by visualizing relationships among objects, users, and the environment. This method assisted teams in moving from traditional designs to abstract concepts.

Maker practices using various materials (paper, card, icing) provided a tangible connection between the prototype and the final product, emphasizing material engagement and sustainability. Combining rich pictures and maker practices promotes iterative prototyping while reducing reliance on high-tech solutions. This aligns with de Blevis's sustainable interaction design theory [7], which stresses long-term human values and waste reduction.

6.5. Rich Pictures and Craft Design: A Methodological Guide for HCI Research

HCI researchers seeking to incorporate rich pictures and craft design methodologies into their investigations should adopt a structured yet flexible approach. Building upon

established frameworks in participatory design, researchers should begin by providing participants with diverse physical materials (such as paper, images, and craft supplies) and clear time constraints for creative exploration.

Rich pictures serve as an effective visual thinking tool that allows participants to map complex relationships and ideas, while craft-based activities enable hands-on engagement with concepts and solutions. To maximize the effectiveness of these methods, researchers should document both the creation process and final artifacts, paying particular attention to participants' decision-making processes and material choices. When analyzing the resulting data, researchers should consider both the tangible outputs and the underlying thought processes they represent, as demonstrated by successful implementations of these methodologies in sustainable design and technological innovation studies. This combined approach not only generates rich qualitative data but also empowers participants to express complex ideas through visual and tactile means, potentially revealing insights that might not emerge through traditional research methods.

6.6. Outcomes, Implications, and Future Directions

Future research directions offer opportunities at the intersection of HCI, the arts, and cultural heritage. Key areas include developing frameworks to evaluate how technology can meaningfully enhance artistic practices.

The combination of rich pictures and maker practices promotes iterative prototyping and flexibility, reducing the reliance on high-tech solutions and aligning with sustainable interaction design principles.

Crafting connects traditional techniques with digital innovation, resulting in meaningful interactive installations that blend sustainability and creativity.

Rich pictures facilitate the mapping of complex relationships, while hands-on crafting allows for practical engagement with concepts and solutions.

Interdisciplinary teams using maker-oriented techniques generate more creative and contextually responsive technological solutions.

Hands-on design methods bridge theoretical concepts with practical implementation.

Craft-based probes act as platforms for conceptual development, emphasizing materiality and leading to design improvements.

6.6.1. Practical Consequences

This research provides a replicable model for investigating human–computer interactions.

The methodology helps understand complex user interactions, generate innovative solutions through collaboration, and develop contextually aware technological artifacts.

Hands-on design with physical materials enables the visual expression of complex ideas, overcoming communication barriers.

Everyday experiences and objects inspire the design of intuitive and engaging interactive installations.

The approach combines data collection with analytical problem-solving, leading to a more democratic and collaborative design.

Craftsmanship inspires and guides peer designers, fostering creativity, collaboration, and continuous learning.

6.6.2. Prospective Consequences and Research Directions

Future HCI research should integrate craft-based approaches, emphasizing low-impact, temporary installations that promote sustainability and user engagement.

The integration of wireless technologies with traditional artistic methods can connect historical and contemporary techniques while maintaining tactile engagement.

Museums offer opportunities to create technologies that establish personal connections between visitors and artifacts through memory and emotional resonance.

Innovative spatial navigation approaches can enhance how individuals experience creative environments.

The combination of creative frameworks with physical and digital materials deepens the understanding of meaningful technological interactions, establishing more holistic strategies for interactive system design.

6.6.3. Methodological Constraints

The research used a qualitative interpretive approach, emphasizing detailed verbal descriptions and the researcher's subjective evaluation. Observation was key, with the researcher noting interactions, communication patterns, and problem-solving strategies.

Rich pictures captured designers' perspectives and interactions within a specific context. A material-based making methodology facilitated the creative process and deepened the data quality.

The study emphasized visual problem-solving and hands-on engagement, allowing rich data collection. Documentation of the creation process and final artifacts provided insights into participants' decision-making.

6.6.4. Future Research and Implications

Future research can focus on developing frameworks to evaluate how technology meaningfully enhances artistic practices. Integrating wireless technologies with traditional artistic methods can bridge historical techniques with contemporary capabilities, preserving tactile engagement in the creative process. In museums, technologies can be created to establish personal connections between visitors and artifacts through memory and emotion. Innovative approaches to spatial navigation could enhance the experience of creative environments.

These directions emphasize the need for technology integration that enhances, rather than diminishes, human artistic expression and cultural engagement.

By acknowledging methodological constraints and exploring future research directions, this study contributes to the transparency and reliability of craft-based approaches in HCI, offering a foundation for further exploration and innovation in the field.

7. Conclusions

As human–computer interaction (HCI) continues to evolve, this research has demonstrated several key findings through the integration of rich pictures, maker practices, and Chindogu-inspired methods in sustainable design:

Combining rich pictures with maker practices encourages iterative prototyping and flexibility, reducing reliance on high-tech solutions while aligning with de Blevis's theory of sustainable interaction design [7]. This approach effectively balances long-term human values with minimal environmental impact.

Rich pictures were visual thinking tools that enabled participants to map complex relationships, while craft-based activities facilitated hands-on engagement with concepts and solutions. The documentation of both creation processes and final artifacts revealed valuable insights into participants' decision-making and material choices.

The case studies highlighted how crafting bridges traditional techniques with digital innovation, creating meaningful interactive installations that combine sustainability with creativity. This was particularly evident in the TIDE case study and cake example, which demonstrated strong emotional and intellectual connections with users.

The research established that interdisciplinary teams using maker-oriented techniques generate more creative and contextually responsive technological solutions [10], while hands-on design methodologies effectively bridge theoretical conceptualization with practical implementation [31].

The study provides a structured yet flexible methodological framework for interdisciplinary design exploration, offering a replicable model for investigating human-technology interactions [48]. This framework particularly benefits researchers seeking to understand complex user interactions, generate innovative solutions through collaboration, and develop contextually aware technological artifacts.

These findings suggest that future HCI research should continue integrating craft-based approaches, focusing on low-impact, temporary installations that promote sustainability while engaging users effectively.

The combination of creative frameworks with physical and digital materials deepens our understanding of meaningful technological interactions, establishing more holistic strategies for interactive system design.

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